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# REMEDIAL INVESTIGATION WORK PLAN PART 2 SAMPLING AND ANALYSIS PLAN FOR MUNITIONS RESPONSE PROGRAM UNEXPLODED ORDNANCE SITES 2, 3, 4, 5, 6, 7 AND 8 MCRD PARRIS ISLAND SC

5/1/2012

TETRA TECH

# Remedial Investigation Work Plan
# Munitions Response Program

# Sampling and Analysis Plan: Part 2
# Munitions Constituents at
# Unexploded Ordnance Sites 2, 3, 4, 5, 6, 7, 8

# Marine Corps Recruit Depot Parris Island
# Parris Island, South Carolina

## Naval Facilities Engineering Command Southeast

**Contract Number N62470-08-D-1001**
**Contract Task Order JM10**

**May 2012**

TETRA TECH

## SAP Worksheet #1 -- Title and Approval Page

(UFP-QAPP Manual Section 2.1)

**FINAL**
**SAMPLING AND ANALYSIS PLAN**
**FOR**
**MUNITIONS RESPONSE PROGRAM**
**MUNITIONS CONSTITUENTS REMEDIAL INVESTIGATION**
**AT**
**UNEXPLODED ORDNANCE SITES 2, 3, 4, 5, 6, 7, and 8**
**MARINE CORPS RECRUIT DEPOT – PARRIS ISLAND**
**PARRIS ISLAND, SOUTH CAROLINA**

**May 2012**

**Prepared for:**
Naval Facilities Engineering Command Southeast
NAS Jacksonville
Jacksonville, Florida 32212-0300

**Prepared by:**
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**Prepared under:**
Comprehensive Long-term Environmental Action Navy Contract
Contract No. N62470-08-D-1001
Contract Task Order JM10

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**SAP Worksheet #1 -- Title and Approval Page**

(UFP-QAPP Manual Section 2.1)

INTERNAL DRAFT

# SAMPLING AND ANALYSIS PLAN FOR MUNITIONS RESPONSE PROGRAM MUNITIONS CONSTITUENTS REMEDIAL INVESTIGATION AT UNEXPLODED ORDNANCE SITES 2, 3, 4, 5, 6, 7, and 8 MARINE CORPS RECRUIT DEPOT – PARRIS ISLAND PARRIS ISLAND, SOUTH CAROLINA

**August 2011**

**Prepared for:**
Naval Facilities Engineering Command Southeast
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Jacksonville, Florida 32212-0300

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ºC | Degrees Celsius |
| ºF | Degrees Fahrenheit |
| %D | Percent Difference or Percent Drift |
| %R | Percent Recovery |
| AET | Apparent Effects Threshold |
| amu | Atomic Mass Unit |
| AR | Administrative Record |
| ASR | Archive Search Report |
| ATV | All-terrain Vehicle |
| bgs | Below Ground Surface |
| CA | Corrective Action |
| CAS | Chemical Abstracts ServiceCCB Continuing Calibration Blank |
| CCV | Continuing Calibration Verification |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| CFR | Code of Federal Regulations |
| CLEAN | Comprehensive Long-term Environmental Action Navy |
| CLP | Contract Laboratory Program |
| COMMARCORSYSCOM | Commander, Marine Corps Systems Command |
| COPC | Contaminant of Potential Concern |
| CRREL | Cold Regions Research and Environmental Laboratory |
| CSM | Conceptual Site Model |
| CTO | Contract Task Order |
| CVAA | Cold Vapor Atomic Absorption |
| CWAP | Comprehensive Work Approval Process |
| DAD | Diode Array Detector |
| DAF | Dilution Attenuation Factor |
| DDESB | Department of Defense Explosives Safety Board |
| DI | Deionized |
| DL | Detection Limit |
| DMM | Discarded Military Munitions |
| DO | Dissolved Oxygen |
| DoD | Department of Defense |
| DOT | Department of Transportation |
| DPT | Direct Push Technology |
| DQI | Data Quality Indicator |

## ACRONYMS AND ABBREVIATIONS (Continued)

| | |
|---|---|
| DQO | Data Quality Objective |
| DVM | Data Validation Manager |
| EDD | Electronic Data Deliverable |
| Eco SSL | USEPA Ecological Soil Screening Level |
| ELAP | Environmental Laboratory Approval Program |
| EOD | Explosive Ordnance Disposal |
| ERA | Ecological Risk Assessment |
| ESQD | Explosives Safety Quantity-Distance |
| ESS | Explosives Safety Submission |
| FBQSTP | Field Branches Quality System and Technical Procedures |
| FFA | Federal Facilities Agreement |
| FOL | Field Operations Leader |
| FS | Feasibility Study |
| FTMR | Field Task Modification Request |
| g | Grams |
| GEL | General Engineering Laboratories, LLC |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| HASP | Health and Safety Plan |
| HAZWOPER | Hazardous Waste Operations and Emergency Response |
| HDOP | Horizontal Dilution of Precision |
| HE | High Explosives |
| HHRA | Human Health Risk Assessment |
| HI | Hazard Index |
| HMX | Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine |
| HPLC | High Performance Liquid Chromatography |
| HSM | Health and Safety Manager |
| IAS | Initial Assessment Study |
| ICAL | Initial Calibration |
| ICB | Initial Calibration Blank |
| ICP-MS | Inductively Coupled Plasma – Mass Spectroscopy |
| ICS | Interference Check Standard |
| ICV | Initial Calibration Verification |
| IDW | Investigation-Derived Waste |
| ILCR | Incremental Lifetime Cancer Risk |
| IRP | Installation Restoration Program |

## ACRONYMS AND ABBREVIATIONS (Continued)

| | |
|---|---|
| IS | Incremental Sampling |
| L | Liter |
| LANL | Los Alamos National Laboratory |
| LANT | Atlantic |
| LCS | Laboratory Control Sample |
| LCSD | Laboratory Control Sample Duplicate |
| LIMS | Laboratory Information Management System |
| LOD | Limit of Detection |
| LOQ | Limit of Quantitation |
| MC | Munitions Constituents |
| MCAS | Marine Corps Air Station |
| MCL | Maximum Contaminant Level |
| MCRD | Marine Corps Recruit Depot |
| MDAS | Material Documented As Safe |
| MEC | Munitions and Explosives of Concern |
| mg/kg | Milligrams per Kilogram |
| mm | Millimeter |
| MMRP | Military Munitions Response Program |
| MPC | Measurement Performance Criterion |
| MPPEH | Material Potentially Presenting an Explosive Hazard |
| MRA | Munitions Response Area |
| MRP | Munitions Response Program |
| MS | Matrix Spike |
| MSD | Matrix Spike Duplicate |
| msl | Mean Sea Level |
| NA | Not Applicable |
| NAD83 | North American Datum of 1983 |
| NAVD88 | North American Vertical Datum of 1988 |
| NAVFAC | Naval Facilities Engineering Command |
| NC | No Screening Criterion |
| NEESA | Naval Energy and Environmental Support Activity |
| NEW | Net Explosive Weight |
| NFA | No Further Action |
| NFI | No Further Investigation |

## ACRONYMS AND ABBREVIATIONS (Continued)

| | |
|---|---|
| NIRIS | Naval Installation Restoration Information Solution |
| NLM | National Library of Medicine |
| NOAA | National Oceanic and Atmospheric Administration |
| NOEC | No Observable Effects Concentration |
| NPL | National Priorities List |
| NTU | Nephelometric Turbidity Unit |
| ORP | Oxidation Reduction Potential |
| OSHA | Occupational Safety and Health Administration |
| oz | Ounce |
| PAL | Project Action Limit |
| PDF | Portable Document Format |
| PM | Project Manager |
| POC | Point of Contact |
| PPE | Personal Protective Equipment |
| PQLG | Project Quantitation Limit Goal |
| PUPS | Palmetto Utility Protection Service, Inc. |
| PVC | Polyvinyl Chloride |
| QA | Quality Assurance |
| QAM | Quality Assurance Manager |
| QAO | Quality Assurance Officer |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| QSM | Quality Systems Manual for Environmental Laboratories |
| r | Linear Regression Correlation Coefficient |
| $r^2$ | Coefficient of Determination |
| R3 BTAG SED | USEPA Region 3 Biological Technical Assistance Group Freshwater Sediment Screening Benchmark |
| R4 ESV | USEPA Region 4 Ecological Screening Value |
| R4 Eco SDSL | USEPA Region 4 Ecological Sediment Screening Level |
| RBSSL | USEPA Regions 3, 6, and 9 Risk-Based Soil Screening Level, Migration to Groundwater |
| RDX | Octahydro-1,3,5,7-Tetranitro-1,3,5-Triazine |
| RF | Response Factor |
| RI | Remedial Investigation |
| RIWP | Remedial Investigation Work Plan |
| RPD | Relative Percent Difference |

## ACRONYMS AND ABBREVIATIONS (Continued)

| | |
|---|---|
| RPM | Remedial Project Manager |
| R-RSL | USEPA Regions 3, 6, and 9 Residential Regional Screening Level |
| RSD | Relative Standard Deviation |
| RT | Retention Time |
| RTC | Response to Comments |
| RV | Recreational Vehicle |
| SAP | Sampling and Analysis Plan |
| SCAR | Subcaliber Aerial Rockets |
| SCDHEC | South Carolina Department of Health and Environmental Control |
| SDG | Sample Delivery Group |
| SE | Southeast |
| SI | Site Inspection |
| SOP | Standard Operating Procedure |
| Southern University | Southern University Center for Energy and Environmental Studies |
| SOW | Statement of Work |
| SPCS | South Carolina State Plane Coordinate System |
| SQL | Structured Query Language |
| SQuiRTs | NOAA Screening Quick Reference Tables |
| SSHO | Site Safety and Health Officer |
| SUXOS | Senior Unexploded Ordnance Supervisor |
| TAL | Target Analyte List |
| TBD | To Be Determined |
| Tetra Tech | Tetra Tech, Inc. |
| Tetryl | Methyl-2,4,6-Trinitrophenylnitramine |
| TNT | Trinitrotoluene |
| TOC | Total Organic Carbon |
| TP | Technical Paper |
| T-RSL | USEPA Regions 3, 6, and 9 Tapwater Regional Screening Level |
| UCL | Upper Confidence Limit |
| UFP | Uniform Federal Policy |
| µg/L | Micrograms per Liter |
| U.S. | United States |
| USACE | United States Army Corps of Engineers |
| USDA | United States Department of Agriculture |
| USEPA | United States Environmental Protection Agency |
| UXO | Unexploded Ordnance |

## ACRONYMS AND ABBREVIATIONS (Continued)

| | |
|---|---|
| UXOSO | UXO Safety Officer |
| WCSD | Watershed Contaminant Source Document |
| WFTBn | Weapons and Field Training Battalion |
| WWII | World War II |
| XRF | X-Ray Fluorescence |

## EXECUTIVE SUMMARY

Tetra Tech, Inc. (Tetra Tech) has prepared this Munitions Constituents (MC) Uniform Federal Policy (UFP) Sampling and Analysis Plan (SAP) on behalf of Naval Facilities Engineering Command (NAVFAC) Southeast (SE) under the Comprehensive Long-term Environmental Action Navy (CLEAN) Contract No. N62470-08-D-1001 Contract Task Order (CTO) JM10. This plan has been prepared to support a Remedial Investigation (RI) of MC at seven Munitions Response Areas (MRAs), identified as Unexploded Ordnance (UXO) Sites 2 to 8, which are located at Marine Corps Recruit Depot (MCRD) Parris Island in Parris Island, South Carolina. These MRAs are being investigated under the Navy's Munitions Response Program (MRP), following the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) process.

This MC SAP comprises Part 2 of a two-part Work Plan that addresses RI activities at the MCRD Parris Island MRP sites. The "Introduction" to the MRP Sites Remedial Investigation Work Plan (RIWP) contains general background information regarding the basis for this investigation, including site location maps, descriptions of active and historical ranges at MCRD Parris Island, responses to regulatory agency comments on the draft version of this document, and a glossary of munitions-related terms used in this SAP. Part 1 of the RIWP [a.k.a. the Munitions and Explosives of Concern (MEC) SAP] describes the MEC investigation of UXO Sites 3 to 8, which includes detector-aided surface surveys, land-based geophysical surveys, intrusive investigations of subsurface anomalies, and aquatic investigations of underwater anomalies. Part 2 of the RIWP (a.k.a. this MC SAP) describes the MC investigation, which includes sampling and analysis of soil, sediment, and groundwater to collect data for UXO Sites 3 to 8, as well as human health and ecological risk evaluations for UXO Sites 2 to 8. Because the highest concentrations of MC are expected to be found in environmental media located directly beneath or adjacent to MEC and Material Potentially Presenting an Explosive Hazard (MPPEH), results of the investigation conducted under the MEC SAP will be used to identify biased sampling locations for investigation under this MC SAP, as necessary, to fulfill the project objectives.

The RI activities described in this MC SAP are designed to establish the nature and extent of surface and subsurface MC contamination associated with the presence of MEC or MPPEH at each of the UXO sites. This will be accomplished by collecting samples of various environmental media in the vicinity of MEC or MPPEH identified during the MEC investigation, and analyzing the samples for area- or site-specific chemicals of potential concern (COPCs). In some cases, supplemental analyses may be included to more completely characterize contaminant concentrations, migration potential, and/or bioavailability at a particular site. The field activities outlined in this MC SAP are similar to those conducted during the SI at these sites, although the scope has been expanded to incorporate the collection and analysis of samples: from additional sites not previously sampled (e.g., UXO 3, UXO 7, and UXO 8), from additional areas

within previously sampled sites (UXO 4, UXO 5, and UXO 6), from additional environmental media not previously sampled (e.g., groundwater, subsurface soil), and for additional MC not previously analyzed (e.g., metals other than lead). If the resulting analytical data indicate the presence of MC at potentially unacceptable concentrations, a Human Health Risk Assessment (HHRA) and/or an Ecological Risk Assessment (ERA) will be performed, as appropriate. If risks are unacceptable, the risk estimates will be available for subsequent use in a Feasibility Study (FS) designed to evaluate options for mitigating the risks due to MC.

Following is a summary of the MC investigation activities to be conducted under this MC SAP:

Aerial Bombing Target at Parade Deck (UXO 3)

Surface and subsurface soil samples will be collected at 12 locations, and groundwater samples will be collected at three temporary well locations. Groundwater samples will be analyzed for metals and explosives. Soil samples from each sampling location will be analyzed for metals. Explosives analysis will be conducted for one surface soil composite and one subsurface soil composite. Surface soil samples will also be analyzed for pH for use in the ERA.

Field Artillery West Main Range (UXO 4)

Biased soil samples will be collected at 12 to 15 locations within the impact area and up to 12 locations near the firing points at discretionary locations (i.e., where site-related MEC/MPPEH are identified during the intrusive MEC investigation). Discretionary surface soil incremental sampling (IS) samples will be collected from up to three investigation grids where evidence of low-order detonations or ruptured projectiles is present. Soil samples will also be collected at 12 systematic locations near Firing Point C to investigate the exceedance of a risk-based screening value for lead observed in the surface soil during the SI. Groundwater samples will be collected at six temporary well locations situated along the impact area boundaries. Sediment samples will be collected at up to ten discretionary locations where surface runoff from areas containing surficial MEC/MPPEH may be entering adjacent waterways. Submerged sediment samples will be collected at up to ten discretionary locations where MEC/MPPEH is observed within the site waterways. The Firing Point C soil samples will be analyzed for metals, and all other discrete samples (including soil, sediment, and groundwater) will be analyzed for metals and explosives. The IS samples from the grids will be analyzed for explosives. Surface soil samples will also be analyzed for pH, and sediment samples will be analyzed for pH and Total Organic Carbon (TOC) for use in the ERA.

Field Artillery East Shrapnel Range (UXO 5 and UXO 6)

At UXO 5, one 50-point composite IS surface soil sample will be collected near the presumed location of the firing point and analyzed for explosives. Up to 12 discrete biased soil samples will be

collected from discretionary locations (only if site-related munitions items are identified during the intrusive MEC investigation). The biased samples will be analyzed for metals and explosives.

At UXO 6, discretionary surface soil, sediment, subsurface soil, and submerged sediment samples may be collected, if warranted, based on results of the MEC investigation. If any site-related MEC/MPPEH are identified during the intrusive MEC investigation along the western boundary of the impact area, biased soil samples will be collected at up to 12 discretionary locations. Discretionary surface soil IS samples will be collected from up to three investigation grids where evidence of low-order detonations or ruptured projectiles is present. Sediment samples will be collected at up to ten discretionary locations where surface runoff from areas containing surficial MEC/MPPEH may be entering adjacent waterways. If any site-related munitions items are identified in the submerged sediments within the waterways, biased samples will be collected at up to ten discretionary sediment locations. Soil and sediment samples will be analyzed for metals and explosives. Surface soil samples will also be analyzed for pH, and sediment samples will be analyzed for pH and TOC for use in the ERA.

Aerial Bombing Target at Golf Course (UXO 7)

Surface and subsurface soil samples will be collected at 12 to 15 soil boring locations, and groundwater samples will be collected at three temporary well locations. Groundwater samples will be analyzed for metals and explosives. Soil samples from each sampling location will be analyzed for metals. Explosives analysis will be conducted for one surface soil composite and one subsurface soil composite. Surface soil samples will also be analyzed for pH for use in the ERA.

Aerial Bombing Target at Southern Tidal Flats (UXO 8)

Shallow and deep surface sediment samples will be collected at 12 locations distributed across the site. Precise locations will be selected in the field to coincide with surface MPPEH accumulations located closest to predetermined default locations. No soil or groundwater sampling will be conducted because the site lies within a tidal flat area that is completely submerged during high tide. Sediment samples from each sampling location will be analyzed for metals, as well as for pH and TOC for use in the ERA. Explosives analysis will be conducted for one shallow surface sediment composite (consisting of one aliquot from each of the 12 shallow surface sediment samples) and one deep surface sediment composite (consisting of one aliquot from each of the 12 deep surface sediment samples).

The Explosives Safety Submission (ESS) governing the implementation of this plan, which was submitted to and approved by the Commander, Marine Corps Systems Command (COMMARCORSYSCOM),

Program Manager of Ammunition (PM Ammo), and Department of Defense Explosives Safety Board (DDESB) prior to field mobilization, is presented in **Appendix A of the MEC SAP**.

## SAP Worksheet #2 -- SAP Identifying Information

(UFP-QAPP Manual Section 2.2.4)

**Site Name/Number:** Marine Corps Recruit Depot (MCRD) Parris Island, South Carolina
**Operable Units:** Unexploded Ordnance (UXO) Sites 2, 3, 4, 5, 6, 7, and 8
**Contractor Name:** Tetra Tech, Inc. (Tetra Tech)
**Contract Number:** N62470-08-D-1001
**Contract Title:** Comprehensive Long-term Environmental Action Navy (CLEAN) Contract
**Work Assignment Number:** Contract Task Order (CTO) JM10

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the United States Environmental Protection Agency (USEPA) *Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP)* (USEPA, 2005) and *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS* (USEPA, 2002).

2. Identify regulatory program: Department of Defense (DoD) Military Munitions Response Program (MMRP) using the general Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) process.

3. This SAP is a project-specific SAP.

4. List dates of scoping sessions that were held:

| Scoping Session | Date |
|---|---|
| Partnering Team Scoping Session | April 26, 2011 |
| Initial Internal Project Scoping Meeting | May 6, 2011 |
| Follow-up Internal Project Scoping Meeting | June 29, 2011 |

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

| Title | Date |
|---|---|
| Sampling and Analysis Plan for Munitions Response Program Site Inspections at Eight Munitions Response Sites (Tetra Tech) | January 2010 |
| | |

6. List organizational partners (stakeholders) and connection with lead organization:

USEPA Region 4 – Regulatory Oversight
South Carolina Department of Health and Environmental Control (SCDHEC) – Regulatory Oversight
MCRD Parris Island – Facility Oversight

7. Lead organization (see **Worksheet #7** for detailed list of data users)

Naval Facilities Engineering Command (NAVFAC) Southeast (SE)

8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

Not Applicable (NA), as there are no exclusions.

## SAP Worksheet #3 -- Distribution List

(UFP-QAPP Manual Section 2.3.1)

| Name of SAP Recipient | Title/Role | Organization | Telephone Number | E-Mail or Mailing Address |
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| To Be Determined (TBD) (electronic upload) | NAVFAC Chemist/ Quality Assurance Officer (QAO)/ Reviews SAP and Quality Assurance (QA) documentation for Navy | NAVFAC Atlantic (LANT) | TBD | TBD |
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| Ralph Basinski | Munitions Response Program (MRP) Coordinator/ Coordinates MRP activities at Navy installations | Tetra Tech | 412.921.8308 | ralph.basinski@tetratech.com |
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| Ralph Brooks | UXO Manager/ Manages corporate Munitions and Explosives of Concern (MEC) hazards and risks | Tetra Tech | 770.413.0965 x231 | ralph.brooks@tetratech.com |

| Name of SAP Recipient | Title/Role | Organization | Telephone Number | E-Mail or Mailing Address |
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| James Rossi | MRP Site Manager/ Manages UXO staff and field activities | Tetra Tech | 770.413.0965 x233 | james.rossi@tetratech.com |
| TBD | Project Geologist/ Field Operations Lead (FOL)/ Manages non-MEC drilling and sample collection activities | Tetra Tech | TBD | TBD |
| James T. Marine | Project Archaeologist | Tetra Tech | 412.920.7006 | james.marine@tetratech.com |
| Kim Zawacki | MCRD Parris Island Archaeologist | MCRD Parris Island | 843.228.2834 | kimberly.zawacki@usmc.mil |
| Bonnie Capito (final cover letter only) | Administrative Record (AR) Librarian/ Maintains long-term records for the Navy | NAVFAC LANT | 757.322.4785 | bonnie.capito@navy.mil |
| Glen Wagner (final cover letter only) | AR/ Maintains AR | Tetra Tech | 412.920.8603 | glenn.wagner@tetratech.com |
| Tom Johnston (electronic copy only) | Quality Assurance Manager (QAM)/ Manages Corporate QA Program and implementation | Tetra Tech | 412.921.8615 | tom.johnston@tetratech.com |
| Matt Soltis [Health and Safety Plan (HASP)] | Health and Safety Manager (HSM)/ Manages Corporate Health and Safety Program | Tetra Tech | 412.921.8912 | matt.soltis@tetratech.com |
| Mark Traxler (electronic copy only) | Project Chemist/ Provides Coordination with Laboratory(s) | Tetra Tech | 610.382.1171 | mark.traxler@tetratech.com |
| Joseph Samchuck (electronic copy only) | Data Validation Manager (DVM)/ Manages Data Validation | Tetra Tech | 412.921.8510 | joseph.samchuck@tetratech.com |

| Name of SAP Recipient | Title/Role | Organization | Telephone Number | E-Mail or Mailing Address |
|---|---|---|---|---|
| Tasha Horton (electronic copy only) | Laboratory PM/ Representative for Laboratory and Analytical Issues | General Engineering Laboratories, LLC (GEL) | 843.556.8171 | tasha.horton@gel.com |
| Dr. Samuel Washington (electronic copy only) | Technical POC/ Representative for Laboratory Contractual Issues | Southern University Center for Energy and Environmental Studies (Southern University) | 225.771.5920 | samuel_washington@subr.edu |
| Jim Coffman (electronic copy only) | Project Geophysicist/ Manages geophysics activities, including utility clearances | Tetra Tech | 412.921.8244 | jim.coffman@tetratech.com |
| Drilling Subcontractor (electronic copy only) | Well Installation Subcontractor PM/ Provides Drilling Services | TBD | TBD | TBD |
| Land Survey Subcontractor (electronic copy only) | Land Surveyor/ Provides Surveying Services | TBD | TBD | TBD |
| Investigation-Derived Waste (IDW) Subcontractor (electronic copy only) | IDW Subcontractor/ Provides IDW Services | TBD | TBD | TBD |

## SAP Worksheet #4 -- Project Personnel Sign-Off Sheet

(UFP-QAPP Manual Section 2.3.2)

Certification that project personnel have read the text will be obtained by one of the following methods as applicable:

1. In the case of regulatory agency personnel with oversight authority approval letters or e-mails will constitute verification that applicable sections of the SAP have been reviewed. Copies of regulatory agency approval letters / e-mails will be retained in the project files and are listed in **Worksheet #29** as project records.

2. E-mails will be sent to Navy, Tetra Tech, and subcontractor project personnel whom will be requested to verify by e-mail that they have read the applicable SAP / sections and the date on which they were reviewed. Copies of the verification e-mail will be included in the project files and identified in **Worksheet #29**.

A copy of the signed **Worksheet #4** will be retained in the project files and identified as a project document in **Worksheet #29**.

| Name | Organization/Title/Role | Telephone Number | Signature/E-Mail Receipt | SAP Section Reviewed | Date SAP Read |
|---|---|---|---|---|---|
| **Navy and Regulator Partnering Team Personnel** | | | | | |
| Charles Cook | Navy RPM/ Manages project activities for Navy | 904.542.6409 | See **Worksheet #1** for signature | All | |
| Lisa Donohoe | IRP Manager/ MCRD Parris Island POC | 843.228.2779 | | All | |
| Meredith Amick | SCDHEC PM/ Provides State regulator input | 803.896.4218 | See **Worksheet #1** for signature | All | |
| Annie Gerry | SCDHEC Geologist/ Hydrologist/ Provides State regulator input | 803.896.4018 | | All | |

| Name | Organization/Title/Role | Telephone Number | Signature/E-Mail Receipt | SAP Section Reviewed | Date SAP Read |
|---|---|---|---|---|---|
| Lila Llamas | USEPA Region 4 RPM/ Provides USEPA regulator input | 404.562.9969 | See **Worksheet #1** for signature | All | |
| Kim Zawacki | MCRD Parris Island Archaeologist | 843.228.2834 | | All | |
| **Tetra Tech Partnering Team Personnel** | | | | | |
| Peggy Churchill | Base Coordinator/ Coordinates activities at the Base for Tetra Tech | 321.636.6470 | | All | |
| Barb Becker | PM/ Manages project activities | 610.382.3770 | See **Worksheet #1** for signature | All | |
| Ralph Brooks | UXO Manager/ Manages project MEC hazards and activities | 770.413.0965 x231 | | All | |
| Tom Johnston | QAM/ Manages Corporate QA Program and implementation | 412.921.8615 | See **Worksheet #1** for signature | All | |
| James Rossi | MRP Site Manager/ Manages UXO staff and field activities | 770.413.0965 x233 | | All | |
| TBD | Project Geologist/ FOL/ Manages non-MEC drilling and sample collection activities | TBD | | All | |
| James T. Marine | Project Archaeologist | 412.920.7006 | | All | |
| Matt Soltis | HSM/ Manages Corporate Health and Safety Program | 412.921.8912 | See signature on HASP | HASP **Worksheet #17** | |

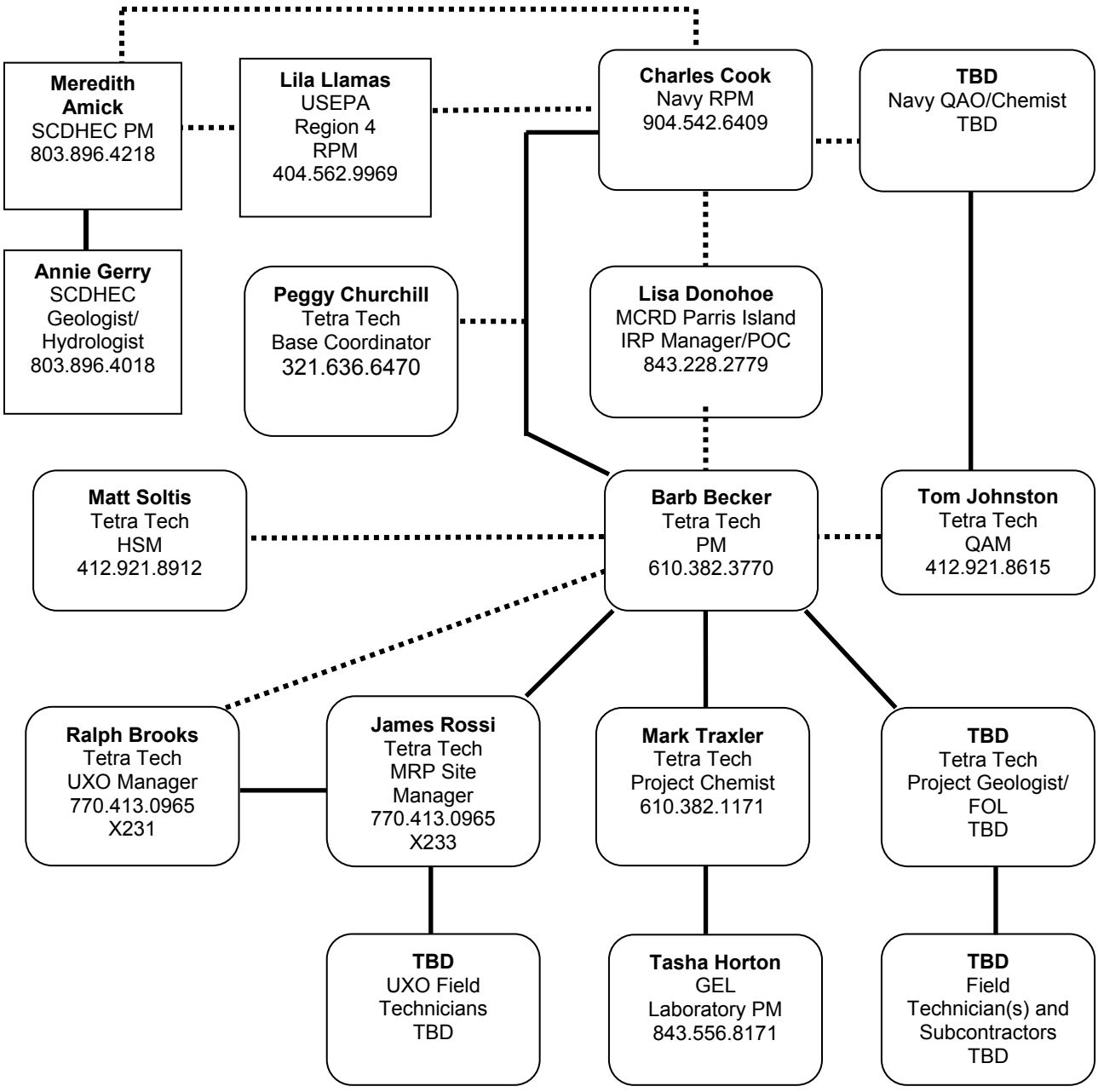
| Name | Organization/Title/Role | Telephone Number | Signature/E-Mail Receipt | SAP Section Reviewed | Date SAP Read |
|---|---|---|---|---|---|
| TBD | Site Geophysicist/ Conducts utility clearance activities | TBD | | All | |
| TBD | Senior UXO Supervisor (SUXOS)/ Supervises UXO field activities | TBD | | All | |
| TBD | UXO Safety Officer (UXOSO)/ Site Safety and Health Officer (SSHO)/ Manages UXO/ site safety operations | TBD | | All; HASP | |
| Mark Traxler | Project Chemist/ Provides coordination with laboratory | 610.382.1171 | | **Worksheets #12, 14, 15, 19, 20, 23-28, 30, 34-37** | |
| **Subcontractor Personnel** | | | | | |
| Tasha Horton | GEL Laboratory PM/ Representative for laboratory and analytical issues | 843.556.8171 | | **Worksheets #12, 14, 15, 19, 20, 23-28, 30, 34-36** | |
| Dr. Samuel Washington | Southern University Technical POC/ Representative for laboratory contractual issues | 225.771.5920 | | **Worksheets #12, 14, 15, 19, 20, 23-28, 30, 34-36** | |
| Drilling Subcontractor (electronic copy only) | TBD/Well Installation Subcontractor PM/ Provides drilling services | TBD | | **Worksheets #14, 17, 20, 21** | |

| Name | Organization/Title/Role | Telephone Number | Signature/E-Mail Receipt | SAP Section Reviewed | Date SAP Read |
|---|---|---|---|---|---|
| Land Survey Subcontractor (electronic copy only) | TBD/ Land Surveyor/ Provides surveying services | TBD | | **Worksheets #14, 17** | |

## SAP Worksheet #5 -- Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1)

Lines of Authority ——— Lines of Communication ·····



## SAP Worksheet #6 -- Communication Pathways

(UFP-QAPP Manual Section 2.4.2)

| Communication Driver | Responsible Entity | Name | Phone Number | Procedure |
|---|---|---|---|---|
| Regulatory Agency Review | SCDHEC PM<br>USEPA RPM | Meredith Amick<br>Lila Llamas | 803.896.4218<br>404.562.9969 | Review technical documents in written form within the time frame agreed upon by the Partnering Team. |
| Regulatory Agency Interface | Navy RPM<br>SCDHEC PM<br>USEPA RPM | Charles Cook<br>Meredith Amick<br>Lila Llamas | 904.542.6409<br>803.896.4218<br>404.562.9969 | The Navy RPM will contact the regulatory agency via phone and/or e-mail within 24 hours of recognizing the issue whenever issues arise. |
| Field Progress Reports | Tetra Tech FOL<br>Tetra Tech PM<br>Navy RPM | TBD<br>Barb Becker<br>Charles Cook | TBD<br>610.382.3770<br>904.542.6409 | 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. |
| Site access and utilities clearance for intrusive activities | Tetra Tech FOL<br>MCRD Parris Island IRP Manager/ POC<br>Tetra Tech Site Geophysicist | TBD<br>Lisa Donohoe<br>TBD | TBD<br>843.228.2779<br>TBD | The Tetra Tech FOL will coordinate verbally or via e-mail with the facility POC at least 7 days in advance of site access and with the Tetra Tech geophysics technician at least 3 days in advance of drilling operations to plan the utility clearance of all well boring locations. The Tetra Tech geophysics technician will coordinate utility clearance verbally or via e-mail with both the South Carolina One Call system representative, Palmetto Utility Protection Service, Inc. (PUPS), and MCRD Parris Island infrastructure personnel prior to drilling. |

| Communication Driver | Responsible Entity | Name | Phone Number | Procedure |
|---|---|---|---|---|
| MEC Finds | Tetra Tech Field Technicians<br>Tetra Tech SUXOS<br>Tetra Tech MRP Site Manager<br>Tetra Tech UXO Manager<br>Tetra Tech PM<br>Navy RPM<br>MCRD Parris Island IRP Manager/POC | TBD<br>TBD<br>James Rossi<br>Ralph Brooks<br>Barb Becker<br>Charles Cook<br>Lisa Donohoe | TBD<br>TBD<br>770.413.0965 x233<br>770.413.0965 x231<br>610.382.3770<br>904.542.6409<br>843.228.2779 | Immediately upon finding MEC, Tetra Tech Field Technicians will verbally notify SUXOS, who will verbally notify the MRP Site Manager.<br>Within 30 minutes of the MEC find, Tetra Tech MRP Site Manager will verbally notify entire field staff, secure the affected area, and verbally notify the Tetra Tech UXO Manager and MCRD Parris Island POC.<br>Tetra Tech UXO Manager will verbally inform Tetra Tech PM the same day.<br>Tetra Tech PM will notify Navy RPM verbally or via e-mail on the same day.<br>Navy RPM will make notifications as stated in the approved Explosives Safety Submission (ESS).<br>MCRD Parris Island POC or designee will make base emergency notifications verbally or via email.<br>Commander, Marine Corps Systems Command (COMMARCORSYSCOM) will be informed on the same day as the MEC find if the Explosives Safety Quantity-Distance (ESQD) or Net Explosive Weight (NEW) increases beyond those identified in the approved ESS or as other explosive safety concerns warrant. |

| Communication Driver | Responsible Entity | Name | Phone Number | Procedure |
|---|---|---|---|---|
| Field issues that require significant changes in field tasks or scope of field work | Tetra Tech FOL<br>Tetra Tech PM<br>Navy RPM<br>SCDHEC PM<br>USEPA RPM | TBD<br>Barb Becker<br>Charles Cook<br>Meredith Amick<br>Lila Llamas | TBD<br>610.382.3770<br>904.542.6409<br>803.896.4218<br>404.562.9969 | Tetra Tech FOL will inform Tetra Tech PM verbally on the day the issue is discovered.<br>Tetra Tech PM will inform Navy RPM verbally or via e-mail within 1 business day.<br>Navy RPM will communicate (verbally or via e-mail) that scope change has been approved, if warranted; scope change will be issued before work is executed. Document the change via a Field Task Modification Request (FTMR) form within 2 days of identifying the need for change and obtain required approvals within 5 days of initiating the form.<br>Tetra Tech PM will notify USEPA and SCDHEC either verbally or via e-mail within 1 business day. |
| SAP amendments | Tetra Tech FOL<br>Tetra Tech PM<br>Navy RPM<br>MCRD Parris Island IRP Manager/POC<br>SCDHEC PM<br>USEPA RPM | TBD<br>Barb Becker<br>Charles Cook<br>Lisa Donohoe<br><br>Meredith Amick<br>Lila Llamas | TBD<br>610.382.3770<br>904.542.6409<br>843.228.2779<br><br>803.896.4218<br>404.562.9969 | Tetra Tech FOL will verbally inform Tetra Tech PM within 24 hours of realizing a need for an amendment.<br>Tetra Tech PM will document the proposed changes via a FTMR form and submit it to the Partnering Team for review within 5 days.<br>The FTMR will constitute a SAP amendment to be reviewed by the Partnering Team within 5 days of receipt.<br>Upon receiving approval of the SAP amendment from the Partnering Team, the Tetra Tech PM will send the Navy RPM a concurrence letter within 7 days if a contract scope change is necessary. |

| Communication Driver | Responsible Entity | Name | Phone Number | Procedure |
|---|---|---|---|---|
| Selection of biased sampling locations | Tetra Tech PM<br>Navy RPM<br>MCRD Parris Island IRP Manager/POC<br>SCDHEC PM<br>USEPA RPM | Barb Becker<br>Charles Cook<br>Lisa Donohoe<br><br>Meredith Amick<br>Lila Llamas | 610.382.3770<br>904.542.6409<br>843.228.2779<br><br>803.896.4218<br>404.562.9969 | Tetra Tech PM will transmit by email figures showing proposed locations for biased sampling at each UXO site based on data collected during MEC investigation.<br>Partnering Team members will be requested to review locations and approve within 2 business days. Conference calls may be scheduled, as needed, to resolve issues. |
| Field work schedule changes | Tetra Tech FOL<br>Tetra Tech PM<br>Navy RPM<br>MCRD Parris Island IRP Manager/POC<br>SCDHEC PM<br>USEPA RPM | TBD<br>Barb Becker<br>Charles Cook<br>Lisa Donohoe<br><br>Meredith Amick<br>Lila Llamas | TBD<br>610.382.3770<br>904.542.6409<br>843.228.2779<br><br>803.896.4218<br>404.562.9969 | Tetra Tech PM will verbally inform Navy RPM on the day that schedule change is known and document in the monthly report. If report deliverable date is expected to be delayed as a result, document via schedule impact letter as soon as impact is realized.<br>Tetra Tech PM will notify USEPA and SCDHEC either verbally or via e-mail within 1 business day of when impact is realized. |
| Coordination of Cultural Resource Issues | Tetra Tech FOL<br>Tetra Tech Archaeologist<br>MCRD Parris Island Archaeologist<br>Tetra Tech PM<br>MCRD IRP Manager/POC<br>Navy RPM | TBD<br>James T. Marine<br>Kim Zawacki<br><br>Barb Becker<br>Lisa Donohoe<br>Charles Cook | TBD<br>412.920.7006<br>843.228.2834<br><br>610.382.3770<br>843.228.2779<br>904.542.6409 | Tetra Tech Archaeologist will provide cultural resources training to field sampling team prior to commencement of field activities.<br>Tetra Tech FOL will coordinate management of any cultural resource finds with the Tetra Tech Archaeologist and MCRD Parris Island Archaeologist, and inform Tetra Tech PM within one day of find.<br>Tetra Tech PM will inform MCRD IRP Manager/POC and Navy RPM verbally or via e-mail within 1 business day. |

| Communication Driver | Responsible Entity | Name | Phone Number | Procedure |
|---|---|---|---|---|
| Recommendation to stop work and initiate work upon corrective action | Tetra Tech MRP Site Manager<br>Tetra Tech FOL<br>Tetra Tech PM<br>Tetra Tech QAM<br>Tetra Tech HSM<br>Navy RPM<br>MCRD Parris Island IRP Manager/POC<br>SCDHEC PM<br>USEPA RPM | James Rossi<br>TBD<br>Barb Becker<br>Tom Johnston<br>Matt Soltis<br>Charles Cook<br>Lisa Donohoe<br>Meredith Amick<br>Lila Llamas | 770.413.0965 x233<br>TBD<br>610.382.3770<br>412.921.8615<br>412.921.8912<br>904.542.6409<br>843.228.2779<br>803.896.4218<br>404.562.9969 | If Tetra Tech is the responsible party for a stop work command, the Tetra Tech FOL will inform onsite personnel, subcontractor(s), MCRD Parris Island POC, and the identified Partnering Team members within 1 hour (verbally or by e-mail). If a subcontractor is the responsible party, the subcontractor PM will verbally inform the Tetra Tech FOL within 15 minutes, and the Tetra Tech FOL will then follow the procedure listed above. |
| Field data quality issues | Tetra Tech FOL<br>Tetra Tech PM | TBD<br>Barb Becker | TBD<br>610.382.3770 | Tetra Tech FOL will inform Tetra Tech PM verbally or by e-mail on the same day that a field data quality issue is discovered. |
| Laboratory data quality issues | GEL Laboratory PM<br>Tetra Tech Project Chemist<br>Tetra Tech DVM<br>Tetra Tech PM<br>Navy RPM | Tasha Horton<br>Mark Traxler<br>Joseph Samchuck<br>Barb Becker<br>Charles Cook | 843.556.8171<br>610.382.1171<br>412.921.8510<br>610.382.3770<br>904.542.6409 | The GEL Laboratory PM will notify (verbally or via e-mail) the Tetra Tech Project Chemist within 1 business day of when an issue related to laboratory data is discovered.<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>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. 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 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. |

| Communication Driver | Responsible Entity | Name | Phone Number | Procedure |
|---|---|---|---|---|
| Corrective action for field program | Tetra Tech QAM<br>Tetra Tech PM<br>Navy RPM | Tom Johnston<br>Barb Becker<br>Charles Cook | 412.921.8615<br>610.382.3770<br>904.542.6409 | Tetra Tech QAM will notify Tetra Tech PM verbally within 1 business day that the corrective action has been completed. The Tetra Tech PM will then notify the Navy RPM verbally or via e-mail within 1 business day. |

## SAP Worksheet #7 – Personnel Responsibilities and Qualifications Table

(UFP-QAPP Manual Section 2.4.3)

| Name | Title/Role | Organizational Affiliation | Responsibilities |
|---|---|---|---|
| Charles Cook | Navy RPM/ Manages project activities for Navy | Navy | Oversees project implementation, including scoping and data review and evaluation. |
| Lisa Donohoe | MCRD Parris Island IRP Manager/POC | Navy | Supports Navy RPM role and responsibilities and is MCRD Parris Island POC for scheduling and coordinating fieldwork. |
| Lila Llamas | USEPA RPM/ Provides USEPA regulator input | USEPA Region 4 | Participates in scoping, data review and evaluation, and approves this SAP. |
| Meredith Amick | State PM/ Provides State regulator input | SCDHEC | Participates in scoping, data review and evaluation, and approves this SAP. |
| Annie Gerry | State Geologist/ Hydrologist/ Provides State regulator input | SCDHEC | Participates in scoping, data review and evaluation, and approves this SAP. |
| Peggy Churchill | Base Coordinator/ Coordinates activities at the Base for Tetra Tech | Tetra Tech | Oversees all Tetra Tech project-related work at MCRD Parris Island. |
| Barbara Becker | PM/ Manages project on a daily basis | Tetra Tech | Oversees project, financial, schedule, and technical day-to-day management of the project. |
| Ralph Brooks | UXO Manager/ Manages corporate MEC hazards and risks | Tetra Tech | Oversees selection of qualified UXO personnel, establishes overall QC program for UXO activities, and addresses UXO-related issues as identified by field personnel. |
| James Rossi | MRP Site Manager/ Manages UXO staff and field activities | Tetra Tech | Manages UXO-related field activities and staff. Ensures that intrusive activities are conducted in full compliance with the approved ESS. Coordinates the appropriate notifications in the event of MEC discovery. |

| Name | Title/Role | Organizational Affiliation | Responsibilities |
|---|---|---|---|
| TBD | Project Geologist/ FOL/ Manages non-MEC drilling and sample collection activities | Tetra Tech | Supervises field personnel and subcontractors in the performance of field sampling activities, in accordance with the SAP. Coordinates site activities and schedules with appropriate installation personnel to ensure successful integration of fieldwork with ongoing base operations. Keeps PM apprised of daily progress on SAP implementation through emails, phone calls, and preparation/submittal of daily progress reports. |
| TBD | SUXOS/ Supervises UXO field activities | Tetra Tech | Supervises the conduct of all on-site UXO-related operations. Conducts daily site safety briefings. Escorts non-UXO personnel in suspect MEC areas. Determines location and identification of suspect MEC. Conducts UXO avoidance activities. |
| TBD | UXOSO/ SSHO/ Manages UXO/ site safety operations | Tetra Tech | Delivers initial site-specific training to all field personnel before field activities begin. Establishes all required site safety control measures. Ensures that all UXO-specific certifications are filed on site and are available for Navy inspection. Enforces personnel limits, safety exclusion zones, and other requirements of the ESS and HASP. |
| Jim Coffman | Project Geophysicist/ Manages geophysics activities, including utility clearances | Tetra Tech | Overall responsibility for managing utility clearance work. |
| TBD | Site Geophysicist/ Performs utility clearances at well and soil boring locations | Tetra Tech | Responsible for conducting utility clearances and mark-out, and for coordinating with South Carolina One-Call. Works under general supervision of Project Geophysicist. |
| TBD | UXO Technician III/ UXO escort during intrusive activities | Tetra Tech | Provides anomaly avoidance services. Will have a minimum of 8 years prior military Explosive Ordnance Disposal (EOD) and/or commercial UXO experience in munitions response actions or range clearance activities. [Department of Defense Explosives Safety Board (DDESB) Technical Paper (TP) 18]. |
| James T. Marine | Licensed Project Archaeologist | Tetra Tech | Coordinates activities to be conducted within culturally sensitive areas to ensure no adverse affect on cultural resources. Delivers initial cultural resource awareness training for field personnel prior to commencement of work. Communicates with MCRD Parris Island Archaeologist during course of investigation regarding any cultural resource finds. |

| Name | Title/Role | Organizational Affiliation | Responsibilities |
|---|---|---|---|
| Tom Johnston | QAM/ Manages Corporate QA Program and implementation | Tetra Tech | Ensures quality aspects of the CLEAN program are implemented, documented, and maintained. |
| Matt Soltis | HSM/ Manages Corporate Health and Safety Program | Tetra Tech | Oversees CLEAN Program Health and Safety Program. |
| Mark Traxler | Project Chemist/ Provides coordination with laboratory | Tetra Tech | Participates in project scoping, prepares laboratory scopes of work, and coordinates laboratory-related functions with laboratory. Oversees data quality reviews and QA of data validation deliverables. |
| Joseph Samchuck | DVM/ Manages data validation | Tetra Tech | Manages data validation activities within Tetra Tech, including ensuring QA of data validation deliverables, providing technical advice on data usability, and coordinating and maintaining the data validation review schedule. |
| Tasha Horton | Laboratory PM/ Representative for laboratory and analytical issues | GEL | Coordinates analyses with laboratory chemists, ensures that scope of work is followed, provides QA of data packages, and communicates with Tetra Tech staff. |
| Dr. Samuel Washington | Technical POC/ Representative for laboratory contractual issues | Southern University | Coordinates laboratory contractual issues and communicates with Tetra Tech staff. |
| TBD | Land Survey Subcontractor/ Performs elevation surveys at well locations | TBD | Performs land survey of temporary well locations and elevations (including top-of-casing and top of ground), according to Statement of Work (SOW). |
| TBD | Well Installation Subcontractor PM/ Provides drilling services | TBD | Performs Direct Push Technology (DPT) soil boring, macrocoring/soil sampling, and temporary well installation and development techniques according to SOW. |

Note: In some cases one person may be designated responsibilities for more than one position. For example, the FOL may also be responsible for SSHO duties. This action will be performed only as credentials, experience, and availability permits.

## SAP Worksheet #8 -- Special Personnel Training Requirements Table

(UFP-QAPP Manual Section 2.4.4)

Each site worker will be required to have completed appropriate Hazardous Waste Operations and Emergency Response (HAZWOPER) training specified in Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 (e). Project-specific safety requirements are addressed in greater detail in the site-specific HASP.

UXO avoidance support will be provided during intrusive field operations. Safety personnel providing this support will meet the requirements of DDESB TP 18 for UXO Technician II or higher and will follow procedures outlined in the Tetra Tech UXO Avoidance Standard Operating Procedure (SOP) included in the site-specific HASP.

Cultural resources training will be provided to sampling technicians by a licensed archaeologist. The training will provide instruction on how work activities should be modified to account for the potential presence of artifacts in culturally sensitive areas.

## SAP Worksheet #9 -- Project Scoping Session Participants Sheet

| | |
|---|---|
| **Project Name:** MCRD Parris Island UXO Sites 2 to 8 Remedial Investigation (RI)<br>**Projected Date(s) of Sampling:** Spring 2012<br>**Task Order Manager:** Barb Becker | **Site Name:** UXO Sites 2 to 8<br>**Site Location:** Parris Island, South Carolina |
| **Date of Session:** April 26, 2011<br>**Scoping Session Purpose:** Partnering Team Meeting –Scoping of RI | |

| Name | Title | Affiliation | Phone No. | E-mail Address | Project Role |
|---|---|---|---|---|---|
| Charles Cook | Navy RPM | NAVFAC SE | 904.542.6409 | charles.cook2@ navy.mil | Manages project on behalf of Navy |
| Lisa Donohoe | MCRD Parris Island IRP Manager/POC | MCRD Parris Island | 943.228.2779 | lisa.donohoe@ usmc.mil | POC for MCRD Parris Island |
| Meredith Amick | SCDHEC Project Manager | SCDHEC | 803.896.4218 | amickms@ dhec.sc.gov | State regulatory oversight |
| Annie Gerry | SCDHEC Geologist/ Hydrologist | SCDHEC | 803.896.4018 | gerryam@ dhec.sc.gov | State regulatory oversight |
| Lila Llamas | USEPA Region 4 RPM | USEPA | 404.562.9969 | llamas.lila@ epa.gov | Federal regulatory oversight |
| Mark Sladic | Previous Base Coordinator | Tetra Tech | 412.921.8216 | mark.sladic@ tetratech.com | Coordinates Tetra Tech activities at the base |
| Barb Becker | PM | Tetra Tech | 610.382.3770 | barb.becker@ tetratech.com | Manages Tetra Tech project activities |
| James Rossi | MRP Site Manager | Tetra Tech | 770.413.0965, x 233 | james.rossi@ tetratech.com | Manages/conducts project MEC/UXO field activities |
| Peggy Churchill | Data Quality Objectives (DQO) Facilitator/Current Base Coordinator | Tetra Tech | 321.636.6470 | peggy.churchill@ tetratech.com | Provides technical support for generating DQOs |

Summary/Comments:

This project was discussed at the Parris Island Partnering Team Meeting on April 26, 2011. Tetra Tech provided a summary of the RI approach currently under development for UXO Sites 2 to 8. The complete meeting notes are presented in Worksheet #9 of the MEC SAP. The following excerpts pertain specifically to the MC investigation:

- EPA and SCDHEC are assembling their comments on the SI Report and expect to be able to send them to Navy and Tetra Tech within the next few weeks. Navy/Tetra Tech should address the

comments by issuing change pages to the SI Report (not by issuing an entirely new version) and by incorporating them into the RI SAP, where applicable. The response-to-comment letter should be published in the front section of the SAP.

- MCRD Parris Island requested that the RI be designed to provide enough information to eliminate the need for LUCs at as many sites as possible. SCDHEC reiterated their requirement for all former MEC sites to carry LUCs as a long-term management approach. Navy/Tetra Tech agreed to design the RI in a manner that minimizes the footprint of areas requiring LUCs as much as possible through careful delineation of impact/target area boundaries.
- In the MC SAP, the agencies would like to see groundwater sampling included at UXO 3, UXO 4, and UXO 7. They also would like us to describe how screening levels for background constituents (e.g., arsenic) will be established. They requested that the two (MEC and MC) SAPs be submitted to them at the same time, as a single document to review.

Consensus Decisions:

As a result of the Partnering Team Meeting discussion, the following decisions were reached regarding the MC SAP:

- The RI SAP will incorporate responses to EPA's and SCDHEC's comments on the SI Report, which are expected to be transmitted in a few weeks.
- The MC RI SAP will include groundwater sampling at UXO 3, UXO 4, and UXO 7, and a discussion of background data.
- The MC/MEC RI SAP will be turned in for review as a single document, in accordance with the current Site Management Plan schedule.

| | |
|---|---|
| **Project Name:** MCRD Parris Island UXO Sites 2 to 8 RI<br>**Projected Date(s) of Sampling:** Spring 2012<br>**Task Order Manager:** Barb Becker | **Site Name:** UXO Sites 2 to 8<br>**Site Location:** Parris Island, South Carolina |
| **Date of Session:** May 6, 2011<br>**Scoping Session Purpose:** Internal Project Scoping Meeting | |

| Name | Title | Affiliation | Phone No. | E-mail Address | Project Role |
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Summary/Comments:

Participants met by teleconference to discuss the Munitions Constituents (MC) RI approaches for each of the six UXO sites to be addressed under this MC RI. Team members used results of the 2010 Site Inspection (SI) (Tetra Tech, 2011) and the field approach outlined in the MEC RI SAP as the basis for establishing the next logical steps toward completing the MC investigation at each site. The following general topics were discussed:

- Historical use of sites, including type(s) of MEC used and types of MC that could be present.
- Results of the SI investigation at each site.
- Contaminant sources, exposure routes, current/future receptors, and screening criteria to be used in the RI risk assessments.
- Establishment of RI data collection objectives.
- Development of conceptual approach to site-specific sampling.

Consensus Decisions:

The following decisions were reached regarding the technical approach for the RI:

- Biased Sampling Strategy - As much as possible, MC should be sampled at biased locations, near the MEC finds, to ensure that the human health risk assessment (HHRA) and ecological risk assessment (ERA) account for worst-case conditions.
- Soil Sampling - Surface soil will be collected from 0 to 1 foot below ground surface (bgs). Subsurface soil will be collected from 1 to 3 feet bgs or from the one-foot interval below the MEC find, whichever is appropriate as detailed in the SAP. Collect 12 to 15 soil samples in each data set to calculate a 95 percent upper confidence limit (UCL) for use in the HHRA.
- Sediment Sampling - Exposed sediment samples will be collected from 0 to 6 inches bgs adjacent to accumulations of MEC debris. Deeper sediment samples (e.g., from 0 to 24 inches bgs or 6 to 24 inches bgs) will also be needed at UXO 8 to evaluate worker exposure to site contamination during future utility installation activities. Waterway sediment samples will be collected from the top 6 inches of submerged material adjacent to MEC finds identified during the underwater RI. The minimum size of sediment sample data sets will be 7 to 10 for use in the ERA. Total organic carbon (TOC) is needed for food chain modeling; pH data is good to have, as well; grain size data is not necessary.
- Groundwater/ Sampling - SCDHEC has requested that groundwater samples be collected at UXO 3, UXO 4, and UXO 7. No groundwater sampling is appropriate for the other sites as they are predominated by marshland and/or tidal flats that are subject to regular tidal influence and saltwater intrusion. Temporary wells are sufficient for collection of groundwater samples. Due to the distance between sites, the design will include at least 3 wells at each site to facilitate a determination of flow direction.
- Surface Water - The only surface water at these sites are tidal waterways. Surface water samples would not be meaningful due to the continual mixing that occurs, so surface water samples will not be collected at any sites.
- Human Receptors - Possible human receptors at each site include recreational users, military/civilian personnel, construction and maintenance workers, and residents. Some parts of UXO 4 are currently residential, and sampling locations should be biased toward those locations, if possible. None of the other sites have current residents, but residential receptors will be evaluated in the HHRA where conditions could support them under a hypothetical future land use.
- Ecological Receptors - Except for UXO 3, each site contains sufficient habitat to support the full range of ecological receptors typically evaluated in an ERA. There is little ecological habitat at UXO 3; thus, the ERA will be limited at this site.
- Contaminants of Potential Concern (COPCs) - COPCs consist of metals at the bombing targets; and metals and explosives at the artillery ranges, based on an evaluation of site-related munitions components.

- Incremental Sampling (IS) - Perform IS for explosives at the revised UXO 5 firing point location to evaluate possible dispersion of explosive compounds during firing operations.
- Project Action Limits (PALs) - The PALs will consist of the lowest respective human health and ecological screening criteria for the identification and selection of COPCs in the HHRA and ERA for each site. PALs will also be identified for defining the thresholds of unacceptable risk as quantified in the HHRA and ERA. PALs will be drafted by the Project Chemist and circulated for review and concurrence from human health and ecological risk assessors.
- Data - Background metals data are needed to reference in case the RI data indicates concentrations of naturally occurring metals slightly greater than the PALs. Background data developed for Marine Corps Air Station (MCAS) Beaufort could be used in the absence of a MCRD Parris Island data set if the soil types are similar. The Project Chemist will evaluate the MCAS Beaufort background data for applicability to MCRD Parris Island and, if appropriate, reference it in the RI risk screening discussion.

The conceptual sampling strategies developed during this meeting are reflected in the planned technical approaches described in **Worksheet #17**.

