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SAMPLING ANS ANALYSIS PLAN FOR SOIL CONTAMINATION DELINEATION FOR CORRECTIVE MEASURES DESIGN AT OLD JEEP TRAIL TREATMENT AREA OF SOLID WASTE MANAGEMENT UNIT 3 (SMWU 3) AMMUNITION BURNING GROUNDS/OLD JEEP TRAIL NSA CRANE IN

11/1/2011

TETRA TECH

15

# Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan)

# Soil Contamination Delineation for Corrective Measures Design at the Old Jeep Trail Treatment Area of SWMU 3 - Ammunition Burning Grounds/Old Jeep Trail

## Naval Support Activity Crane
## Crane, Indiana

Naval Facilities Engineering Command
Midwest

Contract Number N62470-08-D-1001
Contract Task Order F274

November 2011

## Title and Approval Page

(UFP-QAPP Manual Section 2.1)

**FINAL**
**SAMPLING AND ANALYSIS PLAN**
**(Field Sampling Plan and Quality Assurance Project Plan)**
**November 2011**

# SOIL CONTAMINATION DELINEATION FOR CORRECTIVE MEASURES DESIGN AT THE OLD JEEP TRAIL TREATMENT AREA OF SWMU 3 – AMMUNITION BURNING GROUNDS/OLD JEEP TRAIL NAVAL SUPPORT ACTIVITY CRANE CRANE, INDIANA

**Prepared for:**
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**Prepared under:**
Comprehensive Long-term Environmental Action Navy
Contract No. N62470-08-D-1001
Contract Task Order F274

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## Title and Approval Page

(UFP-QAPP Manual Section 2.1)

**DRAFT FINAL**

# SAMPLING AND ANALYSIS PLAN
## (Field Sampling Plan and Quality Assurance Project Plan)
## May 2011

# SOIL CONTAMINATION DELINEATION FOR CORRECTIVE MEASURES DESIGN AT THE OLD JEEP TRAIL TREATMENT AREA OF SWMU 3 – AMMUNITION BURNING GROUNDS/OLD JEEP TRAIL NAVAL SUPPORT ACTIVITY CRANE CRANE, INDIANA

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NAVFAC QA Review

# EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (Tetra Tech) has prepared this Sampling and Analysis Plan (SAP) that encompasses Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) requirements for an investigation to provide data necessary to refine estimates of contaminated soil for a remedial design at Solid Waste Management Unit (SWMU) 3 – Ammunition Burning Grounds/Old Jeep Trail (OJT) at Naval Support Activity (NSA) Crane, located in Crane, Indiana under Contract Task Order (CTO) F274, Contract N62472-08-D-1001, Comprehensive Long-Term Environmental Action Navy (CLEAN).

The SAP contained herein was generated for and complies with applicable United States (U.S.) Department of the Navy (Navy), U. S. Environmental Protection Agency (USEPA) Region 5, and Indiana Department of Environmental Management (IDEM) requirements, regulations, guidance, and technical standards.

This SAP outlines the organization, project management, objectives, planned activities, measurement, data acquisition, assessment, oversight, and data review procedures associated with the planned investigations at the OJT portion of SWMU 3. Protocols for sample collection, handling and storage, chain-of-custody, laboratory and field analyses, data validation, and reporting are also addressed in this SAP.

The OJT portion of SWMU 3 is located in the eastern portion of NSA Crane along Little Sulphur Creek (LSC) (Figure 4-2). Within the OJT is the OJT Treatment Area where five hot spots of contamination were identified. These hot spots are the focus of this SAP. The hot spots (03SB018, 03SB019, 03SB022, 03SB024, and 03SB048) are contaminated with one or more constituents, consisting of the lead, 2,4,6-trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), which present unacceptable levels of risk to human receptors, as described in the Resource Conservation and Recovery Act (RCRA) Facilities Investigation (RFI) Report (Figure 4-4) (Tetra Tech, 2005).

The investigation strategy for SWMU 3 is to implement soil contamination delineation sampling (lead, RDX and TNT) for an Interim Measure Work Plan (IMWP) phase of the project at five discrete "hot spot" areas in order to provide soil excavation design data. The IMWP will include the volume of soil required for excavation in order to achieve the Media Cleanup Standard (MCS), which is based on the horizontal and vertical extent of soil contamination. Based on this approach, no confirmation sampling will be required after excavation.

Investigation procedures will comply with the site-specific field Standard Operating Procedures (SOPs), included in Appendix A. The field work and sampling are scheduled to begin in June 2011.

The field activities under this SAP will be conducted in accordance with the site-specific Health and Safety Plan (HASP) to be prepared for these activities.

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| °C | Degrees Celsius |
| %R | Percent Recovery |
| ABG | Ammunition Burning Ground |
| bgs | Below Ground Surface |
| CA | Corrective Action |
| CAS | Chemical Abstracts Service |
| CFR | Code of Federal Regulations |
| CLEAN | Comprehensive Long-term Environmental Action Navy |
| CLP | Contract Laboratory Program |
| CMS | Corrective Measures Study |
| CMIP | Corrective Measures Implementation Plan |
| CMP | Corrective Measures Proposal |
| COC | Chemical of Concern |
| CSM | Conceptual Site Model |
| CTO | Contract Task Order |
| DL | Detection Limit |
| DoD | Department of Defense |
| DOE | Department of Energy |
| DPT | Direct-Push Technology |
| DQI | Data Quality Indicator |
| DQO | Data Quality Objective |
| DVM | Data Validation Manager |
| EDD | Electronic Data Deliverable |
| ELAP | Environmental Laboratory Approval Program |
| Empirical | Empirical Laboratories, LLC |
| ERSM | Environmental Restoration Site Manager |
| FBL | Fixed Base Laboratory |
| FOL | Field Operations Leader |
| FSP | Field Sampling Plan |
| FTMR | Field Task Modification Request |
| GPS | Global Positioning System |
| HASP | Health and Safety Plan |
| HAZWOPER | Hazardous Waste Operations and Emergency Response |
| HPLC | High Pressure Liquid Chromatography |
| HSM | Health and Safety Manager |

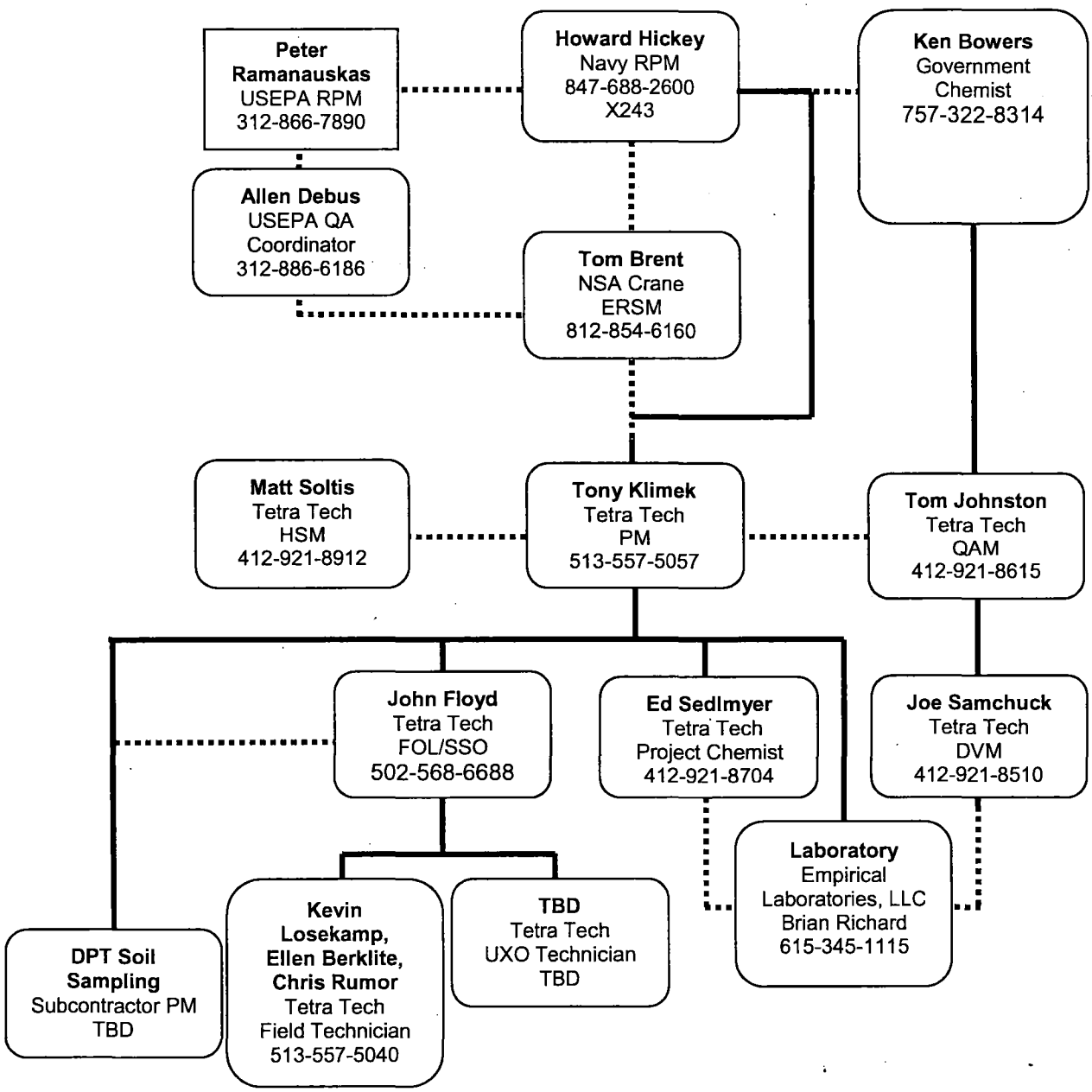
| | |
|---|---|
| ICP-AES | Inductively Coupled Plasma - Atomic Emission Spectrometry |
| ICV | Initial Calibration Verification |
| IDEM | Indiana Department of Environmental Management |
| IDQTF | Intergovernmental Data Quality Task Force |
| IDW | Investigation-Derived Waste |
| IM | Interim Measures |
| IMWP | Interim Measures Work Plan |
| IUPPS | Indiana Underground Plant Protection Services |
| LCS | Laboratory Control Sample |
| LCSD | Laboratory Control Sample Duplicate |
| LOD | Limit of Detection |
| LOQ | Limit of Quantitation |
| LSC | Little Sulphur Creek |
| LUC | Land Use Control |
| MCS | Media Cleanup Standard |
| mg/kg | Milligram per Kilogram |
| MPC | Measurement Performance Criterion |
| MS | Matrix Spike |
| MSD | Matrix Spike Duplicate |
| MTA | Main Treatment Area |
| NA | Not Applicable |
| NAVFAC | Naval Facilities Engineering Command |
| Navy | U. S. Department of the Navy |
| NEDD | NIRIS Electronic Data Deliverable |
| NFA | No Further Action |
| NIRIS | Naval Installation Restoration Information Solutions |
| NSA | Naval Support Activity |
| OJT | Old Jeep Trail |
| OSHA | Occupational Safety and Health Administration |
| oz | Ounce |
| PAL | Project Action Limit |
| PDF | Portable Document Format |
| PID | Photoionization Detector |
| PM | Project Manager |
| PPE | Personal Protective Equipment |
| PQL | Project Quantitation Limit |
| QA | Quality Assurance |

| | |
|---|---|
| QAM | Quality Assurance Manager |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| QSM | Quality Systems Manual |
| RCRA | Resource Conservation and Recovery Act |
| RDX | Octahydro-1,3,5,7-tetranitro-1,3,5-triazine / Royal Demolition Explosive |
| RFI | Resource Conservation and Recovery Act Facility Investigation |
| RPD | Relative Percent Difference |
| RPM | Remedial Project Manager |
| R-RSL | Residential Regional Screening Level |
| RT | Retention Time |
| SAP | Sampling and Analysis Plan |
| SOP | Standard Operating Procedure |
| SSL | Soil Screening Level |
| SSO | Site Safety Officer |
| SWMU | Solid Waste Management Unit |
| TBD | To Be Determined |
| TCE | trichloroethene |
| Tetra Tech | Tetra Tech NUS, Inc. |
| TNT | 2,4,6-Trinitrotoluene |
| UFP | Uniform Federal Policy |
| U.S. | United States |
| USEPA | United States Environmental Protection Agency |
| VIM | Voluntary Interim Measure |
| WP | Work Plan |
| XRF | x-ray fluorescence |

# Worksheet No.1 - Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1 – Worksheet #5)

Lines of Authority ——— ..... Lines of Communication




DVM - Data Validation Manager
ERSM - Environmental Restoration Site Manager
FOL - Field Operation Leader
HSM - Health and Safety Manager
PM - Project Manager
UXO – Unexploded Ordnance
QAM - Quality Assurance Manager
RPM - Remedial Project Manager
TBD - To Be Determined
USEPA - United States Environmental Protection Agency

## Worksheet No. 2 - Communication Pathways

(UFP-QAPP Manual Section 2.4.2 – Worksheet #6)

The communication pathways for the SAP are shown below.

| Communication Drivers | Responsible Entity | Name | Phone Number | Procedure (Timing, Pathway, To/From, etc.) |
|---|---|---|---|---|
| Regulatory Agency Interface | USEPA RPM<br>Navy RPM | Peter Ramanauskas<br>Howard Hickey | 312-866-7890<br>847-688-2600 x243 | The Navy RPM will contact the regulatory agency via phone and/or e-mail within 24 hours of recognizing the issue whenever issues arise. |
| Gaining Site Access | Tetra Tech FOL<br>NSA Crane ERSM | John Floyd<br>Tom Brent | 502-568-6688812-<br>854-6160 | The Tetra Tech FOL shall contact the NSA Crane ESRM verbally or via e-mail at least three days prior to commencement of field work to arrange for access to the site for all field personnel. |
| Obtaining Utility Clearances | Tetra Tech FOL | John Floyd | 502-568-6688 | The Tetra Tech FOL shall contact the Indiana Underground Plant Protection Services (IUPPS) verbally or via e-mail at least 3 days prior to commencement of field work to complete a utility clearance ticket for the areas under investigation. |
| Field Progress Reports | Tetra Tech FOL | John Floyd | 502-568-6688 | The Tetra Tech FOL will contact the Tetra Tech PM on a daily basis via phone, and every 1-2 days summarizing progress via e-mail. |

| Communication Drivers | Responsible Entity | Name | Phone Number | Procedure (Timing, Pathway, To/From, etc.) |
|---|---|---|---|---|
| Stop Work due to Safety Issues | Tetra Tech FOL/SSO<br>Tetra Tech PM<br>Tetra Tech HSM<br>Navy RPM<br>NSA Crane ERSM | John Floyd<br>Anthony Klimek<br>Matt Soltis<br>Howard Hickey<br>Tom Brent | 502-568-6688 513-557-5057<br>412-921-8912<br>847-688-2600 x243<br>812-854-6160 | If Tetra Tech is the responsible party for a stop work command, the Tetra Tech FOL will inform onsite personnel, subcontractor(s), the NSA Crane ERSM, and the identified Project Team members within 1 hour (verbally or by e-mail).<br>If a subcontractor is the responsible party, the Subcontractor PM must inform the Tetra Tech FOL within 15 minutes, and the Tetra Tech FOL will then follow the procedure listed above. |
| SAP Changes Prior to Field/Laboratory Work | Tetra Tech FOL/SSO<br>Tetra Tech PM<br>Navy RPM | John Floyd<br>Anthony Klimek<br>Howard Hickey | 502-568-6688 513-557-5057<br>847-688-2600 x243 | The Tetra Tech FOL will verbally inform the Tetra Tech PM within 24 hours of realizing a need for an amendment.<br>The Tetra Tech PM will document the proposed changes via a Field Task Modification Request (FTMR) form within 5 days and send the Navy RPM a concurrence letter within 7 days of identifying the need for change.<br>SAP changes will be submitted by the Tetra Tech PM to the Navy RPM for review and approval.<br>The Tetra Tech PM will send scope changes to the Project Team via e-mail within 1 business day. |

| Communication Drivers | Responsible Entity | Name | Phone Number | Procedure (Timing, Pathway, To/From, etc.) |
|---|---|---|---|---|
| SAP/WP Changes in the Field | Tetra Tech FOL/SSO<br>Tetra Tech PM<br>Navy RPM<br>NSA Crane ERSM | John Floyd<br>Anthony Klimek<br>Howard Hickey<br>Tom Brent | 502-568-6688 513-557-5057<br>847-688-2600 x243<br>812-854-6160 | The Tetra Tech FOL will verbally inform the Tetra Tech PM on the day that the issue is discovered.<br>The Tetra Tech PM will inform the Navy RPM and the NSA Crane ERSM (verbally or via e-mail) within 1 business day of discovery.<br><br>The Navy RPM will issue a scope change (verbally or via e-mail), if warranted. The scope change is to be implemented before further work is executed.<br><br>The Tetra Tech PM will document the change via an FTMR form within 2 days of identifying the need for change and will obtain required approvals within 5 days of initiating the form. |
| Field Corrective Actions | Tetra Tech PM<br>Tetra Tech QAM<br>Navy RPM | Anthony Klimek<br>Tom Johnston<br>Howard Hickey | 513-557-5057<br>412-921-8615<br>847-668-2600 x243 | The Tetra Tech QAM will notify the Tetra Tech PM verbally or by e-mail within one business day that the corrective action has been completed.<br>The Tetra Tech PM will then notify the Navy RPM (verbally or by e-mail) within 1 business day. |

| Communication Drivers | Responsible Entity | Name | Phone Number | Procedure (Timing, Pathway, To/From, etc.) |
|---|---|---|---|---|
| Analytical Corrective Actions | Empirical PM<br>Tetra Tech Project Chemist<br>Tetra Tech DVM<br>Tetra Tech PM<br>Navy RPM | Brian Richard<br>Ed Sedlmyer<br><br>Joseph Samchuck<br>Anthony Klimek<br>Howard Hickey | 615-345-1115<br>412-921-8704<br><br>412-921-8510<br>513-557-5057<br>847-688-2600 x243 | The Empirical Laboratory PM will notify (verbally or via e-mail) the Tetra Tech Project Chemist within one business day of when an issue related to laboratory data is discovered.<br><br>The Tetra Tech Project Chemist will notify (verbally or via e-mail) the DVM and the Tetra Tech PM within 1 business day.<br><br>Tetra Tech DVM or Project Chemist notifies Tetra Tech PM verbally or via e-mail within 48 hrs of validation completion that a non-routine and significant laboratory quality deficiency has been detected that could affect this project and/or other projects.<br>The Tetra Tech PM verbally advises the Navy RPM within 24 hours of notification from the Tetra Tech Project Chemist or DVM. The Navy RPM takes corrective action that is appropriate for the identified deficiency. Examples of significant laboratory deficiencies include data reported that has a corresponding failed tune or initial calibration verification. Corrective actions may include a consult with the Navy Chemist. |

## Worksheet No. 3 - Project Scoping Session Participants Sheet

(UFP-QAPP Manual Section 2.5.1 – Worksheet #9)

| | |
|---|---|
| **Project Name:** Sampling for Corrective Measures Implementation Plan<br><br>**Projected Date(s) of Sampling:** Spring 2011<br><br>**Project Manager:** Anthony Klimek | **Site Name:** SWMU 3 – Ammunition Burning Grounds (ABG)/Old Jeep Trail (OJT)<br><br>**Site Location:** Crane, Indiana |

**Date of Session:** April 20, 2011
**Scoping Session Purpose: Data Quality Objective** (DQO) Scoping Meeting

| Name | Title | Affiliation | Phone # | E-Mail Address | Project Role |
|---|---|---|---|---|---|
| Tom Johnston | QAM | Tetra Tech | 412-921-8615 | tom.johnston@tetratech.com | Quality Assurance (QA) Management |
| Ralph Basinski | Crane Activity Coordinator | Tetra Tech | 412-921-8308 | ralph.basinski@tetratech.com | Management /Oversight |
| Valerie Plachy[1] | Senior Engineer | Tetra Tech | 412-921-8389 | valerie.plachy@tetratech.com | Technical Support |
| Chris Rumer | Project Scientist | Tetra Tech | 412-921-7105 | chris.rumer@tetratech.com | Technical Support |

1 Valerie Plachy is not currently employed by Tetra Tech

**Comments/Decisions:** The planners identified project objectives and how best to achieve them in a single sampling event to support prescriptive remediation. X-ray fluorescence (XRF) field screening was concluded to be useful for field delineation of lead contamination with Fixed Base Laboratory (FBL) confirmation analysis at boundary between contaminated and uncontaminated soil. The planners concluded that laboratory analysis will be less expensive for octahydro-1,3,5,7-tetranitro-1,3,5-triazine (RDX) and 2,4,6-trinitrotoluene (TNT) than field analysis, and a reliable correlation between field analytical data and FBL data for these analytes has not been demonstrated.

Delineation of RDX and TNT contamination where lead concentrations are greater than media cleanup standards (MCSs) would not be cost-effective because soil contaminated with lead must be excavated, regardless of TNT and RDX concentrations. The planners concluded that a field screening limit of 200 milligrams per kilogram (mg/kg) would be used because previous XRF experience by Tetra Tech at NSA Crane with lead contaminated soil has shown that a lead XRF concentration less than 200 mg/kg has a high probability of yielding a laboratory lead concentration less than the 400 mg/kg, the MCS for lead.

Because the spatial contaminant concentration distribution cannot be determined based on existing data, it is impossible to predict sample locations that would achieve the project objectives. Nevertheless, the soil volume as a function of the contaminated area was explored based on simple linear assumptions. The planners agreed that refining the contamination boundary to within 5 feet should be sufficient to support a reasonable cost of excavation.

**Action Items:** Dr. Johnston, Mr. Rumer, and Ms. Plachy will compile draft DQO-related Tier II Sampling and Analysis Plan (SAP) format Uniform Federal Policy (UFP) SAP worksheets. These worksheets will include the field screening and step-out strategy for determining the contamination boundary around each of the five hot spots.

**Consensus Decisions:**

NAVFAC, NSA Crane, and USEPA had already agreed on the MCSs to use for this project. These MCSs will be incorporated into this SAP.

Equipment rinsate blanks are not needed because the Navy accepts the liability of including an accidentally contaminated sample, such that its concentration will appear to exceed an MCS when it truly does not exceed the MCS.

| | |
|---|---|
| **Project Name**: Sampling for Corrective Measures Implementation Plan<br><br>**Projected Date(s) of Sampling**: Spring 2011<br><br>**Project Manager**: Anthony Klimek | **Site Name**: SWMU 3 – Ammunition Burning Grounds (ABG)/Old Jeep Trail (OJT)<br><br>**Site Location**: Crane, Indiana |

**Date of Session:** March 9, 2011
**Scoping Session Purpose: Data Quality Objective** (DQO) Scoping Meeting

| Name | Title | Affiliation | Phone # | E-Mail Address | Project Role |
|---|---|---|---|---|---|
| Peter Ramanauskas | USEPA RPM | USEPA | 312-866-7890 | Ramanauskas.Peter@epamail.epa.gov | Regulatory Manager |
| Ralph Basinski | Crane Activity Coordinator | Tetra Tech | 412-921-8308 | ralph.basinski@tetratech.com | Management /Oversight |
| Tom Brent | U.S. Navy ERSM | NSA Crane | 812-854-6160 | thomas.brent@navy.mil | Navy ERSM |
| Valerie Plachy[1] | Senior Engineer | Tetra Tech | 412-921-8389 | valerie.plachy@tetratech.com | Technical Support |
| Joe Logan | Project Engineer | Tetra Tech | 412-921-7231 | joe.logan@tetratech.com | Technical Support |

1 Valerie Plachy is not currently employed by Tetra Tech

**Comments/Decisions:**

- OJT RDX and metals (lead) contamination was discussed. In general, these contaminants are co-located and removal of the lead contaminated soil and one RDX contaminated location will result in "no further action" (NFA) for the OJT.

- Navy will conduct voluntary interim measure (VIM)

- Because the OJT VIM for lead will not be completed before submittal of the Corrective Measures Proposal (CMP), the CMP will include alternative for metals in soil at the OJT as follows:

  - No Action
  - Excavation, Stabilization, and off-site disposal

- A groundwater discussion for the OJT will be added that is similar to the discussion for the Main Treatment Area groundwater.

- An Interim Measures Work Plan (IMWP) is being developed for OJT soil remediation.

- Additional delineation will be conducted so that the Interim Measure (IM) can be a prescriptive removal and confirmation sampling will not be part of the IMWP. The additional delineation will be for only the soil contaminants of concern (lead, RDX, and, potentially, HMX). (Note for Tetra Tech: Ralph Basinski to develop a concurrence letter for OJT lead and RDX delineation study including the UFP-SAP)

- The lead, RDX, and, potentially, HMX soil removal will result in an NFA for soils at the OJT.

- EPA stated development of an OJT groundwater CMIP for the Land Use Control (LUC) and Long Term Monitoring (LTM) that incorporates the VIM by reference is required.

- EPA pointed out that the groundwater CMIP needs to incorporate all Indiana Department of Environmental Management (IDEM) requirements for LTM.

**Action Items/ Consensus Decisions:**

Tetra Tech will prepare a SAP to delineate the hot spot to the extent necessary to allow for prescriptive remediation without confirmation sampling.

Note: The Resource Conservation and Recovery Act (RCRA) Facilities Investigation (RFI) Report (Tetra Tech, 2005) was reviewed after the meeting, and it was determined that HMX was not identified as a chemical of concern.

# Worksheet No. 4 - Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2 – Worksheet #10)

This section provides background information for Solid Waste Management Unit (SWMU 3) – Ammunition Burning Grounds (ABG) / Old Jeep Trail (OJT), which consists of the Main Treatment Area (MTA) and the OJT. This SAP includes descriptions of the site and previous investigations that were the basis for a conceptual site model (CSM) developed to support this SAP. This SAP governs the investigation at the treatment portion of the OJT Treatment Area in support of a remedial action to remove discrete, localized areas of contamination.

## 4.1 SITE DESCRIPTION

NSA Crane is located in a rural, sparsely populated region of south-central Indiana, approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky, immediately east of Crane Village and Burns City (Figure 4-1). NSA Crane encompasses 62,463 acres (approximately 98 square miles), most of which is located in the northern portion of Martin County. Smaller portions are located in Greene, Daviess, and Lawrence Counties. Most of NSA Crane is forested, and the surrounding area is wooded or farmed land.

The OJT portion of SWMU 3 is located in the eastern portion of NSA Crane along Little Sulphur Creek (LSC) (Figure 4-2). Within the OJT is the OJT Treatment Area where five hot spots of contamination were identified. These hot spots are the focus of this SAP. The hot spots (03SB018, 03SB019, 03SB022, 03SB024, and 03SB048) are contaminated with one or more of lead, TNT, and RDX and present unacceptable levels of risk to human receptors as determined in the RFI Report (Figure 10-3 of the RFI report) (Tetra Tech, 2005).

The OJT is a closed munitions demilitarization area located adjacent to and downstream along the LSC valley south-southeast of the MTA of SWMU 3 (Figure 4-3). The OJT Treatment Area was used from the mid-1970s through 1983. Materials to be demilitarized were treated at two separate regions of the OJT Treatment Area where the Burn Area and the Burn Pit were located. The approximate locations of these areas are shown on Figure 4-3. The term "pit" may be a misnomer because the area is believed to be a natural topographic depression rather than an excavated pit. At the burn area, bomb casings from which the bulk explosives had been removed were filed with initiating powder, tilted on-end toward a hillside east of the OJT Treatment Area, and flashed to complete the demilitarization process. Some munitions are thought to have been lashed to a horizontally positioned utility pole prior to flashing.

The burn pit was approximately 100 feet long, 30 feet wide, and 10 to 12 feet deep, located just south-southeast of the burn area. Powder was flashed and explosives-contaminated materials were burned in this pit. The contaminated material may have included cardboard, paper, wood, and metal packaging that may have come into contact with explosives, solvent-contaminated rags, and/or any other material that may have been contaminated with explosives. Small munitions items and components were also reportedly treated in the burn pits. The area has not been used for any operations since 1983 when it was filled with clean fill material and revegetated. The area is now overgrown with brush, trees, and grasses (Tetra Tech, 2005).

## 4.2 SUMMARY OF RFI RESULTS

An RFI, which included human health and ecological risk assessments, was conducted at NSA Crane SWMU 3 from 2001 to 2005 (Tetra Tech, 2005). The RFI focused on the OJT and LSC. Soil, groundwater, surface water, and sediment were investigated as part of the RFI.

The results of the RFI indicated that metals (lead) and explosives (TNT and RDX) concentrations exceeded project screening criteria at isolated locations. Only the lead criterion was exceeded at three soil sampling locations (03SB018, 03SB019, and 03SB048). The TNT and RDX criteria were exceeded at sampling location 03SB022, and lead, TNT, and RDX criteria were exceeded at soil sampling location 03SB024. Figure 4-4 presents the sample locations and associated analytical data where concentrations of lead, TNT, and RDX exceeded screening criteria in surface and subsurface soils, and sample locations for samples which target analyte concentrations did not exceed screening criteria. Each of the analytes that exhibited screening criteria exceedances in soil are identified as a contaminant of concern (COC) for soil in the RFI based on human health risk standards. The RFI identified unacceptable levels of human health risk for surface soil.

Groundwater monitoring wells were sampled in 2001 as part of the RFI. Exceedances of MCSs by trichloroethene (TCE) and RDX were observed, but had significantly decreased from previous sampling events through natural attenuation. Surface soil was one of the media identified to represent an unacceptable level of human health risk through exposure to lead and explosives in the soil (Tetra Tech, 2005). The RFI recommended that a Corrective Measures Study (CMS) be conducted to evaluate remedial options designed to mitigate risks in surface soil as well as other contaminated media; however, the risks for all but surface soil are being managed or evaluated further in parallel projects and are not within the scope of this project.

## 4.3 SUMMARY OF CORRECTIVE MEASURES PROPOSAL

Instead of conducting a CMS, potential remedial strategies were evaluated and documented in a CMP (Tetra Tech, 2009).

Three soil remedial alternatives were evaluated in the CMP report for the OJT (Tetra Tech, 2009). They are as follows:

- Alternative OJT - S1 – No Action
- Alternative OJT - S2 – Limited Action – Land Use Controls (LUCs)
- Alternative OJT - S3 – Excavation, Stabilization, and Off Site Disposal

Alternative OJT – S3 was selected as the remedy. There are three components to Alternative OJT – S3: 1) Excavation of explosives and lead contaminated soil, 2) stabilization of lead contaminated soil, and 3) off-site disposal of lead stabilized and explosives contaminated soil. Removal of lead and explosives contaminated soil would eliminate the human health risks that are currently present.

The MCSs for RDX (55 mg/kg) and TNT (190 mg/kg) are based on 10 times the USEPA Soil Screening Value for the protection of the human health residential receptor. The 10 times MCS value equates to a 1 x $10^{-5}$ carcinogenic risk criteria. Explosives were not determined to be a risk concern for groundwater exposure in the RFI Report (Tetra Tech, 2005). In addition, historical data shows a declining trend for explosive concentrations in groundwater; therefore, the removal of explosive contaminated soil, as planned in the remedy, will only further decrease the concentrations of explosives in groundwater.

The MCS for lead was established as 400 mg/kg, which is the same as the human health screening criteria used in the risk assessment.

Implementation of this selected remedial alternative for soil is the impetus for this SAP. The data to be collected will be used in conjunction with the existing data to determine the extent of remediation, which will be addressed in an IMWP.

## 4.4 CONCEPTUAL SITE MODEL

OJT Treatment Area surface soil contaminated with lead, TNT, and RDX was identified to pose a potential unacceptable human health risk for hypothetical future onsite residents. Surface soil contamination has the potential to migrate deeper into subsurface soils and eventually become a contamination source for groundwater, which is why the MCSs developed during the RFI took into account the potential for contaminants to leach from soil to groundwater. Removal of the identified soil

contamination would prevent lead, TNT, RDX, and degradation products of TNT and RDX from leaching into deeper soils, bedrock, and groundwater at unacceptable concentrations.