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|---|---|
| **Project Name:** MCRD Parris Island UXO Sites 2 to 8 RI<br>**Projected Date(s) of Sampling:** Spring 2012<br>**Task Order Manager:** Barb Becker | **Site Name:** UXO Sites 2 to 8<br><br>**Site Location:** Parris Island, South Carolina |
| **Date of Session:** June 29, 2011<br>**Scoping Session Purpose:** Internal Project Scoping Meeting | |

| Name | Title | Affiliation | Phone No. | E-mail Address | Project Role |
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| Charles Warino | Project Geologist | Tetra Tech | 412.921.8361 | charles.warino@ tetratech.com | Provides technical support for sampling strategy design |
| Russ Sloboda | Scientist | Tetra Tech | 610.382.1529 | russell.sloboda@ tetratech.com | Provides technical support for Conceptual Site Model (CSM) development |

Summary/Comments:

Participants met by teleconference to develop site-specific sampling strategies. The following items were discussed or considered in developing the strategies:

- Draft CSM
- Input provided by the risk assessors at the May 6, 2011 meeting
- Recently developed responses to comments (RTCs) from the regulatory agencies on the SI Report

Consensus Decisions:

As a result of the discussion, the following decisions were reached regarding the site-specific sampling designs:

- General - Metals analyses will address all Target Analyte List (TAL) metals, based on the wide variety of metals listed in the specification sheets for both the 75-millimeter (mm) rounds and practice bombs. PALs for groundwater will be the lowest of marine and fresh water screening levels. The CSM worksheet will contain exposure pathway wire diagrams, as requested by USEPA and SCDHEC in their comments on the SI Report. The RI sampling strategy will include groundwater sampling at UXO 3, UXO 4, and UXO 7, as agreed to in the RTCs.

- UXO 2 - No sampling necessary under the RI, but SI data will be carried through the risk assessment and discussed in RI Report. Discussion regarding UXO 2 will be added to SAP **Worksheet #10** and the Executive Summary.
- UXO 3 - Three temporary wells will be placed in a triangular pattern to sample groundwater. One well will be placed in the asphalt area, at the presumed center of the former target. Wells will be temporary, but must remain at least overnight to allow groundwater levels to equilibrate before measuring water levels and collecting samples. Surface (0 to 1 foot bgs) and subsurface (1 to 3 feet bgs) soil samples will be collected from the three well boring locations and from 9 to 12 additional locations, distributed throughout the grassy area or at locations of MEC finds, if any. Samples (soil and groundwater) will be analyzed for metals only. (Specification sheets for the practice bombs used at UXO 3, UXO 7, and UXO 8 do not list any nitroaromatic compounds, so explosives will not be analyzed at those sites.)
- UXO 4 - Soil samples will be collected near Firing Point C to investigate the area surrounding the ecological exceedance (lead) observed during the SI. Twelve surface soil (0 to 1 foot bgs) samples will be collected from a 3-by-4 pattern of 50-foot by 50-foot grids in the vicinity of Firing Point C and analyzed for metals to define the metals concentrations horizontally. Subsurface (1 to 3 feet bgs) samples will be collected from the same locations, but will only be analyzed for metals if the corresponding surface soil sample exceeds a PAL. Six temporary wells will be placed around the perimeter of the site, with a focus on areas that are developed and/or support recreational activities. Surface (0 to 1 foot bgs) and subsurface (1 to 3 feet bgs) soil samples will be collected from the six well boring locations and from 6 to 9 additional locations, distributed throughout the impact area at locations of MEC finds. If any MEC are identified in the waterways during the RI, a sample will be collected from the top 6 inches of sediment adjacent to the MEC find and analyzed for metals and explosives. A maximum of 10 sediment samples will be collected. All samples (soil, sediment, and groundwater) will be analyzed for metals and explosives.
- UXO 5 - One IS sample will be collected from the firing point location, using methodology similar to that used during the SI. The IS sample will be analyzed for explosives. If any MEC or MEC-related items are identified during the RI, a soil sample will be collected for metals analysis at the location and depth of the MEC find.
- UXO 6 - No groundwater sampling will be conducted at this site. Soil and sediment samples will be collected only if MEC or MEC-related items are identified during the RI. If any MEC are identified on the limited land masses during the RI, a soil sample will be collected for metals and explosives analyses at the location and depth of the MEC find. If any MEC are identified in the waterways during the RI, a sample will be collected from the top 6 inches of sediment adjacent to the MEC find and analyzed for metals and explosives. Up to 12 to 15 soil samples and 10 sediment samples will be collected. If no MEC or MEC-related items are identified during the RI, then no MC sampling will be conducted.

- UXO 7 - Three temporary wells will be placed in a triangular pattern to sample groundwater. One well will be placed in the fairway at the center of the former target, and the other two wells will be placed at the treeline northeast and southeast of the target. Surface (0 to 1 foot bgs) and subsurface (1 to 3 feet bgs) soil samples will be collected from the three well boring locations and from 9 to 12 additional locations, distributed throughout the site or at locations of MEC finds, if any. Soil sampling depths will need to account for the presence of up to 5 feet of fill material, particularly in the fairway. Samples (soil and groundwater) will be analyzed for metals only.
- UXO 8 - No groundwater sampling will be conducted at this site. Sediment samples will be collected from 12 to 15 locations where MEC or MEC-related debris is present. Samples will be collected at low tide, from 0 to 6 inches and 6 to 24 inches below the surface, and analyzed for metals only. This site does not contain any areas suitable for residential or commercial development, so no hypothetical future resident or commercial/industrial worker scenarios will be evaluated in the HHRA.

The site-specific design parameters developed during this meeting are reflected in the planned technical approaches described in **Worksheet #17**.

**SAP Worksheet #10 -- Conceptual Site Model**

(UFP-QAPP Manual Section 2.5.2)

## 10.1 GENERAL INTRODUCTION

MCRD Parris Island consists of approximately 8,095 acres of which 3,263 are habitable, according to the MCRD Parris Island Strategic Plan 2008 – 2013 (MCRD, 2011). The installation is located along the southeastern coast of South Carolina, approximately 1 mile south of the City of Port Royal and 30 miles northeast of Savannah, Georgia. Hilton Head Island is located approximately 3 miles southwest of MCRD Parris Island across Port Royal Sound. MCRD Parris Island is the reception and recruit training facility for Marine Corps enlisted personnel. MCRD Parris Island has operated as a recruit training facility since 1915. Currently, access to MCRD Parris Island is controlled at the main entrance, and the surrounding rivers, swamps, and tidal flats make additional routes of ingress difficult.

Prior to its establishment, MCRD Parris Island had a military past that spanned over 400 years and included fortifications constructed by the Spanish, French, and United States Navy. In 1884, the Navy purchased approximately 41 acres of land on the northeastern side of MCRD Parris Island and began construction on the Naval station. In 1891, the facility was officially designated as the United States Naval Station, Port Royal, South Carolina. The name of the post was changed to Marine Barracks, Paris Island, South Carolina, in 1917, and the spelling with two “r”s was mandated in December 1917. Following World War II (WWII), MCRD Parris Island’s primary mission remained recruit training, and it was redesignated as the Marine Corps Recruit Depot, Parris Island, South Carolina, in 1946. In 1983, the base was officially redesignated Marine Corps Recruit Depot, Eastern Recruiting Region, Parris Island, South Carolina. MCRD Parris Island was placed on the National Priorities List (NPL) in 1995.

## 10.2 MCRD PARRIS ISLAND PHYSICAL AND ENVIRONMENTAL CHARACTERISTICS

The following sections provide general information for MCRD Parris Island including climate, topography, geology, soil types, hydrology, hydrogeology, cultural and natural resources, and threatened, endangered, and protected species.

### 10.2.1 Climate

MCRD Parris Island experiences long, hot summers and short, mild winters. Precipitation is abundant, averaging about 49 inches per year, with a range of 40 to 58 inches during most years. The abundant supply of warm, moist, relatively unstable air produces frequent scattered showers and thunderstorms. The winter season is short and mild. Average daily maximum and minimum temperatures are 63 and 38 degrees Fahrenheit (ºF), respectively.

### 10.2.2 Topography

MCRD Parris Island lies within a system of islands, marshes, and interconnecting man-made causeways that form a peninsula. MCRD Parris Island lies in the Lower Coastal Plain physiographic province. Elevations range from sea level to 22 feet above mean sea level (msl). MCRD Parris Island consists of Parris Island (the largest and most developed island), seven smaller named islands, many small unnamed islands, salt marshes, and related tidal creeks. Most of MCRD Parris Island lies within the 100-year flood plain. The majority of the area north of Ballast Creek, the east central area of Page Field, and the central part of Horse Island (see **Figure INT-2**) are the only surfaces of Parris Island situated above the 100-year flood plain [Naval Energy and Environmental Support Activity (NEESA), 1986].

### 10.2.3 Geology

The islands comprising MCRD Parris Island consist primarily of barrier-island sand, silt, and clay deposits that contain a surficial aquifer [Federal Facilities Agreement (FFA), 2006]. A further discussion of the descriptive and structural geology of the Beaufort-Jasper County area can be found in the Master Work Plan for MCRD Parris Island (Brown & Root Environmental, 1998) or the Initial Assessment Study (IAS) (NEESA, 1986).

### 10.2.4 Soil Types

Soils at MCRD Parris Island have been mapped by the United States Department of Agriculture (USDA) Soil Conservation Service (USDA, 1980) as both individual soils and groupings of soils (i.e., soil units). MCRD Parris Island has been mapped as having 15 individual soil types, which can be categorized into three general soil units: the Wando-Seabrook-Seewee, Coosaw-Williman-Ridgeland, and Bohicket-Capers-Handsboro soil units. The Bohicket-Capers-Handsboro soils cover approximately 50 percent of the installation, and are characterized as very poorly drained mineral and organic soils that are flooded daily or occasionally by saltwater. The Coosaw-Williman-Ridgeland soils cover approximately 35 percent of the installation, and are characterized as somewhat poorly drained and poorly drained soils. The Wando-Seabrook-Seewee soils cover approximately 15 percent of the installation, are sandy throughout, and range from excessively well-drained to poorly drained A map showing the predominant soil types at MCRD Parris Island is included in **Appendix A** (USDA, 2011).

### 10.2.5 Hydrology

The marsh areas and tidal creeks that border MCRD Parris Island drain into the Beaufort River and Broad River to form the Port Royal Sound. Surface runoff from most of the site flows into the surrounding surface water bodies or storm drains that discharge into the marshes (FFA, 2006).

### 10.2.6 Hydrogeology

The hydrogeologic framework of the Parris Island area consists of a shallow unconfined surficial aquifer, existing throughout Parris Island, which is estimated to be 30 feet thick and is typically found at a depth of approximately 3 feet bgs. Although the surficial aquifer is not used at Parris Island, the State Water Classification Standards "GB" classify the aquifer, effective 1985, as a potential underground source of drinking water (FFA, 2006). Beneath the surficial aquifer lies the Floridan Aquifer. The surface of the aquifer lies 40 to 90 feet below the surface of the land, with more than 20 feet of the low permeable Hawthorn formation and a layer of clay under the marshes separating the two aquifers. This low permeable formation has been discovered to be thinned or missing in localized areas in and around Parris Island (FFA, 2006). Water from the Floridan Aquifer on base is not used due to high saltwater infiltration (FFA, 2006). The water table in the MCRD Parris Island area usually ranges from 0 to 10 feet bgs and is most commonly found at a depth of 3 feet bgs. The direction of groundwater flow in the upper portion of the shallow surficial aquifer is generally toward the nearest surface water body, such as a pond, river, or tidal creek. Further discussion of the hydrogeology can be found in the Master Work Plan for MCRD Parris Island (Brown & Root Environmental, 1998) or the IAS (NEESA, 1986).

### 10.2.7 Cultural Resources

No existing cultural or natural resources were identified at the MRP sites during information gathering for the Archive Search Report (ASR) (United States Army Corps of Engineers [USACE], 1999a). However, a number of culturally sensitive areas were identified during pre-mobilization coordination with the Cultural Resources Department. These include archeologically significant areas along the eastern edge of UXO 7 and the southeastern corner of UXO 6, where building ruins and cultural items have been discovered. Recovered items date back to early Native American and French settlements, the Spanish-American War era, and early American plantations. Some locations are marked by monuments and placards. This area also contains evidence of a historical graveyard marked by two gravestones but suspected to encompass hundreds of unmarked graves.

To ensure that the MRP investigation does not create any adverse impacts on cultural resources, a licensed archaeologist will be mobilized along with the sampling team to provide instruction and support so that any cultural artifacts encountered during the investigation are properly documented and managed, as described in **SOP AR 01**.

### 10.2.8 Endangered and Special Status Species

Section 7 of the Endangered Species Act states "each Federal Agency shall, in consultation with and with the assistance of the Secretary [of the Department of the Interior], insure any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered

species or threatened species." South Carolina also provides protection to threatened or endangered animal species but presently does not have any regulations that protect threatened or endangered plant species.

No threatened or endangered plant species are known to occur on MCRD Parris Island. Five threatened or endangered animal species are known to occur in or around MCRD Parris Island. They are the American alligator, bald eagle, wood stork, least tern, and the West Indian manatee. The American alligator (*Alligator mississippiensis*) is occasionally observed in the large pond adjacent to the Causeway Landfill in the northwestern portion of MCRD Parris Island and could utilize freshwater ponds and ditches on MCRD Parris Island. Formerly an endangered species, the alligator has recovered in many portions of its range. Bald eagles are occasional visitors, and one pair of nesting bald eagles was discovered at MCRD Parris Island in January 1998. Wood storks are also known to use the estuarine environment in and around MCRD Parris Island, but there are no known rookeries on MCRD Parris Island. Least terns (state-listed as threatened) have been observed feeding in the Third Battalion Pond. Their preferred nesting habitat of beaches is limited on the installation, and their nesting status is not known. Manatees have been recorded in the estuaries around MCRD Parris Island but are transient species in the area and occur rarely. A complete listing of rare, threatened, and endangered species of South Carolina is provided in Volume I of the MCRD Parris Island Master Work Plan (Brown & Root Environmental, 1998).

### 10.2.9 Natural Resources

To ensure that the MRP investigation does not create any adverse impacts on natural resources, fieldwork will be conducted in coordination with the MCRD Natural Resources Department, and ecologically sensitive habitats will be avoided.

### 10.2.10 Sediment Characterization

A sediment characterization study was conducted in the Weapons and Field Training Battalion (WFTBn) area in support of range sustainability planning and analysis (CH2M HILL, 2009). The study was a collaborative effort among MCRD Parris Island, CH2M HILL, University of South Carolina Beaufort, Georgia Institute of Technology, and subcontracted laboratories that focused on the characterization of environmental impacts to tidal marsh sediments, the evaluation of associated human health and ecological risks, and the assessment of potential off-range migration of contaminants. As shown on **Figure INT-2**, the WFTBn is located on the western side of MCRD Parris Island and overlaps the UXO 4 uprange firing fan. A summary of this study is provided below due its potential relevance to contaminant distribution at UXO 2.

Military training activities in the WFTBn area first began in 1918 with the establishment of a rifle range. By 1929, three ranges were located in the area, and today there are seven active outdoor firing ranges. These ranges include the multipurpose infantry weapon range, Khe Sahn, (former Range A); four known distance ranges, Hue City, Chosin, Starlight, Inchon (former Ranges B, C, D and E); and two pistol ranges, Pusan and Nak Tong (see **Figure INT-3**). The WFTBn area has been in continuous use as a weapons training area since 1918, and has undergone a number of changes, including site improvements and new construction, throughout its 94 year history.

Sediments were sampled in the vicinity of the WFTBn area ranges at locations up to 1500 meters downrange of the firing lines to obtain representative chemical data for use in performing risk screening evaluations and characterizing the spatial distribution of the target analytes. Impacts to the WFTBn due to potential releases of MC to sediment were identified by comparing metals concentrations in marsh and channel sediment samples to background samples. The potential bioavailability of metals was also evaluated.

The main findings of the WFTBn sediment characterization study were as follows:

- Sediment sample results indicated that some portions of the WFTBn area have been adversely impacted by range activities, particularly the central portion of the ranges where the highest concentrations of projectiles have been found. Copper concentrations were most frequently elevated relative to background, followed by lead and then zinc. The higher copper concentrations are assumed to be due to the high copper content of the bullet jackets and the tendency of the jackets to remain relatively intact around the solid lead core.
- The preliminary human health screening indicated that potential risks from direct contact with sediment under a recreational use scenario are not of concern. Ecological risk screening indicated that concentrations of lead and/or copper drive the site-wide risk, and that impacts to receptors exposed to sediments are possible, particular to those receptors that have limited mobility.
- The sediment transport evaluation indicated that significant resuspension and offsite transport of MC from the interior of the intertidal marsh is unlikely, although metals that are adsorbed to fine-grained sediments could potentially be transported by tidal currents or wave action along the shoreline.

The possible relevance of these findings to expected MC concentrations and distributions at UXO 2 is discussed in **Section 10.4.2.3**.

## 10.3 INDIVIDUAL MRP SITE-SPECIFIC CHARACTERISTICS

**Table 10-1** summarizes the seven MRP sites at MCRD Parris Island that will be investigated as part of this RI and are the subject of this UFP-SAP. **Figure INT-2** shows the locations of these MRP sites within

MCRD Parris Island. The following sections provide the site-specific background information and CSM summaries for each of the seven sites.

**TABLE 10-1**
**SUMMARY OF MUNITIONS RESPONSE PROGRAM SITES**
**MCRD PARRIS ISLAND**
**PARRIS ISLAND, SOUTH CAROLINA**

| Site Name | UXO Site No. | Estimated Size of Site | Historical Use | Dates of Use |
|---|---|---|---|---|
| Rifle Range at Ballast Creek (Old Rifle Range) | UXO 2 | 1,800 feet long; 500 feet wide | Rifle and Pistol Range; Flying Field | 1916-1919 (rifle and pistol range) 1919-1922 (flying field) |
| Aerial Bombing Target at Parade Deck | UXO 3 | <1-acre target circle, plus 5-acre grassy area to the north | Bombing Target | 1930s-early 1940s |
| Field Artillery West Main Range | UXO 4 | Impact area: 8,000 feet long, 6,000 feet wide; Firing fan: 17,000 feet long | Field Artillery Range | 1937-1940 |
| Field Artillery East Shrapnel Range (UXO 5 is the northern section of this range and includes the firing point; UXO 6 is the southern portion of this range and includes the impact area) | UXO 5 and UXO 6 | Impact area: 6,500 feet long, 3,500 feet wide; Firing fan: 12,000 feet long | Field Artillery Range | 1937-1940 |
| Aerial Bombing Target at Golf Course | UXO 7 | 3-acre target circle, plus surrounding 16 acres | Bombing Target | 1942-1946 |
| Aerial Bombing Target at Southern Tidal Flats | UXO 8 | 4-acre target circle, plus surrounding 40 acres | Bombing Target | 1940s (utilized during WWII) |

## 10.4 CSM SUMMARY FOR RIFLE RANGE AT BALLAST CREEK (UXO 2)

This section presents general background information regarding UXO 2 (Rifle Range at Ballast Creek) and a CSM that describes potential MC contamination routes and possible exposure pathways. This CSM provides the basis for the investigative program.

### 10.4.1 Site Setting and Background

The Rifle Range at Ballast Creek (**Figure 10-1**) was the first identified range in use at Parris Island, appearing on site maps dating back to 1916. This 600-yard range was located on the high ground of an inside bend of Ballast Creek, south of the contemporary Quarantine/Receiving Station. The site was sometimes referred to as the "Old Rifle Range" to differentiate it from the rifle and pistol ranges constructed in the Weapons and Field Training Battalion Area in 1918. Following World War I, this range was used as an aircraft flying field. Later, warehouses, and storage structures were built and remain at the site. According to the ASR (USACE, 1999a), …"the Rifle Range at Ballast Creek…has been heavily regraded and reportedly received dredge spoil in the past," and "Most of the land for this site has since been covered by dredge fill." It is assumed that the area that was covered with dredge fill is the area currently being investigated under the IRP as Site 13C (see **Figure 10-1**). The locations of utilities that may be present at this site are unknown.

The precise location of the firing line associated with the rifle range is unknown, although it has been inferred from the remains of concrete target foundations observed near the river. Munitions use at this range was limited to small arms ammunition (.30-caliber bullets), evidence of which was found scattered on the ground surface near the target area. There is no historical documentation or field data that would suggest the past use or current presence of MEC at this site.

### 10.4.2 Previous Environmental Investigations

#### 10.4.2.1 Site Inspection

An SI was conducted at UXO 2 in early 2010 (Tetra Tech, 2011), which included the collection of soil and sediment samples for analysis of lead (see **Appendix B, Figure 5-3**). The SI findings were consistent with the historical use of this site for the firing of small arms ammunition. Analytical results indicated that lead is present at generally low concentrations in the surface soil surrounding the concrete target foundations. There were three slight exceedances of the minimum ecological screening level in the soil samples but no exceedances of human health screening levels. Concentrations of lead were also low in most sediment samples. Only a few sediment samples (located downgradient of the eastern target foundations) exhibited lead concentrations indicative of potential ecological risk, and these samples represented very small areas. Samples were not collected at the firing line during the SI, and metals other than lead were not investigated.

#### 10.4.2.2 Expanded Site Inspection

An Expanded SI is planned for UXO 2 to collect additional soil and sediment data for use in assessing potential impacts from MC other than lead and for delineating the extent of lead contamination near the concrete target foundations. Expanded SI activities will include detector-aided surface surveys to

determine whether caches of bullets are present, the collection of soil samples from the firing line area for analysis of nitroglycerin, and the collection of soil and sediment samples from the target area for analysis of lead and other metals associated with small arms ammunition (e.g., antimony, arsenic, copper, and zinc). These additional field activities are detailed in the Expanded SI Work Plan, to be submitted under separate cover.

#### 10.4.2.3 Sediment Characterization in Weapons and Field Training Battalion Area

Results of the sediment characterization study at the WFTBn area (CH2M HILL, 2009) may have some relevance to the expected MC concentrations and distributions at UXO 2, particularly with respect to the need to investigate metals other than lead. However, the following differences between the two study areas should be considered before extrapolating conclusions regarding MC at the WFTBn area to UXO 2: 1) the overall contaminant loading is expected to be significantly higher at the WFTBn area ranges than at UXO 2 because the WFTBn area ranges have been in continuous use for more than 60 years, with some ranges dating back to 1918, while UXO 2 was used as a rifle range for only three years (1916 to 1918); and 2) bullets are likely to be dispersed over a greater area at the WFTBn ranges than at UXO 2 due to the more powerful weapons and propellants in use today as compared to the early 1900s. Data to be collected under the Expanded SI Work Plan will provide additional information that can help determine the extent to which the WFTBn findings can be extrapolated to UXO 2.

### 10.4.3 Conceptual Site Model

This section presents the CSM for UXO 2, which describes potential and known sources of MC contamination, potential contamination routes, and possible exposure pathways and receptors. **Figure 10-2** presents a graphical depiction of the UXO 2 CSM.

#### 10.4.3.1 Potential or Known Sources of MC

Only small arms (.30-caliber) ammunition was used at this range. The primary COPC is lead from bullets and, to a lesser extent, antimony and arsenic. Bullets are composed of 90 to 99 percent lead, and antimony is added as a hardening agent in proportions ranging from 0.1 to 2 percent. Arsenic is naturally present in lead at trace levels (i.e., 0.001 to 0.05 percent). If present, antimony and arsenic would be spatially correlated with lead because they are associated with the lead in the bullets. Copper and zinc may also be present because they were components of the brass casings and bullet jackets.

Considering the relative proportions of metals used in the manufacture of projectiles fired at UXO 2 as compared to their respective USEPA residential soil screening levels, the SI Report (Tetra Tech, 2010) concluded that lead would need to be present in soil or sediment at concentrations greater than 600 mg/kg for antimony, arsenic, copper, or zinc from bullets to be present at concentrations that could

pose an unacceptable human health risk. The maximum concentration of lead in any sample collected during the SI was 142 mg/kg; therefore, antimony, arsenic, copper, and zinc were not considered to be human health COPCs at UXO 2. However, no analytical data for these metals was collected at UXO 2 to verify this assumption.

Sources of potential MC contamination are the sediment in the vicinity of the concrete target foundations, which contain metals MC due to bullets that hit the targets and fell to the ground; and the surface soil uprange of the targets, which contains metals MC due to bullets that fell short of the targets. Based on the SI findings, neither of these media contains lead at concentrations high enough to pose an unacceptable human health risk. However, three soil samples uprange of the targets and five sediment samples in the vicinity of the targets contained lead in concentrations that could pose a risk to some ecological receptors. Other sources of potential MC contamination are the soil in the firing line area, which may contain unacceptable concentrations of nitroglycerin as a result of firing activities, and sediments in the marsh downrange of the target area, which may contain metals due to bullets that overshot the targets.

#### 10.4.3.2 Contaminant Migration Pathways

Soil and sediment in the area of the range closest to concrete target foundations contain lead in concentrations that could pose an unacceptable ecological risk. This contamination could infiltrate to deeper soil and sediment and, possibly, leach to the tidal waters underlying and adjacent to the site. In addition, storm water run-off and tidal currents could transport dissolved contaminants in the sediment across the surface toward the waterways.

#### 10.4.3.3 Land Use, Receptors, and Exposure Pathways

A three-dimensional CSM illustration for this site is included on **Figure 10-2**, and an Exposure Pathway Analysis diagram is presented on **Figure 10-3**. The portion of the site that contains lead-contaminated sediment is currently undeveloped and unused; thus, there is a low probability of human exposure to contaminated site media. In addition, the SI did not identify any media containing lead at high enough concentrations to pose an unacceptable human health risk. Therefore, no human receptors with complete exposure pathways to contaminated soil or sediment have been identified to-date at this site. Future land use is assumed to be the same as current land use, with no reasonable expectation of future residential development in the marshy areas where lead-contaminated sediment is present.

Ecological receptors at this site consist of common flora and fauna and, possibly, endangered and special status species identified near MCRD Parris Island including fish, shellfish, crustaceans, wading birds, ospreys, and pelicans, which would be potential receptors in areas where the sediment has been

impacted. Ecological receptors could contact MC contaminants through the food chain when ingesting fish and vegetation at this site.

## 10.5 CSM SUMMARY FOR AERIAL BOMBING TARGET AT PARADE DECK (UXO 3)

This section presents general background information regarding UXO 3 (Aerial Bombing Target at Parade Deck) and a CSM that describes potential MC migration routes and possible exposure pathways. This CSM provides the basis for the investigative program.

### 10.5.1 Site Setting and Background

The former bombing target at the Parade Deck center is known to have been located at the site of the current Parade Deck as early as 1937 (**Figure 10-4**). The bombing target consisted of concentric circles outlined on the ground (sometimes with lime), which would have been visible from the air. Miniature inert practice bombs with pyrotechnic spotting signal cartridges are reported to have been the ordnance used for target practice at the time. Target use ceased when the Parade Deck was paved in the early 1940s. Currently, the Parade Deck is used regularly for ceremonies, with military personnel and visitors frequenting the site and the surrounding area. Paved parking lots and several buildings currently surround the former target area. There are also unpaved areas (e.g., open fields, lawns) adjacent to the former target area, which have been maintained, mowed, and have trees and shrubs planted in them. Potential future land use is assumed to be the same as present land use, which includes possible construction projects (such as the installation of a ground source heat pump) in the vicinity of the site.

It is assumed, but not confirmed, that the open area/field to the north of the bomb target and other non-paved areas surrounding the target may have received ricochets or impacts from practice bombs that missed their targets. It is also assumed that any practice bombs or munitions discovered during construction of the Parade Deck, adjacent parking lots, and other structures in the area (which cover a majority of the site) would have been removed at the time of discovery as a general safety precaution. Previous construction activities likely resulted in the redistribution of munitions-related items during soil excavation and/or surface grading; thus, it is assumed that a distinct target pattern of anomalies no longer exists. The ASR did not uncover any information concerning past range clearances at this location.

### 10.5.2 Previous Environmental Investigations - Site Inspection

SI activities were conducted at UXO 3 in early 2010 (Tetra Tech, 2011). The investigation focused on the undeveloped or minimally developed grassy area located north-northwest of the target area, where exposure to potential MC contamination would be most likely to occur. A geophysical survey was conducted over this area using a Geonics EM61-MK2 all-metals detector with integrated GPS and 2.5-foot survey line spacing. Detector-aided surface surveys were not necessary because visual

inspection of the area to be surveyed indicated that no surface MEC/MPPEH were present at this site. Three core borings were drilled through the Parade Deck near the presumed location of the former target circle, and samples were obtained from the soil beneath the asphalt to collect information regarding construction materials and depth of fill underneath the Parade Deck. No further intrusive investigations were conducted at this site during the SI, nor were any environmental samples collected.

Results of the geophysical survey conducted during the SI are summarized in the MEC SAP. No MEC or Material Potentially Presenting an Explosive Hazard (MPPEH) were encountered during the SI, and there have been no reports of surficial MEC or MPPEH being found at or near UXO 3. Numerous subsurface anomalies and a few possible utilities were detected during the SI geophysical survey, but the nature of the items causing these anomalies could not be determined from the geophysical data alone. Core samples collected from beneath the Parade Deck (see **Appendix B, Figure 6-4**), which was approximately 6 to 8 inches thick, indicate that the material beneath the asphalt appeared to consist of natural materials to a depth of approximately 4 feet bgs, at which point the soil became saturated.

### 10.5.3 Conceptual Site Model

This section presents the CSM for UXO 3, which describes potential and known sources of MC contamination, potential migration routes, and possible exposure pathways and receptors. **Figure 10-5** presents a graphical depiction of the UXO 3 CSM.

#### 10.5.3.1 Potential or Known Sources of MC

Munitions used at this site were miniature practice bombs with pyrotechnic spotting signal cartridges. There were several types of miniature practice bombs that differed in material (e.g., cast iron, zinc alloy) and weight (3 to 4 pounds). The spotting charge contained in these bombs resembled an extra-long 10-gauge shotgun shell, which measured 8.25 inches long by 2.18 inches in diameter, and emitted a puff of smoke upon impact (see **Appendix C** for additional details regarding Munitions Specifications). These types of practice bombs contained a spotting signal charge that consisted of a black powder expelling charge and a red phosphorus pyrotechnic mixture to provide smoke and burn brightly. MC associated with the practice bombs used at this site may include metals, black powder (mixture of sulfur, charcoal, and potassium nitrate), red phosphorus (often used as a component of matchbook strike plates or as an ingredient in rat and cockroach poisons), and fluorescein dye.

Metals are the primary MC at this site with the potential to present an environmental hazard. Sulfur and charcoal are not of concern at the concentrations that could be present in the environment due to historical site activities. Fluorescein dye is not of concern because there are no published chronic or subchronic human toxicity criteria for this substance, and its acute toxicity is considered low because it is

used for ophthalmological and vascular testing (National Library of Medicine [NLM], 2001, Watson, 1990, and Yankell, 1977). The other MC (nitrate and phosphorus) would not be expected to be environmentally significant contaminants at this site after approximately 70 years because of eventual dissolution and flushing in groundwater (nitrates) or because they are not considered to be of environmental significance from a toxicity perspective (phosphates).

MC-contaminated source media are generally expected to be collocated with MEC and/or MPPEH. Thus, the sources of potential MC contamination at this site include the target area itself and other nearby areas that may have received ricochets or impacts from bombs that may have missed their target. Although no MEC of MPPEH items were encountered during the SI, numerous geophysical anomalies were identified, which may or may not indicate the presence of MEC/MPPEH in the subsurface.

Maximum penetration depths for miniature practice bombs are estimated to be 1 to 2 feet bgs, depending on the type of soil and velocity on impact (USACE, 1999b). However, if present, the actual depth of MEC/MPPEH items may be somewhat deeper in locations where fill material was placed on top of the impacted soil during site development and/or paving. It is assumed that any practice bombs or related debris that might have once been present on or near the ground surface would have been discovered and removed during construction or other activities that have taken place in the area as a general safety precaution. If not, these items would now be located underneath the fill material used to grade the area during site development.

#### 10.5.3.2 Contaminant Migration Pathways

Munitions-related items are not expected to be visible, nor were any observed during the SI, on the surface at UXO 3. In addition, there have been no reports of surficial practice bombs or related debris ever being found at or near UXO 3. Until the subsurface anomalies identified during the SI are intrusively investigated, it is unknown whether any practice bombs exist beneath the surface.

Most MC associated with the practice bombs used at this site are not expected to pose an environmental concern or be persistent in the environment. However, if practice bombs or related debris exist beneath the surface, metal contaminants may leach from the items to the surrounding soils and, possibly, infiltrate to the deeper soils and underlying groundwater. Future construction, excavation, and/or maintenance activities may provide an additional migration pathway for MC if metals-contaminated subsurface soils are brought to the surface during intrusive operations. Soil and groundwater contaminants, if present, could be assimilated by plants or animals, although most assimilation of this nature would be expected in the shallow soil depths, especially the root zone of vegetation.

#### 10.5.3.3 Land Use, Receptors, and Exposure Pathways

Future land use at UXO 3 is assumed to be the same as current land use (e.g., Parade Deck and adjacent grounds), which includes possible construction projects in the vicinity of the site. Residential use is also considered a plausible future scenario for the purpose of risk evaluation. Because the surficial aquifer is classified as a potential underground source of drinking water (FFA, 2006), it is assumed that future residents could be exposed to MC (if it is present) through ingestion of groundwater. Future residents and construction workers could also be exposed to MC in subsurface soil in the event that land use changes and the subsurface soil is disturbed and redistributed at the ground surface during construction or landscaping activities.

A three-dimensional CSM illustration for this site is included on **Figure 10-5**, and an Exposure Pathway Analysis diagram is presented on **Figure 10-6**. These diagrams identify potential receptors and possible mechanisms by which these receptors could be exposed to site-related contamination, if it is present. Human receptors at this site include military and civilian site workers, maintenance workers, and visitors, who would be exposed to MC if it exists in the surface soil; as well as construction workers and hypothetical future residents, who may take part in intrusive activities or come into contact with groundwater and, thereby, be exposed to MC if it exists in the surface soil, subsurface soil, and groundwater.

UXO 3 is located in an urbanized area of MCRD Parris Island that is not a viable habitat for ecological receptors because the target area of interest is paved. The small grass lawn adjacent to the target area is regularly maintained and also does not present a suitable habitat for most ecological species. While plants, invertebrates, and insects may be present in the grassy area, higher level ecological receptors in the vicinity of UXO 3 would seek a more sustainable habitat in the nearby undeveloped areas of Parris Island.

## 10.6 CSM SUMMARY FOR FIELD ARTILLERY WEST MAIN RANGE (UXO 4)

This section presents general background information regarding UXO 4 (Field Artillery West Main Range) and a CSM that describes potential MC migration routes and possible exposure pathways. This CSM provides the basis for the investigative program.

### 10.6.1 Site Setting and Background

In 1937, the Marines established two artillery ranges, the largest being the Field Artillery West Main Range (UXO 4) and the other being the Field Artillery East Shrapnel Range (UXO 5 and UXO 6). The Field Artillery West Main Range (**Figure 10-7**) is believed to have been used from 1937 to 1940, and had a concrete observation point and a total of nine firing positions, including three concrete points (Firing

Points B, H, and R). According to historical site maps, Firing Point R on Horse Island provided the approximate apex of the surface danger zone (i.e., firing fan), which was approximately 17,000 feet long. The artillery impact area was approximately 6,000 feet wide and 8,000 feet long, and covered an area from 9,000 to 17,000 feet southeast of Firing Point R (USACE, 1999a).

A portion of UXO 4 (between Firing Point R and the observation structure) was developed after the range closed and is currently part of the installation's Cantonment Area (see **Figure 10-7**). The Cantonment Area, also known as the Weapons and Field Training Battalion, is located outside the northwest boundary of the UXO 4 impact area and contains installation support facilities including active rifle and pistol ranges, other training areas, buildings and other structures, roadways, cleared areas, and housing areas that are necessary to the mission at MCRD Parris Island. Areas associated with the active ranges at the Weapons and Field Training Battalion are not included as part of the MRP site because they are still in operation.

A 125-home trailer park formerly occupied a parcel of land approximately 1,500 feet southeast of Firing Point B; however, it has been vacated and all homes have been removed from the site. A portion of the former trailer park has since been converted to a recreational vehicle (RV) park, with 18 RV camp sites, a bath house, and plans to install 22 prefabricated cabins. Page Field overlaps the eastern side of the range, and the golf course is located directly south of the range. The south central portion of the range is largely undeveloped, and consists mostly of marsh/swamp areas.

Munitions used at this range included high explosives (HE) and shrapnel rounds fired from the 75-mm Model 1897 gun, as well as the 75-mm M1 pack howitzer. Other weapons systems, such as the 2.95-inch mountain gun, 37-mm anti-tank, and 105-mm howitzer, may have been fired but no evidence has been uncovered to support this.

Utilities are present in the developed portions of the site. Whether utilities are present in the open, undeveloped portions of this site is unknown at this time. Access to the site is possible by road and by the Broad River, which borders this site on the west. Potential future land use at this site is assumed to be the same as present land use, which includes construction projects (such as the installation of a ground source heat pump or the construction of new barracks or training facilities) currently planned in the Cantonment Area. MCRD Parris Island envisions continued use of the depot, in general, for recruit training and the Cantonment Area of UXO 4, in particular, for mission support.

### 10.6.2 Previous Environmental Investigations - Site Inspection

SI activities, which were conducted at UXO 4 in early 2010 (Tetra Tech, 2011), included detector-aided surface surveys at the firing points; surface and land-based geophysical surveys along transects (with

100-foot line spacing) within the impact area; aquatic-based geophysical surveys within the accessible waterways; and collection of surface soil and sediment samples for x-ray fluorescence (XRF) lead screening and analysis of nitroaromatic and nitramine explosives and lead at a fixed base laboratory.

Results of the detector-aided and geophysical surveys conducted during the SI are summarized in the MEC SAP. No MEC or MPPEH were encountered at the firing points; however, 14 MEC/MPPEH items were discovered during detector-aided surface surveys within the impact area, two of which were identified as site-related MEC. In addition, numerous geophysical anomalies were detected during the land-based and aquatic surveys within the impact area, which may or may not indicate the presence of subsurface or underwater MEC/MPPEH. Surface soil and sediment samples were collected from the firing points and impact area, and submerged sediment samples were collected from within the waterway located near the center of the impact area. Explosives were not detected in any of the grab or composite surface soil or sediment samples collected at the firing points, impact areas, or waterways at UXO 4. Lead was detected at concentrations less than screening criteria in all soil and sediment samples from the impact area, waterways, and firing points except for the soil sample from Firing Point C (see **Appendix B, Figure 7-9**). At Firing Point C, soil lead concentrations exceeded the most stringent PAL, which was based on the minimum ecological screening level. Lead was also detected at concentrations slightly greater than the ecological PAL in the surface soil grab samples collected from within the impact area for field screening by XRF (see **Appendix B, Figure 7-10**), but none of the impact area laboratory results exceeded any PALs.

### 10.6.3 Conceptual Site Model

This section presents the CSM for UXO 4, which describes potential and known sources of MC contamination, potential migration routes, and possible exposure pathways and receptors. **Figure 10-8** presents a graphical depiction of the UXO 4 CSM.

#### 10.6.3.1 Potential or Known Sources of MC

The source areas where MC could exist at this site are collocated with MEC/MPPEH that may be present at the firing points, where munitions may have been discarded and the target/impact area (assumed to be land areas of higher elevation), where soil may have become contaminated with residual explosives when projectiles experienced low-order (incomplete) detonations or failed to detonate (i.e., duds). Areas between the firing points and the observation point are not considered to be significant source locations of MC contamination because of the low likelihood of MEC and MPPEH presence.

Precise locations of former targets within the impact area are unknown, and the impact area, as it is referred to in the ASR and SI Reports, is very large (greater than 1,000 acres of marsh and flat land).

Sandy high topographic points near the center of the impact area are considered to be the most likely locations of former impact area targets because these features are present on the historical layout drawing of the artillery range (USACE, 1999a). These higher areas would have allowed for visual observation, kept targets out of the tidal wash, and provided access to targets for periodic maintenance. Furthermore, these areas are present in the central portion of the site (where impact area targets would be expected), and are relatively distant to Page Field, Page Field Road, the estuary, and more recently developed areas on the western side of the impact area. The large distances from these areas would have constituted a safety margin that minimized the potential for errant projectiles to land in populated areas. Therefore, the high sandy areas are surmised to be the most likely locations of the impact area targets based on available information. These areas were investigated during the SI, and several MEC/MPPEH items were identified on the ground surface. Suspect subsurface anomalies were identified both on land and in the waterways at numerous locations within the UXO 4 impact area.

The types of munitions used at this site were 75-mm HE and shrapnel rounds. Projectiles from these munitions measured approximately 10 to 12 inches long by 3 inches in diameter, and weighed 12 to 15 pounds (see **Appendix C**). Maximum penetration depths for fired projectiles are estimated to be between 5 and 10 feet bgs, depending on the type of soil and velocity on impact (USACE, 1999b). However, this estimate may be high (see **MEC SAP, Section 10.5.3.1**). The actual depth of MEC/MPPEH presence at this site will be determined during the intrusive investigation to be conducted under the MEC SAP.

Prior to the SI, it was hypothesized that the area around the firing points located in undeveloped portions of the site (Firing Points, A, B, C, D, E, and R) could contain complete rounds of ammunition that may have been discarded during firing operations. It was assumed that any discarded rounds would have been placed on or just beneath the ground surface; thus, these areas were investigated during the SI by means of detector-aided surface surveys. However, no MEC/MPPEH items were found at any of these firing points during the detector-aided surveys. There remains a possibility that unfired munitions are present at these locations buried deeper than 1 foot (but above the water table), however, because subsurface anomalies were not investigated during the SI.

Firing Points H and L are located on active ranges and, therefore, were not investigated during the SI. Firing Point F is located beneath the foundation of a recently constructed building (Building 730) and, thus, was also not investigated during the SI. MEC are not expected to be present in the vicinity of this firing point because no munitions-related discoveries were reported during the construction of Building 730.

According to the design specifications for 75-mm rounds (see **Appendix C**), the types of MC that may be present at the Field Artillery West Main Range are metals, explosives (primarily trinitrotoluene [TNT]), but

may also include HE) and black powder. MC-contaminated source media are generally expected to be collocated with MEC/MPPEH. Metals other than lead, if present, would be spatially correlated with the lead because they are associated with the same components of the munitions, particularly the shrapnel. While no explosives were detected during the SI, previously unidentified locations of MEC/MPPEH may be contaminated with TNT and its degradation products or other HE explosives. Constituents of black powder in 75-mm shrapnel projectiles do not present an environmental hazard, as discussed in **Section 10.5.3.1**; however, 75-mm HE projectiles include explosives that may present an environmental hazard.

Environmental samples collected during the SI from impact area locations where MEC/MPPEH had been identified indicated no detectable explosives contamination. However, lead was detected at concentrations greater than the ecological screening criteria at a few of the impact area locations. Samples collected from the six firing points located in undeveloped areas similarly indicated no detectable explosives contamination, but one sample (near Firing Point C) exceeded the ecological screening criteria for lead.

#### 10.6.3.2 Contaminant Migration Pathways

Soil, sediment, and groundwater at UXO 4 may be impacted by MC. It is assumed that MC, if present, would be concentrated in areas where MEC/MPPEH exist. If present in soil and sediment at this site, MC could infiltrate deeper into the subsurface soil and sediment and eventually migrate to the underlying groundwater. Additional migration pathways include storm water run-off that could transport MC-contaminated soil, sediment, and dissolved contaminants across the surface toward the waterways, and the influences of rising and falling tides along the waterways that could redistribute suspended contaminants throughout the tidal areas of the site. Future construction, excavation, and/or maintenance activities in developed areas of the site provide an additional release mechanism that could allow further MC migration (i.e., from transfer of surface soil to subsurface soil or vice versa).

#### 10.6.3.3 Land Use, Receptors, and Exposure Pathways

Future land use is assumed to be the same as current land use, which varies across the site to include areas of residential, industrial, and recreational use, as well as areas of inaccessible marshland. Because the surficial aquifer is classified as a potential underground source of drinking water (FFA, 2006), it is assumed that residents could be exposed to MC (if it is present) through ingestion of groundwater.

A three-dimensional CSM illustration for this site is included on **Figure 10-8**, and an Exposure Pathway Analysis diagram is presented on **Figure 10-9**. These diagrams identify potential receptors and possible mechanisms by which these receptors could be exposed to site-related contamination, if it is present.

Human receptors at this site include military and civilian site workers, maintenance workers, recreational users, and trespassers, who may be exposed to MC if it exists in the surface soil; as well as construction workers and residents, who may take part in intrusive activities or come into contact with groundwater and, thereby, be exposed to MC if it exists in the surface soil, subsurface soil, and groundwater. Most receptors would not be exposed to MC that might be present in subsurface soil and/or groundwater. However, construction workers could be exposed to subsurface soil and groundwater encountered during excavation or utility work. Residents could also be exposed to subsurface soil if it is disturbed and redistributed at the ground surface during construction or re-landscaping activities.

Ecological receptors would include common flora and fauna and, possibly, endangered and special status species identified near MCRD Parris Island including large mammals (e.g., deer), small mammals (e.g., squirrels, rabbits, opossum, and raccoon), reptiles, birds, invertebrates, and insects that would be exposed to MC contamination in the surface soil. Fish, shellfish, crustaceans, benthics, wading birds, ospreys, and pelicans are also potential receptors in areas where sediment has been or could be contaminated. Ecological receptors could also contact MC contaminants through the food chain when ingesting fish and vegetation at this site.

## 10.7 CSM SUMMARY FOR FIELD ARTILLERY EAST SHRAPNEL RANGE (UXO 5 AND UXO 6)

This section presents general background information regarding UXO 5 and UXO 6 (Field Artillery East Shrapnel Range) and a CSM that describes potential MC migration routes and possible exposure pathways. This CSM provides the basis for the investigative program.

### 10.7.1 Site Setting and Background

The Field Artillery East Shrapnel Range has been divided into two parts, designated UXO 5 (northern portion, which includes the presumed location of the firing point and the uprange portion of the firing fan) and UXO 6 (southern portion, which includes the target/impact area). The active grenade range, which splits this former range into UXO 5 and UXO 6 (shown on **Figure 10-10**), is not included as part of this MRP site because it is still in operation. Established in 1937 as one of two field artillery ranges, the Field Artillery East Shrapnel Range consisted of a single firing point (T) at Ballast Creek with a southerly direction of fire. According to historical site maps, this range had an impact area approximately 6,500 feet long and 3,500 feet wide and a surface danger zone (i.e., firing fan) that was approximately 12,000 feet long, which extended along the eastern edge of MCRD Parris Island (USACE, 1999a). This range does not contain any concrete observation points or firing points, and no specific records of weapons firing have been found. Presumably, munitions use at this range included 75-mm ammunition for M1897 guns and M1 howitzers because these were the artillery pieces in use at the West Main Range during the same time period.

The locations of utilities that may be present at this range are unknown at this time; however, it is unlikely that utilities exist in the marsh areas of the range. The Beaufort River borders this range on the east, and access is possible from the river. The majority of this range consists of marsh areas that are not currently being used and have little, if any, reasonable potential for development. The small land area in the southwestern corner of UXO 6 contains an archaeologically significant site that dates back to the 1500s. Potential future land use is assumed to be the same as present land use, as MCRD Parris Island envisions continued use of the depot for recruit training.

### 10.7.2 Previous Environmental Investigations - Site Inspection

SI activities, which were conducted at UXO 5 and UXO 6 in early 2010 (Tetra Tech, 2011), included detector-aided surface surveys of the presumed firing point location and one small area along the western edge of the impact area; aquatic geophysical surveys within the accessible waterways; and the collection of surface soil and sediment samples for explosives and lead laboratory analysis. Results of the detector-aided and geophysical surveys conducted during the SI are summarized in the MEC SAP. No MEC or MPPEH items were encountered during the SI at these sites.

Surface soil samples were collected at the UXO 5 firing point, and sediment samples were collected within the accessible waterways of UXO 6. Explosives were not detected in either the surface soil at UXO 5 or the sediment at UXO 6 during the SI MC investigation. Lead was detected in the surface soil at UXO 5 at concentrations slightly greater than the minimum ecological screening criteria (see **Appendix B, Figure 8-7**). However, lead results for the sediment samples at UXO 6 were all less than the screening criteria (see **Appendix B, Figure 8-8**).

### 10.7.3 Conceptual Site Model

This section presents the CSM for UXO 5 and UXO 6, which describes potential and known sources of MC contamination, potential migration routes, and possible exposure pathways and receptors. **Figure 10-11** presents a graphical depiction of the UXO 5/UXO 6 CSM.

#### 10.7.3.1 Potential or Known Sources of MC

The source areas where MC could exist at UXO 5 and UXO 6 are collocated with MEC/MPPEH that may be present at the firing point, where munitions may have been discarded, and the target/impact area, where projectiles may have experienced low-order (incomplete) detonations or failed to detonate (i.e., duds). At both locations, where MEC/MPPEH is present, soil and sediment may be contaminated with residual metals and/or explosives. Areas between the firing point and the observation point are not

considered to be significant source locations of MC contamination because of the low likelihood of MEC and MPPEH presence.

Although no MEC/MPPEH items were identified at the firing point (UXO 5) during the SI, it remains a potential source of MC contamination because the actual firing point location has not been confirmed by field observations. Similarly, although no MEC/MPPEH items were identified in the UXO 6 impact area, it also remains a potential source of MC contamination because only a small percentage of the site was surveyed and sampled during the SI. Underwater anomalies were identified within the accessible waterways of the range fan, which may indicate sunken or buried MEC/MPPEH items within the submerged sediments of the wetlands and waterways at UXO 6.

The types of munitions presumably used at this site were 75-mm shrapnel rounds. Projectiles from these munitions measured approximately 10 to 12 inches long by 3 inches in diameter, and weighed 12 to 15 pounds (see **Appendix C**). Maximum penetration depths for fired projectiles are estimated to be between 5 and 10 feet bgs, depending on the type of soil and velocity on impact (USACE, 1999b). However, this estimate may be high (see **MEC SAP, Section 10.5.3.1)**.

According to the design specifications for 75-mm rounds (see **Appendix C**), the types of MC that may be present at the Field Artillery East Shrapnel Range are metals, explosives (primarily TNT, but may also include HE), and black powder. MC-contaminated source media are generally expected to be collocated with MEC and/or MPPEH. Metals other than lead, if present, are expected to be spatially correlated with the lead because they are associated with the same components of the munitions, particularly the shrapnel. While no explosives were detected during the SI, previously unidentified locations of MEC/MPPEH may be contaminated with TNT and its degradation products or other HE explosives. Constituents of black powder in 75-mm shrapnel projectiles do not present an environmental hazard, as discussed in **Section 10.5.3.1**; however, 75-mm HE projectiles include explosives that may present an environmental hazard.

Environmental samples collected during the SI at the firing point (UXO 5) and within the impact area waterways (UXO 6) indicated no detectable explosives contamination in any of the soil or sediment samples. However, lead was detected in the soil at UXO 5 at concentrations greater than the most stringent PAL, which was based on the minimum ecological screening level. Lead was detected at concentrations less than the most stringent PAL in all sediment samples from UXO 6.

#### 10.7.3.2 Contaminant Migration Pathways

Soil (UXO 5 and 6) and sediment (UXO 6 only) may be impacted by MC. It is assumed that MC, if present, would be concentrated in areas where MEC/MPPEH exist. If present in soil and sediment at this

site, MC could infiltrate deeper into the subsurface soil and sediment. (Note: Since all areas of UXO 5 and 6 are within or in close proximity to the tidal marsh, it is assumed that groundwater is not a viable exposure medium and, therefore, that leaching to groundwater is not a reasonable migration pathway.) Additional migration pathways include storm water run-off that could transport MC-contaminated soil, sediment, and dissolved contaminants across the surface toward the waterways, and the influences of rising and falling tides along the waterways that could redistribute suspended contaminants throughout the tidal areas of the site and, eventually, to the river. Future construction, excavation, and/or maintenance activities in land-based areas of the site provide an additional release mechanism that could allow further MC migration (i.e., from transfer of surface soil to subsurface soil or vice versa).

#### 10.7.3.3 Land Use, Receptors, and Exposure Pathways

Future land use is assumed to be the same as current land use (e.g., predominantly marshland, with a few small land areas that are either unused or considered archaeologically significant), except that residential use (without drinking water exposure) is also considered a plausible future scenario for the purpose of risk evaluation. The small areas of the range associated with dry land, such as the firing point (UXO 5) and the coastal area east of Page Field (UXO 6) are currently accessible to human receptors and could support future development, resulting in potential exposure of human receptors to MC in the surface and subsurface soil. Contact with groundwater is not considered a potential exposure pathway, however, because the land-based portions of the sites are so close to the marsh that the underlying groundwater would be similar in quality to the tidal marsh and, thus, would not be suitable for use as a drinking water source.

A three-dimensional CSM illustration for the UXO 5 and UXO 6 sites is included on **Figure 10-11**. Exposure Pathway Analysis diagrams are presented for UXO 5 on **Figure 10-12** and UXO 6 on **Figure 10-13**. These diagrams identify potential receptors and possible mechanisms by which these receptors could be exposed to site-related contamination (if it is present). Human receptors at this site include military and civilian site workers, maintenance workers, trespassers, and recreational users, who would be exposed to MC (if it exists) on the surface; as well as construction workers and hypothetical future residents, who may take part in intrusive activities and, thereby, be exposed to MC (if it exists) in the surface and subsurface soils.

Ecological receptors would include common flora and fauna and, possibly, endangered and special status species identified near MCRD Parris Island including large mammals (e.g., deer), small mammals (e.g., squirrels, rabbits, opossum, and raccoon), reptiles, birds, invertebrates, and insects that would be exposed to MC contamination in the surface soil. Fish, shellfish, crustaceans, benthics, wading birds, ospreys, and pelicans are also potential receptors in areas where sediment has been or could be

contaminated. Ecological receptors could also contact MC contaminants through the food chain when ingesting fish and vegetation at this site.

## 10.8 CSM SUMMARY FOR AERIAL BOMBING TARGET AT GOLF COURSE (UXO 7)

This section presents general background information regarding UXO 7 (Aerial Bombing Target at Golf Course) and a CSM that describes potential MC migration routes and possible exposure pathways. This CSM provides the basis for the investigative program.

### 10.8.1 Site Setting and Background

The Aerial Bombing Target at Golf Course was established as a replacement for the Aerial Bombing Target at Page Field in 1942. At both of these targets, miniature practice bombs were used. There is no evidence that any other types of bombs were used at the Aerial Bombing Target at Golf Course. Miniature practice bombs were recovered in the area during previous archaeological excavations (an archaeologically significant area borders the site to the east, along the marsh), and the ASR (USACE, 1999) mentions the discovery of four practice bomblets (i.e., 3-pound MK 23) in the golf course area. Other areas in and around the target may also have received ricochets or impacts from bombs that missed their target.

Use of this bombing target is thought to have ceased around the time Page Field was placed on caretaker status in July 1946. The construction of the golf course was completed over the target area in 1948, and the area assumed to be the target center is now located on the golf course driving range (**Figure 10-14**). To construct the golf course, the grade of the original target area was raised as much as 5 to 6 feet above the grade present when the site was an active bombing target. It is possible that grading activities have resulted in the redistribution of MEC/MPPEH so that a distinct target pattern of anomalies no longer exists.

The golf course is open to the general public, as well as military personnel, and there are no access controls or restrictions in place to limit access to this area once on the installation. Potential future land use is assumed to be the same as present land use, as MCRD Parris Island envisions continued use of this area as a golf course.

### 10.8.2 Previous Environmental Investigations - Site Inspection

SI activities, which were conducted at UXO 7 in early 2010 (Tetra Tech, 2011), included detector-aided surface surveys (along transects with 5-foot line spacing) and subsurface geophysical surveys (along transects with 10-foot line spacing). No intrusive investigations were conducted at this site during the SI, nor were any environmental samples collected.

Results of the detector-aided and geophysical surveys conducted during the SI are summarized in the MEC SAP. No MEC or MPPEH were encountered during the SI. Numerous subsurface anomalies were detected during the SI geophysical survey, but the nature of the items causing these anomalies could not be determined from the geophysical data alone.

### 10.8.3 Conceptual Site Model

This section presents the CSM for UXO 7, which describes potential and known sources of MC contamination, potential migration routes, and possible exposure pathways and receptors. **Figure 10-15** presents a graphical depiction of the UXO 7 CSM.

#### 10.8.3.1 Potential or Known Sources of MC

Munitions used at this site were miniature 3- to 4-pound practice bombs, of the same type used at UXO 3 (see **Section 10.5.3.1** and **Appendix C**). These practice bombs contained a spotting signal charge that consisted of a black powder expelling charge and a red phosphorus pyrotechnic mixture to provide smoke and burn brightly. MC associated with these practice bombs may include metals, black powder, red phosphorus, and fluorescein dye. Of these constituents, only metals have the potential to present an environmental hazard, as discussed in **Section 10.5.3.1**.

MC-contaminated source media are generally expected to be collocated with MEC and/or MPPEH. Thus, the sources of potential MC contamination at this site include the target area itself and other nearby areas that may have received ricochets or impacts from bombs that missed their target, and areas where surface material that may have been scraped from the target area could have been deposited during golf course construction. Although no MEC/MPPEH items were encountered during the SI, numerous geophysical anomalies were identified, which may indicate the presence of MEC/MPPEH in the subsurface.

Maximum penetration depths for miniature practice bombs are estimated to be between 1 and 2 feet bgs, depending on the type of soil and velocity on impact (USACE, 1999b). However, since the original grade near the area of the center of the target has been raised to construct the golf course, the actual depth (in feet bgs) of potential MEC could be deeper. The center of the target is located on the golf course driving range, and it is assumed that any MEC/MPPEH items discovered previously in this area would either have been removed as a general safety precaution during construction of the golf course or. If not, these items would now be located underneath the fill material used to raise the level of the grade in this area to construct the golf course.

#### 10.8.3.2 Contaminant Migration Pathways

No site-related munitions items were encountered during the SI at UXO 7, but there have been reports of practice bombs being recovered during previous archeological investigations in the vicinity of the site. Thus, it is assumed that MEC/MPPEH items may be present, and that the associated surface soil, subsurface soil, and groundwater may be contaminated by MC. Most MC associated with the practice bombs used at this site are not expected to pose an environmental concern or be persistent in the environment. However, if practice bombs or related debris exist on or beneath the ground surface, metal contaminants may leach from the items to the surrounding soils and, possibly, infiltrate to the deeper soils and underlying groundwater. In addition, storm water run-off could transport metals-contaminated soil and dissolved metals across the ground surface toward the waterways. Future construction, excavation, and/or maintenance activities may provide an additional migration pathway for MC if metals-contaminated subsurface soils are brought to the surface during intrusive activities. Soil and groundwater contaminants, if present, could be assimilated by plants or animals, although most assimilation of this nature would be expected in the shallow soil depths, especially in the root zone of vegetation.

#### 10.8.3.3 Land Use, Receptors, and Exposure Pathways

Future land use at UXO 7 is assumed to be the same as current land use (e.g., golf course), except that residential use is also considered a plausible future scenario for the purpose of risk evaluation. Because the surficial aquifer is classified as a potential underground source of drinking water (FFA, 2006), it is assumed that future residents could be exposed to MC (if it is present) through ingestion of groundwater. Future residents and construction workers could also be exposed to MC in subsurface soil in the event that land use changes and the subsurface soil is disturbed and redistributed at the ground surface during construction or landscaping activities.

A three-dimensional CSM illustration for this site is included on **Figure 10-15**, and an Exposure Pathway Analysis diagram is presented on **Figure 10-16**. These diagrams identify potential receptors and possible mechanisms by which these receptors could be exposed to site-related contamination, if it is present. Human receptors at this site include military and civilian site workers, maintenance workers, recreational users, and trespassers, who would be exposed to MC if it exists on the surface; as well as construction workers and hypothetical future residents, who may take part in intrusive activities or come into contact with groundwater and, thereby, be exposed to MC if it exists in the surface soil, subsurface soil, and groundwater.

Ecological receptors would include common flora and fauna and, possibly, endangered and special status species identified near MCRD Parris Island including large mammals (e.g., deer), small mammals (e.g., squirrels, rabbits, opossum, and raccoon), reptiles, birds, invertebrates, and insects that would be

exposed to MC contamination in the surface soil. Ecological receptors could also contact MC contaminants through the food chain when ingesting vegetation at this site.

## 10.9 CSM SUMMARY FOR AERIAL BOMBING TARGET AT SOUTHERN TIDAL FLATS (UXO 8)

This section presents general background information regarding UXO 8 (Aerial Bombing Target at Southern Tidal Flats) and a CSM that describes potential MC migration routes and possible exposure pathways. This CSM provides basis for the investigative program.

### 10.9.1 Site Setting and Background

The Aerial Bombing Target at Southern Tidal Flats was used for bombing practice during WWII. Munitions used at this site included 3- to 4-pound miniature and 100-pound practice bombs. The 100-pound practice bombs (such as the Mk 15) were water- and sand-filled, light case munitions, which normally broke apart upon impact.

The location of this bombing target is shown on **Figure 10-17**. Although not identified on any of the historical site plans reviewed during ASR information gathering, the location of this target was confirmed in the field by the presence of two 10-foot tall metal posts, which are believed to have formed the target's center. Rusty sheet metal debris, apparently derived from 100-pound practice bombs, is scattered throughout the area. This rusty sheet metal debris is considered to be munitions debris and not MEC/MPPEH. No debris derived from other munitions [including subcaliber aerial rockets (SCAR) or HE bombs] has been found at this location.

Access to this site is possible from the golf course parking lot, which is located directly north of the site. The site can also be accessed from the Broad River, which borders the south side of the site, approximately 1,000 feet south of the apparent center of the target. There are no buildings or utilities associated with this site. Potential future land use is assumed to be the same as present land use, as MCRD Parris Island envisions continued use of the depot for recruit training.

### 10.9.2 Previous Environmental Investigations - Site Inspection

SI activities, which were conducted at UXO 8 in early 2010 (Tetra Tech, 2011), included detector-aided surface and subsurface geophysical surveys along transects with 5-foot line spacing. No intrusive investigations were conducted at this site during the SI, nor were any environmental samples collected.

Results of the detector-aided and geophysical surveys conducted during the SI are summarized in the MEC SAP. No MEC or MPPEH were encountered during the SI; however, a large quantity of practice bomb fragments were scattered across the site. More than 1,000 anomalies were detected during the SI

geophysical survey but it was unclear whether these anomalies were caused by the surficial fragments or by potential MEC or MPPEH in the subsurface.

### 10.9.3 Conceptual Site Model

This section presents the CSM for UXO 8, which describes potential and known sources of MC contamination, potential migration routes, and possible exposure pathways and receptors. **Figure 10-18** presents a graphical depiction of the UXO 8 CSM.

#### 10.9.3.1 Potential or Known Sources of MC

Munitions used at this site included 100-pound practice bombs (such as the Mk 15) and miniature practice bombs of the same type used at UXO 3 and UXO 7 (see **Section 10.5.3.1**). The 100-pound practice bomb was a water- or sand-filled, light case munition that normally broke apart upon impact. These bombs measured approximately 41 inches long by 8 inches in diameter (see **Appendix C**). Both the 100-pound and miniature practice bombs contained a spotting signal charge that consisted of a black powder expelling charge and a red phosphorus pyrotechnic mixture to provide smoke and burn brightly. MC associated with these practice bombs include metals, black powder, red phosphorus, and (in the case of miniature practice bombs) fluorescein dye. Of these constituents, only metals have the potential to present an environmental hazard, as discussed in **Section 10.5.3.1**.

MC-contaminated source media are generally expected to be collocated with MEC and/or MPPEH. Thus, the sources of potential MC contamination at this site include the target area and other nearby areas that may have received ricochets or impacts from bombs that missed their target. Although no MEC/MPPEH items were encountered during the SI, numerous geophysical anomalies were identified, which may indicate the presence of MEC/MPPEH in the subsurface.

Maximum penetration depths for the practice bombs used at this site are estimated to be 3 to 6 feet bgs for an intact 100-pound bomb and 1 to 2 feet bgs for smaller miniature practice bombs, depending on the type of soil and velocity on impact (USACE, 1999b). However, due to the physical conditions at this site (i.e., saturated, tidal flats sand), actual penetration depths are not likely to exceed the low end of the estimate (i.e., approximately 3 feet bgs for the 100-pound bombs and 1 foot bgs for the miniature bombs).

#### 10.9.3.2 Contaminant Migration Pathways

Numerous site-related munitions items were encountered on the surface during the SI at UXO 8. Thus, it is assumed that the associated surface sediment and, possibly, subsurface sediment may be impacted by MC. Most MC associated with the practice bombs used at this site are not expected to pose an environmental concern or be persistent in the environment. However, the presence of practice bomb

debris indicates the potential for metal contaminants to leach from the items to the surrounding sediments and, possibly, to migrate to the deeper sediments. (Note: Since all areas of UXO 8 lie within the tidal flats, it is assumed that groundwater is not a viable exposure medium and, therefore, that leaching to groundwater is not a reasonable migration pathway.) An additional migration pathway would include the influences of rising and falling tides, which could redistribute suspended contaminants throughout the tidal flats and, eventually, to the river.

#### 10.9.3.3 Land Use, Receptors, and Exposure Pathways

Future land use is assumed to be the same as current land use (e.g., undeveloped tidal flats), with no reasonable expectation of future residential use. The site is not currently used and is underwater during periods of high tide. Future use of the site on a recurring or regular basis by military or contractor personnel is unlikely; however, MCRD is considering plans to install a floodlight or warning beacon in the area.

A three-dimensional CSM illustration for this site is included on **Figure 10-18**, and an Exposure Pathway Analysis diagram is presented on **Figure 10-19**. These diagrams identify potential receptors and possible mechanisms by which these receptors could be exposed to site-related contamination, if it is present. Human receptors at this site include trespassers and recreational users, who would be exposed to MC if it exists on the surface; as well as construction workers, who may take part in intrusive activities during utility installation and, thus, come into contact with subsurface sediments.

Ecological receptors would include common flora and fauna and, possibly, endangered and special status species identified near MCRD Parris Island including large mammals (e.g., deer), small mammals (e.g., squirrels, rabbits, opossum, and raccoon), reptiles, birds, invertebrates, and insects that would be exposed to MC contamination in the surface sediment. Crustaceans, benthics, wading birds, ospreys, and pelicans may also be potential receptors in areas where sediment has been impacted.

**SAP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements**
(UFP-QAPP Manual Section 2.6.1)

The following text describes the development of project DQOs using USEPA's Systematic Planning Process (USEPA, 2006a) for the MC investigation to be conducted at UXO Sites 3 to 8 and the risk assessments to be performed for UXO Sites 2 to 8.

## 11.1 PROBLEM STATEMENTS

Generic UXO 2 to 8 Problem Statement

Analyses of soil and sediment samples collected during the SI have generally identified the presence of site-related contaminants at concentrations that are potentially harmful to human and ecological receptors because they exceed risk-based screening criteria (and site-specific background concentrations for metals) and are, thus, considered COPCs. Soil and sediment were investigated during the SI at four sites (UXO 2, UXO 4, UXO 5, and UXO 6), but the data generated were not sufficient to completely define the horizontal and vertical extent of COPCs in those media. In addition, no soil or sediment sampling has been conducted at UXO 3, UXO 7, or UXO 8, and the underlying groundwater has not yet been investigated at any of the sites where it represents a potential exposure medium (UXO 3, UXO 4, and UXO 7). No surface water data have been collected at any of the UXO sites, although none is deemed necessary because the continual mixing due to tidal influences would prevent the collection of meaningful data. To determine whether exposure of human and ecological receptors to soil, sediment, and groundwater at UXO Sites 2 to 8 may pose an unacceptable risk, an RI must be conducted and the data generated must be considered, in conjunction with data generated during the SI (including the Expanded SI), in the human health and ecological risk evaluations.

The COPCs at these sites are limited to constituents of the specific munitions used at each site (based on historical records and military munitions databases), which may be present in high enough concentrations to pose a human health and/or ecological risk. These COPCs include certain metals associated with the types of munitions that were historically used at each site and explosives associated with the types of munitions that were historically used at UXO 4, UXO 5, and UXO 6.

Upon collecting data to fill the existing data gaps, risk evaluations must be completed for soil, sediment, and groundwater exposure at each site to determine whether risks to human and/or ecological receptors are potentially unacceptable and, if so, whether actions to evaluate options for reducing the unacceptable risks are warranted.

The CSMs for UXO Sites 2 to 8 account for the potential presence of site-related MEC, MPPEH, or debris at each site. Bullets related to historical site usage were identified on the ground surface during the SI at UXO 2. MEC/MPPEH and/or munitions debris related to historical site usage were identified on the ground surface during the SI at UXO 4 and UXO 8. In addition, geophysical anomalies identified during the SI surveys may be indicative of MEC or MPPEH in the subsurface soils and sediments at UXO 3, UXO 4, UXO 6, UXO 7, and UXO 8. In order to define the nature and extent of MEC/MPPEH at UXO Sites 3 to 8, additional surface and subsurface surveys and intrusive investigation of identified anomalies will be performed, as described in the MEC SAP. To evaluate the potential impact of range-related MEC/MPPEH on the surrounding soils, sediments, and groundwater at each site, MC data must be collected at biased locations associated with MEC/MPPEH finds, which is the subject of this MC SAP.

The primary goal of the MC RI for UXO Sites 2 to 8 is to determine whether, and to what extent, MC are present at each site as a result of previous range operations. This information will be used, in conjunction with the SI data for UXO 2, UXO 4, UXO 5, and UXO 6 to refine the CSMs and evaluate potential risks and hazards associated with each site for presentation in the RI Report. If MC are detected in concentrations that could pose unacceptable risk at any site, the combined SI and RI data sets will be considered by the Partnering Team in developing remedial alternatives for evaluation in the FS.

It is uncertain whether MEC, MPPEH, or MC exist at UXO 3, UXO 7, or UXO 8 as a result of historical use of these sites as practice bomb targets, or at UXO 4, UXO 5, or UXO 6 as a result of historical use of these sites as artillery ranges. If MEC and/or MPPEH are present, associated MC could also be present at concentrations that pose an unacceptable risk. Although no surface MEC were identified during the SI (except in the target/impact areas of UXO 4), geophysical anomalies detected in the subsurface soil suggest the potential presence of subsurface MEC/MPPEH. Additionally, geophysical anomalies were detected in the waterways in UXO 4 and UXO 6, which suggest the potential presence of submerged MEC/MPPEH. Additional surveys and intrusive and underwater investigations will be conducted under the MEC SAP to determine whether the geophysical anomalies are due to MEC, MPPEH, or unrelated debris. Where MEC/MPPEH is found, additional analytical data are also required to determine the extent to which the site has been impacted by the associated MC.

The data generated during the RI must be used in conjunction with data generated during the SI (including the Expanded SI) to define the nature and extent of MC contamination at each site to an area as small as possible, and to determine whether there are any unacceptable risks to human or ecological receptors so appropriate action can be taken to mitigate the risks if risks are unacceptable.

In addition to the general problem statements applicable to all sites subject to this MC SAP, the following problem statements are applicable to individual sites, as indicated.

UXO 2 Problem Statement (Site-Specific Issue)

Previously collected SI data indicate that lead is present at some locations within UXO 2 in concentrations that could pose an unacceptable risk to ecological receptors. The Partnering Team has concurred that an Expanded SI should be conducted to collect additional data to delineate the lead contamination and evaluate the presence of other MC, including select metals in the target area and nitroglycerin in the firing line area. Thus, no additional data collection is necessary during the RI. Instead, the SI data (including the Expanded SI data) must be used to define the nature and extent of MC contamination in the soil and sediment to an area as small as possible and to perform a HHRA and/or ERA, as appropriate, to determine whether there are any associated unacceptable risks to site receptors so that suitable action can be taken to mitigate the risks if risks are unacceptable. In addition, the physical overlap of UXO 2 with Site 13C should be considered, and any future remedies deemed necessary at either site should be coordinated with those planned for the other site.

UXO 4 Problem Statement (Site-Specific Issue)

A soil sample collected from Firing Point C during the SI contained lead in a concentration that exceeded the lowest ecological screening level, as confirmed in the SI Report (Tetra Tech, 2011). Since lead was the only metal analyzed during the SI, additional analytical data are required to determine the extent to which the Firing Point C area of UXO 4 has been impacted by lead and other metals. The resulting data must be used to define the nature and extent of metals contamination at Firing Point C and to determine whether there are any unacceptable risks to human or ecological receptors so that suitable action can be taken to mitigate the risks if risks are unacceptable.

UXO 5 Problem Statement (Site-Specific Issue)

The presumed historical use of Firing Point T as an artillery range firing point may have resulted in the release of explosives at or near the firing point. If explosives are present, they could exist at a mean soil concentration that poses an unacceptable risk to human or ecological receptors. No evidence of surface or shallow subsurface MEC items were identified during the SI, and the presence of explosives was not confirmed at the originally suspected firing point location. Thus, the actual location of Firing Point T remains in question. Additional analytical data are required from an adjacent area to determine whether Firing Point T was actually located in the adjacent area and if so, whether a contaminant release has occurred at that location.

## 11.2 INFORMATION INPUTS

Data that are required to resolve the problems described in Section 11.1 are as follows:

1. MEC/MPPEH finds: Because MC will most likely be found in areas where MEC/MPPEH is present, the locations of any MEC, MPPEH, or range-related debris identified during the MEC investigation must be used to guide soil and sediment data collection toward areas containing MEC or MPPEH. Default systematic sampling locations should be prescribed for each site and used, as necessary, to fulfill the minimum data set requirements for each environmental medium within each investigated area for the risk assessments, as recommended by the project human health and ecological risk assessors during the project planning meetings (see **Worksheet #9**).

2. Chemical data: Soil and sediment concentrations of MC (explosives and/or metals) are needed to evaluate the soil and sediment as potential sources of contamination at UXO Sites 3 to 8 and to determine the extent of contamination. Groundwater concentrations of MC (explosives and/or metals) are needed to support a determination of the nature and extent of contamination due to COPCs in groundwater at UXO 3, UXO 4, and UXO 7. These data must be obtained by analyzing samples of surface and subsurface soil, sediment, and groundwater collected from the populations described in **Section 11.3**. The complete list of target analytes is presented in **Worksheet #15**. As described in **Worksheet #15**, surface water samples will not be collected at any UXO site because the continual mixing that occurs in the site waterways due to tidal fluctuations would prevent the collection of conclusive data.

3. Physical data: Field investigation of physical groundwater parameters, including pH, specific conductance, turbidity, temperature, oxidation-reduction potential (ORP), and dissolved oxygen (DO), must be conducted to ensure the representativeness of groundwater samples collected and to assist with site characterization of the surficial aquifer. Soil and sediment sampling must include the evaluation of physical parameters, including pH in soil, and pH and total organic carbon (TOC) in sediment to support site-specific risk calculations.

4. Groundwater level measurements: Water level measurements (via water level meter) are needed to provide information regarding the potentiometric surface (i.e., elevation) of the water table at sampling locations and to determine the direction(s) of groundwater flow. Temporary wells allow for the collection of sufficiently accurate groundwater level measurements to meet this objective.

5. Dissolved metals data (provisional): Groundwater concentrations of dissolved metals are needed to provide additional data at locations where the sample matrix has a turbidity of greater than 10 nephelometric turbidity units (NTUs). Total metals data are generally used for risk screening

comparisons to PALs (see PALs below). However, previous groundwater sampling results at other sites within Parris Island suggest that turbidity may be an issue throughout the installation, thus limiting the ability of total metals data to represent actual groundwater conditions. In addition, the use of temporary wells, while sufficient for collecting organic parameter concentration data in groundwater, may not be optimal for metals because of a potential for increased turbidity compared to groundwater collected from permanent wells. The increased turbidity is caused by entrained soil, which contains relatively high concentrations of metals. Nevertheless, the speed and reduced cost associated with installation of temporary wells is considered to be an acceptable compromise. In anticipation of turbidity issues during this investigation, dissolved metals concentrations must be measured, in addition to total metals concentrations. The dissolved metals concentrations may be used by the Partnering Team in a "lines of evidence" approach to estimate the degree of partitioning of metals between aqueous and particulate phases for a variety of reasons, such as:

- Estimating bioavailabilities of metals;
- Qualifying the degree of risk as estimated based on total metal concentrations; and
- Other uses within the context of an updated CSM that provide a more complete or accurate picture of risks than would be possible using total metals concentrations alone.

6. Sample location data: Sample location horizontal coordinates and vertical depths must be measured. Horizontal coordinates may be measured with equal effectiveness using a global positioning system (GPS) or by a land survey. Depth intervals are best measured using a tape measure or other device with similar accuracy and precision (e.g., water level meter). These coordinates must be documented in the datums identified in **Worksheet #14**, "Global Position System Locating" section.

7. Project Action Limits: PALs are necessary to evaluate soil, sediment, and groundwater data for the selection of COPCs in the HHRA and ERA. The selected human health and ecological screening values are presented and referenced in **Worksheet #15**. Backup tables supporting the selection of the human health and ecological screening values are presented in **Appendix F**. The PALs to be used in this investigation are derived from the following criteria:

   - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites - Residential Soil Values, Protection of Groundwater Values, and Tapwater Values (USEPA, 2011a).
   - Federal Maximum Contaminant Levels (MCLs) for comparison to measured groundwater concentrations (USEPA, 2011b).
   - Ecological Screening Values: Available ecological screening values were selected from a variety of resources.

- Background concentrations of metals will be used as PALs when the background concentration exceeds the risk-based value because metals occur naturally in environmental media, and it is Navy policy to consider naturally occurring constituents in the background concentration range as not representing contamination. For any metal with a background soil or sediment concentration greater than the applicable risk-based PAL, the background soil or sediment concentration is used as the PAL for that particular metal. In the absence of a robust set of background data specific to MCRD Parris Island, the Partnering Team suggested that background values derived for MCAS Beaufort be considered for use at MCRD Parris Island due to the proximity and similar physical settings of the two facilities. Tetra Tech evaluated the data presented in the Basewide Background Report for MCAS Beaufort (Tetra Tech, 2006), qualitatively comparing the soil types at the two facilities. The evaluation, which is presented in **Appendix A**, concluded that the soil types are similar and that the background data set for MCAS Beaufort can also be used at MCRD Parris Island. Background values for soil and sediment that are applicable to MCRD Parris Island as a result of this evaluation are provided in the PAL backup tables in **Appendix F**.
- Watershed Contaminant Source Document (WCSD) (Tetra Tech, TBD): Currently undergoing internal review, this document is being prepared in accordance with Navy policy to evaluate sources other than MCRD Parris Island that may have contributed to contaminant concentrations in the regional watershed sediments. Findings presented in the WCSD are not expected to impact the evaluation of data for UXO 4 or UXO 6 because the sediment sampling locations are in inland waterways that are not likely to receive stormwater from upstream sources other than MCRD Parris Island. The WCSD findings also are not likely to impact the evaluation of data for UXO 8 because the tidal effects of the Broad River and Atlantic Ocean would significantly dilute the concentration of contaminants from upstream sources that could be deposited there. If the WCSD, however, indicates that potential non-Navy sources of contamination could have contributed to contamination at any of the sites investigated under this SAP, the project team will evaluate the effect of this finding and include appropriate discussions in the RI report.

PALs are also necessary to evaluate risk to identified receptors from exposure to soil, sediment, and groundwater data. The selected human health and ecological risk benchmarks are as follows:

- Human Health Risk: An incremental lifetime cancer risk (ILCR) greater than 1 x $10^{-4}$ or a non-cancer Hazard Index (HI) greater than 1 (based on common target organs or effects) is considered to be unacceptable.
- Ecological Risk: A Hazard Quotient greater than 1 for any receptor in any medium is considered to be unacceptable.

Note that, according to OSWER directive 9355.0-30 (EPA, 1991), when the cumulative carcinogenic risk for both current and future land use is less than 1 x $10^{-4}$ (based on reasonable maximum exposure) and the non-cancer HI is less than 1 (based on common target organs), then action is generally not warranted unless there are adverse environmental impacts or if MCLs or non-zero MCL goals are exceeded.

This RI requires chemical data that can be used to determine the nature and extent of contamination and to evaluate potential risk to site receptors. To identify COPCs, laboratory results from the SI for surface and subsurface soil and sediment sample analyses were compared to medium-specific human health and ecological PALs as part of the risk screening process. Surface and subsurface soil and sediment PALs were set at the lowest matrix-specific, risk-based, or regulatory human health and ecological screening criteria appropriate for the sites. The complete list of applicable soil, sediment, and groundwater PALs corresponding to the COPCs for each site is presented in **Worksheet #15.** These PALs are identified to ensure that laboratory sensitivity is sufficient to meet project goals.

To conduct comparisons of site data to PALs, the selected laboratory must be able to achieve Limits of Quantitation (LOQs) that are low enough to measure constituent concentrations less than the PALs. In cases where conventional test methods are not able to achieve LOQs that are lower than the PALs (such as for arsenic and selected explosives), rules for evaluating the data are required that help the Partnering Team determine with reasonable satisfaction whether the constituent poses a potentially unacceptable risk. Analytical data reported by the laboratory must use the following reporting conventions:

- All concentrations less than Detection Limits (DLs) will be considered non-detects and will be reported as DL values with a "U" qualifier. This reporting convention is preferred by SCDHEC.
- Concentrations between the DL and LOQ will be reported as estimated values with a “J” qualifier.

In the event that a target analyte has a PAL between the DL and LOQ, the “J” flagged data will be accepted to achieve project goals. The inability to quantifiably compare individual analytes to PALs with confidence must be addressed in the risk evaluation uncertainty analysis in each risk assessment.

8. Risk Assessments: Previously collected SI data will be used along with the newly collected RI data to determine the nature and extent of contamination from COPCs and to assess risk to human and ecological receptors at UXO Sites 2 to 8. These risk assessments will be conducted in accordance with USEPA protocols and Navy guidance documents for HHRAs and ERAs.

## 11.3 STUDY AREA BOUNDARIES

Study area boundaries are described below for each environmental medium of interest as it applies to each of the sites being investigated. In general, the investigations must be biased toward areas of each site that have the greatest potential for being contaminated, such as locations at or near MEC finds, to ensure that contamination has the greatest chance of being detected and delineated. To delineate contamination, however, some data collection must include areas thought not to be contaminated so the boundary of contamination can be delineated.

### 11.3.1 Groundwater

Horizontal and vertical boundaries - The groundwater population that is representative of any impacted groundwater will be investigated at UXO 3, UXO 4, and UXO 7. The groundwater population of interest at these sites is the top 5 feet of the surficial aquifer that may have been impacted by leaching of MC from historical bombing or artillery activities. The initial horizontal boundaries of the investigation must coincide with the boundaries shown for UXO 3, UXO 4, and UXO 7 on **Figure 10-4, Figure 10-7,** and **Figure 10-14,** respectively. If MEC is found outside these boundaries during the MEC field investigation, then the horizontal study boundaries will be extended as described in the MEC SAP to include new areas near each MEC find. Results of recent investigations at other sites within MCRD Parris Island, and the proximity of these sites to the Atlantic Ocean suggest that surficial groundwater could be encountered within 5 feet bgs at each site, with the possible exception of UXO 7, where as much as 5 feet of fill material was placed on top of the native soil during construction of the golf course. The water table is anticipated to be encountered at approximately 5 to 10 feet bgs at UXO 3 and UXO 4, and 10 to 15 feet bgs at UXO 7. Although not currently used for drinking water production, the shallow formation contains the groundwater most likely to have been impacted by migration from soil contaminants deposited during site operations. In general, groundwater contaminant concentrations must be measured in the surficial aquifer at locations of greatest potential for contamination, such as at the center of the former bombing/artillery targets, and/or at locations of potential contact with human receptors, such as in developed areas of the sites. Water level measurements at a minimum of three locations at each site are required to establish groundwater flow directions. These locations should include locations near site boundaries to measure contaminant concentrations that could be flowing off-site toward potential receptors.

Temporal boundaries – Groundwater COPC concentrations are not expected to change significantly during the course of this investigation other than through the ongoing influence of tides due to the sites' proximities to the Atlantic Ocean. Groundwater data must be collected during low tide to minimize potential variations that could be caused by fluctuations in surface water. Low tide is considered to be the

tidal elevation that represents the greatest opportunity for detecting contaminants that have leached from soil because the shallow groundwater at or near low tide has spent the previous half-tide cycle in contact with site soil.

### 11.3.2 Sediment

Horizontal and vertical boundaries - Sediment potentially impacted by site operations must be investigated in the impact areas and waterways within UXO 4 and UXO 6 (only if MEC/MPPEH are present), and the tidal flats at UXO 8. The sediment populations of interest are any sediment that may have been contaminated by MC from historical bombing or artillery activities. The initial horizontal boundaries of the investigation must coincide with the boundaries shown for UXO 4, UXO 6, and UXO 8 on **Figure 10-7, Figure 10-10,** and **Figure 10-17,** respectively. If MEC is found outside these boundaries during the MEC field investigation, then the horizontal study boundaries must be extended as described in the MEC SAP to include new areas near each MEC find. The shallowest depth of interest at each site is 0 to 6 inches below the sediment surface, as this is the sediment interval that relates to ecological exposure. At UXO 8, an additional depth of interest includes 6 to 24 inches below the sediment surface, as this interval relates to human health exposure (i.e., during shallow intrusive activities such as utility installation). Sediment in the impact areas of UXO 4 and UXO 6 must be investigated at locations where surface runoff from areas containing surficial MEC/MPPEH may enter adjacent waterways only if site-related MEC/MPPEH are identified during the intrusive investigation. Sediment in the waterways of UXO 4 and UXO 6 must be investigated near MEC/MPPEH finds to determine the extent of sediment contamination only if MEC/MPPEH are discovered during the underwater investigation phase of the RI. Sediment in the tidal flats of UXO 8 must be investigated to determine the extent of sediment contamination beneath accumulations of MEC/MPPEH and/or munitions debris known to be present at that site. Surface water in locations adjacent to the sediment population of interest will not be investigated due to the continual mixing and dilutive effects of tidal influences.

Temporal boundaries – Sediment COPC concentrations are not expected to change significantly during the course of this investigation. However, sediment samples in UXO 8 must be collected at low tide to ensure that the data represent plausible exposure and to ensure that sediment sampling locations are accessible by foot. In addition, sediment samples must be collected prior to, or in coordination with, the MEC survey field activities to avoid complications that could be caused by debris removal along the MEC survey transects.

### 11.3.3 Surface and Subsurface Soil

Horizontal and vertical boundaries - Soil potentially impacted by site operations must be investigated at UXO 3, UXO 4, UXO 5, UXO 6, and UXO 7. The soil populations of interest at UXO 3, UXO 4, UXO 5,

UXO 6, and UXO 7 are any soil that may have been contaminated by MC from historical bombing or artillery activities. The initial horizontal boundaries of the investigation must coincide with the boundaries shown for UXO 3, UXO 4, UXO 5/UXO 6, and UXO 7 on **Figure 10-4, Figure 10-7, Figure 10-10,** and **Figure 10-14,** respectively. If MEC is found outside these boundaries during the MEC field investigation, then the horizontal study boundaries of the MC investigation must be extended as described in the MEC SAP to include new areas near each MEC find.

The surface soil depth of interest is 0 to 1 feet bgs. The only exception to this is at Firing Point T (UXO 5), where soil samples will be collected for explosives by IS methodology at 0 to 2 inches (5 centimeters) bgs. Non-saturated soil from 1 to 3 feet bgs is the subsurface soil of interest, unless the discovery of MEC dictates that deeper soil be investigated. The intrusive anomaly investigations are designed to extend to depth, as necessary, to resolve each selected anomaly. Anomalies that cannot be resolved through hand digging in the top 4 feet bgs or down to 6 inches below the water table (i.e., in saturated soil), whichever comes first, may be investigated to greater depths using mechanized low-input operations, if field conditions allow. At biased locations of MEC finds, the vertical boundary of MC sampling must extend to one foot deeper than the discovery depth of MEC to determine whether any vertical (downward) migration of contamination has occurred.

Temporal boundaries – Due to the time that has elapsed since active UXO operations ceased at UXO Sites 3 to 8 (approximately 70 years), soil COPC concentrations are not expected to change significantly during the course of this investigation.

## 11.4 ANALYTIC APPROACH

The decision rules below explain how the Partnering Team will use the chemical data for decision making at UXO Sites 3 to 8. The decision rules for this RI are as follows:

**Decision Rule #1 (Applicable Only to UXO 5 Firing Point T and Other UXO Site Grids Where Incremental Samples May Be Collected)**

If the average IS surface soil concentration for each detected target analyte (i.e., explosives) is less than the soil PALs, then conclude that there are no unacceptable risks associated with explosives in soil at these locations and recommend no further action or investigation with respect to explosives contamination; otherwise, determine that insufficient data have been collected to define this area with respect to explosives contamination and convene the Partnering Team to identify the appropriate next step in the remedial process. In cases where target analytes have risk-based PALs that are lower than the LOQs achievable by the laboratory, the uncertainties associated with the results of the investigation

will be discussed in the RI Report, and a decision to recommend no further action or investigation with respect to those analytes will be considered by the Project Team.

**Decision Rule #2 (Applicable Individually to Each Site for Each Investigated Medium)**

Convene the Partnering Team to determine, based on a combination of the SI and RI data, whether the presence of MC contamination has been adequately delineated in all environmental media of concern at each site and whether the data are sufficient for completing the RI. If so, then proceed with completing the human health and ecological risk screening evaluations; otherwise, determine what additional data collection is necessary to adequately characterize the nature and extent of soil, sediment, and/or groundwater contamination before proceeding to Decision Rule #3. At a minimum, this evaluation must consider the following factors relative to the existing CSM in each environmental medium:

- Frequency of detection for each constituent.
- Frequency and magnitude of PAL exceedance for each constituent.
- Background concentrations of metals that exceed PALs.
- Magnitude of concentrations within, and on the perimeter of, the investigated areas.
- Identities of COPCs and their estimated contributions to unacceptable levels of risk.

Note: The tendency to collect more data will increase as spatial concentration patterns indicate that a potentially unacceptable risk exists outside the investigated areas, that the levels or distribution of contaminants are not known to a satisfactory degree of confidence, or that the data indicate that the CSM is in significant error.

**Decision Rule #3 (Applicable Individually to Each Site for Each Investigated Medium)**

If soil, sediment, or groundwater concentrations of all contaminants measured (e.g., explosives and/or metals) at each sampling location are less than the respective soil, sediment, or groundwater PALs, then conclude that there are no unacceptable risks associated with soil, sediment, or groundwater (as applicable) at that site and recommend no further action or investigation with respect to chemical contamination in the applicable medium; otherwise, complete the risk screening and proceed to Decision Rule #4. In cases where target analytes have risk-based PALs that are lower than the LOQs achievable by the laboratory in any environmental medium, the uncertainties associated with the results of the investigation will be discussed in the RI Report, and a decision to recommend no further action or investigation with respect to those analytes will be considered by the Project Team.

**Decision Rule #4 (Applicable Individually to Each Site for Each Investigated Medium)**

If the risk screening evaluation concludes that target analyte concentrations in soil, sediment, and/or groundwater are greater than the PALs within the individual study area boundaries, then conduct an HHRA and/or an ERA, as appropriate, to determine whether an unacceptable human health or ecological risk is present.

- Soil: If risks are unacceptable from soil [i.e., hazard quotients or hazard indices are greater than 1, and/or incremental lifetime cancer risks (ILCRs) are greater than $1 \times 10^{-4}$], then proceed to a Feasibility Study (FS) to evaluate soil remedial alternatives for the site; if ILCRs are within the USEPA target range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$, then the Partnering Team will make risk management decisions for the site on a case-by-case basis; otherwise, recommend no further investigation with respect to chemical contamination in soil and proceed to a focused FS.

- Sediment: If risks are unacceptable from sediment (i.e., hazard quotients or hazard indices are greater than 1, and/or ILCRs are greater than $1 \times 10^{-4}$), then proceed to an FS to evaluate sediment remedial alternatives for the site; ; if ILCRs are within the USEPA target range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$, then the Partnering Team will make risk management decisions for the site on a case-by-case basis; otherwise, recommend no further investigation with respect to chemical contamination in sediment and proceed to a focused FS.

- Groundwater: If target analyte concentrations in groundwater are greater than the MCL or present a human health risk (i.e., hazard quotients or hazard indices are greater than 1, and/or ILCRs are greater than $1 \times 10^{-4}$), then proceed to an FS to evaluate groundwater remedial alternatives for the site; ; if ILCRs are within the USEPA target range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$, then the Partnering Team will make risk management decisions for the site on a case-by-case basis; otherwise, recommend no further investigation with respect to chemical contamination in groundwater and proceed to a focused FS.

QA data to be collected as part of the analytic approach at UXO Sites 3 to 8 are described in **Worksheets #12, 20, and 28**.

## 11.5 PERFORMANCE OR ACCEPTANCE CRITERIA

Samples for MC analysis will be collected primarily from biased locations where subsurface MEC/MPPEH items are found during intrusive investigation of anomalies, with supplemental samples collected from default systematic locations in areas most likely to be contaminated based on the CSM. This biased selection of sample locations does not support the use of quantitative statistics to estimate

decision performance as specified in the DQO guidance (USEPA, 2006a). Instead, the Partnering Team will use the results of this investigation to determine whether the quality of data collected is sufficient to support the attainment of project objectives and to decide whether further investigation is required. Performance criteria for laboratory-generated data are normal laboratory QA limits and pre-established detection limits for MC target analytes, as listed in **Worksheet #15**. The data quality will be reviewed to ensure that performance criteria have been met and that the data are sufficient for decision-making purposes. The RI Report will document the detection limits achieved by the laboratory for all sample analyses, and any associated uncertainties will be discussed in the risk assessment section.

The data set generated by the laboratory will be reviewed to ensure that the intended samples were collected and that usable data was reported for all samples submitted. If all data are collected as planned and no data points are missing or rejected for quality reasons, then the investigation completeness will be considered satisfactory. If any data gaps are identified, including missing or rejected data, the Partnering Team will assess whether a claim of having obtained project objectives is reasonable based on the quantity and types of data gaps. Partnering Team members will be involved in rendering the final conclusion by consensus regarding adequacy of the data.

### 11.6 DATA COLLECTION PLAN

The sampling rationale is described in **Worksheet #17**. Proposed sampling locations are shown on **Figures 17-1 through 17-7**. Sampling locations and identifications are listed in **Worksheet #18**.

## SAP Worksheet #12 -- Measurement Performance Criteria Table – Field Quality Control Samples

(UFP-QAPP Manual Section 2.6.2)

| Quality Control (QC) Sample | Analytical Group | Frequency | Data Quality Indicators (DQIs) | Measurement Performance Criteria (MPCs) |
|---|---|---|---|---|
| Equipment Rinsate Blank | All analytical groups | One per 20 field samples per matrix per sampling equipment (1) | Bias/ Contamination | No analytes ≥ ½ LOQ, except common lab contaminants, which must be < LOQ. |
| Trip Blank | VOCs | One per cooler containing VOC samples | Bias/ Contamination | No analytes ≥ ½ LOQ, except common lab contaminants, which must be < LOQ. |
| Field Duplicate | All analytical groups | One per 10 field samples collected | Precision | Values > 5X LOQ: Relative Percent Difference (RPD) must be ≤ 30%(2,3) (aqueous); ≤ 50%(2,3) (solids). |
| Field Triplicate (IS only) | Explosives (by IS methodology) | One per 10 field IS samples collected | Precision | Values > 5X LOQ: Relative Standard Deviation (RSD) must be ≤ 30% (solids). |
| Cooler Temperature Blank | All analytical groups | One per cooler | Representativeness | Temperature must be less than or equal to 6 degrees Celsius (°C), but samples must not be frozen. |

1 – Equipment rinsate blanks will be collected if non-dedicated submersible pumps or other equipment are used.
2 – If duplicate values for non-metals are less than five times the LOQ, the absolute difference should be less than or equal to two times the LOQ.
3 – If duplicate values for metals are less than five times the LOQ, the absolute difference should be less than or equal to four times the LOQ.

## SAP Worksheet #13 -- Secondary Data Criteria and Limitations Table

(UFP-QAPP Manual Section 2.7)

| Secondary Data | Data Source (originating organization, report title and date) | Data Generator(s) (originating organization, data types, data generation / collection dates) | How Data Will Be Used | Limitations on Data Use |
|---|---|---|---|---|
| Site Inspection Report for Munitions Response Program Sites – UXOs 1 through 8 | Tetra Tech NUS, Inc. / Site Inspection Report for Munitions Response Program Sites – UXOs 1 through 8, Marine Corps Recruit Depot Parris Island/ June 2011 | Tetra Tech | Data will be used to calculate environmental risks. | None, the data were validated as planned. |

## SAP Worksheet #14 -- Summary of Project Tasks

(UFP-QAPP Manual Section 2.8.1)

### 14.1 FIELD INVESTIGATION TASKS

Field tasks include the following:

- Mobilization/Demobilization
- Site-Specific Health and Safety Training
- Utility Clearance
- Anomaly Avoidance and UXO Escort Activities
- Sample Collection Tasks
- Field Instrument Calibration
- Well Borings and Lithologic Soil Sampling
- Surface and Subsurface Soil Sampling
- IS Methodology Surface Soil Sampling
- Sediment Sampling
- Temporary Well Installation and Development
- Synoptic Water Level Measurements
- Groundwater Sampling
- Temporary Well Abandonment
- Other Field Instruments and Data Collection
- Investigation-Derived Waste Management
- Global Positioning System Locating
- Land Surveying
- Equipment Decontamination
- Quality Control Tasks

Additional project-related tasks include the following:

- Analytical Tasks
- Data Management
- Assessment and Oversight
- Data Review
- Project Report

These tasks are summarized below. The Field SOPs and Field Forms referenced below and in other worksheets are included in **Appendix D**. The titles of the SOPs are identified in **Worksheet #22**.

## 14.2 FIELD TASKS

**Mobilization/Demobilization:** Mobilization/demobilization activities include the following: field equipment procurement and transport to the work site, subcontractor procurement and coordination, utility awareness and clearance, location and setup of areas for decontamination and waste storage, acquisition of vehicles, and establishment of an on-site staging area.

Equipment requirements will be finalized by the Tetra Tech FOL following the acceptance of the UFP-SAP. The Tetra Tech FOL will review the scope of work and assemble the necessary equipment (e.g., vehicles, sampling, personal protection, and decontamination equipment) to implement and complete the field investigations. The Tetra Tech FOL will be responsible for receiving and unpacking the equipment and ensuring that all equipment is operable and calibrated. The Tetra Tech FOL will also be responsible for tracking and maintaining equipment used in the field and for ensuring that it is properly decontaminated and repackaged prior to returning it to the vendor.

The Tetra Tech FOL will coordinate the sample shipment schedule with the Laboratory PM. The Tetra Tech Project Chemist will be responsible for coordinating analytical services and scheduling the delivery of sample containers to the site.

Upon completion of all site investigation activities, the Tetra Tech FOL and field crew will demobilize from the site and transport field equipment back to the Tetra Tech Pittsburgh office or third party vendor, as necessary. All sample location pin flags will be removed from the sites, work areas will be thoroughly checked, and trash will be bagged and disposed in a trash dumpster outside the field office.

**Site-Specific Health and Safety Training:** Before mobilization, the Tetra Tech FOL will review the roles and responsibilities of each field team member, as well as the specific field requirements outlined in this SAP. Teleconferences and meetings will be conducted, as necessary, to review the sampling and analytical requirements with the field crew members. Upon mobilization, the Tetra Tech FOL will ensure that all field personnel have read and understand this SAP, and that all non-health-and-safety-related equipment is available and operational. The Tetra Tech SSHO will ensure that all health-and-safety-related equipment is available and operational, and that all field crew members (including subcontractors) have read and understood the HASP associated with this SAP. Safety meetings will be conducted each morning by Tetra Tech to discuss the planned activities for the day and address the potential site hazards.

**Utility Clearance:** Prior to commencing any work at MCRD Parris Island, the Navy's Comprehensive Work Approval Process (CWAP) will be followed. The CWAP will identify constraints in the work area, such as the locations of eagle's nests, archeological sites, wetlands, etc., that may affect work at the site and other requirements that must be met prior to commencing work (such as locating underground utilities) at each of the investigative areas. Prior to the commencement of any intrusive activities, Tetra Tech will coordinate utility clearance with the MCRD Parris Island POC and with the South Carolina One Call system representative, PUPS. The Facility and Utility Companies subscribed to PUPS will identify and mark-out utilities that may be present within the proposed well installation areas. Subsurface utilities will also be cleared by the Tetra Tech geophysicist through geophysical surveys of the intended well locations.

**Anomaly Avoidance and UXO Escort Activities:** A qualified UXO Technician will be present to support the MC sampling effort and provide UXO Escort during all field activities, in accordance with procedures described in the MEC SAP and **Appendix D** of this MC SAP. UXO Technicians will have the appropriate level of training and experience as stated in DDESB TP-18. UXO anomaly avoidance procedures will be performed in accordance with **SOP HS-2.0** to avoid contact with potential MEC during intrusive activities. Surveys conducted for anomaly avoidance will be performed in accordance with **MRP SOP 01** using a Schonstedt GA-52Cx magnetic locator or White's Spectrum XLT all metals detector, or equivalent. The UXO Technician will screen each soil boring during sampling and temporary well installation, at 2-foot intervals, using an MG-220 magnetic gradiometer (down-hole magnetometer) or equivalent. Any MEC encountered will be recorded in accordance with **MRP SOP 02**. (**MRP SOP 01** and **MRP SOP 02** are presented in **Appendix E of the MEC SAP**.) This work will be conducted in accordance with the approved ESS for this project (see **Appendix A of the MEC SAP**). Should any unanticipated MEC or MPPEH be encountered during MC sampling activities, work will cease and notifications will be made, as described in **Worksheet #6**.

Downhole anomaly avoidance will be conducted by a qualified UXO Technician during the installation of temporary wells in accordance with **SOP HS-2.0** (see **Appendix D**). If surface MEC, MPPEH, metal debris, or subsurface anomalies are detected, well locations will be adjusted, as necessary, to avoid contact with the suspect item. Every effort will be made to keep the well locations within the intended vertical and horizontal boundaries of the investigation while avoiding possible contact with MEC. Any significant alterations to the proposed investigation area boundaries will be recorded and documented in an FTMR.

**Sample Collection Tasks:** Sample labeling will be performed in accordance with **SOP-01**, and the sample numbering scheme will be in accordance with **SOP-02**. Methods for recording field data will be in

accordance with **SOP-03**, and selection of sample containers, sample preservation, packaging, and shipping will be in accordance with **SOP-04**.

The sampling and analysis program is outlined in **Worksheet #18**. Sampling requirements for each type of analysis (e.g., container type, preservation method, holding time) are listed in **Worksheet #19**. Field and laboratory QC samples will also be collected, as outlined in **Worksheet #20**.

**Field Instrument Calibration:** Field instrument calibration procedures are described in **Worksheet #22**.

**Well Borings and Lithologic Soil Sampling**: Soil samples associated with temporary well locations will be obtained for lithologic purposes from the well borings using DPT dual-tube methods. The proposed well boring locations at UXO 3, UXO 4, and UXO 7 are presented on **Figure 17-1, Figure 17-2,** and **Figure 17-6,** respectively. The DPT vehicle will be a rubber-tired or track-mounted all-terrain vehicle (ATV). Soil cores will be collected continuously to the target depth at each location by advancing a macrocore sampler (4 or 5 feet long) to approximately 8 feet below the top of the first water-bearing zone encountered. The macrocore sampler will be withdrawn and the soils will be described in accordance with **SOP-05**. When lithologic soil sampling is completed, each well boring will be converted to a temporary well for the purpose of collecting samples of groundwater for chemical analyses.

**Surface and Subsurface Soil Sampling**: Surface and subsurface soil samples will be collected at non-well sampling locations using a hand auger in accordance with **SOP-06**. Soil samples will be collected at temporary well locations using DPT, in accordance with **SOP-07**. Surface soil samples are considered to be from 0 to 1 foot bgs. Subsurface soil samples are considered to be from 1 to 3 feet bgs. The soil samples will be containerized by filling the sample jars using either a decontaminated stainless steel trowel or a dedicated disposable plastic trowel – either choice is acceptable.

**Incremental Sampling (IS) Methodology Surface Soil Sampling**: One 50-point IS methodology surface soil sample will be collected from the vicinity of the revised location of Firing Point T (UXO 5), in accordance with **SOP-08.** Methodology in **SOP-08** follows guidance from USEPA SW-846 Method 8330B, Appendix A (USEPA, 2006b), and the USACE guidance document "Interim Guidance 09-02: Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program" (USACE, 2009).

IS is a sample collection and processing methodology that incorporates specific design elements to control data variability that might otherwise be introduced by heterogeneity in the contaminant distribution. The sampling objective is to obtain a single composite sample that contains target analytes in the same proportion as the overall decision unit. This type of sample increases the likelihood of incorporating small

areas with significant contamination than would be possible if only a few discrete samples were obtained. While IS can dilute the effect of small areas with high contaminant concentrations on the overall data, the intent is to mimic the average exposure to site receptors through the collection of multiple sample increments across a broad area. The primary advantage of the IS method is that it provides reasonably unbiased and reproducible estimates of the mean concentration of target analytes in a specifically defined volume of soil (i.e., a specific population) so that the data are representative of average exposure to site contaminants.

IS increments will be collected using a USACE Cold Regions Research and Environmental Laboratory (CRREL)-designed coring device (or equivalent) that provides a consistent sampling diameter and depth to reduce increment mass variability. Incremental samples will be collected at designated grid locations from 0 to 2 inches (5 centimeters) bgs. Since 1 to 2 kilograms of sample are necessary for IS samples, each of the 50 increments must weigh between 20 and 40 grams (equivalent to a core with a diameter of approximately ¾- to 1-inch, assuming a soil density of 1.5 grams per cubic centimeter and a depth interval of 5 centimeters), and each increment must be of similar mass to ensure uniformity over the entire decision unit. Increments will be combined in a 2-liter wide-mouth container or a plastic bag – either choice is acceptable. Upon receipt at the laboratory, GEL will air dry and reduce the particle size of the entire sample by sieving and grinding. The processed sample will be multi-increment sub-sampled from the entire processed sample to minimize the fundamental error associated with the original sample prior to analysis.

In accordance with the USACE guidance, replicate sampling will be used to verify that the targeted precision has been met in all facets of sampling and analysis. As a general rule, collection of triplicate IS from 10 percent of the sampling units is recommended, so the one planned IS sample will be collected along with replicate IS samples from 5 feet northeast and 5 feet southeast of each grid location to ensure that the samples are not co-located, but that they provide separate representations of the same decision unit.

**Sediment Sampling**: Sediment samples (from 0 to 6 inches bgs and from 6 to 24 inches bgs) will be collected from tidal flats at UXO 8, in accordance with **SOP-09**. Large water body sediment samples (from 0 to 6 inches bgs) will be collected from waterways at UXO 4 and UXO 6, in accordance with **SOP-10**, only if MEC are identified during the aquatic investigation. Sediment samples will be containerized by filling the sample jars using either a decontaminated stainless steel trowel or dedicated plastic trowel.

**Temporary Well Installation and Development:** Temporary wells will be installed to intercept the first water-bearing zone encountered at UXO 3, UXO 4, and UXO 7. Well locations have been selected to

provide data that can be used to determine whether contaminants are migrating from the soil to underlying groundwater. Planned well locations for the three sites are shown on **Figure 17-1, Figure 17-2,** and **Figure 17-6,** respectively. The temporary wells will be installed using DPT dual-tube drilling methods, constructed with nominal 1-inch inside diameter polyvinyl chloride (PVC) pre-packed screens, and abandoned in accordance with **SOP-11**. Well screens will be 10 feet in length, with a 0.010-inch slot size, and will be positioned so that the screened intervals intercept the top ten feet of surficial aquifer. The wells will be developed in accordance with **SOP-12**.

Temporary wells will be installed in accordance with South Carolina Well Standards (SCDHEC, 2002). This includes completion and submittal of SCDHEC Form 1903 for each location by the licensed driller within 30 days after installation procedures have been completed. The most recently available updated Form 1903s are dated July 2003.

Prescribed well locations may be adjusted in the field by +/- 50 feet in any direction, as necessary, to avoid roads, buildings, utilities, and other geophysical anomalies, and to ensure minimal impact on the existing environment. If a planned well location lies within a heavily wooded area or an area not readily accessible to the drill rig, the Tetra Tech FOL will confer with the PM to select an appropriate alternate location that will allow for the collection of meaningful data without undue disruption of ecological habitat. Similarly, if the planned well locations lie within a paved road or would otherwise interfere with base operations, the FOL will confer with the PM to make appropriate adjustments in the well location so that construction and sampling activities will not disrupt base operations. Vegetation clearing will be conducted by the UXO escort, if necessary, to facilitate removal of high grass or shrubs that present obstacles to UXO avoidance or well installation activities. Paths to the planned well locations will be selected so that the least amount of clearing is required, and no trees greater than 2 inches in diameter will be removed.

During drilling operations, UXO avoidance techniques will be followed. The UXO Escort will conduct a detector-aided survey of the area prior to access by the drilling team to ensure that no surface MEC hazards exist. The UXO Escort will also monitor the boreholes in 2-foot depth intervals using a downhole magnetometer. If any anomalies are detected, the boring will be abandoned and the well location will be offset by an appropriate distance from the anomaly to ensure the safety of the field crew.

Temporary wells will be developed in accordance with USEPA Region 4 Field Branches Quality System and Technical Procedures (FBQSTP) (USEPA, 2007), SCDHEC regulations, and **SOP-12** no sooner than 24 hours after well completion to remove fine material from the annular space around the sand pack and the screened interval of the well. If there is a conflict between these two methods, the FBQSTP must be followed. Wells will be developed by surging and bailing or pumping, as determined by the Tetra Tech

FOL based on field conditions. A well will be considered fully developed when the water is visually clear and/or the field parameters (i.e., pH, specific conductance, and temperature) have stabilized to within 10 percent fluctuation and the total water volume removed from the well is equal to three well volumes. Water quality measurements and volumes removed will be recorded for each well on a well development form. A blank copy of the form is provided in **Appendix D**.

**Synoptic Water Level Measurements:** One synoptic round of water level measurements will be conducted at the site in accordance with **SOP-13** to provide information regarding groundwater elevations and flow gradients. Water level measurements will be completed within the shortest time possible on the same day, and no sooner than 24 hours after a significant precipitation event to minimize the precipitation effects on the data sets. Groundwater level measurements will be recorded for each well prior to the collection of any groundwater samples. Water level measurements will be recorded to the nearest 0.01 foot and referenced to the top of casing on the north side of the well casing. The measuring device will be decontaminated between each temporary well prior to obtaining measurements.

**Groundwater Sampling**: Groundwater samples will be collected in accordance with the USEPA Region 4 FBQSTP (USEPA, 2007) and SCDHEC regulations. Low-flow purging will be conducted in accordance with **SOP-14**. Water quality meters will be calibrated and used following **SOP-15**. Groundwater sampling will be conducted following **SOP-16**.

Temporary wells will be purged using a low-flow peristaltic pump and dedicated polyethylene tubing. The water level and the total depth of the temporary well will be measured before the start of purging. Measurements of pH, specific conductance, turbidity, temperature, ORP, and DO will be made during purging and recorded on sample log sheets. These measurements will be made at the start of purging and every 5 to 10 minutes thereafter until the temperature, specific conductance, ORP, and DO have stabilized to within 10 percent over a minimum of three readings, pH has stabilized to within ±0.2 pH units over a minimum of three readings, and turbidity is less than 10 NTUs. In the event that stabilization cannot be achieved after 30 minutes, appropriate notation will be recorded in the field logs and the sample will be collected. All purge water removed from the wells will be containerized, handled, and disposed of as IDW.

Groundwater samples will be collected immediately following purging using low-flow sampling procedures. Samples will be transferred directly from the peristaltic pump tubing to the sample containers.

**Temporary Well Abandonment**: Temporary wells will be abandoned in accordance with **SOP-11** and the South Carolina Well Standards (SCDHEC, 2002) within 5 days of installation. If there is a conflict

between these two methods, the South Carolina Well Standards procedure must be followed. An attempt to remove the well casing and screening materials will be made, and the remaining borehole will be grouted with cement-bentonite grout to the surface using a tremie pipe. Surface conditions will be restored to match the grade and surrounding area. If the well casing and screen cannot be removed, then the riser will be cut at least one foot below the surface, and the well will be grouted in place using a cement-bentonite mixture emplaced with a tremie pipe.

**Other Field Instruments and Data Collection:** Field measurements of pH, specific conductance, turbidity, temperature, ORP, and DO will be collected for groundwater, and static water levels in the temporary wells will be recorded. Other field measurements that may be recorded during MC sampling operations, if deemed necessary for health and safety purposes, include airborne contaminant concentrations in the well casings, breathing zones, and/or work areas.

The following instruments are expected to be used for field data collection:

- YSI Model 600 (or equivalent) water quality meter
- Electronic water-level meter
- Lamotte Model 2020 (or equivalent) turbidity meter

Field instruments will be calibrated according to the manufacturers' procedures and in accordance with the following:

- YSI or Horiba® multi-parameter water quality meters are commonly used in place of separate temperature, conductivity, pH, ORP, and DO meters. This device can record up to six separate parameters and is calibrated automatically before each day's use.

- Lamotte turbidity meters are used to give more accurate measurements of turbidity than a multi-parameter water quality meter. This device will be calibrated before each day's use.

All instrument calibration will be recorded on an equipment calibration log sheet, which will be included in the RI Report. During calibration, a maintenance check will be performed on each piece of equipment. If damaged or defective parts are identified during the maintenance check and it is determined that the damage could have an impact on the instrument's performance, the instrument will be removed from service until the defective parts can be repaired or the instrument replaced.

**IDW Management:** Solid and liquid wastes generated as a result of this investigation will be handled in accordance with the procedures described in Section 2.11 of the Master Work Plan (Brown and Root

Environmental, 1998) and **SOP-17**. IDW generated during drilling, purging, development, and decontamination activities will be containerized in Department of Transportation (DOT)-approved (DOT specification 17C) 55-gallon drums. IDW will be stored in a centralized location designated by the MCRD Parris Island POC. Soil cuttings will be placed in drums, subject to analytical testing, and disposed appropriately. Decontamination water will be collected in drums, subject to analytical testing, and based on test results, either discharged to the sanitary sewer or transported off-site for disposal. Personal protective equipment (PPE) such as gloves, wipes, discarded paper towels, etc., will be properly discarded on base in a solid waste dumpster. IDW disposal manifests and end-user certifications for Material Documented as Safe (MDAS) will be appended to the RI Report.

**Global Positioning System Locating:** A hand-held GPS unit capable of sub-meter accuracy (i.e., Trimble GeoXM or Trimble GeoHX) will be used to locate all sampling points identified in the MC SAP according to **SOP-18**. The GPS coordinate system will be set up so that horizontal coordinates are collected and documented in the field using the North American Datum of 1983 (NAD83) South Carolina State Plane Coordinate System (SPCS) in United States U.S. survey feet for easting and northing. Vertical coordinates will be documented by land surveying (see below) using the North American Vertical Datum of 1988 (NAVD88) to map the ground surface and groundwater elevations to the accuracy required to properly determine groundwater flow direction.

The GPS survey will utilize third order monument data, if available. Select monuments or markers (such as surveyed permanent monitoring wells) will be visited at the start and end of each day. The GPS data will be used to accurately record the positions of soil, sediment, and groundwater sampling locations. Tetra Tech will load site boundaries, known cultural or terrain features that may affect surveys, and background maps into the GPS prior to deployment. GPS data collected during the investigation will be stored in the GPS unit and downloaded to a computer daily or as soon as possible after acquisition. Data will also be manually entered into a field log as it is collected. Once downloaded from the GPS unit, the data will then be uploaded to the MRP Data Repository website located at http://www.ttnus.com/MrpRepository/Login.aspx for processing by Tetra Tech geographic information system (GIS) personnel. Certain spatial data acquired during the RI fieldwork will be uploaded to GeoFidelis, as well, to ensure that significant site features are appropriately documented in the MCRD Parris Island spatial data base files.

If GPS accuracy is not sub-meter, data will not be collected until more satellites become available and the accuracy criteria specified in **SOP-18** are met. In locations where the overhead canopy interferes with satellite lines-of-sight and GPS accuracy cannot be reasonably established, an alternative positioning technique will be employed (e.g., compass and tape measure, fiducials, or total station) to ensure that anomaly locations can be reacquired at a later date, if necessary.

**Land Surveying:** After the temporary wells are installed, well locations will be surveyed by Tetra Tech personnel or by a professional surveyor licensed in the State of South Carolina. Existing survey monuments at MCRD Parris Island will be used as reference points. The surveyor will provide horizontal coordinates of all points X, Y, to the nearest 0.05 foot, and vertical coordinates of all points Z, to the nearest 0.01 foot. Coordinates will be provided in the South Carolina SPCS. NAD83 will be used as the horizontal datum. The vertical datum will be the NAVD88. Elevations for the temporary wells will be determined at the measuring point, where the uncapped PVC well riser pipe is notched, and at the top of ground surface. All coordinate systems will be pre-approved prior to commencement of the survey. All measurements will be reported and recorded in U.S. Survey Feet. Tetra Tech will use the survey data, along with groundwater measurements discussed above to determine the direction of groundwater flow. A potentiometric surface map will be included in the RI Report.