# Worksheet No. 5 - Project Quality Objectives/Systematic Planning Process Statements

(UFP-QAPP Manual Section 2.6.1 – Worksheet #11)

## 5.1 PROBLEM STATEMENT

Data were gathered during the RFI to support a risk assessment. The risk assessment identified unacceptable levels of risk for humans exposed to contaminated soil containing lead, TNT, and RDX. An IM has been selected to remove contaminated soil and mitigate risks to site receptors. The selected remedy consists of soil excavation and off-site disposal of contaminated soil.

The Navy and United States Environmental Protection Agency (USEPA) Region 5 agreed to incorporate a prescriptive soil remediation into the IM at the March 9, 2011 meeting at NSA Crane. In this remedy, the horizontal and vertical extent of soil contamination will be delineated sufficiently to support soil excavations in a way that minimizes the cost of excavation and disposal, but ensures removal of all soil with contaminant concentrations greater than established MCSs. Excavation will reduce contaminant concentrations to less than MCS levels around each location of known contamination. No confirmation sampling will then be required.

The boundary of the contaminated soil is currently known with a relatively coarse degree of spatial resolution designed to support the risk assessment. Consequently, excavation from the most contaminated locations to the nearest current locations at which contaminant concentrations are less than MCSs would potentially cause more soil to be excavated than necessary to attain MCS concentrations across the site. The potentially excess excavated soil represents an unnecessary expenditure for the Navy. Therefore, the Project Team must collect data to delineate lead, TNT, and RDX contamination in OJT Treatment Area soils with a spatial resolution that supports a "no further action" (NFA) for soil recommendation at the completion of the planned excavation, while at the same time cost-effectively minimizing excavation and disposal costs (i.e., soil volume). In addition, the data collection must be accomplished in a single field event.

## 5.2 DATA NEEDS

Data required to resolve the problem described in Section 5.1 are as follows:

- Lead, TNT, and RDX concentrations in soil. These data (both previously collected and new data) must be obtained using FBL analyses of soil. Using XRF measurements of lead concentrations in the field is suitable for guiding fieldwork. However, the use of RDX or TNT field test kits would not be

cost-effective because the areas contaminated with explosives appear to be relatively small. Field screening data are not definitive whereas, the FBL data are and can be used for decision making.

- Global Positioning System (GPS) coordinates (sub-meter accuracy) of previous and new data collection points in soil. The previous data locations are required to serve as points of reference for new data collection points. Data collection point coordinates must be documented in accordance with Standard Operating Procedure (SOP)-10.

- Depths of soil intervals to be investigated. These measurements must be obtained in accordance with SOP-06.

- Quality Control Sample Data. It is necessary to use temperature blanks in coolers containing samples scheduled for TNT and RDX laboratory analysis. Cooling of samples and use of temperature blanks is not required for coolers containing only samples scheduled for lead analysis. Field duplicate samples will be collected at a frequency of one duplicate sample for every 20 environmental samples. Field duplicate analyses will be unnecessary for field XRF analyses because those measurements are subject to a relatively high degree of imprecision and decisions concerning delineation will be based on the FBL data. Equipment rinsate blanks are not be needed because the Navy accepts the liability of accidentally contaminating a sample such that its concentration appears to exceed an MCS when it really does not exceed the MCS.

## 5.3 STUDY BOUNDARIES

Two populations of soil are of interest around each of the hot spots identified to have contaminant concentrations greater than their MCSs. One population is the soil contaminated as a result of past site operations. The other population is soil not contaminated by site operations (that is, uncontaminated soil) that will help to delineate the extent of site-related contamination. Red and yellow dots on Figures 5-1 and 5-2 depict the known locations of contamination (red dots) and maximum known extent of contamination (yellow dots for concentrations below MSCs). On Figure 5-1, the solid red lines show the maximum extent of contamination in areas where data are available. The dashed red lines show the inferred maximum extent of contamination based on concentration patterns in areas where actual data are not available. The horizontal limit of this investigation is represented by these solid and dashed red boundaries. These lines also represent the maximum estimated area of excavation.

Figure 4-4 shows the constituents that exceeded MCSs at each sample location. Only boring 03SB024 exhibits MCS exceedances for all three contaminants; only boring 03SB024 has an exceedance of the RDX MCS; the TNT concentration exceeds its MCS at borings 03SB022 and 03SB024; and lead

concentrations exceed the MCS at borings 03SB018, 03SB019, 03SB024 and 03SB048. These combinations of MCS exceedances at different locations affect the data needs for delineating contamination. Figures 5-1 and 5-2 show the degree of delineation already achieved around each hot spot.

The planned maximum depth of soil excavation is 10 feet below ground surface (bgs); therefore, delineation of contamination deeper than 10 feet is not warranted. Existing data shows that soil contamination is generally limited to a depth of 10 feet or less. Bedrock is shallower than 10 feet in several locations in the area of SWMU 3, but excavation of bedrock is not included in the planned excavation strategy. Groundwater at SWMU 3 is located at a depth of approximately 15 to 20 feet bgs; therefore, excavations to 10 feet bgs or less are not expected to encounter groundwater.

Data collection is limited to a single field event. This constraint favors data collection in the field to delineate contamination as closely as possible to the actual contamination limit (e.g., MCS) in real time.

Contamination identified at each sample location is as follows:

- **Borings 03SB018**: Lead only to a depth of 4 feet bgs. Contamination in excess to MCS at this location could be deeper than 4 feet bgs, and the lateral extent of contamination is unknown.

- **Borings 03SB019**: Lead only at a depth of 4 feet bgs. The sample from 12 to 15 feet bgs did not exceed MCS. Contamination at this location deeper than 4 feet and less than 12 feet bgs could exceed the MCS; however, the Project Team has determined that the maximum depth for the excavation is 10 feet bgs. Therefore, the contamination at this location between 4 to 10 feet bgs could exceed the MCS. The lateral extent of contamination is unknown.

- **Boring 03SB048**: Lead only to a depth of 10 feet bgs because the Project Team has determined that the maximum depth for the excavation is 10 feet bgs, the vertical extent of contamination is defined. The lateral extent of contamination is unknown.

- **Boring 03SB022**: TNT and RDX to a depth of 2 feet bgs. Samples from 2 to 4 feet bgs and 12 to 15 feet bgs did not exceed the MCS. Contamination in excess of MCSs at this location could be deeper than 4 feet bgs and less than 12 feet bgs; however, the Project Team has determined that the maximum depth for the excavation is 10 feet bgs. Therefore, the contamination at this location between 4 to 10 feet bgs could exceed the MCS. The lateral extent of contamination is unknown.

- **Boring 03SB024**: Lead, TNT, and RDX to a maximum depth of 2 feet bgs. Samples from 4 to 6 feet bgs and 12 to 15 feet bgs did not exceed the MCS. Contamination in excess of MCSs at this location could be between 2 to 4 feet bgs and 6 to 12 feet bgs; however, the Project Team has determined that the maximum depth for the excavation is 10 feet bgs. Therefore, the contamination at this location from 2 to 4 feet bgs and 6 to 10 feet bgs could exceed the MCS. The lateral extent of contamination is unknown.

Areas where contamination is not bounded within approximately 5 feet laterally of known hot spots constitute data gaps, and depths below which contamination has not been investigated also constitute data gaps.

## 5.4 ANALYTIC APPROACH

To resolve the problem statement presented in Section 5.1, the following decision rule will be used:

If all data have been collected as planned (See Worksheet No. 8) and contamination has been delineated to below the MCS in all directions, with no significant quality deficiencies, consider the delineation of soil contamination to be complete and document this in the project report; otherwise, convene the Project Team to determine the appropriate course of action. The Project Team will consider during this evaluation whether the inability to collect data was a result of site conditions (e.g., encountering refusal prior to reaching the targeted maximum depth) or factors that indicate a need to collect additional data, either prior to or in conjunction with the planned excavation.

**Note:** Because of the high sampling density anticipated, the need for additional data collection is expected to be very low unless it is due to data quality deficiencies or a decision to reduce excavation costs further.

## 5.5 PERFORMANCE CRITERIA

The only performance criterion applicable to this project is a need to collect all planned data with no significant quality deficiencies. If this is achieved, the data collected will be considered sufficient to support the planned remediation. To evaluate data quality, the processes and criteria described will be used. Data quality deficiencies will be brought to the attention of all Project Team members for their consideration regarding how the deficiencies affect attainment of project objectives (see also Section 5.4).

## 5.6 SAMPLING DESIGN AND RATONALE

The sampling design requires collecting soil samples over a regular grid that has vertical and horizontal dimensions reflecting what is known and inferred about the extent of contamination. Contamination is defined as a target analyte concentration being greater than its MCS. The grid spacing was determined based on expectations for finding or not finding contamination, and by balancing the cost of sampling and analysis with soil excavation and disposal costs.

Sampling/analysis costs are relatively inexpensive unless the grid spacing is too small. Soil excavation/disposal costs increase dramatically if the grid spacing is too large. The balance point between sampling/analysis and excavation/disposal was determined by considering that excavation must extend in all directions from a contaminated boring to the nearest borings demonstrated to be uncontaminated. Also considered was the need to complete the delineation in a single field event.

The sampling design takes into account the differences from one location to another regarding the known contaminants and the maximum depth of contamination. Associations between contaminated soil borings and planned analysis and sampling depth ranges are presented below. Note: the analyses for the step-out samples associated with sample 03SB022 will include lead, even though lead concentrations did not exceed the MCS at this location, in order to simplify the sampling approach and facilitate the sampling effort in the area of 03SB022 and nearby location 03SB024 (which showed an exceedance of the MCS for lead). Some step-out boring locations are associated with more than one initial boring location.

| Initial Soil Boring Location | Associated Step-Out Soil Boring Locations | Required Analyses | Sampling Depth Interval Ranges |
|---|---|---|---|
| 03SB018<br>Note: 0 to 2 feet bgs <MCS<br>2 to 4 feet bgs >MCS | 03SB132, 03SB131, 03SB130, 03SB129, 03SB133, SB03134, 03SB122, 03SB123, 03SB124, 03SB125, | Lead | 2 to 4 feet bgs,<br>4 to 6 feet bgs,<br>6 to 8 feet bgs, and<br>8 to 10 feet bgs or bedrock, whichever is shallower |
| 03SB019<br>Note: 0 to 2 feet bgs <MCS<br>2 to 4 feet bgs >MCS<br>12 to 15 feet bgs <MCS | 03SB131, 03SB130, 03SB129, 03SB128, 03SB134, SB03127, 03SB151, 03SB123, 03SB124, 03SB125, 03SB126, 03SB150, | Lead | 2 to 4 feet bgs,<br>4 to 6 feet bgs,<br>6 to 8 feet bgs, and<br>8 to 10 or bedrock, whichever is shallower |

| Initial Soil Boring Location | Associated Step-Out Soil Boring Locations | Required Analyses | Sampling Depth Interval Ranges |
|---|---|---|---|
| 03SB022<br>Note: 0 to 2 feet bgs >MCS<br>2 to 4 feet bgs <MCS<br>12 to 15 feet bgs <MCS | 03SB152, 03SB153, 03SB154, 03SB135, 03SB149, 03SB148, 03SB155, SB03136, 03SB137, 03SB138, 03SB147, 03SB146, 03SB139, 03SB140, 03SB141, 03SB145, 03SB142, 03SB143, 03SB144, 03SB159, 03SB160 | Lead, TNT and RDX | 0 to 2 feet bgs and<br>2 to 4 feet bgs.<br>Detections from the 2 to 15 feet bgs intervals were below MSCs, and therefore, vertically bounds the contamination. |
| 03SB024<br>Note: 0 to 2 feet bgs >MCS<br>4 to 6 feet bgs <MCS<br>12 to 15 feet bgs <MCS | 03SB135, 3SB149, 03SB155, 03SB148, SB03136, 03SB137, 03SB138, 03SB147, 03SB146, 03SB139, 03SB140, 03SB141, 03SB145, 03SB156, 03SB142, 03SB143, 03SB144, 03SB157, 03SB158, 03SB159, 03SB160 | Lead, TNT, and RDX | 0 to 2 feet bgs and 2 to 4 feet bgs |
| 03SB048<br>Note: 0 to 2 feet bgs <MCS<br>2 to 6 feet bgs >MCS<br>6 to 10 feet bgs >MCS | 03SB164, 03SB165, 03SB161, 03SB163, 03SB166, SB03162, 03SB167, | Lead | No samples will be collected at 03SB048 since contamination is known to be present in subsurface soils to the limits of excavation.<br><br>Surrounding step-out samples:<br>2 to 4 feet bgs<br>4 to 6 feet bgs,<br>6 to 8 feet bgs, and<br>8 to 10 feet bgs |

To the extent that previously sampled locations coincide with or are within 5 feet of a grid node, the grid node data point will be represented by the existing data, and a sample will not be collected at that node. Locations to be sampled and the analyses to be conducted on the samples collected at each node are tabulated on Worksheet No. 8, Table 8-1. These locations are also shown on Figures 7-1 and 7-2.

The sampling design optimizes the number of samples collected and analyses performed by sequencing as many lead contamination data collection points as possible based on field XRF screening.

Samples scheduled for TNT and RDX analyses must be accorded priority because they have shorter holding times than the samples designated for lead analysis only.

## Worksheet No. 6 - Field Quality Control Samples

(UFP-QAPP Manual Section 2.6.2 – Worksheet #12)

| Quality Control (QC) Sample | Analytical Group | Frequency | Data Quality Indicators (DQIs) | Measurement Performance Criteria (MPCs) | QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A) |
|---|---|---|---|---|---|
| Cooler Temperature Indicator | All analytical groups | One per cooler. | Representativeness | Temperature must be between 0 and 6 degrees Celsius (°C). | S |
| Duplicate Samples | All analytical groups | One per 20 field samples collected per matrix | Precision | Values > 5x LOQ: Relative Percent Difference (RPD) ≤50%. If duplicate values are < 5x LOQ, absolute difference should be < 4x LOQ. | S&A |

Note: Equipment rinsate blanks are not needed because the Navy accepts the liability of accidentally contaminating a sample such that its concentration appears to exceed an MCS, when it really does not exceed the MCS.

## Worksheet No. 7 - Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1 – Worksheet #17)

The overall sampling strategy is relatively complex. Its goal is to establish horizontal and vertical extents of contamination for residential receptors while optimizing sample collection and laboratory analyses to establish an area of contamination within ±5 feet horizontally for lead, and within ±10 feet horizontally for TNT and RDX, and within nominal vertical intervals. Nominal vertical sampling intervals are 0 to 2, 2 to 4, 4 to 6, 6 to 8, and 8 to 10 feet bgs with a maximum depth of 10 feet bgs established by residential receptor exposure potential. If bedrock is encountered between a nominal interval top elevation and bottom elevation, only the available soil within that interval will be collected. Bedrock will not be sampled.

The five known contamination "hot spots" at the OJT Treatment Area were grouped into "types" according to the contaminants detected. Two "types" of soil contamination "hot spots" (i.e., soil concentrations above established MCS) have been identified based on contaminants identified above MCSs and proximity of soil borings to each other. The first "hot spot" type is in the area of soil borings 03SB018, 03SB019, and 03SB048, where only lead concentrations have been identified above the MCS. The second "hot spot" type is in the area of soil boring 03SB022, where only TNT and RDX concentrations have been identified above the MCS, and soil boring 03SB024, where lead, TNT, and RDX concentrations have been identified above the MCSs.

Field XRF measurements will be used to guide lead contamination soil sampling. These field measurements will be supported with laboratory confirmation that lead concentrations are less than 400 mg/kg in samples considered to be uncontaminated based on field analysis. The 400 mg/kg limit is the MCS for lead. For field screening of lead contamination, a lead XRF limit of 200 mg/kg in soil was selected as field screening criteria. This 200 mg/kg limit for field XRF is based on Tetra Tech's experience with similar projects that have shown when field XRF measurements are less than 200 mg/kg the corresponding laboratory analytical lead concentration is less than 400 mg/kg. However, only FBL lead analyses will be used to establish the extent of lead contamination for remedial purposes.

Only FBL analyses will be used to establish the extent of TNT and RDX contamination because laboratory analysis will be less extensive for these organic contaminants than field analysis, and a reliable correlation between field analytical data and FBL data for these organics has not been demonstrated; that is, field analyses do not provide a significant cost benefit, nor a predictable correlation. Furthermore, relegating organic explosives analyses to an FBL helps to simplify this delineation strategy. The existence of two different hot spot types requires different sampling and analysis sub-strategies to be applied depending on the contaminants of concern of each area being delineated. These two sub-strategies are described below by type of hot spot.

**Notes:**

- During the sampling event, XRF sample data sheets were developed to aid in the identification and tracking of sample locations shared by two hot spots so that the minimum number of laboratory analyzed samples will be collected to achieve the project objective.

- All samples analyzed in the field by XRF that are submitted for FBL analysis must be labeled in a logical manner as illustrated on Figure 7-1.

## 7.1 HOT SPOT TYPE 1

**Hot Spot Type 1**
**Delineation of Lead Contamination**
**Soil Borings 03SB018, 03SB019, and 03SB048**

To delineate lead contamination, an iterative sampling design will be used.

1. Select a starting hot spot (i.e., 03SB018, 03SB019, or 03SB048) as indicated on Figures 7-1 or 7-2).
2. From this starting hot spot, identify the four adjacent grid nodes with their soil boring numbers for the four major compass directions (north, south, east, and west) that represent the same nominal depth interval). That is, measure 20 feet to the north, south, east, and west and tag those locations with the appropriate soil boring identification number based on Figure 7-1 or Figure 7-2.
3. For each of these four nodes, collect a sample from the selected depth interval and analyze and record the lead concentration using a field portable XRF, in accordance with SOP-08.
4. Log the XRF data on the XRF Field Data Sheet (SOP-08).
5. If a node has a lead XRF concentration greater than 200 mg/kg, label the node as a new starting hot spot location with the soil boring number as shown on Figure 7-1 or Figure 7-2.
6. Repeat Steps 2 through 5 along grid nodes in directions away from the initial starting hot spot location until all grid nodes furthest from the starting hot spot have a lead XRF concentration less than 200 mg/kg.

**Note:**

Sample nodes are not expected to extend past the Clean Sampling Area Boundary or the Estimated Clean Sampling Area Boundary as shown on Figures 7-1 and 7-2. If the XRF is greater than 200 mg/kg for the sample closest to the Clean Sampling Area Boundary or the Estimated Clean

Sampling Area Boundary, contact the Tetra Tech PM and NSA Crane ERSM for a decision regarding whether to add additional sample nodes.

7. As identified in the following table, repeat Steps 1 through 5 for each nominal sampling depth interval.

| Initial Soil Boring Location | Associated Step-Out Soil Boring Locations | Required Analyses | Sampling Depth Interval Ranges |
|---|---|---|---|
| 03SB018<br>Note: 0 to 2 feet bgs <MCS<br>2 to 4 feet bgs >MCS | 03SB132, 03SB131, 03SB130, 03SB129, 03SB133, SB03134, 03SB122, 03SB123, 03SB124, 03SB125 | Lead | 2 to 4 feet bgs,<br>4 to 6 feet bgs,<br>6 to 8 feet bgs, and<br>8 to 10 feet bgs or bedrock, whichever is shallower |
| 03SB019<br>Note: 0 to 2 feet bgs <MCS<br>2 to 4 feet bgs >MCS<br>12 to 15 feet bgs <MCS | 03SB131, 03SB130, 03SB129, 03SB128, 03SB134, SB03127, 03SB151, 03SB123, 03SB124, 03SB125, 03SB126, 03SB150 | Lead | 2 to 4 feet bgs,<br>4 to 6 feet bgs,<br>6 to 8 feet bgs, and<br>8 to 10 or bedrock, whichever is shallower |
| 03SB048<br>Note: 0 to 2 feet bgs <MCS<br>4 to 6 feet bgs <MCS<br>12 to 15 feet bgs <MCS | 03SB164, 03SB165, 03SB161, 03SB163, 03SB166, SB03162, 03SB167 | Lead | No samples will be collected at 03SB048 since contamination is known to be present in subsurface soils to the limits of excavation<br><br>Surrounding step-out samples:<br>2 to 4 feet bgs<br>4 to 6 feet bgs,<br>6 to 8 feet bgs, and<br>8 to 10 feet bgs |

**Note:**

When this process is complete, there will be groups of contiguous nodes (soil boring locations) in three dimensions (horizontally and vertically) with lead XRF concentrations greater than 200 mg/kg surrounded by nodes (soil boring locations) with lead XRF concentrations less than or equal to 200 mg/kg, and to an identified soil contamination depth. In some cases, a contiguous group of nodes with lead XRF concentrations greater than 200 mg/kg may be a single point, a linear array of points, or other geometric configurations.

8. Conduct a sequential Step-in/Step-out process to refine the location of the contamination boundary equal to a lead XRF concentration less than or equal to 200 mg/kg for each sample depth interval of interest. This will be done by oscillating in decreasing distances between

perimeter "hot spots" (i.e., XRF concentration greater than 200 mg/kg) and perimeter "cold spots" (i.e., XRF concentration less than or equal to 200 mg/kg) surrounding them as described below:

a. Select a perimeter cold spot.

b. Move along the north grid equidistant between the cold spot and nearest hot spot and collect and analyze a sample using XRF from this intermediate location spot for lead.

c. If the XRF lead concentration is greater than 200 mg/kg at this intermediate location, designate the location as a new lead contaminated node (new soil boring identification [ID] number based upon the numbering system shown on Figure 7-3). Using this new hot spot node, collect and XRF analyze a sample located equidistant from this new lead contaminated node toward the cold spot.

d. If the XRF lead concentration is less than 200 mg/kg, designate this location as a new cold spot node and collect with a new soil boring ID as indicated in Figure 7-3, then analyze a sample equidistant between this new cold spot node and the hot spot.

e. Repeat Steps 8a through 8d until perimeter hot spots and perimeter cold spots are 5 feet apart in all horizontal directions or the perimeter hot spot is at the Clean Sampling Area Boundary, whichever is achieved first.

   NOTE:

   If the XRF is greater than 200 mg/kg at the Clean Sampling Area Boundary or the Estimated Clean Sampling Area Boundary, contact the Tetra Tech PM and NSA Crane ERSM for a decision regarding whether to add additional sample nodes.

f. Repeat Steps 8a through 8d for the southern direction from the cold spot until all perimeter hot spots and perimeter cold spots are 5 feet apart in a horizontal direction.

g. Repeat Steps 8a through 8d for the eastern direction from the cold spot until all perimeter hot spots and perimeter cold spots are 5 feet apart in a lateral direction.

h. Repeat Steps 8a through 8d for the western direction from the cold spot until all perimeter hot spots and perimeter cold spots are 5 feet apart in a lateral direction.

9. Submit for FBL lead analysis all samples.

## 7.2 HOT SPOT TYPE 2

**Hot Spot Type 2**
**Delineation of Lead, TNT, and RDX Contamination**
**Soil Borings 03SB022 and 03SB024**

For hot spot 03SB024 where lead, TNT, and RDX contamination is present, and hot spot 03SB022 where TNT and RDX contamination is present, the delineation sampling strategy is described below:

1. Apply the Hot Spot Area 1 strategy for lead delineation only.

2. When delineation of lead contamination around soil boring 03SB024 is complete, identify all perimeter cold spots and the adjacent grid nodes 40 feet away in a direction away from 03SB024 and within the Clean Sampling Area Boundary.

3. Collect lead, TNT and RDX samples at the adjacent grid nodes representing the sample depth interval of 2 to 4 feet bgs. These sampling nodes are identified in the table below, and shown on Figure 7-1.

| Initial Soil Boring Location | Associated Step-Out Soil Boring Locations | Required Analyses | Sampling Depth Interval Ranges |
|---|---|---|---|
| 03SB022<br>Note: 0 to 2 feet bgs >MCS<br>2 to 4 feet bgs <MCS<br>12 to 15 feet bgs <MCS | 03SB152, 03SB153, 03SB154, 03SB135, 03SB149, 03SB148, 03SB155, SB03136, 03SB137, 03SB138, 03SB147, 03SB146, 03SB139, 03SB140, 03SB141, 03SB145, 03SB142, 03SB143, 03SB144, 03SB159, 03SB160 | Lead, TNT and RDX | 0 to 2 feet bgs and<br>2 to 4 feet bgs. |
| 03SB024<br>Note: 0 to 2 feet bgs >MCS<br>4 to 6 feet bgs <MCS<br>12 to 15 feet bgs <MCS | 03SB135, 3SB149, 03SB155, 03SB148, SB03136, 03SB137, 03SB138, 03SB147, 03SB146, 03SB139, 03SB140, 03SB141, 03SB145, 03SB156, 03SB142, 03SB143, 03SB144, 03SB157, 03SB158, 03SB159, 03SB160 | Lead, TNT, and RDX | 0 to 2 feet bgs and 2 to 4 feet bgs |

**Note:**

Figure 7-4 presents an example of the number strategy based on Sample Boring 03SB024. The same sampling strategy will be implemented for the area around Soil Boring 03SB022. The Soil Boring ID north, south, east, or west of the soil boring being sampled and ends with a dash ("-") then the first letter of the step out direction (N for north, S for south, E for east, and W for west) followed by the first digit of the step out distance (1 for 10 feet, 2 for 20 feet, 3 for 30 feet, and 4 for 40 feet).

4. Place pin flags at 10 foot intervals between soil boring 03SB024 and 03SB141.

5. Place pin flags at 10 foot intervals between soil boring 03SB024 and 03SB143.

6. Place pin flags at 10 foot intervals between soil boring 03SB024 and 03SB145.

7. Place pin flags at 10 foot intervals between soil boring 03SB024 and 03SB147.
8. Collect a soil sample at the 2 to 4 feet bgs depth interval at the flagged locations. Label the samples as shown on the 03SB024 Log Sheet as shown on Figure 7-4.
9. Submit these samples to the FBL for lead, TNT, and RDX analysis.

## 7.3 ESTABLISHING THE LIMIT OF EXCAVATION

Using only sampling points that have FBL concentrations of lead, TNT, and RDX less than the MCSs listed below, the closed 3-dimensional boundaries that represent the volume of soil greater than the MCSs will be drawn:

- Lead: 400 mg/kg
- TNT: 190 mg/kg
- RDX: 55 mg/kg

These drawings will represent the hot spot area-specific maximum extent of excavation required to remove unacceptable levels of lead, TNT, and RDX contamination, and achieve a no further action concurrence from USEPA for soil at the OJT Treatment Area.

# Worksheet No. 8 - Field Project Implementation (Field Project Instructions)

(UFP-QAPP Manual Section 2.5.1)

## 8.1 - Field Project Tasks

(UFP-QAPP Manual Section 2.5.1 – Worksheet #14)

Site-specific SOPs have been developed for field activities at NSA Crane and are located in Appendix A. Field tasks are summarized below with a short description for each task.

- Mobilization/Demobilization
- Utility Clearance
- Site-specific Health and Safety Training
- Monitoring Equipment Calibration
- Sample Collection Tasks
- Surface and Subsurface Soil Sampling
- Investigation-Derived Waste (IDW) Management
- Field Decontamination Procedures
- Field Documentation Procedures
- Sample Handling
- GPS Locating
- XRF Field Analysis

### Mobilization/Demobilization

Mobilization will consist of the delivery of all equipment materials, and supplies to the site, complete assembly in satisfactory working order of all such equipment at the site, and satisfactory storage at the site of all such materials and supplies. The Tetra Tech FOL or designee will coordinate with the NSA Crane ESRM to identify appropriate locations for the storage of equipment with supplies. Site-specific health and safety training for all Tetra Tech field personnel and subcontractors will be provided as part of site mobilization

Demobilization will consist of the prompt and timely removal of all equipment, materials, and supplies from the site following completion of the work. Demobilization includes the cleanup and removal of waste generated during the performance of the investigation.

## Utility Clearance

One week prior to the commencement of any subsurface intrusive activities, the Tetra Tech FOL or designee will contact IUPPS to complete a utility clearance ticket for the areas under investigation. Work permits, if required by the facility, will be obtained prior to conducting field activities. The Tetra Tech FOL will be responsible for coordinating these activities.

## Site-Specific Health and Safety Training

There are no specialization/non-routine project-specific training requirements or certifications needed by personnel to successfully complete the project or tasks. All field personnel will have appropriate training to conduct the field activities to which they are assigned. Each site worker will be required to have completed Occupational Safety and Health Administration's (OSHA's) Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour course (and 8-hour refresher, if applicable) in health and safety training. Safety requirements are addressed in greater detail in the site-specific Health and Safety Plan (HASP).

## Sample Collection Tasks

The sampling and analysis program is outlined in Worksheet No. 7 and Table 8-1. Sample collection will be in accordance with the site-specific SOPs listed in Worksheet No. 8.2 and provided in Appendix A. The sampling requirements for each type of analysis (i.e., bottleware, preservation, holding time) are listed in Table 8-2. Field and laboratory QC samples will also be collected as outlined in Table 8-3.

## Surface and Subsurface Soil Sampling

Surface and subsurface soil samples will be collected in accordance with SOP-05 (Borehole Advancement and Soil Coring Using Direct-Push Technology (DPT) and Hand Auger Techniques). Surface soil only samples will be collected with a hand auger. Subsurface soil samples will be collected using DPT; one subsurface soil location maybe sampled using a hand auger if the DPT cannot access the location. The subsurface soil borings will be described by the field personnel in accordance with SOP-06 (Soil Sample Logging). Any qualitative visual signs of potential contamination (such as soil staining) will be noted on the soil boring log. The surface and subsurface soil samples will be collected in accordance with SOP-07 (Surface and Subsurface Soil Sampling).

## Investigation-Derived Waste Management

Significant volumes of solid or semi-solid IDW in the form of soil are not anticipated to be generated during field activities, including during collection of subsurface samples using DPT. Soil will be replaced

into the boring from which it was excavated. IDW that is generated, including personal protective equipment (PPE) and decontamination fluids, will be handled in accordance with SOP-11 (Management of Investigation-Derived Waste).

**Field Decontamination Procedures**

Decontamination of sampling equipment will not be necessary for dedicated and disposable hand trowels. Decontamination of reusable sampling equipment (e.g., non-disposable hand trowels, hand augers, or DPT) will be conducted prior to sampling and between samples at each location. Decontamination of equipment will be conducted according to the sequence established in SOP-09 (Decontamination of Field Sampling Equipment).

**Field Documentation Procedures**

Field documentation will be performed in accordance with SOP-03 (Sample Custody and Documentation of Field Activity).

A summary of all field activities will be properly recorded in a bound logbook with consecutively numbered pages that cannot be removed. Logbooks will be assigned to field personnel and will be stored in a secured area when not in use.

At a minimum, the following information will be recorded in the site logbook:

- Name of the person to whom the logbook is assigned.
- Project name.
- Project start date.
- Names and responsibilities of on-site project personnel including subcontractor personnel.
- Arrival/departure of site visitors.
- Arrival/departure of equipment.
- Sampling activities and sample log sheet references.
- Description of subcontractor activities.
- Sample pick-up information including chain-of-custody form numbers, air bill numbers, carriers, times, and dates.
- Descriptions of borehole activities and operations.
- Descriptions monitoring well installation activities and operations, if monitoring wells are deemed necessary.

- Health and safety issues.
- Description of photographs including date, time, photographer, picture number, location, and compass direction of each photograph.

All logbook entries will be written in ink, and no erasures will be made. If an incorrect entry is made, striking a single line through the incorrect information will make the correction, and the person making the correction will initial and date the change.

**Sample Handling**

Methods for sample handling will be in accordance with SOP-03 (Sample Custody and Documentation of Field Activities, Appendix A). Sample containers will be provided certified-clean. Sample labeling will be in accordance with SOP-01 (Sample Labeling), and the sample numbering scheme will be in accordance with SOP-02 (Sample Identification and Nomenclature). The selection of sample containers, sample preservation, packaging, and shipping will be in accordance with Worksheet No 8, Table 8-2 and SOP-04 (Sample Preservation, Packaging, and Shipping).

**Global Positioning System Locating**

A Global Positioning System (GPS) will be used to locate all sampling points in accordance with SOP-10 (Global Positioning System). The GPS equipment will be checked on control monuments before and after day's use, and these checks will be documented in the field notebook. To ensure sub-meter accuracy, the GPS SOP requires a minimum of six satellites to capture a position.

**XRF Analysis**

On-site field XRF analysis for lead will be performed according to SOP-08

**Additional Project-Related Tasks**

Additional project-related tasks include:

- Analytical tasks
- Data management
- Assessment and oversight
- Data review
- Project reports

## Analytical Tasks

Chemical analyses for Lead, RDX, and TNT will be performed by Empirical, a Department of Defense (DoD) Environmental Laboratory Approval Program (ELAP)-accredited laboratory. A copy of the laboratory accreditation for Empirical is included in Appendix B. Analyses will be performed in accordance with the analytical methods identified in Table 8-2. Empirical will meet the MCSs specified in Worksheet No. 9 and will perform the chemical analyses following laboratory-specific SOPs (see Table 8-2 and Worksheet 10) developed based on the methods listed in Table 8-2.

All soil results will be reported by the laboratory on an adjusted dry-weight basis. Results of percent moisture will be reported in each analytical data package and associated electronic data files. This information will also be captured in the project database, which will eventually be uploaded to the Naval Installation Restoration Information Solution (NIRIS) database. Percent moisture information will also be captured in the IMWP.

The analytical data packages provided by Empirical will be in a Contract Laboratory Program (CLP)-like format and will be fully validatable and contain raw data, summary forms for all sample and laboratory method blank data, and summary forms containing all method-specific QC (results, percent recoveries (%Rs), relative percent differences (RPDs), relative standard deviations (RSDs), and/or percent differences or percent drifts (%Ds), etc.).

## Data Management

The principal data generated for this project will be from field and laboratory analytical data. Field sampling log sheets will be organized by date and medium, and filed in the project files. The field logbooks for this project will be used only for this site and will also be categorized and maintained in the project files after the completion of the field program. Project personnel completing concurrent field sampling activities may maintain multiple field logbooks. When possible, logbooks will be segregated by sampling activity. The field logbooks will be titled based on date and activity.

The data handling procedures to be followed by Empirical will meet the requirements of the technical specifications. Electronic data results will be automatically downloaded into the Tetra Tech database in accordance with the proprietary Tetra Tech processes.

The Tetra Tech PM (or designee) is responsible for the overall tracking and control of data generated for the project.

- **Data Tracking**. Data are tracked from generation to archiving in the Tetra Tech project-specific files. The Tetra Tech Project Chemist (or designee) is responsible for tracking the samples collected and shipped to Empirical. Upon receipt of the data packages from Empirical, the Tetra Tech Project Chemist will monitor the data validation effort, which includes verifying that the data packages are complete and results for all samples have been delivered by Empirical.

- **Data Storage, Archiving, and Retrieval**. The data packages received from Empirical are tracked in the data validation logbook. After the data are validated, the data packages are entered into the Tetra Tech Navy CLEAN file system and archived in secure files. The field records, including field log books, sample logs, chain-of-custody records, and field calibration logs, will be submitted by the Tetra Tech FOL to be entered into the Navy CLEAN file system prior to archiving in secure project files. Project files are audited for accuracy and completeness. At the completion of the Navy contract, the records will be stored by Tetra Tech.

- **Data Security**. Access to Tetra Tech project files is restricted to designated personnel only. Records can only be borrowed temporarily from the project file using a sign-out system. The Tetra Tech Data Manager maintains the electronic data files, and access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.

- **Electronic Data**. All electronic data will be compiled into a NIRIS Electronic Data Deliverable (NEDD) and loaded into NIRIS.

- **Data Review**. This review comprises data verification, validation, and usability assessment. The data verification and validation processes and requirements are described in Worksheet No. 6. The data usability assessment will, at a minimum, constitute evaluation of the following characteristics to ensure that the amount, type, and quality of data are sufficient to achieve project objectives. The means of conducting these evaluations will vary depending on the nature of the data. For example, soil borings and well construction logs will generally be evaluated qualitatively or semiquantitatively whereas precision, accuracy, and sensitivity of analytical data will generally be evaluated quantitatively and may be based on, or may supplement, data validation findings. Examples include:

  - Comparing actual to intended sampling locations and verifying that the correct datum was used to delineate contamination

  - Evaluating trends across sample delivery groups or sampling events

- Assessing quantitative relationships between parameters (e.g., relative magnitudes of TCE and its degradation product concentrations)

- Identifying potential errant or outlier data points

- Assessing planning assumption validity

- Evaluating the potential for contamination of samples by samplers

Data quality indicators to be evaluated during this assessment include:

1. **Precision.** A semiquantitative estimate of the uncertainty in contaminant concentrations as a function of location will be made.

2. **Accuracy.** Accuracy data will be evaluated to ensure sampling and measurement accuracy is within or exceeds analytical method specifications and may depend in part on the data validation findings.

3. **Representativeness.** This evaluation will assess whether the data are adequately representative of intended populations based on the sample collection and data generation requirements specified in this SAP.

4. **Completeness.** Failure to obtain critical data from planned locations will be documented. Minor variations in actual versus intended sampling locations (or depths) that do not adversely affect the attainment of project objectives will not be documented.

5. **Comparability.** This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction for each sampled area. This will not require quantitative comparisons unless the Tetra Tech Project Chemist indicates that such quantitative analysis is beneficial to the project and the Tetra Tech PM agrees.

6. **Sensitivity.** The Tetra Tech Project Chemist will determine whether project sensitivity goals were achieved by comparing non-detect values to MCSs.

7. **Other quantitative characteristics.** These may include quantities such as verification of soil volume calculations, soil disposal cost estimates, etc., that are used to determine whether the contaminants are sufficiently well delineated to estimate remediation costs.

If significant data quality deficiencies are detected that prevent the attainment of project objectives, the limitations on the affected data will be described in the project report. The Tetra Tech PM will bring these deficiencies to the attention of the project team for their evaluation and the team will determine an appropriate corrective action depending on the circumstances.

**Project Reports**

Draft and final versions of the Sampling Data Report will be prepared and incorporated into the IMWP as an appendix. The reports will include the following sections:

- Executive Summary – will include a brief description of the work conducted and the findings.

- Introduction and Background – will include a description of the history of operations and activities at the site and a summary of any previous investigations and removal actions.

- Description of Field Investigations – will include a summary of the work performed in accordance with the approved UFP-SAP and any field modifications as documented by the Tetra Tech FOL. This section will include maps showing the sampling locations and tables summarizing the data collected.

- Data Quality – will include a summary of quantitative analytical performance indicators such as completeness, precision, bias, and sensitivity and qualitative indicators such as representativeness and comparability. This section includes a reconciliation of project data with the DQOs and an identification of deviations from this UFP-SAP.

  A data usability assessment will be used to identify significant deviations in analytical performance that could affect the ability to meet project objectives.

- Nature and Extent of Contamination – will include a discussion of the extent of the contaminated soil which requires removal.

## 8.2 - Field SOP References Table

(UFP-QAPP Manual Section 3.1.2 – Worksheet #21)

| Reference Number | Title, Revision Date, and/or Number | Originating Organization of Sampling SOP | Equipment Type | Modified for Project Work? (Y/N) | Comments |
|---|---|---|---|---|---|
| SOP-01 | Sample Labeling, 05/11, Revision 0. | Tetra Tech | NA | N | Contained in Appendix A |
| SOP-02 | Sample Identification Nomenclature, 05/11, Revision 0. | Tetra Tech | NA | Y | Contained in Appendix A and Figures 7-3 through 7-9. |
| SOP-03 | Sample Custody and Documentation of Field Activities, 05/11, Revision 0. | Tetra Tech | Field logbook, sample log sheets, boring logs | N | Contained in Appendix A |
| SOP-04 | Sample Preservation, Packaging, and Shipping, 05/11, Revision 0. | Tetra Tech | NA | N | Contained in Appendix A |
| SOP-05 | Borehole Advancement and Soil Coring Using Direct-Push Technology and Hand Auger Techniques, 05/11, Revision 0. | Tetra Tech | DPT rig, stainless steel augers, extension rods, and T-handle | N | Contained in Appendix A |
| SOP-06 | Soil Sample Logging, 05/11, Revision 0. | Tetra Tech | NA | Y | Contained in Appendix A and Figures 7-3 through 7-9. |
| SOP-07 | Surface and Subsurface Soil Sampling, 05/11, Revision 0. | Tetra Tech | Stainless steel auger bucket, extension rods, and T-handle, photoionization detector (PID) | N | Contained in Appendix A |
| SOP-08 | Field Portable X-Ray Fluorescence Analyses of Soil and Sediment Samples Using the Innov-X Alpha Series Instrument, 05/11, Revision 0 | Tetra Tech | XRF unit | Y | Contained in Appendix A |
| SOP-09 | Decontamination of Field Sampling Equipment, 05/11, Revision 0. | Tetra Tech | Decontamination equipment, scrub brushes, 5-gallon buckets, spray bottles, phosphate free detergent, de-ionized water | N | Contained in Appendix A |
| SOP-10 | Global Positioning System, 05/11, Revision 0. | Tetra Tech | GPS unit | N | Contained in Appendix A |
| SOP-11 | Management of Investigation-Derived Waste, 05/11, Revision 0. | Tetra Tech | NA | Y | Contained in Appendix A |

## Table 8-1 – Sample Details

(UFP-QAPP Manual Section 3.1.1 – Worksheet #18, 19, 20, and 30.)

| Sample Location | Sample ID | Analyses | | | |
|---|---|---|---|---|---|
| | | XRF Lead[1] | FBL Lead | TNT | RDX |
| 03SB122 | 03SB1220204 | 1 | TBD[2] | NA | NA |
| | 03SB1220406 | 1 | TBD[2] | NA | NA |
| | 03SB1220608 | 1 | TBD[2] | NA | NA |
| | 03SB1220810 | 1 | TBD[2] | NA | NA |
| 03SB123 | 03SB1230204 | 1 | TBD[2] | NA | NA |
| | 03SB1230406 | 1 | TBD[2] | NA | NA |
| | 03SB1230608 | 1 | TBD[2] | NA | NA |
| | 03SB1230810 | 1 | TBD[2] | NA | NA |
| 03SB124 | 03SB1240204 | 1 | TBD[2] | NA | NA |
| | 03SB1240406 | 1 | TBD[2] | NA | NA |
| | 03SB1240608 | 1 | TBD[2] | NA | NA |
| | 03SB1240810 | 1 | TBD[2] | NA | NA |
| 03SB125 | 03SB1250204 | 1 | TBD[2] | NA | NA |
| | 03SB1250406 | 1 | TBD[2] | NA | NA |
| | 03SB1250608 | 1 | TBD[2] | NA | NA |
| | 03SB1250810 | 1 | TBD[2] | NA | NA |
| 03SB126 | 03SB1260204 | 1 | TBD[2] | NA | NA |
| | 03SB1260406 | 1 | TBD[2] | NA | NA |
| | 03SB1260608 | 1 | TBD[2] | NA | NA |
| | 03SB1260810 | 1 | TBD[2] | NA | NA |
| 03SB127 | 03SB127020 | 1 | TBD[2] | NA | NA |
| | 03SB1270406 | 1 | TBD[2] | NA | NA |
| | 03SB1270608 | 1 | TBD[2] | NA | NA |
| | 03SB1270810 | 1 | TBD[2] | NA | NA |
| 03SB128 | 03SB1280204 | 1 | TBD[2] | NA | NA |
| | 03SB1280406 | 1 | TBD[2] | NA | NA |
| | 03SB1280608 | 1 | TBD[2] | NA | NA |
| | 03SB1280810 | 1 | TBD[2] | NA | NA |

| Sample Location | Sample ID | Analyses | | | |
|---|---|---|---|---|---|
| | | XRF Lead[1] | FBL Lead | TNT | RDX |
| 03SB129 | 03SB1290204 | 1 | TBD[2] | NA | NA |
| | 03SB1290406 | 1 | TBD[2] | NA | NA |
| | 03SB1290608 | 1 | TBD[2] | NA | NA |
| | 03SB1290810 | 1 | TBD[2] | NA | NA |
| 03SB130 | 03SB1300204 | 1 | TBD[2] | NA | NA |
| | 03SB1300406 | 1 | TBD[2] | NA | NA |
| | 03SB1300608 | 1 | TBD[2] | NA | NA |
| | 03SB1300810 | 1 | TBD[2] | NA | NA |
| 03SB131 | 03SB1310204 | 1 | TBD[2] | NA | NA |
| | 03SB1310406 | 1 | TBD[2] | NA | NA |
| | 03SB1310608 | 1 | TBD[2] | NA | NA |
| | 03SB1310810 | 1 | TBD[2] | NA | NA |
| 03SB132 | 03SB1320204 | 1 | TBD[2] | NA | NA |
| | 03SB1320406 | 1 | TBD[2] | NA | NA |
| | 03SB1320608 | 1 | TBD[2] | NA | NA |
| | 03SB1320810 | 1 | TBD[2] | NA | NA |
| 03SB133 | 03SB1330204 | 1 | TBD[2] | NA | NA |
| | 03SB1330406 | 1 | TBD[2] | NA | NA |
| | 03SB1330608 | 1 | TBD[2] | NA | NA |
| | 03SB1330810 | 1 | TBD[2] | NA | NA |
| 03SB134 | 03SB1340204 | 1 | TBD[2] | NA | NA |
| | 03SB1340406 | 1 | TBD[2] | NA | NA |
| | 03SB1340608 | 1 | TBD[2] | NA | NA |
| | 03SB1340810 | 1 | TBD[2] | NA | NA |
| 03SB135 | 03SB1350204 | 1 | TBD[2] | 1 | 1 |
| | 03SB1350406 | 1 | TBD[2] | 1 | 1 |
| | 03SB1350608 | 1 | TBD[2] | 1 | 1 |
| | 03SB1350810 | 1 | TBD[2] | 1 | 1 |
| 03SB136 | 03SS1360002 | 1 | TBD[2] | 1 | 1 |
| | 03SS1360204 | 1 | TBD[2] | 1 | 1 |
| 03SB137 | 03SS1370002 | 1 | TBD[2] | 1 | 1 |
| | 03SS1370204 | 1 | TBD[2] | 1 | 1 |

| Sample Location | Sample ID | Analyses | | | |
|---|---|---|---|---|---|
| | | XRF Lead[1] | FBL Lead | TNT | RDX |
| 03SB138 | 03SS1380002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1380204 | 1 | TBD[2] | 1 | 1 |
| 03SB139 | 03SS1390002 | 1 | TBD[2] | 1 | 1 |
| | 03SS1390204 | 1 | TBD[2] | 1 | 1 |
| 03SB140 | 03SS1400002 | 1 | TBD[2] | 1 | 1 |
| | 03SS1400204 | 1 | TBD[2] | 1 | 1 |
| 03SB141 | 03SS1410002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1410204 | 1 | TBD[2] | 1 | 1 |
| 03SB142 | 03SS1420002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1420204 | 1 | TBD[2] | 1 | 1 |
| 03SB143 | 03SB1430002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1430204 | 1 | TBD[2] | 1 | 1 |
| 03SB144 | 03SB1440002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1440204 | 1 | TBD[2] | 1 | 1 |
| 03SB145 | 03SB1450002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1450204 | 1 | TBD[2] | 1 | 1 |
| 03SB146 | 03SB1460002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1460204 | 1 | TBD[2] | 1 | 1 |
| 03SB147 | 03SB1470002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1470204 | 1 | TBD[2] | 1 | 1 |
| 03SB148 | 03SS1480204 | 1 | TBD[2] | 1 | 1 |
| | 03SB1480406 | 1 | TBD[2] | 1 | 1 |
| | 03SB1480608 | 1 | TBD[2] | 1 | 1 |
| | 03SB1480810 | 1 | TBD[2] | 1 | 1 |
| 03SB149 | 03SS1490002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1490204 | 1 | TBD[2] | 1 | 1 |
| | 03SB1490608 | 1 | TBD[2] | 1 | 1 |
| | 03SB1490810 | 1 | TBD[2] | 1 | 1 |
| 03SB150 | 03SB1500204 | 1 | TBD[2] | NA | NA |
| | 03SB1500406 | 1 | TBD[2] | NA | NA |
| | 03SB1500608 | 1 | TBD[2] | NA | NA |
| | 03SB1500810 | 1 | TBD[2] | NA | NA |

| Sample Location | Sample ID | Analyses | | | |
|---|---|---|---|---|---|
| | | XRF Lead[1] | FBL Lead | TNT | RDX |
| 03SB151 | 03SB1510204 | 1 | TBD[2] | NA | NA |
| | 03SB1510406 | 1 | TBD[2] | NA | NA |
| | 03SB1510608 | 1 | TBD[2] | NA | NA |
| | 03SB1510810 | 1 | TBD[2] | NA | NA |
| 03SB152 | 03SB1520204 | 1 | TBD[2] | 1 | 1 |
| | 03SB1520406 | 1 | TBD[2] | 1 | 1 |
| | 03SB1520608 | 1 | TBD[2] | 1 | 1 |
| | 03SB1520810 | 1 | TBD[2] | 1 | 1 |
| 03SB153 | 03SB1530204 | 1 | TBD[2] | 1 | 1 |
| | 03SB1530406 | 1 | TBD[2] | 1 | 1 |
| | 03SB1530608 | 1 | TBD[2] | 1 | 1 |
| | 03SB1530810 | 1 | TBD[2] | 1 | 1 |
| 03SB154 | 03SB1540204 | 1 | TBD[2] | 1 | 1 |
| | 03SB1540406 | 1 | TBD[2] | 1 | 1 |
| | 03SB1540608 | 1 | TBD[2] | 1 | 1 |
| | 03SB1540810 | 1 | TBD[2] | 1 | 1 |
| 03SB155 | 03SB1550002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1550204 | 1 | TBD[2] | 1 | 1 |
| 03SB156 | 03SB1560002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1560204 | 1 | TBD[2] | 1 | 1 |
| 03SB157 | 03SB1570002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1570204 | 1 | TBD[2] | 1 | 1 |
| 03SB158 | 03SB1580002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1580204 | 1 | TBD[2] | 1 | 1 |
| 03SB159 | 03SB1590002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1590204 | 1 | TBD[2] | 1 | 1 |
| 03SB160 | 03SB1600002 | 1 | TBD[2] | 1 | 1 |
| | 03SB1600204 | 1 | TBD[2] | 1 | 1 |
| 03SB161 | 03SS1610204 | 1 | TBD[2] | NA | NA |
| | 03SB1610406 | 1 | TBD[2] | NA | NA |
| | 03SB1610608 | 1 | TBD[2] | NA | NA |
| | 03SB1610810 | 1 | TBD[2] | NA | NA |

| Sample Location | Sample ID | Analyses | | | |
|---|---|---|---|---|---|
| | | XRF Lead[1] | FBL Lead | TNT | RDX |
| 03SB162 | 03SS1620204 | 1 | TBD[2] | NA | NA |
| | 03SB1620406 | 1 | TBD[2] | NA | NA |
| | 03SB1620608 | 1 | TBD[2] | NA | NA |
| | 03SB1620810 | 1 | TBD[2] | NA | NA |
| 03SB163 | 03SS1630204 | 1 | TBD[2] | NA | NA |
| | 03SB1630406 | 1 | TBD[2] | NA | NA |
| | 03SB1630608 | 1 | TBD[2] | NA | NA |
| | 03SB1630810 | 1 | TBD[2] | NA | NA |
| 03SB164 | 03SS1640204 | 1 | TBD[2] | NA | NA |
| | 03SB1640406 | 1 | TBD[2] | NA | NA |
| | 03SB1640608 | 1 | TBD[2] | NA | NA |
| | 03SB1640810 | 1 | TBD[2] | NA | NA |
| 03SB165 | 03SS1650204 | 1 | TBD[2] | NA | NA |
| | 03SB1650406 | 1 | TBD[2] | NA | NA |
| | 03SB1650608 | 1 | TBD[2] | NA | NA |
| | 03SB1650810 | 1 | TBD[2] | NA | NA |
| 03SB166 | 03SS1660204 | 1 | TBD[2] | NA | NA |
| | 03SB1660406 | 1 | TBD[2] | NA | NA |
| | 03SB1660608 | 1 | TBD[2] | NA | NA |
| | 03SB1660810 | 1 | TBD[2] | NA | NA |
| 03SB167 | 03SS1670204 | 1 | TBD[2] | NA | NA |
| | 03SB1670406 | 1 | TBD[2] | NA | NA |
| | 03SB1670608 | 1 | TBD[2] | NA | NA |
| | 03SB1670810 | 1 | TBD[2] | NA | NA |

FBL = Fixed-base laboratory
MS/MSD = Matrix spike/matrix spike duplicate
NA = Not applicable
TBD = To be determined
XRF = X-Ray fluorescence

1. XRF analyses will be a field determination based on the step out criteria presented in Worksheet No. 7.
2. Lead sample to be submitted to the FBL for analysis if XRF lead concentration is less than or equal to 200 mg/kg.

**Note:** MS/MSD samples will be collected at a frequency of 1 per 20 samples per medium per analyte for FBL samples.

## Table 8-2 - Analytical SOP Requirements

**Laboratory point of contact, e-mail address, and phone number:** Brian Richard, brichard@empirlabs.com, 615-345-1113 Ext. 249
**Laboratory Name and Address:**
Empirical Laboratories, LLC
621 Mainstream Drive, Suite 270 Nashville, TN 37228
**Data Package Turnaround time:** 21 days
**Tentative Sampling Dates: To be determined** (TBD)

| **Matrix** | **Analytical Group** | **Analytical and Preparation Method/ SOP Reference** [(1)] | **Containers** (number, size, and type) | **Sample Volume** (units) | **Preservation Requirements** (chemical, temperature, light protected) | **Maximum Holding Time** (preparation/ analysis) |
|---|---|---|---|---|---|---|
| Soil | TNT and RDX Empirical SOP-327 | SW-846 8330A | One 4-ounce (oz.) glass jar with a Teflon-lined lid | 30 grams (g) | Cool to ≤6 °C | 14 days until extraction, 40 days to analysis |
| Soil | Lead Empirical SOP-100/105 | SW-846 3050B/6010C | One 4-oz glass jar with a Teflon-lined lid | 1 to 2 g | Cool to ≤6 °C | 180 days to analysis |

Notes:

1 Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet No. 10).

## Table 8-3 - Field Quality Control Sample Summary

| Matrix | Analytical Group | No. of Samples | No. of MS/MSDs(1) | No. of Duplicate Samples(2) | Total No. of Samples to Lab |
|---|---|---|---|---|---|
| Soil | TNT and RDX | 60 | 3/3 | 3 | 63 |
| | Lead | 70(2) | 4/4 | 4 | 74 |

1 Although MS/MSDs are not typically considered field QC samples, they are included here because location determination is often established in the field. The MS/MSDs are not included in the total number of samples sent to the laboratory.
2 One duplicate sample will be collected for every 20 environmental samples collected.
3 Lead quantity identified above is an estimate. The actual number of lead samples that will be sent to Empirical for analysis will be based on field XRF results as described previously.

## Worksheet No. 9 - Reference Limits and Evaluation Tables

(UFP-QAPP Manual Section 2.8.1 – Worksheet #15)

| Analyte | Chemical Abstract Service (CAS) Number | MCS (mg/kg) | MCS Reference (1) | Project Quantitation Limit Goal (PQLG) (mg/kg) | Empirical | | |
|---|---|---|---|---|---|---|---|
| | | | | | Limit of Quantitation (LOQ)(mg/kg) | Limit of Detection (LOD)(mg/kg) | Detection Limit (DL)(mg/kg) |
| Lead | 7439-92-1 | 400 | USEPA-RSSL | 130 | 1.00 | 0.600 | 0.300 |
| RDX | 121-82-4 | 55 | USEPA-RSSL | 18 | 0.400 | 0.200 | 0.100 |
| TNT | 118-96-7 | 190 | USEPA-RSSL | 63 | 0.400 | 0.200 | 0.100 |

Notes:

1. USEPA-RSSL –Resident Soil Screening Level provided by USEPA Summary dated (USEPA, 2010). The MCS references for surface and subsurface soil are 10 times the USEPA-RSSL - USEPA Regions 3, 6, and 9 Risk-Based Soil Screening Level, Residential (November, 2010).

## Worksheet No. 10 - Analytical SOP Reference Table

(UFP-QAPP Manual Section 3.2.1 – Worksheet #23)

| Lab SOP Number | Title, revision date, and/or Number | Definitive or Screening Data | Matrix and Analytical Group | Instrument | Organization Performing Analysis | Variance to QSM? (Y or N) | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|---|
| Empirical SOP-100 | Metals Digestion/ Preparation, Methods 3005A/ USEPA CLP ILMO 4.1 Aqueous, 3010A, 3030C, 3050B, USEPA CLP ILMO 4.1 (Soil/Sediment), 200.7, Standard Methods 3030C (Revision 21, 09/01/10) | Definitive | Soil/ Metals Digestion | NA/Preparation | Empirical | N | N |
| Empirical SOP-105 | Metals by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) Technique, SW-846 Methods 6010B, 6010C, USEPA Method 200.7, Standard Methods 19th Edition 2340B, USEPA CLP ILMO 4.1 (Revision 16, 04/11/10) | Definitive | Soil/ Metals (Lead) | ICP-AES | Empirical | N | N |
| Empirical SOP-327 | Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC) Method 8330, 8330A, 8330B, and 8332 (Revision 18, 09/07/10 | Definitive | Soil/ Explosives (TNT and RDX) | HPLC | Empirical | N | N |

# Worksheet No. 11 - Laboratory QC Samples Tables

(UFP-QAPP Manual Section 3.4 – Worksheet #28)

| | |
|---|---|
| **Matrix** | **Soil** |
| **Analytical Group** | **TNT and RDX** |
| **Analytical Method / SOP Reference** | **SW-846 8330A Empirical SOP-327** |

| QC Sample | Frequency / Number | Method / SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method Blank | One per preparatory batch of 20 or fewer samples. | All analytes must be ≤½ LOQ. | Investigate source of contamination and rerun method blank prior to analysis of samples, if possible.<br><br>Evaluate the samples and associated QC: if blank results are above LOQ, then report sample results that are <LOQ or >10X the blank concentration.<br><br>Re-prepare and reanalyze blank and those samples that were >LOQ and <10X the blank. | Analyst, Supervisor | Bias/ Contamination | Same as QC Acceptance Limits |
| Laboratory Control Sample (LCS)<br>Laboratory Control Sample Duplicate (LCSD) (not required) | One per preparatory batch of 20 or fewer samples. | %Rs must meet the DoD Quality Systems Manual for Environmental Laboratories (QSM) Version 4.1 limits as per Appendix G of the DoD QSM.<br>RPD must be ≤30% (for LCS/LCSD, if LCSD is performed). | Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to DOD QSM Version 4.1 Table G-1 for number of marginal exceedences allowed. Contact Client if samples cannot be reprepared within hold time. | Analyst, Supervisor | Accuracy/ Bias<br>Precision also, if LCSD is analyzed | Same as QC Acceptance Limits |

| | |
|---|---|
| **Matrix** | **Soil** |
| **Analytical Group** | **TNT and RDX** |
| **Analytical Method / SOP Reference** | **SW-846 8330A Empirical SOP-327** |

| QC Sample | Frequency / Number | Method / SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| MS/MSD | One per preparatory batch of 20 or fewer samples per matrix. | %Rs must meet the DoD QSM Version 4.1 limits as per Appendix G of the DoD QSM.<br>The RPD between MS and MSD should be ≤30%. | Flag the parent sample with a "J" flag for failed analytes which exceed the acceptance criteria. | Analyst, Supervisor | Accuracy/ Bias/ Precision | Same as QC Acceptance Limits |
| Surrogate Spikes | All field and QC samples - one per sample. | %Rs must meet the DoD QSM Version 4.1 limits as per Appendix G of the DoD QSM. | If surrogate recovery falls outside acceptance criteria, the sample should be re-extracted and re-analyzed. | Analyst, Supervisor | Accuracy/ Bias | Same as QC Acceptance Limits |
| Second Column Confirmation | All positive results must be confirmed. | Results between primary and second column - RPD must be ≤40%. | None. Apply "J" flag if RPD >40% and discuss in the case narrative. | Analyst, Supervisor | Precision | Same as QC Acceptance Limits |

| | |
|---|---|
| **Matrix** | **Soil** |
| **Analytical Group** | **Lead** |
| **Analytical Method / SOP Reference** | **SW-846 6010C Empirical SOP-105** |

| QC Sample | Frequency / Number | Method / SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method Blank | One per preparatory batch of 20 or fewer samples of similar matrix. | All target analytes must be ≤½ LOQ. | If the blank value > LOQ, then report sample results. If the blank value < LOQ or > 10x the blank value, then redigest. If blank value is less than negative LOQ, then report sample results. If > 10x the absolute value of the blank result, then redigest and reanalyze. | Analyst, Supervisor | Bias/ Contamination | Same as QC Acceptance Limits |
| LCS | One per preparatory batch of 20 or fewer samples of similar matrix. | %R must be within 80-120% of true value. | Evaluate and reanalyze, if possible. If the LCS recoveries are high, but the sample results are < LOQ, then narrate. Otherwise, re-digest and reanalyze all associated samples for failed target analyte(s). | Analyst, Supervisor | Accuracy/ Bias | Same as QC Acceptance Limits |
| MS | One per preparatory batch of 20 or fewer samples of similar matrix. | %R should be within 80-120% of true value (if sample is < 4x spike added). | Flag results for affected analytes for all associated samples with "N". | Analyst, Supervisor | Accuracy/ Bias | Same as QC Acceptance Limits |
| Sample Duplicate | One per preparatory batch of 20 or fewer samples of similar matrix. | The RPD should be ≤20% for duplicate samples for both water and soils. | Narrate any results that are outside control limits. | Analyst, Supervisor | Precision | Same as QC Acceptance Limits |
| Serial Dilution | One per preparatory batch with sample concentration(s) >50x LOD. | The 5-fold dilution result must agree within ±10 percent difference or percent drift (%D) of the original sample result if result is >50x LOD. | Perform post spike addition. | Analyst, Supervisor | Accuracy/ Bias | Same as QC Acceptance Limits |

| | |
|---|---|
| **Matrix** | **Soil** |
| **Analytical Group** | **Lead** |
| **Analytical Method / SOP Reference** | **SW-846 6010C Empirical SOP-105** |

| QC Sample | Frequency / Number | Method / SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Post Spike | One is performed when serial dilution fails or target analyte concentration(s) in all samples are < 50x LOD. | The %R must be within 75-125% of expected value to verify the absence of an interference. Spike addition should produce a concentration of 10-100x LOQ. | Flag results for affected analytes for all associated samples with "J". | Analyst, Supervisor | Accuracy/ Bias | Same as QC Acceptance Limits |
| Results between DL and LOQ | NA. | Apply "J" qualifier to results between DL and LOQ. | NA. | Analyst, Supervisor | Accuracy | Same as QC Acceptance Limits |