**Equipment Decontamination**: Non-dedicated equipment used in field sampling activities will be decontaminated in accordance with **SOP-19** prior to beginning work, between locations, during drilling and sampling activities, and at the completion of the project in a laydown area designated by the MCRD Parris Island POC.

***Major Equipment:*** All downhole drilling equipment, including downhole drilling tools, will be cleaned with potable water prior to beginning work, between boreholes, whenever the drill rig leaves the site prior to completing a boring, and at the conclusion of the drilling program.

Decontamination operations consist of washing equipment using a high-pressure wash from a potable water supply. All decontamination activities will be take place at a predetermined area within MCRD Parris Island. Additional requirements are found in **SOP-19**.

***Sampling Equipment:*** Non-disposable sampling equipment will be decontaminated prior to beginning field sampling, between samples, and at the conclusion of the sampling program. Sampling equipment will be washed with potable water and Alconox (or equivalent), rinsed with potable water, and then rinsed with deionized water. Disposable sampling equipment used for sampling activities shall be discarded as IDW. Field analytical equipment such as pH, conductivity, and temperature instrument probes will be rinsed with deionized water and Alconox.

**Quality Control Tasks:** Equipment rinsate blanks, field duplicates, field triplicates, matrix spikes (MS), and matrix spike duplicates (MSD) will be collected as presented in **Worksheet #20**. Initial and continuing calibrations, tuning, reagent blanks, surrogates, duplicates, laboratory control samples (LCS), laboratory control sample duplicates (LCSD), and all other applicable QC for all analytical methods are

presented in **Worksheets #12, 24, 25, and 28**. **Worksheets #24 and 28** describe analytical QC procedures, **Worksheet #25** addresses inspection and maintenance, and **Worksheet #12** describes field QC samples.

### 14.3 ADDITIONAL PROJECT-RELATED TASKS

**Analytical Tasks:** Chemical analyses for explosives, metals, pH, and TOC will be performed by GEL. GEL is DoD Environmental Laboratory Approval Program (ELAP) accredited for the target analytes and analytical groups that will be reported by them. GEL is also a SCDHEC-approved laboratory. GEL will also perform the laboratory air drying, sieving, particle size reduction by grinding, and multi-incremental sub-sampling preparation steps of IS samples for explosives in accordance with SW-846 Method 8330B Appendix A. Copies of laboratory certifications are included in **Appendix E**. Analyses will be performed in accordance with the analytical methods identified in **Worksheet #30**. GEL will meet the PALs specified in **Worksheet #15** and will perform the chemical analyses following laboratory-specific SOPs (**Worksheets #19 and 23**) that were developed based on the methods listed in **Worksheets #19 and 30**.

The GEL QAMs will ensure that all laboratory SOPs are followed and will verify that all method QC samples are analyzed and in control, as listed in the analytical SOPs. If method QA is not in control, the GEL QAM, as appropriate, will contact the Tetra Tech PM for guidance prior to report preparation. 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 the associated electronic data deliverable (EDD) files. This information will also be included in the project database that will eventually be uploaded to the Naval Installation Restoration Information Solution (NIRIS) database. Percent moisture information will also be captured in the RI Report.

The analytical data packages provided by GEL 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 information [results, percent recoveries (%Rs), RPDs, RSDs, and/or percent differences or percent drifts (%Ds), etc.].

**Data Generation Procedures:** Project documentation and records include the following:

- Field sample collection and field measurement records are described in **Worksheets #27 and 29**.
- Data assessment documents and records are listed in **Worksheet #29**.
- Data recording formats are described in **Worksheet #27**.

**Data Handling and Management:** Data management tasks, including data handling, tracking, storage, archiving, retrieval, and security processes, are addressed in **Worksheet #29**.

**Assessment and Oversight:** Refer to **Worksheet #32** for assessment findings and corrective actions and to **Worksheet #33** for QA management reports.

**Data Review:** Data verification is described in **Worksheet #34**; data validation is described in **Worksheets #35** and **36**; and usability assessment is described in **Worksheet #37**.

**Project Report:** A Draft RI Report will be prepared and submitted to the Navy and regulators (i.e., the Partnering Team) for review. The report will include a summary of the work performed in accordance with the approved SAP, field modifications as documented by the Tetra Tech FOL, summary and analysis of analytical results, updated CSMs, HHRAs and ERAs, as necessary, based on the risk screening evaluations, decision rules, conclusions, and recommendations for each UXO Site.

Tetra Tech will respond to comments received on the Draft RI Report. The final version of the RI Report will be submitted in hardcopy and electronic format to the Partnering Team and the AR.

## SAP Worksheet #15 -- Reference Limits and Evaluation Table

(UFP-QAPP Manual Section 2.8.1)

**Matrix:** Soil
**Analytical Group:** Explosives (SW-846 Method 8330B)

| Analyte | CAS Number | PALs (mg/kg) | | PAL References[(1)] | PQLG (mg/kg) | GEL | | |
|---|---|---|---|---|---|---|---|---|
| | | HHRA | ERA | HHRA / ERA | | LOQ (mg/kg) | LOD (mg/kg) | DL (mg/kg) |
| **1,3,5-Trinitrobenzene** | **99-35-4** | 1.7 | **0.376** | RBSSL / **NOAA** | **0.13** | **0.5** | **0.3** | **0.15** |
| **1,3-Dinitrobenzene** | **99-65-0** | **0.0033** | NC | **RBSSL** / None | **0.00047** | **0.5** | **0.3** | **0.15** |
| **2,4,6-Trinitrotoluene (TNT)** | **118-96-7** | **0.013** | 6 | **RBSSL** / Sunahara | **0.0043** | **0.5** | **0.3** | **0.15** |
| **2,4-Dinitrotoluene** | **121-14-2** | **0.00028** | 1.28 | **RBSSL** / NOAA | **0.000093** | **0.5** | **0.3** | **0.15** |
| **2,6-Dinitrotoluene** | **606-20-2** | **0.020** | 600 | **RBSSL** / Sunahara | **0.0067** | **0.5** | **0.3** | **0.15** |
| Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) | 2691-41-0 | 0.99 | NC | RBSSL / None | 0.33 | 0.5 | 0.3 | 0.15 |
| **3-Nitrotoluene** | **99-08-1** | **0.0012** | NC | **RBSSL** / None | **0.00040** | **0.5** | **0.3** | **0.15** |
| **2-Nitrotoluene** | **88-72-2** | **0.00025** | NC | **RBSSL** / None | **0.000083** | **0.5** | **0.3** | **0.15** |
| **4-Nitrotoluene** | **99-99-0** | **0.0034** | NC | **RBSSL** / None | **0.0011** | **0.5** | **0.3** | **0.15** |
| **4-Amino-2,6-Dinitrotoluene** | **19406-51-0** | **0.023** | NC | **RBSSL** / None | **0.0077** | **0.5** | **0.3** | **0.15** |
| **2-Amino-4,6-Dinitrotoluene** | **35572-78-2** | **0.023** | 80 | **RBSSL** / LANL | **0.0077** | **0.5** | **0.3** | **0.15** |
| Methyl-2,4,6-trinitrophenylnitramine (Tetryl) | 479-45-8 | 0.59 | 25 | R-RSL / LANL | 0.20 | 0.5 | 0.3 | 0.15 |
| **Nitrobenzene** | **98-95-3** | **0.000079** | 40 | **RBSSL /** R4 ESV | **0.000027** | **0.5** | **0.3** | **0.15** |
| **Octahydro-1,3,5,7-tetranitro-1,3,5-triazine (RDX)** | **121-82-4** | **0.00023** | 98 | **RBSSL** / Sunahara | **0.000077** | **0.5** | **0.3** | **0.15** |

CAS – Chemical Abstracts Service
mg/kg – Milligrams per kilogram (dry weight)
NC – No Screening Criterion
PQLG – Project Quantitation Limit Goal
LOD – Limit of Detection

(1) The PAL references for surface and subsurface soil are: R-RSL – Regions 3, 6, and 9 Regional Screening Level, Direct Contact Residential, adjusted to 1/10 of value for noncarcinogens (USEPA, 2012); RBSSL – Regions 3, 6, and 9 Soil Screening Level, Risk-Based Migration-to-Groundwater, Dilution Attenuation Factor (DAF) = 1 (USEPA, 2012); R4 ESV – USEPA Region 4 Ecological Screening Value (USEPA, 2001); NOAA – National Oceanic and Atmospheric

Administration Soil Screening Quick Reference Tables (SQuiRTs) (NOAA, 2008); Sunahara – Ecotoxicity of Explosives (Sunahara et al., 2009); LANL – Los Alamos National Laboratory ECORISK Database (Release 2.4) (LANL, 2009). Refer to **Appendix F** for further explanation and justification of PALs.

**Bold rows indicate that one or both PALs are between the laboratory LOQ and the DL**. **Bold and shaded rows indicate that one or both PALs are less than the DL.** All results will be reported to detection limits and any limitations on data use that result from having DLs greater than PALs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PALs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained.

**Matrix:** Soil
**Analytical Group:** Metals (SW-846 Methods 6010B/6020A* and 7471A)

| Analyte | CAS Number | PALs (mg/kg) | | PAL References[(1)] | PQLG (mg/kg) | GEL | | |
|---|---|---|---|---|---|---|---|---|
| | | HHRA | ERA | HHRA / ERA | | LOQ (mg/kg) | LOD (mg/kg) | DL (mg/kg) |
| Aluminum | 7429-90-5 | 7,700 | 50 | R-RSL / R4 ESV | 17 | 20 | 13.6 | 6.8 |
| **Antimony** | **7440-36-0** | **0.27** | **0.27** | **RBSSL / Eco SSL** | **0.090** | **1.0** | **0.66** | **0.33** |
| **Arsenic *** | **7440-38-2** | **0.0013** | 18 | **RBSSL** / Eco SSL | **0.00043** | **0.50** | **0.2** | **0.1** |
| Barium | 7440-39-3 | 120 | 330 | RBSSL / Eco SSL | 40 | 0.5 | 0.2 | 0.1 |
| Beryllium | 7440-41-7 | 13 | 21 | RBSSL / Eco SSL | 4.3 | 0.5 | 0.2 | 0.1 |
| Cadmium * | 7440-43-9 | 0.52 | 0.36 | RBSSL / Eco SSL | 0.12 | 0.1 | 0.02 | 0.01 |
| Calcium | 7440-70-2 | NC | NC | None / None | NC | 25 | 16 | 8 |
| **Chromium *** | **7440-47-3** | **0.00059** | 26 | **RBSSL** / Eco SSL | **0.00020** | **0.3** | **0.2** | **0.1** |
| Cobalt * | 7440-48-4 | 0.21 | 13 | RBSSL / Eco SSL | 0.070 | 0.1 | 0.06 | 0.03 |
| Copper | 7440-50-8 | 22 | 28 | RBSSL / Eco SSL | 7.3 | 1.0 | 0.6 | 0.3 |
| Iron | 7439-89-6 | 270 | 200 | RBSSL / R4 ESV | 67 | 25 | 16 | 8 |
| Lead | 7439-92-1 | 14 | 11 | RBSSL / Eco SSL | 3.7 | 1.0 | 0.66 | 0.33 |
| Magnesium | 7439-95-4 | NC | NC | None / None | NC | 30 | 17 | 8.5 |
| Manganese | 7439-97-6 | 21 | 220 | RBSSL / Eco SSL | 7.0 | 1.0 | 0.4 | 0.2 |
| Mercury | 7439-97-6 | 0.033 | 0.1 | RBSSL / R4 ESV | 0.011 | 0.01 | 0.0044 | 0.0022 |
| Nickel | 7440-02-0 | 20 | 38 | RBSSL / Eco SSL | 6.7 | 0.5 | 0.3 | 0.15 |
| Potassium | 7440-09-7 | NC | NC | None / None | NC | 25 | 12.8 | 6.4 |
| **Selenium *** | **7782-49-2** | **0.40** | 0.52 | **RBSSL** / Eco SSL | **0.13** | **0.5** | **0.33** | **0.165** |
| Silver | 7440-22-4 | 0.60 | 4.2 | RBSSL / Eco SSL | 0.20 | 0.5 | 0.2 | 0.1 |
| Sodium | 7440-23-5 | NC | NC | None / None | NC | 25 | 14 | 7 |
| **Thallium *** | **7791-12-0** | **0.011** | 1 | **RBSSL** / R4 ESV | **0.0037** | **0.2** | **0.06** | **0.03** |
| Vanadium | 7440-62-2 | 39 | 7.8 | R-RSL / Eco SSL | 2.6 | 0.5 | 0.2 | 0.1 |
| Zinc | 7440-66-6 | 290 | 46 | RBSSL / Eco SSL | 15 | 1.0 | 0.8 | 0.4 |

(1) The PAL references for surface and subsurface soil are: R-RSL – Regions 3, 6, and 9 Regional Screening Level, Direct Contact Residential, adjusted to 1/10 of value for noncarcinogens (USEPA, 2012); RBSSL – Regions 3, 6, and 9 Soil Screening Level, Risk-Based Migration-to-Groundwater, DAF = 1 (USEPA, 2012); Eco SSL – USEPA Ecological Soil Screening Level (USEPA, 2008); R4 ESV – USEPA Region 4 Ecological Screening Value (USEPA, 2001). Refer to **Appendix F** for further explanation and justification of PALs.

**Bold rows indicate that one or both PALs are between the laboratory LOQ and the DL**. **Bold and shaded rows indicate that one or both PALs are less than the DL.** All results will be reported to detection limits and any limitations on data use that result from having DLs greater than PALs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PALs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained.

**Matrix:** Sediment
**Analytical Group:** Explosives (SW-846 Method 8330B)

| Analyte | CAS Number | PALs (mg/kg) | | PAL References[(1)] | PQLG (mg/kg) | GEL | | |
|---|---|---|---|---|---|---|---|---|
| | | HHRA | ERA | HHRA / ERA | | LOQ (mg/kg) | LOD (mg/kg) | DL (mg/kg) |
| 1,3,5-Trinitrobenzene | 99-35-4 | 220 | 8 | R-RSL / NOEC | 2.7 | 0.5 | 0.3 | 0.15 |
| 1,3-Dinitrobenzene | 99-65-0 | 0.61 | NC | R-RSL / None | 0.20 | 0.5 | 0.3 | 0.15 |
| **2,4,6-TNT** | **118-96-7** | 3.6 | **0.092** | R-RSL / **R3 BTAG SED** | **0.031** | **0.5** | **0.3** | **0.15** |
| **2,4-Dinitrotoluene** | **121-14-2** | 1.6 | **0.0416** | R-RSL **/ R3 BTAG SED** | **0.013** | **0.5** | **0.3** | **0.15** |
| **2,6-Dinitrotoluene** | **606-20-2** | 6.1 | **0.0416** | R-RSL **/ R3 BTAG SED** | **0.013** | **0.5** | **0.3** | **0.15** |
| HMX | 2691-41-0 | 38 | 126 | R-RSL / NOEC | 42 | 0.5 | 0.3 | 0.15 |
| 3-Nitrotoluene | 99-08-1 | 0.61 | 4.06 | R-RSL / R3 BTAG SED | 0.20 | 0.5 | 0.3 | 0.15 |
| 2-Nitrotoluene | 88-72-2 | 2.9 | 4.06 | R-RSL / R3 BTAG SED | 0.97 | 0.5 | 0.3 | 0.15 |
| 4-Nitrotoluene | 99-99-0 | 24 | 4.06 | R-RSL / R3 BTAG SED | 1.3 | 0.5 | 0.3 | 0.15 |
| 4-Amino-2,6-Dinitrotoluene | 19406-51-0 | 15 | 150 | R-RSL / R3 BTAG SED | 5.0 | 0.5 | 0.3 | 0.15 |
| 2-Amino-4,6-Dinitrotoluene | 35572-78-2 | 15 | 150 | R-RSL / R3 BTAG SED | 5.0 | 0.5 | 0.3 | 0.15 |
| Tetryl | 479-45-8 | 24 | 240 | R-RSL / R3 BTAG SED | 8.0 | 0.5 | 0.3 | 0.15 |
| **Nitrobenzene** | **98-95-3** | 4.8 | **0.021** | R-RSL **/ NOAA AET** | **0.0070** | **0.5** | **0.3** | **0.15** |
| **RDX** | **121-82-4** | 5.6 | **0.013** | R-RSL **/ R3 BTAG SED** | **0.0043** | **0.5** | **0.3** | **0.15** |

(1) The PAL references for sediment are: R-RSL – Regions 3, 6, and 9 Regional Screening Level, Direct Contact Residential, adjusted to 1/10 of value for noncarcinogens (USEPA, 2012); NOEC – No Observable Effects Concentration (Sunahara, et al., 2009); R3 BTAG SED – Region 3 Biological Technical Assistance Group Freshwater Sediment Screening Benchmarks (USEPA, 2006c); NOAA AET – National Oceanic and Atmospheric Administration Marine Apparent Effects Threshold (NOAA, 2008). Refer to **Appendix F** for further explanation and justification of PALs.

**Bold rows indicate that one or both PALs are between the laboratory LOQ and the DL**. **Bold and shaded rows indicate that one or both PALs are less than the DL.** All results will be reported to detection limits and any limitations on data use that result from having DLs greater than PALs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PALs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained.

**Matrix:** Sediment
**Analytical Group:** Metals (SW-846 Methods 6010B/6020A* and 7471A)

| Analyte | CAS Number | PALs (mg/kg) | | PAL References[(1)] | PQLG (mg/kg) | GEL | | |
|---|---|---|---|---|---|---|---|---|
| | | HHRA | ERA | HHRA / ERA | | LOQ (mg/kg) | LOD (mg/kg) | DL (mg/kg) |
| Aluminum | 7429-90-5 | 7,700 | 18,000 | R-RSL / NOAA AET | 2,600 | 20 | 13.6 | 6.8 |
| Antimony | 7440-36-0 | 3.1 | 2 | R-RSL / R4 Eco SDSL | 0.67 | 1.0 | 0.66 | 0.33 |
| **Arsenic *** | **7440-38-2** | **0.39** | 7.24 | **R-RSL /** R4 Eco SDSL | **0.13** | **0.50** | **0.2** | **0.1** |
| Barium | 7440-39-3 | 1,500 | 48 | R-RSL / NOAA AET | 16 | 0.5 | 0.2 | 0.1 |
| Beryllium | 7440-41-7 | 16 | NC | R-RSL / None | 5.3 | 0.5 | 0.2 | 0.1 |
| Cadmium * | 7440-43-9 | 7.0 | 0.676 | R-RSL / R4 Eco SDSL | 0.23 | 0.1 | 0.02 | 0.01 |
| Calcium | 7440-70-2 | NC | NC | None / None | NC | 25 | 16 | 8 |
| **Chromium *** | **7440-47-3** | **0.29** | 52.3 | **R-RSL** / R4 Eco SDSL | 0.097 | **0.3** | **0.2** | **0.1** |
| Cobalt * | 7440-48-4 | 2.3 | 50 | R-RSL / R3 BTAG SED | 0.77 | 0.1 | 0.06 | 0.03 |
| Copper | 7440-50-8 | 310 | 18.7 | R-RSL / R4 Eco SDSL | 6.2 | 1.0 | 0.6 | 0.3 |
| Iron | 7439-89-6 | 5,500 | 20,000 | R-RSL / R3 BTAG SED | 1,800 | 25 | 16 | 8 |
| Lead | 7439-92-1 | 400 | 30.2 | R-RSL / R4 Eco SDSL | 10 | 1.0 | 0.66 | 0.33 |
| Magnesium | 7439-95-4 | NC | NC | None / None | NC | 30 | 17 | 8.5 |
| Manganese | 7439-97-6 | 180 | 460 | R-RSL / R3 BTAG SED | 60 | 1.0 | 0.4 | 0.2 |
| Mercury | 7439-97-6 | 2.3 | 0.13 | R-RSL / R4 Eco SDSL | 0.044 | 0.01 | 0.0044 | 0.0022 |
| Nickel | 7440-02-0 | 150 | 15.9 | R-RSL / R4 Eco SDSL | 5.3 | 0.5 | 0.3 | 0.15 |
| Potassium | 7440-09-7 | NC | NC | None / None | NC | 25 | 12.8 | 6.4 |
| Selenium * | 7782-49-2 | 39 | 2 | R-RSL / R3 BTAG SED | 0.67 | 0.5 | 0.33 | 0.165 |
| Silver | 7440-22-4 | 39 | 0.733 | R-RSL / R4 Eco SDSL | 0.24 | 0.5 | 0.2 | 0.1 |
| Sodium | 7440-23-5 | NC | NC | None / None | NC | 25 | 14 | 7 |
| **Thallium *** | **7791-12-0** | **0.078** | NC | **R-RSL** / None | **0.026** | **0.2** | **0.06** | **0.03** |
| Vanadium | 7440-62-2 | 39 | 57 | R-RSL / NOAA AET | 13 | 0.5 | 0.2 | 0.1 |
| Zinc | 7440-66-6 | 2,300 | 124 | R-RSL / R4 Eco SDSL | 41 | 1.0 | 0.8 | 0.4 |

(1) The PAL references for sediment are: R-RSL – Regions 3, 6, and 9 Regional Screening Level, Direct Contact Residential, adjusted to 1/10 of value for noncarcinogens (USEPA, 2012); NOAA AET – National Oceanic and Atmospheric Administration Marine Apparent Effects Threshold (NOAA, 2008); R4 Eco SDSL – Region 4 Ecological Sediment Screening Level (USEPA, 2001); R3 BTAG SED – Region 3 Biological Technical Assistance Group Freshwater Sediment Screening Benchmarks (USEPA, 2006c). Refer to **Appendix F** for further explanation and justification of PALs.

**Bold rows indicate that one or both PALs are between the laboratory LOQ and the DL**. **Bold and shaded rows indicate that one or both PALs are less than the DL.** All results will be reported to detection limits and any limitations on data use that result from having DLs greater than PALs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PALs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained.

**Matrix:** Groundwater
**Analytical Group:** Explosives (SW-846 Method 8330B)

| Analyte | CAS Number | PALs (µg/L) | PAL References[(1)] | PQLG (µg/L) | GEL | | |
|---|---|---|---|---|---|---|---|
| | | HHRA | HHRA | | LOQ (µg/L) | LOD (µg/L) | DL (µg/L) |
| 1,3,5-Trinitrobenzene | 99-35-4 | 46 | T-RSL | 15 | 0.325 | 0.208 | 0.104 |
| **1,3-Dinitrobenzene** | **99-65-0** | **0.15** | **T-RSL** | **0.050** | **0.325** | **0.208** | **0.104** |
| 2,4,6-TNT | 118-96-7 | 0.76 | T-RSL | 0.60 | 0.325 | 0.208 | 0.104 |
| **2,4-Dinitrotoluene** | **121-14-2** | **0.20** | **T-RSL** | **0.067** | **0.325** | **0.208** | **0.104** |
| 2,6-Dinitrotoluene | 606-20-2 | 1.5 | T-RSL | 0.50 | 0.325 | 0.208 | 0.104 |
| HMX | 2691-41-0 | 78 | T-RSL | 26 | 0.325 | 0.208 | 0.104 |
| **3-Nitrotoluene** | **99-08-1** | **0.13** | **T-RSL** | **0.043** | **0.325** | **0.208** | **0.104** |
| **2-Nitrotoluene** | **88-72-2** | **0.27** | **T-RSL** | **0.090** | **0.325** | **0.213** | **0.1066** |
| 4-Nitrotoluene | 99-99-0 | 3.7 | T-RSL | 1.2 | 0.65 | 0.39 | 0.195 |
| 4-Amino-2,6-Dinitrotoluene | 19406-51-0 | 3.0 | T-RSL | 1.0 | 0.325 | 0.208 | 0.104 |
| 2-Amino-4,6-Dinitrotoluene | 35572-78-2 | 3.0 | T-RSL | 1.0 | 0.325 | 0.208 | 0.104 |
| Tetryl | 479-45-8 | 6.3 | T-RSL | 2.1 | 0.65 | 0.208 | 0.104 |
| **Nitrobenzene** | **98-95-3** | **0.12** | **T-RSL** | **0.040** | **0.325** | **0.208** | **0.104** |
| RDX | 121-82-4 | 0.61 | T-RSL | 0.20 | 0.325 | 0.208 | 0.104 |

µg/L – Micrograms per liter

(1) The PAL references for groundwater are: T-RSL – Regions 3, 6, and 9 Regional Screening Level for Tapwater, adjusted to 1/10 of value for noncarcinogens (USEPA, 2012). Refer to **Appendix F** for further explanation and justification of PALs.

**Bold rows indicate that one or both PALs are between the laboratory LOQ and the DL**. **Bold and shaded rows indicate that one or both PALs are less than the DL.** All results will be reported to detection limits and any limitations on data use that result from having DLs greater than PALs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PALs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained.

**Matrix:** Groundwater
**Analytical Group:** Metals (SW-846 Methods 6010B/6020A* and 7470A)

| Analyte | CAS Number | PALs (µg/L) | PAL References[(1)] | PQLG (µg/L) | GEL | | |
|---|---|---|---|---|---|---|---|
| | | HHRA | HHRA | | LOQ (µg/L) | LOD (µg/L) | DL (µg/L) |
| Aluminum | 7429-90-5 | 1,600 | T-RSL | 530 | 200 | 136 | 68 |
| Antimony * | 7440-36-0 | 6 | MCL | 2.0 | 3.0 | 2.0 | 1.0 |
| Arsenic * | 7440-38-2 | 10 | MCL | 3.3 | 5.0 | 3.4 | 1.7 |
| Barium | 7440-39-3 | 2,000 | MCL | 670 | 5.0 | 2.0 | 1.0 |
| Beryllium * | 7440-41-7 | 4 | MCL | 1.3 | 0.5 | 0.4 | 0.2 |
| Cadmium * | 7440-43-9 | 5 | MCL | 1.7 | 1.0 | 0.22 | 0.11 |
| Calcium | 7440-7-2 | NC | None | NC | 200 | 100 | 50 |
| Chromium | 7440-47-3 | 100 | MCL | 33 | 5.0 | 2.0 | 1.0 |
| **Cobalt *** | **7440-48-4** | **0.47** | **T-RSL** | **0.16** | **1.0** | **0.2** | **0.1** |
| Copper * | 7440-50-8 | 1,300 | MCL | 430 | 1.0 | 0.7 | 0.35 |
| Iron | 7439-89-6 | 1,100 | T-RSL | 370 | 100 | 60 | 30 |
| Lead * | 7439-92-1 | 15 | T-RSL | 5.0 | 2.0 | 1.0 | 0.5 |
| Magnesium | 7439-95-4 | NC | None | NC | 300 | 220 | 110 |
| Manganese | 7439-97-6 | 32 | T-RSL | 11 | 10.0 | 4.0 | 2.0 |
| Mercury | 7439-97-6 | 2 | MCL | 0.67 | 0.20 | 0.132 | 0.066 |
| Nickel | 7440-02-0 | 30 | T-RSL | 10 | 5.0 | 3.0 | 1.5 |
| Potassium | 7440-09-7 | NC | None | NC | 150 | 100 | 50 |
| Selenium * | 7782-49-2 | 50 | MCL | 17 | 5.0 | 3.0 | 1.5 |
| Silver * | 7440-22-4 | 7.1 | T-RSL | 2.4 | 1.0 | 0.4 | 0.2 |
| Sodium | 7440-23-5 | NC | None | NC | 300 | 200 | 100 |
| Thallium | 7791-12-0 | 2 | MCL | 0.67 | 2.0 | 0.9 | 0.45 |
| Vanadium | 7440-62-2 | 7.8 | T-RSL | 2.6 | 5.0 | 2.0 | 1.0 |
| Zinc | 7440-66-6 | 470 | T-RSL | 160 | 10 | 6.6 | 3.3 |

(1) The PAL references for groundwater are: T-RSL – Regions 3, 6, and 9 Regional Screening Level for Tapwater, adjusted to 1/10 of value for noncarcinogens (USEPA, 2012); MCL – USEPA Maximum Contaminant Level (USEPA, 2011). Refer to **Appendix F** for further explanation and justification of PALs.

**Bold rows indicate that one or both PALs are between the laboratory LOQ and the DL**. **Bold and shaded rows indicate that one or both PALs are less than the DL.** All results will be reported to detection limits and any limitations on data use that result from having DLs greater than PALs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PALs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained.

## SAP Worksheet #16 -- Project Schedule / Timeline Table

(UFP-QAPP Manual Section 2.8.2)

| Activity | Organization | Anticipated Delivery Date |
|---|---|---|
| ***Submit Internal Draft RI SAP*** | Tetra Tech | 08/24/11 |
| Navy Review Complete | Navy | 09/23/11 |
| ***Submit Draft RI SAP*** | Tetra Tech | 09/30/11 |
| Regulator Review Complete | USEPA and SCDHEC | 12/07/12 |
| ***Submit Final RI SAP*** | Tetra Tech | 01/30/12 |
| ***Submit Draft ESS*** | Tetra Tech | 10/21/11 |
| Navy Review Complete | Navy | 01/30/12 |
| ***Submit Final ESS*** | Tetra Tech | 02/10/12 |
| **Mobilization and Field Investigation** | Tetra Tech | 05/01/12 |
| **Complete Field Investigation and Demobilization** | Tetra Tech | 10/03/12 |
| **Data Review and Validation** | Tetra Tech | 11/23/12 |
| **Risk Assessment Scoping Session** | Partnering Team and NRTs | 12/14/12 |
| ***Submit Internal Draft RI Report*** | Tetra Tech | 01/31/13 |
| Navy Review | Navy | 03/01/13 |
| ***Submit Draft RI Report*** | Tetra Tech | 03/22/13 |
| Regulator Review | USEPA and SCDHEC | 05/08/13 |
| ***Submit Final RI Report*** | Tetra Tech | 06/20/13 |
| ***Submit Internal Draft FS Report*** | Tetra Tech | 08/15/13 |
| Navy Review | Navy | 09/13/13 |
| ***Submit Draft FS Report*** | Tetra Tech | 10/04/13 |
| Regulator Review | USEPA and SCDHEC | 11/18/13 |
| ***Submit Final FS Report*** | Tetra Tech | 12/31/13 |

## SAP Worksheet #17 -- Sample Design and Rationale

(UFP-QAPP Manual Section 3.1.1)

This section describes sampling locations, methods, and rationales for the sampling activities to be conducted in support of the field investigations at the six MRP sites proposed for MC sampling at MCRD Parris Island. All referenced field SOPs are presented in **Appendix D**.

Discrete surface and subsurface soil samples will be collected using a stainless-steel hand auger, in accordance with **SOP-06,** except for the subsurface soil samples that will be collected at temporary well locations utilizing DPT, which will be collected in accordance with **SOP-07**. Surface soil samples will be collected at depths of 0 to 1 foot bgs, and subsurface soil samples will be collected at depths of 1 to 3 feet bgs or the 1-foot interval directly beneath a previously identified MEC or MPPEH item, if applicable. IS samples will be collected in accordance with **SOP-08** as a 50-point composite from Firing Point T and as discretionary 49-point composites from investigation grids in UXO 4 and 6. Discrete sediment samples will be collected from upland areas at depths of 0 to 6 inches bgs, and from tidal flat areas at depths of 0 to 6 inches bgs and 6 to 24 inches bgs, in accordance with **SOP-09**, using stainless-steel or disposable trowels in areas accessible by foot. Discrete waterway sediment samples will be collected from underwater locations at depths of 0 to 6 inches bgs, in accordance with **SOP-10**, using petite Ponar samplers. Groundwater samples will be collected in accordance with **SOP-16** following the installation and development of temporary wells. Temporary wells will be installed and abandoned in accordance with **SOP-11**.

The sampling objective for this MC RI is to collect sufficient data at each site to determine whether historical site operations have resulted in chemical contamination that poses an unacceptable risk to human and/or ecological receptors. To accomplish this, a biased sampling design with default systematically selected locations will be implemented at each site. The bias will be toward locations and areas where MEC, MPPEH, or other evidence of contamination is observed, based on current knowledge of the sites and the MEC surveys that will be conducted separately under Part 1 (MEC SAP). Some sampling, however, will be performed in areas that are not expected to be contaminated, as represented by the systematic locations. The combination of biased and systematic sampling will enable the Partnering Team to bound the extent of contamination, if any, at a particular site and to conduct a risk assessment. The estimated risks are likely to be overestimated because of the biased sampling component; however, the bias helps to mitigate the effects of having LOQs or LODs for some target analytes that exceed the PALs (see **Worksheet #15**). If significant levels of MC target analyte concentrations are found at any of the sites, it is possible that additional data must be collected to complete the delineation and to support the HHRA and/or ERA.

As indicated in **Worksheet #18**, samples of groundwater, soil, and sediment will be collected and analyzed for explosives and metals, as appropriate for the types of munitions used at each site. Field information and visual observations pertinent to sample collection will be recorded on sample log sheets. If MEC or MPPEH is identified during sampling in the immediate vicinity of the work area, sample collection will be halted, and the presence of MEC/MPPEH will be communicated in accordance with the procedure presented in **Worksheet #6**. If obvious soil or sediment staining is observed during sampling, the staining will be described in the sample log, and additional soil and/or sediment samples may be collected at the discretion of the Tetra Tech FOL to determine the nature and, possibly, the extent of associated site-related contamination. Field work implementation details are presented in **Worksheet #14**.

The site-specific sampling strategies presented in this worksheet are designed to confirm the presence or absence of MC and, if MC is found, to define the range and extent of contaminant concentrations at UXO Sites 3 to 8. By using an interactive approach that combines the collection of biased samples at locations where MEC or MPPEH items are present with the collection of default samples at pre-determined systematic locations, this sampling strategy ensures that each site receives adequate spatial coverage of the targeted areas of potential contamination and that the resulting data represents worst-case conditions. This approach provides for the collection of sufficient data to validate or revise the site-specific CSMs to ensure that a potential unacceptable human health or ecological risk is not overlooked.

The remaining sections of this worksheet provide details regarding the site-specific sampling strategies for each site. As discussed in **Worksheet #10**, no sampling will be conducted at UXO 2 because the sample results obtained during the SI, combined with data to be collected under the Expanded SI, will be sufficient for site characterization and risk assessment purposes.

### 17.1 UXO 3 – AERIAL BOMBING TARGET AT PARADE DECK

To determine the extent to which MC-related contamination may be present in the soil and/or groundwater at UXO 3, soil samples will be collected at 12 soil boring locations, and groundwater samples will be collected at three temporary well locations. Based on the CSM for UXO 3 presented in **Section 10.5**, soil and groundwater samples will be analyzed for metals, which are the COPCs identified for this site. To confirm that explosives are not also COPCs (i.e., that they were not components of the practice bombs used at this site), aliquots from each of the 12 soil sampling locations will be combined to generate composite samples for explosives analysis, and the groundwater samples will be analyzed for explosives, as well. Soil samples will be analyzed for pH for use in the ERA.

Three temporary well locations and nine additional default soil sampling locations for this site are shown on **Figure 17-1**. Nominal sampling depths are 0-1 ft bgs (surface soil) and 1-3 ft bgs (subsurface soil). If any fill material is encountered during the well installation or soil sampling activities, or if MEC/MPPEH is detected, a surface sample will be collected from 0 to 1 foot bgs, and the subsurface sample will be collected from the 1-foot interval directly below the fill/natural material horizon or directly below the item, as applicable.

Surface (0 to 1 ft bgs) and subsurface (1 to 3 ft bgs) soil samples will be collected at the three temporary well locations. Nine additional surface (0 to 1 ft bgs) and subsurface (nominal 1 to 3 ft bgs) soil samples will be collected at each of nine locations that represent either the nine default locations identified on **Figure 17-1** or locations that are as close as possible to MEC/MPPEH finds, as described next. If MEC is detected, a surface and subsurface soil sample will be collected from each of as many as nine different MEC/MPPEH finds. If more than nine finds are identified, the FOL will consult the Tetra Tech PM to determine whether additional sampling is necessary to achieve project objectives. Soil samples associated with a MEC/MPPEH find will be numbered to correspond to the closest of the nine default soil sampling locations. If fewer than nine MEC/MPPEH finds are identified, a surface and subsurface soil sample will be collected from each of the default sampling locations not associated with a find. When all soil samples have been collected, the surface soil and the subsurface soil sample locations will number 12, for a total of 24 soil samples collected from the three temporary well locations plus nine additional (either default or MEC find) soil sampling locations. Each soil sample will be analyzed for metals and pH. Explosives analysis will be conducted for one surface soil composite (consisting of one aliquot from each of the 12 surface soil samples) and one subsurface soil composite (consisting of one aliquot from each of the 12 subsurface soil samples).

Groundwater samples will be collected from the three temporary well locations following the completion and development of all three wells and the collection of synoptic groundwater elevation data. Water levels will be allowed to equilibrate for 24 hours so that static water levels can be measured and the potentiometric surface can be established prior to purging and sampling. Groundwater samples will be analyzed for metals and explosives.

## 17.2 UXO 4 – FIELD ARTILLERY WEST MAIN RANGE

To determine the extent to which MC-related contamination may be present in the soil, sediments, and/or groundwater at UXO 4, discrete soil samples will be collected at 12 to 15 locations within the impact area, up to 12 discretionary locations at the firing points, and 12 locations near Firing Point C; groundwater samples will be collected at six temporary well locations situated along the impact area boundaries; and sediment samples will be collected at up to ten discretionary locations in swales leading to the waterways

and up to ten discretionary locations within the site waterways. In addition, an IS sample will be collected from surficial soil in up to three MEC investigation grids that exhibit evidence of a low-order detonation. Data generated from these samples will be used to define the nature and extent of site-related contaminants in the surface soil, subsurface soil, groundwater, and sediment. Based on the CSM for UXO 4 presented in **Section 10.6**, the impact area soil, groundwater, and sediment samples will be analyzed for metals and explosives, which are the COPCs identified for those locations. The Firing Point C systematic soil samples will be analyzed for metals only, which are the COPCs identified for that location, and the discretionary firing point samples collected at locations of MEC/MPPEH finds will be analyzed for metals and explosives. Soil samples will be analyzed for pH, and sediment samples will be analyzed for pH and TOC for use in the ERA. The IS sample will be analyzed for explosives.

Impact Area

Planned sample locations for this site are shown on **Figure 17-2**. Four of the six temporary wells are located where future development has the potential to result in groundwater exposure to residents, construction workers, and/or recreational users. These well locations are near the officer's housing area (TW01), the former trailer park (TW02), Elliots Beach (TW04), and the golf course (TW06). The other two wells are located in wooded areas near the airfield runways. These six well locations have been selected to ensure that the groundwater data generated provides information regarding site-related contaminant concentrations and general flow direction, with a focus on areas where groundwater is most likely to be encountered. These locations may be revised based on the results of the MEC investigation and subsequent discussions with the Partnering Team.

Soil samples will be collected at the six temporary well locations and at a minimum of six to a maximum of nine additional locations distributed throughout the impact area. The additional soil samples will be collected from up to nine biased locations where site-related MEC or MPPEH items are identified during the intrusive MEC investigation or, if none are identified, from the six default systematic locations shown on **Figure 17-2.** Each biased sample that is collected will be identified using the closest available default sample location name until all default sample locations have been exhausted. The default locations, which coincide with coordinates of MEC/MPPEH items identified on the ground surface during the SI (see **Appendix B, Table 7-1**), will be used to supplement the biased locations for the collection of as many samples as necessary to ensure that both the surface and subsurface soil data sets contain 12 to 15 results each. Also, if the grid investigation reveals evidence of low-order detonation or ruptured rounds, an IS sample will be collected from up to three grids.

At the temporary well and default soil sample locations, surface and subsurface soil samples will be collected from 0 to 1 foot bgs and 1 to 3 feet bgs, respectively. At any biased sampling locations

identified during the intrusive investigation (i.e., due to the presence of buried MEC or MPPEH), a surface sample will be collected from 0 to 1 foot bgs, and a subsurface sample will be collected from the 1-foot interval directly below the depth of the find.

Groundwater samples will be collected from the six temporary well locations following the completion and development of all six wells and the collection of synoptic groundwater elevation data. Water levels will be allowed to equilibrate for 24 hours so that static water levels can be measured and the potentiometric surface can be established prior to purging and sampling. Groundwater samples will be analyzed for metals and explosives.

Sediment sample collection is contingent on the MEC RI findings. If any surficial MEC or MPPEH are identified in areas that may be impacting the waterways through surface runoff, discretionary sediment samples will be collected from the swales leading to the waterways at up to ten such locations. If any underwater MEC or MPPEH is identified during the aquatic investigation, up to ten sediment samples will be collected from the top 6 inches of sediment lying on the bottom of the waterways or from the edge of the waterway in cases where the item is found within 6 feet of solid ground. Waterway samples will be collected using a petite Ponar dredge, and analyzed for metals and explosives. The three general areas where submerged sediment samples may be collected are identified as locations for "Investigation of Underwater Anomalies" on **Figure 17-2**. The precise quantity and locations of sediment samples will be determined based on results of the MEC investigation.

Firing Point C

As shown on **Figure 17-3**, soil samples will be collected from 12 systematic sample locations near Firing Point C. Both surface (0 to 1 foot bgs) and subsurface (1 to 3 feet bgs) soil samples will be collected to delineate the horizontal and vertical extent of metals contamination associated with the previously identified lead exceedance at Firing Point C. The surface soil samples will be analyzed for metals and, if any results exceed a surface soil PAL, the corresponding subsurface soil sample(s) collected at those locations will be analyzed for each metal that exceeded the PAL to define the vertical extent of contamination. The sampler will clearly identify on the chain-of-custody record each subsurface soil sample that must be held for contingent metals analysis based on any PAL exceedances in the corresponding surface soil sample.

Firing Points A, B, C, D, E, and R

Additional soil sampling at firing point locations is contingent on the MEC RI findings. If geophysical surveys and intrusive investigations conducted under the MEC SAP at Firing Points A, B, C, D, E, or R

(see **Figure 17-2**) identify any buried MEC or MPPEH, discretionary soil samples will be collected at up to 12 locations. A subsurface soil sample will be collected from the one-foot interval directly beneath each item and analyzed for metals and explosives.

## 17.3 UXO 5 – FIELD ARTILLERY EAST SHRAPNEL RANGE FIRING POINT

To determine whether MC-related contamination is present in the surface soil at a mean concentration that may be unacceptable as a result of firing operations at Firing Point T, one 50-point composite (i.e., "incremental") surface soil sample will be collected, in accordance with **SOP-08**, and analyzed for explosives.

A revised decision unit for IS, measuring approximately 200 feet by 50 feet, is identified at Firing Point T directly east of the IS decision unit investigated during the SI (see **Figure 17-4**). The new decision unit will be divided into grids (10 from east to west, 5 from north to south); and one sample increment will be collected (in triplicate for QA purposes) from each grid, for a total of 50 increments from the overall decision unit. Each surface soil increment will be collected from a depth of 0 to 2 inches bgs using a CRREL-designed coring device (or equivalent). All 50 increments will be combined into one sample container, and the IS sample will be submitted to the laboratory for processing in accordance with SW-846 Method 8330B Appendix A (i.e., air drying, sieving, particle size reduction by grinding, and multi-increment sub-sampling) prior to being analyzed for explosives.

In addition to the IS explosives sampling, up to 12 discretionary soil samples will be collected from biased locations at if any site-related munitions items are identified during the geophysical surveys and intrusive investigations conducted in the firing point area under the MEC SAP. If any MEC or MPPEH items are discovered at this site, a subsurface soil sample will be collected from the one-foot interval directly beneath each item and analyzed for metals and explosives.

## 17.4 UXO 6 – FIELD ARTILLERY EAST SHRAPNEL RANGE IMPACT AREA

If any MEC or MPPEH are identified during the intrusive MEC investigation along the western boundary of the impact area, discretionary surface and subsurface samples will be collected at up to 12 biased locations. If any surficial MEC or MPPEH are identified in areas that may be impacting the waterways through surface runoff, discretionary sediment samples will be collected from the swales leading to the waterways at up to ten such locations. If any MEC or MPPEH are identified in the submerged sediments within the waterways, discretionary samples will be collected at up to ten biased sediment locations. In addition, an IS sample will be collected from surficial soil in up to three MEC investigation grids that exhibit evidence of a low-order detonation. If no MEC or MPPEH items are identified during MEC

investigation field activities, no soil or sediment samples will be collected because sufficient data was collected during the SI to characterize the non-impacted areas. Data generated from the SI samples and the RI samples, if any, will be used to define the nature and extent of site-related contaminants in the soil and sediment. Based on the CSM for UXO 6 presented in **Section 10.7**, the discrete samples will be analyzed for metals and explosives, which are the COPCs identified for this site. Soil samples will be analyzed for pH, and sediment samples will be analyzed for pH and TOC for use in the ERA. The IS sample will be analyzed for explosives.

Most of UXO 6 consists of low-lying wetlands with waterways meandering through the site. The area is subject to tidal surges, has very limited accessibility by foot, and cannot be easily accessed. Most of the planned investigation area is situated west of the marsh, outside the UXO 6 boundary presented in the ASR; therefore, no default soil sampling locations are planned. However, in the event that MEC or MPPEH items are identified during the intrusive MEC investigation, a surface soil sample will be collected from 0 to 1 foot bgs and a subsurface sample will be collected from the 1-foot interval directly below the depth of the MEC/MPPEH find. Also, if the grid investigation reveals evidence of low-order detonation or ruptured rounds, an IS sample will be collected from up to three grids.

Submerged sediment sample collection is, likewise, contingent on the MEC RI findings. If underwater MEC is identified during the aquatic investigation, up to ten sediment samples will be collected from the top 6 inches of sediment at the bottom of the waterways or from the edge of the waterway in cases where the item is found within 6 feet of solid ground. These samples will be collected using a petite Ponar dredge, and analyzed for metals and explosives. The three general areas where sediment samples may be collected are indicated on **Figure 17-5**. However, the precise quantity and locations of sediment samples will be determined based on results of the aquatic MEC investigation.

## 17.5 UXO 7 – AERIAL BOMBING TARGET AT GOLF COURSE

To determine the extent to which MC-related contamination may be present in the soil and/or groundwater at UXO 7, soil samples will be collected at 12 to 15 soil boring locations, and groundwater samples will be collected at three temporary well locations. Based on the CSM for UXO 7 presented in **Section 10.8**, soil and groundwater samples will be analyzed for metals, which are the COPCs identified for this site. To confirm that explosives are not also COPCs (i.e., that they were not components of the practice bombs used at this site), aliquots from each of the 12 to 15 soil sampling locations will be combined to generate composite samples for explosives analysis, and the groundwater samples will be analyzed for explosives, as well. Soil samples will be analyzed for pH for use in the ERA.

As shown on **Figure 17-6,** one temporary well will be installed west of the driving range fairway, one will be installed approximately to the northeast (near the tree line), and one will be installed to the southeast (near the tree line). Soil samples will be collected at these three well locations and at 9 to 12 additional locations distributed throughout the site. The additional soil samples will be collected from biased locations where MEC or MPPEH items are identified during the intrusive MEC investigation or, if none are identified, from the nine additional default systematic locations shown on **Figure 17-6.** Each biased sample that is collected will be identified using the closest available default sample location name until all default sample locations have been exhausted. Default locations will be used to supplement the biased locations, if any are identified, for the collection of as many samples as necessary to ensure that both the surface and subsurface soil data sets contain 12 to 15 results each.

At the temporary well and default systematic soil sample locations, surface and subsurface soil samples will be collected from 0 to 1 foot bgs and 1 to 3 feet bgs, respectively. If any fill material is encountered during the soil boring or well installation activities, however, a surface sample will be collected from 0 to 1 foot bgs, and a subsurface sample will be collected from the 1-foot interval directly below the fill/natural material horizon. At any biased sampling locations identified during the intrusive MEC investigation (i.e., due to the presence of buried MEC or MPPEH), a surface sample will be collected from 0 to 1 foot bgs, and the subsurface sample will be collected from the 1-foot interval directly below the depth of the MEC find instead of the default 1 to 3 feet bgs interval. Each soil sample will be analyzed for metals and pH. Explosives analysis will be conducted for one surface soil composite (consisting of one aliquot from each of the 12 to 15 surface soil samples) and one subsurface soil composite (consisting of one aliquot from each of the 12 to 15 subsurface soil samples).

Groundwater samples will be collected from the three temporary well locations following the completion and development of all three wells and the collection of synoptic groundwater elevation data. Water levels will be allowed to equilibrate for 24 hours so that static water levels can be measured and the potentiometric surface can be established prior to purging and sampling. Groundwater samples will be analyzed for metals and explosives.

## 17.6 UXO 8 – AERIAL BOMBING TARGET AT SOUTHERN TIDAL FLATS

To determine the extent to which MC-related contamination may be present in the sediment at UXO 8, sediment samples will be collected at 12 locations distributed across the site. (No soil or groundwater sampling will be conducted because the site lies within a tidal flat area that is completely submerged during high tide.) Based on the CSM for UXO 8 presented in **Section 10.9**, samples will be analyzed for metals, which are the COPCs identified for this site, and for pH and TOC for use in the ERA. To confirm that explosives are not also COPCs (i.e., that they were not components of the practice bombs used at

this site), aliquots from each of the 12 sediment sampling locations will be combined to generate composite samples for explosives analysis.

Sediment samples are planned for collection at locations where surface accumulations of practice bomb fragments have been identified. To ensure full site coverage, samples will be collected at or near the default locations indicated on **Figure 17-7**. Precise locations will be selected in the field at the discretion of the Tetra Tech FOL, beneath surface debris accumulations located closest to the default systematic locations. Sediment samples will be collected from depths of 0 to 6 inches bgs and 6 to 24 inches bgs. Samples from each location will be analyzed for metals, pH, and TOC. Explosives analysis will be conducted for one shallow surface sediment composite (consisting of one aliquot from each of the 12 shallow surface samples) and one deep surface sediment composite (consisting of one aliquot from each of the 12 deep surface samples).