## Worksheet No. 12 - Data Verification and Validation (Steps I and IIa/IIb) Process Table

(UFP-QAPP Manual Section 5.2.1, UFP-QAPP Manual Section 5.2.2,, Figure 37 UFP-QAPP Manual, Table 9 UFP-QAPP Manual – Worksheets #34, 35, 36)

| Data Review Input | Description | Responsible for Verification (name, organization) | Internal/ External |
|---|---|---|---|
| Chain of Custody Forms | The Tetra Tech FOL or designee will review and sign the chain-of-custody form to verify that all samples listed are included in the shipment to the laboratory and the sample information is accurate. The forms will be signed by the sampler and a copy will be retained for the project file, the Tetra Tech PM, and the Tetra Tech Data Validators. The Tetra Tech FOL or designee will review the chain-of-custody form to verify that all samples listed in the SAP have been collected. All deviations should be documented in the report. | Sampler and FOL, Tetra Tech | Internal |
| Chain of Custody Forms | 1 - The Laboratory Sample Custodian will review the sample shipment for completeness and integrity, and sign accepting the shipment.<br>2- The Tetra Tech Data Validators will check that the chain-of-custody form was signed and dated by the Tetra Tech FOL or designee relinquishing the samples and also by the Laboratory Sample Custodian receiving the samples for analyses. | 1 - Laboratory Sample Custodian, Empirical<br><br>2 - Data Validators, Tetra Tech | 1 – Internal<br><br>2 - External |
| Chain of Custody Forms and SAP | Ensure that the custody and integrity of the samples was maintained from collection to analysis and the custody records are complete and any deviations are recorded. Review that the samples were shipped and stored at the required temperature and preservation conditions for chemically-preserved samples meet the requirements listed in the SAP. Ensure that the analyses were performed within the holding times listed in the SAP. | Data Validators, Tetra Tech | External |

| Data Review Input | Description | Responsible for Verification (name, organization) | Internal/ External |
|---|---|---|---|
| Sample Log Sheets, Chain of Custody Forms, SAP, and Laboratory sample login documentation | Verify that information recorded in the log sheets is accurate and complete. Verify that samples were correctly identified, that sampling location coordinates are accurate, and that documentation establishes an unbroken trail of documented chain-of-custody from sample collection to report generation. Verify that the correct sampling and analytical methods/SOPs were applied. Verify that the sampling plan was implemented and carried out as written and that any deviations are documented. Document any discrepancies in the final report. | PM, FOL, or designee, Tetra Tech | Internal |
| SAP, Analytical SOPs, and Analytical Data Packages | Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied. Establish that all method QC samples were analyzed and in control as listed in the analytical SOPs. If method QA is not in control, the Laboratory QAM will contact the Tetra Tech PM verbally or via e-mail for guidance prior to report preparation. | Laboratory QAM, Empirical | Internal |
| SAP/ Chain-of-Custody Forms | Check that all field QC samples determined necessary were collected as required. | FOL or designee, Tetra Tech | Internal |
| Analytical Data Package | Verify all analytical data packages for completeness. The Laboratory QAM will sign the case narrative for each data package. | Laboratory QAM, Empirical | Internal |
| Electronic Data Deliverables (EDDs)/ Analytical Data Packages | Check each EDD against the chain-of-custody and hard copy data package for accuracy and completeness. Compare laboratory analytical results to the electronic analytical results to verify accuracy. Evaluate sample results for laboratory contamination and qualify false detections using the laboratory method/preparation blank summaries. Qualify analyte concentrations between the DL and the LOQ as estimated. Remove extraneous laboratory qualifiers from the validation qualifier. | Data Validators, Tetra Tech | External |

| Data Review Input | Description | Responsible for Verification (name, organization) | Internal/ External |
|---|---|---|---|
| Analytical Data Package | Verify each data package for completeness. Request missing information from the Laboratory PM. | Data Validators, Tetra Tech | External |
| SAP/ Laboratory Data Packages/ EDDs | Ensure that the laboratory QC samples were analyzed and that the MPCs listed in were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed and that the analytical QC criteria set up for this project were met. | Data Validators, Tetra Tech | External |
| SAP/ Laboratory Data Packages/ EDDs | Check the field sampling precision by calculating RPDs for field duplicate samples. Check laboratory precision by reviewing the RPD or percent difference values from laboratory duplicate analyses; MS/MSDs; and LCS/LCSD, if available. Ensure compliance with the methods and project MPCs accuracy goals listed in the SAP. | Data Validators, Tetra Tech | External |
| SAP/ Laboratory Data Packages/ EDDs | Check that the laboratory recorded the temperature at sample receipt and the pH of samples preserved with acid or base to ensure sample integrity from sample collection to analysis. | Data Validators, Tetra Tech | External |
| SAP/ Laboratory Data Packages/ EDDs | Review the chain-of-custody forms generated in the field to ensure that the required analytical samples have been collected, appropriate sample identifications have been used, and correct analytical methods have been applied. The Tetra Tech Data Validator will verify that elements of the data package required for validation are present, and if not, the laboratory will be contacted and the missing information will be requested. Check that all data have been transferred correctly and completely to the Tt SQL database. | Data Validators, Tetra Tech | External |
| SAP/ Laboratory Data Packages/ EDDs | Ensure that the project LOQs listed in SAP were achieved. | Data Validators, Tetra Tech | External |

| Data Review Input | Description | Responsible for Verification (name, organization) | Internal/ External |
|---|---|---|---|
| SAP/ Laboratory Data Packages/ EDDs | Discuss the impact on DLs that are elevated because of matrix interferences. Be especially cognizant of and evaluate the impact of sample dilutions on low-concentration analytes when the dilution was performed because of the high concentration of one or more other contaminants. Document this usability issue and inform the Tetra Tech PM. Review and add PALs to the laboratory EDDs. Flag samples and notify the Tetra Tech PM of samples that exceed PALs listed in SAP. | Data Validators, Tetra Tech | External |
| SAP/ Laboratory Data Packages/ EDDs | Ensure that all QC samples specified in the SAP were collected and analyzed and that the associated results were within prescribed SAP acceptance limits. Ensure that QC samples and standards prescribed in analytical SOPs were analyzed and within the prescribed control limits. If any significant QC deviations occur, the Laboratory QAM shall have contacted the Tetra Tech PM. | Data Validators, Tetra Tech | External |
| SAP/ Laboratory Data Packages/ EDDs | Summarize deviations from methods, procedures, or contracts in the Data Validation Report. Determine the impact of any deviation from sampling or analytical methods and SOPs requirements and matrix interferences effect on the analytical results. Qualify data results based on method or QC deviation and explain all the data qualifications. Print a copy of qualified data stored the project database to depict data qualifiers and data qualifier codes that summarize the reason for data qualifications. Determine if the data met the MPCs and determine the impact of any deviations on the technical usability of the data. | Data Validators, Tetra Tech | External |

| Data Review Input | Description | Responsible for Verification (name, organization) | Internal/ External |
|---|---|---|---|
| Soil – RDX and TNT | Validation will be performed using criteria for SW-846 Methods 8330A listed in this SAP and the current DoD QSM. The logic outlined in USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review USEPA-540/R-99-008, (USEPA, October 1999) will be used to apply qualifiers to data to the extent possible. | Data Validators, Tetra Tech | External |
| Soil – Lead | Validation will be performed using criteria for SW-846 Method 6010C listed in this SAP and the current DoD QSM. The logic outlined in USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA, October 2004) will be used to apply qualifiers to data to the extent possible. | Data Validators, Tetra Tech | External |

## REFERENCES

Tetra Tech 2009. Corrective Measures Proposal for Solid Waste Management Unit 3, Naval Surface Warfare Center, Crane, Indiana, July 2009.

Tetra Tech 2005. Resource Conservation and Recovery Act Facilities Investigation Report for SWMU 03 – Old Jeep Trail/Little Sulphur Creek, Naval Surface Warfare Center Crane Division, Crane, Indiana, January 2005

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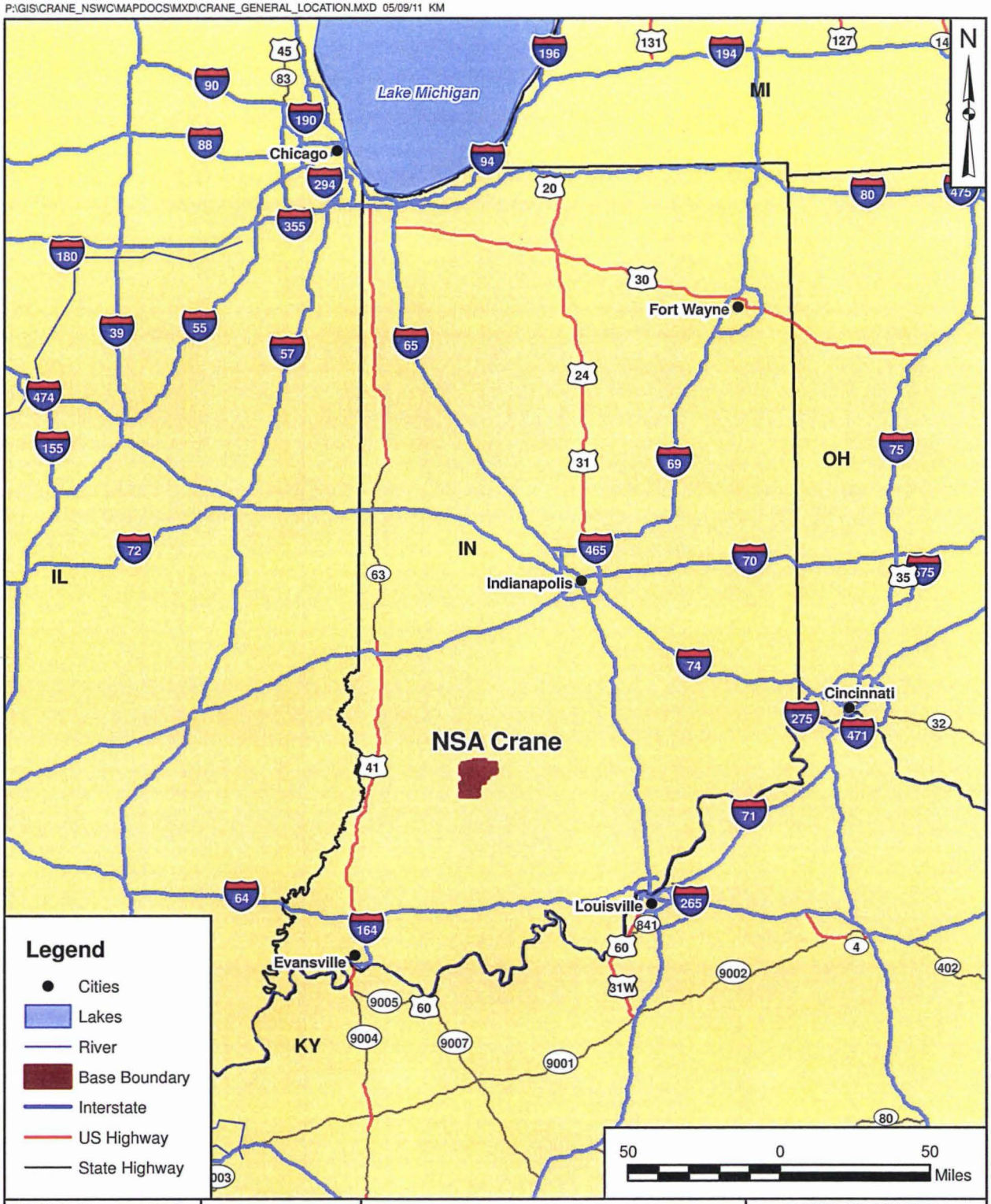


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| CHECKED BY J. DUCAR | DATE 05/09/11 | | OWNER NUMBER — |
| REVISED BY — | DATE — | | APPROVED BY — / DATE — |
| SCALE AS NOTED | | | FIGURE NO. FIGURE 4-1 / REV 0 |

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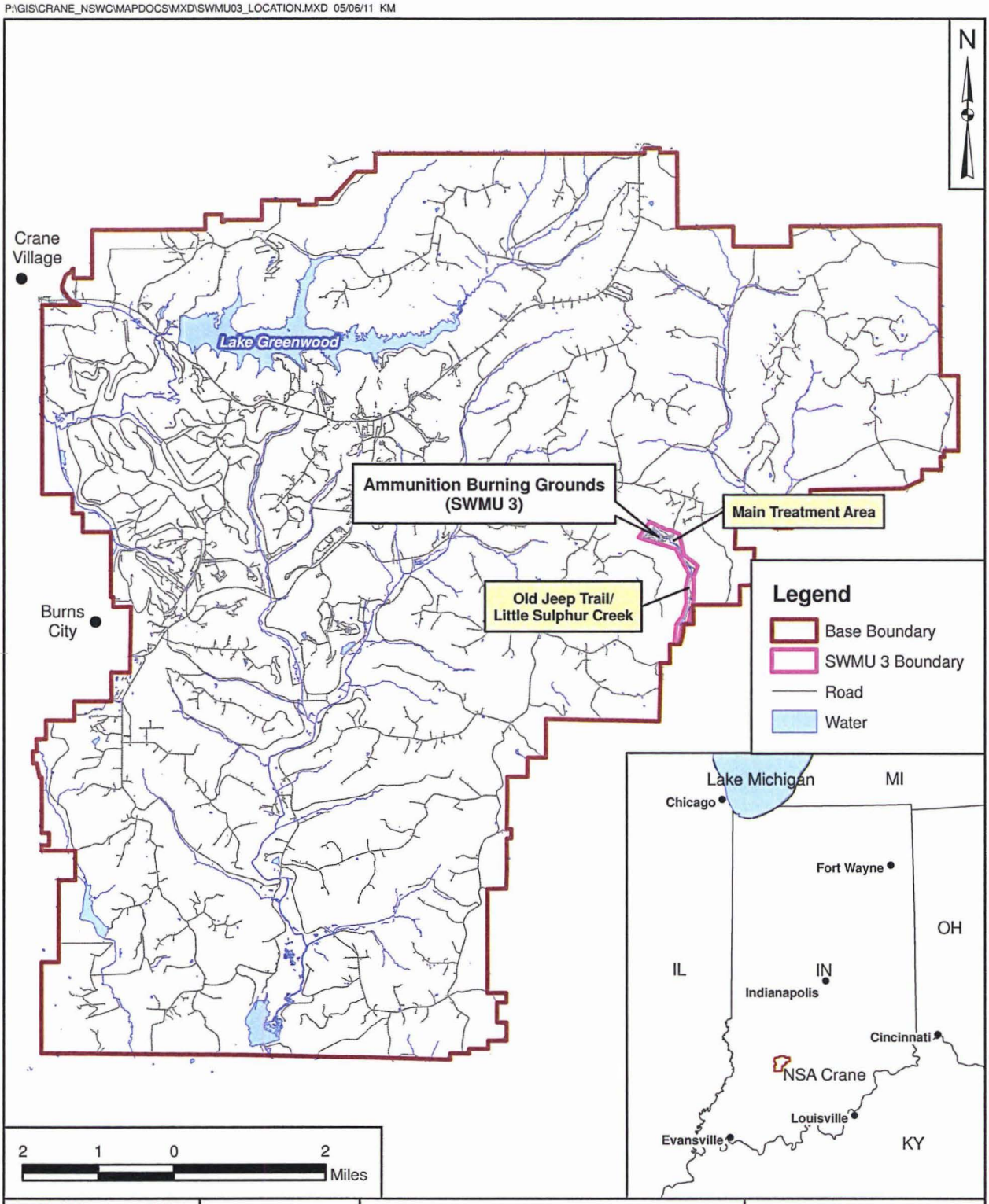


| DRAWN BY | DATE | | | CONTRACT NUMBER |
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| CHECKED BY | DATE | | SWMU 3 - AMMUNITION BURNING GROUNDS/ | OWNER NUMBER |
| J. DUCAR | 05/06/11 | | OJT TREATMENT AREA | — |
| REVISED BY | DATE | | NSA CRANE | APPROVED BY / DATE |
| — | — | | CRANE, INDIANA | — / — |
| SCALE | | NAVFAC | | FIGURE NO. / REV |
| AS NOTED | | | | FIGURE 4-2 / 0 |

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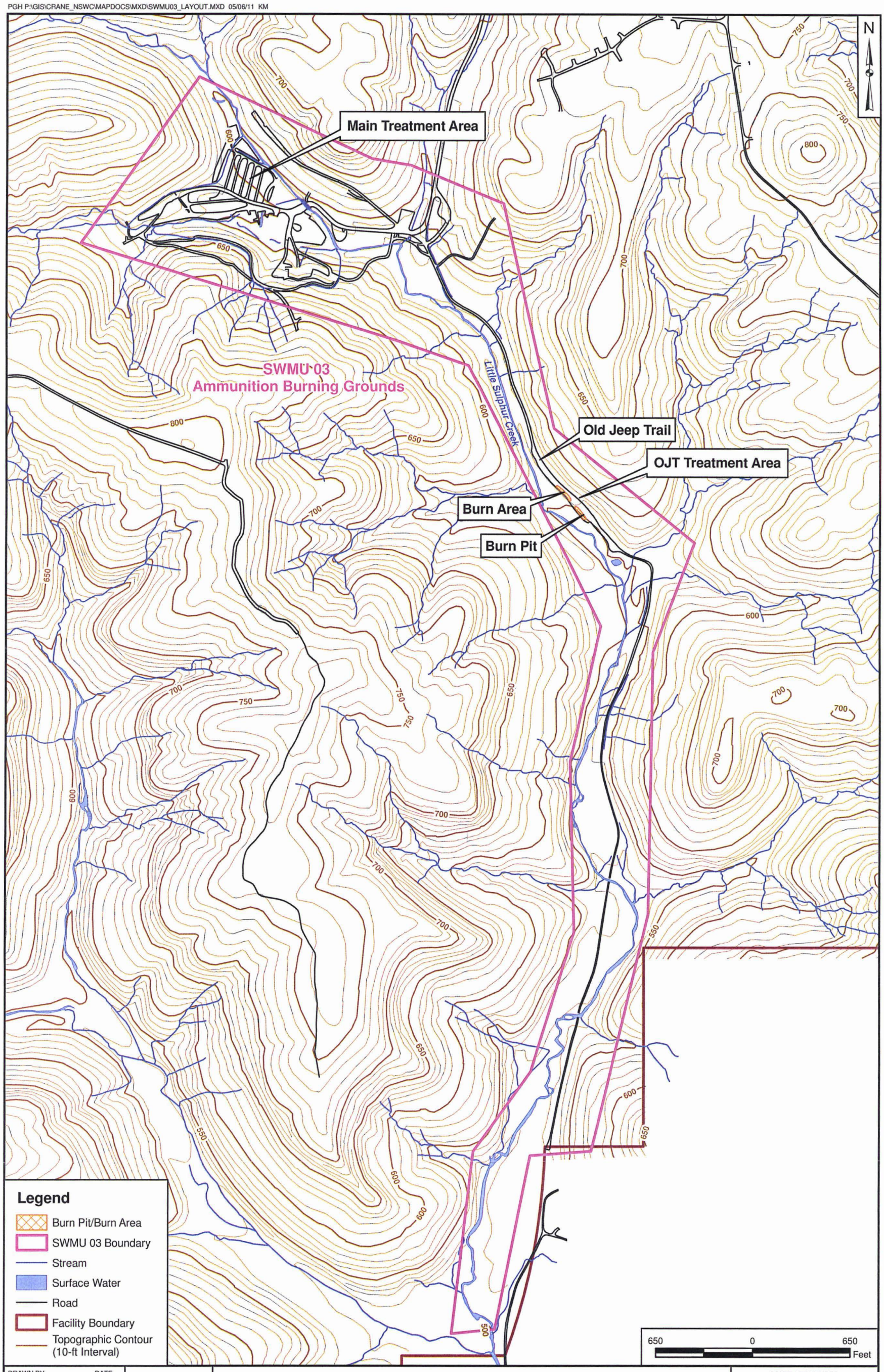


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| AS NOTED | |

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SITE LOCATION MAP

SWMU 03 - AMMUNITION BURNING GROUNDS/OJT TREATMENT AREA

NSA CRANE

CRANE, INDIANA

| CONTRACT NUMBER | |
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| CTO F274 | |
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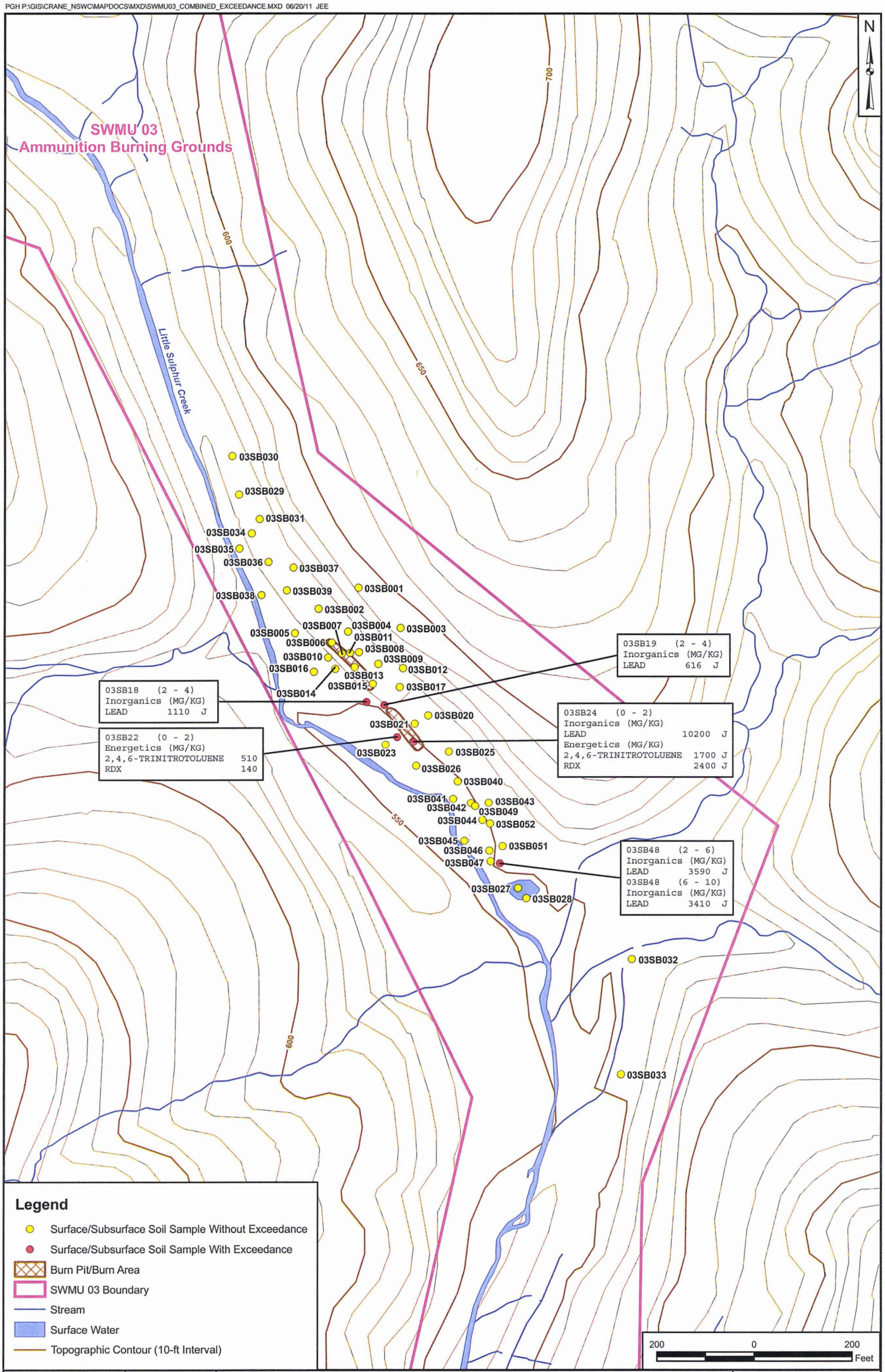


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| T. WHEATON | 04/07/11 |
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| J. DUCAR | 06/20/11 |
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| SCALE | |
| AS NOTED | |

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LEAD AND EXPLOSIVES EXCEEDANCES IN
SURFACE AND SUBSURFACE SOIL
SWMU 03 - AMMUNITION BURNING GROUNDS/OJT TREATMENT AREA
NSA CRANE
CRANE, INDIANA

| CONTRACT NUMBER | |
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| CTO F274 | |
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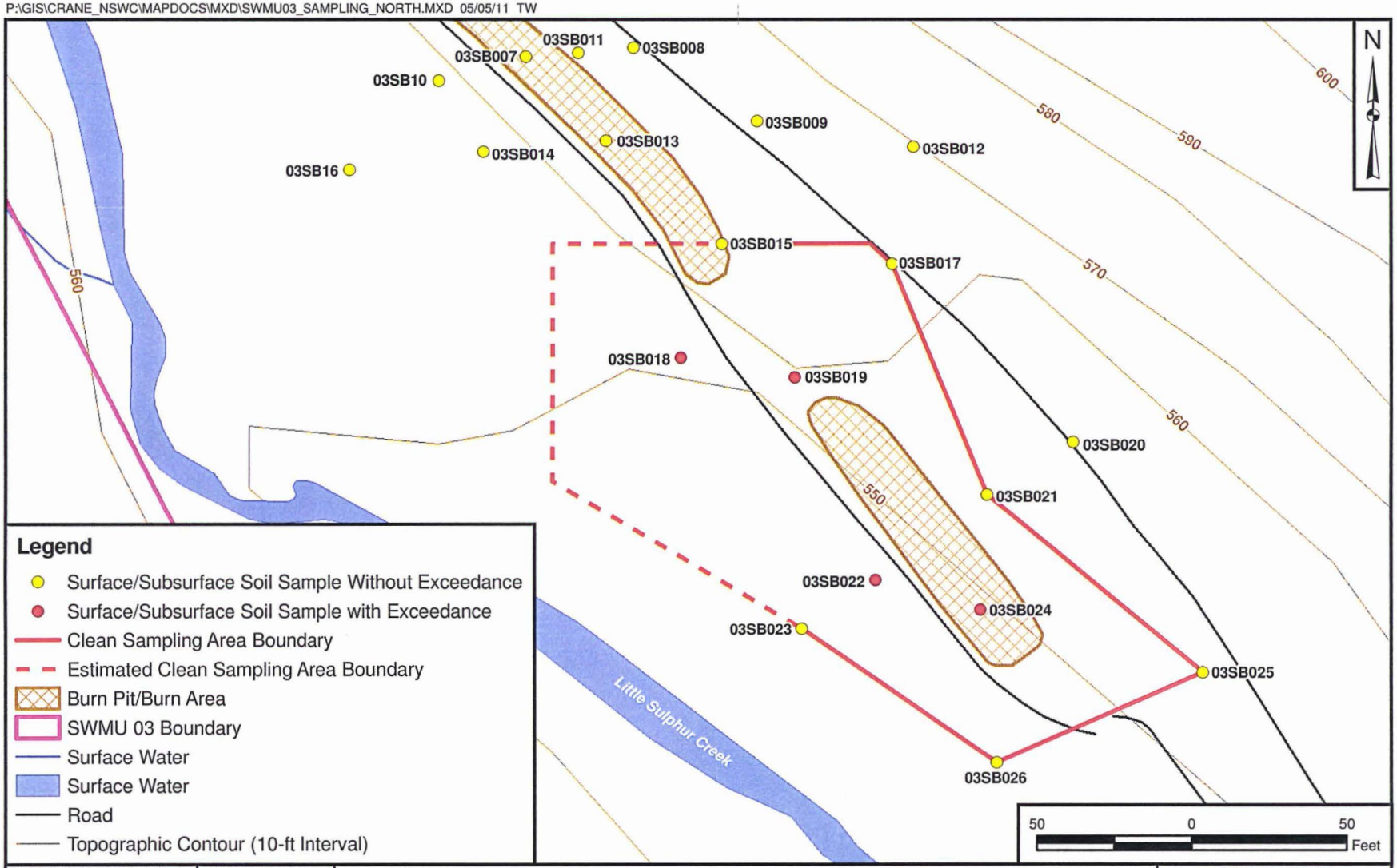


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| J. DUCAR | 05/06/11 |
| REVISED BY | DATE |
| K. MOORE | 05/06/11 |
| SCALE | |
| AS NOTED | |

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ESTIMATED EXCAVATION AREA NORTH
SWMU 03 - AMMUNITION BURNING GROUNDS/OJT TREATMENT AREA
NSA CRANE
CRANE, INDIANA

| CONTRACT NUMBER | |
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| APPROVED BY | DATE |
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| FIGURE 5-1 | 0 |

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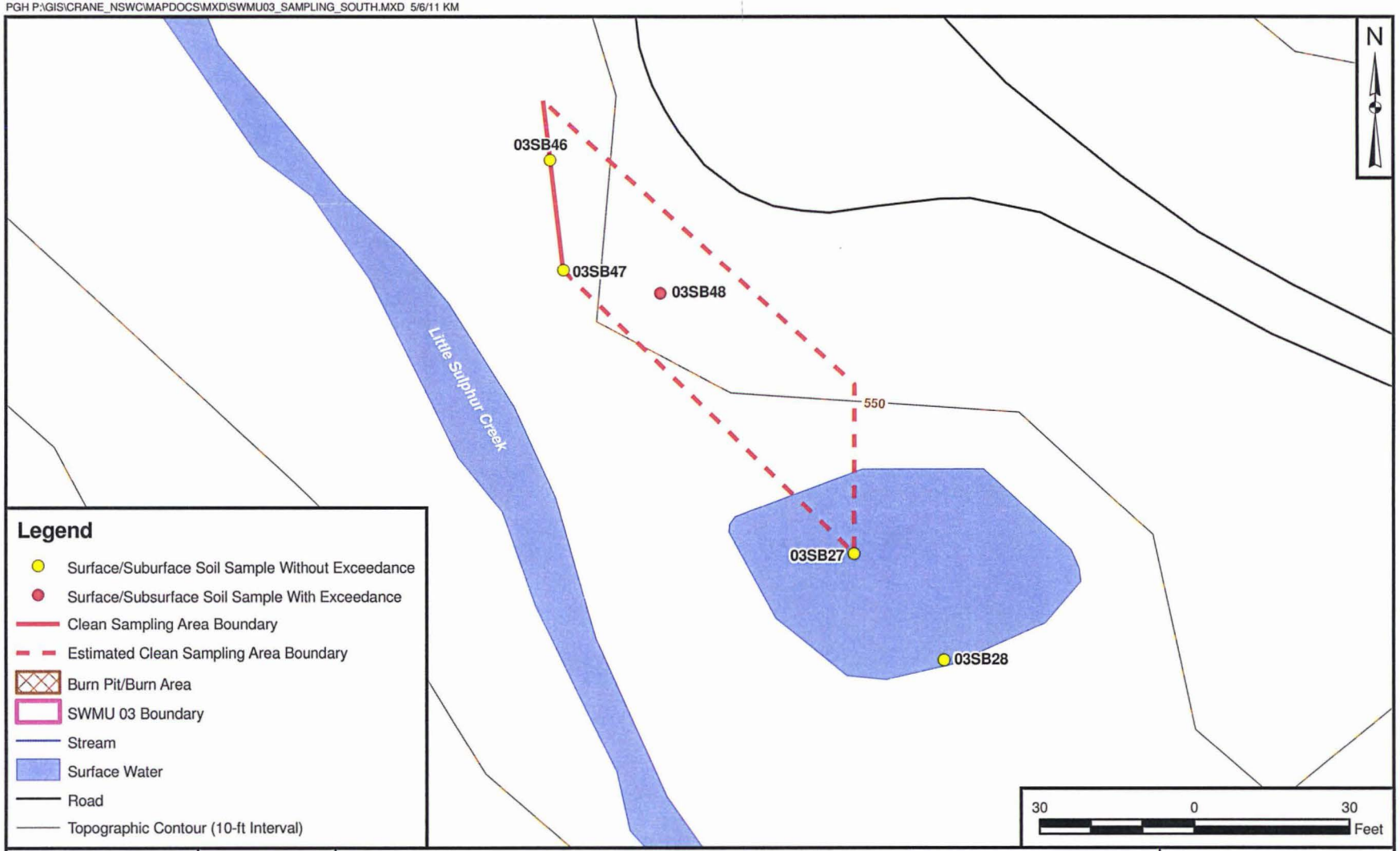


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| J. DUCAR | 5/6/11 |
| REVISED BY | DATE |
| K. MOORE | 5/6/11 |
| SCALE | |
| AS NOTED | |

NAVFAC

ESTIMATED EXCAVATION AREA SOUTH
SWMU 03 - AMMUNITION BURNING GROUNDS/OJT TREATMENT AREA
NSA CRANE
CRANE, INDIANA

| CONTRACT NUMBER | |
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| FIGURE NO. | REV |
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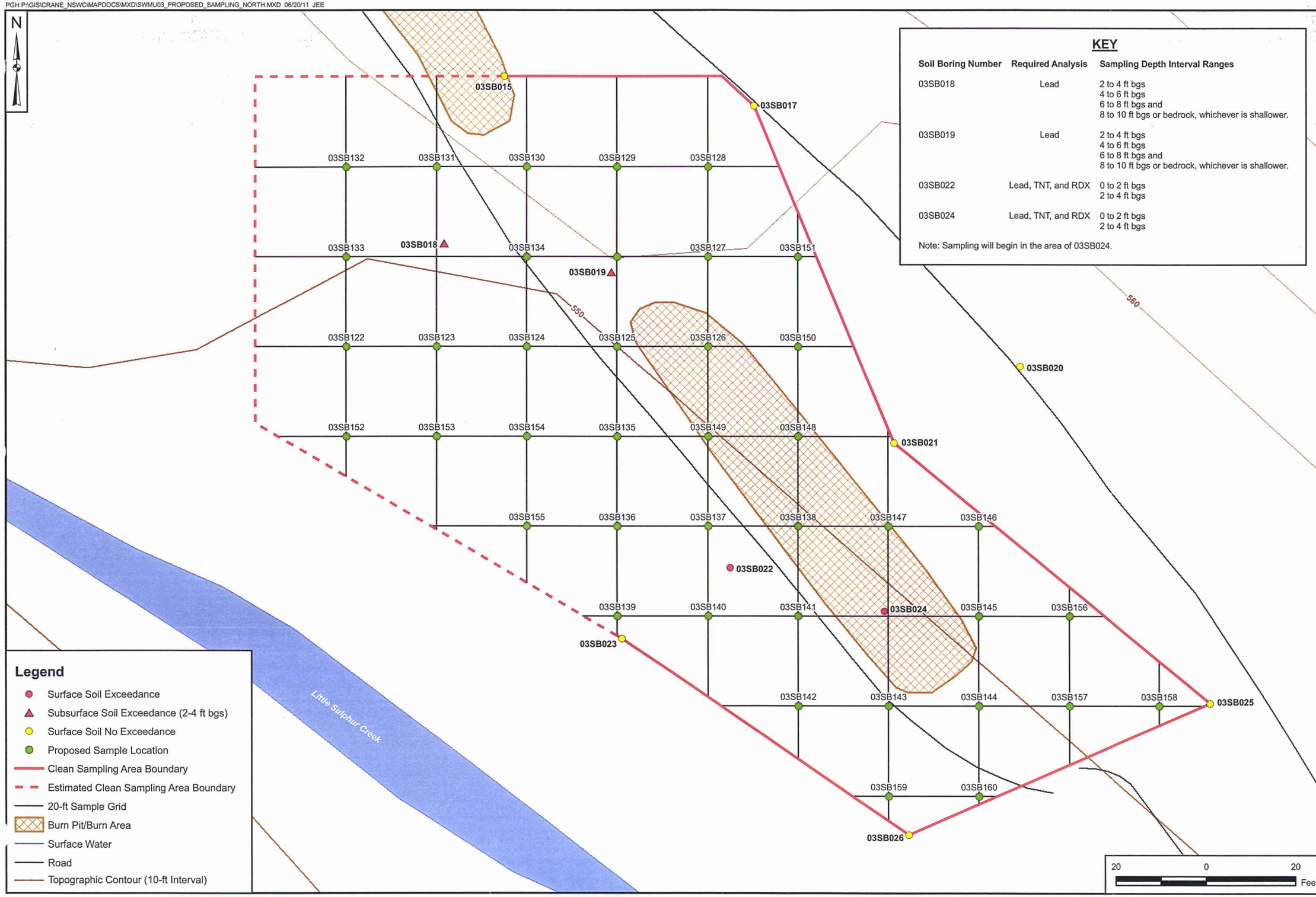


## KEY

| Soil Boring Number | Required Analysis | Sampling Depth Interval Ranges |
|---|---|---|
| 03SB018 | Lead | 2 to 4 ft bgs<br>4 to 6 ft bgs<br>6 to 8 ft bgs and<br>8 to 10 ft bgs or bedrock, whichever is shallower. |
| 03SB019 | Lead | 2 to 4 ft bgs<br>4 to 6 ft bgs<br>6 to 8 ft bgs and<br>8 to 10 ft bgs or bedrock, whichever is shallower. |
| 03SB022 | Lead, TNT, and RDX | 0 to 2 ft bgs<br>2 to 4 ft bgs |
| 03SB024 | Lead, TNT, and RDX | 0 to 2 ft bgs<br>2 to 4 ft bgs |

Note: Sampling will begin in the area of 03SB024.

## Legend

- Surface Soil Exceedance
- Subsurface Soil Exceedance (2-4 ft bgs)
- Surface Soil No Exceedance
- Proposed Sample Location
- Clean Sampling Area Boundary
- Estimated Clean Sampling Area Boundary
- 20-ft Sample Grid
- Burn Pit/Burn Area
- Surface Water
- Road
- Topographic Contour (10-ft Interval)

CONTRACT NUMBER CTO F274

APPROVED BY ___ DATE ___

APPROVED BY ___ DATE ___

FIGURE NO. FIGURE 7-1

REV 0

# PROPOSED SAMPLING LOCATIONS - NORTH
## SWMU 3 - AMMUNITION BURNING GROUNDS/OJT TREATMENT AREA
## NSA CRANE
## CRANE, INDIANA

NAVFAC

DRAWN BY T. WHEATON DATE 04/18/11

CHECKED BY J. DUCAR DATE 06/20/11

REVISED BY ___ DATE ___

SCALE AS NOTED

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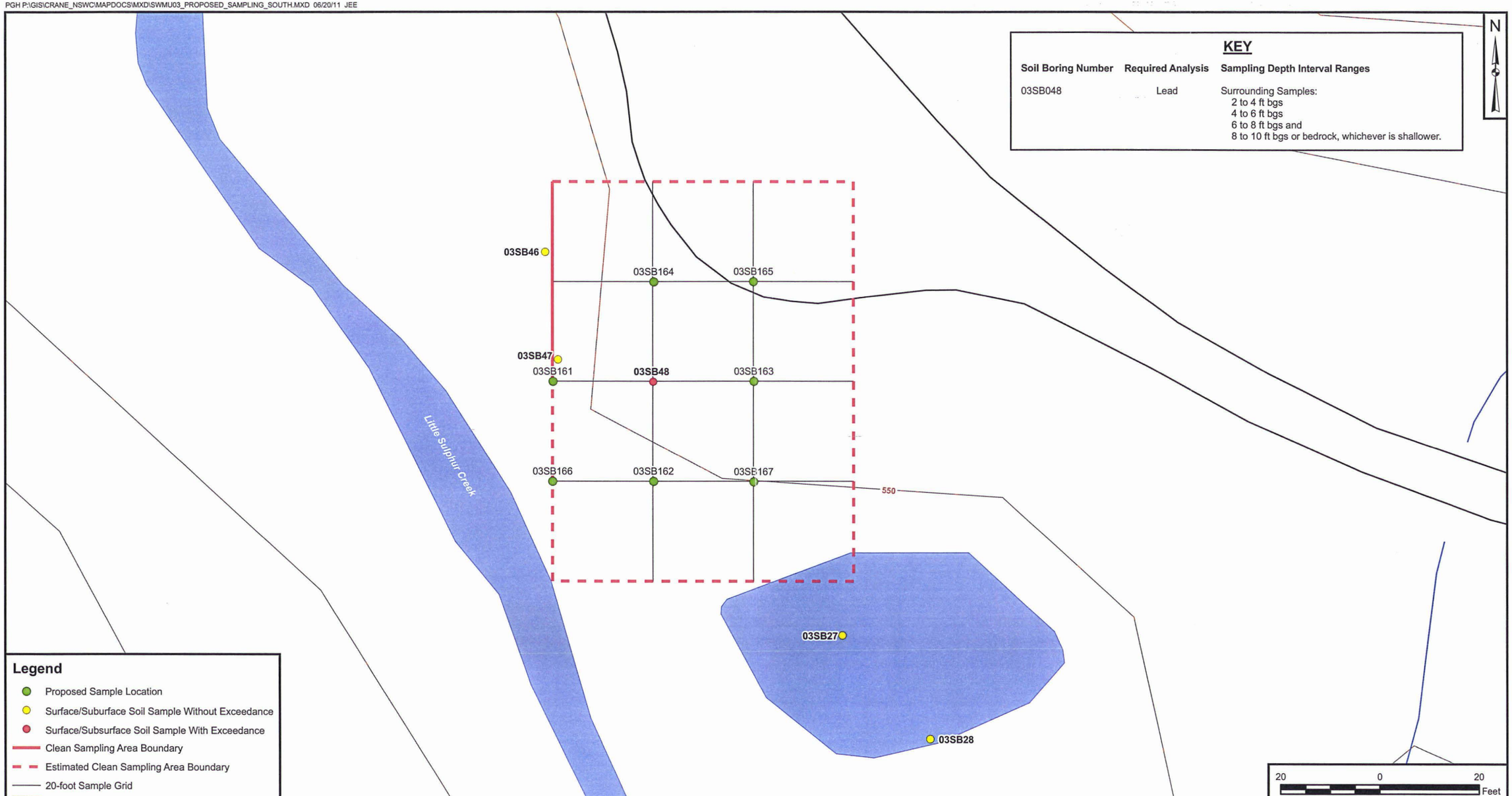


**KEY**

| Soil Boring Number | Required Analysis | Sampling Depth Interval Ranges |
|---|---|---|
| 03SB048 | Lead | Surrounding Samples:<br>2 to 4 ft bgs<br>4 to 6 ft bgs<br>6 to 8 ft bgs and<br>8 to 10 ft bgs or bedrock, whichever is shallower. |

**Legend**

- Proposed Sample Location
- Surface/Suburface Soil Sample Without Exceedance
- Surface/Subsurface Soil Sample With Exceedance
- Clean Sampling Area Boundary
- Estimated Clean Sampling Area Boundary
- 20-foot Sample Grid
- Burn Pit/Burn Area
- SWMU 03 Boundary
- Stream
- Surface Water
- Road
- Topographic Contour (10-ft Interval)

| DRAWN BY | DATE |
|---|---|
| T. WHEATON | 04/18/11 |
| CHECKED BY | DATE |
| J. DUCAR | 06/20/11 |
| REVISED BY | DATE |
| | |
| SCALE | |
| AS NOTED | |

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PROPOSED SAMPLING LOCATIONS - SOUTH
SWMU 03 - AMMUNITION BURNING GROUNDS/OJT TREATMENT AREA
NSA CRANE
CRANE, INDIANA

| CONTRACT NUMBER | |
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| FIGURE NO. | REV |
| FIGURE 7-2 | 0 |

**FIGURE 7-3**

## HOT SPOT TYPE 1 - SAMPLE LOG SHEET

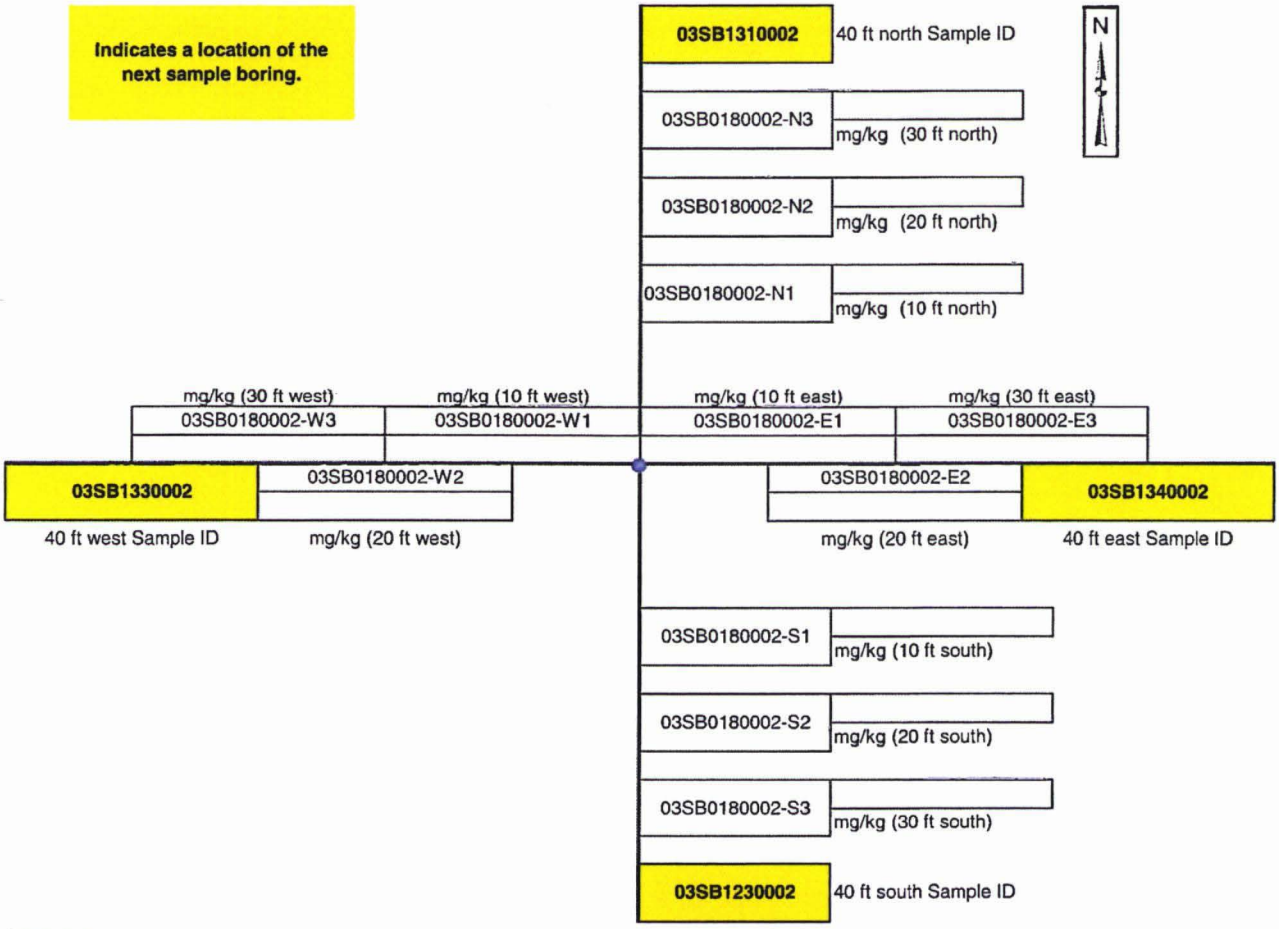
PAGE _____ of _____

| | | |
|---|---|---|
| CLIENT NSA Crane | | JOB NUMBER |
| SUBJECT SWMU 3 - Ammunition Burning Ground/OJT Treatment Area Delineation Soil Sampling | | |
| BY: | DATE: | DRAWING NUMBER Figures 7-1 & 7-2 |

**Objective:** Collect XRF step-out data associated with soil boring locations (03SB018, 03SB019, 03SB048) with Lead at a concentration that exceed the MCS.

**Inputs and Assumptions:** XRF samples will be collected along the northern, southern, eastern, and western axes from a soil boring location know to be contaminated with lead a concentration greater than 400 mg/kg.

● Soil Boring Number: 03SB018 (no surface soil sample at node) Sample depth: 0 - 2 feet
Contaminant: Lead




Comments: No surface soil sample at the 03SB018 because the 0 to 2 ft bgs sample was less than the MCS at the soil boring.

FIGURE 7-4

## HOT SPOT TYPE 2 - SAMPLE LOG SHEET

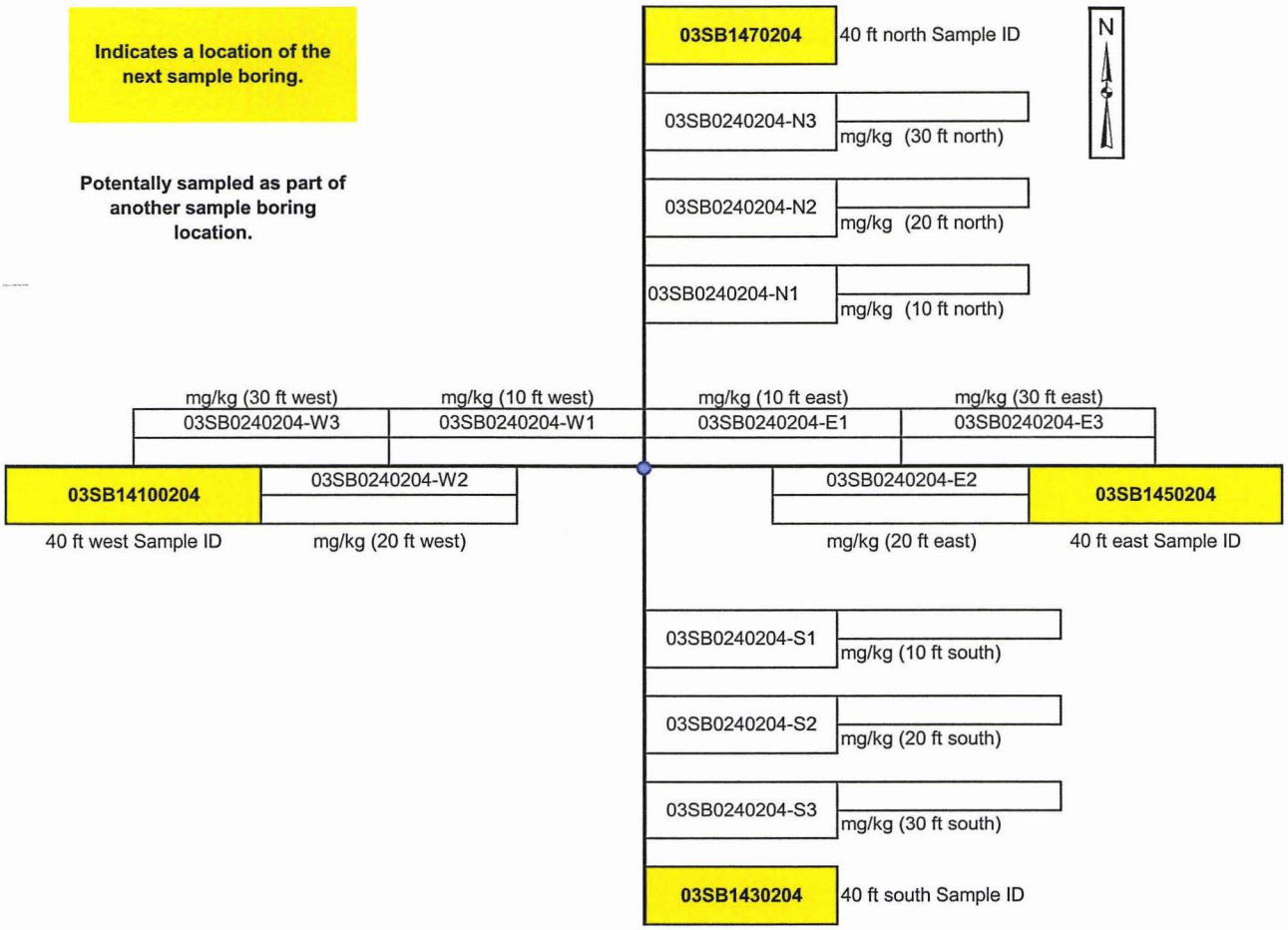
PAGE _____ of _____

| CLIENT NSA Crane | | JOB NUMBER |
|---|---|---|
| SUBJECT SWMU 3 - Ammunition Burning Ground/OJT Treatment Area Soil Sampling | | |
| BY: | DATE: | DRAWING NUMBER Figure 7-1 |

**Objective:** Develop a system for identifying the step out sample locations for 03SB022 and 03SB024.

**Inputs and Assumptions:** Lead, TNT, and RDX samples will be collected along the northern, southern, eastern, and western axes from both soil boring locations 03SB022 and 03SB024.

Soil Boring Number: 03SB024 (no surface soil sample at node) Sample depth: 2 - 4 feet
Contaminant: Lead, TNT, and RDX




Comments:

No surface soil sample at the 03SB024 because the 0 to 2 ft bgs sample was previously sampled.

Only samples from the 2 to 4 ft bgs sample depth interval will be collected for nodes associated with 03SB024.

A 0 to 2 ft sample was collected at 03SB141 for TNT only.

When the lead XRF exceeds 200 mg/kg, the sample will be sent to the fix base laboratory for lead, TNT, and RDX analyses.

# APPENDIX A

# SITE-SPECIFIC FIELD STANDARD OPERATING PROCEDURES AND FIELD FORMS

# STANDARD OPERATING PROCEDURE
# SOP-01

# SAMPLE LABELING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures to be used for labeling sample containers. Sample labels are used to document the sample identification number (ID), date, time, analysis to be performed, preservative, matrix, sampler, and the analytical laboratory. A sample label will be attached to each sample container.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Writing utensil (preferably black pen with indelible ink)**
**Disposable medical-grade gloves (e.g. latex, nitrile)**
**Sample log sheets**
**Required sample containers:** All sample containers for analysis by fix-based laboratories will be supplied and deemed certified-clean by the laboratory.
**Sample labels**
**Chain-of-custody records**
**Sealable polyethylene bags**
**Heavy-duty cooler**
**Ice**

## 3.0 PROCEDURES

3.1 The following information will be electronically printed on each sample label prior to mobilizing for field activities. Additional "generic" labels will also be printed prior to mobilization to be used for field QC and backups.

- Project Number
- Sample Location ID
- Contract Task Order Number (CTO F274)
- Sample ID

- Sample Matrix
- Preservative
- Analysis to be Performed
- Laboratory Name

3.2 Select the container(s) that are appropriate for a given sample. Select the sample-specific ID label(s), complete date, time, and sampler name, and affix to the sample container(s).

3.3 Fill the appropriate containers with sample material. Securely close the container lids without overtightening.

3.4 Place the sample container in a sealable polyethylene bag and place in a cooler containing ice.

Example of a sample label is attached at the end of this SOP.

## 4.0 ATTACHMENTS

1. Sample Label

**ATTACHMENT 1**
**SAMPLE LABEL**

| | | |
|---|---|---|
| Tetra Tech NUS, Inc.<br>661 Andersen Drive<br>Pittsburgh, 15220<br>(412)921-7090 | Project:<br>Location:<br>CTO: | |
| Sample No: | | Matrix: |
| Date: | Time: | Preserve: |
| Analysis: | | |
| Sampled by: | Laboratory | |

# STANDARD OPERATING PROCEDURE
# SOP-02

# SAMPLE IDENTIFICATION NOMENCLATURE

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish a consistent sample nomenclature system that will facilitate subsequent data management at the Naval Support Activity (NSA) Crane. The sample nomenclature system has been devised such that the following objectives can be attained.

- Sorting of data by site, location, or matrix
- Maintenance of consistency (field, laboratory, and database sample numbers)
- Accommodation of all project-specific requirements
- Accommodation of laboratory sample number length constraints
- Ease of sample identification

The NSA Crane Environmental Protection Department must approve any deviations from this procedure.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Writing utensil (preferably black pen with indelible ink)**
**Sample tags**
**Sample container labels**

## 3.0 SAMPLE IDENTIFICATION NOMENCLATURE

### 3.1 Environmental Samples

All environmental samples will be properly labeled with a sample label affixed to the sample container. Each sample will be assigned a unique sample tracking number.

#### 3.1.1 Environmental Sample Numbering Scheme

The sample tracking number will consist of a four- or five-segment alpha-numeric code that identifies the sample's associated Solid Waste Management Unit (SWMU) number, SWMU subarea letter (if

applicable), sample type, location, and for soil or sediment samples, where applicable, sample depth, and for aqueous samples, where applicable, whether a sample is filtered. For soil samples, the final four tracking numbers will identify the depth in units of feet below ground surface (bgs) at which the sample was collected (rounded to the nearest foot). For sediment samples, the final four tracking numbers will identify the depth in units of inches bgs at which the sample was collected.

The alphanumeric coding to be used is explained in the following diagram and subsequent definitions:

| **NN** | **AA** | **NNN (-F)** | **NNNN (Soils)** |
|---|---|---|---|
| SWMU Number | Matrix | Sample Location Number | Sequential depth interval from freshly exposed surface |

**Character Type:**

A = Alpha
N = Numeric

**SWMU Number (NN):**

03 = SWMU 03

**Matrix Code (AA):**

SS = Surface Soil Sample
SB = Subsurface Soil Sample

**Depth Interval (NNNN):**

This code section will be used for soil samples. The depth code is used to note the depth below ground surface (bgs) at which a soil sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth numbers specify the bottom interval of the sample depth. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet, boring log, logbook, etc.

**Depth (for soil, in feet bgs)**

0002 = soil collected from 0 to 2 feet bgs

0204 = soil collected from 2 to 4 feet bgs

0810 = soil collected from 8 to 10 feet bgs

### 3.1.2 Examples of Sample Nomenclature

A soil sample collected from soil boring location 003 at SWMU 03, at a depth of 0- to 2-feet bgs would be labeled as "03SB0030002".

## 3.2 Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature

Field QA/QC samples are described in the UFP-SAP. They will be designated using a different coding system than the one used for regular field samples.

### 3.2.1 QC Sample Numbering

The QC code will consist of a four-segment alpha-numeric code that identifies the SWMU number, sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

| NN | AA | NNNNNN | NN |
|---|---|---|---|
| SWMU Number | QC Type | Date | Sequence Number (per day) |

The QC types are identified as:

TB = Trip Blank

RB = Rinsate Blank

FD = Field Duplicate

SB = Source Water Blank

The sampling time recorded on the Chain-of-Custody Form, labels, and tags for duplicate samples will be "0000" so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

### 3.2.2 Examples of Field QA/QC Sample Nomenclature

The first trip blank associated with samples collected on June 6, 2011 would be designated as "03TB06061101".

# STANDARD OPERATING PROCEDURE
# SOP-03

# SAMPLE CUSTODY AND DOCUMENTATION OF FIELD ACTIVITIES

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures for sample custody and documentation of field sampling and field analyses activities.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following logbooks, forms, labels, and equipment are required.

**Writing utensil (preferably black pen with indelible ink)**
**Site logbook**
**Field logbook**
**Sample label**
**Chain-of-Custody Form**
**Custody seals**
**Equipment calibration log**
**Soil Boring Log**
**Soil and Sediment Sample Log Sheet**
**Surface Water Sample Log Sheet**

## 3.0 PROCEDURES

This section describes custody and documentation procedures. All entries made into the logbooks, custody documents, logs, and log sheets described in this SOP must be made in indelible ink (black is preferred). No erasures are permitted. If an incorrect entry is made, the entry will be crossed out with a single strike mark, initialed, and dated.

## 3.1 Site Logbook

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major on-site activities are documented. At a minimum, the following activities and events will be recorded (daily) in the site logbook:

- All field personnel present
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start or completion of sampling activities
- Daily on-site activities performed each day
- Sample pickup information
- Health and safety issues
- Weather conditions

The site logbook is initiated at the start of the first on-site activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day that on-site activities take place.

The following information must be recorded on the cover of each site logbook:

- Project name
- Project number
- Book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). At the completion of each day's entries, the site logbook must be signed and dated by the Tetra Tech Field Operations Leader (FOL).

## 3.2 Field Logbooks

The field logbook is a separate, dedicated notebook used by field personnel to document his or her activities in the field. This notebook is hardbound and paginated. At a minimum, the following activities and events will be recorded (daily) in the field logbooks:

- Field personnel for activities in the field logbook
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start or completion of sampling activities
- Daily on-site activities performed each day
- Sample pickup information
- Health and safety issues
- Weather conditions

Entries are to be made for every day that on-site activities take place.

The following information must be recorded on the cover of each field logbook:

- Project name
- Project number
- Book number
- Start date
- End date

## 3.3 Sample Labels

Adhesive sample container labels must be completed and applied to every sample container. Information on the label includes the project name, location, sample number, date, time, preservative, analysis, matrix, sampler's initials, and the name of the laboratory performing the analysis. Sample labeling and nomenclature are described in SOP-01 and SOP-02, respectively.

## 3.4 Chain-of-Custody Form

The Chain-of-Custody Form (COC) is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as it is transferred from person to person. This

form must accompany any samples collected for laboratory chemical analysis. Each COC will be uniquely numbered. A copy of a blank COC form is attached at the end of this SOP.

The FOL must include the name of the laboratory in the upper right hand corner section to ensure that the samples are forwarded to the correct location. If more than one COC is necessary for any cooler, the FOL will indicate "Page __ of __" on each COC. The original (top) signed copy of the COC will be placed inside a sealable polyethylene bag and taped inside the lid of the shipping cooler. Once the samples are received at the laboratory, the sample custodian checks the contents of the cooler(s) against the enclosed COC(s). Any problems are noted on the enclosed COC Form (bottle breakage, discrepancies between the sample labels, COC form, etc.) and will be resolved through communication between the laboratory point-of-contact and the Tetra Tech Project Manager (PM). The COC form is signed and retained by the laboratory and becomes part of the sample's corresponding analytical data package.

## 3.5 Custody Seal

The custody seal is an adhesive-backed label and is part of the chain-of-custody process. Custody seals are used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transit to the laboratory. Custody seals will be signed and dated by the samplers and affixed across the opening edges of each cooler (two seals per cooler on opposite sides) containing environmental samples. The laboratory sample custodian will examine the custody seal for evidence of tampering and will notify the Tetra Tech PM if evidence of tampering is observed.

## 3.6 Equipment Calibration Log

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device requiring calibration. Entries must be made for each day the equipment is used.

## 3.7 Sample Log Sheets

The Soil and Sediment Sample Log Sheets are used to document the sampling of soil and sediment. Copies of the sample log sheets are attached at the end of the SOP. A sample log sheet will be prepared for each sample collected and submitted for laboratory analysis.

## 4.0 ATTACHMENTS

1. Chain-of-Custody Record
2. Equipment Calibration Log
3. Soil and Sediment Sample Log

# ATTACHMENT 1
# CHAIN-OF-CUSTODY RECORD

CHAIN OF CUSTODY | NUMBER | PAGE ____ OF _____

| PROJECT NO: | SITE NAME: | PROJECT MANAGER AND PHONE NUMBER | LABORATORY NAME AND CONTACT: |
|---|---|---|---|
| SAMPLERS (SIGNATURE) | | FIELD OPERATIONS LEADER AND PHONE NUMBER | ADDRESS |
| | | CARRIER/WAYBILL NUMBER | CITY, STATE |

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE
PLASTIC (P) or GLASS (G)

PRESERVATIVE
USED

TYPE OF ANALYSIS

| DATE YEAR | TIME | SAMPLE ID | MATRIX | GRAB (G) COMP (C) | No. OF CONTAINERS | | | | | | | | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 1. RELINQUISHED BY | DATE | TIME | 1. RECEIVED BY | DATE | TIME |
| 2. RELINQUISHED BY | DATE | TIME | 2. RECEIVED BY | DATE | TIME |
| 3. RELINQUISHED BY | DATE | TIME | 3. RECEIVED BY | DATE | TIME |

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

3/99
FORM NO. TINUS-001

**ATTACHMENT 2**
**EQUIPMENT CALIBRATION LOG**

# EQUIPMENT CALIBRATION LOG

PROJECT NAME : _____ INSTRUMENT NAME/MODEL: _____

SITE NAME: _____ MANUFACTURER: _____

PROJECT No.: _____ SERIAL NUMBER: _____

| Date of Calibration | Instrument I.D. Number | Person Performing Calibration | Instrument Settings | | Instrument Readings | | Calibration Standard (Lot No.) | Remarks and Comments |
|---|---|---|---|---|---|---|---|---|
| | | | Pre-calibration | Post-calibration | Pre-calibration | Post-calibration | | |
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# ATTACHMENT 3

# SOIL AND SEDIMENT SAMPLE LOG SHEET

## SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| Date: | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Time: | | | |
| Method: | | | |
| Monitor Reading (ppm): | | | |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):**

# STANDARD OPERATING PROCEDURE
# SOP-04

# SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for sample preservation, packaging, and shipping to be used in handling soil, sediment, and aqueous samples.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Shipping labels**
**Custody seals**
**Chain-of-custody (COC) form(s)**
**Sample containers with preservatives**: All sample containers for analysis by fixed-base laboratories will be supplied, with preservatives added (if required) and deemed certified clean by the laboratory.
**Sample shipping containers (coolers)**: All sample shipping containers are supplied by the laboratory.
**Packaging material**: Bubble wrap, sealable polyethylene bags, strapping tape, etc.

## 3.0 PROCEDURES FOR SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

3.1 The laboratory provides sample containers with preservative already included (as required) for the analytical parameter for which the sample is to be analyzed. All samples will be held, stored, and shipped at 4 degrees Celsius (°C). This will be accomplished through refrigeration (used to hold samples prior to shipment) and/or ice.

3.2 The sampler shall maintain custody of the samples until the samples are relinquished to another custodian or to the common carrier.

3.3 Check that each sample container is properly labeled, the container lid is securely fastened, and the container is sealed in a polyethylene bag.

3.4 If the container is glass, place the sample container into a bubble-out shipping bag and seal the bag using the self-sealing, pressure sensitive tape supplied with the bag.

3.5 Inspect the insulated shipping cooler. Check for any cracks, holes, broken handles, etc. If the cooler has a drain plug, make certain it is sealed shut, both inside and outside of the cooler. If the cooler is questionable for shipping, the cooler must be discarded.