## SAP Worksheet #18 -- Sampling Locations and Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| **UXO 3** | | | | | | | |
| **Soil Borings (Surface and Subsurface Soil)** | | | | | | | |
| X3SB101 | X3SS101-XXXX[2] and X3SSDUP-01[3] | Soil | 0 – 1 | Metals pH | 2 | **SOP-05, SOP-06, SOP-07** | Paved area of the Parade Deck, at X3TW01 location |
| | X3SB101-XXXX[2] and X3SBDUP-01[3] | Soil | 1 – 3 | Metals pH | 2 | | |
| X3SB102 | X3SS102-XXXX[2] | Soil | 0 – 1 | Metals pH | 1 | **SOP-05, SOP-06, SOP-07** | Northeast corner of the grassy area, at X3TW02 location |
| | X3SB102-XXXX[2] | Soil | 1 – 3 | Metals pH | 1 | | |
| X3SB103 | X3SS103-XXXX[2] | Soil | 0 – 1 | Metals pH | 1 | **SOP-05, SOP-06, SOP-07** | Southwest corner of the grassy area, at X3TW03 location |
| | X3SB103-XXXX[2] | Soil | 1 – 3 | Metals pH | 1 | | |
| X3SB104 | X3SS104-XXXX[2] | Soil | 0 – 1 | Metals pH | 1 | **SOP-06** | Nine locations – preferentially at biased locations of MEC/MPPEH finds, then at default systematic locations |
| | X3SB104-XXXX[2] | Soil | 1 – 3 | Metals pH | 1 | | |
| X3SB105 | X3SS105-XXXX[2] | Soil | 0 – 1 | Metals pH | 1 | **SOP-06** | |
| | X3SB105-XXXX[2] | Soil | 1 – 3 | Metals pH | 1 | | |
| X3SB106 | X3SB106-XXXX[2] | Soil | 0 – 1 | Metals pH | 1 | **SOP-06** | |
| | X3SB106-XXXX[2] | Soil | 1 – 3 | Metals pH | 1 | | |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| X3SB107 | X3SS107-XXXX[2] | Soil | 0 – 1 | Metals<br>pH | 1 | SOP-06 | |
| | X3SB107-XXXX[2] | Soil | 1 – 3 | Metals<br>pH | 1 | | |
| X3SB108 | X3SS108-XXXX[2] | Soil | 0 – 1 | Metals<br>pH | 1 | SOP-06 | |
| | X3SB108-XXXX[2] | Soil | 1 – 3 | Metals<br>pH | 1 | | |
| X3SB109 | X3SS109-XXXX[2] | Soil | 0 – 1 | Metals<br>pH | 1 | SOP-06 | |
| | X3SB109-XXXX[2] | Soil | 1 – 3 | Metals<br>pH | 1 | | |
| X3SB110 | X3SS110-XXXX[2] | Soil | 0 – 1 | Metals<br>pH | 1 | SOP-06 | |
| | X3SB110-XXXX[2] | Soil | 1 – 3 | Metals<br>pH | 1 | | |
| X3SB111 | X3SS111-XXXX[2] and X3SSDUP-02[3] | Soil | 0 – 1 | Metals<br>pH | 2 | SOP-06 | |
| | X3SB111-XXXX[2] and X3SBDUP-02[3] | Soil | 1 – 3 | Metals<br>pH | 2 | | |
| X3SB112 | X3SS112-XXXX[2] | Soil | 0 – 1 | Metals<br>pH | 1 | SOP-06 | |
| | X3SB112-XXXX[2] | Soil | 1 – 3 | Metals<br>pH | 1 | | |
| **Composite Sample (Surface and Subsurface Soil)** | | | | | | | |
| X3SBC101 | X3SBC101-XXXX[2] | Soil | 0 - 1 | Explosives | 1 | SOP-06 | Composite of one surface soil aliquot each from X3SB101 through X3SB112 |
| | X3SBC101-XXXX[2] | Soil | 1 - 3 | Explosives | 1 | SOP-06 | Composite of one subsurface soil aliquot each from X3SB101 through X3SB112 |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| **Temporary Well Locations (Groundwater)** | | | | | | | |
| X3TW01 | X3TW01-YYYYMMDD[4] and X3TWDUP-01[3] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 2 | **SOP-11, SOP-12, SOP-13, SOP-14, SOP-15, SOP-16.** | Paved area of the Parade Deck |
| X3TW02 | X3TW02-YYYYMMDD[4] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 1 | | Northeast corner of the grassy area |
| X3TW03 | X3TW03-YYYYMMDD[4] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 1 | | Southwest corner of the grassy area |
| **UXO 4** | | | | | | | |
| **Soil Borings (Surface and Subsurface Soil)** | | | | | | | |
| X4SB101 | X4SS101-XXXX[2] and X4SSDUP-01[3] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 2 | **SOP-05, SOP-06, SOP-07.** | Near Officers housing area, at X4TW01 location |
| | X4SB101-XXXX[2] and X4SBDUP-01[3] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 2 | | |
| X4SB102 | X4SS102-XXXX[2] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 1 | **SOP-05, SOP-06, SOP-07.** | Near former trailer park, at X4TW02 location |
| | X4SB102-XXXX[2] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 1 | | |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| X4SB103 | X4SS103-XXXX[2] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 1 | SOP-05, SOP-06, SOP-07. | Wooded area near airfield runway, at X4TW03 location |
| | X4SB103-XXXX[2] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 1 | | |
| X4SB104 | X4SS104-XXXX[2] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 1 | SOP-05, SOP-06, SOP-07 | Near Elliots Beach, at X4TW04 location |
| | X4SB104-XXXX[2] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 1 | | |
| X4SB105 | X4SS105-XXXX[2] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 1 | SOP-05, SOP-06, SOP-07 | Wooded area near airfield runway, at X4TW05 location |
| | X4SB105-XXXX[2] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 1 | | |
| X4SB106 | X4SB106-XXXX[2] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 1 | SOP-05, SOP-06, SOP-07 | Near Golf Course, at X4TW06 location |
| | X4SB106-XXXX[2] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 1 | | |
| X4SB107 | X4SS107-XXXX[2] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 1 | SOP-06 | Six to nine locations – preferentially at biased locations of MEC/MPPEH finds, then at default systematic locations |
| | X4SB107-XXXX[2] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 1 | | |
| X4SB108 | X4SS108-XXXX[2] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 1 | SOP-06 | |
| | X4SB108-XXXX[2] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 1 | | |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| X4SB109 | X4SS109-XXXX[2] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 1 | SOP-06 | |
| | X4SB109-XXXX[2] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 1 | | |
| X4SB110 | X4SS110-XXXX[2] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 1 | SOP-06 | |
| | X4SB110-XXXX[2] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 1 | | |
| X4SB111 | X4SS111-XXXX[2] and X4SSDUP-02[3] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 2 | SOP-06 | |
| | X4SB111-XXXX[2] and X4SBDUP-02[3] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 2 | | |
| X4SB112 | X4SS112-XXXX[2] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 1 | SOP-06 | |
| | X4SB112-XXXX[2] | Soil | 1 – 3 | Explosives<br>Metals<br>pH | 1 | | |
| X4SB113 | X4SS113-XXXX[2] and X4SSDUP-03[3] | Soil | 0 – 1 | Metals | 2 | SOP-06 | Twelve locations – systematic grid locations at Firing Point C based on PAL exceedance in SI<br><br>Subsurface samples will only be analyzed if surface samples have PAL exceedances |
| | X4SB113-XXXX[2] and X4SBDUP-03[3] | Soil | 1 – 3 | Metals | 2 | | |
| X4SB114 | X4SS114-XXXX[2] | Soil | 0 – 1 | Metals | 1 | SOP-06 | |
| | X4SB114-XXXX[2] | Soil | 1 – 3 | Metals | 1 | | |
| X4SB115 | X4SS115-XXXX[2] | Soil | 0 – 1 | Metals | 1 | SOP-06 | |
| | X4SB115-XXXX[2] | Soil | 1 – 3 | Metals | 1 | | |
| X4SB116 | X4SS116-XXXX[2] | Soil | 0 – 1 | Metals | 1 | SOP-06 | |
| | X4SB116-XXXX[2] | Soil | 1 – 3 | Metals | 1 | | |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| X4SB-117 | X4SS117-XXXX[2] | Soil | 0 – 1 | Metals | 1 | SOP-06 | |
| | X4SB117-XXXX[2] | Soil | 1 – 3 | Metals | 1 | | |
| X4SB118 | X4SB118-XXXX[2] | Soil | 0 – 1 | Metals | 1 | SOP-06 | |
| | X4SB118-XXXX[2] | Soil | 1 – 3 | Metals | 1 | | |
| X4SB119 | X4SS119-XXXX[2] | Soil | 0 – 1 | Metals | 1 | SOP-06 | |
| | X4SB119-XXXX[2] | Soil | 1 – 3 | Metals | 1 | | |
| X4SB120 | X4SS120-XXXX[2] | Soil | 0 – 1 | Metals | 1 | SOP-06 | |
| | X4SB120-XXXX[2] | Soil | 1 – 3 | Metals | 1 | | |
| X4SB121 | X4SS121-XXXX[2] | Soil | 0 – 1 | Metals | 1 | SOP-06 | |
| | X4SB121-XXXX[2] | Soil | 1 – 3 | Metals | 1 | | |
| X4SB122 | X4SS122-XXXX[2] | Soil | 0 – 1 | Metals | 1 | SOP-06 | |
| | X4SB122-XXXX[2] | Soil | 1 – 3 | Metals | 1 | | |
| X4SB123 | X4SS123-XXXX[2] and X4SSDUP-04[3] | Soil | 0 – 1 | Metals | 2 | SOP-06 | |
| | X4SB123-XXXX[2] and X4SBDUP-04[3] | Soil | 1 – 3 | Metals | 2 | | |
| X4SB124 | X4SS124-XXXX[2] | Soil | 0 – 1 | Metals | 1 | SOP-06 | |
| | X4SB124-XXXX[2] | Soil | 1 – 3 | Metals | 1 | | |
| X4SB125 | X4SB125-XXXX[2] and X4SBDUP-01[3] | Soil | 1-foot interval below MEC Find | Metals<br>Explosives | 2 | SOP-06 | Up to 12 discretionary samples – at biased locations of MEC/MPPEH finds near firing point locations (subsurface soil only) |
| X4SB126 to X4SB136 | X4SB126-XXXX[2] to X4SB136-XXXX[2] | Soil | 1-foot interval below MEC Find | Metals<br>Explosives | 1 (each) | | |
| **Temporary Well Locations (Groundwater)** | | | | | | | |
| X4TW01 | X4TW01-YYYYMMDD[4] and X4TWDUP-01[3] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 2 | SOP-11, SOP-12, SOP-13, SOP-14, SOP-15, | Near Officers housing area |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| X4TW02 | X4TW02-YYYYMMDD[4] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 1 | | Near former trailer park |
| X4TW03 | X4TW03-YYYYMMDD[4] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 1 | | Wooded area near airfield runway |
| X4TW04 | X4TW04-YYYYMMDD[4] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 1 | | Near Elliots Beach |
| X4TW05 | X4TW05-YYYYMMDD[4] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 1 | | Wooded area near airfield runway |
| X4TW06 | X4TW06-YYYYMMDD[4] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 1 | | Near Golf Course |
| **Incremental Samples (Surface Soil)** | | | | | | | |
| X4IS101 to X4IS103 | X4IS101-XXXX[2] to X4IS103-XXXX[2] | Soil | 0 – 0.2 | Explosives | 1 (each) | **SOP-08** | Up to 3 discretionary IS samples from MEC investigation grids in impact area where evidence of low-order detonation is discovered |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| **Waterway Locations (Sediment)** | | | | | | | |
| X4SD101 | X4SD101-XXXX[2] and X4SDDUP-01[3] | Sediment | 0 – 0.5 | Explosives<br>Metals<br>pH<br>TOC | 2 | SOP-10 | Up to 10 discretionary samples – at biased locations of MEC/MPPEH finds only |
| X4SD102 to X4SD110 | X4SD102-XXXX[2] to X4SD110-XXXX[2] | Sediment | 0 – 0.5 | Explosives<br>Metals<br>pH<br>TOC | 1 (each) | | |
| **Swale Locations (Sediment)** | | | | | | | |
| X4SD111 | X4SD111-XXXX[2] and X4SDDUP-02[3] | Sediment | 0 – 0.5 | Explosives<br>Metals<br>pH<br>TOC | 2 | SOP-09 | Up to 10 discretionary samples – at biased locations downgradient from surficial MEC/MPPEH finds only |
| X4SD112 to X4SD120 | X4SD112-XXXX[2] to X4SD120-XXXX[2] | Sediment | 0 – 0.5 | Explosives<br>Metals<br>pH<br>TOC | 1 (each) | | |
| **UXO 5** | | | | | | | |
| **Incremental Sample (Surface Soil)** | | | | | | | |
| X5IS101 | X5IS101-XXXX[2]-01 | Soil | 0 – 0.2 | Explosives | 1 | SOP-08 | One IS decision unit sample – near Firing Point T, collected in triplicate for QA purposes |
| | X5IS101-XXXX[2]-02 | Soil | 0 – 0.2 | Explosives | 1 | | |
| | X5IS101-XXXX[2]-03 | Soil | 0 – 0.2 | Explosives | 1 | | |
| **Soil Borings (Subsurface Soil)** | | | | | | | |
| X5SB101 | X5SB101-XXXX[2] and X5SBDUP-01[3] | Soil | 1-foot interval below MEC Find | Metals<br>Explosives | 2 | SOP-06 | Up to 12 discretionary samples – at biased locations of MEC/MPPEH finds near Firing Point T (subsurface soil only) |
| X5SB102 to X5SB112 | X5SB102-XXXX[2] to X5SB112-XXXX[2] | Soil | 1-foot interval below MEC Find | Metals<br>Explosives | 1 (each) | | |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| **UXO 6** | | | | | | | |
| **Soil Borings (Surface and Subsurface Soil)** | | | | | | | |
| X6SB101 | X6SS101-XXXX[2] and X6SSDUP-01[3] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 2 | SOP-06 | Up to 12 discretionary samples – Along western boundary, at biased locations of MEC/MPPEH finds only |
| | X6SB101-XXXX[2] and X6SBDUP-01[3] | Soil | 1-foot interval below MEC Find | Explosives<br>Metals<br>pH | 2 | | |
| X6SB102 to X6SB112 | X6SS102-XXXX[2] to X6SS112-XXXX[2] | Soil | 0 – 1 | Explosives<br>Metals<br>pH | 1 (each) | SOP-06 | |
| | X6SB102-XXXX[2] to X6SS112-XXXX[2] | Soil | 1-foot interval below MEC Find | Explosives<br>Metals<br>pH | 1 (each) | | |
| **Incremental Samples (Surface Soil)** | | | | | | | |
| X6IS101 to X6IS103 | X6IS101-XXXX[2] to X6IS103-XXXX[2] | Soil | 0 – 0.2 | Explosives | 1 (each) | SOP-08 | Up to 3 discretionary IS samples from MEC investigation grids in impact area where evidence of low-order detonation is discovered |
| **Waterway Locations (Sediment)** | | | | | | | |
| X6SD101 | X6SD101-XXXX[2] and X6SDDUP-01[3] | Sediment | 0 – 0.5 | Explosives<br>Metals<br>pH<br>TOC | 2 | SOP-10 | Up to 10 discretionary samples – at biased locations ofMEC/MPPEH finds only |
| X6SD102 to X6SD110 | X4SD102-XXXX[2] to X4SD110-XXXX[2] | Sediment | 0 – 0.5 | Explosives<br>Metals<br>pH<br>TOC | 1 (each) | | |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| **Swale Locations (Sediment)** | | | | | | | |
| X6SD111 | X6SD111-XXXX[2] and X6SDDUP-02[3] | Sediment | 0 – 0.5 | Explosives<br>Metals<br>pH<br>TOC | 2 | SOP-09 | Up to 10 discretionary samples – at biased locations downgradient from surficial MEC/MPPEH finds only |
| X6SD112 to X6SD120 | X6SD112-XXXX[2] to X6SD120-XXXX[2] | Sediment | 0 – 0.5 | Explosives<br>Metals<br>pH<br>TOC | 1 (each) | | |
| **UXO 7** | | | | | | | |
| **Soil Borings (Surface and Subsurface Soil)** | | | | | | | |
| X7SB101 | X7SS101-XXXX[2] and X7SSDUP-01[3] | Soil | 0 – 1 | Metals<br>pH | 2 | SOP-05, SOP-06, SOP-07. | West of center of target, on west side of driving range fairway, at X7TW01 location |
| | X7SB101-XXXX[2] and X7SBDUP-02[3] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals<br>pH | 2 | | |
| X7SB102 | X7SS102-XXXX[2] | Soil | 0 – 1 | Metals<br>pH | 1 | SOP-05, SOP-06, SOP-07. | Approximately 500 feet northeast of center of target, at X7TW02 location |
| | X7SB102-XXXX[2] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals<br>pH | 1 | | |
| X7SB103 | X7SS103-XXXX[2] | Soil | 0 – 1 | Metals<br>pH | 1 | SOP-05, SOP-06, SOP-07. | Approximately 500 feet southeast of center of target, at X7TW03 location |
| | X7SB103-XXXX[2] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals<br>pH | 1 | | |
| X7SB104 | X7SS104-XXXX[2] | Soil | 0 – 1 | Metals<br>pH | 1 | SOP-05, SOP-06, SOP-07. | 9 to 12 locations – preferentially at biased locations of MEC/MPPEH finds, then at default systematic locations |
| | X7SB104-XXXX[2] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals<br>pH | 1 | | |
| X7SB105 | X7SS105-XXXX[2] | Soil | 0 – 1 | Metals<br>pH | 1 | SOP-05, SOP-06, SOP-07. | |
| | X7SB105-XXXX[2] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals<br>pH | 1 | | |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| X7SB106 | X7SB106-XXXX[2] | Soil | 0 – 1 | Metals pH | 1 | SOP-05, SOP-06, SOP-07. | |
| | X7SB106-XXXX[2] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals pH | 1 | | |
| X7SB107 | X7SS107-XXXX[2] | Soil | 0 – 1 | Metals pH | 1 | SOP-05, SOP-06, SOP-07. | |
| | X7SB107-XXXX[2] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals pH | 1 | | |
| X7SB108 | X7SS108-XXXX[2] | Soil | 0 – 1 | Metals pH | 1 | SOP-05, SOP-06, SOP-07. | |
| | X7SB108-XXXX[2] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals pH | 1 | | |
| X7SB109 | X7SS109-XXXX[2] | Soil | 0 – 1 | Metals pH | 1 | SOP-05, SOP-06, SOP-07. | |
| | X7SB109-XXXX[2] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals pH | 1 | | |
| X7SB110 | X7SS110-XXXX[2] | Soil | 0 – 1 | Metals pH | 1 | SOP-05, SOP-06, SOP-07. | |
| | X7SB110-XXXX[2] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals pH | 1 | | |
| X7SB111 | X7SS111-XXXX[2] and X7SSDUP-02[3] | Soil | 0 – 1 | Metals pH | 2 | SOP-05, SOP-06, SOP-07. | |
| | X7SB111-XXXX[2] and X7SBDUP-04[3] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals pH | 2 | | |
| X7SB112 | X7SS112-XXXX[2] | Soil | 0 – 1 | Metals pH | 1 | SOP-05, SOP-06, SOP-07. | |
| | X7SB112-XXXX[2] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Metals pH | 1 | | |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| **Composite Sample (Surface and Subsurface Soil)** | | | | | | | |
| X7SBC101 | X7SBC101-XXXX[2] | Soil | 0 - 1 | Explosives | 1 | **SOP-06** | Composite of one surface soil aliquot each from X7SB101 through X7SB112 |
| | X7SBC101-XXXX[2] | Soil | 1 – 3, or the 1-foot interval below the top of natural material | Explosives | 1 | **SOP-06** | Composite of one subsurface soil aliquot each from X7SB101 through X7SB112 |
| **Temporary Well Locations (Groundwater)** | | | | | | | |
| X7TW01 | X7TW01-YYYYMMDD[4] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 1 | **SOP-11, SOP-12, SOP-13, SOP-14, SOP-15, SOP-16.** | West of center of target, on west side of driving range fairway |
| X7TW02 | X7TW02-YYYYMMDD[4] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 1 | | Approximately 500 feet northeast of center of target |
| X7TW03 | X7TW03-YYYYMMDD[4] | Ground-water | TBD | Explosives<br>Total Metals<br>Dissolved Metals (if necessary)[5] | 1 | | Approximately 500 feet southeast of center of target |
| **UXO 8** | | | | | | | |
| **Tidal Flats Locations (Sediment)** | | | | | | | |
| X8SD101 | X8SD101-XXXX[2] and X8SDDUP-01[3] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 2 | **SOP-09** | 12 locations – preferentially beneath surface debris associated with practice bomb fragments near default systematic locations |
| | X8SD101-XXXX[2] and X8SDDUP-02[3] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 2 | | |
| X8SD102 | X8SD102-XXXX[2] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 1 | | |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| | X8SD102-XXXX[2] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 1 | | |
| X8SD103 | X8SD103-XXXX[2] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 1 | | |
| | X8SD103-XXXX[2] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 1 | | |
| X8SD104 | X8SD104-XXXX[2] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 1 | | |
| | X8SD104-XXXX[2] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 1 | | |
| X8SD105 | X8SD105-XXXX[2] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 1 | | |
| | X8SD105-XXXX[2] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 1 | | |
| X8SD106 | X8SD106-XXXX[2] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 1 | | |
| | X8SD106-XXXX[2] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 1 | | |
| X8SD107 | X8SD107-XXXX[2] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 1 | | |
| | X8SD107-XXXX[2] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 1 | | |
| X8SD108 | X8SD108-XXXX[2] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 1 | | |

| Sampling Location | ID Number | Matrix | Depth[2] (feet bgs) | Analytical Groups | Number of Samples (identify field duplicates) | Sampling SOP Reference[1] | Sampling Location Description |
|---|---|---|---|---|---|---|---|
| | X8SD108-XXXX[2] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 1 | | |
| X8SD109 | X8SD109-XXXX[2] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 1 | | |
| | X8SD109-XXXX[2] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 1 | | |
| X8SD110 | X8SD110-XXXX[2] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 1 | | |
| | X8SD110-XXXX[2] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 1 | | |
| X8SD111 | X8SD111-XXXX[2] and X8SDDUP-03[3] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 2 | | |
| | X8-SD-111-XXXX[2] and X8SDDUP-04[3] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 2 | | |
| X8SD112 | X8SD112-XXXX[2] | Sediment | 0 – 0.5 | Metals<br>pH<br>TOC | 1 | | |
| | X8SD112-XXXX[2] | Sediment | 0.5 – 2 | Metals<br>pH<br>TOC | 1 | | |
| **Composite Sample (Shallow and Deep Sediment)** | | | | | | | |
| X8SDC101 | X8SDC101-XXXX[2] | Sediment | 0 – 0.5 | Explosives | 1 | **SOP-09** | Composite of one shallow aliquot each from X8SD101 through X8SD112 |
| | X8SDC101-XXXX[2] | Sediment | 0.5 – 2 | Explosives | 1 | **SOP-09** | Composite of one deep aliquot each from X8SD101 through X8SD112 |

[1] SOP or worksheet that describes the sample collection procedures (**Worksheet #21**).
[2] XXXX represents the depth interval of the sample, in inches. Depth will be determined in the field. For example, if a sample is collected from 0 to 0.5 feet, the depth interval will be recorded as 0006; if a sample is collected from 0.5 to 2 feet, the depth interval will be recorded as 0624. For samples that are collected from directly beneath MEC Finds, the depth will be the 1-foot interval directly beneath the MEC Find. For samples that are collected from beneath fill material (UXO 3 or UXO 7), the depth will be the 1-foot interval directly beneath the bottom of the fill material (e.g., the top 1-foot interval of the natural material). The default systematic subsurface soil sampling depth of 1 to 3 feet bgs will be recorded as 1236. At UXO 7, the Tetra Tech Geologist will determine by professional judgment the top of the natural material horizon depth and collect a sample from the top 12 inches of natural material at all locations where fill has been placed over the original grade.
[3] Field duplicate locations may change in the field at the discretion of the Tetra Tech Geologist based on visual observations for soil and sediment samples. The intent will be to target those locations that exhibit the greatest degree of visual discoloration to increase the likelihood of generating meaningful data.
[4] YYYYMMDD represents the date of the sample collection for the groundwater sampling events. For example, if sample TW01 at UXO 4 is collected on March 13, 2012, the sample ID will be recorded as X4TW01-20120313.
[5] For groundwater samples, if the turbidity is > 10 NTU, then dissolved metals must also be collected.

## SAP Worksheet #19 -- Analytical SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

| Matrix | Analytical Group | Analytical and Preparation Method/SOP Reference | Containers (number, size, and type) | Sample volume (units) | Preservation Requirements (chemical, temperature, light protected) | Maximum Holding Time (preparation / analysis) |
|---|---|---|---|---|---|---|
| Surface Soil, Subsurface Soil, and Sediment | Explosives | SW-846 8330B<br>GEL GL-OA-E-068 | One 4-ounce (oz) amber glass jar with Teflon®-lined cap | 30 grams (g) | Cool to above freezing and ≤ 6 °C | 14 days until extraction, 40 days to analysis |
| | Explosives – IS (sample preparation only) | SW-846 8330B<br>GEL GL-OA-E-071, GEL GL-OA-E-068 | One plastic bag, 5-gallon bucket, or other container | 1 to 4 kilograms | Cool to above freezing and ≤ 6 °C | 14 days until extraction |
| | Metals (Including Mercury) | SW-846 3050B/6010B/6020A, 7471A<br>GEL GL-MA-E-009, GL-MA-E-010, GL-MA-E-013, GL-MA-E-014 | One 8-oz wide-mouth glass jar | 250 g | Cool to above freezing and ≤ 6 °C | 180 days to analysis/ 28 days to analysis for mercury |
| Soil and Sediment | pH | SW-846 9045D<br>GEL GL-GC-E-008 | One 4-oz glass jar | 50 g | Cool to above freezing and ≤ 6 °C | Analyze as soon as possible |
| Sediment | TOC | SW-846 9060 Modified/ Lloyd Kahn<br>GEL GL-GC-E-062 | One 4-oz wide-mouth amber glass jar | 10 g | Cool to above freezing and ≤ 6 °C | 14 days to analysis |
| Aqueous Field QC Blanks | Explosives | SW-846 8330B<br>GEL GL-MA-E-068 | Two 1-liter (L) glass amber bottles with Teflon®-lined cap | 1L | Cool to above freezing and ≤ 6 °C | 7 days until extraction, 40 days to analysis |
| | Metals (Including Mercury) (Total and Dissolved) | SW-846 3010A/6010B/6020A, 7470A<br>GEL GL-MA-E-006, GL-MA-E-008, GL-MA-E-010, GL-MA-E-013, GL-MA-E-014 | One 1-L plastic bottle | 1L | Nitric acid to pH < 2; Cool to above freezing and ≤ 6 °C | 180 days to analysis/ 28 days to analysis for mercury |

## SAP Worksheet #20 -- Field Quality Control Sample Summary Table

(UFP-QAPP Manual Section 3.1.1)

| Matrix | Analytical Group | No. of Sampling Locations | No. of Field Duplicates | No. of MS/MSDs[1] | No. of Field Blanks | No. of Equipment Blanks | No. of VOC Trip Blanks | Total No. of Samples to Lab |
|---|---|---|---|---|---|---|---|---|
| **UXO 3** | | | | | | | | |
| Surface Soil (Grass Area plus 1 in asphalt) | Metals | 12 | 2 | 1/1 | 0 | 1 | NA | 15 |
| | Explosives | 1 | 1 | 1/1 | 0 | 1 | NA | 3 |
| | pH | 12 | 0 | 0/0 | 0 | 0 | NA | 12 |
| Subsurface Soil (Grass Area plus 1 in asphalt) | Metals | 12 | 2 | 1/1 | 0 | 1 | NA | 15 |
| | Explosives | 1 | 0 | 0/0 | 0 | 0 | NA | 1 |
| | pH | 12 | 0 | 0/0 | 0 | 0 | NA | 12 |
| Groundwater (Grass Area) | Explosives | 3 | 1 | 1/1 | 0 | 1 | NA | 5 |
| | Total Metals | 3 | 1 | 1/1 | 0 | 1 | NA | 5 |
| | Dissolved Metals[2] | 0 to 3 | 1 | 1/1 | 0 | 1[2] | NA | 0 to 5 |
| **UXO 4** | | | | | | | | |
| Surface Soil (Impact Area) | Explosives | 12 to 15 | 2 | 1/1 | 0 | 1 | NA | 15 to 18 |
| | Metals | 12 to 15 | 2 | 1/1 | 0 | 1 | NA | 15 to 18 |
| | pH | 12 to 15 | 0 | 0/0 | 0 | 0 | NA | 12 |
| Subsurface Soil (Impact Area) | Explosives | 12 to 15 | 2 | 1/1 | 0 | 1 | NA | 15 to 18 |
| | Metals | 12 to 15 | 2 | 1/1 | 0 | 1 | NA | 15 to 18 |
| | pH | 12 to 15 | 0 | 0/0 | 0 | 0 | NA | 12 |
| Surface Soil (Firing Position C) | Metals | 12 | 2 | 1/1 | 0 | 1 | NA | 15 |
| Subsurface Soil (Firing Position C) | Metals | 12 | 2 | 1/1 | 0 | 1 | NA | 15 |
| Subsurface Soil (Firing Points A, B, C, D, E, R), if there are MEC finds | Metals | 0 to 12 | 0 to 2 | 1/1 | 0 | 1 | NA | 0 to 15 |
| | Explosives | 0 to 12 | 0 to 2 | 1/1 | 0 | 1 | NA | 0 to 15 |
| Surface Soil (IS), if evidence of low-order detonation in grid | Explosives | 0 to 3 | 0 | 0/0 | 0 | 0 | NA | 0 to 3 |
| Sediment (Surface Drainages, downgradient from MEC Finds) | Explosives | 0 to 10 | 0 to 1 | 1/1 | 0 | 0 to 1 | NA | 0 to 12 |
| | Metals | 0 to 10 | 0 to 1 | 1/1 | 0 | 0 to 1 | NA | 0 to 12 |
| | pH | 0 to 10 | 0 | 0/0 | 0 | 0 | NA | 0 to 10 |
| | TOC | 0 to 10 | 0 to 1 | 0/0 | 0 | 0 | NA | 0 to 11 |
| Sediment (Waterways, if there are MEC Finds) | Explosives | 0 to 10 | 0 to 1 | 1/1 | 0 | 0 to 1 | NA | 0 to 12 |
| | Metals | 0 to 10 | 0 to 1 | 1/1 | 0 | 0 to 1 | NA | 0 to 12 |
| | pH | 0 to 10 | 0 | 0/0 | 0 | 0 | NA | 0 to 10 |

| Matrix | Analytical Group | No. of Sampling Locations | No. of Field Duplicates | No. of MS/MSDs[1] | No. of Field Blanks | No. of Equipment Blanks | No. of VOC Trip Blanks | Total No. of Samples to Lab |
|---|---|---|---|---|---|---|---|---|
| | TOC | 0 to 10 | 0 to 1 | 0/0 | 0 | 0 | NA | 0 to 11 |
| Groundwater (Impact Area) | Explosives | 6 | 1 | 1/1 | 0 | 1 | NA | 8 |
| | Total Metals | 6 | 1 | 1/1 | 0 | 1 | NA | 8 |
| | Dissolved Metals[2] | 0 to 6 | 1 | 1/1 | 0 | 1[2] | NA | 0 to 8 |
| **UXO 5** | | | | | | | | |
| Surface Soil (IS in Triplicate) (Firing Point) | Explosives | 3 | 0 | 1/1 | 0 | 0 | NA | 3 |
| Subsurface Soil (Firing Point T), if there are MEC Finds | Metals | 0 to 12 | 0 to 2 | 1/1 | 0 | 1 | NA | 0 to 15 |
| | Explosives | 0 to 12 | 0 to 2 | 1/1 | 0 | 1 | NA | 0 to 15 |
| **UXO 6** | | | | | | | | |
| Surface Soil (Impact Area, if there are MEC Finds) | Explosives | 0 to 12 | 0 to 2 | 1/1 | 0 | 1 | NA | 0 to 15 |
| | Metals | 0 to 12 | 0 to 2 | 1/1 | 0 | 1 | NA | 0 to 15 |
| | pH | 0 to 12 | 0 | 0/0 | 0 | 0 | NA | 0 to 12 |
| Subsurface Soil (Impact Area, if there are MEC Finds) | Explosives | 0 to 12 | 0 to 2 | 1/1 | 0 | 1 | NA | 0 to 15 |
| | Metals | 0 to 12 | 0 to 2 | 1/1 | 0 | 1 | NA | 0 to 15 |
| | pH | 0 to 12 | 0 | 0/0 | 0 | 0 | NA | 0 to 12 |
| Surface Soil (IS), if evidence of low-order detonation in grid | Explosives | 0 to 3 | 0 | 0/0 | 0 | 0 | NA | 0 to 3 |
| Sediment (Surface Drainages, downgradient from MEC Finds) | Explosives | 0 to 10 | 0 to 1 | 1/1 | 0 | 0 to 1 | NA | 0 to 12 |
| | Metals | 0 to 10 | 0 to 1 | 1/1 | 0 | 0 to 1 | NA | 0 to 12 |
| | pH | 0 to 10 | 0 | 0/0 | 0 | 0 | NA | 0 to 10 |
| | TOC | 0 to 10 | 0 to 1 | 0/0 | 0 | 0 | NA | 0 to 11 |
| Sediment (Waterways, if there are MEC Finds) | Explosives | 0 to 10 | 0 to 1 | 1/1 | 0 | 0 to 1 | NA | 0 to 12 |
| | Metals | 0 to 10 | 0 to 1 | 1/1 | 0 | 0 to 1 | NA | 0 to 12 |
| | pH | 0 to 10 | 0 | 0/0 | 0 | 0 | NA | 0 to 10 |
| | TOC | 0 to 10 | 0 to 1 | 0/0 | 0 | 0 | NA | 0 to 11 |
| **UXO 7** | | | | | | | | |
| Surface Soil (Target Area) | Metals | 12 to 15 | 2 | 1/1 | 0 | 1 | NA | 15 to 18 |
| | Explosives | 1 | 0 | 0/0 | 0 | 0 | NA | 1 |
| | pH | 12 to 15 | 0 | 0/0 | 0 | 0 | NA | 12 to 15 |
| Subsurface Soil (Target Area) | Metals | 12 to 15 | 2 | 1/1 | 0 | 1 | NA | 15 to 18 |
| | Explosives | 1 | 0 | 0/0 | 0 | 0 | NA | 1 |
| | pH | 12 to 15 | 0 | 0/0 | 0 | 0 | NA | 12 to 15 |
| Groundwater (Off of Driving Range) | Explosives | 3 | 0 | 1/1 | 0 | 1 | NA | 4 |
| | Total Metals | 3 | 0 | 1/1 | 0 | 1 | NA | 4 |
| | Dissolved Metals[2] | 0 to 3 | 0 | 1/1 | 0 | 1[2] | NA | 0 to 4 |

| Matrix | Analytical Group | No. of Sampling Locations | No. of Field Duplicates | No. of MS/MSDs(1) | No. of Field Blanks | No. of Equipment Blanks | No. of VOC Trip Blanks | Total No. of Samples to Lab |
|---|---|---|---|---|---|---|---|---|
| **UXO 8** | | | | | | | | |
| Sediment (0 to 6 inches bgs) (Tidal Flats) | Metals | 12 | 2 | 1/1 | 0 | 1 | NA | 15 |
| | Explosives | 1 | 0 | 0/0 | 0 | 0 | NA | 1 |
| | pH | 12 | 0 | 0/0 | 0 | 0 | NA | 12 |
| | TOC | 12 | 2 | 0/0 | 0 | 0 | NA | 14 |
| Sediment (6 to 24 inches bgs) (Tidal Flats) | Metals | 12 | 2 | 1/1 | 0 | 1 | NA | 15 |
| | Explosives | 1 | 0 | 0/0 | 0 | 0 | NA | 1 |
| | pH | 12 | 0 | 0/0 | 0 | 0 | NA | 12 |
| | TOC | 12 | 2 | 0/0 | 0 | 0 | NA | 14 |

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. For total and dissolved metals, a duplicate sample will be collected in place of an MSD.

2 Dissolved metals will be collected at locations where the groundwater turbidity is above 10 NTU to address the potential effect from metals adhering to particulates. The equipment blank for dissolved metals, if collected, will be obtained by passing rinse water through a 0.45-micron filter.

## SAP Worksheet #21 -- Project SOP References Table

(UFP-QAPP Manual Section 3.1.2)

| 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 (Revision 0, August 2011) | Tetra Tech | NA | Y | Contained in Appendix D. |
| SOP-02 | Sample Identification Nomenclature (Revision 0, August 2011) | Tetra Tech | NA | Y | Contained in Appendix D. |
| SOP-03 | Sample Custody and Documentation of Field Activities (Revision 0, August 2011) | Tetra Tech | Field logbook, sample log sheets, boring logs | Y | Contained in Appendix D. |
| SOP-04 | Sample Preservation, Packaging, and Shipping (Revision 0, August 2011) | Tetra Tech | Sample containers, coolers, and packaging materials | Y | Contained in Appendix D. |
| SOP-05 | Lithologic Soil Sample Logging (Revision 0, August 2011) | Tetra Tech | General field supplies | Y | Contained in Appendix D. |
| SOP-06 | Soil Coring and Sampling Using Hand Auger Techniques(Revision 0, August 2011) | Tetra Tech | Stainless steel auger bucket, extension rods, and T-handle | Y | Contained in Appendix D. |
| SOP-07 | Subsurface Soil and Groundwater Sampling Using Direct-Push Technology (Revision 0, August 2011) | Tetra Tech | Sampling kit, macrocore sampler, probe sampling adapters, roto hammer with bit | Y | Contained in Appendix D. |
| SOP-08 | Increment Sampling for the Military Munitions Response Program (Revision 0, August 2011) | Tetra Tech | Hand held coring devise | Y | Contained in Appendix D. |
| SOP-09 | Sediment Sampling (Revision 0, August 2011) | Tetra Tech | Stainless steel or disposable trowels | Y | Contained in Appendix D. |
| SOP-10 | Large Water Body Sediment Sampling (Revision 0, August 2011) | Tetra Tech | Stainless steel trowel, large Ziploc-type baggies, petite ponar dredge with rope, boat | Y | Contained in Appendix D. |
| SOP-11 | Temporary Monitoring Well Installation and Abandonment (Revision 0, August 2011) | Tetra Tech | Health and safety equipment, well drilling and installation equipment, hydrogeologic equipment | Y | Contained in Appendix D. |
| SOP-12 | Temporary Well Development (Revision 0, August 2011) | Tetra Tech | Pump | Y | Contained in Appendix D. |
| SOP-13 | Measurement of Water Levels (Revision 0, August 2011) | Tetra Tech | Water level indicator | Y | Contained in Appendix D. |

| Reference Number | Title, Revision Date and / or Number | Originating Organization of Sampling SOP | Equipment Type | Modified for Project Work? (Y/N) | Comments |
|---|---|---|---|---|---|
| SOP-14 | Low-Flow Well Purging and Stabilization (Revision 0, August 2011) | Tetra Tech | Submersible pump, multiparameter meter, turbidimeter | Y | Contained in Appendix D. |
| SOP-15 | Calibration and Care of Water Quality Meters (Revision 0, August 2011) | Tetra Tech | Multiparameter meter, turbidimeter | Y | Contained in Appendix D. |
| SOP-16 | Groundwater Sampling (Revision 0, August 2011) | Tetra Tech | Multi-parameter water quality meter | Y | Contained in Appendix D. |
| SOP-17 | Management of Investigation-Derived Waste (Revision 0, August 2011) | Tetra Tech | NA | Y | Contained in Appendix D. |
| SOP-18 | Global Positioning System (Revision 0, August 2011) | Tetra Tech | GPS unit | Y | Contained in Appendix D. |
| SOP-19 | Decontamination of Field Sampling Equipment (Revision 0, August 2011) | Tetra Tech | Decontamination equipment, scrub brushes, 5-gallon buckets, spray bottles, phosphate-free detergent, deionized (DI) water | Y | Contained in Appendix D. |
| SOP HS-2.0 | Munitions and Explosives of Concern and Chemical Warfare Agents Activities (Revision 2, March 2008) | Tetra Tech | Metals detector, downhole magnetometer | N | Contained in Appendix D. |

## SAP Worksheet #22 -- Field Equipment Calibration, Maintenance, Testing, and Inspection Table

(UFP-QAPP Manual Section 3.1.2.4)

| Field Equipment | Activity | Frequency | Acceptance Criteria | Corrective Action | Responsible Person | SOP Reference[1] | Comments |
|---|---|---|---|---|---|---|---|
| DPT Rig | Inspection | Daily | Equipment Inspection Sheet Criteria | Correct deficiencies before operating | DPT subcontractor/ Tetra Tech FOL or designee | **SOP-06** | None. |
| Hand Auger | Inspection | Per use | NA. | Replace | Tetra Tech FOL or designee | **SOP-06** | None. |
| Disposable Hand Trowel | Inspection | Per use | NA. | Replace | Tetra Tech FOL or designee | **SOP-06** | None. |
| GPS | Positioning | Twice daily | Accuracy: for sub-meter horizontal dilution of precision (HDOP)<3, number of satellites must be at least six | Wait for better signal, replace unit, or choose alternate location technique | Tetra Tech FOL or designee | **MRP SOP 05, SOP-17** | None. |
| Magnetic Locator | Visual/Auditory Inspection | Beginning of day and after battery change | Verify operational. | Replace battery or instrument | UXO Technician | **MRP SOP 01** | None. |
| Electric Water Level Indicator | Visual/Auditory Inspection<br><br>Field checks as per manufacturer | Daily<br><br>Once upon receiving from vendor | 0.01 foot accuracy | Operator correction or replacement | Tetra Tech FOL or designee | **SOP-12**, Manufacturer's Guidance Manual | None. |
| Water Quality Meter (YSI Series 600 or equivalent) | Visual Inspection<br><br>Calibration/ Verification | Daily<br><br>Beginning and end of day | Manufacturer's guidance | Operator correction or replacement | Tetra Tech FOL or designee | **SOP-14**, **SOP-15**, Manufacturer's Guidance Manual | None. |
| Turbidity Meter (LaMotte 2020 or equivalent) | Visual Inspection<br><br>Calibration/ Verification | Daily<br><br>Beginning and end of day | Manufacturer's guidance; calibrations must bracket expected values; Initial Calibration Verification (ICV) must be <10 NTU. | Operator correction or replacement | Tetra Tech FOL or designee | **SOP-14**, **SOP-15**, Manufacturer's Guidance Manual | To be used to determine the need to collect Dissolved Metals samples (if >10 NTU). |
| Submersible Pump | Visual Inspection | Daily | Equipment Inspection Sheet Criteria | Replace | Tetra Tech FOL or designee | Manufacturer's Guidance Manual | None. |

[1] Specify the appropriate reference letter or number from the Project Sampling SOP References table (**Worksheet #21**).

## SAP Worksheet #23 -- Analytical SOP Reference Table

(UFP-QAPP Manual Section 3.2.1)

| Laboratory SOP Number | Title, Revision Date, and / or Number | Definitive or Screening Data | Matrix and Analytical Group | Instrument | Organization Performing Analysis | Variance to QSM? (Y/N) | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|---|
| GEL SOP GL-OA-E-071 | The Pre-Extraction Processing of Soil Samples Collected Using Multi-Incremental Sampling (MIS) Techniques (Revision 2, 10/2011) | Definitive | Soil / Explosives (IS samples only) | NA – Preparatory Laboratory Grinding | GEL | N | N |
| GEL SOP GL-OA-E-068 | Sample Processing and Analysis of Nitroaromatics, Nitramines, and Nitrate Esters by SW-846 8330B (Revision 4, 06/2011) | Definitive | Soil, sediment, groundwater, and aqueous QC samples / Explosives | See SOPs GL-OA-E-033 and GL-OA-E-056. | GEL | N | N |
| GEL SOP GL-OA-E-033 | Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC) (Revision 21, 01/2012) | Definitive | Soil, sediment, groundwater, and aqueous QC samples / Explosives | High Pressure Liquid Chromatography (HPLC)/ Diode Array Detector (DAD) | GEL | N | N |
| GEL SOP GL-OA-E-056 | Definitive Low Level Analysis of Nitroaromatic Explosives Utilizing Liquid Chromatography/ Mass Spectrometry/ Mass Spectrometry (LC/MS/MS) by SW-846 Method 8321 Modified (8321M) (Revision 16, 01/2012) | Definitive | Soil, sediment, groundwater, and aqueous QC samples / Explosives | Liquid Chromatography/ Mass Spectrometry/ Mass Spectrometry (LC/MS/MS) | GEL | N | N |
| GEL SOP GL-MA-E-006 | Acid Digestion of Total Recoverable or Dissolved Metals in Surface and Groundwater Samples for Analysis by ICP or ICP-MS (Revision 9, 03/2004) | Definitive | Groundwater and aqueous QC samples / Metals Digestion | NA – Sample Preparation | GEL | NA | N |
| GEL SOP GL-MA-E-008 | Acid Digestion of Total Metals in Aqueous Samples and Extracts for Analysis by ICP and ICP-MS (Revision 13, 04/2005) | Definitive | Groundwater and aqueous QC samples / Metals Digestion | NA – Sample Preparation | GEL | NA | N |
| GEL SOP GL-MA-E-009 | Acid Digestion of Sediment, Sludges and Soils (Revision 21, 03/2011) | Definitive | Soil and sediment / Metals Digestion | NA – Sample Preparation | GEL | NA | N |
| GEL SOP GL-MA-E-010 | Mercury Analysis Using the Perkin Elmer Automated Mercury Analyzer (Revision 25, 08/2011) | Definitive | Soil, sediment, groundwater, and aqueous QC samples / Mercury Digestion and Analysis | Cold Vapor Atomic Absorption (CVAA) | GEL | N | N |

| Laboratory SOP Number | Title, Revision Date, and / or Number | Definitive or Screening Data | Matrix and Analytical Group | Instrument | Organization Performing Analysis | Variance to QSM? (Y/N) | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|---|
| GEL SOP GL-MA-E-013 | Determination of Metals by ICP (Revision 20, 09/2009) | Definitive | Aqueous and Soil, Metals | Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) | GEL | N | N |
| GEL SOP GL-MA-E-014 | Determination of Metals by ICP-MS (Revision 24, 12/2011) | Definitive | Soil, sediment, groundwater, and aqueous field QC samples / Metals | Inductively Coupled Plasma - Mass Spectroscopy (ICP-MS) | GEL | N | N |
| GEL SOP GL-GC-E-008 | pH (Revision 20, 11/2011) | Definitive | Soil / pH | pH Meter | GEL | NA | N |
| GEL SOP GL-GC-E-062 | Total Carbon and Total Organic Carbon Analysis Using the Dohrmann DC-190 Boat Sampler (Revision 12, 11/2010) | Definitive | Soil and Sediment / TOC | TOC Analyzer | GEL | Y – Lloyd Kahn Method | N |

QSM – Quality Systems Manual for Environmental Laboratories, Version 4.1 (April, 2009), or more current.

## SAP Worksheet #24 -- Analytical Instrument Calibration Table

(UFP-QAPP Manual Section 3.2.2)

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference[1] |
|---|---|---|---|---|---|---|
| HPLC/DAD Explosives | Initial Calibration (ICAL) – A minimum of a 5-point calibration curve is analyzed | Prior to sample analysis. | The average response factor (RF) RSD for each target analyte must be ≤ 20%, or the linear least squares regression correlation coefficient (r) must be ≥ 0.990. | Correct problem, then repeat ICAL. No samples can be run without a valid ICAL. | Analyst, Supervisor | GEL SOP GL-OA-E-068, GL-OA-E-033 |
| | ICV - Second source | Once after each ICAL, prior to beginning a sample run. | All target analytes must be within established retention time (RT) windows. The %R of all target analytes and surrogates must be within 80-120% of the true value. | Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. No samples may be run until calibration has been verified. | Analyst, Supervisor | |
| | Initial Calibration Blank (ICB) | Before beginning a sample sequence. | All target analytes must be ≤ LOD. | Correct the problem, then re-prepare and reanalyze. | Analyst, Supervisor | |
| | RT Window Position Establishment | Once per ICAL for each target analyte and surrogate. | Absolute RT is set using the midpoint standard of the ICAL. | NA. | Analyst, Supervisor | |
| | Continuing Calibration Verification (CCV) | Prior to sample analysis, after every 10 field samples, and at the end of the analysis sequence. | All target analytes and surrogates must be ≤20 %D of the expected value from the ICAL. | Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since last successful CCV. | Analyst, Supervisor | |
| | Continuing Calibration Blank (CCB) | After the initial CCV, after every 10 samples, and at the end of the sequence. | All target analytes must be ≤ LOD. | Correct the problem, then re-prepare and reanalyze calibration blank and previous 10 samples. | Analyst, Supervisor | |
| | Low-Level Check Standard | Daily after 1-point ICAL and before samples. | The %R of all target analytes must be within 80-120% of true value. | Investigate and perform necessary equipment maintenance. Recalibrate and reanalyze all affected samples. | Analyst, Supervisor | |
| LC/MS/MS Explosives | Tune Verification – Sodium rubidium iodide | Prior to ICAL. | Must meet the ion abundance criteria required by the method. | Correct problem, then repeat tune. No samples can be run without a valid tune. | Analyst, Supervisor | GEL SOP GL-OA-E-068, GL-OA-E-056 |

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference[1] |
|---|---|---|---|---|---|---|
| | Initial Calibration (ICAL) – A minimum of a 5-point calibration curve is analyzed | Prior to sample analysis. | The average RF RSD for each target analyte must be ≤ 20%, or r must be ≥ 0.990, or the coefficient of determineation ($r^2$) must be ≥ 0.990 (six points are required for second order). | Correct problem, then repeat ICAL. No samples can be run without a valid ICAL. | Analyst, Supervisor | |
| | ICV - Second source | Once after each ICAL, prior to beginning a sample run. | The %R of all target analytes and surrogates must be within 85-115% of the true value. | Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. No samples may be run until calibration has been verified. | Analyst, Supervisor | |
| | ICB | Before beginning a sample sequence. | All target analytes must be ≤ LOQ. | Correct the problem, then re-prepare and reanalyze. | Analyst, Supervisor | |
| | RT Window Position Establishment | Once per ICAL for each target analyte and surrogate. | Due to the nature of LC/MS/MS per Method 8321, the RT of the analyte should be observed, but it is not significant in determining false positives. | NA. | Analyst, Supervisor | |
| | CCV | Prior to sample analysis, after every 10 field samples, and at the end of the analysis sequence. | All target analytes and surrogates must be ≤15 %D of the expected value from the ICAL. | Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since last successful CCV. | Analyst, Supervisor | |
| | CCB | After the initial CCV, after every 10 samples, and at the end of the sequence. | All target analytes must be ≤ LOQ. | Correct the problem, then re-prepare and reanalyze calibration blank and previous 10 samples. | Analyst, Supervisor | |
| | Low-Level Check Standard | Daily after 1-point ICAL and before samples. | The %R of all target analytes must be within 80-120% of true value. | Investigate and perform necessary equipment maintenance. Recalibrate and reanalyze all affected samples. | Analyst, Supervisor | |
| ICP-AES Metals | ICAL – A minimum of a 1-point calibration curve is analyzed | At the beginning of each day, prior to the analysis of samples. | None; only one high standard and a calibration blank must be analyzed. If more than one calibration point is used, r must be ≥ 0.995. | Correct problem then repeat ICAL. No samples may be run until ICAL has passed. | Analyst, Supervisor | GEL SOP GL-MA-E-013 |
| | ICV - Second source | Following ICAL, prior to the analysis of samples. | The %R of all target analytes must be within 90-110 % of the true value. | Correct problem then repeat ICV. If that fails, correct problem and repeat ICAL. | Analyst, Supervisor | |

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference[1] |
|---|---|---|---|---|---|---|
| | ICB | Before beginning a sample sequence. | No target analytes detected > LOD. For negative blanks, absolute value must be < LOD. | Correct the problem. Re-prepare and reanalyze ICB. All samples following the last acceptable calibration blank must be reanalyzed. | Analyst, Supervisor | |
| | CCV | After each 10 field samples and at the end of the analysis sequence. | The %R of all target analytes must be within 90-110 % of the true value. | Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since last successful CCV. | Analyst, Supervisor | |
| | CCB | After the initial CCV, after every 10 samples, and at the end of the sequence. | No target analytes detected > LOD. For negative blanks, absolute value must be < LOD. | Correct the problem. Re-prepare and reanalyze CCB. All samples following the last acceptable calibration blank must be reanalyzed. | Analyst, Supervisor | |
| | Low-Level Check Standard (if a 1-point calibration) | Daily after ICAL and before samples. | The %R of all target analytes must be within 80-120 % of the true value. | Correct problem, then reanalyze. No samples may be analyzed without a valid low-level calibration check standard. | Analyst, Supervisor | |
| | Interference Check Standard (ICS) - ICSA & ICSB | At the beginning of an analytical run and every 12 hours. | The absolute value of ICS A recoveries must be < LOD and ICS B %Rs must be within 80-120 % of the true value. | Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples. | Analyst, Supervisor | |
| ICP-MS Metals | Tuning | Prior to ICAL. | Mass calibration must be ≤ 0.1 atomic mass units (amu) from the true value. Resolution must be < 0.9 amu full width at 10% peak height. RSD must be ≤ 5% for five replicate analyses. | Retune instrument, then reanalyze tuning solutions. No analysis shall be performed without a valid tune. | Analyst, Supervisor | GEL SOP GL-MA-E-014 |
| | ICAL – A minimum of a 1-point calibration curve is analyzed | At the beginning of each day, prior to the analysis of samples. | None; only one high standard and a calibration blank must be analyzed. If more than one calibration point is used, r must be ≥ 0.998. | Correct problem then repeat ICAL. No samples may be run until ICAL has passed. | Analyst, Supervisor | |
| | ICV - Second source | Following ICAL, prior to the analysis of samples. | The %R of all target analytes must be within 90-110 % of the true value. | Correct problem then repeat ICV. If that fails, correct problem and repeat ICAL. | Analyst, Supervisor | |
| | ICB | Before beginning a sample sequence. | No target analytes detected > LOD. For negative blanks, absolute value must be < LOD. | Correct the problem. Re-prepare and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed. | Analyst, Supervisor | |

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference[1] |
|---|---|---|---|---|---|---|
| | CCV | After each 10 field samples and at the end of the analysis sequence. | The %R of all target analytes must be within 90-110 % of the true value. | Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since last successful CCV. | Analyst, Supervisor | |
| | CCB | After the initial CCV, after every 10 samples, and at the end of the sequence. | No target analytes detected > LOD. For negative blanks, absolute value must be < LOD. | Correct the problem. Re-prepare and reanalyze CCB. All samples following the last acceptable calibration blank must be reanalyzed. | Analyst, Supervisor | |
| | Low-Level Check Standard (if a 1-point calibration) | Daily after ICAL and before samples. | The %R of all target analytes must be within 80-120 % of the true value. | Correct problem, then reanalyze. No samples may be analyzed without a valid low-level calibration check standard. | Analyst, Supervisor | |
| | Interference Check Standard (ICS) - ICSA & ICSB | At the beginning of an analytical run and every 12 hours. | The absolute value of ICS A recoveries must be < LOD and ICS B %Rs must be within 80-120 % of the true value. | Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples. | Analyst, Supervisor | |
| CVAA Mercury | ICAL – A minimum of a 5-point calibration is prepared | Perform daily prior to sample analysis. | r must be ≥ 0.995. | Correct problem then repeat ICAL. No samples may be run until ICAL has passed. | Analyst, Supervisor | GEL SOP GL-MA-E-010 |
| | ICV – Second Source | Following ICAL, prior to the analysis of samples. | The %R for mercury must be within 90-110% of true value. | Correct problem and verify ICV. If that fails, correct problem and repeat ICAL. No samples may be run until ICV has been verified. | Analyst, Supervisor | |
| | Low-Level Check Standard | Daily after ICAL and before samples. | The %R of all target analytes must be within 80-120 % of the true value. | Correct problem, then reanalyze. No samples may be analyzed without a valid low-level calibration check standard. | Analyst, Supervisor | |
| | Calibration Blank | Before beginning a sample run, after every 10 samples, and at the end of the sequence. | No mercury detected > LOD. For negative blanks, absolute value must be < LOD. | Correct the problem, then re-prepare and reanalyze. | Analyst, Supervisor | |
| | CCV | Perform every 10 samples and at the end of the analytical sequence. | The %R for mercury must be within 80-120% of true value. | Correct problem and rerun CCV. If that fails, repeat ICAL and reanalyze all samples analyzed since the last successful CCV. | Analyst, Supervisor | |

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action | Person Responsible for Corrective Action | SOP Reference[1] |
|---|---|---|---|---|---|---|
| pH Meter<br>pH | ICAL – 2-point calibration with pH buffers with a mid-range calibration check | Daily before use. | Each buffer must read within ± 0.05 pH units of true value. | Check meter, buffer solutions, and probe; replace if necessary; repeat calibration. | Analyst, Supervisor | GEL SOP GL-GC-E-008 |
| | CCV | Analyze standard at the beginning and end of sequence and after every 5 samples. | Must read within ± 0.05 pH units of true value. | Correct problem and rerun CCV. If that fails, repeat ICAL and reanalyze all samples analyzed since the last successful CCV. | Analyst, Supervisor | |
| TOC Analyzer<br>TOC | ICAL – a 3-point calibration is prepared | Upon instrument receipt, major instrument change, or when the CCV does not meet criteria. | The %R must be within 80-120% of true value. | Correct problem then repeat ICAL. No samples may be run until ICAL has passed. | Analyst, Supervisor | GEL SOP GL-GC-E-062 |
| | ICV – Second Source | Once after each ICAL prior to sample analysis. | The %R must be within 80-120% of true value. | Correct problem and verify ICV. If that fails, correct problem and repeat ICAL. No samples may be run until ICV has been verified. | Analyst, Supervisor | |
| | ICB | Before beginning a sample sequence. | All target analytes must be ≤ LOQ. | Correct the problem, then re-prepare and reanalyze. | Analyst, Supervisor | |
| | CCV | Analyze standard at the beginning and end of sequence and after every 8 samples. | The %R must be within 80-120% of true value. | Correct problem and rerun CCV. If that fails, repeat ICAL and reanalyze all samples analyzed since the last successful CCV. | Analyst, Supervisor | |
| | CCB | After the initial CCV, after every 8 samples, and at the end of the sequence. | All target analytes must be ≤ LOQ. | Correct the problem, then re-prepare and reanalyze calibration blank and previous 10 samples. | Analyst, Supervisor | |

[1] Specify the appropriate reference letter or number from the Analytical SOP References table (**Worksheet #23**).

## SAP Worksheet #25 -- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

(UFP-QAPP Manual Section 3.2.3)

| Instrument / Equipment | Maintenance Activity | Testing Activity | Inspection Activity | Frequency | Acceptance Criteria | Corrective Action | Responsible Person | SOP Reference[1] |
|---|---|---|---|---|---|---|---|---|
| HPLC/DAD | Check pressure and gas supply daily, change analytical column as needed, change mobile phase when insufficient for run or contamination, change inlet filters as needed for contamination. Other maintenance specified in SOP. | Explosives | Check pump pressure, check for leaks, check for adequate mobile phase. | Prior to ICAL and as necessary. | Acceptable ICAL and CCV. | Correct the problem and repeat ICAL or CCV. | Analyst, Supervisor | GEL SOP GL-OA-E-033 |
| LC/MS/MS | Check vacuum pressure, rotary pumps, elements and traps; clean cone, nozzle, ion block, lenses as needed. Other maintenance specified in SOP. | Explosives | Ion source, injector, column pressure and baseline. | Prior to ICAL and as necessary. | Acceptable ICAL and CCV. | Correct the problem and repeat ICAL or CCV. | Analyst, Supervisor | GEL SOP GL-OA-E-056 |
| ICP-AES | Clean torch assembly and spray chamber when discolored or when degradation in data quality is observed. Clean nebulizer, check argon, and replace peristaltic pump tubing as needed. Other maintenance specified in SOP. | Metals | Torch, filters, nebulizer chamber, pump, pump tubing. | Prior to ICAL and as necessary. | Acceptable ICAL and CCV. | Correct the problem and repeat ICAL or CCV. | Analyst, Supervisor | GEL SOP GL-MA-E-013 |
| ICP-MS | Clean torch assembly and spray chamber when discolored or when degradation in data quality is observed. Clean nebulizer, check argon, and replace peristaltic pump tubing as needed. Other maintenance specified in SOP. | Metals | Torch, filters, nebulizer chamber, pump, pump tubing. | Prior to ICAL and as necessary. | Acceptable ICAL and CCV. | Correct the problem and repeat ICAL or CCV. | Analyst, Supervisor | GEL SOP GL-MA-E-014 |
| CVAA | Replace peristaltic pump tubing, replace mercury lamp, replace drying tube, clean optical cell and/or clean liquid/gas separator as needed. Other maintenance specified in SOP. | Mercury | Tubing, sample probe, optical cell. | Prior to ICAL and as necessary. | Acceptable ICAL and CCV. | Correct the problem and repeat ICAL or CCV. | Analyst, Supervisor | GEL SOP GL-MA-E-010 |

| Instrument / Equipment | Maintenance Activity | Testing Activity | Inspection Activity | Frequency | Acceptance Criteria | Corrective Action | Responsible Person | SOP Reference[1] |
|---|---|---|---|---|---|---|---|---|
| pH Meter | Clean, drain, and refill reference electrode as needed. | pH | Inspect reference electrode for white crystals or damage. | Before use. | pH 7.00 ± 0.05 pH units. | Recalibrate and/or perform necessary equipment maintenance. | Analyst, Supervisor | GEL SOP GL-GC-E-008 |
| TOC Analyzer | Check level of dilution water, drain vessel water, humidifier water, autosampler rinse water and phosphoric acid vessel and fill as needed. Replace oxygen cylinder. | TOC | Tubing, sample boat, syringe, humidifier, rinse Electrode, phosphoric acid vessel, oxygen pressure. | Prior to ICAL and as needed. | Acceptable ICAL and CCV. | Correct the problem and repeat calibration or CCV. | Analyst, Supervisor | GEL SOP GL-GC-E-062 |

[1] Specify the appropriate reference letter or number from the Analytical SOP References table (**Worksheet #23**).

## SAP Worksheet #26 -- Sample Handling System

(UFP-QAPP Manual Appendix A)

| **SAMPLE COLLECTION, PACKAGING, AND SHIPMENT** |
|---|
| Sample Collection (Personnel/Organization): FOL or designee / Tetra Tech |
| Sample Packaging (Personnel/Organization): FOL or designee / Tetra Tech |
| Coordination of Shipment (Personnel/Organization): FOL or designee / Tetra Tech |
| Type of Shipment/Carrier: Overnight courier service (FedEx) |
| **SAMPLE RECEIPT AND ANALYSIS** |
| Sample Receipt (Personnel/Organization): Sample Custodian / GEL |
| Sample Custody and Storage (Personnel/Organization): Sample Custodian / GEL |
| Sample Preparation (Personnel/Organization): Preparation laboratory staff / GEL |
| Sample Determinative Analysis (Personnel/Organization): Explosives Lab and Metals Lab personnel / GEL |
| **SAMPLE ARCHIVING** |
| Field Sample Storage (No. of days from sample collection): 60 days from submittal of final report |
| Sample Extract/Digestate Storage (No. of days from extraction/digestion): 60 days from submittal of final report |
| Biological Sample Storage (No. of days from sample collection): NA |
| **SAMPLE DISPOSAL** |
| Personnel/Organization: Sample Custodians / GEL |
| Number of Days from Analysis: 60 days from submittal of final report |

## SAP Worksheet #27 -- Sample Custody Requirements Table

(UFP-QAPP Manual Section 3.3.3)

### Field Sample Custody Procedures

GEL will provide pre-preserved sample containers for sample collection. Following sample collection into the appropriate bottle ware, all samples will be immediately placed on ice in a cooler. Glass sample containers will be enclosed in bubble-wrap in order to protect the bottle ware during shipment. The cooler will be secured using strapping tape along with a signed custody seal. Sample coolers will be delivered to a local courier location for priority overnight delivery to the selected laboratory for analysis. Samples will be preserved as appropriate based on the analytical method. Samples will be maintained at ≤ 6 °C (but not frozen) until delivery to the laboratory(s). Proper custody procedures will be followed throughout all phases of sample collection and handling.

Chain-of-custody protocols will be used throughout sample handling to establish the evidentiary integrity of samples. These protocols will be used to demonstrate that the samples were handled and transferred in a manner that would eliminate possible tampering. Samples for the laboratory will be packaged and shipped in accordance with **SOP-04**.

### Chain-of-Custody Procedures

After collection, each sample will be maintained in the sampler's custody until formally transferred to another party (e.g., FedEx). For all samples collected, chain-of-custody forms will document the date and time of sample collection, the sampler's name, and the names of all others who subsequently held custody of the sample. Specifications for chemical analyses will also be documented on the chain-of-custody form. **SOP-03** provides further details on the chain-of-custody procedure. Chain-of-custody requirements are also documented with instructions contained in each shipment from the laboratories.

### Laboratory Sample Custody Procedures

The laboratory sample custody procedures (receipt of samples, archiving, and disposal) documented in GEL SOPs will be followed. Coolers will be received and checked for proper temperature. A sample cooler receipt form will be completed to note conditions and any discrepancies. The chain-of-custody form will be compared against the sample containers received for correctness. Samples will be logged into the laboratory information management system (LIMS) and assigned a unique log number that can be tracked through processing. The Tetra Tech PM or Project Chemist will be notified of any problems by the GEL Laboratory PM on the same day that the issue is identified.

### Sample Designation System

Each sample collected for analysis will be assigned a unique sample tracking number. This number will consist of a two-segment alphanumeric code that identifies the site, the sample type (sample medium or QC sample designation), the sample location, and the sample depth indicator. **SOP-02** addresses sample identification nomenclature. All pertinent information regarding sample identification will be recorded in the field logbooks and on sample log sheets where appropriate.