3.6 Line the cooler with large plastic bag, and line the bottom of the cooler with a layer of bubble wrap. Place the sample containers into the shipping cooler in an upright position (containers will be upright, with the exception of any 40-milliliter vials). Continue filling the cooler with ice until the cooler is nearly full and the movement of the sample containers is limited.

3.7 Wrap the large plastic bag closed and secure with tape.

3.8 Place the original (top) signed copy of the COC form inside a sealable polyethylene bag. Tape the bag to the inside of the lid of the shipping cooler.

3.9 Close the cooler and seal the cooler with approximately four wraps of strapping tape at each end of the cooler. Prior to wrapping the last wrap of strapping tape, apply a signed and dated custody seal to each side of the cooler (one per side). Cover the custody seal with the last wrap of tape. This will provide a tamper evident custody seal system for the sample shipment.

3.10 Affix shipping labels to each of the coolers, ensuring all of the shipping information is filled in properly. Overnight (e.g., FedEx Priority Overnight) courier services will be used for all sample shipments.

3.11 All samples will be shipped to the laboratory no more than 72 hours after collection. Under no circumstances should sample hold times be exceeded.

# STANDARD OPERATING PROCEDURE
# SOP-05

# BOREHOLE ADVANCEMENT AND SOIL CORING USING DIRECT-PUSH TECHNOLOGY AND HAND AUGER TECHNIQUES

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for collecting surface and subsurface soil cores from unconsolidated overburden materials using direct-push technology (DPT) and hand augering techniques at the NSA Crane facility.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Cut-resistant non-latex Impermeable Gloves**
**Cotton gloves**
**Disposable medical-grade gloves (e.g., latex, nitrile)**
**Writing utensil**
**Boring log sheets:** A copy of this form is included in SOP-09.
**DPT Equipment:**
- **DPT Probe Rig**
- **Geoprobe® Macrocore Sampler or equivalent**
- **Geoprobe® Sampling Kit or equivalent**
- **Clear acetate liners:** one new liner for each soil core

**Hand Auger Equipment:**
- **Stainless Steel Auger Buckets**
- **Stainless Steel Extension Rods**
- **Cross Handle**

**Required decontamination materials** (see SOP-09)
**Bentonite pellets**

## 3.0 BOREHOLE ADVANCEMENT AND SOIL SAMPLING USING A DPT

DPT will be employed to collect soil cores. DPT refers to sampling tools and sensors that are driven directly into the ground without the use of conventional rotary drilling equipment. DPT typically utilizes

hydraulic pressure and/or percussion hammers to advance the sampling tools. Geoprobe® is a manufacturer of a hydraulically powered, percussion/probing machine utilizing DPT to collect subsurface environmental samples.

3.1 Clear the area to be sampled of any surface debris (herbaceous vegetation, twigs, rocks, litter, etc.).

3.2 Place a new clear acetate liner in the detachable sampling core barrel, and attach the coring device to the DPT rig.

3.3 Drive the sampler (lined with an acetate sleeve) into the ground to the desired depth using hydraulic pressure.

3.4 Retract the sampler from the borehole, and remove the acetate liner and the soil core from the sampler barrel.

3.5 Attach the metal trough from the sampling kit firmly to a suitable surface.

3.6 Place the acetate liner containing the soil core in the trough.

3.7 While wearing cut-resistant gloves (constructed of non-latex over cotton), cut the acetate liner through its entire length using the double-bladed knife that accompanies the Geoprobe® Sampling Kit. Then remove the strip of acetate from the trough to gain access to the collected soils. **CAUTION:** Do not attempt to cut the acetate liner while holding it in your hand.

3.8 Log the soil core on the Boring Log Sheet (see SOP-07).

3.09 Place the soil core in a stainless-steel mixing bowl, thoroughly homogenize, and collect the remainder of the soil sample aliquots, as described in SOP-06.

3.10 Repeat steps 3.2 through 3.11 for the next depth intervals.

3.11 Upon completion of the boring, backfill the borehole with the soil from the location. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole. If soil materials from the boring are suspected of being contaminated, the soil boring will be backfilled with bentonite pellets up to the ground surface.

The contaminated material will be securely staged until arrangements are made for proper off-site disposal.

3.12 Decontaminate all soil sampling equipment in accordance with SOP-09 before collecting the next sample.

## 4.0 BOREHOLE ADVANCEMENT AND SOIL SAMPLING USING A HAND AUGER

Hand augers may be employed to collect soil cores when the area is inaccessible by the drill rig. A hand augering system generally consists of a variety of all stainless steel bucket bits (i.e. cylinders 6-1/2" long and 2-3/4", 3-1/4", and 4" in diameter), a series of extension rods (available in 2', 3', 4' and 5' lengths), a cross handle. A larger diameter bucket bit is commonly used to bore a hole to the desired sampling depth and then withdrawn. In turn, the larger diameter bit is replaced with a smaller diameter bit, lowered down the hole, and slowly turned into the soil at the completion depth or refusal. The apparatus is then withdrawn and the soil sample collected.

The hand auger can be used in a wide variety of soil conditions. It can be used to sample soil, both from the surface, or to depths in excess of 12 feet. However, the presence of rock layers and the collapse of the borehole normally contribute to its limiting factors.

4.1 Attach a properly decontaminated bucket bit into a clean extension rod and further attach the cross handle to the extension rod.

4.2 Clear the area to be sampled of any surface debris (vegetation, twigs, rocks, litter, etc.)

4.3 Begin augering to the desired sample depth (periodically removing accumulated soils from the bucket bit into a properly decontaminated stainless steel mixing bowl), and add additional rod extensions as necessary. Discard the top of the core (approximately 1"), which represents any loose material collected by the bucket bit before penetrating the sample material.

4.4 Log the soil core each time soil is placed into the mixing bowl on the Boring Log Sheet (see SOP-06). Also, note (in a field notebook or on standardized data sheets) the changes in the color, texture or odor of the soil.

4.5 After reaching the desired sample depth, slowly and carefully withdraw the apparatus from the borehole.

4.6 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the last of the sample material from the bucket bit and place into the properly decontaminated stainless steel mixing bowl and thoroughly homogenize the sample material prior to filling the sample containers, as described in SOP-07.

4.12 Excess soil core materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole.

4.13 If soil materials from the boring are suspected of being contaminated, the soil boring will be backfilled with bentonite pellets up to the ground surface.

4.14 Decontaminate all soil sampling equipment in accordance with SOP-09 before collecting the next sample.

# STANDARD OPERATING PROCEDURE
# SOP-06

# SOIL SAMPLE LOGGING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the standard procedures and technical guidance on the logging of soil samples.

## 2.0 FIELD FORMS AND EQUIPMENT

**Knife**
**Ruler** (marked in tenths and hundredths of feet)
**Boring Log:** An example of this form is attached.
**Writing utensil (preferably black pen with indelible ink)**

## 3.0 RESPONSIBILITIES

A field geologist or engineer is responsible for supervising all activities and assuring that each soil sample is properly and completely logged.

## 4.0 PROCEDURES FOR SAMPLE LOGGING

To maintain a consistent classification of soil, it is imperative that the field geologist understands and accurately uses the field classification system described in this SOP. This identification is based on visual examination and manual tests.

### 4.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure 1 (attached to this SOP). This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification

purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no distinguishable size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils will be divided into categories: rock fragments, sand, or gravel. The terms "sand" (S) and "gravel" (G) not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term "rock fragments" will be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges that are typically observed indicate little or no transport from their source area; and therefore, the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used, it will be followed by a size designation such as "(1/4-inch or ½-inch diameter)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

## 4.2 Color

Soil colors will be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Because color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples will be broken or split vertically to describe colors. Samplers tend to smear the sample surface, creating color variations between the sample interior and exterior.

The term "mottled" will be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

## 4.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are non-cohesive (particles do not adhere well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Figure 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in the following table.

**CONSISTENCY FOR COHESIVE SOILS**

| Consistency | Standard Penetration Resistance (Blows per Foot) | Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration) | Field Identification |
|---|---|---|---|
| Very soft | 0 to 2 | Less than 0.25 | Easily penetrated several inches by fist. |
| Soft | 2 to 4 | 0.25 to 0.50 | Easily penetrated several inches by thumb. |
| Medium stiff | 4 to 8 | 0.50 to 1.0 | Can be penetrated several inches by thumb with moderate effort. |
| Stiff | 8 to 15 | 1.0 to 2.0 | Readily indented by thumb but penetrated only with great effort. |
| Very stiff | 15 to 30 | 2.0 to 4.0 | Readily indented by thumbnail. |
| Hard | Over 30 | More than 4.0 | Indented with difficulty by thumbnail. |

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Figure 1).

The consistency of cohesive soils is determined by hand by determining the resistance to penetration by the thumb. The thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5-foot of the sample. The sample will be broken in half and the thumb pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. One of the other methods will be used in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in the above-listed table.

### 4.4 Weight Percentages

In nature, soils are consist of particles of varying size and shape and are combinations of the various grain types. The following terms are useful in the description of soil:

| Terms of Identifying Proportion of the Component | Defining Range of Percentages by Weight |
|---|---|
| Trace | 0 - 10 percent |
| Some | 11 - 30 percent |

| | |
|---|---|
| Adjective form of the soil type (e.g., sandy) | 31 - 50 percent |

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

## 4.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the gloved hand or on a porous surface liberates water (i.e., dirties or muddies the surface). Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire field activity.

## 4.6 Classification of Soil Grain Size for Chemical Analysis

To determine the gross grain size classification (e.g., clay, silt, and sand) from the USCS classification described above, the following table will be used.

| Gross Soil Grain Size Classification | USCS Abbreviation | Description |
|---|---|---|
| Clay | CL | inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. |
| | CH | inorganic clays of high plasticity, fat clays. |
| | OH | organic clays of medium to high plasticity, organic silts. |
| Silt | ML | inorganic silts and very fine sands, rock four, silty or clayey fine sands with slight plasticity. |
| | OL | organic silts and organic silty clays of low plasticity. |
| | MH | inorganic silts, micaceous or diatomaceous fine sand or silty soils. |
| Sand | SW | well graded sands, gravelly sands, little or no fines. |
| | SP | poorly graded sands, gravelly sands, little or no fines. |
| | SM | silty sands, sand-silt mixtures. |
| | SC | clayey sands, sand-clay mixtures. |

## 4.7 Summary of Soil Classification

In summary, soils will be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (optional)
- Soil types
- Moisture content
- Other distinguishing features
- Grain size
- Depositional environment

## 5.0 ATTACHMENTS

1. Figure 1 - Unified Soil Classification System
2. Boring Log

## ATTACHMENT 1

## FIGURE 1 - UNIFIED SOIL CLASSIFICATION SYSTEM

### Unified Soil Classification System

| | | | |
|---|---|---|---|
| Coarse Grained Soils (more than half of soil > No. 200 sieve) | Gravels (More than half of coarse fraction > no. 4 sieve size) | GW | Well graded gravels or gravel-sand mixtures, little or no fines |
| | | GP | Poorly graded gravels or gravel-sand mixtures, little or no fines |
| | | GM | Sandy gravels, gravel-sand-silt mixtures |
| | | GC | Clayey gravels, gravel-sand-silt mixtures |
| | Sands (More than half of coarse fraction < no. 4 sieve size) | SW | Well graded sands or gravelly sands, little or no fines |
| | | SP | Poorly graded sands or gravelly sands, little or no fines |
| | | SM | Silty sands, sand-silt mixtures |
| | | SC | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity |
| Fine Grained Soils (more than half of soil < No. 200 sieve) | Silts and Clays LL = < 50 | ML | Inorganic silts and very fine sands, rock flour, silty fine sands or clayey silts with slight plasticity |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays |
| | | OL | Organic silts and organic silty clays of low plasticity |
| | Silts and Clays LL = > 50 | MH | Inorganic silts, micaceous or diatomaceous fine sand or silty soils, elastic silts |
| | | CH | Inorganic silts of high plasticity, fat clays |
| | | OH | Organic clays of high plasticity, organic silty clays, organic silts |
| Highly Organic Soils | | Pt | Peat and other highly organic soils |

### Grain Size Chart

| Classification | Range of Grain Sizes | |
|---|---|---|
| | U.S. Standard Sieve Size | Grain Size In Millimeters |
| Boulders | Above 12" | Above 305 |
| Cobbles | 12" to 3" | 305 to 76.2 |
| Gravel | 3" to No. 4 | 76.2 to 7.76 |
| coarse | 3" to 3/4" | 76.2 to 4.76 |
| fine | 3/4" to No.4 | 19.1 to 4.76 |
| Sand | No. 4 to No. 200 | 4.76 to 0.074 |
| coarse | No.4 to No. 10 | 4.76 to 2.00 |
| medium | No. 10 to No. 40 | 2.00 to 0.420 |
| fine | No. 40 to No. 200 | 0.420 to 0.074 |
| Silt and Clay | Below No. 200 | Below 0.074 |

### Relative Density (SPT)

| SANDS AND GRAVELS | BLOWS/FOOT |
|---|---|
| VERY LOOSE | 0 – 4 |
| LOOSE | 4 – 10 |
| MEDIUM DENSE | 10 – 30 |
| DENSE | 32 – 50 |
| VERY DENSE | OVER 50 |

### Consistency (SPT)

| SILTS AND CLAYS | BLOWS/FOOT |
|---|---|
| VERY SOFT | 0 – 2 |
| SOFT | 2 – 4 |
| MEDIUM STIFF | 4 – 8 |
| STIFF | 8 – 16 |
| VERY STIFF | 16 – 22 |
| HARD | OVER 32 |

## ATTACHMENT 2

## BORING LOG

Tetra Tech NUS, Inc.

# BORING LOG

Page ___ of ___

PROJECT NAME: _____ BORING No.: _____
PROJECT NUMBER: _____ DATE: _____
DRILLING COMPANY: _____ GEOLOGIST: _____
DRILLING RIG: _____ DRILLER: _____

| Sample No. and Type or RQD | Depth (Ft.) or Run No. | Blows / 6" or RQD (%) | Sample Recovery / Sample Length | Lithology Change (Depth/Ft.) or Screened Interval | MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness | MATERIAL DESCRIPTION: Color | MATERIAL DESCRIPTION: Material Classification | USCS * | Remarks | PID/FID Reading (ppm): Sample | PID/FID Reading (ppm): Sampler BZ | PID/FID Reading (ppm): Borehole** | PID/FID Reading (ppm): Driller BZ** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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* When rock coring, enter rock brokeness.
** Include monitor reading in 6 foot intervals @ boreholes. Increase reading frequency if elevated response read.

Drilling Area Background (ppm): ____

Remarks: _____

Converted to Well: Yes _____ No _____ Well I.D. #: _____

# STANDARD OPERATING PROCEDURE
# SOP-07

# SURFACE AND SUBSURFACE SOIL SAMPLING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures to be used for surface and subsurface soil sampling using direct-push technology (DPT) or hand augers during field activities at the NSA Crane facility. This procedure also describes the collection of samples for analysis of volatile organic compounds (VOCs) using EnCore samplers and the use of field screening [i.e., photoionization detector (PID)] to select the most appropriate subsurface soil interval for VOC sampling.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Writing utensil (preferably black pen with indelible ink)**
**Disposable medical-grade gloves (i.e. latex, nitrile)**
**Boring log**
**Soil sample logsheets**
**Stainless-steel mixing bowls**
**Stainless-steel trowel or soup spoon**
**EnCore handle and samplers**
**Disposable trowels**
**Photoionization Detector (PID) or similar**
**Required sample containers**: All sample containers including shipping coolers for analysis by fixed-base laboratories will be supplied and certified clean by the laboratory.
**Required decontamination materials**
**Chain-of-custody records**
**Required personnel protective equipment (PPE)**
**Wooden stakes or pin flags**
**Survey tape**
**Marking Paint**
**Sealable polyethylene bags**
**Heavy-duty cooler**
**Ice**

**Razor knife**

**DPT Probe Rig and sampling equipment**

**Sample labels**

## 3.0 COLLECTION OF SOIL SAMPLES FOR VOLATILE ORGANIC COMPOUNDS (VOCs)

When soil cores are collected using DPT, such as Geoprobe®, 4- to 5-foot soil intervals will be collected in clear acetate tubes, which can be extracted from the Geoprobe® core barrel upon retrieval at the surface (see SOP-05). Note: A surface soil sample is collected from the 0- to 2-foot depth. Additional subsurface soil samples each consist of 2-foot core segments.

3.1 Slit the acetate liner lengthwise with a razor knife, remove a section of the liner, and expose the length of the soil interval (see SOP-05).

3.2 Scan the soil core interval with a PID, slowly moving the intake nozzle along the length of the core where the acetate liner has been slit open. Note on the boring log the range of PID readings that are detected and the specific location(s) along the sample interval where above-background readings are encountered. If elevated volatile organics are measured via the PID, collect the VOC samples from the specific interval where the highest PID reading is measured. If no above-background PID readings are measured, then the VOC sample will be collected from a specific interval where visual signs of contamination (staining, etc.) are observed. If no above-background PID reading is measured and no discoloration or odor in the soil core indicates potential contamination, then collect the VOC sample from near the center of a core.

3.3 A small quantity of undisturbed soil (approximately *6* oz.) is removed from the sampler (e.g., Macrocore®, split-spoon sampler, etc.) and immediately placed in a sealing (Ziploc®-type) plastic bag. Once sealed in the bag, the sample is gently massaged to break apart any large soil clumps. The bag is then warmed for 15 minutes in order to volatilize the potential contaminants from the soil sample into the head-space of the bag. After 15 minutes, the tip of the PID is carefully pushed directly through the plastic bag and a direct reading is obtained of the maximum detection. All head-space readings (maximum detection per sample) will be noted on the appropriate soil boring log and/or sample log form.

3.4 The 0- to 2-foot core interval will be collected as a surface soil sample. Determine where in this core interval the highest PID reading was encountered. Soil samples collected for volatile organics will be obtained directly from soil cores using four EnCore samplers for each VOC

sample. These samples are to be collected by pushing the EnCore samplers directly into the soil core where the highest PID readings were measured, ensuring that the sampler is packed tight with soil and leaving no headspace between cap and container. All four EnCore sample containers will be collected as close to each other as possible. Make sure that all caps are securely fastened to the samplers and locked in place with both clips (see instructions that come with samplers). Write the sample identification on the strip labels that come with the samplers and place a label on each of the four samplers.

3.5 Place the four EnCore samplers in the ziplock pouches that come with the samplers and fill in appropriate information, including sample identification, date, time, and other information on the label. Place the four pouches in a plastic bag and place the tag on the bag, identifying the sample identification and other necessary information (see SOP-01).

3.6 Once the samples are properly labeled and bagged, place the sample into the cooler containing ice and a trip blank. The cooler should be kept at 4°C and shipped to the analytical laboratory for preservation or extraction within 48 hours.

3.7 Fill in the required information on the Soil Sample Log Sheet (attached at the end of this SOP) and fill in the required information on the Chain-of-Custody (COC) Form.

## 4.0 COLLECTION OF OTHER SOIL SAMPLE ALIQUOTS

4.1 After the VOC sample has been collected for the soil interval of interest (see 3.0 above), the remainder of the remainder of the soil interval will be composited and used to fill the sample containers. Any surface debris (e.g., herbaceous vegetation, twigs, rocks, litter, etc.) should first be removed from the top of the surface soil core. For other core intervals, the top 2 inches of each core should be discarded because it often contains material scraped from the side of the borehole and not fresh material from the bottom of the borehole.

4.2 Slide the remaining core material out of the acetate liner and into a clean, decontaminated stainless-steel mixing bowl. Mix the soil thoroughly with a stainless-steel spoon and remove gravel, large pebbles, and other coarse materials. Fill the required sample containers in the following order:

- Containers for other organic analyses (including energetics, TPH, and perchlorate)
- Container for metals

- Container for pH

4.3 Complete all required information on the sample labels and secure the label to the sample container (see SOP-01).

4.4 Place the sample container in a ziplock plastic bag and seal shut. Place the bag in a cooler containing ice and cool to 4°C ± 2°C.

4.5 Record the required information on the Soil Sample Log Sheet and the COC Record form.

## 5.0 COLLECTION OF SOIL SAMPLES USING A HAND AUGER

5.1 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the sample material from the bucket bit and remove gravel, large pebbles, and other coarse materials.

5.2 Collect sample aliquot for VOCs directly from the hand auger bucket prior to disturbing the material. (See Sections 3.4 and 3.5 above.)

5.3 Slide the remaining core material out of the hand auger bucket and into a clean, decontaminated stainless-steel mixing bowl. Mix the soil thoroughly with a stainless-steel spoon and remove gravel, large pebbles, and other coarse materials. Fill the required sample containers in the following order:

5.4 Fill the remaining required sample containers for analysis.

5.5 Complete all required information on the sample labels and secure the label to the sample container (see SOP-01).

5.4 Place the sample container in a ziplock plastic bag and seal shut. Place the bag in a cooler containing ice and cool to 4°C ± 2°C.

5.6 Record the required information on the Soil Sample Log Sheet and the COC Record form.

## 6.0 PACKAGING AND SHIPPING OF SAMPLES

Samples will be packaged and shipped according to SOP-04.

## 7.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

# ATTACHMENT 1

## SOIL AND SEDIMENT SAMPLE LOG SHEET

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**SOIL & SEDIMENT SAMPLE LOG SHEET**

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| Date: | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Time: | | | |
| Method: | | | |
| Monitor Reading (ppm): | | | |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings | | | | |
| (Range in ppm): | | | | |
| | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

# STANDARD OPERATING PROCEDURE
# SOP-08

# FIELD PORTABLE X-RAY FLUORESCENCE ANALYSIS OF SOIL SAMPLES USING THE INNOV-X ALPHA SERIES INSTRUMENT

## 1.0 PURPOSE

This procedure is for the semiquantitative analysis of metallic lead particles and chemical compounds of lead in soil using a field portable x-ray fluorescence (FPXRF) spectrometer. This procedure is based on the United States Environmental Protection Agency (USEPA)-approved XRF field screening method for elemental analysis (Method 6200).

## 2.0 SCOPE, APPLICATION, AND LIMITATIONS

### 2.1 Scope of Procedure

Analysis of any other elements besides lead using FPXRF may require changes to this Standard Operating Procedure (SOP), and are therefore outside the scope of this SOP.

Although it is possible to use FPXRF to measure analytes in situ, this SOP requires removal of a soil sample from its native environment prior to analysis. By removing, drying, and homogenizing the sample prior to analysis, more precise and accurate results are obtained.

### 2.2 Analyst Training

Use of this method is restricted to personnel both trained and knowledgeable in the operation of the Innov-X alpha series XRF instrument or under the supervision of a trained and knowledgeable individual. Proper training for the safe operation of the instrument should be completed by the analyst prior to analysis. This training may be obtained directly from INNOV-X, an INNOV-X instrument distributor or lessor, or another trained Tetra Tech person.

## 3.0 ACRONYMS AND ABBREVIATIONS

FPXRF: Field portable x-ray fluorescence.
mg/kg: milligrams per kilogram.
MDL: Method detection limit.
PQL: Practical quantitation limit.
QC: Quality control.
RPD: Relative percent difference.
USGS: United States Geological Survey.
XRF: X-ray fluorescence.

## 4.0 RESPONSIBILITIES

Analyst/Chemist - Responsible for all aspects of sample preparation and analysis including equipment maintenance. Also responsible for maintaining chain-of-custody of samples after receipt from sampling personnel.

## 5.0 PROCEDURES

### 5.1 Safety

#### 5.1.1 Radiation Safety

Radiation safety practices for the INNOV-X instrument can be found in the operator's manual (typically shipped with unit). Protective shielding should never be removed by the analyst or any personnel other than the manufacturer.

An additional hazard present with x-ray tubes is the danger of electric shock from the high voltage supply. The danger of electric shock is as substantial as the danger from radiation but is often overlooked because of its familiarity.

#### 5.1.2 Protective Equipment

Analysts must wear disposable plastic gloves whenever sample aliquots are being transferred from one vessel to another. Consult the health and safety plan for other protection requirements.

## 5.2 Apparatus and Materials

Apparatus and materials consist of the following:

INNOV-X Alpha Series FPXRF spectrometer with data processing unit (iPAQ) pocket personnel computer):

INNOV-X Alpha Series XRF instrument manual to match the INNOV-X Alpha Series instrument.

Aluminum drying pans or aluminum foil: Sized suitably to hold as much as 50 grams of sample and fit into the drying oven.

Calibration verification check sample: A National Institute of Standards and Technology (NIST) or other Standard reference material (SRM) that contains lead in a concentration range that is compatible with the project objectives to verify the accuracy of the instrument. SRMs are shipped with the unit. Acceptable limits for SRM percent recoveries are usually provided with the SRMs. In their absence, a limit of ± 30 percent will be used as a guideline.

Instrument Blank: May be silicon dioxide, a Teflon block, a quartz block, "clean" sand, or lithium carbonate and is typically shipped with the unit.

Lead calibration check standard: Supplied by the FPXRF manufacturer.

Method blank material for performing method blank checks: May be lead-free silica sand or lithium carbonate that undergoes the same preparation procedure as the samples.

Battery charger.

Polyethylene sample cups: 31 millimeters (mm) to 40 mm in diameter with collar, or equivalent (appropriate for FPXRF instrument).

X-ray window film: Mylar™, Kapton™, Spectrolene™, polypropylene, or equivalent; 2.5 to 6.0 micrometers (µm) thick.

Sample containers: glass or plastic to store samples.

Sieves: 60-mesh Stainless steel, Nylon, or equivalent for preparing soil and sediment samples if necessary.

Trowels: for collecting soil samples.

Plastic bags: used for collection and homogenization of soil samples. May also be used as sample presentation device.

Drying oven: standard convection or toaster oven, for soil samples that require drying.

Rolling pin (optional): Wooden rolling pin for crushing dried samples.

## 5.3 Sample Collection, Preservation, and Handling

Samples shall be provided to the FPXRF analyst in plastic bags. The analyst is responsible for maintaining chain-of-custody of all samples until all analyses have been successfully completed. No sample preservation is necessary. All samples shall be handled in accordance with sample handling SOPs in effect for the field event.

## 5.4 Preventive Maintenance

Refer to the instrument manual for specific manufacturer's recommendations.

## 5.5 Instrument Start-Up

5.5.1 Ensure the pocket PC (iPAQ) is plugged into the FPXRF instrument body and install a fully charged battery into the instrument.

5.5.2 Press the ON/OFF button on the base of the pistol grip of the instrument. If the iPAQ does not automatically power up, press the Power button in the right corner of the iPAQ.

5.5.3 Tap the Microsoft icon at the upper left corner of the iPAQ.

5.5.4 Choose START.

5.5.5 Tap "Soil Mode" on the menu or choose Mode (bottom of screen) and then choose Soil Mode from the drop down menu.

5.5.6 Allow the instrument to warm up (approximately 3 minutes).

5.5.7 Release the manual trigger lock.

5.5.8 Standardize the instrument in accordance with Section 5.6.

## 5.6 Standardization/Calibration Check

It is not possible to start an analysis if the instrument has not been standardized. To verify proper calibration of the instrument it is necessary to periodically standardize it using the automated standardization procedure. This must be done anytime the instrument is restarted and every 4 hours of operation, although re-standardization may be done at any other time (e.g., when instrument drift is suspected).

5.6.1 Click the standardization piece (supplied with the instrument) on the front of the instrument, verifying that the solid portion of the standard completely covers the analysis window. If using a manufacturer supplied test stand, lay the standardization plate over the analysis window.

5.6.2 Select "Tap here to Standardize" or select *File* → *Standardize*. The red light on top of the instrument will blink indicating that the instrument is producing x-rays and the shutter is open. The amber light on the rear of the instrument will also be illuminated and a status bar will appear to display the progress of the standardization.

5.6.3 Upon successful standardization the message "Successful Standardization" will appear along with the instrument resolution. In this case tap "ok" to dismiss the completion message. If problems are encountered, either follow the prompts that appear and/or repeat the standardization. Contact the FOL if problems persist. Take note of any error messages that appear as they may be useful if the instrument manufacturer must be contacted. Additional assistance is also available in the manufacturer's instrument manual.

## 5.7 Quality Control

The quality control (QC) program includes analysis of blanks, calibration verification checks, duplicate analyses, and field duplicate samples. For all the above areas, any identified problems and corrective action must be documented in the instrument run log, analysis narrative report, and instrument

maintenance log or standards log (as applicable). Identical operating conditions will be used for each sample.

### 5.7.1 Laboratory Blanks

Two types of blank samples shall be analyzed for FPXRF analysis: instrument blanks and method blanks.

5.7.1.1 At the beginning of each day, at the end of each day, and after every 20th sample or when potential contamination of the instrument is suspected, analyze an instrument blank to verify that no contamination exists in the spectrometer or on the probe window.

If the lead concentration in the blank exceeds the method detection limit (MDL, see Section 5.9.3) check the probe window and other potentially contaminated instrument components for contamination. If contamination is not causing the elevated blank readings, "zero" the instrument according to manufacturer's instructions.

5.7.1.2 After every 20th sample analyze a method blank. If the method blank lead concentration exceeds the practical quantitation limit (PQL, see Section 5.9.4), identify the cause of the elevated lead concentration and reanalyze all samples since the last acceptable method blank.

### 5.7.2 Calibration Verification Checks

5.7.2.1 After performing each blank check (Section 5.7.2), analyze a calibration verification check sample to check the accuracy of the instrument and to assess the stability and consistency of the analysis for the analytes of interest.

5.7.2.2 If the measured lead percent recovery (See Section 5.9.1) is less than 60 percent or greater than 135 percent, reanalyze the check sample. If the value continues to fall outside this acceptance range, the instrument should be recalibrated, or restandardized according to the manufacture instructions and the batch of samples analyzed before the unacceptable calibration verification check must be reanalyzed.

### 5.7.3 XRF Duplicate Samples

XRF duplicate samples are two portions of the same sample that have been prepared and homogenized together, and then split and analyzed in the same manner by the XRF analyst.

5.7.3.1 Analyze an XRF duplicate at a frequency of 1 per 20 or once per day, whichever is more frequent.

5.7.3.2 If the computed RPD (See Section 5.9.2) exceeds 50 percent reanalyze both samples. If the RPD again exceeds 50 percent RPD consider whether the high degree of imprecision is caused by sample heterogeneity or other causes. This assessment may be aided by repeating the analysis of a sample that was analyzed previously. If the observed imprecision is attributed to sample heterogeneity, increase the number of readings made per sample to try to limit the imprecision and repeat the analyses. If this does not correct the problem notify the FOL.

## 5.8 Sample Analysis

**Note:**

This section provides sample analysis instructions, assuming that appropriate instrument start-up and calibration checks have been completed. The longer the instrument count time, the lower the detection limits and the less uncertainty there is with a recorded result. Count time is user-selectable through the instrument's software. Because the XRF data will be used in a screening capacity to make preliminary decisions concerning the soil concentrations relative to 400 mg/kg, it is not necessary to obtain a high degree of accuracy or precision with the instrument. Therefore, count times should be limited to less than 180 seconds unless an usually high degree of precision is expected. To change the count time, select Options → Setup Testing and enter the same value (in seconds) to minimum and maximum count times.

**Note:**

Section 5.7 identifies the appropriate frequencies for conducting various QC sample analyses and the associated acceptance limits and corrective actions for potentially unsuitable conditions. The specified QC analysis frequencies are minimum frequencies. More frequent QC sample analyses are permitted, especially when diagnosing quality problems.

5.8.1 Ensure that calibration checks and blanks have been analyzed according to Sections 5.6, 5.7.1, and 5.7.2. Count times shall be at least 60 seconds but generally less than 180 seconds.

5.8.2 Acquire enough soil sample to fill an 8-ounce jar and separate from it all particles greater than the size of a pea.

5.8.3 Homogenize the remaining finer grained portion of the sample by simple mixing until it appears as uniform in texture and composition as practicable. Mixing may be done in a beaker or other suitable lead-free container. If the sample is moist and has high clay content, it may be kneaded

in a plastic bag. Mixing shall continue for at least two minutes to ensure that the sample is well mixed. To aid mixing, the sample may be placed into a thick-walled (3 mil or thicker) gallon-sized freezer bag (e.g., ZipLoc®) and rolled flat with a rolling pin to break up large chunks of dirt.