## SAP Worksheet #28 -- QC Samples Table

(UFP-QAPP Manual Section 3.4)

| | |
|---|---|
| Matrix | Soil, sediment, groundwater, and aqueous field QC samples |
| Analytical Group | Explosives |
| Analytical Method/ SOP Reference | SW-846 8330B<br>GEL GL-MA-E-068/ -033/-056 |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action (CA) | Person(s) Responsible for Corrective Action | DQI | MPC |
|---|---|---|---|---|---|---|
| Method Blank | One per batch of 20 or fewer samples per matrix. | No analytes ≥½ LOQ. | Correct problem. If required, re-extract and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. | Analyst, Supervisor | Bias / Contamination | Same as QC Acceptance Limits. |
| Soil Grinding Blank (IS samples only) | Between each sample. | No analytes ≥½ LOQ. | All blank results must be reported and the affected samples must be flagged accordingly if blank criteria are not met. | Analyst, Supervisor | Bias / Contamination | Same as QC Acceptance Limits. |
| Surrogates | All field and QC samples.<br>One per sample:<br>3,4-Dinitrotoluene | %R must be within 50-150%. | The extract may be reanalyzed once to determine if the out of control result is instrument related. If the %R is below the lower control limit, all associated samples must be re-extracted and re-analyzed for that analyte. If the %R is above the upper control limit and samples are not detected, then results may be reported. | Analyst, Supervisor | Accuracy / Bias | Same as QC Acceptance Limits. |
| LCS/LCSD (LCSD not required) | One per batch of 20 or fewer samples per matrix. | %R for target analytes must be within DoD QSM Version 4.1 limits as per Appendix G. | Correct problem, then re-extract and reanalyze LCS and all samples processed with the failed analytes. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. | Analyst, Supervisor | Accuracy / Bias Precision also, if LCSD is analyzed | Same as QC Acceptance Limits. |

| | |
|---|---|
| Matrix | Soil, sediment, groundwater, and aqueous field QC samples |
| Analytical Group | Explosives |
| Analytical Method/ SOP Reference | SW-846 8330B<br>GEL GL-MA-E-068/ -033/-056 |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | Corrective Action (CA) | Person(s) Responsible for Corrective Action | DQI | MPC |
|---|---|---|---|---|---|---|
| MS/MSD | One per batch of 20 or fewer samples per matrix. | %R for target analytes should be within DoD QSM Version 4.1 limits as per Appendix G.<br>RPD between MS and MSD should be ≤20%. | If MS and MSD recoveries are unacceptable, but the LCS %R meets control limits, then the MS and MSD may be rerun to verify matrix interference. Examine the project DQOs and the Laboratory PM will contact the Tetra Tech Project Chemist to determine the course of action. | Analyst, Supervisor | Accuracy / Bias Precision | Same as QC Acceptance Limits. |
| Triplicates (Soils only) | One per batch of 20 or fewer samples per matrix. | RSD should be ≤20%, if sample results are > LOQ. | For samples with responses above the LOQ, re-extraction and re-analysis is required. For triplicates that fall outside the acceptance criteria with responses below the LOQ, the Laboratory PM will contact the Tetra Tech Project Chemist to decide if re-extraction is necessary. | Analyst, Supervisor | Precision | Same as QC Acceptance Limits. |
| Internal Standard (LC/MS/MS Only) | Every field sample, standard, and QC sample - two per sample – 1,3-Dinitrobenzene-$d_4$ 2,6-Dinitrobenzene-$d_3$ | Response areas must be within 70-130% of the average RF. | Reanalyze affected samples. | Analyst, Supervisor | Accuracy / Bias | Same as QC Acceptance Limits. |
| Second Column Confirmation (HPLC Only) | All positive results must be confirmed. | Results between primary and second column - RPD must be ≤ 40%. | None. Report from both columns. Apply "J" flag if RPD >40% and discuss in the case narrative. | Analyst, Supervisor | Precision | Same as QC Acceptance Limits. |
| Results between the DL and LOQ | NA. | Apply "J" qualifier to results detected between DL and LOQ. | None. | Analyst, Supervisor | Accuracy | Same as QC Acceptance Limits. |

| | |
|---|---|
| Matrix | Soil, sediment, groundwater, and aqueous field QC samples |
| Analytical Group | Metals (Including Mercury) |
| Analytical Method/ SOP Reference | SW-846 6010B/6020A/ 7470A/7471B<br>GEL GL-MA-E-010/ GL-MA-E-013/ GL-MA-E-014 |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for Corrective Action | DQI | MPC |
|---|---|---|---|---|---|---|
| Method Blank | One per batch of 20 or fewer samples per 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 batch of 20 or fewer samples per matrix. | %Rs 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/MSD (MSD not required) | One per batch of 20 or fewer samples per matrix. | The %R should be within 80-120% of true value (if sample < 4x spike added).<br>RPD between MS and MSD should be ≤20%. | Flag results for affected analytes for all associated samples. | Analyst, Supervisor | Accuracy / Bias Precision also, if MSD analyzed | Same as QC Acceptance Limits. |
| Duplicate Sample | One per batch of 20 or fewer samples per matrix (if MSD is not included). | RPD between duplicate samples should be ≤20%, if both results are >5x LOQ, or ± LOQ when ≤5x LOQ. | Narrate any results that are outside control limits. | Analyst, Supervisor | Precision | Same as QC Acceptance Limits. |

| | |
|---|---|
| Matrix | Soil, sediment, groundwater, and aqueous field QC samples |
| Analytical Group | Metals (Including Mercury) |
| Analytical Method/ SOP Reference | SW-846 6010B/6020A/ 7470A/7471B<br>GEL GL-MA-E-010/ GL-MA-E-013/ GL-MA-E-014 |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for Corrective Action | DQI | MPC |
|---|---|---|---|---|---|---|
| Serial Dilution (not needed for mercury) | One per batch of 20 or fewer samples per matrix with sample concentration(s) >50x LOD or on failure of MS/MSD. | The 5-fold dilution result must agree within ± 10%D of the original sample result if result is > 50x LOD. | Perform post spike addition. | Analyst, Supervisor | Precision | Same as QC Acceptance Limits. |
| Post-Digestion Spike (not needed for mercury) | When MS/MSD exceed criteria, serial dilution test fails, or all analyte concentrations are <50 x LOD. | The %R must be within 75-125% of expected value to verify the absence of 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. |
| IS (ICP-MS only) | Every sample. | IS intensity must be within 30-120% of intensity of the IS in the ICAL. | Reanalyze sample at 5-fold dilution with addition of appropriate amounts of IS. | Analyst, Supervisor | Precision | Same as QC Acceptance Limits. |
| Results between the DL and LOQ | NA. | Apply “J” qualifier to results detected between DL and LOQ. | None. | Analyst, Supervisor | Accuracy | Same as QC Acceptance Limits. |

| | |
|---|---|
| Matrix | Soil and sediment |
| Analytical Group | pH |
| Analytical Method/ SOP Reference | SW-846 9045D<br>GEL GL-GC-E-008 |

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for Corrective Action | DQI | MPC |
|---|---|---|---|---|---|---|
| LCS | One per batch of 20 or fewer samples per matrix. | Must be within 0.05 pH units of the true value. | Correct problem, recalibrate, and reanalyze samples. | Analyst, Supervisor | Accuracy / Bias | Same as QC Acceptance Limits. |
| Sample duplicate | One sample duplicate per every 10 field samples. | RPD must be ≤ 20%. | 1) Investigate problem and reanalyze sample in duplicate (2) If RPD is still unacceptable, report original result with notation or narration. | Analyst, Supervisor | Precision | Same as QC Acceptance Limits. |

| | |
|---|---|
| Matrix | Soil and sediment |
| Analytical Group | TOC |
| Analytical Method/ SOP Reference | SW-846 9060 Modified / Lloyd Kahn GEL GL-GC-E-062 |

| QC Sample | Frequency/ Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for Corrective Action | DQI | MPC |
|---|---|---|---|---|---|---|
| Method Blank | One per batch of 20 or fewer samples per matrix. | No analytes ≥ LOQ. | Investigate source of contamination. Evaluate samples and associated QC. Reprepare a method blank and the remaining samples. | Analyst, Supervisor | Bias / Contamination | Same as QC Acceptance Limits. |
| LCS | One per batch of 20 or fewer samples per matrix. | %R for TOC must be within 80-120% of the true value. | Investigate source of problem. If the LCS recovery is high but the sample results are < LOQ, narrate; otherwise, reanalyze the LCS and all effected samples. | Analyst, Supervisor | Accuracy / Bias | Same as QC Acceptance Limits. |
| MS | One per 10 or fewer samples per matrix. | %R should be within 75-125%. | If LCS in criteria and matrix interference suspected, flag data. Otherwise, reanalyze. | Analyst, Supervisor | Accuracy / Bias | Same as QC Acceptance Limits. |
| Laboratory Duplicates | All samples. | RPD should be ≤30%, if sample results are > LOQ. | If LCS in criteria and matrix interference suspected, flag data. Otherwise, reanalyze. | Analyst, Supervisor | Precision | Same as QC Acceptance Limits. |
| Laboratory Quadruplicates | One per batch of 20 or fewer samples per matrix is required per Lloyd Khan method. All other samples may be analyzed in duplicate. | RSD should be ≤30%, if sample results are > LOQ. | If LCS in criteria and matrix interference suspected, flag data. Otherwise, reanalyze. | Analyst, Supervisor | Precision | Same as QC Acceptance Limits. |
| Results between the DL and LOQ | NA. | Apply “J” qualifier to results detected between DL and LOQ. | None. | Analyst, Supervisor | Accuracy | Same as QC Acceptance Limits. |

## SAP Worksheet #29 -- Project Documents and Records Table

(UFP-QAPP Manual Section 3.5.1)

| Document | Where Maintained |
|---|---|
| **Field Documents**<br>Field Logbook (and sampling notes)<br>Field Sample Forms (e.g. boring logs, sample log sheets, drilling logs, etc.)<br>Chain-of-Custody Records<br>Sample Shipment Air Bills<br>Sampling Instrument Calibration Logs<br>Photographs<br>FTMR Forms<br>This SAP<br>Field Sampling SOPs<br>Health and Safety Plan | Field documents will be maintained in the project file located in the Tetra Tech King of Prussia, Pennsylvania office. |
| **Laboratory Documents**<br>Sample Receipt, Custody, and Tracking Record<br>Equipment Calibration Logs<br>Analysis Run Logs<br>Corrective Action Forms<br>Reported Results for Standards, QC Checks, and QC Samples<br>Raw Data<br>Data Completeness Checklist | Laboratory documents will be included in the hardcopy and Portable Document Format (PDF) deliverables from the laboratory. Laboratory data deliverables will be maintained in the Tetra Tech King of Prussia, Pennsylvania project file and in long-term data package storage at a third-party professional document storage firm.<br><br>Electronic data results will be maintained in a database on a password protected Structured Query Language (SQL) server. |
| **Assessment Findings**<br>All versions of the SAP<br>All letter and e-mail correspondence with regulatory agencies, including approvals and comments<br>Data Validation Memoranda (includes tabulated data summary forms) | All assessment documents will be maintained in the Tetra Tech King of Prussia, Pennsylvania project file. |
| **Reports**<br>UXO Sites 2 to 8 RI Report | All versions of the UXO Sites 2 to 8 RI Report and all support documents (e.g., Data Validation Reports) will be stored in hardcopy in the Tetra Tech King of Prussia, Pennsylvania project file and electronically in the server library. |

**Data Handling and Management** - After the RI is completed, the 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 GEL will meet the requirements of the technical specifications. The electronic data results will be automatically uploaded into the Tetra Tech database in accordance with the proprietary Tetra Tech processes.

**Data Tracking and Control** - 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 GEL. Upon receipt of the data packages from GEL, the Tetra Tech Project Chemist will oversee the data validation effort, which includes verifying that the data packages are complete and that results for all samples have been delivered by GEL.

- **Data Storage, Archiving, and Retrieval**. The data packages received from GEL 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 logbooks, sample log sheets, 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. The 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.

## SAP Worksheet #30 -- Analytical Services Table

(UFP-QAPP Manual Section 3.5.2.3)

| Matrix | Analytical Group | Sample Location/ ID Number | Analytical Method | Data Package Turnaround Time | Laboratory/ Organization (name and address, contact person and telephone number) | Backup Laboratory/ Organization (name and address, contact person and telephone number) |
|---|---|---|---|---|---|---|
| Soil and Sediment | Explosives | See **Worksheet #18** | SW-846 8330B | 21 calendar days | General Engineering Laboratories, LLC<br>2040 Savage Road<br>Charleston, SC 29407<br><br>Contact:<br>Tasha Horton<br>Laboratory PM<br>843.556.8171 | NA |
| | Metals (Including Mercury) | | SW-846 6010B/6020A/ 7471A | | | |
| | pH | | SW-846 9045D | | | |
| Sediment | TOC | See **Worksheet #18** | SW-846 9060 Modified/ Lloyd Kahn | 21 calendar days | | |
| Aqueous Field QC Samples | Explosives | See **Worksheet #18** | SW-846 8330B | 21 calendar days | | |
| | Metals (Including Mercury) | | SW-846 6010B/6020A/ 7470A | | | |

## SAP Worksheet #31 -- Planned Project Assessments Table

(UFP-QAPP Manual Section 4.1.1)

| **Assessment Type** | **Frequency** | **Internal or External** | **Organization Performing Assessment** | **Person(s) Responsible for Performing Assessment** (title and organizational affiliation) | **Person(s) Responsible for Responding to Assessment Findings** (title and organizational affiliation) | **Person(s) Responsible for Identifying and Implementing Corrective Actions** (title and organizational affiliation) | **Person(s) Responsible for Monitoring Effectiveness of Corrective Action** (title and organizational affiliation) |
|---|---|---|---|---|---|---|---|
| Laboratory Systems Audit[1] | Every two years | External | DoD ELAP Accrediting Body | DoD ELAP Accrediting Body Auditor | Laboratory QA Manager or Laboratory Manager, GEL | Laboratory QA Manager or Laboratory Manager, GEL | Laboratory QA Manager or Laboratory Manager, GEL |

[1] GEL is DoD ELAP accredited and SCDHEC certified for all analytical groups and target analytes required for this project, including the laboratory grinding procedure for SW-846 Method 8330B in accordance with SW-846 8330B Appendix A. The DoD ELAP and SCDHEC accreditation documentation is included in **Appendix E**.

## SAP Worksheet #32 -- Assessment Findings and Corrective Action Responses

(UFP-QAPP Manual Section 4.1.2)

| **Assessment Type** | **Nature of Deficiencies Documentation** | **Individual(s) Notified of Findings** (name, title, organization) | **Timeframe of Notification** | **Nature of Corrective Action Response Documentation** | **Individual(s) Receiving Corrective Action Response** (name, title, organization) | **Timeframe for Response** |
|---|---|---|---|---|---|---|
| Laboratory Systems Audit | Written audit report | Laboratory QA Manager, GEL | Specified by DoD ELAP Accrediting Body | Letter | DoD ELAP Accrediting Body | Specified by DoD ELAP Accrediting Body |

## SAP Worksheet #33 -- QA Management Reports Table

(UFP QAPP Manual Section 4.2)

| Type of Report | Frequency (daily, weekly monthly, quarterly, annually, etc.) | Projected Delivery Date(s) | Person(s) Responsible for Report Preparation (title and organizational affiliation) | Report Recipient(s) (title and organizational affiliation) |
|---|---|---|---|---|
| Data validation report | Per Sample Delivery Group (SDG) | Within two weeks after receiving the data from the laboratory | DVM or designee, Tetra Tech | PM and project file, Tetra Tech |
| Project monthly progress report | Monthly for duration of the project | Monthly | PM, Tetra Tech | Navy RPM, Navy; CLEAN QAM, Program Manager, and project file, Tetra Tech |
| Laboratory QA report | When significant plan deviations results from unanticipated circumstances | Immediately upon detection of problem (on the same day) | Laboratory PM, GEL | PM and project file, Tetra Tech |

## SAP Worksheet #34 -- Verification (Step I) Process Table - Preparatory and Initial Inspection

(UFP-QAPP Manual Section 5.2.1)

| Verification Input | Description | Internal / External | Responsible for Verification (name, organization) |
|---|---|---|---|
| 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. | Internal | Sampler and FOL, Tetra Tech |
| | 1 - The Laboratory Sample Custodian will review the sample shipment for completeness, 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. | External | 1 - Laboratory Sample Custodian, GEL<br>2 - Data Validators, Tetra Tech |
| SAP Sample Tables/ Chain-of-Custody Forms | 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. | Internal | FOL or designee, Tetra Tech |
| Sample Log Sheets | Verify that information recorded in the log sheets is accurate and complete. | Internal | FOL or designee, Tetra Tech |
| SAP/ Field Logs/ Analytical Data Packages | Ensure that all sampling SOPs were followed. Verify that deviations have been documented and MPCs have been achieved. Particular attention should be given to 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. | Internal | PM or designee, Tetra Tech |
| SAP/ Analytical SOPs/ Analytical Data Packages | Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied. | Internal | Laboratory QAM, GEL |
| SAP/ Laboratory SOPs/ Raw Data/ Applicable Control Limits Tables | 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. | Internal | Laboratory QAM, GEL |

| Verification Input | Description | Internal / External | Responsible for Verification (name, organization) |
|---|---|---|---|
| SAP/ Chain-of-Custody Forms | Check that field QC samples listed in **Worksheet #20** were collected as required. | Internal | FOL or designee, Tetra Tech |
| Electronic Data Deliverables/ Analytical Data Packages | Each EDD will be verified against the chain-of-custody and hard copy data package for accuracy and completeness. Laboratory analytical results will be verified and compared to the electronic analytical results for accuracy. Sample results will be evaluated for laboratory contamination and will be qualified for false positives using the laboratory method/preparation blank summaries. Positive results reported between the DL and the LOQ will be qualified as estimated. Extraneous laboratory qualifiers will be removed from the validation qualifier. | External | Data Validators, Tetra Tech |
| Analytical Data Packages | All analytical data packages will be verified internally for completeness by the laboratory performing the work. The Laboratory QAM will sign the case narrative for each data package. | Internal | Laboratory QAM, GEL |
| | Each data package will be verified for completeness by the Tetra Tech Data Validator. Missing information will be requested by the Tetra Tech Data Validator from the GEL Laboratory PM. | External | Data Validators, Tetra Tech |

Notes:
Verification includes field data verification and laboratory data verification. Verification inputs as per **Worksheet #34** will be checked.

## SAP Worksheet #35 -- Validation (Steps IIa and IIb) Process Table

(UFP-QAPP Manual Section 5.2.2) (Figure 37 UFP-QAPP Manual) (Table 9 UFP-QAPP Manual)

| Step IIa / IIb | Validation Input | Description | Responsible for Validation (name, organization) |
|---|---|---|---|
| IIa | SAP/ Sample Log Sheets | Ensure that sample locations are correct and in accordance with the SAP proposed locations. Document any discrepancies in the final report. | PM, FOL, or designee, Tetra Tech |
| IIa | Chain-of-Custody Forms | 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 store at the required temperature and sample pH for chemically-preserved samples meet the requirements listed in **Worksheet #19**. Ensure that the analyses were performed within the holding times listed in **Worksheet #19**. | Project Chemist or Data Validators, Tetra Tech |
| IIa/IIb | SAP/ Laboratory Data Packages/ EDDs | Ensure that the laboratory QC samples listed in **Worksheet #28** were analyzed and that the MPCs listed in **Worksheet #12** 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. | Project Chemist or Data Validators, Tetra Tech |
| | | Check the field sampling precision by calculating the RPD for field duplicate samples and the RSD for field triplicate samples. Check the 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 **Worksheet #12**. | |
| | | Check that the laboratory recorded the temperature at sample receipt and the pH of the chemically preserved samples to ensure sample integrity from sample collection to analysis. | |
| | | 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. Validation will be performed as per **Worksheet #36**. Check that all data have been transferred correctly and completely to the final SQL database. | |

| Step IIa / IIb | Validation Input | Description | Responsible for Validation (name, organization) |
|---|---|---|---|
| IIb | SAP/ Laboratory Data Packages/ EDDs | Ensure that the project LOQs listed in **Worksheet #15** were achieved. | Project Chemist or Data Validators, Tetra Tech |
| | | Discuss the impact on reported DLs due to matrix interferences or sample dilutions performed because of the high concentration of one or more other contaminants, on the other target compounds reported as non-detected. 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 **Worksheet #15**. | |
| | | 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. | |
| | | 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 the project database qualified data depicting data qualifiers and data qualifiers 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. | |

## SAP Worksheet #36 -- Analytical Data Validation (Steps IIa and IIb) Summary Table

(UFP-QAPP Manual Section 5.2.2.1)

| Step IIa/IIb | Matrix | Analytical Group | Validation Criteria | Data Validator (title and organizational affiliation) |
|---|---|---|---|---|
| IIa and IIb | Soil, Sediment, Surface Water, and Aqueous QC Samples | Explosives | Limited data validation will be performed using criteria for SW-846 Method 8330B listed in **Worksheets #12, 15, 24, and 28**, and the current DoD QSM. If not included in the aforementioned, then the logic outlined in the "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" EPA-540/R-99-008 (USEPA, October 1999) will be used to apply qualifiers to data. | Project Chemist or Data Validator, Tetra Tech |
| IIa and IIb | Soil, Sediment, Surface Water, and Aqueous QC Samples | Metals (Including Mercury) | Limited data validation will be performed using criteria for SW-846 Methods 6020, 7470A, and 7471A listed in **Worksheets #12, 15, 24, and 28**, and the current DoD QSM. If not included in the aforementioned, then the logic outlined in the "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review", EPA 540-R-04-004 (USEPA, October 2004) will be used to apply qualifiers to data. | Project Chemist or Data Validator, Tetra Tech |
| IIa and IIb | Sediment | pH | Data validation will not be performed on pH data. | None |
| IIa and IIb | Sediment | TOC | Data validation will not be performed on TOC data. | None |

Limited data validation focuses the review to specific review parameters (Data Completeness/Data Verification, Holding times, Calibrations, Blank Contamination, and Detection Limits) to determine gross deficiencies only. The limited data validation is best expressed as a review to preclude the possibility of false negatives and to eliminate false positives. Raw data are not evaluated and sample result verification is not conducted. A formal report, similar to a full data validation report, is prepared but the scope is more limited than a full validation report. The data packages provided by GEL will be expansive enough to allow future complete formal data validation to be performed, if necessary.

## SAP Worksheet #37 -- Usability Assessment

(UFP-QAPP Manual Section 5.2.3)

**Data Usability Assessment**

The usability of the data generated during the project directly affects whether project objectives can be achieved. The following characteristics will be evaluated at a minimum. The results of these evaluations will be included in the project report. The characteristics will be evaluated for multiple concentration levels if the evaluator determines that this is necessary. To the extent required by the type of data being reviewed, the assessors will consult with other technically competent individuals to render sound technical assessments of these DQI characteristics:

**Completeness**

- For each matrix that was scheduled to be sampled, the Tetra Tech FOL acting on behalf of the Partnering Team will prepare a table listing planned samples/analyses to collected samples/analyses. If deviations from the scheduled sample collection or analyses are identified, the Tetra Tech PM and Project Risk Assessor(s) will determine whether the deviations compromise the ability to meet project objectives. If they do, the Tetra Tech PM will consult with the Navy RPM and other project team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions.

**Precision**

- The Tetra Tech Project Chemist acting on behalf of the Partnering Team will determine whether precision goals for field duplicates and laboratory duplicates were met. This will be accomplished by comparing duplicate results to precision goals identified in **Worksheets #12 and 28**. This will also include a comparison of field and laboratory precision with the expectation that laboratory duplicate results will be no less precise than field duplicate results. If the goals are not met, or data have been flagged as estimated (J qualifier), limitations on the use of the data will be described in the project report.

**Accuracy**

- The Tetra Tech Project Chemist acting on behalf of the Partnering Team will determine whether the accuracy/bias goals were met for project data. This will be accomplished by comparing percent recoveries of LCS, LCSD, MS, MSD, and surrogate compounds to accuracy goals identified in **Worksheet #28**. This assessment will include an evaluation of field and laboratory contamination; instrument calibration variability; and analyte recoveries for surrogates, matrix spike, and laboratory control samples. If the goals are not met, limitations on the use of the data will be described in the project report. Bias of the qualified results and a description of the impact of identified non-compliances on a specific data package or on the overall project data will be described in the project report.

**Representativeness**

- A Project Scientist identified by the Tetra Tech PM and acting on behalf of the Partnering Team will determine whether the data are adequately representative of intended populations, both spatially and temporally. This will be accomplished by verifying that samples were collected and processed for analysis in accordance with the SAP, by reviewing spatial and temporal data variations, and by comparing these characteristics to expectations. The usability report will describe the representativeness of the data for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Project Scientist indicates that a quantitative analysis is required.

**Comparability**

- The Tetra Tech Project Chemist acting on behalf of the Partnering Team will determine whether the data generated under this project are sufficiently comparable to historical site data generated by different methods and for samples collected using different procedures and under different site conditions. This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Tetra Tech Project Chemist indicates that such quantitative analysis is required. Dissolved and total metals results will also be compared to ensure that dissolved metals results are not greater than total metals concentrations after allowance for typical measurement uncertainty.

**Sensitivity**

- The Tetra Tech Project Chemist acting on behalf of the Partnering Team will determine whether project sensitivity goals listed in **Worksheet #15** were achieved. The overall sensitivity and quantitation limits from multiple data sets for each matrix and analysis will be compared. If sensitivity goals are not achieved, the limitations on the data will be described. The Tetra Tech Project Chemist will enlist the help of the Tetra Tech Risk Assessor to evaluate deviations from planned sensitivity goals.

**Project Assumptions and Data Outliers**

- The Tetra Tech PM and designated team members will evaluate whether project assumptions are valid. This will typically be a qualitative evaluation but may be supported by quantitative evaluations. The type of evaluation depends on the assumption being tested. Quantitative assumptions include assumptions related to data distributions (e.g., normal versus log-normal) and estimates of data variability. Potential outliers will be removed if a review of the associated indicates that the results have an assignable cause the renders them inconsistent with the rest of the data. During this evaluation, the team will consider whether outliers could be indications of unanticipated site conditions. Consideration will be given to whether outliers represent an unanticipated site condition.

**Describe the evaluative procedures used to assess overall measurement error associated with the project:**

After completion of the data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples exhibiting non-detected results, number of samples exhibiting positive results, and the proportion of samples with detected and non-detected results. The Partnering Team members identified by the Tetra Tech PM will assess whether the data collectively support the attainment of project objectives. They will consider whether any missing or rejected data have compromised the ability to make decisions or to make the decisions with the desired level of confidence. The data will be evaluated to determine whether missing or rejected data can be compensated by other data. Although rejected data will generally not be used, there may be reason to use them in a weight of evidence argument, especially when they supplement data that have not been rejected. If rejected data are used, their use will be supported by technically defensible rationales.

For mathematical manipulations, non-detected values will be represented by a concentration equal to one-half the sample-specific reporting limit. Duplicate results (original and duplicate) will not be averaged for the purpose of representing the range of concentrations. However, the average of the original and duplicate samples will be used to represent the concentration at a particular sampled location.

**Identify the personnel responsible for performing the usability assessment**:

The Tetra Tech PM, Project Chemist, FOL, and Project Scientist will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the Navy RPM, the USEPA RPM, and the SCDHEC PM. If deficiencies affecting the attainment of project objectives are identified, the review will take place either in a face to face meeting or a teleconference depending on the extent of identified deficiencies. If no significant deficiencies are identified, the data usability assessment will simply be documented in the project report and reviewed during the normal document review cycle.

**Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:**

The data will be presented in tabular format, including data qualifications such as estimation (J, UJ) or rejection (R). Written documentation will support the non-compliance estimated or rejected data results. The project report will identify and describe the data usability limitations and suggest re-sampling or other corrective actions, if necessary.

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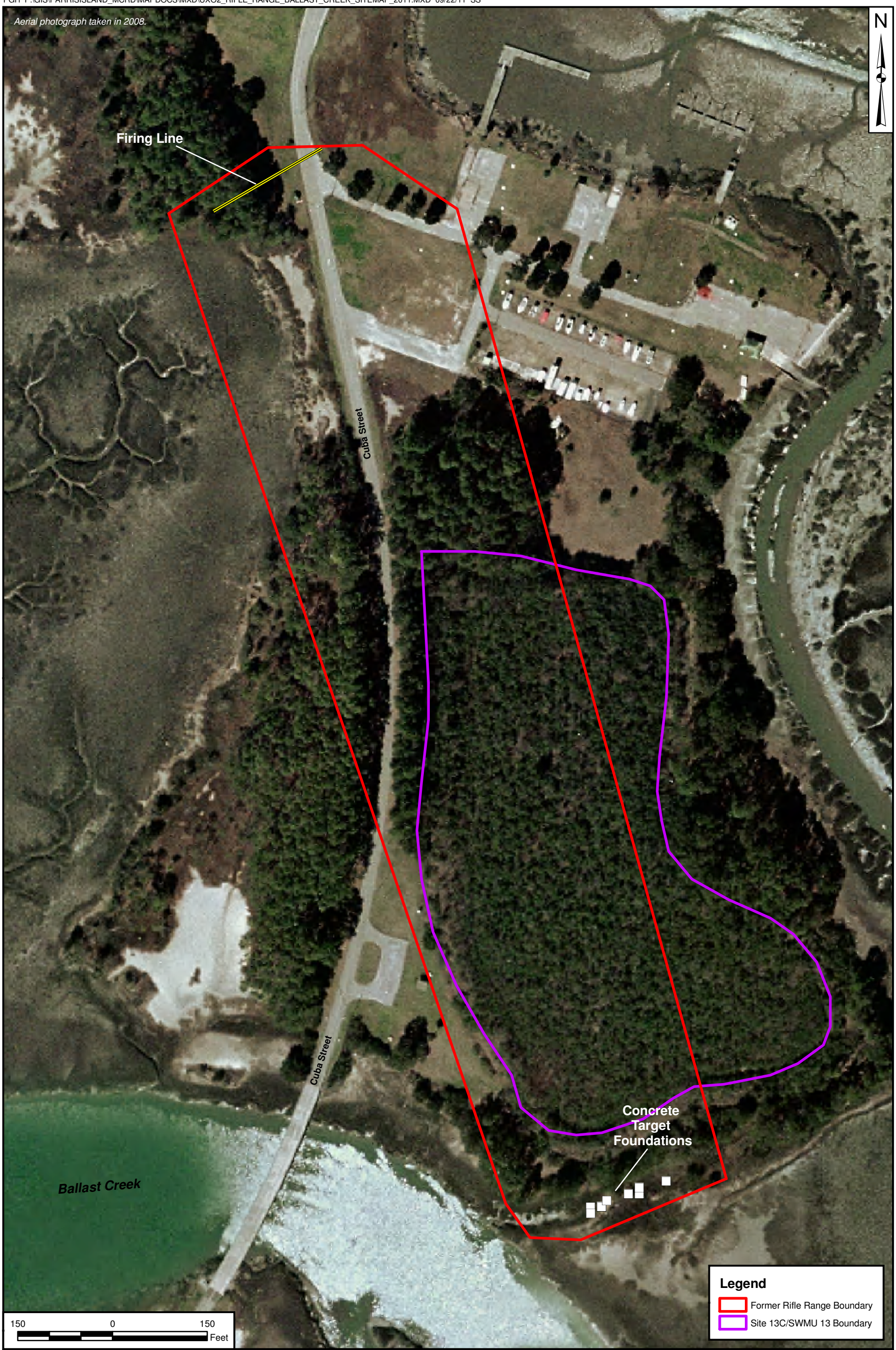
# FIGURES

PGH P:\GIS\PARRISISLAND_MCRD\MAPDOCS\MXD\UXO2_RIFLE_RANGE_BALLAST_CREEK_SITEMAP_2011.MXD 09/22/11 SS

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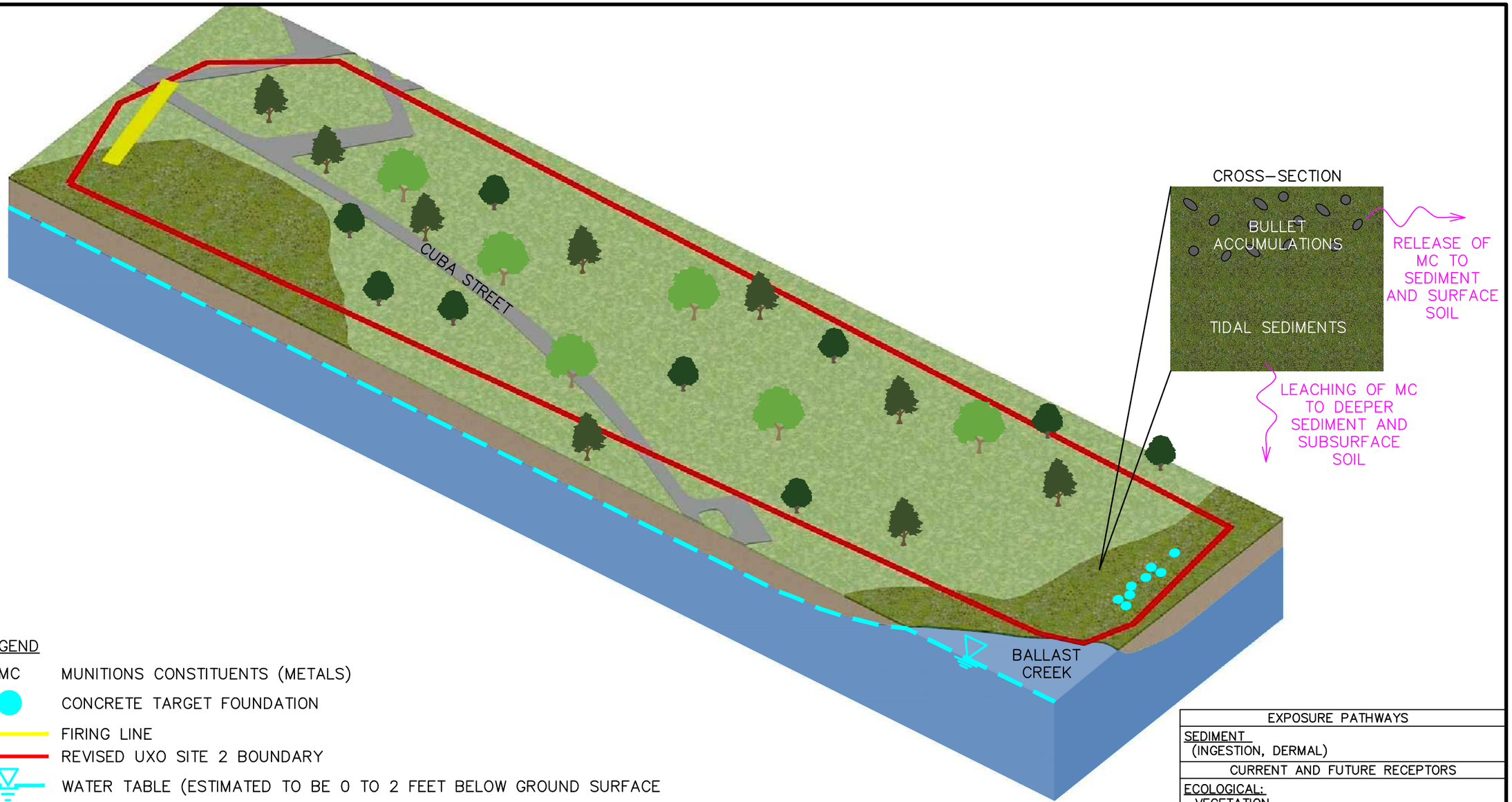
|---|---|
| DRAWN BY: J. ENGLISH | DATE: 08/16/11 |
| CHECKED BY: B. BECKER | DATE: 09/22/11 |
| REVISED BY: ___ | DATE: ___ |
| SCALE: AS NOTED | |

SITE LOCATION
RIFLE RANGE AT BALLAST CREEK - UXO 2
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER: 02296 | CTO NUMBER: JM10 |
| APPROVED BY: ___ | DATE: ___ |
| APPROVED BY: ___ | DATE: ___ |
| FIGURE NO.: FIGURE 10-1 | REV: 0 |




LEGEND

- MC — MUNITIONS CONSTITUENTS (METALS)
- CONCRETE TARGET FOUNDATION
- FIRING LINE
- REVISED UXO SITE 2 BOUNDARY
- WATER TABLE (ESTIMATED TO BE 0 TO 2 FEET BELOW GROUND SURFACE
- MARSH
- WOODED AREA
- WATER

| EXPOSURE PATHWAYS |
|---|
| SEDIMENT (INGESTION, DERMAL) |
| CURRENT AND FUTURE RECEPTORS |
| ECOLOGICAL: –VEGETATION –WILDLIFE (FOOD CHAIN EXPOSURE) |

| | | |
|---|---|---|
| DRAWN BY ND DATE 8/17/11 | UXO 2 – RIFLE RANGE AT BALLAST CREEK CONCEPTUAL SITE MODEL MCRD PARRIS ISLAND PARRIS ISLAND, SOUTH CAROLINA | CONTRACT NO. 2296 |
| CHECKED BY BWB DATE 9/21/11 | | OWNER NO. |
| REVISED BY DATE | | APPROVED BY DATE |
| SCALE NOT TO SCALE | | DRAWING NO. FIGURE 10–2 REV. 0 |

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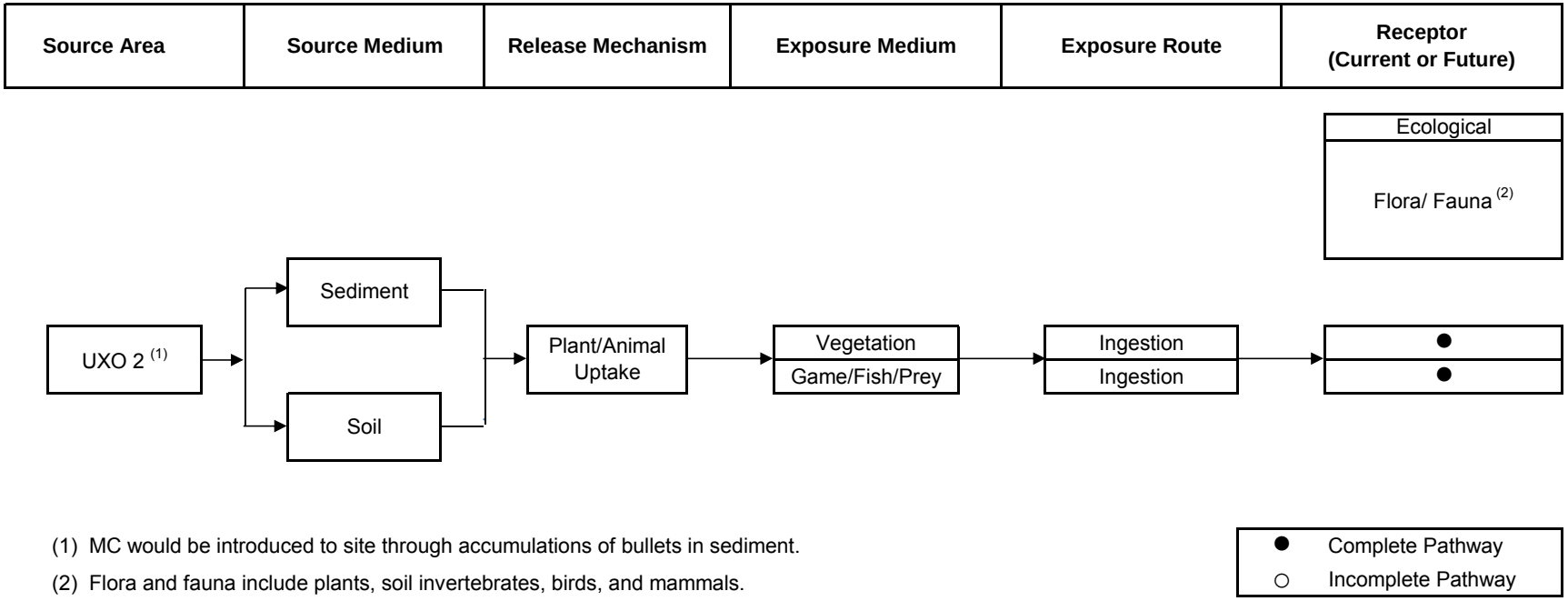
**FIGURE 10-3**

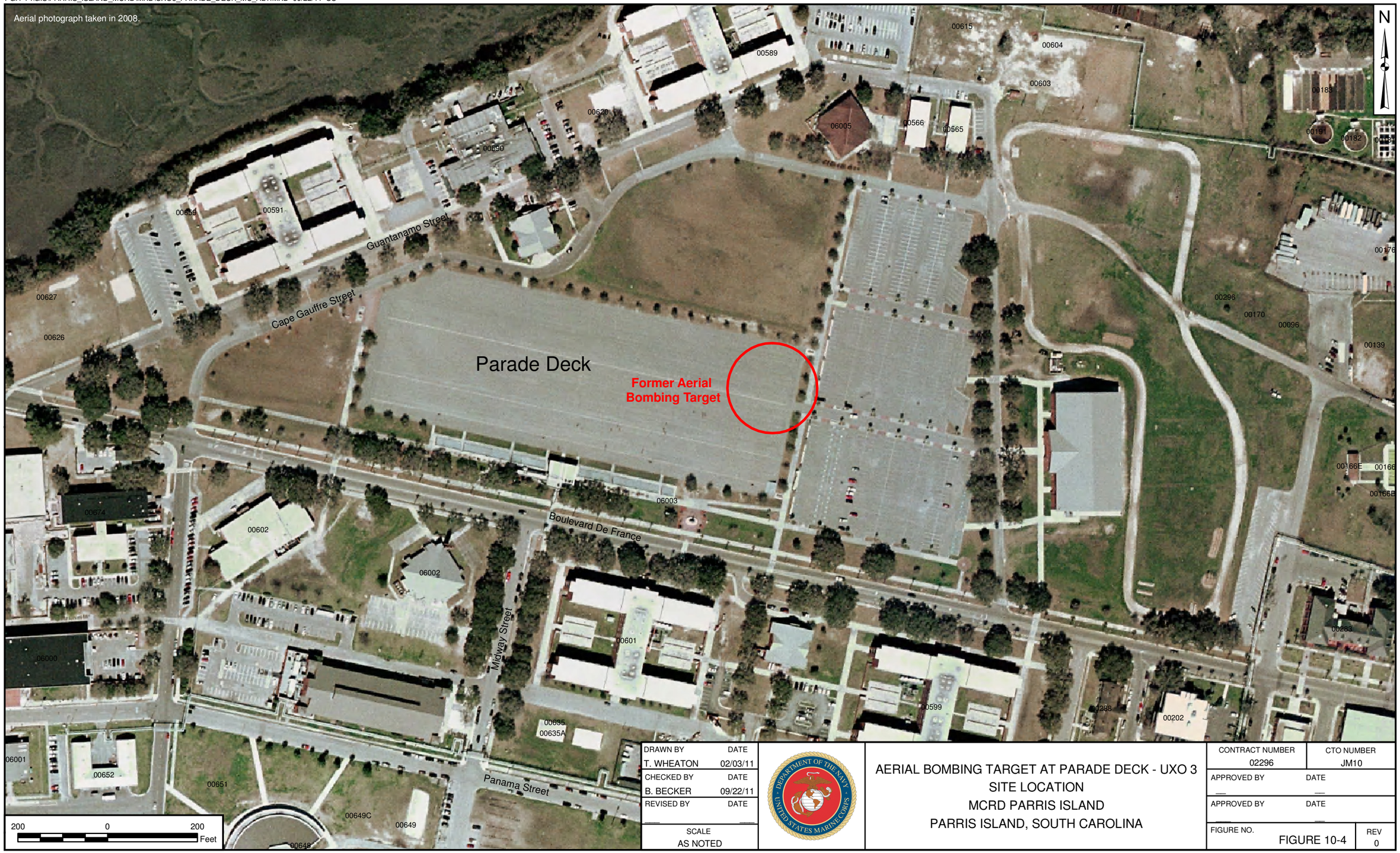
**UXO 2 - RIFLE RANGE AT BALLAST CREEK**
**MC EXPOSURE PATHWAY ANALYSIS**
**MCRD PARRIS ISLAND**
**PARRIS ISLAND, SOUTH CAROLINA**




(1) MC would be introduced to site through accumulations of bullets in sediment.

(2) Flora and fauna include plants, soil invertebrates, birds, and mammals.

PGH P:\GIS\PARRIS_ISLAND_MCRD\MXD\UXO3_PARADE_DECK_MC_ALT.MXD 09/22/11 SS

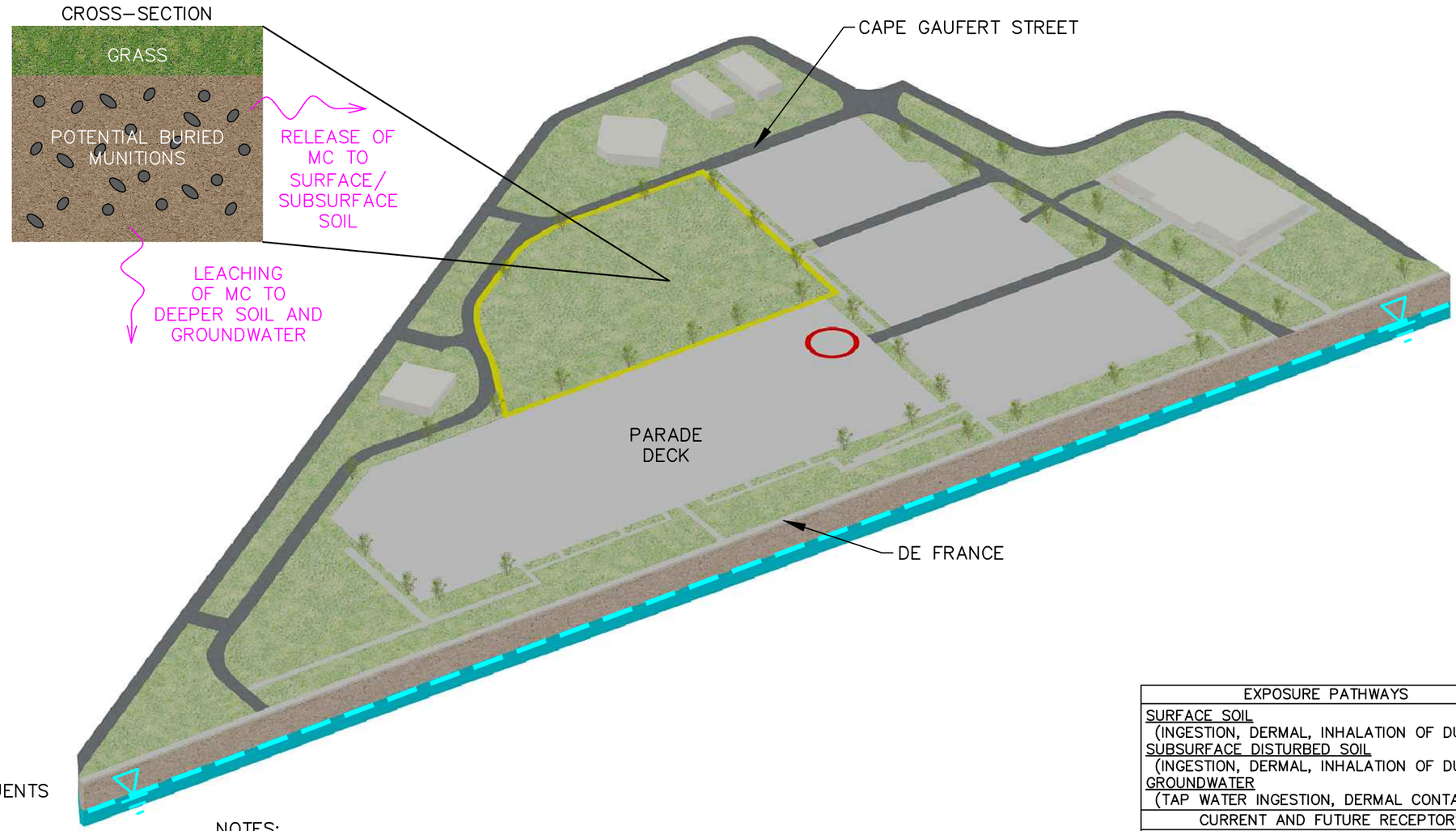



| DRAWN BY | DATE |
|---|---|
| T. WHEATON | 02/03/11 |
| CHECKED BY | DATE |
| B. BECKER | 09/22/11 |
| REVISED BY | DATE |
| SCALE | |
| AS NOTED | |

AERIAL BOMBING TARGET AT PARADE DECK - UXO 3
SITE LOCATION
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| CONTRACT NUMBER | CTO NUMBER |
|---|---|
| 02296 | JM10 |
| APPROVED BY | DATE |
| APPROVED BY | DATE |
| FIGURE NO. FIGURE 10-4 | REV 0 |

Text




LEGEND

| | |
|---|---|
| MC | MUNITIONS CONSTITUENTS (METALS) |
| | UXO 3 TARGET AREA |
| | MEC SI GEOPHYSICAL SURVEY AREA BOUNDARY |
| | WATER TABLE (ASSUMED TO BE 3 TO 10 FEET BELOW GROUND SURFACE) |
| | PAVED AREAS |
| | GRASSY AREAS |

NOTES:

1. NO MUNITIONS–RELATED ITEMS LOCATED ON SURFACE DURING SI.
2. 780 ANOMALIES IDENTIFIED IN GEOPHYSICAL SURVEY AREA DURING SI.
3. GROUNDWATER IS NOT USED AS DRINKING WATER SOURCE.
4. FUTURE LAND USE IS ANTICIPATED TO BE SIMILIAR TO CURRENT LAND USE, SO RESIDENTIAL USE IS HYPOTHETICAL.
5. LAND USE REPRESENTS AN INDUSTRIAL/ URBANIZED AREA AND CURRENTLY NOT A VIABLE HABITAT FOR MOST WILDLIFE.

| EXPOSURE PATHWAYS |
|---|
| SURFACE SOIL<br>(INGESTION, DERMAL, INHALATION OF DUSTS)<br>SUBSURFACE DISTURBED SOIL<br>(INGESTION, DERMAL, INHALATION OF DUSTS)<br>GROUNDWATER<br>(TAP WATER INGESTION, DERMAL CONTACT) |
| CURRENT AND FUTURE RECEPTORS |
| HUMAN:<br>–MILITARY/CIVILIAN SITE WORKER<br>–CONSTRUCTION/MAINTENANCE WORKER<br>–VISITOR<br>–RESIDENT (HYPOTHETICAL)<br>ECOLOGICAL:<br>–VEGETATION |

| | | |
|---|---|---|
| DRAWN BY ND | DATE 8/17/11 | UXO 3 – AERIAL BOMBING TARGET AT PARADE DECK<br>CONCEPTUAL SITE MODEL<br>MCRD PARRIS ISLAND<br>PARRIS ISLAND, SOUTH CAROLINA |
| CHECKED BY BWB | DATE 9/21/11 | |
| REVISED BY | DATE | |
| SCALE NOT TO SCALE | | |

| | |
|---|---|
| CONTRACT NO. 2296 | |
| OWNER NO. | |
| APPROVED BY | DATE |
| DRAWING NO. FIGURE 10–5 | REV. 0 |

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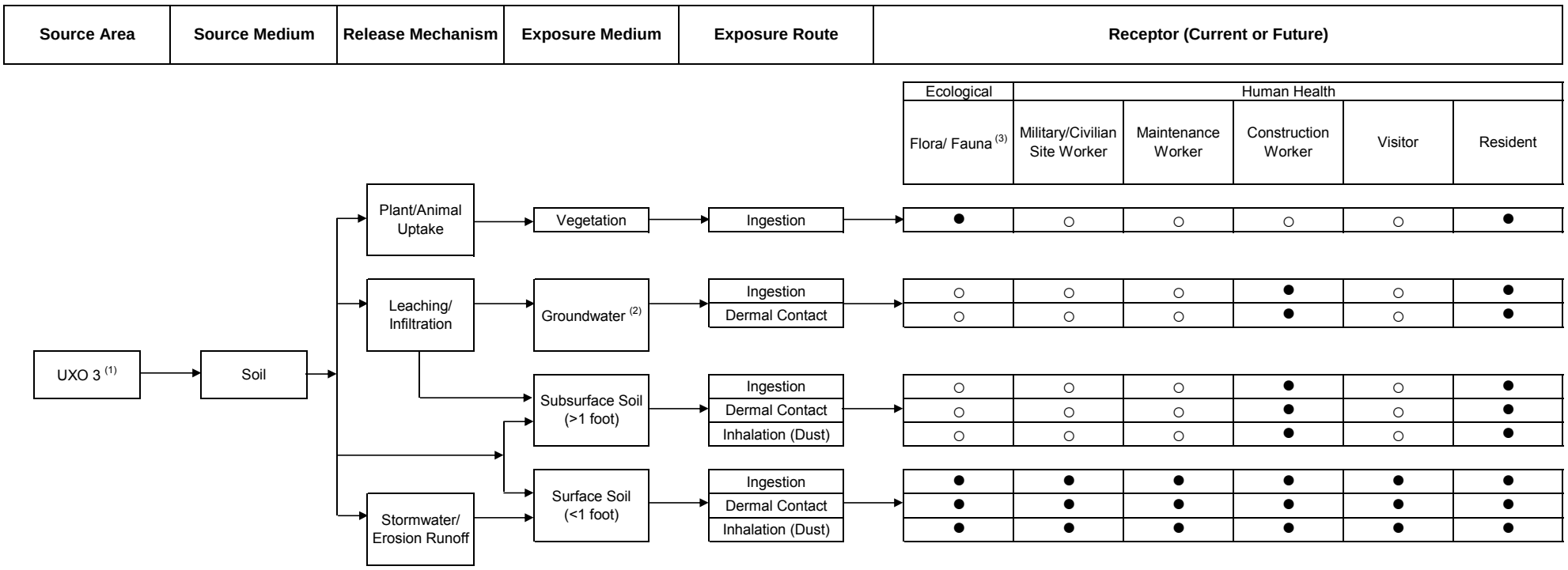
**FIGURE 10-6**

**UXO 3 - AERIAL BOMBING TARGET AT PARADE DECK**
**MC EXPOSURE PATHWAY ANALYSIS**
**MCRD PARRIS ISLAND**
**PARRIS ISLAND, SOUTH CAROLINA**




(1) If present, MC would be introduced to site through munitions-related items in site soil.

(2) Groundwater is not currently used as a drinking water source. However, all groundwater in South Carolina is considered a potential drinking water source. Thus, the groundwater pathways are shown as complete.

(3) Flora and fauna include plants and soil invertebrates.