5.8.4 Place approximately 20 to 50 grams (one U.S. nickel weighs about 5 grams) in a suitable container (e.g., aluminum drying pan) for drying.

5.8.5 Dry the homogenized sample from Step 5.8.4 for approximately 20 to 30 minutes in the oven at a temperature not greater than 150°C (a setting of approximately 300°F). If the sample is not visibly dry after this initial drying time, place the sample back into the oven until the sample is dry.

5.8.6 Re-homogenize the dried sample aliquot in a beaker or other suitable lead-free container to obtain a well mixed soil sample. Mixing shall continue for at least one minute.

5.8.7 Place a portion (approximately 1.5 cubic inches) of the dried, homogenized sample aliquot into the instrument manufacturer's recommended sample cup (e.g., a 31.0-mm polyethylene sample cup (or equivalent) or place it in a thin-walled (1.0 mil or thinner) plastic sandwich bag (e.g., ZipLoc®).

5.8.8 If using a disposable plastic sample cup, ensure the cup is at least three-quarters full and cover with mylar (or other) film per the manufacturer's recommendations.

5.8.9 Present a portion of the sample to the instrument in Soil Mode.

5.8.10 Perform a single pull of the trigger to start the count. The count time shall be the same as was used for the calibrations, calibration checks, and blank analyses. The message "Test in progress" will appear on the instrument and the red light on top of the instrument and will illuminate.

5.8.11 When the predetermined count period has expired the message "Test complete" will appear on the instrument. A slight delay may also be incurred during which time the message "calculating" may appear to indicate that results are being computed.

5.8.12 Record the displayed results for lead concentration in mg/kg on Figure 1.

**CAUTION**

Inconsistent positioning of samples in front of the probe window is a potential source of error because the x-ray signal decreases by the square of the distance from the radioactive source. This error is minimized by maintaining the same distance between the window and each sample. For the best results, the window of the probe should be in direct contact with the sample, which means that the sample surface should be flat and smooth to provide a good contact surface.

5.8.13 Rotate the sample cup approximately one-third of a turn, or if using a thin plastic baggie, read another 1/3 portion of the sample bag. Acquire another measurement by repeating Steps 5.8.10 through 5.8.12.

5.8.14 Repeat Steps 5.8.10 through 5.8.11 a third time, and calculate the average concentration.

5.8.15 Based on the degree of precision demonstrated by the three individual measurements, determine whether additional readings should be acquired on the sample. This determination shall be based on professional judgment of the FPXRF analyst and shall consider the degree of precision observed during calibration checks and previous sample analyses. The objective will be to ensure that the average reading reported for each sample is representative of the true sample concentration. If the analyst feels that non-representative readings are being obtained the analyst shall correct the analytical system or notify the FOL prior to continuing with analyses.

5.8.16 Ensure that measured results are reported to the following standards

- Results < 1000 mg/kg (or parts per million) are reported to two significant figures and results > 1000 mg/Kg are reported to three significant figures.
- All values < MDL shall be reported as the MDL and flagged with the letter "U".
- All values > MDL and < PQL shall be reported as is and flagged with the letter "B".

## 5.9 Calculations

5.9.1 Percent Recovery: The equation for determining percent recovery of calibration verification check standards and standard reference materials is:

$$\%R = \frac{\text{Experimental Concentration}}{\text{Certified or Known Concentration}} \text{ X } 100\%$$

5.9.2 Relative Percent Difference: The equation for determining relative percent difference for laboratory and field duplicate samples is:

$$RPD = \frac{|\text{Amount in Sample 1} - \text{Amount in Sample 2}|}{0.5\,(\text{Amount in Sample 1} + \text{Amount in Sample 2})} \text{ X } 100\,\%$$

5.9.3 Method Detection Limit (MDL): Because the analyses governed by this SOP are semi-quantitative, the manufacturer-specified detection limit will be reported as the MDL unless the specified detection limit is less than 20 mg/kg. Care will taken to ensure that the appropriate count time is consistent with the reported detection limit. However, no value less than 20 mg/kg will be reported as an MDL.

5.9.4 Practical Quantitation Limit (PQL): Multiply the MDL by 3 to obtain the PQL: PQL = MDL*3

## 6.0 REFERENCES

Innov-X Systems, Inc. Innov-X Systems X-Ray Fluorescence Spectrometers Instruction Manual. Woburn, MA. June 2002.

Stephen Shefsky, NITON Corporation. Comparing Field Portable X-Ray Fluorescence (XRF) To Laboratory Analysis of Heavy Metals In Soil. Presented at the International Symposium of Field Screening Methods for Hazardous Wastes and Toxic Chemicals. Las Vegas, Nevada. January 29-31, 1997.

USEPA (U.S. Environmental Protection Agency), Method 6200: Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment, Office of Solid Waste, Washington, D.C. January 1998.

USEPA, Region I, Northeast Waste Management Officials' Association (NEWMOA) Technology Review Committee Advisory Opinion. Innovative Technology: X-Ray Fluorescence Field Analysis. September 21, 1999.

# FIGURE 1

## FIELD PORTABLE XRF SAMPLE ANALYSIS LOG SHEET

Page___ of ___

Project Site Name: ______________________ Run Length/Duration: ______________________
Project No.: ______________________ Measurement Units: ______________________
Analyzed By: ______________________ Reference/Calibration: ______________________

SAMPLING AND FIELD PORTABLE XRF RESULTS DATA

| SAMPLE ID | ANALYSIS DATE | ANALYSIS TIME | ELEMENT ANALYSIS | RESULT RUN 1 | RESULT RUN 2 | RESULT RUN 3 | RESULTS AVERAGE | ERROR RUN 1 | ERROR RUN 2 | ERROR RUN 3 | ERROR AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|
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# STANDARD OPERATING PROCEDURE
# SOP-09

# DECONTAMINATION OF FIELD SAMPLING EQUIPMENT

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures to be followed when decontaminating non-dedicated field sampling equipment during the field investigations.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Writing utensil (preferably black pen with indelible ink)**
**Non-latex rubber or plastic gloves**
**Cotton gloves**
**Field logbook**
**Potable water**
**Deionized water**
**Isoproponal (optional)**
**Liqui-Nox® or Alconox® detergent**
**Brushes, spray bottles, paper towels, etc.**
**Container to collect and transport decontamination fluids**

## 3.0 DECONTAMINATION PROCEDURES

3.1 Don non-latex and/or cotton gloves and decontaminate sampling equipment (in accordance with the following steps) prior to field sampling and between samples.

3.2 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.3 Wash the equipment with a solution of Liqui-Nox® or Aloconox® detergent. Prepare the detergent wash solution in accordance with the instructions on the detergent container. Collect the wash solution into a container. Use brushes or sprays as appropriate for the equipment. If oily residue has accumulated on the sampling equipment, remove the residue with an isopropanol wash and repeat the detergent wash.

3.4 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.5 Rinse the equipment with deionized water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the deionized water rinsate into a container.

3.6 Remove excess water by air drying and shaking or by wiping with paper towels as necessary.

3.7 Document decontamination by recording it in the field logbook.

3.8 Containerized decontamination solutions will be managed in accordance with the procedures described in SOP-11.

# STANDARD OPERATING PROCEDURE
# SOP-10

# GLOBAL POSITIONING SYSTEM

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide the field personnel with basic instructions for operating a handheld Global Positioning System (GPS) unit allowing them to set GPS parameters in the receiver, record GPS positions on the field device, and update existing Geographic Information System (GIS) data. This SOP is specific to GIS quality data collection for Trimble®-specific hardware and software.

If possible, the Trimble® GeoXM™ or GeoXH™ operators manual should be downloaded onto the operator's personal computer for reference before or while in the field. The manual can be downloaded at http://trl.trimble.com/docushare/dsweb/Get/Document-311749/TerraSyncReferenceManual.pdf

Unless the operator is proficient in the setup and operation of the GPS unit, the Project Manager (or designee) should have the GPS unit shipped to the project-specific contact listed below in the Pittsburgh, Pennsylvania, office at least five working days prior to field mobilization so project-specific shape files, data points, background images, and correct coordinate systems can be uploaded into the unit.

Tetra Tech NUS, Inc.
Attn: John Wright
661 Anderson Drive, Bldg #7
Pittsburgh, PA 15220

## 2.0 REQUIRED EQUIPMENT

The following hardware and software should be utilized for locating and establishing GPS points in the field:

### 2.1 Required GPS Hardware

- Hand-held GPS unit capable of sub-meter accuracy (i.e. Trimble® GeoXM™ or Trimble® GeoXH™). This includes the docking cradle, A/C adapter, stylus, and USB cable for data transfer.

Optional Accessories:

- External antenna
- Range pole
- Hardware clamp (for mounting GPS unit to range pole)
- GeoBeacon

- Writing utensil (preferably black pen with indelible ink)
- Non-metallic pin flags for temporary marking of positions

## 2.2 Required GPS Software

The following software is required to transfer data from the handheld GPS unit to a personal computer:

- Trimble® TerraSync version 2.6 or later (pre-loaded onto GPS unit from vendor)

- Microsoft® ActiveSync® version 4.5 or later. Download to personal computer from: http://www.microsoft.com/windowsmobile/en-us/downloads/microsoft/activesync-download.mspx

- Trimble® Data Transfer Utility (freeware version 2.1 or later). Download to personal computer from: http://www.trimble.com/datatransfer.shtml

## 3.0 START-UP PROCEDURES

Prior to utilizing the GPS in the field, ensure the unit is fully charged. The unit may come charged from the vendor, but an overnight charge is recommended prior to fieldwork.

The Geo-series GPS units require a docking cradle for both charging and data transfer. The Geo-series GPS unit is docked in the cradle by first inserting the domed end in the top of the cradle, then gently seating the contact end into the latch. The power charger is then connected to the cradle at the back end using the twist-lock connector. Attach a USB cable as needed between the cradle (B end) and the laptop/PC (A end).

It is recommended that the user also be familiar and check various Windows Mobile settings. One critical setting is the Power Options. The backlight should be set as needed to conserve power when not in use.

Start Up:

1) Power on the GPS unit by pushing the small green button located on the lower right front of the unit.

2) Utilizing the stylus that came with the GPS unit, launch **TerraSync** from the Windows Operating System by tapping on the start icon located in the upper left hand corner of the screen and then tap on **TerraSync** from the drop-down list.

3) If the unit does not default to the Setup screen, tap the Main Menu (uppermost left tab, just below the Windows icon) and select Setup.

4) If the unit was previously shipped to the Pittsburgh office for setup, you can skip directly to Section 4.0. However, to confirm or change settings, continue on to Section 3.1.

## 3.1 Confirm Setup Settings

Use the Setup section to confirm the TerraSync software settings. To open the Setup section, tap the Main Menu and select Setup.

1) Coordinate System
   a. Tap on the Coordinate System.
   b. Verify the project specs are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu. **Note:** It is always best to utilize the Cancel tab rather than the OK tab if no changes are made since configurations are easily changed by mistake.
   c. Tap on the Units.
   d. Verify the user preferences are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
   e. Tap Real-time Settings.
   f. Verify the Real-time Settings are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
   g. The GPS unit is now configured correctly for your specific project.

## 4.0 ANTENNA CONNECTION

1) If a connection has been properly made with the internal antenna, a satellite icon along with the number of usable satellites will appear at the top of the screen next to the battery icon. If no connection is made (e.g.: no satellite icon), tap on the GPS tab to connect antenna.
2) At this point the GPS unit is ready to begin collecting data.

## 5.0 COLLECTING NEW DATA IN THE FIELD

1) From the Main Menu select Data.
2) From the Sub Menu (located below the Data tab) select New which will bring up the New Data File menu.
3) An auto-generated filename appears and should be edited for your specific project. If the integral keyboard does not appear, tap the small keyboard icon at the bottom of the screen.
4) After entering the file name, tap Create to create the new file.
5) Confirm antenna height if screen appears. Antenna height is the height that the GPS unit will be held from the ground surface (Typically 3 to 4 feet).
6) The Choose Feature screen appears.

### 5.1 Collecting Features

1) If not already open, the Collect Feature screen can be opened by tapping the Main Menu and selecting Data. The Sub Menu should default to Collect.
2) **Do not begin the data logging process until you are at the specific location for which you intend to log the data.**
3) A known reference or two should be shot at the beginning and at the end of each day in which the GPS unit is being used. This allows for greater accuracy during post-processing of the data.
4) Upon arriving at the specific location, tap on Point_generic as the Feature Name.
5) Tap Create to begin data logging.
6) In the Comment Box enter sample ID or location-specific information.
7) Data logging can be confirmed by viewing the writing pencil icon in the upper part of the screen. Also, the logging counter will begin. As a Rule of Thumb, accumulate a minimum of 20 readings on the counter, per point, as indicated by the logging counter before saving the GPS data.
8) Once the counter has reached a minimum number of counts (i.e. 20), tap on OK to save the data point to the GPS unit. Confirm the feature. All data points are automatically saved within the GPS unit.
9) Repeat steps 2 through 8, giving each data point a unique name or number.

**Note:** If the small satellite icon or the pencil icon is blinking, this is an indication the GPS unit is not collecting data. A possible problem may be too few satellites. While still in data collection mode, tap on Main Menu in upper left hand corner of the screen and select Status. Skyplot will display as the default showing the number of available satellites. To increase productivity (number of usable satellites) use the stylus to move the pointer on the productivity and precision line to the left. This will decrease precision, but increase productivity. The precision and productivity of the GPS unit can be adjusted as the number of usable satellites changes throughout the day. To determine if GPS is correctly recording data, see Section 5.2.

## 5.2 Viewing Data or Entering Additional Data Points to the Current File

1) To view the stored data points in the current file, tap on the Main Menu and select Map. Stored data points for that particular file will appear. Use the +/- and <-/-> icons in lower left hand corner of screen to zoom in/out and to manipulate current view.
2) To return to data collection, tap on the Main Menu and select Data. You are now ready to continue to collect additional data points.

## 5.3 Viewing Data or Entering Data Points from an Existing File

1) To view data points from a previous file, tap on Main Menu and select Data, then select File Manager from the Sub Menu.
4) Highlight the file you want to view and select Map from the Main Menu.
5) To add data points to this file, tap on Main Menu and select Data. Continue to collect additional data points.

# 6.0 NAVIGATION

This section provides instructions on navigating to saved data points in an existing file within the GPS unit.

1) From the Main Menu select Map.
2) Using the Select tool, pick the point on the map to where you want to navigate.
3) The location you select will have a box placed around the point.
4) From the Options menu, choose the Set Nav Target (aka set navigation target).
5) The location will now have double blue flags indicating this point is you navigation target.
6) From the Main Menu select Navigation.

7) The dial and data on this page will indicate what distance and direction you need to travel to reach the desired target.
8) Follow the navigation guide until you reach the point you select.
9) Repeat as needed for any map point by going back to Step 1.

## 7.0 PULLING IN A BACKGROUND FILE

This section provides instructions on pulling in a pre-loaded background file. These files are helpful in visualizing your current location.

1) From the Main Menu select Map, then tap on Layers, select the background file from drop down list.
2) Select the project-specific background file from the list of available files.
3) Once the selected background file appears, the operator can manipulate the screen utilizing the +/- and <-/-> functions at the bottom of the screen.
4) In operating mode, the operator's location will show up on the background file as a floating "x".

## 8.0 DATA TRANSFER

This section provides instructions on how to transfer stored data on the handheld GPS unit to a personal computer. Prior to transferring data from the GPS unit to a computer, Microsoft ActiveSync and Trimble Data Transfer Utility software must be downloaded to the computer from the links provided in Section 2.2 (Required GPS Software). If a leased computer is utilized in which the operator cannot download files, see the Note at the end of Section 8.0.

1) See Attachment A at the end of this SOP for instructions on how to transfer data from the GPS to a personal computer.

**Note:** If you are unable to properly transfer data from the GPS unit to a personal computer, the unit should be shipped to the project-specific contact listed in Section 1.0 where the data will be transferred and the GPS unit then shipped back to the vendor.

## 9.0 SHUTTING DOWN

This section provides instruction for properly shutting down the GPS unit.

1) When shutting down the GPS unit for the day, first click on the "X" in the upper right hand corner.

2) You will be prompted to ensure you want to exit TerraSync. Select Yes.
3) Power off the GPS unit by pushing the small green button located on the bottom face of the unit.
4) Place the GPS unit in its cradle to recharge the battery overnight. Ensure the green charge light is visible on the charging cradle.

# ATTACHMENT A

**How to Transfer Trimble GPS Data between Data Collector and PC**
original 11/21/06 (5/1/08 update) – John Wright

***Remember – Coordinate System, Datum, and Units are critical!!!***

**Trimble Data Collection Devices:**
Standard rental systems include the Trimble® ProXR/XRS backpack and the newer handheld GeoXT™ or GeoXH™ units. Some of the older backpack system may come with either a RECON "PDA-style" or a TSCe or TSC1 alpha-numeric style data collector.

The software on all of the above units should be Trimble® TerraSync (v 2.53 or higher – current version is 3.20) and to the user should basically look and function similar. The newer units and software versions (which should always be requested when renting) include enhancements for data processing, real-time display functions, and other features.

**Data Transfer:**
Trimble provides a free transfer utility program to aid in the transfer of GIS and field data. The Data Transfer Utility is a standalone program that will run on a standard office PC or laptop.

To connect a field data collector such as a RECON, GeoXM, GeoXT, GeoXH, or ProXH, you must first have Microsoft® ActiveSync® installed to allow the PC and the data collector to talk to one another. A standard USB cable is also needed to connect the two devices.

A CD or USB drive is provided with the data collector for use in data transfer. If needed, these programs are also available without charge via the web at:

• **Trimble Data Transfer Utility** (v 1.38) program to download the RECON or GeoXH field data to your PC: http://www.trimble.com/datatransfer.shtml

• **ActiveSync** from Microsoft to connect the data collector to the PC. The latest version (v4.5) can be found at: http://www.microsoft.com/windowsmobile/en-us/downloads/microsoft/activesync-download.mspx
**(see page 2 for data transfer instructions)**

**To Transfer Data Collected in the Field:**

• Install the Data Transfer and ActiveSync software installed on your PC
• Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
• ActiveSync should auto-detect the connection and recognize the data collector
• Make sure the data file desired is CLOSED in TerraSync prior to transfer
• Connect via ActiveSync as a guest (not a partnership)
• Run the Trimble Data Transfer Utility program on your PC
• Select "***GIS Datalogger on Windows CE***" or similar selection
• Hit the green connect icon to the right - the far right area should say "***Connected to ....***" if successful
• Select the "***Receive***" data tab (under device)
• Select "***Data***" from file types on the right
• Find the file(s) needed for data transfer. You can sort the data files by clicking on the date/time header
• Select or browse to a C-drive folder you can put this file for emailing
• When the file appears on the list, hit the "***Transfer All***"
• Go to your Outlook or other email, send a message to: John.Wright@tetratech.com (or GIS department)
• Attach the file(s) you downloaded from your C-drive. For each TerraSync data file created you should have a packet of multiple data files. All need to be sent as a group – make sure you attach all files (the number of files may vary – examples include: ssf, obx, obs, gix, giw, gis, gip, gic, dd, and car)

**To Transfer GIS Data from PC to the Field Device (must be converted in Pathfinder Office):**

• Obtain GIS file(s) desired from GIS Department and have converted to Trimble extension
• Contact John Wright (John.Wright@tetratech.com) if needed for file conversion and upload support
• The GIS file(s) can be quickly converted if requested and sent back to the field user in the needed "Trimble xxx.imp" extension via email – then quickly downloaded from Outlook to your PC for transfer
• Install the Data Transfer and ActiveSync software installed on your PC
• Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
• ActiveSync should auto-detect the connection and recognize the data collector
• Connect via ActiveSync as a guest (not a partnership)
• Run the Trimble Data Transfer Utility program on your PC
• Select "***GIS Datalogger on Windows CE***" or similar selection
• Hit the green connect icon to the right - the far right area should say "***Connected to ....***" if successful
• Select the "**Send**" data tab (under device)
• Select "**Data**" from file types on the right (you can also send background files)
• Browse to the location of the data on your PC (obtain the file from Pathfinder Office or from the person who converted the data for field use)
• Select the options as appropriate for the name and location of the data file to go on the data collector (usually you can choose main memory or a data storage card)
• When the file(s) appears on the list, hit the "***Transfer All***"
• Run TerraSync on the field device and open the existing data files. Your transferred file should appear (make sure you have selected Main Memory, Default, or Storage Card as appropriate)

# STANDARD OPERATING PROCEDURE
# SOP-11

# MANAGEMENT OF INVESTIGATION-DERIVED WASTE

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes how investigation-derived waste (IDW) will be collected, segregated, classified, and managed during the field investigations at Naval Support Activity (NSA) Crane. The following types of IDW may be generated during this investigation:

- Soil sampling residues
- Decontamination solutions
- Personal protective equipment (PPE) and clothing
- Miscellaneous trash and incidental items

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Health and safety equipment (with PPE)**
**Bucket** (with collected development/purge water)
**Decontamination equipment**
**Field logbook**
**Writing utensil (preferably black pen with indelible ink)**
**Plastic sheeting and/or tarps**
**55-gallon drums with sealable lids**
**IDW labels for drums**
**Plastic garbage bags**

## 3.0 PROCEDURES

Management of IDW includes the collection, segregation, temporary storage, classification, final disposal, and documentation of the waste-handling activities if necessary.

## 3.1 Liquid Wastes

Liquid wastes that may be generated during the site activities include decontamination solutions from sampling equipment. These wastes will be collected and containerized in a central location at NSA Crane for proper disposal.

## 3.2 Solid Wastes

Solid wastes that may be generated during site activities include soil and sediment sampling residues. Excess soil core/sampling materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole and hydrated with potable water. Excess sediment sampling materials will be returned to the point of collection. The disposition of this materials will be carried out in a manner such as not to contribute further environmental degradation or pose a threat to public health or safety.

## 3.3 PPE and Incidental Trash

All PPE wastes and incidental trash materials (e.g., wrapping or packing materials from supply cartons, waste paper, etc.) will be decontaminated (if contaminated), double bagged, securely tied shut, and placed in a designated waste receptacle at NSA Crane.

# APPENDIX B

# LABORATORY DoD ELAP ACCREDITATION

LABORATORY
ACCREDITATION
BUREAU

# Certificate of Accreditation

***ISO/IEC 17025:2005*** ***Certificate Number L2226***

## *Empirical Laboratories, LLC*

621 Mainstream Drive, Suite 270
Nashville, TN 37228

**has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).***

**The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).**

**Accreditation Granted through: November 30, 2012**

**R. Douglas Leonard, Jr., Managing Director**
**Laboratory Accreditation Bureau**
**Presented the 30th of November 2009**

*See the laboratory's Scope of Accreditation for details of the DoD ELAP requirements
Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

# Scope of Accreditation For Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228
Marcia K. McGinnity
877-345-1113

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.1) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Empirical Laboratories, LLC to perform the following tests:

Accreditation granted through: **November 30, 2012**

**Testing - Environmental**

| **Non-Potable Water** | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8260B | 1,1,1,2-Tetrachloroethane |
| GC/MS | EPA 8260B | 1,1,1-Trichloroethane (1,1,1-TCA) |
| GC/MS | EPA 8260B | 1,1,2,2-Tetrachloroethane |
| GC/MS | EPA 8260B | 1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113) |
| GC/MS | EPA 8260B | 1,1,2-Trichloroethane |
| GC/MS | EPA 8260B | 1,1-Dichloroethane (1,1-DCA) |
| GC/MS | EPA 8260B | 1,1-Dichloroethene (1,1-DCE) |
| GC/MS | EPA 8260B | 1,1-Dichloropropene |
| GC/MS | EPA 8260B | 1,2,3-Trichlorobenzene |
| GC/MS | EPA 8260B | 1,2,3-Trichloropropane |
| GC/MS | EPA 8260B | 1,2,4-Trichlorobenzene |
| GC/MS | EPA 8260B | 1,2,4-Trimethylbenzene |
| GC/MS | EPA 8260B | 1,2-Dibromo-3-chloropropane (DBCP) |
| GC/MS | EPA 8260B | 1,2-Dibromoethane (EDB) |
| GC/MS | EPA 8260B | 1,2-Dichlorobenzene |
| GC/MS | EPA 8260B | 1,2-Dichloroethane (EDC) |
| GC/MS | EPA 8260B | 1,2-Dichloropropane |
| GC/MS | EPA 8260B | 1,3,5-Trimethylbenzene |

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8260B | 1,3-Dichlorobenzene |
| GC/MS | EPA 8260B | 1,3-Dichloropropane |
| GC/MS | EPA 8260B | 1,4-Dichlorobenzene |
| GC/MS | EPA 8260B | 1,4-Dioxane |
| GC/MS | EPA 8260B | 1-Chlorohexane |
| GC/MS | EPA 8260B | 2,2-Dichloropropane |
| GC/MS | EPA 8260B | 2-Butanone (Methyl ethyl ketone; MEK) |
| GC/MS | EPA 8260B | 2-Chloroethyl vinyl ether |
| GC/MS | EPA 8260B | 2-Chlorotoluene |
| GC/MS | EPA 8260B | 2-Hexanone (Methyl butyl ketone; MBK) |
| GC/MS | EPA 8260B | 4-Chlorotoluene |
| GC/MS | EPA 8260B | 4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK) |
| GC/MS | EPA 8260B | Acetone |
| GC/MS | EPA 8260B | Acetonirile |
| GC/MS | EPA 8260B | Acrolein |
| GC/MS | EPA 8260B | Acrylonitrile |
| GC/MS | EPA 8260B | Allyl chloride |
| GC/MS | EPA 8260B | Benzene |
| GC/MS | EPA 8260B | Bromobenzene |
| GC/MS | EPA 8260B | Bromochloromethane |
| GC/MS | EPA 8260B | Bromodichloromethane |
| GC/MS | EPA 8260B | Bromoform |
| GC/MS | EPA 8260B | Bromomethane |
| GC/MS | EPA 8260B | Carbon Disulfide |
| GC/MS | EPA 8260B | Carbon Tetrachloride |
| GC/MS | EPA 8260B | Chlorobenzene |
| GC/MS | EPA 8260B | Chloroethane |
| GC/MS | EPA 8260B | Chloroform |
| GC/MS | EPA 8260B | Chloromethane |
| GC/MS | EPA 8260B | Chloroprene |
| GC/MS | EPA 8260B | cis-1,2-Dichloroethene (cis-1,2-DCE) |
| GC/MS | EPA 8260B | cis-1,3-Dichloropropene |
| GC/MS | EPA 8260B | cis-1,4-Dichloro-2-butene |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8260B | Cyclohexane |
| GC/MS | EPA 8260B | Dibromochloromethane |
| GC/MS | EPA 8260B | Dibromomethane |
| GC/MS | EPA 8260B | Dichlorodifluoromethane (CFC-12) |
| GC/MS | EPA 8260B | Di-isopropyl ether |
| GC/MS | EPA 8260B | ETBE |
| GC/MS | EPA 8260B | Ethyl methacrylate |
| GC/MS | EPA 8260B | Ethylbenzene |
| GC/MS | EPA 8260B | Hexachlorobutadiene |
| GC/MS | EPA 8260B | Hexane |
| GC/MS | EPA 8260B | Iodomethane |
| GC/MS | EPA 8260B | Isobutyl alcohol |
| GC/MS | EPA 8260B | Isopropylbenzene (Cumene) |
| GC/MS | EPA 8260B | Methacrylonitrile |
| GC/MS | EPA 8260B | Methyl Acetate |
| GC/MS | EPA 8260B | Methyl methacrylate |
| GC/MS | EPA 8260B | Methyl Tertiary Butyl Ether (MTBE) |
| GC/MS | EPA 8260B | Methylcyclohexane |
| GC/MS | EPA 8260B | Methylene Chloride, or Dichloromethane |
| GC/MS | EPA 8260B | Naphthalene |
| GC/MS | EPA 8260B | n-Butylbenzene |
| GC/MS | EPA 8260B | n-Propylbenzene |
| GC/MS | EPA 8260B | p-Isopropyltoluene |
| GC/MS | EPA 8260B | Propionitrile |
| GC/MS | EPA 8260B | sec-Butylbenzene |
| GC/MS | EPA 8260B | Styrene |
| GC/MS | EPA 8260B | t-Butyl alcohol |
| GC/MS | EPA 8260B | tert-Amyl methyl ether |
| GC/MS | EPA 8260B | tert-Butylbenzene |
| GC/MS | EPA 8260B | Tetrachloroethene (PCE; PERC) |
| GC/MS | EPA 8260B | Tetrahydrofuran |
| GC/MS | EPA 8260B | Toluene |
| GC/MS | EPA 8260B | trans-1,2-Dichloroethene (trans-1,2-DCE) |

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8260B | trans-1,3-Dichloropropene |
| GC/MS | EPA 8260B | trans-1,4-Dichloro-2-butene |
| GC/MS | EPA 8260B | Trichloroethene (TCE) |
| GC/MS | EPA 8260B | Trichlorofluoromethane (CFC-11) |
| GC/MS | EPA 8260B | Vinyl acetate |
| GC/MS | EPA 8260B | Vinyl Chloride (VC) |
| GC/MS | EPA 8260B | Xylenes (Total) |
| GC/MS | EPA 8270C/D | 1,1'-Biphenyl |
| GC/MS | EPA 8270C/D | 1,2,4,5-Tetrachlorobenzene |
| GC/MS | EPA 8270C/D | 1,2,4-Trichlorobenzene |
| GC/MS | EPA 8270C/D | 1,2-Dichlorobenzene |
| GC/MS | EPA 8270C/D | 1,2-Diphenylhydrazine |
| GC/MS | EPA 8270C/D | 1,3-Dichlorobenzene |
| GC/MS | EPA 8270C/D | 1,4-Dichlorobenzene |
| GC/MS | EPA 8270C/D | 1,4-Dioxane |
| GC/MS | EPA 8270C/D | 1-Methylnaphthalene |
| GC/MS | EPA 8270C/D | 2,3,4,6-Tetrachlorophenol |
| GC/MS | EPA 8270C/D | 2,4,5-Trichlorophenol |
| GC/MS | EPA 8270C/D | 2,4,6-Trichlorophenol (TCP) |
| GC/MS | EPA 8270C/D | 2,4-Dichlorophenol (DCP) |
| GC/MS | EPA 8270C/D | 2,4-Dimethylphenol |
| GC/MS | EPA 8270C/D | 2,4-Dinitrophenol |
| GC/MS | EPA 8270C/D | 2,4-Dinitrotoluene (DNT) |
| GC/MS | EPA 8270C/D | 2,6-Dichlorophenol |
| GC/MS | EPA 8270C/D | 2,6-Dinitrotoluene |
| GC/MS | EPA 8270C/D | 2-Chloronaphthalene |
| GC/MS | EPA 8270C/D | 2-Chlorophenol |
| GC/MS | EPA 8270C/D | 2-Methylnaphthalene |
| GC/MS | EPA 8270C/D | 2-Methylphenol (o-Cresol) |
| GC/MS | EPA 8270C/D | 2-Nitroaniline |
| GC/MS | EPA 8270C/D | 2-Nitrophenol (ONP) |
| GC/MS | EPA 8270C/D | 3,3'-Dichlorobenzidine (DCB) |
| GC/MS | EPA 8270C/D | 3-Methylphenol |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8270C/D | 3-Nitroaniline |
| GC/MS | EPA 8270C/D | 4,6-Dinitro-2-methylphenol (DNOC) |
| GC/MS | EPA 8270C/D | 4-Bromophenyl phenyl ether |
| GC/MS | EPA 8270C/D | 4-Chloro-3-methylphenol |
| GC/MS | EPA 8270C/D | 4-Chloroaniline |
| GC/MS | EPA 8270C/D | 4-Chlorophenyl phenyl ether |
| GC/MS | EPA 8270C/D | 4-Methylphenol (p-Cresol) |
| GC/MS | EPA 8270C/D | 4-Nitroaniline (PNA) |
| GC/MS | EPA 8270C/D | 4-Nitrophenol (PNP) |
| GC/MS | EPA 8270C/D | 7,12-Dimethylbenz(a)anthracene |
| GC/MS | EPA 8270C/D | Acenaphthene |
| GC/MS | EPA 8270C/D | Acenaphthylene |
| GC/MS | EPA 8270C/D | Acetaphenone |
| GC/MS | EPA 8270C/D | Aniline |
| GC/MS | EPA 8270C/D | Anthracene |
| GC/MS | EPA 8270C/D | Atrazine |
| GC/MS | EPA 8270C/D | Benzaldehyde |
| GC/MS | EPA 8270C/D | Benzidine |
| GC/MS | EPA 8270C/D | Benzo(a)anthracene |
| GC/MS | EPA 8270C/D | Benzo(a)pyrene |
| GC/MS | EPA 8270C/D | Benzo(b)fluoranthene |
| GC/MS | EPA 8270C/D | Benzo(g,h,i)perylene |
| GC/MS | EPA 8270C/D | Benzo(k)fluoranthene |
| GC/MS | EPA 8270C/D | Benzoic Acid |
| GC/MS | EPA 8270C/D | Benzyl alcohol |
| GC/MS | EPA 8270C/D | bis(2-Chloroethoxy)methane |
| GC/MS | EPA 8270C/D | bis(2-Chloroethyl)ether (BCEE) |
| GC/MS | EPA 8270C/D | Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane) |
| GC/MS | EPA 8270C/D | bis(2-Ethylhexyl)phthalate (BEHP) |
| GC/MS | EPA 8270C/D | Butyl benzyl phthalate (BBP) |
| GC/MS | EPA 8270C/D | Caprolactam |
| GC/MS | EPA 8270C/D | Carbazole |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8270C/D | Chrysene |
| GC/MS | EPA 8270C/D | Dibenz(a,h)anthracene |
| GC/MS | EPA 8270C/D | Dibenzofuran (DBF) |
| GC/MS | EPA 8270C/D | Diethyl phthalate (DEP) |
| GC/MS | EPA 8270C/D | Dimethyl phthalate (DMP) |
| GC/MS | EPA 8270C/D | Di-n-butyl phthalate (DBP) |
| GC/MS | EPA 8270C/D | Di-n-octyl phthalate (DNOP) |
| GC/MS | EPA 8270C/D | Fluoranthene |
| GC/MS | EPA 8270C/D | Fluorene |
| GC/MS | EPA 8270C/D | Hexachlorobenzene (HCB) |
| GC/MS | EPA 8270C/D | Hexachlorobutadiene (HCBD) |
| GC/MS | EPA 8270C/D | Hexachlorocyclopentadiene (HCCPD) |
| GC/MS | EPA 8270C/D | Hexachloroethane (HCE) |
| GC/MS | EPA 8270C/D | Indeno(1,2,3-cd)pyrene |
| GC/MS | EPA 8270C/D | Isophorone |
| GC/MS | EPA 8270C/D | Naphthalene |
| GC/MS | EPA 8270C/D | Nitrobenzene |
| GC/MS | EPA 8270C/D | N-Nitrosodimethylamine |
| GC/MS | EPA 8270C/D | N-Nitroso-di-n-propylamine (NDPA) |
| GC/MS | EPA 8270C/D | N-nitrosodiphenylamine (NDPHA) |
| GC/MS | EPA 8270C/D | Pentachlorophenol |
| GC/MS | EPA 8270C/D | Phenanthrene |
| GC/MS | EPA 8270C/D | Phenol |
| GC/MS | EPA 8270C/D | Pyrene |
| GC/MS | EPA 8270C/D | Pyridine |
| GC/ECD | EPA 8081A/B | 4,4'-DDD |
| GC/ECD | EPA 8081A/B | 4,4'-DDE |
| GC/ECD | EPA 8081A/B | 4,4'-DDT |
| GC/ECD | EPA 8081A/B | Aldrin |
| GC/ECD | EPA 8081A/B | alpha-BHC (alpha-HCH) |
| GC/ECD | EPA 8081A/B | alpha-Chlordane |
| GC/ECD | EPA 8081A/B | beta-BHC (beta-HCH) |
| GC/ECD | EPA 8081A/B | delta-BHC (delta-HCH) |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/ECD | EPA 8081A/B | Dieldrin |
| GC/ECD | EPA 8081A/B | Endosulfan I |
| GC/ECD | EPA 8081A/B | Endosulfan II |
| GC/ECD | EPA 8081A/B | Endosulfan sulfate |
| GC/ECD | EPA 8081A/B | Endrin |
| GC/ECD | EPA 8081A/B | Endrin aldehyde |
| GC/ECD | EPA 8081A/B | Endrin ketone |
| GC/ECD | EPA 8081A/B | gamma-BHC (Lindane; gamma-HCH) |
| GC/ECD | EPA 8081A/B | gamma-Chlordane |
| GC/ECD | EPA 8081A/B | Heptachlor |
| GC/ECD | EPA 8081A/B | Heptachlor epoxide |
| GC/ECD | EPA 8081A/B | Methoxychlor |
| GC/ECD | EPA 8081A/B | Chlordane |
| GC/ECD | EPA 8081A/B | Toxaphene |
| GC/ECD | EPA 8082 /A | Aroclor-1016 |
| GC/ECD | EPA 8082 /A | Aroclor-1221 |
| GC/ECD | EPA 8082 /A | Aroclor-1232 |
| GC/ECD | EPA 8082 /A | Aroclor-1242 |
| GC/ECD | EPA 8082 /A | Aroclor-1248 |
| GC/ECD | EPA 8082 /A | Aroclor-1254 |
| GC/ECD | EPA 8082 /A | Aroclor-1260 |
| GC/ECD | EPA 8082 /A | Aroclor-1262 |
| GC/ECD | EPA 8082 /A | Aroclor-1268 |
| GC/ECD | EPA 8151A | 2,4,5-T |
| GC/ECD | EPA 8151A | 2,4,5-TP (Silvex) |
| GC/ECD | EPA 8151A | 2,4-D |
| GC/ECD | EPA 8151A | 2,4-DB |
| GC/ECD | EPA 8151A | Dalapon |
| GC/ECD | EPA 8151A | Dicamba |
| GC/ECD | EPA 8151A | Dichlorprop |
| GC/ECD | EPA 8151A | Dinoseb |
| GC/ECD | EPA 8151A | MCPA |
| GC/ECD | EPA 8151A | MCPP (Mecoprop) |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| HPLC/UV | EPA 8330A/B | 1,3,5-Trinitrobenzene |
| HPLC/UV | EPA 8330A/B | 1,3-Dinitrobenzene |
| HPLC/UV | EPA 8330A/B | 2,4,6-Trinitrophenylmethylnitramine (Tetryl) |
| HPLC/UV | EPA 8330A/B | 2,4,6-Trinitrotoluene (TNT) |
| HPLC/UV | EPA 8330A/B | 2,4-Dinitrotoluene (DNT) |
| HPLC/UV | EPA 8330A/B | 2,6-Dinitrotoluene |
| HPLC/UV | EPA 8330A/B | 2-Amino-4,6-dinitrotoluene |
| HPLC/UV | EPA 8330A/B | 2-Nitrotoluene (ONT) |
| HPLC/UV | EPA 8330A/B | 3,5-Dinitroaniline |
| HPLC/UV | EPA 8330A/B | 3-Nitrotoluene |
| HPLC/UV | EPA 8330A/B | 4-Amino-2,6-dinitrotoluene |
| HPLC/UV | EPA 8330A/B | 4-Nitrotoluene (PNT) |
| HPLC/UV | EPA 8330A/B | Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) |
| HPLC/UV | EPA 8330A/B | Nitrobenzene |
| HPLC/UV | EPA 8330A/B | Nitroglycerin |
| HPLC/UV | EPA 8330A/B | Nitroguanidine |
| HPLC/UV | EPA 8330A/B | Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) |
| HPLC/UV | EPA 8330A/B | 3,5-Dinitroaniline |
| HPLC/UV | EPA 8330A/B | PETN |
| GC/FID | FLPRO | Petroleum Range Organics |
| GC/FID | EPA 8015B | TPH DRO |
| GC/FID | EPA 8015B | TPH GRO |
| GC/FID | RSK-175 | Methane |
| GC/FID | RSK-175 | Ethane |
| GC/FID | RSK-175 | Ethene |
| GC/ECD | EPA 8011 | 1,2-Dibromoethane (EDB) |
| GC/ECD | EPA 8011 | 1,2-Dibromo-3-chloropropane (DBCP) |
| HPLC/MS | EPA 6850 | Perchlorate |
| ICP | EPA 6010B/C | Aluminum |
| ICP | EPA 6010B/C | Antimony |
| ICP | EPA 6010B/C | Arsenic |
| ICP | EPA 6010B/C | Barium |
| ICP | EPA 6010B/C | Beryllium |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| ICP | EPA 6010B/C | Boron |
| ICP | EPA 6010B/C | Cadmium |
| ICP | EPA 6010B/C | Calcium |
| ICP | EPA 6010B/C | Chromium, total |
| ICP | EPA 6010B/C | Cobalt |
| ICP | EPA 6010B/C | Copper |
| ICP | EPA 6010B/C | Iron |
| ICP | EPA 6010B/C | Lead |
| ICP | EPA 6010B/C | Magnesium |
| ICP | EPA 6010B/C | Manganese |
| CVAA | EPA 7470A | Mercury |
| ICP | EPA 6010B/C | Molybdenum |
| ICP | EPA 6010B/C | Nickel |
| ICP | EPA 6010B/C | Potassium |
| ICP | EPA 6010B/C | Selenium |
| ICP | EPA 6010B/C | Silver |
| ICP | EPA 6010B/C | Sodium |
| ICP | EPA 6010B/C | Strontium |
| ICP | EPA 6010B/C | Thallium |
| ICP | EPA 6010B/C | Tin |
| ICP | EPA 6010B/C | Titanium |
| ICP | EPA 6010B/C | Vanadium |
| ICP | EPA 6010B/C | Zinc |
| IC | EPA 300.0 | Chloride |
| IC | EPA 300.0 | Fluoride |
| IC | EPA 300.0 | Nitrate |
| IC | EPA 300.0 | Nitrite |
| IC | EPA 300.0 | Sulfate |
| IC | EPA 9056A | Chloride |
| IC | EPA 9056A | Fluoride |
| IC | EPA 9056A | Nitrate |
| IC | EPA 9056A | Nitrite |
| IC | EPA 9056A | Sulfate |

LABORATORY ACCREDITATION BUREAU

**Certificate # L2226**

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Titration | SM 2320B 20th/21st edition | Alkalinity |
| Colorimetric | SM 4500 B, G, 20th/21st edition | Ammonia |
| Colorimetric | EPA 410.4 | COD |
| UV/Vis | EPA 7196A | Hexavalent Chromium |
| Colorimetric | EPA 353.2 | Nitrocellulose |
| Colorimetric | EPA 353.2 | Nitrate/Nitrite |
| Gravimetric | EPA 1664A | O&G |
| Titration | Chap.7, Sect. 7.3.4 Mod. | Reactive Sulfide |
| Titration | SM 4500 S-2CF, 20th/21st edition | Sulfide |
| UV/Vis | SM 4500 P B5, E, 20th/21st edition | Total Phosphorus (as P) |
| UV/Vis | SM 4500 PE, 20th/21st edition | Ortho-Phosphate (as P) |
| TOC | 9060A/SM5310C, 20th/21st edition | Total Organic Carbon |
| Gravimetric | SM 2540C, 20th/21st edition | TDS |
| Gravimetric | SM 2540D, 20th/21st edition | TSS |
| Colorimetric | EPA 9012A/B | Cyanide |
| Physical | EPA 1010A | Ignitability |
| Physical | EPA 9095B | Paint Filter |
| Probe | EPA 9040B/C | pH |
| **Preparation** | **Method** | **Type** |
| Preparation | EPA 1311 | TCLP |
| Preparation | EPA 3005A | Metals digestion |
| Preparation | EPA 3010A | Metals digestion |
| Preparation | EPA 3510C | Organics Liquid Extraction |
| Preparation | EPA 5030A/B | Purge and Trap Water |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8260B | 1,1,1-Trichloroethane (1,1,1-TCA) |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8260B | 1,1,1,2-Tetrachloroethane |
| GC/MS | EPA 8260B | 1,1,2,2-Tetrachloroethane |
| GC/MS | EPA 8260B | 1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113) |
| GC/MS | EPA 8260B | 1,1,2-Trichloroethane |
| GC/MS | EPA 8260B | 1,1-Dichloroethane (1,1-DCA) |
| GC/MS | EPA 8260B | 1,1-Dichloroethene (1,1-DCE) |
| GC/MS | EPA 8260B | 1,1-Dichloropropene |
| GC/MS | EPA 8260B | 1,2,3-Trichlorobenzene |
| GC/MS | EPA 8260B | 1,2,3-Trichloropropane |
| GC/MS | EPA 8260B | 1,2,4-Trichlorobenzene |
| GC/MS | EPA 8260B | 1,2,4-Trimethylbenzene |
| GC/MS | EPA 8260B | 1,2-Dibromo-3-chloropropane (DBCP) |
| GC/MS | EPA 8260B | 1,2-Dibromoethane (EDB) |
| GC/MS | EPA 8260B | 1,2-Dichlorobenzene |
| GC/MS | EPA 8260B | 1,2-Dichloroethane (EDC) |
| GC/MS | EPA 8260B | 1,2-Dichloropropane |
| GC/MS | EPA 8260B | 1,3,5-Trimethylbenzene |
| GC/MS | EPA 8260B | 1,3-Dichlorobenzene |
| GC/MS | EPA 8260B | 1,3-Dichloropropane |
| GC/MS | EPA 8260B | 1,4-Dichlorobenzene |
| GC/MS | EPA 8260B | 1,4-Dioxane |
| GC/MS | EPA 8260B | 2,2-Dichloropropane |
| GC/MS | EPA 8260B | 2-Butanone (Methyl ethyl ketone; MEK) |
| GC/MS | EPA 8260B | 2-Chlorotoluene |
| GC/MS | EPA 8260B | 2-Hexanone (Methyl butyl ketone; MBK) |
| GC/MS | EPA 8260B | 4-Chlorotoluene |
| GC/MS | EPA 8260B | 4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK) |
| GC/MS | EPA 8260B | Acetone |
| GC/MS | EPA 8260B | Acetonitrile |
| GC/MS | EPA 8260B | Acrolein |
| GC/MS | EPA 8260B | Acrylonitrile |
| GC/MS | EPA 8260B | Allyl chloride |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8260B | Benzene |
| GC/MS | EPA 8260B | Bromobenzene |
| GC/MS | EPA 8260B | Bromochloromethane |
| GC/MS | EPA 8260B | Bromodichloromethane |
| GC/MS | EPA 8260B | Bromoform |
| GC/MS | EPA 8260B | Bromomethane |
| GC/MS | EPA 8260B | Carbon Disulfide |
| GC/MS | EPA 8260B | Carbon Tetrachloride |
| GC/MS | EPA 8260B | Chlorobenzene |
| GC/MS | EPA 8260B | Chloroethane |
| GC/MS | EPA 8260B | Chloroform |
| GC/MS | EPA 8260B | Chloromethane |
| GC/MS | EPA 8260B | Chloroprene |
| GC/MS | EPA 8260B | cis-1,2-Dichloroethene (cis-1,2-DCE) |
| GC/MS | EPA 8260B | cis-1,3-Dichloropropene |
| GC/MS | EPA 8260B | cis-1,4-Dichloro-2-butene |
| GC/MS | EPA 8260B | Cyclohexane |
| GC/MS | EPA 8260B | Dibromochloromethane |
| GC/MS | EPA 8260B | Dibromomethane |
| GC/MS | EPA 8260B | Dichlorodifluoromethane (CFC-12) |
| GC/MS | EPA 8260B | Ethyl methacrylate |
| GC/MS | EPA 8260B | Ethylbenzene |
| GC/MS | EPA 8260B | Hexachlorobutadiene |
| GC/MS | EPA 8260B | Hexane |
| GC/MS | EPA 8260B | Iodomethane |
| GC/MS | EPA 8260B | Isobutyl alcohol |
| GC/MS | EPA 8260B | Isopropylbenzene (Cumene) |
| GC/MS | EPA 8260B | Methacrylonitrile |
| GC/MS | EPA 8260B | Methyl Acetate |
| GC/MS | EPA 8260B | Methyl methacrylate |
| GC/MS | EPA 8260B | Methyl Tertiary Butyl Ether (MTBE) |
| GC/MS | EPA 8260B | Methylcyclohexane |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8260B | Methylene Chloride, or Dichloromethane |
| GC/MS | EPA 8260B | Naphthalene |
| GC/MS | EPA 8260B | n-Butylbenzene |
| GC/MS | EPA 8260B | n-Propylbenzene |
| GC/MS | EPA 8260B | p-Isopropyltoluene |
| GC/MS | EPA 8260B | Propionitrile |
| GC/MS | EPA 8260B | sec-Butylbenzene |
| GC/MS | EPA 8260B | Styrene |
| GC/MS | EPA 8260B | tert-Butylbenzene |
| GC/MS | EPA 8260B | Tetrachloroethene (PCE; PERC) |
| GC/MS | EPA 8260B | Toluene |
| GC/MS | EPA 8260B | trans-1,2-Dichloroethene (trans-1,2-DCE) |
| GC/MS | EPA 8260B | trans-1,3-Dichloropropene |
| GC/MS | EPA 8260B | trans-1,4-Dichloro-2-butene |
| GC/MS | EPA 8260B | Trichloroethene (TCE) |
| GC/MS | EPA 8260B | Trichlorofluoromethane (CFC-11) |
| GC/MS | EPA 8260B | Vinyl acetate |
| GC/MS | EPA 8260B | Vinyl Chloride (VC) |
| GC/MS | EPA 8260B | Xylenes (Total) |
| GC/MS | EPA 8270C/D | Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane) |
| GC/MS | EPA 8270C/D | 1,1'-Biphenyl |
| GC/MS | EPA 8270C/D | 1,2,4,5-Tetrachlorobenzene |
| GC/MS | EPA 8270C/D | 1,2,4-Trichlorobenzene |
| GC/MS | EPA 8270C/D | 1,2-Dichlorobenzene |
| GC/MS | EPA 8270C/D | 1,2-Diphenylhydrazine |
| GC/MS | EPA 8270C/D | 1,3-Dichlorobenzene |
| GC/MS | EPA 8270C/D | 1,4-Dichlorobenzene |
| GC/MS | EPA 8270C/D | 1,4-Dioxane |
| GC/MS | EPA 8270C/D | 1-Methylnaphthalene |
| GC/MS | EPA 8270C/D | 2,3,4,6-Tetrachlorophenol |
| GC/MS | EPA 8270C/D | 2,4,5-Trichlorophenol |
| GC/MS | EPA 8270C/D | 2,4,6-Trichlorophenol (TCP) |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8270C/D | 2,4-Dichlorophenol (DCP) |
| GC/MS | EPA 8270C/D | 2,4-Dimethylphenol |
| GC/MS | EPA 8270C/D | 2,4-Dinitrophenol |
| GC/MS | EPA 8270C/D | 2,4-Dinitrotoluene (DNT) |
| GC/MS | EPA 8270C/D | 2,6-Dichlorophenol |
| GC/MS | EPA 8270C/D | 2,6-Dinitrotoluene |
| GC/MS | EPA 8270C/D | 2-Chloronaphthalene |
| GC/MS | EPA 8270C/D | 2-Chlorophenol |
| GC/MS | EPA 8270C/D | 2-Methylnaphthalene |
| GC/MS | EPA 8270C/D | 2-Methylphenol (o-Cresol) |
| GC/MS | EPA 8270C/D | 2-Nitroaniline |
| GC/MS | EPA 8270C/D | 2-Nitrophenol (ONP) |
| GC/MS | EPA 8270C/D | 3,3'-Dichlorobenzidine (DCB) |
| GC/MS | EPA 8270C/D | 3-Methylphenol |
| GC/MS | EPA 8270C/D | 3-Nitroaniline |
| GC/MS | EPA 8270C/D | 4,6-Dinitro-2-methylphenol (DNOC) |
| GC/MS | EPA 8270C/D | 4-Bromophenyl phenyl ether |
| GC/MS | EPA 8270C/D | 4-Chloro-3-methylphenol |
| GC/MS | EPA 8270C/D | 4-Chloroaniline |
| GC/MS | EPA 8270C/D | 4-Chlorophenyl phenyl ether |
| GC/MS | EPA 8270C/D | 4-Methylphenol (p-Cresol) |
| GC/MS | EPA 8270C/D | 4-Nitroaniline (PNA) |
| GC/MS | EPA 8270C/D | 4-Nitrophenol (PNP) |
| GC/MS | EPA 8270C/D | Acenaphthene |
| GC/MS | EPA 8270C/D | Acenaphthylene |
| GC/MS | EPA 8270C/D | Acetaphenone |
| GC/MS | EPA 8270C/D | Aniline |
| GC/MS | EPA 8270C/D | Anthracene |
| GC/MS | EPA 8270C/D | Atrazine |
| GC/MS | EPA 8270C/D | Benzaldehyde |
| GC/MS | EPA 8270C/D | Benzidine |
| GC/MS | EPA 8270C/D | Benzo(a)anthracene |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8270C/D | Benzo(a)anthracene |
| GC/MS | EPA 8270C/D | Benzo(a)pyrene |
| GC/MS | EPA 8270C/D | Benzo(b)fluoranthene |
| GC/MS | EPA 8270C/D | Benzo(g,h,i)perylene |
| GC/MS | EPA 8270C/D | Benzo(k)fluoranthene |
| GC/MS | EPA 8270C/D | Benzoic Acid |
| GC/MS | EPA 8270C/D | Benzyl alcohol |
| GC/MS | EPA 8270C/D | bis(2-Chloroethoxy)methane |
| GC/MS | EPA 8270C/D | bis(2-Chloroethyl)ether (BCEE) |
| GC/MS | EPA 8270C/D | bis(2-Ethylhexyl)phthalate (BEHP) |
| GC/MS | EPA 8270C/D | Butyl benzyl phthalate (BBP) |
| GC/MS | EPA 8270C/D | Caprolactam |
| GC/MS | EPA 8270C/D | Carbazole |
| GC/MS | EPA 8270C/D | Chrysene |
| GC/MS | EPA 8270C/D | Dibenz(a,h)anthracene |
| GC/MS | EPA 8270C/D | Dibenzofuran (DBF) |
| GC/MS | EPA 8270C/D | Diethyl phthalate (DEP) |
| GC/MS | EPA 8270C/D | Dimethyl phthalate (DMP) |
| GC/MS | EPA 8270C/D | Di-n-butyl phthalate (DBP) |
| GC/MS | EPA 8270C/D | Di-n-octyl phthalate (DNOP) |
| GC/MS | EPA 8270C/D | Fluoranthene |
| GC/MS | EPA 8270C/D | Fluorene |
| GC/MS | EPA 8270C/D | Hexachlorobenzene (HCB) |
| GC/MS | EPA 8270C/D | Hexachlorobutadiene (HCBD) |
| GC/MS | EPA 8270C/D | Hexachlorocyclopentadiene (HCCPD) |
| GC/MS | EPA 8270C/D | Hexachloroethane (HCE) |
| GC/MS | EPA 8270C/D | Indeno(1,2,3-cd)pyrene |
| GC/MS | EPA 8270C/D | Isophorone |
| GC/MS | EPA 8270C/D | Naphthalene |
| GC/MS | EPA 8270C/D | Nitrobenzene |
| GC/MS | EPA 8270C/D | N-Nitrosodimethylamine |
| GC/MS | EPA 8270C/D | N-Nitroso-di-n-propylamine (NDPA) |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/MS | EPA 8270C/D | N-nitrosodiphenylamine (NDPHA) |
| GC/MS | EPA 8270C/D | Pentachlorophenol |
| GC/MS | EPA 8270C/D | Phenanthrene |
| GC/MS | EPA 8270C/D | Phenol |
| GC/MS | EPA 8270C/D | Pyrene |
| GC/MS | EPA 8270C/D | Pyridine |
| GC/ECD | EPA 8081A/B | 4,4'-DDD |
| GC/ECD | EPA 8081A/B | 4,4'-DDE |
| GC/ECD | EPA 8081A/B | 4,4'-DDT |
| GC/ECD | EPA 8081A/B | Aldrin |
| GC/ECD | EPA 8081A/B | alpha-BHC (alpha-HCH) |
| GC/ECD | EPA 8081A/B | alpha-Chlordane |
| GC/ECD | EPA 8081A/B | beta-BHC (beta-HCH) |
| GC/ECD | EPA 8081A/B | delta-BHC (delta-HCH) |
| GC/ECD | EPA 8081A/B | Chlordane |
| GC/ECD | EPA 8081A/B | Dieldrin |
| GC/ECD | EPA 8081A/B | Endosulfan I |
| GC/ECD | EPA 8081A/B | Endosulfan II |
| GC/ECD | EPA 8081A/B | Endosulfan sulfate |
| GC/ECD | EPA 8081A/B | Endrin |
| GC/ECD | EPA 8081A/B | Endrin aldehyde |
| GC/ECD | EPA 8081A/B | Endrin ketone |
| GC/ECD | EPA 8081A/B | gamma-BHC (Lindane; gamma-HCH) |
| GC/ECD | EPA 8081A/B | gamma-Chlordane |
| GC/ECD | EPA 8081A/B | Heptachlor |
| GC/ECD | EPA 8081A/B | Heptachlor epoxide |
| GC/ECD | EPA 8081A/B | Methoxychlor |
| GC/ECD | EPA 8081A/B | Toxaphene |
| GC/ECD | EPA 8082 /A | Aroclor-1016 |
| GC/ECD | EPA 8082 /A | Aroclor-1221 |
| GC/ECD | EPA 8082 /A | Aroclor-1232 |
| GC/ECD | EPA 8082 /A | Aroclor-1242 |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| GC/ECD | EPA 8082 /A | Aroclor-1248 |
| GC/ECD | EPA 8082 /A | Aroclor-1254 |
| GC/ECD | EPA 8082 /A | Aroclor-1260 |
| GC/ECD | EPA 8082 /A | Aroclor-1262 |
| GC/ECD | EPA 8082 /A | Aroclor-1268 |
| GC/ECD | EPA 8151A | 2,4,5-T |
| GC/ECD | EPA 8151A | 2,4,5-TP (Silvex) |
| GC/ECD | EPA 8151A | 2,4-D |
| GC/ECD | EPA 8151A | 2,4-DB |
| GC/ECD | EPA 8151A | Dalapon |
| GC/ECD | EPA 8151A | Dicamba |
| GC/ECD | EPA 8151A | Dichlorprop |
| GC/ECD | EPA 8151A | Dinoseb |
| GC/ECD | EPA 8151A | MCPA |
| GC/ECD | EPA 8151A | MCPP (Mecoprop) |
| HPLC/UV | EPA 8330A | 1,3,5-Trinitrobenzene |
| HPLC/UV | EPA 8330A | 1,3-Dinitrobenzene |
| HPLC/UV | EPA 8330A | 2,4,6-Trinitrophenylmethylnitramine (Tetryl) |
| HPLC/UV | EPA 8330A | 2,4,6-Trinitrotoluene (TNT) |
| HPLC/UV | EPA 8330A | 2,4-Dinitrotoluene (DNT) |
| HPLC/UV | EPA 8330A | 2,6-Dinitrotoluene |
| HPLC/UV | EPA 8330A | 2-Amino-4,6-dinitrotoluene |
| HPLC/UV | EPA 8330A | 2-Nitrotoluene (ONT) |
| HPLC/UV | EPA 8330A | 3-Nitrotoluene |
| HPLC/UV | EPA 8330A | 3,5-Dinitroaniline |
| HPLC/UV | EPA 8330A | 4-Amino-2,6-dinitrotoluene |
| HPLC/UV | EPA 8330A | 4-Nitrotoluene (PNT) |
| HPLC/UV | EPA 8330A | Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) |
| HPLC/UV | EPA 8330A | Nitroglycerin |
| HPLC/UV | EPA 8330A | Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) |
| HPLC/UV | EPA 8330A | Nitrobenzene |
| HPLC/UV | EPA 8330A | Nitroguanidine |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| HPLC/UV | EPA 8330A | PETN |
| HPLC/UV | EPA 8330B | 1,3,5-Trinitrobenzene |
| HPLC/UV | EPA 8330B | 1,3-Dinitrobenzene |
| HPLC/UV | EPA 8330B | 2,4,6-Trinitrophenylmethylnitramine (Tetryl) |
| HPLC/UV | EPA 8330B | 2,4,6-Trinitrotoluene (TNT) |
| HPLC/UV | EPA 8330B | 2,4-Dinitrotoluene (DNT) |
| HPLC/UV | EPA 8330B | 2,6-Dinitrotoluene |
| HPLC/UV | EPA 8330B | 2-Amino-4,6-dinitrotoluene |
| HPLC/UV | EPA 8330B | 2-Nitrotoluene (ONT) |
| HPLC/UV | EPA 8330B | 3-Nitrotoluene |
| HPLC/UV | EPA 8330B | 3,5-Dinitroaniline |
| HPLC/UV | EPA 8330B | 4-Amino-2,6-dinitrotoluene |
| HPLC/UV | EPA 8330B | 4-Nitrotoluene (PNT) |
| HPLC/UV | EPA 8330B | Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) |
| HPLC/UV | EPA 8330B | Nitroglycerin |
| HPLC/UV | EPA 8330B | Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) |
| HPLC/UV | EPA 8330B | Nitrobenzene |
| HPLC/UV | EPA 8330B | Nitroguanidine |
| HPLC/UV | EPA 8330B | PETN |
| GC/FID | FLPRO | Petroleum Range Organics |
| GC/FID | EPA 8015B | TPH DRO |
| GC/FID | EPA 8015B | TPH GRO |
| HPLC/MS | EPA 6850 | Perchlorate |
| ICP | EPA 6010B/C | Aluminum |
| ICP | EPA 6010B/C | Antimony |
| ICP | EPA 6010B/C | Arsenic |
| ICP | EPA 6010B/C | Barium |
| ICP | EPA 6010B/C | Beryllium |
| ICP | EPA 6010B/C | Boron |
| ICP | EPA 6010B/C | Cadmium |
| ICP | EPA 6010B/C | Calcium |
| ICP | EPA 6010B/C | Chromium, total |

LABORATORY ACCREDITATION BUREAU

**Certificate # L2226**

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| ICP | EPA 6010B/C | Cobalt |
| ICP | EPA 6010B/C | Copper |
| ICP | EPA 6010B/C | Iron |
| ICP | EPA 6010B/C | Lead |
| ICP | EPA 6010B/C | Magnesium |
| ICP | EPA 6010B/C | Manganese |
| CVAA | EPA 7471A/B | Mercury |
| ICP | EPA 6010B/C | Molybdenum |
| ICP | EPA 6010B/C | Nickel |
| ICP | EPA 6010B/C | Potassium |
| ICP | EPA 6010B/C | Selenium |
| ICP | EPA 6010B/C | Silver |
| ICP | EPA 6010B/C | Sodium |
| ICP | EPA 6010B/C | Strontium |
| ICP | EPA 6010B/C | Tin |
| ICP | EPA 6010B/C | Titanium |
| ICP | EPA 6010B/C | Thallium |
| ICP | EPA 6010B/C | Vanadium |
| ICP | EPA 6010B/C | Zinc |
| UV/Vis | EPA 7196A | Hexavalent Chromium |
| TOC | Lloyd Kahn | Total Organic Carbon |
| Colorimetric | EPA 353.2 | Nitrocellulose |
| Colorimetric | EPA 9012A/B | Cyanide |
| Titration | Chap.7, Sect. 7.3.4 Mod. | Reactive Sulfide |
| Titration | EPA 9034 | Sulfide |
| Probe | EPA 9045C/D | pH |
| **Preparation** | **Method** | **Type** |
| Preparation | EPA 1311 | TCLP |
| Preparation | EPA 1312 | SPLP |
| Preparation | NJ Modified 3060A | Hexavalent Chromium |
| Preparation | EPA 3050B | Metals Digestion |
| Preparation | EPA 3546 | Organics Microwave Extraction |

LABORATORY ACCREDITATION BUREAU

**Certificate # L2226**

| **Solid and Chemical Materials** | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Preparation | EPA 3550B/C | Organics Sonication |
| Preparation | SM 2540B 20th/21st edition | Percent Solids (Percent Moisture) |
| Preparation | EPA 5035 /A | Purge and Trap Solid |

Notes:

1) This laboratory offers commercial testing service.

Approved By: _____ Date: April 8, 2011

R. Douglas Leonard
Chief Technical Officer

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