● Complete Pathway
○ Incomplete Pathway

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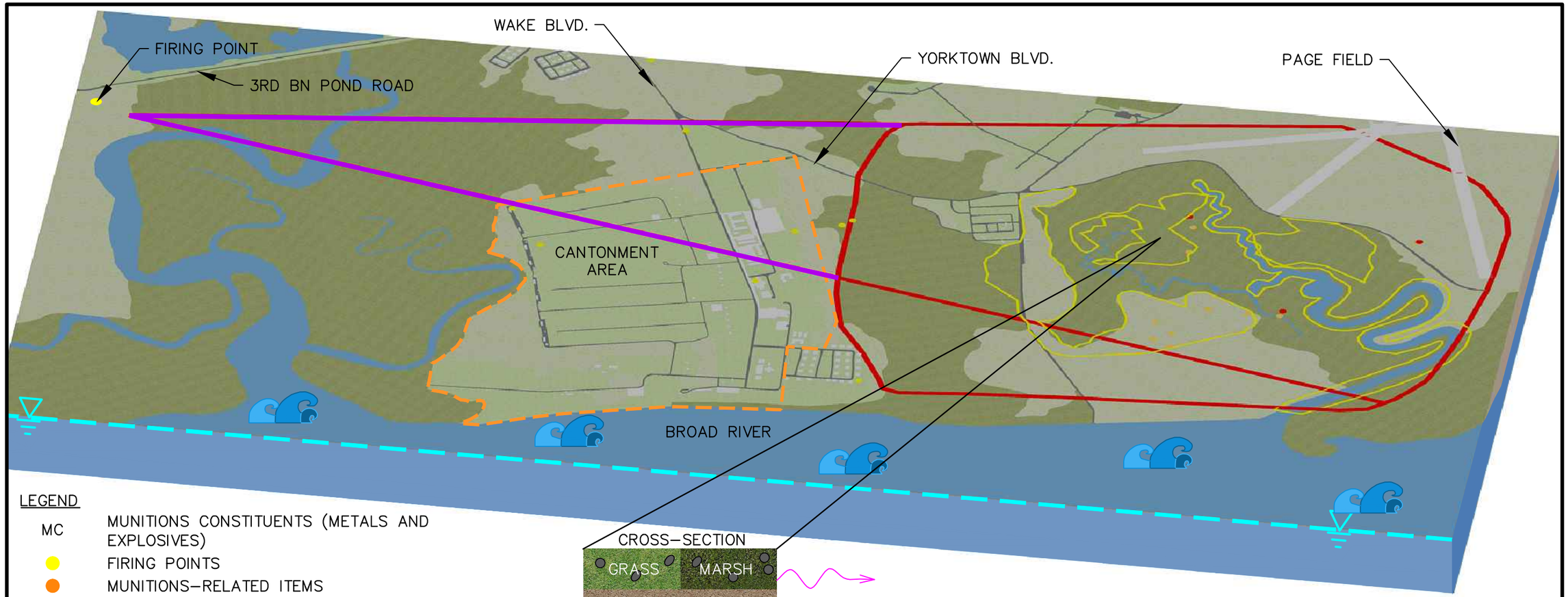
| | |
|---|---|
| DRAWN BY | DATE |
| T. WHEATON | 02/03/11 |
| CHECKED BY | DATE |
| B. BECKER | 04/27/12 |
| REVISED BY | DATE |
| MK BOND | 04/27/12 |
| SCALE | |
| AS NOTED | |

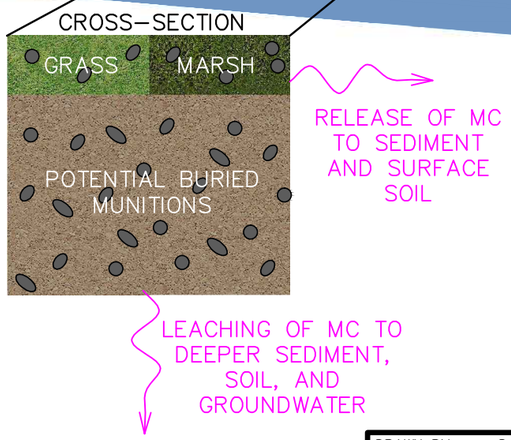
FIELD ARTILLERY WEST MAIN RANGE - UXO 4
SITE LOCATION
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER | CTO NUMBER |
| 02296 | JM10 |
| APPROVED BY | DATE |
| — | — |
| APPROVED BY | DATE |
| — | — |
| FIGURE NO. | REV |
| FIGURE 10-7 | 0 |




LEGEND

- MC — MUNITIONS CONSTITUENTS (METALS AND EXPLOSIVES)
- FIRING POINTS
- MUNITIONS–RELATED ITEMS
- MEC OR MPPEH ITEMS
- MEC SI GEOPHYSICAL SURVEY AREA BOUNDARY
- UXO 4 UPRANGE FIRING FAN BOUNDARY
- UXO 4 SITE IMPACT AREA BOUNDARY
- PAVED ROADWAYS
- WATER TABLE (ESTIMATED TO BE 0 TO 10 FEET BELOW GROUND SURFACE)
- MARSH
- BUILDINGS
- WATER
- GRASSY AREAS




NOTES:

1. 14 MEC, MPPEH, AND/OR MUNITIONS–RELATED ITEMS IDENTIFIED ON GROUND SURFACE DURING SI.
2. 201 ANOMALIES (138 TERRESTRIAL, 63 AQUATIC) IDENTIFIED DURING SI GEOPHYSICAL SURVEY.
3. GROUNDWATER IS NOT USED AS DRINKING WATER SOURCE.

| EXPOSURE PATHWAYS | CURRENT AND FUTURE RECEPTORS |
|---|---|
| SURFACE SOIL<br>(INGESTION, DERMAL, INHALATION OF DUSTS)<br>SUBSURFACE DISTURBED SOIL<br>(INGESTION, DERMAL, INHALATION OF DUSTS)<br>SEDIMENT<br>(INGESTION, DERMAL)<br>GROUNDWATER<br>(TAP WATER INGESTION, DERMAL CONTACT, INHALATION OF VAPOR) | HUMAN:<br>–MILITARY/CIVILIAN SITE WORKER<br>–CONSTRUCTION/MAINTENANCE WORKER<br>–TRESPASSER/RECREATIONAL USER<br>–RESIDENT<br>ECOLOGICAL:<br>–VEGETATION<br>–WILDLIFE (FOOD CHAIN EXPOSURE) |

| | | |
|---|---|---|
| DRAWN BY ND DATE 8/17/11<br>CHECKED BY BWB DATE 9/21/11<br>REVISED BY DATE<br>SCALE NOT TO SCALE | DEPARTMENT OF THE NAVY – UNITED STATES MARINE CORPS | UXO 4–FIELD ARTILLERY WEST<br>MAIN RANGE<br>CONCEPTUAL SITE MODEL<br>MCRD PARRIS ISLAND<br>PARRIS ISLAND, SOUTH CAROLINA |

| | |
|---|---|
| CONTRACT NO. 2296 | |
| OWNER NO. | |
| APPROVED BY | DATE |
| DRAWING NO. FIGURE 10–8 | REV. 0 |

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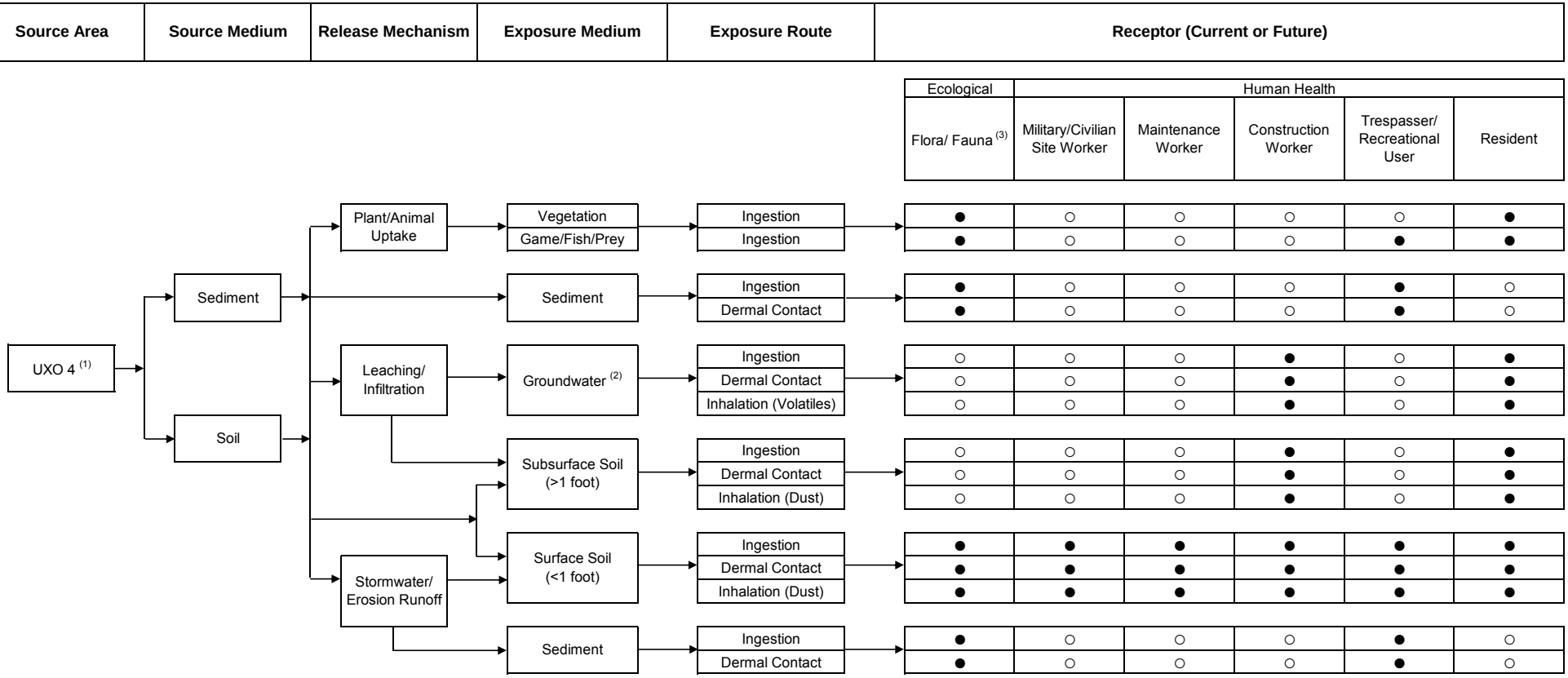
**FIGURE 10-9**

**UXO 4 - FIELD ARTILLERY WEST MAIN RANGE**
**MC EXPOSURE PATHWAY ANALYSIS**
**MCRD PARRIS ISLAND**
**PARRIS ISLAND, SOUTH CAROLINA**




(1) If present, MC would be introduced to site through munitions-related items in site soil and sediment.

(2) Groundwater is not currently used as a drinking water source. However, all groundwater in South Carolina is considered a potential drinking water source. Thus, the groundwater pathways are shown as complete.

(3) Flora and fauna include plants, soil invertebrates, birds, and mammals.

| | |
|---|---|
| ● | Complete Pathway |
| ○ | Incomplete Pathway |

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*Aerial photograph taken in 2008.*

N

T

UXO 2

Ballast Creek

Cuba Street

Beaufort River

UXO 5

Active Grenade Range

Page Field

UXO 6

UXO 7

**Legend**

- Firing Point (Presumed Location)
- Active Range
- Uprange Firing Fan and Firing Point Boundaries
- Impact Area Boundaries

1,000 0 1,000 Feet

| | |
|---|---|
| DRAWN BY | DATE |
| T. WHEATON | 08/06/11 |
| CHECKED BY | DATE |
| B. BECKER | 01/25/12 |
| REVISED BY | DATE |
| MK BOND | 01/25/12 |
| SCALE | |
| AS NOTED | |

FIELD ARTILLERY EAST SHRAPNEL RANGE - UXO 5 / UXO 6
SITE LOCATION
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER | CTO NUMBER |
| 02296 | JM10 |
| APPROVED BY | DATE |
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| APPROVED BY | DATE |
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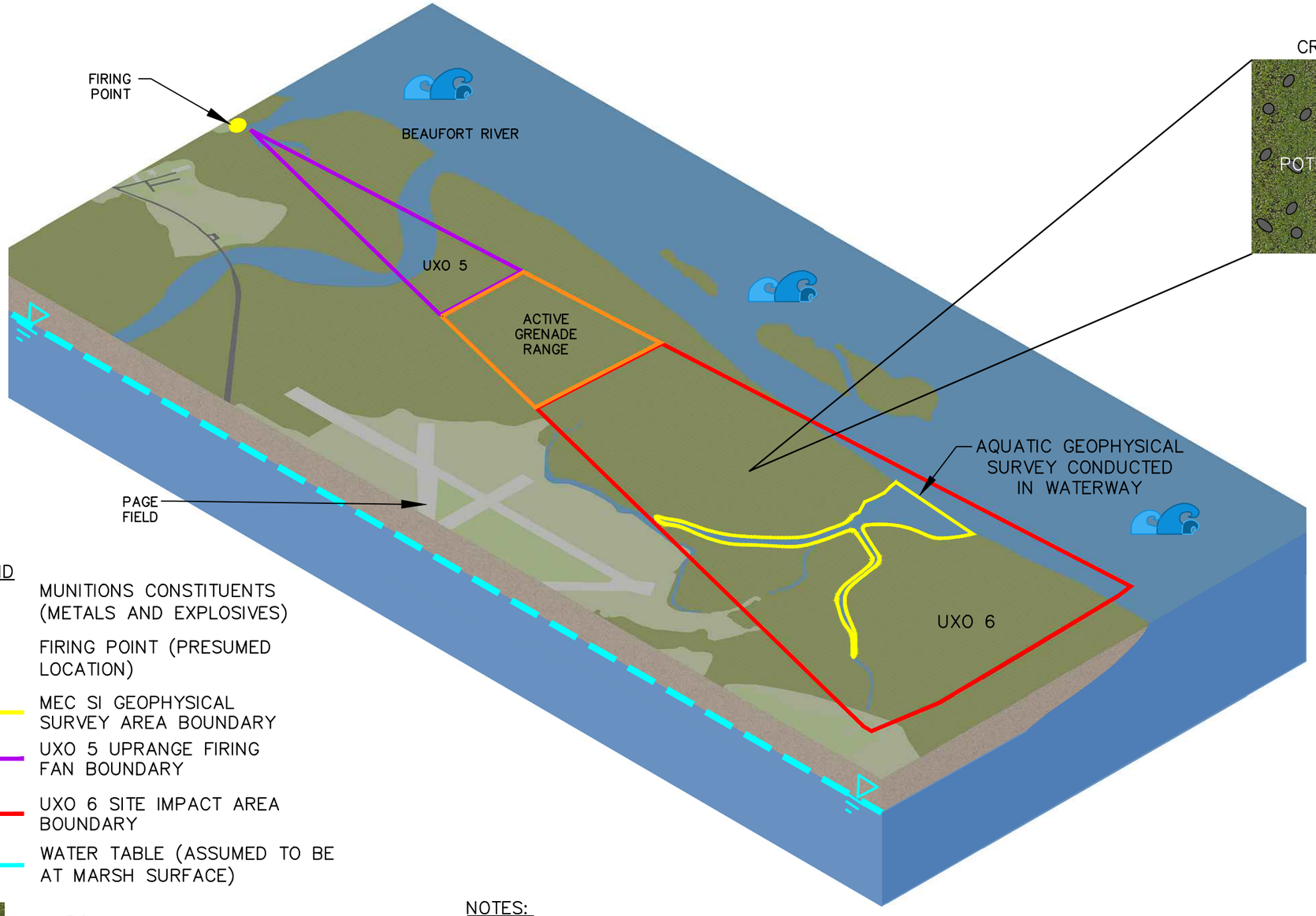
| FIGURE 10-10 | 0 |




LEGEND

- MC — MUNITIONS CONSTITUENTS (METALS AND EXPLOSIVES)
- FIRING POINT (PRESUMED LOCATION)
- MEC SI GEOPHYSICAL SURVEY AREA BOUNDARY
- UXO 5 UPRANGE FIRING FAN BOUNDARY
- UXO 6 SITE IMPACT AREA BOUNDARY
- WATER TABLE (ASSUMED TO BE AT MARSH SURFACE)
- MARSH
- WATER
- GRASSY AREAS

NOTES:

1. 67 ANOMALIES IDENTIFIED DURING SI GEOPHYSICAL SURVEY OF ACCESSIBLE WATERWAYS.
2. GROUNDWATER IS ASSUMED TO BE AT THE MARSH SURFACE AND, THUS, NOT AVAILABLE FOR USE AS A DRINKING WATER SOURCE.

| EXPOSURE PATHWAYS |
|---|
| SURFACE SOIL (INGESTION, DERMAL, INHALATION OF DUSTS) |
| SUBSURFACE DISTURBED SOIL (INGESTION, DERMAL, INHALATION OF DUSTS) |
| SEDIMENT (INGESTION, DERMAL) |
| **CURRENT AND FUTURE RECEPTORS** |
| HUMAN: |
| –MILITARY/CIVILIAN SITE WORKER |
| –CONSTRUCTION/MAINTENANCE WORKER |
| –TRESPASSER/RECREATIONAL USER |
| –RESIDENT (HYPOTHETICAL) |
| ECOLOGICAL: |
| –VEGETATION |
| –WILDLIFE (FOOD CHAIN EXPOSURE) |

| | | |
|---|---|---|
| DRAWN BY ND | DATE 8/17/11 | UXO 5/ UXO 6 – FIELD ARTILLERY EAST SHRAPNEL RANGE CONCEPTUAL SITE MODEL MCRD PARRIS ISLAND PARRIS ISLAND, SOUTH CAROLINA |
| CHECKED BY BWB | DATE 9/21/11 | CONTRACT NO. 2296 |
| REVISED BY | DATE | OWNER NO. |
| SCALE NOT TO SCALE | | APPROVED BY / DATE |
| | | DRAWING NO. FIGURE 10–11 / REV. 0 |

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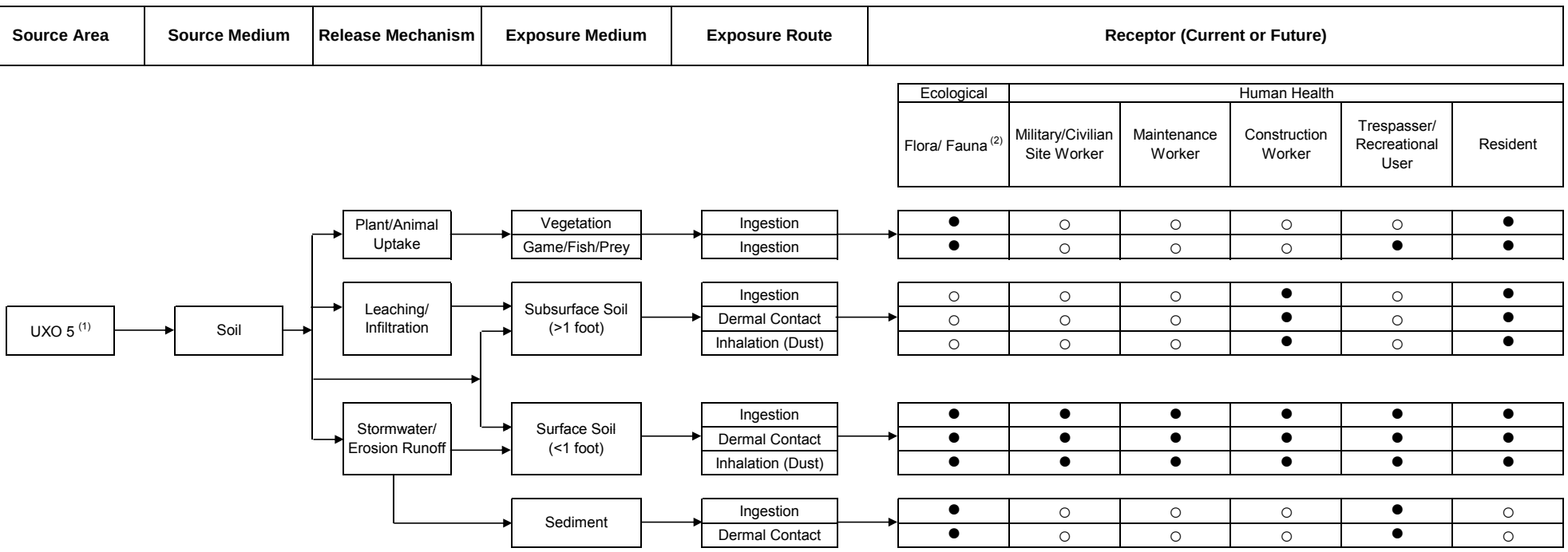
**FIGURE 10-12**

**UXO 5 - FIELD ARTILLERY EAST SHRAPNEL RANGE, FIRING POINT**
**MC EXPOSURE PATHWAY ANALYSIS**
**MCRD PARRIS ISLAND**
**PARRIS ISLAND, SOUTH CAROLINA**



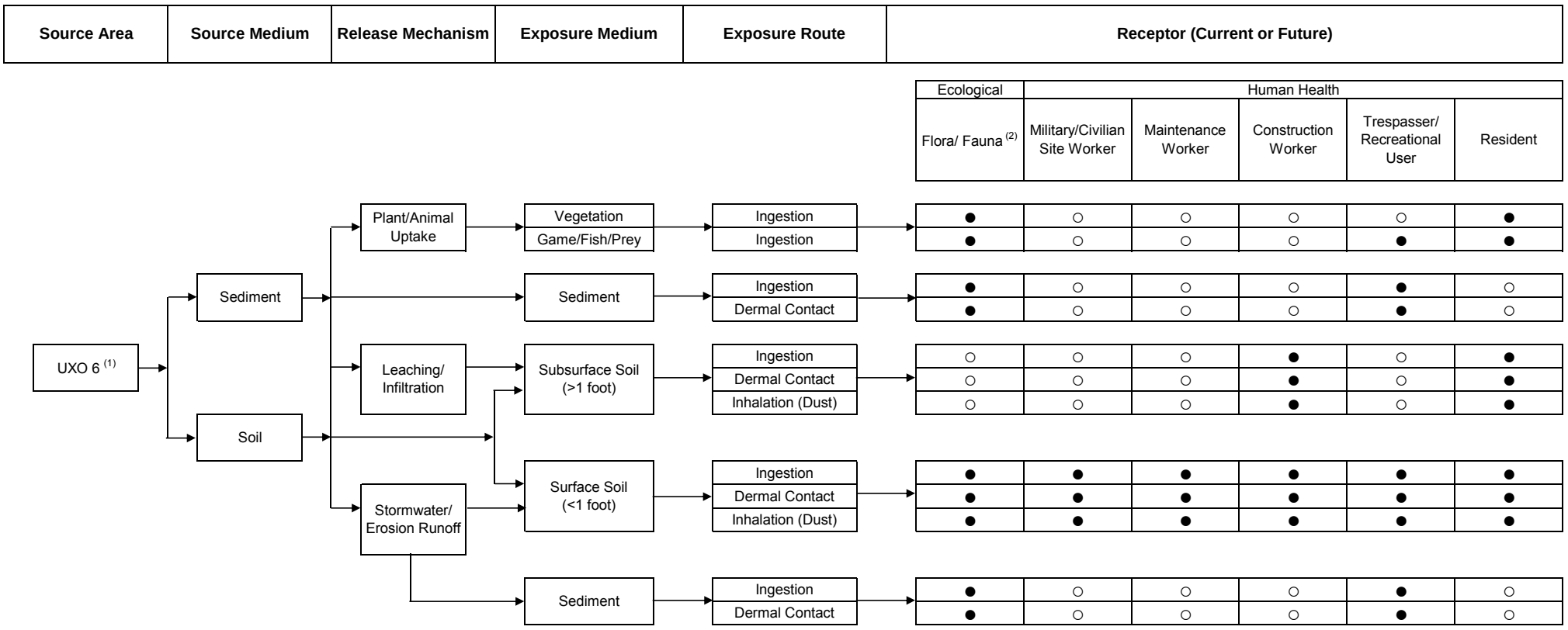

(1) If present, MC would be introduced to site through discarded munitions-related items in site soil.

(2) Flora and fauna include plants, soil invertebrates, birds, and mammals.

● Complete Pathway
○ Incomplete Pathway

**FIGURE 10-13**

**UXO 6 - FIELD ARTILLERY EAST SHRAPNEL RANGE, IMPACT AREA**
**MC EXPOSURE PATHWAY ANALYSIS**
**MCRD PARRIS ISLAND**
**PARRIS ISLAND, SOUTH CAROLINA**




(1) If present, MC would be introduced to site through munitions-related items in site soil and sediment.
(2) Flora and fauna include plants, soil invertebrates, birds, and mammals.

● Complete Pathway
○ Incomplete Pathway

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|---|---|
| J. ENGLISH | 12/08/08 |
| CHECKED BY | DATE |
| B. BECKER | 09/28/11 |
| REVISED BY | DATE |
| | |

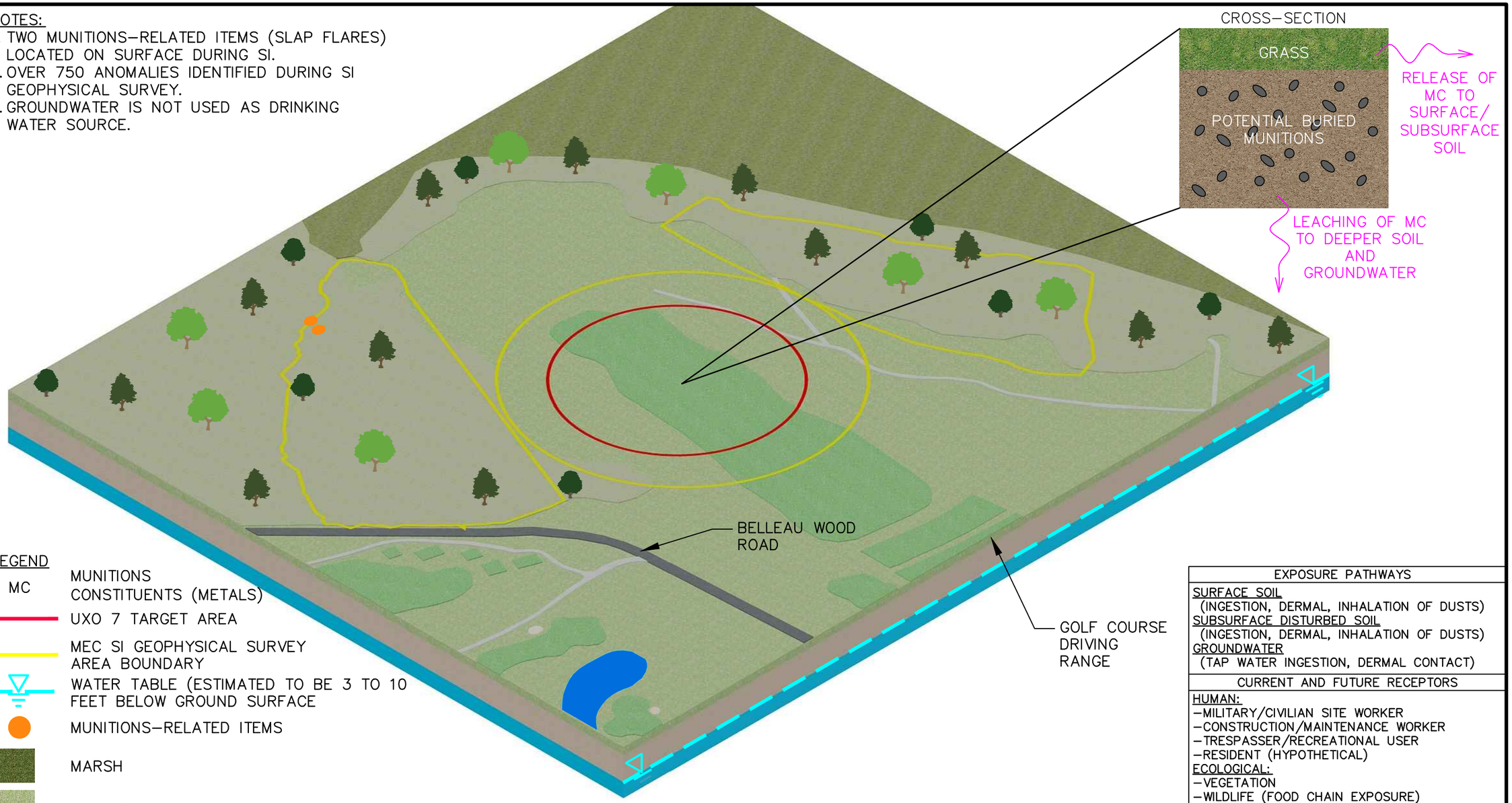
SCALE
AS NOTED

DEPARTMENT OF THE NAVY · UNITED STATES MARINE CORPS

AERIAL BOMBING TARGET AT GOLF COURSE - UXO 7
SITE LOCATION
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| CONTRACT NUMBER | CTO NUMBER |
|---|---|
| 02296 | |
| APPROVED BY | DATE |
| | |
| APPROVED BY | DATE |
| | |
| FIGURE NO. FIGURE 10-14 | REV 0 |

NOTES:
1. TWO MUNITIONS–RELATED ITEMS (SLAP FLARES) LOCATED ON SURFACE DURING SI.
2. OVER 750 ANOMALIES IDENTIFIED DURING SI GEOPHYSICAL SURVEY.
3. GROUNDWATER IS NOT USED AS DRINKING WATER SOURCE.




LEGEND

| | |
|---|---|
| MC | MUNITIONS CONSTITUENTS (METALS) |
| | UXO 7 TARGET AREA |
| | MEC SI GEOPHYSICAL SURVEY AREA BOUNDARY |
| | WATER TABLE (ESTIMATED TO BE 3 TO 10 FEET BELOW GROUND SURFACE |
| | MUNITIONS–RELATED ITEMS |
| | MARSH |
| | WOODED AREA |
| | WATER |
| | GRASSY AREAS |

| EXPOSURE PATHWAYS |
|---|
| SURFACE SOIL (INGESTION, DERMAL, INHALATION OF DUSTS) |
| SUBSURFACE DISTURBED SOIL (INGESTION, DERMAL, INHALATION OF DUSTS) |
| GROUNDWATER (TAP WATER INGESTION, DERMAL CONTACT) |
| **CURRENT AND FUTURE RECEPTORS** |
| HUMAN: |
| –MILITARY/CIVILIAN SITE WORKER |
| –CONSTRUCTION/MAINTENANCE WORKER |
| –TRESPASSER/RECREATIONAL USER |
| –RESIDENT (HYPOTHETICAL) |
| ECOLOGICAL: |
| –VEGETATION |
| –WILDLIFE (FOOD CHAIN EXPOSURE) |

| | | |
|---|---|---|
| DRAWN BY ND | DATE 8/17/11 | UXO 7 – AERIAL BOMBING TARGET AT GOLF COURSE CONCEPTUAL SITE MODEL MCRD PARRIS ISLAND PARRIS ISLAND, SOUTH CAROLINA |
| CHECKED BY BWB | DATE 9/21/11 | |
| REVISED BY | DATE | |
| SCALE NOT TO SCALE | | |

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|---|---|
| CONTRACT NO. | 2296 |
| OWNER NO. | |
| APPROVED BY | DATE |
| DRAWING NO. | FIGURE 10–15 |
| REV. | 0 |

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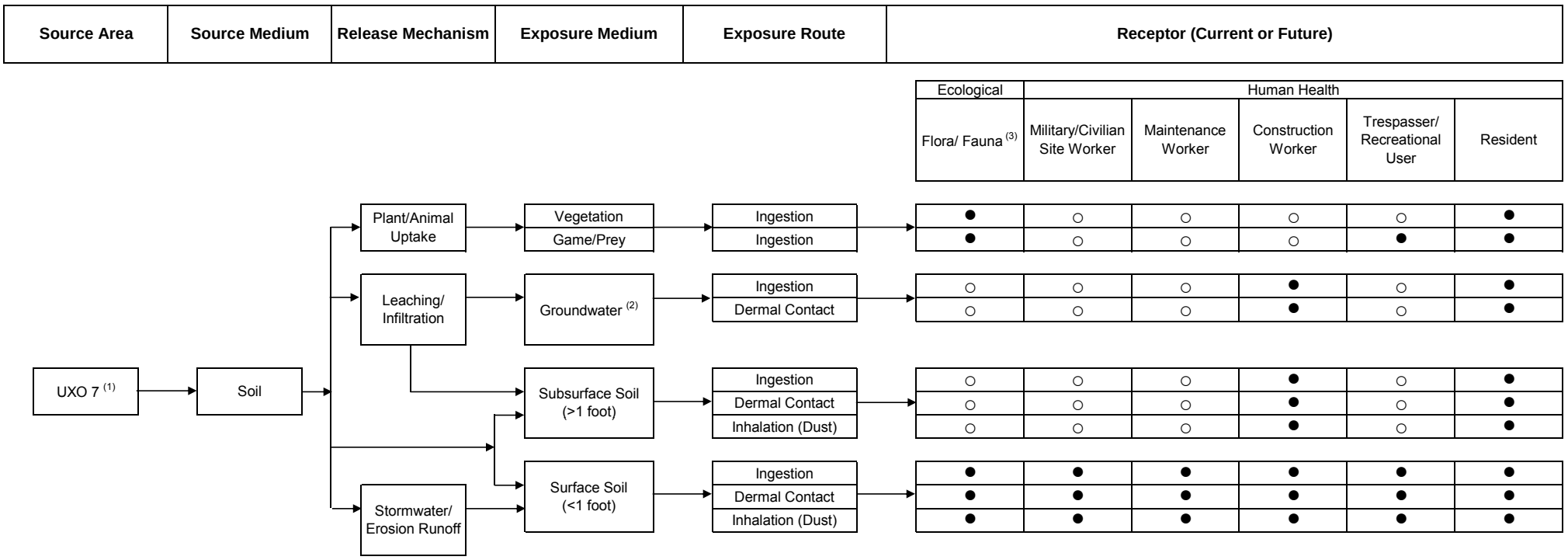
**FIGURE 10-16**

**UXO 7 - AERIAL BOMBING TARGET AT GOLF COURSE**
**MC EXPOSURE PATHWAY ANALYSIS**
**MCRD PARRIS ISLAND**
**PARRIS ISLAND, SOUTH CAROLINA**




(1) If present, MC would be introduced to site through munitions-related items in site soil.

(2) Groundwater is not currently used as a drinking water source. However, all groundwater in South Carolina is considered a potential drinking water source. Thus, the groundwater pathways are shown as complete.

(3) Flora and fauna include plants, soil invertebrates, birds, and mammals.

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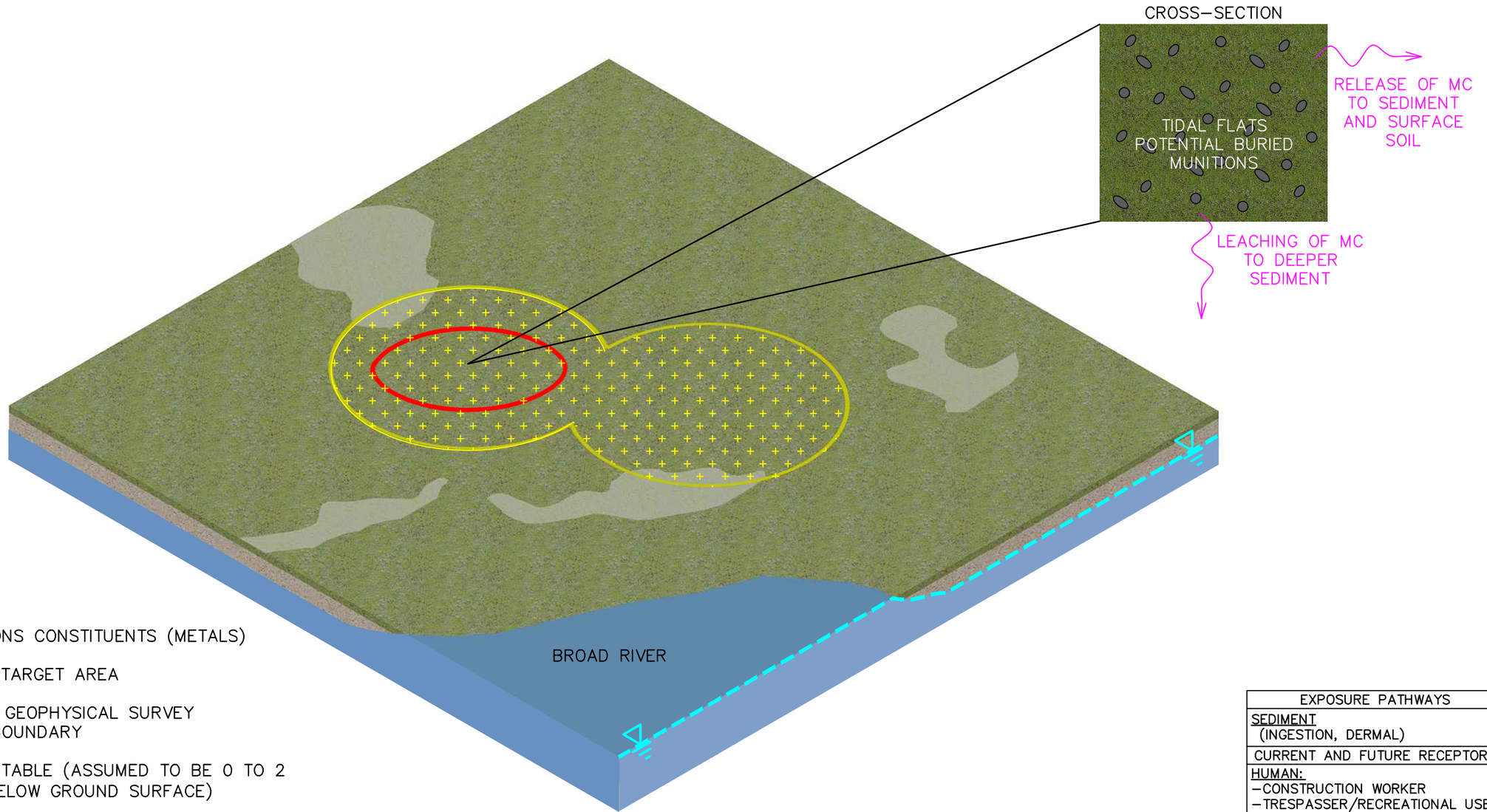
| | |
|---|---|
| DRAWN BY / DATE | T. WHEATON / 02/03/11 |
| CHECKED BY / DATE | B. BECKER / 09/28/11 |
| REVISED BY / DATE | ___ / ___ |
| SCALE | AS NOTED |

AERIAL BOMBING TARGET AT SOUTHERN TIDAL FLATS - UXO 8
SITE LOCATION
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER | 02296 |
| CTO NUMBER | JM10 |
| APPROVED BY / DATE | ___ / ___ |
| APPROVED BY / DATE | ___ / ___ |
| FIGURE NO. | FIGURE 10-17 |
| REV | 0 |




LEGEND

| | |
|---|---|
| MC | MUNITIONS CONSTITUENTS (METALS) |
| | UXO 8 TARGET AREA |
| | MEC SI GEOPHYSICAL SURVEY AREA BOUNDARY |
| | WATER TABLE (ASSUMED TO BE 0 TO 2 FEET BELOW GROUND SURFACE) |
| | TIDAL FLATS |
| | TREES/BRUSH |
| | WATER |

NOTES:
1. MUNITIONS–RELATED SURFACE DEBRIS SCATTERED THROUGHOUT AND OUTSIDE OF GEOPHYSICAL SURVEY AREA BOUNDARY.
2. 1,224 ANOMALIES IDENTIFIED DURING SI GEOPHYSICAL SURVEY.

| EXPOSURE PATHWAYS |
|---|
| SEDIMENT (INGESTION, DERMAL) |
| CURRENT AND FUTURE RECEPTORS |
| HUMAN:<br>–CONSTRUCTION WORKER<br>–TRESPASSER/RECREATIONAL USER |
| ECOLOGICAL:<br>–VEGETATION<br>–WILDLIFE (FOOD CHAIN EXPOSURE) |

| | |
|---|---|
| DRAWN BY / DATE | ND 8/17/11 |
| CHECKED BY / DATE | BWB 9/21/11 |
| REVISED BY / DATE | |
| SCALE | NOT TO SCALE |

# UXO 8 – AERIAL BOMBING TARGET AT SOUTHERN TIDAL FLATS CONCEPTUAL SITE MODEL MCRD PARRIS ISLAND PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NO. | 2296 |
| OWNER NO. | |
| APPROVED BY / DATE | |
| DRAWING NO. | FIGURE 10–18 |
| REV. | 0 |

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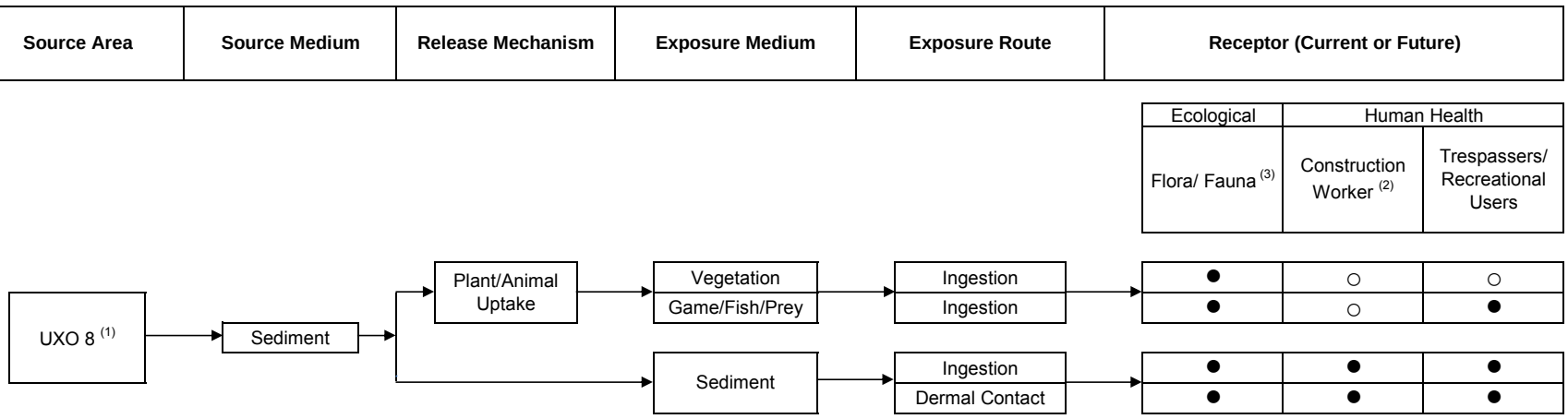
**FIGURE 10-19**

**UXO 8 - AERIAL BOMBING TARGET AT SOUTHERN TIDAL FLATS**
**MC EXPOSURE PATHWAY ANALYSIS**
**MCRD PARRIS ISLAND**
**PARRIS ISLAND, SOUTH CAROLINA**




(1) If present, MC would be introduced to site through munitions-related items in tidal flats sediment.

(2) There is a potential for future construction workers accessing the area to lay cable for a spotlight/floodlight. The site is not currently used and is underwater at high tide. Regular future use by other human receptors is unlikely.

(3) Flora and fauna include plants, soil invertebrates, birds, and mammals.

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Aerial photograph taken in 2008.

N

X3SB104
X3SB105
X3SB103
X3TW103
X3SB106
X3SB107
X3SB108
X3SB109
X3SB102
X3TW102
X3SB110
X3SB111
X3SB112
X3SB101
X3TW101

Former Aerial Bombing Target

Parade Deck

Guantanamo Street

Cape Gauffre Street

Boulevard De France

Midway Street

Panama Street

00589 00615 00604 00603 00183 00620 06005 00566 00565 00191 00182 00590 00658 00591 00627 00626 00176 00296 00170 00096 00139 00674 00602 06002 06003 00601 00599 00166E 00166 00166B 00283 00635 00635A 00651

200 0 200 Feet

## Legend

- Colocated Temporary Well / Soil Boring Location
- Soil Boring Location
- MEC RI: Intrusive Investigation of Anomalies
- MEC SI: Geophysical Survey (2.5-foot Transect Spacing)
- Approximate Location of Former Aerial Bombing Target

Notes:
1. Collect discrete samples at all soil boring locations for metals analysis.
2. Collect composite samples, comprised of one aliquot from each soil boring location, for explosives analysis.
3. Collect groundwater samples from each well location for metals and explosives analysis.

| | |
|---|---|
| DRAWN BY | DATE |
| J. ENGLISH | 08/17/11 |
| CHECKED BY | DATE |
| B. BECKER | 01/25/12 |
| REVISED BY | DATE |
| MK BOND | 01/25/12 |
| SCALE | |
| AS NOTED | |

MC INVESTIGATION LOCATIONS
UXO 3 - AERIAL BOMBING TARGET AT PARADE DECK
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER 02296 | CTO NUMBER JM10 |
| APPROVED BY — | DATE — |
| APPROVED BY — | DATE — |
| FIGURE NO. FIGURE 17-1 | REV 0 |

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*Aerial photograph taken in 2008.*

N

R
E
H
L
A
F
B
C
D

UXO 3
UXO 1
UXO 7

Active
Pistol / Rifle
Ranges

X4SB101
X4TW101
X4SB102
X4TW102
X4SB103
X4TW103
X4SB104
X4TW104
X4SB105
X4TW105
X4SB106
X4TW106
X4SB107
X4SB108
X4SB109
X4SB110
X4SB111
X4SB112

Broad River

## Legend

- Concrete Firing Position (B, H, R)
- Non-Permanent Firing Position (A, C, D, E, F, L)
- Colocated Temporary Well / Soil Boring Location
- Soil Boring Location

NOTE: Additional soil and sediment samples may be collected at discretionary locations if MEC/MPPEH items are identified during intrusive investigation.

- Concrete Observation Post
- Cantonment Area - Weapons and Field Training Battalion
- Active Ranges
- Uprange Firing Fan and Firing Point Boundaries
- Site/Impact/Target Area Boundaries
- MEC RI: Investigation of Underwater Anomalies
- MEC SI: Land-based Surface and Geophysical Survey (100-Foot Transect Spacing); Aquatic Geophysycal Survey Along Accessible Portions of Waterway; Surface Survey at Firing Points
- MEC RI: Land-based Surface and Geophysical Survey (160-Foot Transect Spacing)

1,500 0 1,500 Feet

| | |
|---|---|
| DRAWN BY | DATE |
| J. ENGLISH | 08/17/11 |
| CHECKED BY | DATE |
| B. BECKER | 01/25/12 |
| REVISED BY | DATE |
| MK BOND | 01/25/12 |
| SCALE | |
| AS NOTED | |

MC INVESTIGATION LOCATIONS
UXO 4 - FIELD ARTILLERY WEST MAIN RANGE
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER | CTO NUMBER |
| 02296 | JM10 |
| APPROVED BY | DATE |
| — | — |
| APPROVED BY | DATE |
| — | — |
| FIGURE NO. | REV |
| FIGURE 17-2 | 0 |

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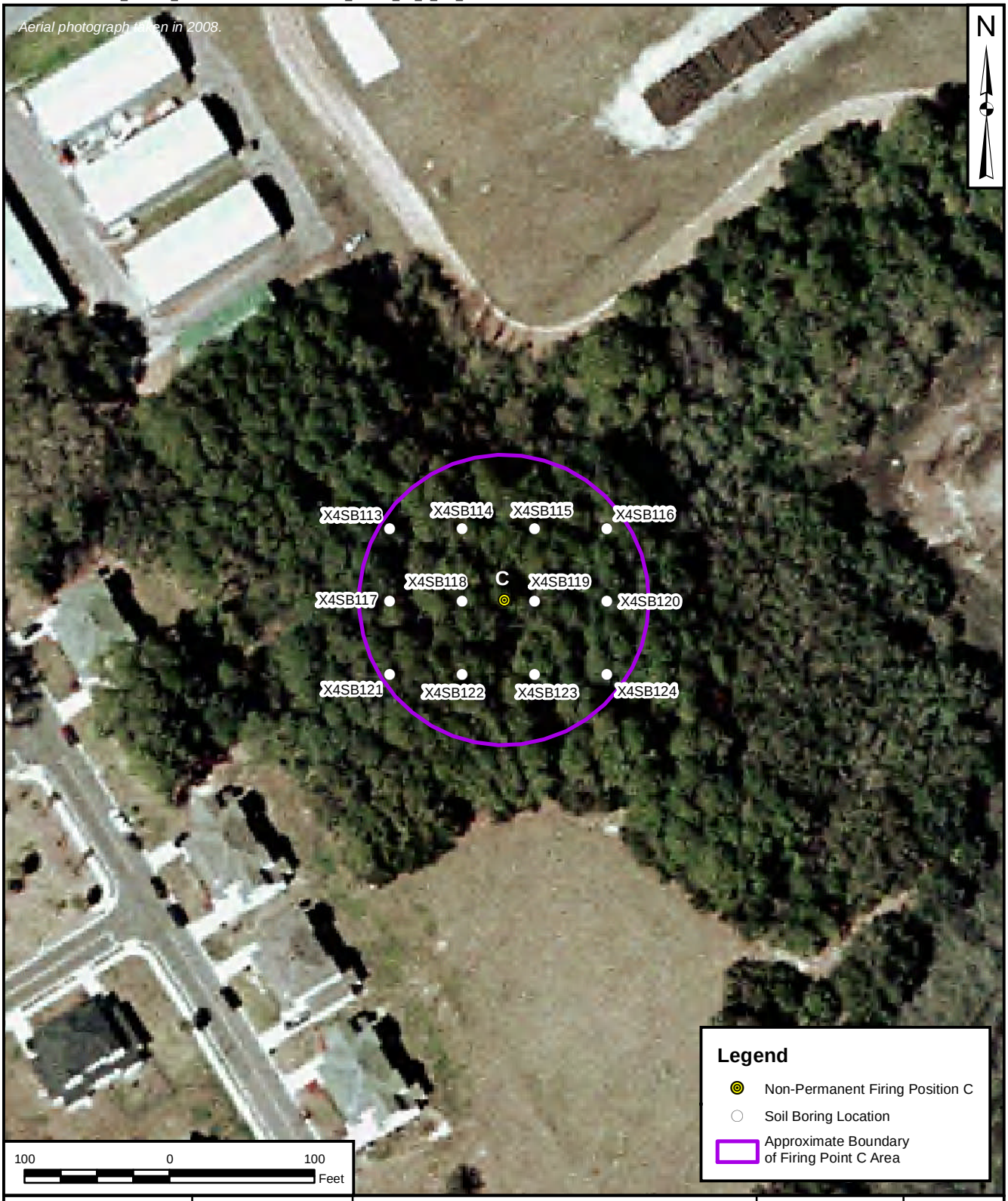


| | |
|---|---|
| DRAWN BY: J. ENGLISH | DATE: 08/17/11 |
| CHECKED BY: M. COFFMAN | DATE: 12/29/11 |
| REVISED BY | DATE |
| SCALE: AS NOTED | |

MC INVESTIGATION LOCATIONS
UXO 4 - FIELD ARTILLERY WEST MAIN RANGE
FIRING POINT C
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER: 2296 | CTO NUMBER: JM10 |
| APPROVED BY: ___ | DATE: ___ |
| APPROVED BY: ___ | DATE: ___ |
| FIGURE NO.: FIGURE 17-3 | REV: 0 |

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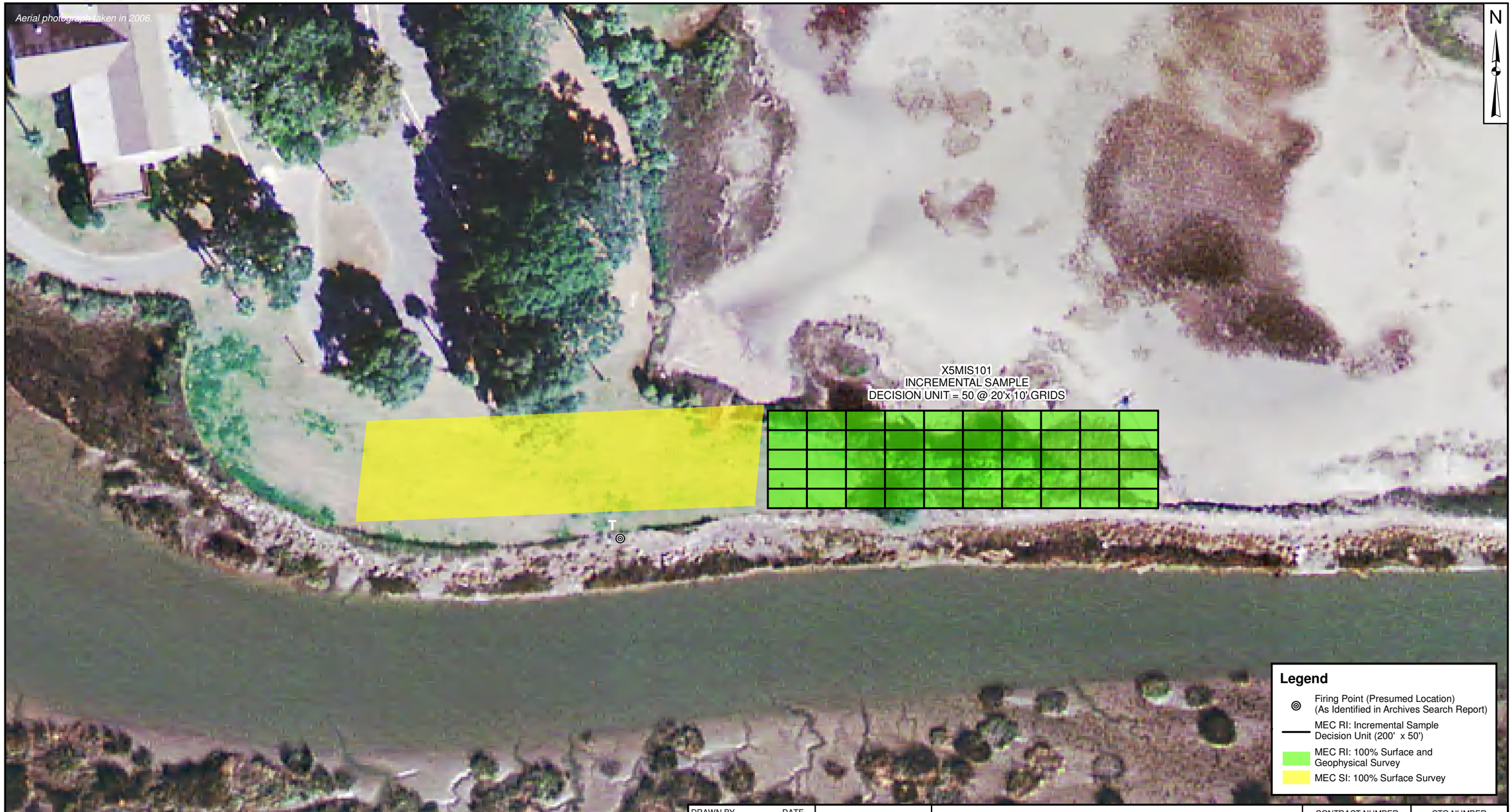


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|---|---|
| DRAWN BY | DATE |
| J. ENGLISH | 08/18/11 |
| CHECKED BY | DATE |
| B. BECKER | 09/22/11 |
| REVISED BY | DATE |
| SCALE | |
| AS NOTED | |

MC INVESTIGATION LOCATIONS
UXO 5 - FIELD ARTILLERY EAST
SHRAPNEL RANGE FIRING POINT
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER | CTO NUMBER |
| 2296 | ____ |
| APPROVED BY | DATE |
| ___ | ___ |
| APPROVED BY | DATE |
| ___ | ___ |
| FIGURE NO. | REV |
| FIGURE 17-4 | 0 |

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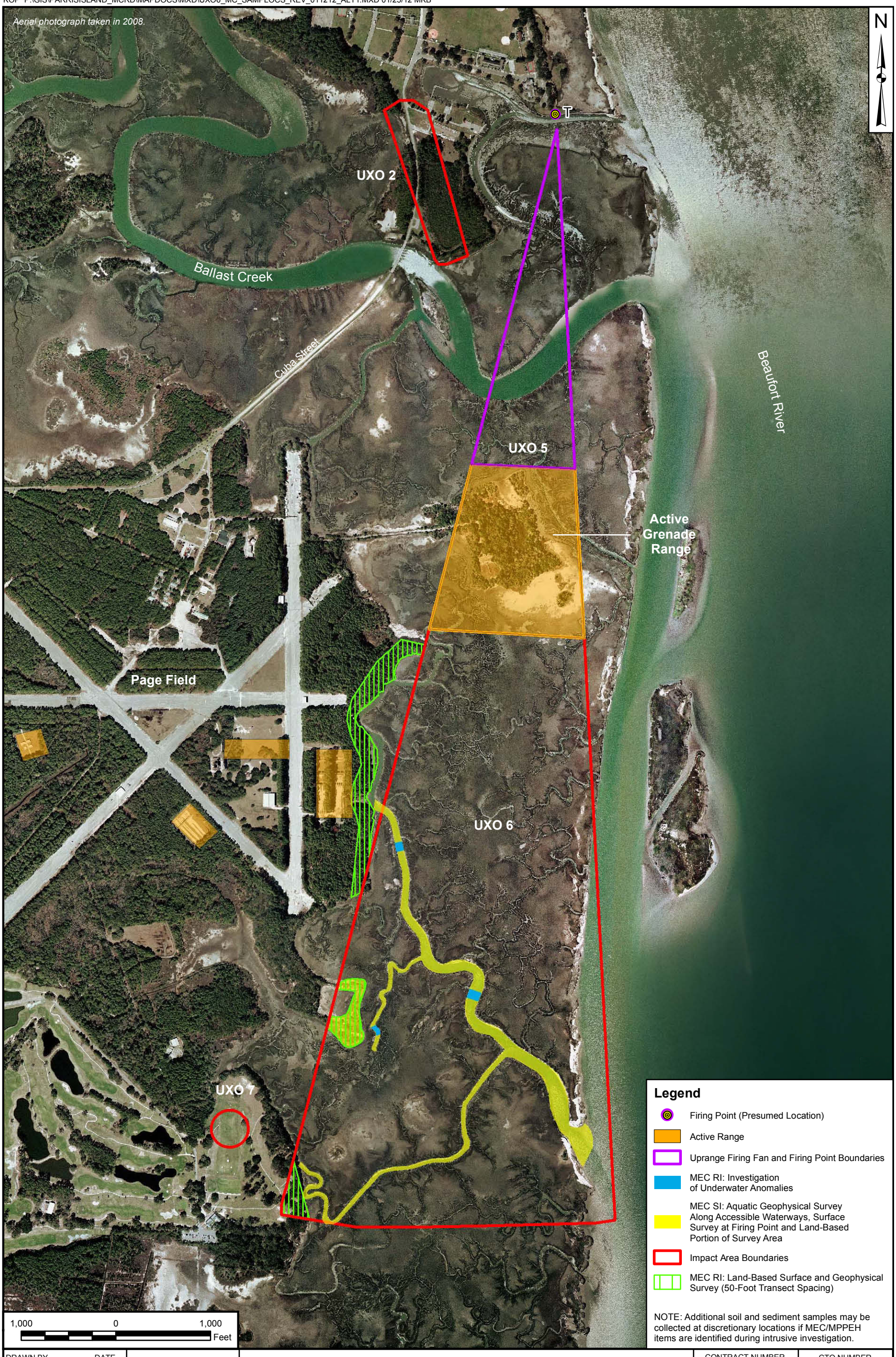


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|---|---|
| DRAWN BY / DATE | J. ENGLISH 08/18/11 |
| CHECKED BY / DATE | B. BECKER 01/25/12 |
| REVISED BY / DATE | MK BOND 01/25/12 |
| SCALE | AS NOTED |

MC INVESTIGATION LOCATIONS
UXO 5 / UXO 6 - FIELD ARTILLERY EAST SHRAPNEL RANGE
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER | 02296 |
| CTO NUMBER | JM10 |
| APPROVED BY / DATE | — — |
| APPROVED BY / DATE | — — |
| FIGURE NO. | FIGURE 17-5 |
| REV | 0 |

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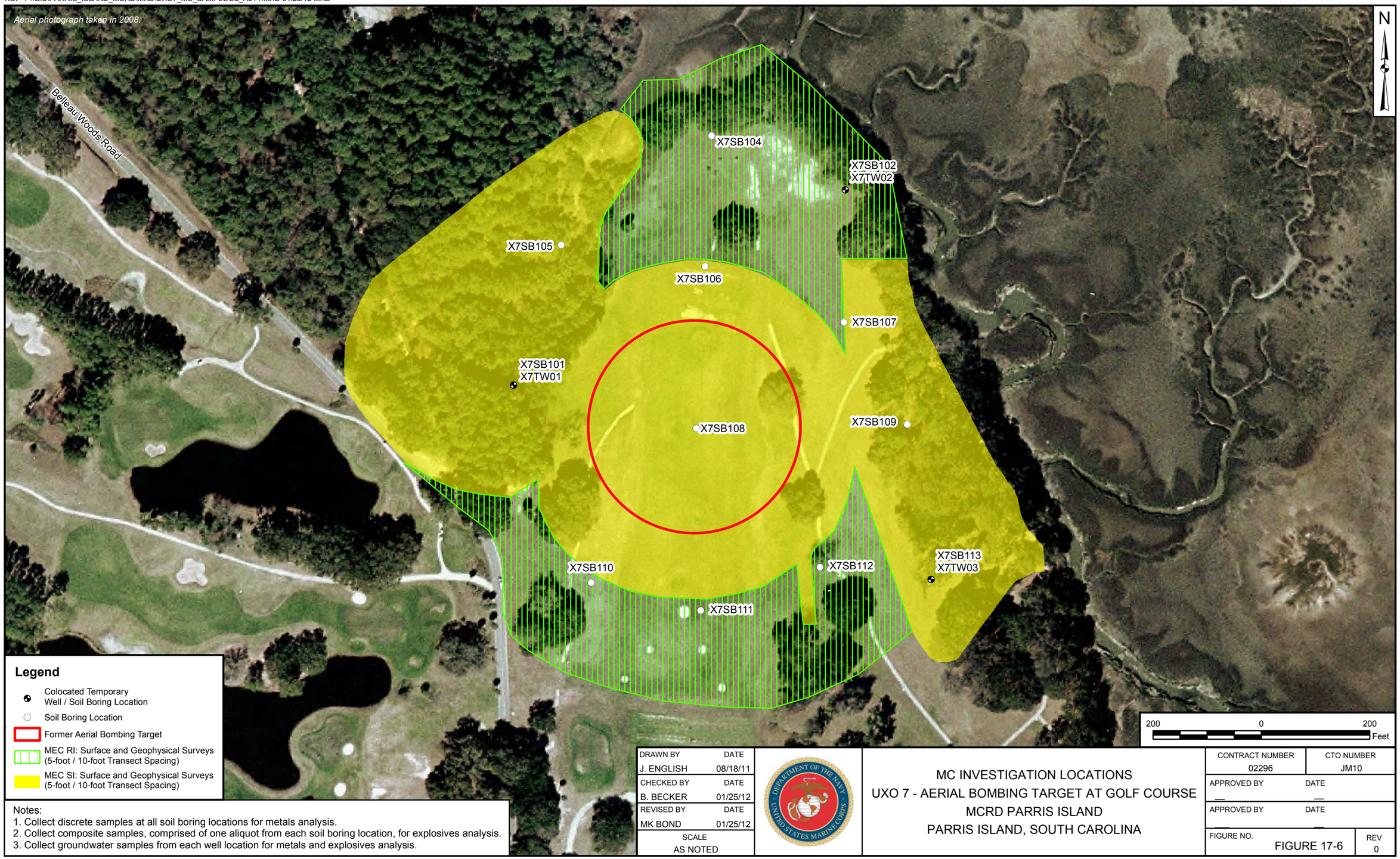


**Legend**

- Colocated Temporary Well / Soil Boring Location
- Soil Boring Location
- Former Aerial Bombing Target
- MEC RI: Surface and Geophysical Surveys (5-foot / 10-foot Transect Spacing)
- MEC SI: Surface and Geophysical Surveys (5-foot / 10-foot Transect Spacing)

Notes:
1. Collect discrete samples at all soil boring locations for metals analysis.
2. Collect composite samples, comprised of one aliquot from each soil boring location, for explosives analysis.
3. Collect groundwater samples from each well location for metals and explosives analysis.

| DRAWN BY | DATE |
|---|---|
| J. ENGLISH | 08/18/11 |
| CHECKED BY | DATE |
| B. BECKER | 01/25/12 |
| REVISED BY | DATE |
| MK BOND | 01/25/12 |
| SCALE | |
| AS NOTED | |

MC INVESTIGATION LOCATIONS
UXO 7 - AERIAL BOMBING TARGET AT GOLF COURSE
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| CONTRACT NUMBER | CTO NUMBER |
|---|---|
| 02296 | JM10 |
| APPROVED BY | DATE |
| — | — |
| APPROVED BY | DATE |
| — | — |
| FIGURE NO. | REV |
| FIGURE 17-6 | 0 |

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*Aerial photograph taken in 2008.*

N

X8SD101
X8SD102
X8SD103
X8SD104
X8SD105
X8SD106
X8SD107
X8SD108
X8SD109
X8SD110
X8SD111
X8SD112

Broad River

**Legend**

- Sediment Sampling Location
- Former Aerial Bombing Target
- MEC RI: Surface and Geophysical Surveys (50-Foot Transect Spacing)
- MEC SI: Surface and Geophysical Surveys (5-Foot Transect Spacing)

250 0 250 Feet

Notes:
1. Collect discrete samples at all sediment sample locations for metals analysis.
2. Collect composite samples, comprised of one aliquot from each sediment sample location, for explosives analysis.

| | |
|---|---|
| DRAWN BY / DATE | J. ENGLISH / 08/18/11 |
| CHECKED BY / DATE | B. BECKER / 01/25/12 |
| REVISED BY / DATE | MK BOND / 01/25/12 |
| SCALE | AS NOTED |

MC INVESTIGATION LOCATIONS
UXO 8 - AERIAL BOMBING TARGET AT SOUTHERN TIDAL FLATS
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER | 02296 |
| CTO NUMBER | JM10 |
| APPROVED BY / DATE | — / — |
| APPROVED BY / DATE | — / — |
| FIGURE NO. | FIGURE 17-7 |
| REV | 0 |

# APPENDICES

# APPENDIX A

# SOIL AND SEDIMENT BACKGROUND EVALUATION

# MCRD Parris Island Soil and Sediment Background Evaluation

There is currently no basewide background data set for MCRD Parris Island. The Partnering Team has agreed that the basewide background data set compiled for soils and sediments at Marine Corps Air Station (MCAS) Beaufort may be applicable to MCRD Parris Island, since both installations are located in the coastal area of Beaufort County, South Carolina. Due to the close proximity of MCRD Parris Island to MCAS Beaufort and due to the similar nature of the soils and sediments present at these two facilities, a study was performed to determine if the soil types at MCRD Parris Island are similar to those at MCAS Beaufort. If the soil types at the two facilities are similar, then the approved basewide background data set for soils and sediments at MCAS Beaufort is applicable to soils and sediments at MCRD Parris Island. If they are significantly different, then the MCAS Beaufort basewide background data set is not applicable at MCRD Parris Island.

Information about the soil series present at MCRD Parris Island and MCAS Beaufort were obtained from the United States Department of Agriculture (USDA), Natural Resources Conservation Service, Soil Data Mart (http://soildatamart.nrcs.usda.gov/Default.aspx). A comparative listing of the different soil series occurring at various Resource Conservation and Recovery Act (RCRA) Solid Waste Management Units (SWMUs) at MCRD Parris Island and MCAS Beaufort is presented in Table 1. Information was gathered from the USDA Web Soil Survey website on August 19, 2011 to graphically depict and document the similarities between the soil series map units, Unified Soil Classification (Surface), and hydrologic soil groups at MCRD Parris Island and MCAS Beaufort. This information is provided in Attachment A.

These soil series were categorized into four soil types based on their physical and geochemical properties as identified in the "RCRA Facility Investigation Report for Solid Waste Management Unit 3, Borrow Pit Landfill, Appendix Z, Basewide Background Report, Marine Corps Air Station Beaufort, South Carolina (Tetra Tech, November 2006). These four generalized soil types were identified at RCRA SWMUs at MCAS Beaufort. According to USDA soil survey maps, the same soil types exist across MCRD Parris Island. These generalized soil types are discussed below. As the names imply, the soil types were identified based on grain size and probable USDA soil type in addition to soil origin (e.g., fill material and/or reworked natural material versus natural material deposited in place) and physiographic location (e.g, uplands, lowlands, marsh, etc.).

**Sandy Soil (SSA)**

The USDA map units of Seabrook fine sand, Rosedhu fine sand, Seewee fine sand, Polowana loamy fine sand, Ridgeland fine sand, Baratari fine sand, Wando fine sand, and Borrow pits are included in the sandy soil (a) (SSA) soil type. With the exception of Borrow pits, which may represent a wider range of material, these soils series have sand content ranging from 65 percent to 100 percent. The pHs of these soils ranges from 3.6 to 7.3, and the salinity is less than 2 millimhos per centimeter (mmhos/cm). The Seabrook, Seewee, Wando, and Borrow pits soil series can be found scattered throughout the interior of MCRD Parris Island.

**Sandy Soil (SSB)**

The USDA map unit of Udorthents sandy soil is included in the sandy soil (b) (SSB) soil type and is similar to the soils in the SSA soil category, but was placed into its own category due to its description as "Sandy material that has been either filled or removed such as dredged material from rivers or waterways, filled areas, borrow pits, or sand pits." These soils have a sand content that can vary from 5 percent to 95 percent, a pH that ranges from 4.5 to 7.3, and a salinity of less than 2 mmhos/cm. Soil in this soil category is located beneath and around runways at MCAS Beaufort where, during construction of the runways, the soil was removed, filled, or moved around.

**Silty-to-Clayey Sand Soil (SCS)**

The USDA map units of Coosaw loamy fine sand, Berile loamy fine sand, Murad fine sand, Eddings fine sand, Tomotley loamy fine sand, Williman loamy fine sand, and Deloss fine sandy loam are included in the silty-to-clayey sand (SCS) soil type. Sand content ranges from 48 percent to 71 percent. The pH of these soils is similar to those of the sandy soil categories. Salinity is 0 mmhos/cm. The organic content ranges from 1.04 percent to 5.34 percent. The soil series included in this soil category appear to represent a transition from upland sandy soil to fine-grained clayey soil as described below. The Coosaw, Eddings, Murad, Tomotley, and Williman soil series are found scattered across MCRD Parris Island.

**Clayey Soil (CSA)**

Clayey soil (CSA) is typically neutral to slightly basic, with high organic content and high salinity. Bohicket Association and Capers Association are the soil series that represent the majority of the soils found in the CSA soil type at MCAS Beaufort and MCRD Parris Island. Bohicket Association contains an average of about 47.0 percent clay, and Capers Association averages 45.3 percent clay. The pH averages about 7.25 for Bohicket Association and 7.40 for Capers Association. Salinity is 12 mmhos/cm for Bohicket Association and 16 mmhos/cm for Capers Association. The organic content ranges from 12.5 to 15 percent for both soil series. The average hydraulic conductivity is 0.03 meters per day (m/day) for Bohicket Association and 0.26 m/day for Capers Association. These two soil types comprise the salt marsh areas at MCAS Beaufort and MCRD Parris Island. These soils cover about 17.5 percent of MCAS Beaufort, and over 30 percent of MCRD Parris Island. Because these two soil types comprise the salt marsh areas, it was anticipated that the samples collected from this soil category could be used to define background conditions for sediments.

**Soil Series Comparison**

The USDA map units of Coastal beaches, Wahee fine sandy loam, Yemassee loamy fine sand, and Yonges loamy fine sand are soil series identified at MCRD Parris Island that are not included in the background soil samples from MCAS Beaufort. These soils make up only approximately 3 percent of the soils at MCRD Parris Island. Based on the parent material found in the same soil series and the generalized soil types, the background samples from MCAS Beaufort and MCRD Parris Island represent the same general soil and sediment populations.

**MCAS Beaufort Basewide Background Report Conclusions**

As identified in the MCAS Beaufort Basewide Background Report, different soil types such as those at MCAS Beaufort may have naturally different chemical compositions and physical characteristics. Twenty-two soil series were initially identified during a basewide assessment of the soils at MCAS Beaufort. Soil characteristics were evaluated and used to combine the soil series into six distinct categories, of which only four were present at the regulated SWMUs at MCAS Beaufort. Data sets determined to be statistically similar were combined to create larger data sets which inherently have higher degrees of confidence. The MCAS Beaufort Basewide Background Report concluded that:

- CSA (sediment) results were statistically different from the other soil categories and can be considered as a separate data set for background sediment comparison.

- Surface soil results were statistically similar to subsurface results for each of the three soil categories (SSA, SSB, and SCS).
- SSA, SSB, and SCS results were statistically similar to one another and can be considered as one data set for background soil comparison.

Representative concentrations of background were determined statistically for certain organic and inorganic target analytes in soils (SSA, SSB, and SCS) and sediments (CSA). These values were presented in Table ES-1 and Table ES-2 of the Executive Summary of the MCAS Beaufort Basewide Background Report for soils and sediments, respectively. The same information is reproduced in Table 2 and Table 3 of this report for reference.

## Conclusions

Due to the close proximity of MCAS Beaufort and MCRD Parris Island and the similar percentages of the same soil types that are present at both facilities, the conclusions that were drawn regarding: (a) the statistical similarity of surface and subsurface soil data across all soil types at MCAS Beaufort, and (b) that the sediment results are a separate data set are both applicable to MCRD Parris Island. Thus, the basewide background data set that was approved by the Partnering Team at MCAS Beaufort is applicable for use by the Partnering Team at MCRD Parris Island.

# TABLES

**Table 1**

**Soil Series Comparison**
**MCRD Parris Island Soil and Sediment Background Evaluation**
**MCRD Parris Island, Parris Island, South Carolina**

| Soil Series (USDA Map Unit) | Symbol | Present at MCAS Beaufort | Present at MCRD Parris Island | Soil Type[1] |
|---|---|---|---|---|
| Baratari Fine Sand | Ba | X | | SSA |
| Berile Loamy Fine Sand | Bb | X | | SCS |
| Bohicket Association | BK | X | X | CSA |
| Borrow Pits | Bp | X | X | CSA |
| Capers Association | CE | X | X | CSA |
| Coastal Beaches | Co | | X | (SSA) |
| Coosaw Loamy Fine Sand | Cs | X | X | SCS |
| Deloss Fine Sandy Loam | De | X | | SCS |
| Eddings Fine Sand | EdB | X | X | SCS |
| Murad Fine Sand | Mu | X | X | SCS |
| Polowana Loamy Fine Sand | Po | X | | SSA |
| Ridgeland Fine Sand | Rd | X | | SSA |
| Rosedhu Fine Sand | Ro | X | | SSA |
| Seabrook Fine Sand | Sk | X | X | SSA |
| Seewee Fine Sand | Sw | X | X | SSA |
| Tomotley Loamy Fine Sand | To | X | X | SCS |
| Udorthents Sandy | US | X | | SSB |
| Wahee Fine Sandy Loam | Wa | | X | (SSA) |
| Wando Fine Sand | Wd | X | X | SSA |
| Williman Loamy Fine Sand | Wn | X | X | SCS |
| Yemassee Loamy Fine Sand | Ye | | X | (SCS) |
| Yonges Loamy Fine Sand | Yo | | X | (SCS) |

1 - Soil Type, as defined in the MCAS Beaufort Basewide Background Report, except for those soil series not present at MCAS Beaufort, which are based on similar soil descriptions (in parenthesis).

**Table 2**

**Representative Concentrations - Soil**
**MCRD Parris Island Soil and Sediment Background Evaluation**
**MCRD Parris Island, Parris Island, South Carolina**

| CHEMICAL | FREQUENCY OF DETECTION | MINIMUM DETECTION | MAXIMUM DETECTION | REPRESENTATIVE CONCENTRATION[1] |
|---|---|---|---|---|
| **Volatile Organics (ug/kg)** | | | | |
| CARBON DISULFIDE | 26/60 | 2 J | 230 J | 51.5 |
| DICHLORODIFLUOROMETHANE | 2/60 | 1 J | 2.8 J | 2.8 |
| METHYL ACETATE | 2/60 | 1.9 J | 3 J | 3 |
| TRICHLOROFLUOROMETHANE | 5/60 | 2 J | 7 | 4.81 |
| **Semivolatile Organics (ug/kg)** | | | | |
| ANTHRACENE | 2/60 | 77 J | 590 J | 206 |
| BENZALDEHYDE | 1/3 | 580 J | 580 J | 580 |
| BENZO(A)ANTHRACENE | 3/60 | 150 J | 2200 | 284 |
| BENZO(A)PYRENE | 4/60 | 58 J | 1400 J | 248 |
| BENZO(B)FLUORANTHENE | 4/60 | 89 J | 1900 J | 271 |
| BENZO(G,H,I)PERYLENE | 2/60 | 220 J | 1100 J | 230 |
| BENZO(K)FLUORANTHENE | 4/60 | 66 J | 1500 J | 252 |
| CARBAZOLE | 1/60 | 450 J | 450 J | 201 |
| CHRYSENE | 3/60 | 180 J | 2500 | 299 |
| DIBENZO(A,H)ANTHRACENE | 1/60 | 550 J | 550 J | 205 |
| FLUORANTHENE | 4/60 | 84 J | 5800 | 705 |
| INDENO(1,2,3-CD)PYRENE | 2/60 | 210 J | 980 J | 225 |
| PHENANTHRENE | 3/60 | 92 J | 3200 | 325 |
| PYRENE | 3/60 | 280 J | 3500 | 356 |
| TOTAL PAHs | 4/60 | 142 | 25220 | 628 |
| **Pesticides PCBs (ug/kg)** | | | | |
| 4,4'-DDD | 1/60 | 1.8 J | 1.8 J | 1.8 |
| 4,4'-DDE | 4/60 | 2.4 J | 8.9 | 2.94 |
| 4,4'-DDT | 5/60 | 1.8 J | 5.2 | 2.76 |
| ALPHA-CHLORDANE | 20/60 | 0.862 J | 280 J | 26.7 |
| ENDOSULFAN SULFATE | 3/60 | 2.42 J | 7.715 J | 2.79 |
| ENDRIN | 1/60 | 3.64 J | 3.64 J | 2.64 |
| ENDRIN ALDEHYDE | 1/60 | 4.18 J | 4.18 J | 2.65 |
| GAMMA-CHLORDANE | 1/60 | 200 | 200 | 18.7 |
| HEPTACHLOR | 1/60 | 1.03 J | 1.03 J | 1.03 |
| METHOXYCHLOR | 2/60 | 2.11 J | 32.8 J | 13.5 |
| TOTAL DDT | 6/60 | 2.93 | 12.5 | 2.24 |
| **Herbicides (ug/kg)** | | | | |
| 2,4-D | 1/60 | 14.5 J | 14.5 J | 13.7 |
| DALAPON | 1/60 | 25 J | 25 J | 25.0 |
| **Inorganics (mg/kg)** | | | | |
| ALUMINUM | 60/60 | 746 | 12100 | 4778 |
| ARSENIC | 46/60 | 0.25 | 3.3 | 1.16 |
| BARIUM | 60/60 | 1.8 | 32.5 J | 12.9 |
| BERYLLIUM | 39/60 | 0.055 | 0.288 J | 0.288 |
| CADMIUM | 5/60 | 0.0665 J | 0.32 | 0.320 |
| CALCIUM | 37/60 | 39.9 J | 43300 | 1880 |
| CHROMIUM | 60/60 | 1.532 J | 14.3 | 5.17 |
| COBALT | 53/60 | 0.129 J | 1.2 | 1.20 |
| COPPER | 60/60 | 0.32 J | 4.85 J | 2.50 |
| IRON | 60/60 | 125.15 | 11200 | 2875 |
| LEAD | 60/60 | 0.978 | 20.4 | 6.92 |
| MAGNESIUM | 60/60 | 32.13 J | 1040 | 278 |
| MANGANESE | 60/60 | 2.01 J | 80.1 | 19.2 |
| MERCURY | 36/60 | 0.025 | 0.77 | 0.248 |
| NICKEL | 57/60 | 0.314 J | 3.6 | 1.65 |
| POTASSIUM | 58/60 | 19.5 J | 570 | 105 |
| SELENIUM | 20/60 | 0.15 | 1.4 | 0.595 |
| SILVER | 3/60 | 0.14 | 0.986 J | 0.99 |
| SODIUM | 17/60 | 40 J | 549 | 491 |
| THALLIUM | 3/60 | 0.379 J | 0.682 J | 0.682 |
| VANADIUM | 60/60 | 1.33 J | 23.2 | 8.22 |
| ZINC | 26/60 | 1.6 | 18 | 4.27 |
| **Miscellaneous Parameters** | | | | |
| CATION EXCHANGE CAPACITY (MEQ/100) | 60/60 | 0.46 J | 47.7 | 16.0 |
| PERCENT SOLIDS (%) | 60/60 | 76 | 99 | 89.1 |
| PH (S.U.) | 60/60 | 3.63 | 8.1 | 5.61 |
| TOTAL ORGANIC CARBON (mg/kg) | 54/60 | 21 J | 30500 | 5509 |

1 The concentration used as the representative concentration is the most appropriate 95% UCL based on the evaluation of the results of the ProUCL calculation, or the maximum concentration.

**Table 3**

**Representative Concentrations - Sediment**
**MCRD Parris Island Soil and Sediment Background Evaluation**
**MCRD Parris Island, Parris Island, South Carolina**

| CHEMICAL | FREQUENCY OF DETECTION | MINIMUM DETECTION | MAXIMUM DETECTION | REPRESENTATIVE CONCENTRATION[1] |
|---|---|---|---|---|
| **Volatile Organics (ug/kg)** | | | | |
| CARBON DISULFIDE | 10/10 | 2.7 J | 1400 J | 998 |
| METHYL ACETATE | 1/10 | 3.3 J | 3.3 J | 3.3 |
| **Pesticides PCBs (ug/kg)** | | | | |
| ENDRIN KETONE | 3/10 | 12.9 J | 76.5 J | 57.9 |
| METHOXYCHLOR | 2/10 | 22.4 J | 362 J | 362 |
| **Inorganics (mg/kg)** | | | | |
| ALUMINUM | 10/10 | 938 J | 7090 | 5803 |
| ARSENIC | 6/10 | 0.99 J | 5.66 | 3.98 |
| BARIUM | 10/10 | 2.23 J | 18.6 J | 10.9 |
| BERYLLIUM | 4/10 | 0.165 J | 0.416 J | 0.416 |
| CALCIUM | 10/10 | 387 J | 1960 J | 1392 |
| CHROMIUM | 10/10 | 1.52 J | 13.7 | 9.25 |
| COBALT | 8/10 | 0.261 J | 2.33 J | 4.86 |
| COPPER | 10/10 | 1.66 J | 23 | 12.1 |
| IRON | 10/10 | 493.5 | 10200 | 6560 |
| LEAD | 10/10 | 1.49 | 12.7 | 7.99 |
| MAGNESIUM | 10/10 | 348 J | 3400 | 2423 |
| MANGANESE | 10/10 | 4.44 J | 67.9 | 43.1 |
| MERCURY | 10/10 | 0.027 J | 0.29 | 0.190 |
| NICKEL | 10/10 | 0.5005 J | 3.97 J | 2.43 |
| POTASSIUM | 10/10 | 134 J | 2060 J | 1671 |
| SELENIUM | 3/10 | 1.12 J | 1.67 J | 1.54 |
| SODIUM | 10/10 | 135 J | 14900 J | 9208 |
| VANADIUM | 10/10 | 2.53 J | 22.7 | 14.3 |
| ZINC | 10/10 | 3.825 J | 55.2 | 38.4 |
| **Miscellaneous Parameters** | | | | |
| CATION EXCHANGE CAPACITY (MEQ/100) | 10/10 | 27.5 J | 76.4 | 55.6 |
| PERCENT SOLIDS (%) | 10/10 | 42 | 72 | 62.9 |
| PH (S.U.) | 10/10 | 5.995 | 7.66 | 6.97 |
| TOTAL ORGANIC CARBON (mg/kg) | 10/10 | 8900 | 64000 | 41816 |

1 The concentration used as the representative concentration is the most appropriate 95% UCL based on the evaluation of the results of the ProUCL calculation, or the maximum concentration.

# ATTACHMENT A
# BACKGROUND INFORMATION

# Beaufort County, South Carolina

## Bb—Bertie loamy fine sand

### Map Unit Setting

*Elevation:* 30 to 250 feet
*Mean annual precipitation:* 45 to 52 inches
*Mean annual air temperature:* 64 to 70 degrees F
*Frost-free period:* 240 to 280 days

### Map Unit Composition

*Yauhannah and similar soils:* 100 percent

### Description of Yauhannah

#### Setting

*Landform:* Marine terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Loamy marine deposits

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Moderately well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)
*Depth to water table:* About 18 to 30 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Moderate (about 7.2 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 2w

#### Typical profile

*0 to 17 inches:* Loamy fine sand
*17 to 42 inches:* Sandy clay loam
*42 to 57 inches:* Fine sandy loam
*57 to 85 inches:* Loamy fine sand

# Data Source Information

Soil Survey Area: Beaufort County, South Carolina
Survey Area Data: Version 8, Feb 2, 2010

# Beaufort County, South Carolina

## BK—Bohicket association

### Map Unit Setting

*Elevation:* 30 to 250 feet
*Mean annual precipitation:* 45 to 52 inches
*Mean annual air temperature:* 64 to 70 degrees F
*Frost-free period:* 240 to 280 days

### Map Unit Composition

*Bohicket and similar soils:* 100 percent

### Description of Bohicket

#### Setting

*Landform:* Marshes
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Clayey and/or silty marine deposits

#### Properties and qualities

*Slope:* 0 to 1 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Very poorly drained
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately low (0.00 to 0.06 in/hr)
*Depth to water table:* About 0 inches
*Frequency of flooding:* Very frequent
*Frequency of ponding:* Frequent
*Maximum salinity:* Slightly saline to moderately saline (8.0 to 16.0 mmhos/cm)
*Sodium adsorption ratio, maximum:* 55.0
*Available water capacity:* Very low (about 2.9 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 8w

#### Typical profile

*0 to 10 inches:* Silty clay loam
*10 to 49 inches:* Silty clay
*49 to 80 inches:* Clay

# Data Source Information

Soil Survey Area: Beaufort County, South Carolina
Survey Area Data: Version 8, Feb 2, 2010

# Beaufort County, South Carolina

## CE—Capers association

### Map Unit Setting

*Elevation:* 30 to 250 feet
*Mean annual precipitation:* 45 to 52 inches
*Mean annual air temperature:* 64 to 70 degrees F
*Frost-free period:* 240 to 280 days

### Map Unit Composition

*Capers and similar soils:* 100 percent

### Description of Capers

#### Setting

*Landform:* Marshes, marine terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Clayey and/or silty marine deposits

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Very poorly drained
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately low (0.00 to 0.06 in/hr)
*Depth to water table:* About 0 to 12 inches
*Frequency of flooding:* Very frequent
*Frequency of ponding:* None
*Maximum salinity:* Slightly saline to strongly saline (8.0 to 24.0 mmhos/cm)
*Available water capacity:* Very low (about 1.2 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 8w

#### Typical profile

*0 to 22 inches:* Silty clay loam
*22 to 68 inches:* Clay

# Data Source Information

Soil Survey Area: Beaufort County, South Carolina
Survey Area Data: Version 8, Feb 2, 2010

# Beaufort County, South Carolina

## Cs—Coosaw loamy fine sand

### Map Unit Setting

*Elevation:* 30 to 250 feet
*Mean annual precipitation:* 45 to 52 inches
*Mean annual air temperature:* 64 to 70 degrees F
*Frost-free period:* 240 to 280 days

### Map Unit Composition

*Coosaw and similar soils:* 100 percent

### Description of Coosaw

#### Setting

*Landform:* Marine terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Loamy and/or sandy marine deposits

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Moderately well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)
*Depth to water table:* About 24 to 36 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Moderate (about 7.0 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 3w

#### Typical profile

*0 to 7 inches:* Loamy fine sand
*7 to 27 inches:* Loamy fine sand
*27 to 31 inches:* Fine sandy loam
*31 to 77 inches:* Sandy clay loam
*77 to 85 inches:* Fine sandy loam

# Data Source Information

Soil Survey Area: Beaufort County, South Carolina
Survey Area Data: Version 8, Feb 2, 2010

# Beaufort County, South Carolina

## EdB—Eddings fine sand, 0 to 6 percent slopes

### Map Unit Setting

*Elevation:* 30 to 250 feet
*Mean annual precipitation:* 45 to 52 inches
*Mean annual air temperature:* 64 to 70 degrees F
*Frost-free period:* 240 to 280 days

### Map Unit Composition

*Eddings and similar soils:* 100 percent

### Description of Eddings

#### Setting

*Landform:* Marine terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Sandy and/or loamy marine deposits

#### Properties and qualities

*Slope:* 0 to 6 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Moderately well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)
*Depth to water table:* About 42 to 54 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Low (about 5.7 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 3s

#### Typical profile

*0 to 14 inches:* Fine sand
*14 to 44 inches:* Fine sand
*44 to 66 inches:* Sandy clay loam
*66 to 84 inches:* Fine sandy loam

# Data Source Information

Soil Survey Area: Beaufort County, South Carolina
Survey Area Data: Version 8, Feb 2, 2010

# Beaufort County, South Carolina

## Sk—Seabrook fine sand

### Map Unit Setting

*Elevation:* 30 to 250 feet
*Mean annual precipitation:* 45 to 52 inches
*Mean annual air temperature:* 64 to 70 degrees F
*Frost-free period:* 240 to 280 days

### Map Unit Composition

*Chipley and similar soils:* 96 percent
*Minor components:* 4 percent

### Description of Chipley

#### Setting

*Landform:* Marine terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Sandy marine deposits

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat poorly drained
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)
*Depth to water table:* About 24 to 36 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Low (about 3.8 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 3s

#### Typical profile

*0 to 10 inches:* Fine sand
*10 to 80 inches:* Fine sand

### Minor Components

#### Pickney

*Percent of map unit:* 4 percent
*Landform:* Depressions, flood plains
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear

*Across-slope shape:* Linear

## Data Source Information

Soil Survey Area: Beaufort County, South Carolina
Survey Area Data: Version 8, Feb 2, 2010

# Beaufort County, South Carolina

## Sw—Seewee fine sand

### Map Unit Setting

*Elevation:* 30 to 250 feet
*Mean annual precipitation:* 45 to 52 inches
*Mean annual air temperature:* 64 to 70 degrees F
*Frost-free period:* 240 to 280 days

### Map Unit Composition

*Seewee and similar soils:* 95 percent
*Minor components:* 5 percent

### Description of Seewee

#### Setting

*Landform:* Marine terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Sandy marine deposits

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat poorly drained
*Capacity of the most limiting layer to transmit water (Ksat):* High (1.98 to 5.95 in/hr)
*Depth to water table:* About 12 to 24 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Low (about 3.8 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 3w

#### Typical profile

*0 to 8 inches:* Fine sand
*8 to 25 inches:* Fine sand
*25 to 45 inches:* Fine sand
*45 to 80 inches:* Fine sand

### Minor Components

#### Pickney

*Percent of map unit:* 5 percent
*Landform:* Depressions, flood plains
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear

*Across-slope shape:* Linear

## Data Source Information

Soil Survey Area: Beaufort County, South Carolina
Survey Area Data: Version 8, Feb 2, 2010

# Beaufort County, South Carolina

## Wa—Wahee fine sandy loam

### Map Unit Setting

*Elevation:* 30 to 250 feet
*Mean annual precipitation:* 45 to 52 inches
*Mean annual air temperature:* 64 to 70 degrees F
*Frost-free period:* 240 to 280 days

### Map Unit Composition

*Wahee and similar soils:* 90 percent
*Minor components:* 4 percent

### Description of Wahee

#### Setting

*Landform:* Marine terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Loamy marine deposits

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat poorly drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* About 6 to 18 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Moderate (about 7.5 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 2w

#### Typical profile

*0 to 6 inches:* Fine sandy loam
*6 to 13 inches:* Fine sandy loam
*13 to 16 inches:* Clay loam
*16 to 40 inches:* Clay
*40 to 62 inches:* Sandy clay loam

### Minor Components

#### Bladen

*Percent of map unit:* 4 percent
*Landform:* Depressions, marine terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear

*Across-slope shape:* Linear

## Data Source Information

Soil Survey Area: Beaufort County, South Carolina
Survey Area Data: Version 8, Feb 2, 2010

# Beaufort County, South Carolina

## Wd—Wando fine sand, 0 to 6 percent slopes

### Map Unit Setting

*Elevation:* 30 to 250 feet
*Mean annual precipitation:* 45 to 52 inches
*Mean annual air temperature:* 64 to 70 degrees F
*Frost-free period:* 240 to 280 days

### Map Unit Composition

*Lakeland and similar soils:* 95 percent

### Description of Lakeland

#### Setting

*Landform:* Marine terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Sandy marine deposits

#### Properties and qualities

*Slope:* 0 to 6 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Excessively drained
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Low (about 4.0 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 4s

#### Typical profile

*0 to 52 inches:* Fine sand
*52 to 85 inches:* Fine sand

# Data Source Information

Soil Survey Area: Beaufort County, South Carolina
Survey Area Data: Version 8, Feb 2, 2010

# Beaufort County, South Carolina

## Wn—Williman loamy fine sand

### Map Unit Setting

*Elevation:* 30 to 250 feet
*Mean annual precipitation:* 45 to 52 inches
*Mean annual air temperature:* 64 to 70 degrees F
*Frost-free period:* 240 to 280 days

### Map Unit Composition

*Williman and similar soils:* 100 percent

### Description of Williman

#### Setting

*Landform:* Depressions, marine terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Loamy marine deposits

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Poorly drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)
*Depth to water table:* About 0 to 12 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Moderate (about 6.5 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 3w

#### Typical profile

*0 to 5 inches:* Loamy fine sand
*5 to 26 inches:* Loamy fine sand
*26 to 58 inches:* Sandy clay loam
*58 to 80 inches:* Sandy clay loam

# Data Source Information

Soil Survey Area: Beaufort County, South Carolina
Survey Area Data: Version 8, Feb 2, 2010

# Beaufort County, South Carolina

## Yo—Yonges loamy fine sand

### Map Unit Setting

*Elevation:* 30 to 250 feet
*Mean annual precipitation:* 45 to 52 inches
*Mean annual air temperature:* 64 to 70 degrees F
*Frost-free period:* 240 to 280 days

### Map Unit Composition

*Yonges and similar soils:* 100 percent

### Description of Yonges

#### Setting

*Landform:* Depressions, marine terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Loamy marine deposits

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Poorly drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 5.95 in/hr)
*Depth to water table:* About 0 to 12 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Moderate (about 8.9 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 3w

#### Typical profile

*0 to 9 inches:* Loamy fine sand
*9 to 18 inches:* Fine sandy loam
*18 to 60 inches:* Sandy clay loam
*60 to 80 inches:* Sandy clay loam

# Data Source Information

Soil Survey Area: Beaufort County, South Carolina
Survey Area Data: Version 8, Feb 2, 2010

Search

Area of Interest

Open All | Close All

AOI Properties

Clear AOI

**AOI Information**

Name

Map Unit Symbols
- (•) Use Soil Survey Area Map Unit Symbols
- ( ) Use National Map Unit Symbols

Area (acres) 305.1

**Soil Data Available from Web Soil Survey**

**Beaufort County, South Carolina (SC013)**

Spatial Data Version 1, Apr 30, 2004

Tabular Data Version 8, Feb 2, 2010

Clear AOI

Import AOI

Export AOI

Quick Navigation

Address

State and County

Soil Survey Area

Latitude and Longitude

PLSS (Section, Township, Range)

Bureau of Land Management

Department of Defense

Forest Service

National Park Service

Hydrologic Unit

Area of Interest Interactive Map

View Extent Contiguous U.S.

Scale (not to scale)

View Soil Information By Use: All Uses

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Intro to Soils | Suitabilities and Limitations for Use | Soil Properties and Qualities | Ecological Site Assessment | Soil Reports

**Search**

**Properties and Qualities Ratings**

Open All | Close All

Soil Chemical Properties

Soil Erosion Factors

Soil Physical Properties

**Soil Qualities and Features**

AASHTO Group Classification (Surface)

Depth to a Selected Soil Restrictive Layer

Depth to Any Soil Restrictive Layer

Drainage Class

Frost Action

Frost-Free Days

**Hydrologic Soil Group**

View Description | View Rating

**View Options**

Map ☑

Table ☑

Description of Rating ☑

Rating Options ☑

Detailed Description ☐

**Advanced Options**

Aggregation Method: Dominant Condition

Component Percent Cutoff

Tie-break Rule: ○ Lower ◉ Higher

View Description | View Rating

Map Unit Name

Parent Material Name

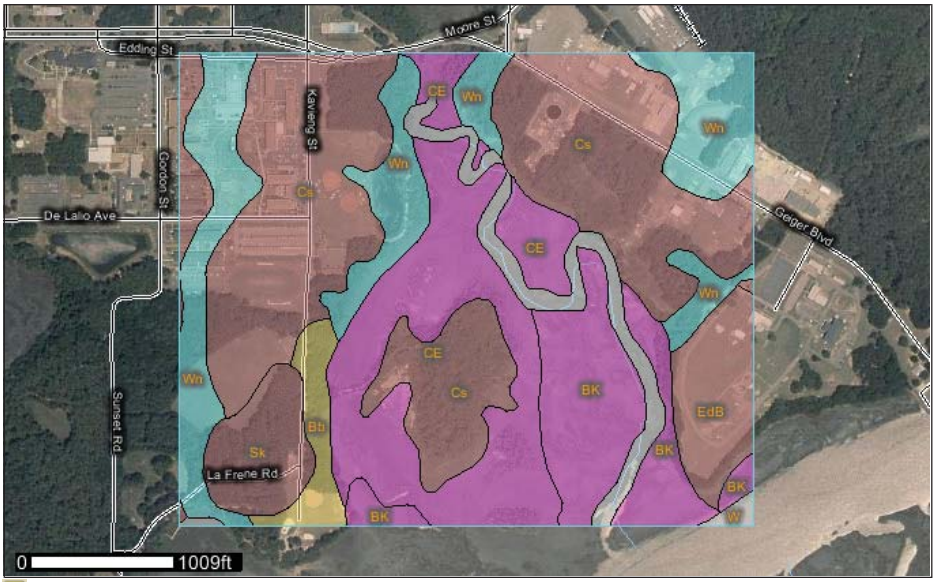
Representative Slope

Unified Soil Classification (Surface)

Water Features

**Map — Hydrologic Soil Group**

Scale (not to scale)




**Warning: Soil Ratings Map may not be valid at this scale.**

You have zoomed in beyond the scale at which the soil map for this area is intended to be used. Mapping of soils is done at a particular scale. The soil surveys that comprise your AOI were mapped at 1:20,000. The design of map units and the level of detail shown in the resulting soil map are dependent on that map scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

**Tables — Hydrologic Soil Group — Summary By Map Unit**

**Summary by Map Unit — Beaufort County, South Carolina (SC013)**

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| Bb | Bertie loamy fine sand | C | 7.8 | 2.6% |
| BK | Bohicket association | D | 34.2 | 11.2% |
| CE | Capers association | D | 55.4 | 18.2% |
| Cs | Coosaw loamy fine sand | A | 114.3 | 37.5% |
| EdB | Eddings fine sand, 0 to 6 percent slopes | A | 14.9 | 4.9% |
| Sk | Seabrook fine sand | A | 13.2 | 4.3% |
| W | Water | | 14.3 | 4.7% |
| Wn | Williman loamy fine sand | B/D | 51.1 | 16.8% |
| **Totals for Area of Interest** | | | **305.1** | **100.0%** |

**Description — Hydrologic Soil Group**

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture

to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

**Rating Options — Hydrologic Soil Group**

**Aggregation Method:** Dominant Condition

**Component Percent Cutoff:** *None Specified*

**Tie-break Rule:** Higher

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## Search

## Map Unit Legend

**Beaufort County, South Carolina (SC013)**

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| Bb | Bertie loamy fine sand | 7.8 | 2.6% |
| BK | Bohicket association | 34.2 | 11.2% |
| CE | Capers association | 55.4 | 18.2% |
| Cs | Coosaw loamy fine sand | 114.3 | 37.5% |
| EdB | Eddings fine sand, 0 to 6 percent slopes | 14.9 | 4.9% |
| Sk | Seabrook fine sand | 13.2 | 4.3% |
| W | Water | 14.3 | 4.7% |
| Wn | Williman loamy fine sand | 51.1 | 16.8% |
| **Totals for Area of Interest** | | **305.1** | **100.0%** |

## Soil Map

Scale (not to scale)

**Warning: Soil Map may not be valid at this scale.**

You have zoomed in beyond the scale at which the soil map for this area is intended to be used. Mapping of soils is done at a particular scale. The soil surveys that comprise your AOI were mapped at 1:20,000. The design of map units and the level of detail shown in the resulting soil map are dependent on that map scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Search

Properties and Qualities Ratings

Open All | Close All

Soil Chemical Properties

Soil Erosion Factors

Soil Physical Properties

Soil Qualities and Features

- AASHTO Group Classification (Surface)
- Depth to a Selected Soil Restrictive Layer
- Depth to Any Soil Restrictive Layer
- Drainage Class
- Frost Action
- Frost-Free Days
- Hydrologic Soil Group
- Map Unit Name
- Parent Material Name
- Representative Slope
- Unified Soil Classification (Surface)

View Description | View Rating

View Options

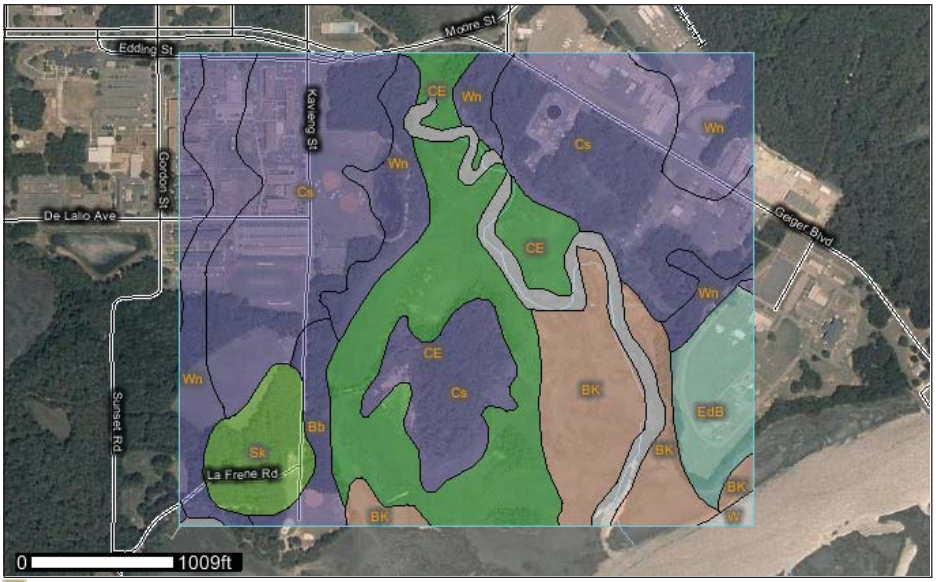
Map ☑
Table ☑
Description of Rating ☑
Rating Options ☑
Detailed Description ☐

Advanced Options

Aggregation Method: Dominant Condition
Component Percent Cutoff:
Tie-break Rule: Lower / Higher
Layer Options: Surface Layer / Depth Range
Top Depth:
Bottom Depth:
Inches

## Map — Unified Soil Classification (Surface)

Scale (not to scale)




**Warning: Soil Ratings Map may not be valid at this scale.**

You have zoomed in beyond the scale at which the soil map for this area is intended to be used. Mapping of soils is done at a particular scale. The soil surveys that comprise your AOI were mapped at 1:20,000. The design of map units and the level of detail shown in the resulting soil map are dependent on that map scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

## Tables — Unified Soil Classification (Surface) — Summary By Map Unit

**Summary by Map Unit — Beaufort County, South Carolina (SC013)**

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| Bb | Bertie loamy fine sand | SC-SM | 7.8 | 2.6% |
| BK | Bohicket association | OH | 34.2 | 11.2% |
| CE | Capers association | CL | 55.4 | 18.2% |
| Cs | Coosaw loamy fine sand | SC-SM | 114.3 | 37.5% |
| EdB | Eddings fine sand, 0 to 6 percent slopes | SM | 14.9 | 4.9% |
| Sk | Seabrook fine sand | SP-SM | 13.2 | 4.3% |
| W | Water | | 14.3 | 4.7% |
| Wn | Williman loamy fine sand | SC-SM | 51.1 | 16.8% |
| **Totals for Area of Interest** | | | **305.1** | **100.0%** |

## Description — Unified Soil Classification (Surface)

The Unified soil classification system classifies mineral and organic mineral soils for engineering purposes on the basis of particle-size characteristics, liquid limit, and plasticity index. It identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter; and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified system.

The various groupings of this classification correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can serve to make some general interpretations relating to probable performance of the soil

Centimeters

All Layers

View Description | View Rating

Water Features

for engineering uses.

For each soil horizon in the database one or more Unified soil classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

**Rating Options — Unified Soil Classification (Surface)**

**Aggregation Method:** Dominant Condition

**Component Percent Cutoff:** *None Specified*

**Tie-break Rule:** Lower

**Layer Options:** Surface Layer

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Search

Area of Interest

Open All Close All

AOI Properties

Clear AOI

**AOI Information**

Name

Map Unit Symbols
- (•) Use Soil Survey Area Map Unit Symbols
- ( ) Use National Map Unit Symbols

Area (acres) 5,348.1

**Soil Data Available from Web Soil Survey**

**Beaufort County, South Carolina (SC013)**

Spatial Data Version 1, Apr 30, 2004

Tabular Data Version 8, Feb 2, 2010

Clear AOI

Import AOI

Export AOI

Quick Navigation

Address

State and County

Soil Survey Area

Latitude and Longitude

PLSS (Section, Township, Range)

Bureau of Land Management

Department of Defense

Forest Service

National Park Service

Hydrologic Unit

Area of Interest Interactive Map

View Extent Contiguous U.S.

Scale (not to scale)

Search

Properties and Qualities Ratings

Open All | Close All

Soil Chemical Properties

Soil Erosion Factors

Soil Physical Properties

Soil Qualities and Features

- AASHTO Group Classification (Surface)
- Depth to a Selected Soil Restrictive Layer
- Depth to Any Soil Restrictive Layer
- Drainage Class
- Frost Action
- Frost-Free Days
- Hydrologic Soil Group

View Description | View Rating

View Options

Map ☑
Table ☑
Description of Rating ☑
Rating Options ☑
Detailed Description ☐

Advanced Options

Aggregation Method: Dominant Condition
Component Percent Cutoff:
Tie-break Rule: Lower / Higher

View Description | View Rating

- Map Unit Name
- Parent Material Name
- Representative Slope
- Unified Soil Classification (Surface)

Water Features

Map — Hydrologic Soil Group

Scale (not to scale)

Tables — Hydrologic Soil Group — Summary By Map Unit

Summary by Map Unit — Beaufort County, South Carolina (SC013)

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| BK | Bohicket association | D | 817.5 | 15.3% |
| Bp | Borrow pits | B | 111.7 | 2.1% |
| CE | Capers association | D | 737.4 | 13.8% |
| Co | Coastal beaches | | 7.2 | 0.1% |
| Cs | Coosaw loamy fine sand | A | 206.4 | 3.9% |
| Mu | Murad fine sand | A | 128.9 | 2.4% |
| Sk | Seabrook fine sand | A | 265.9 | 5.0% |
| Sw | Seewee fine sand | A/D | 385.2 | 7.2% |
| US | Udorthents, sandy | A | 34.7 | 0.6% |
| W | Water | | 2,308.4 | 43.2% |
| Wa | Wahee fine sandy loam | C/D | 19.6 | 0.4% |
| Wd | Wando fine sand, 0 to 6 percent slopes | A | 66.4 | 1.2% |
| Wn | Williman loamy fine sand | B/D | 248.5 | 4.6% |
| Yo | Yonges loamy fine sand | A/D | 10.0 | 0.2% |
| **Totals for Area of Interest** | | | **5,348.1** | **100.0%** |

Description — Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture

to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

**Rating Options — Hydrologic Soil Group**

**Aggregation Method:** Dominant Condition

**Component Percent Cutoff:** *None Specified*

**Tie-break Rule:** Higher

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## Search

## Map Unit Legend

**Beaufort County, South Carolina (SC013)**

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| BK | Bohicket association | 817.5 | 15.3% |
| Bp | Borrow pits | 111.7 | 2.1% |
| CE | Capers association | 737.4 | 13.8% |
| Co | Coastal beaches | 7.2 | 0.1% |
| Cs | Coosaw loamy fine sand | 206.4 | 3.9% |
| Mu | Murad fine sand | 128.9 | 2.4% |
| Sk | Seabrook fine sand | 265.9 | 5.0% |
| Sw | Seewee fine sand | 385.2 | 7.2% |
| US | Udorthents, sandy | 34.7 | 0.6% |
| W | Water | 2,308.4 | 43.2% |
| Wa | Wahee fine sandy loam | 19.6 | 0.4% |
| Wd | Wando fine sand, 0 to 6 percent slopes | 66.4 | 1.2% |
| Wn | Williman loamy fine sand | 248.5 | 4.6% |
| Yo | Yonges loamy fine sand | 10.0 | 0.2% |
| **Totals for Area of Interest** | | **5,348.1** | **100.0%** |

## Soil Map

Scale (not to scale)

Search

Properties and Qualities Ratings

Open All | Close All

Soil Chemical Properties

Soil Erosion Factors

Soil Physical Properties

Soil Qualities and Features

- AASHTO Group Classification (Surface)
- Depth to a Selected Soil Restrictive Layer
- Depth to Any Soil Restrictive Layer
- Drainage Class
- Frost Action
- Frost-Free Days
- Hydrologic Soil Group
- Map Unit Name
- Parent Material Name
- Representative Slope
- Unified Soil Classification (Surface)

View Description | View Rating

View Options

Map ☑
Table ☑
Description of Rating ☑
Rating Options ☑
Detailed Description ☐

Advanced Options

Aggregation Method: Dominant Condition
Component Percent Cutoff:
Tie-break Rule: Lower / Higher
Layer Options: Surface Layer / Depth Range
Top Depth:
Bottom Depth:
Inches

## Map — Unified Soil Classification (Surface)

Scale (not to scale)

## Tables — Unified Soil Classification (Surface) — Summary By Map Unit

### Summary by Map Unit — Beaufort County, South Carolina (SC013)

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| BK | Bohicket association | OH | 817.5 | 15.3% |
| Bp | Borrow pits | SC | 111.7 | 2.1% |
| CE | Capers association | CL | 737.4 | 13.8% |
| Co | Coastal beaches | SW-SM | 7.2 | 0.1% |
| Cs | Coosaw loamy fine sand | SC-SM | 206.4 | 3.9% |
| Mu | Murad fine sand | SC-SM | 128.9 | 2.4% |
| Sk | Seabrook fine sand | SP-SM | 265.9 | 5.0% |
| Sw | Seewee fine sand | SM | 385.2 | 7.2% |
| US | Udorthents, sandy | SC-SM | 34.7 | 0.6% |
| W | Water | | 2,308.4 | 43.2% |
| Wa | Wahee fine sandy loam | SC | 19.6 | 0.4% |
| Wd | Wando fine sand, 0 to 6 percent slopes | SP-SM | 66.4 | 1.2% |
| Wn | Williman loamy fine sand | SC-SM | 248.5 | 4.6% |
| Yo | Yonges loamy fine sand | SC-SM | 10.0 | 0.2% |
| **Totals for Area of Interest** | | | **5,348.1** | **100.0%** |

## Description — Unified Soil Classification (Surface)

The Unified soil classification system classifies mineral and organic mineral soils for engineering purposes on the basis of particle-size characteristics, liquid limit, and plasticity index. It identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter; and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified system.

The various groupings of this classification correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can serve to make some general interpretations relating to probable performance of the soil

Centimeters

All Layers

View Description | View Rating

Water Features

for engineering uses.

For each soil horizon in the database one or more Unified soil classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

**Rating Options — Unified Soil Classification (Surface)**

**Aggregation Method:** Dominant Condition

**Component Percent Cutoff:** *None Specified*

**Tie-break Rule:** Lower

**Layer Options:** Surface Layer

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# APPENDIX B

## SITE INSPECTION REPORT FIGURES AND TABLES

**(Excerpted from: Site Inspection Report for Munitions Response Program Sites UXOs 1 through 8, Marine Corps Recruit Depot, Parris Island, South Carolina, Tetra Tech, June 2011)**

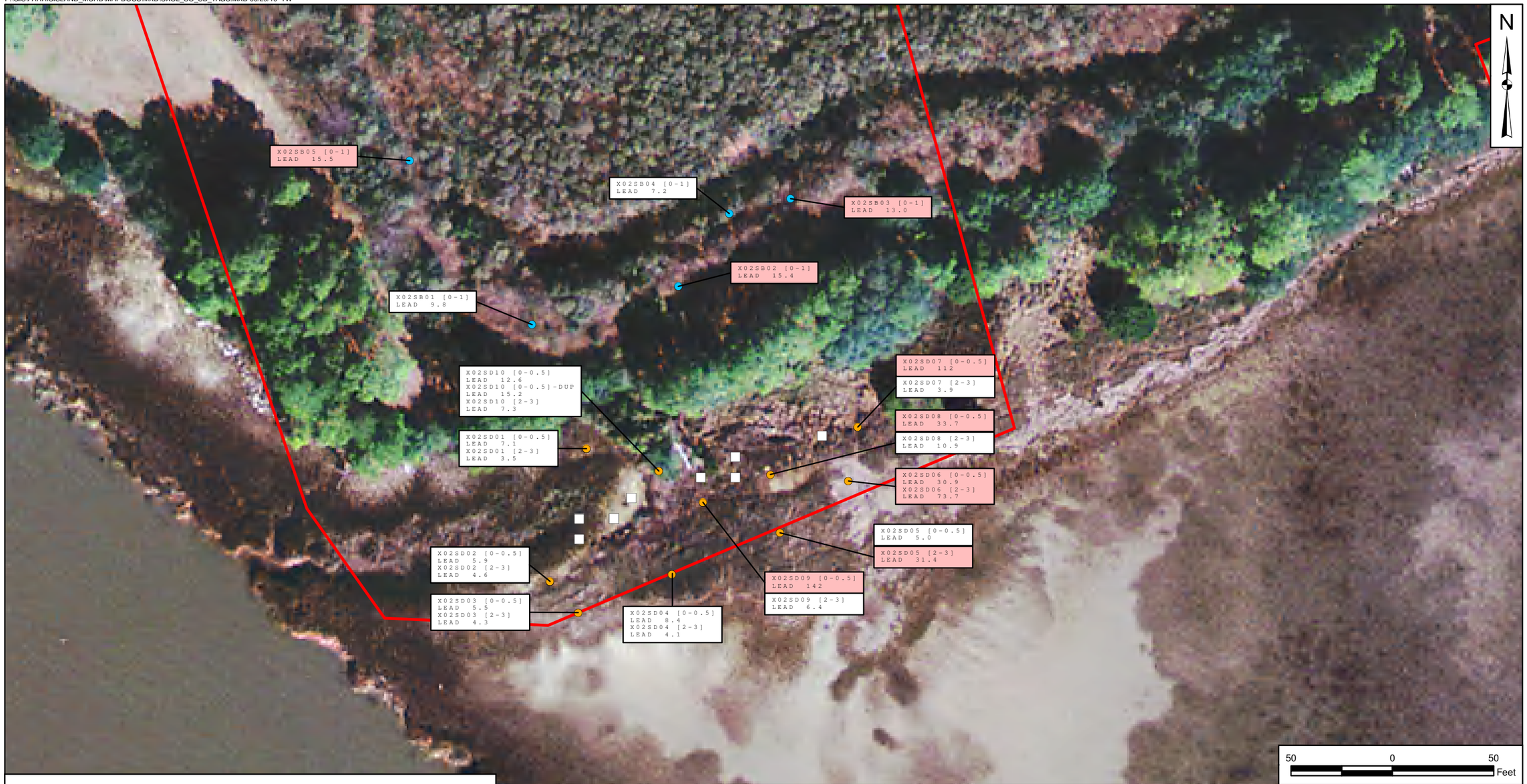
**TABLE 7-1**

**ITEMS DISCOVERED DURING DETECTOR-AIDED SURFACE SURVEYS AT UXO 4**
**MCRD PARRIS ISLAND**
**PARRIS ISLAND, SOUTH CAROLINA**

| Item # | Date Identified | Item Description/Type | GPS Location US Survey Feet | Resolution |
|---|---|---|---|---|
| 1 | 1/7/10 | Slap Flare/MDAS | N176751.49 E2094080.84 | No immediate hazard, left on site |
| 2 | 1/8/10 | Slap Flare/MDAS | N177072.29 E2093892.59 | No immediate hazard, left on site |
| 3 | 1/9/10 | Smoke Grenade/MDAS | N177502.37 E2093079.35 | No immediate hazard, left on site |
| 4 | 1/10/10 | 75mm Projectile (rusted)/MEC | N176779.16 E2094179.85 | EOD removed item from site on 1/10/19 |
| 5 | 1/10/10 | 75mm Projectile/MDAS | N177465.06 E2093717.65 | No immediate hazard, left on site |
| 6 | 1/11/10 | Slap Flare/MDAS | N177368.96 E2092879.84 | No immediate hazard, left on site |
| 7 | 1/11/10 | Slap Flare/MDAS | N177608.00 E2092892.39 | No immediate hazard, left on site |
| 8 | 1/19/10 | 75mm Shrapnel/MDAS | N178286.97 E2094471.72 | No immediate hazard, left on site |
| 9 | 1/19/10 | 75mm Shrapnel/MDAS | N178527.63 E2094874.33 | No immediate hazard, left on site |
| 10 | 1/19/10 | Marine Marker Mk 25 Mod 4 (intact burned spots)/MEC | N178676.27 E2095013.74 | EOD removed item from site on 1/20/10 |
| 11 | 1/20/10 | 75mm HE (fired/unarmed)/MPPEH | N176368.39 E2096146.95 | EOD removed item from site on 1/20/10 |
| 12 | 1/22/10 | Slap Flare Fin Assembly/MDAS | N176372.29 E2096122.74 | No immediate hazard, left on site |
| 13 | 1/22/10 | 75mm Shrapnel/MDAS | N176370.87 E2096116.90 | No immediate hazard, left on site |
| 14 | 1/22/10 | 75mm Shrapnel/MDAS | N177778.72 E2093178.18 | No immediate hazard, left on site |

EOD = Explosive Ordnance Disposal.
MDAS = Material Documented as Safe.
MEC = Munitions and Explosives of Concern.

P:\GIS\PARRISISLAND_MCRD\MAPDOCS\MXD\UXO2_SO_SD_TAGS.MXD 06/29/10 TW




## Legend

- Soil Sample Location
- Sediment Sample Location
- Concrete Target Foundations
- UXO 2 Site Boundary

Sample Location — Depth in feet

X02SD06 [0-0.5]
LEAD 30.9 — Result in mg/kg

X02SD06 [2-3]
LEAD 73.7 — Exceeds PAL (minimum criteria)

| | |
|---|---|
| DRAWN BY | DATE |
| K. MOORE | 05/24/10 |
| CHECKED BY | DATE |
| N. ROCHNA | 06/29/10 |
| COST/SCHED AREA | |
| SCALE | AS NOTED |

DEPARTMENT OF THE NAVY · UNITED STATES MARINE CORPS

POSITIVE DETECTIONS - SURFACE SOIL AND SEDIMENT
UXO 2 - RIFLE RANGE AT BALLAST CREEK
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER | CTO 089 |
| APPROVED BY | DATE |
| ___ | ___ |
| APPROVED BY | DATE |
| ___ | ___ |
| FIGURE NO. | REV |
| FIGURE 5-3 | 0 |

P:\GIS\PARRIS_ISLAND_MCRD\MXD\UXO3_CORE_LOCS.MXD 05/19/10 KM

**Legend**

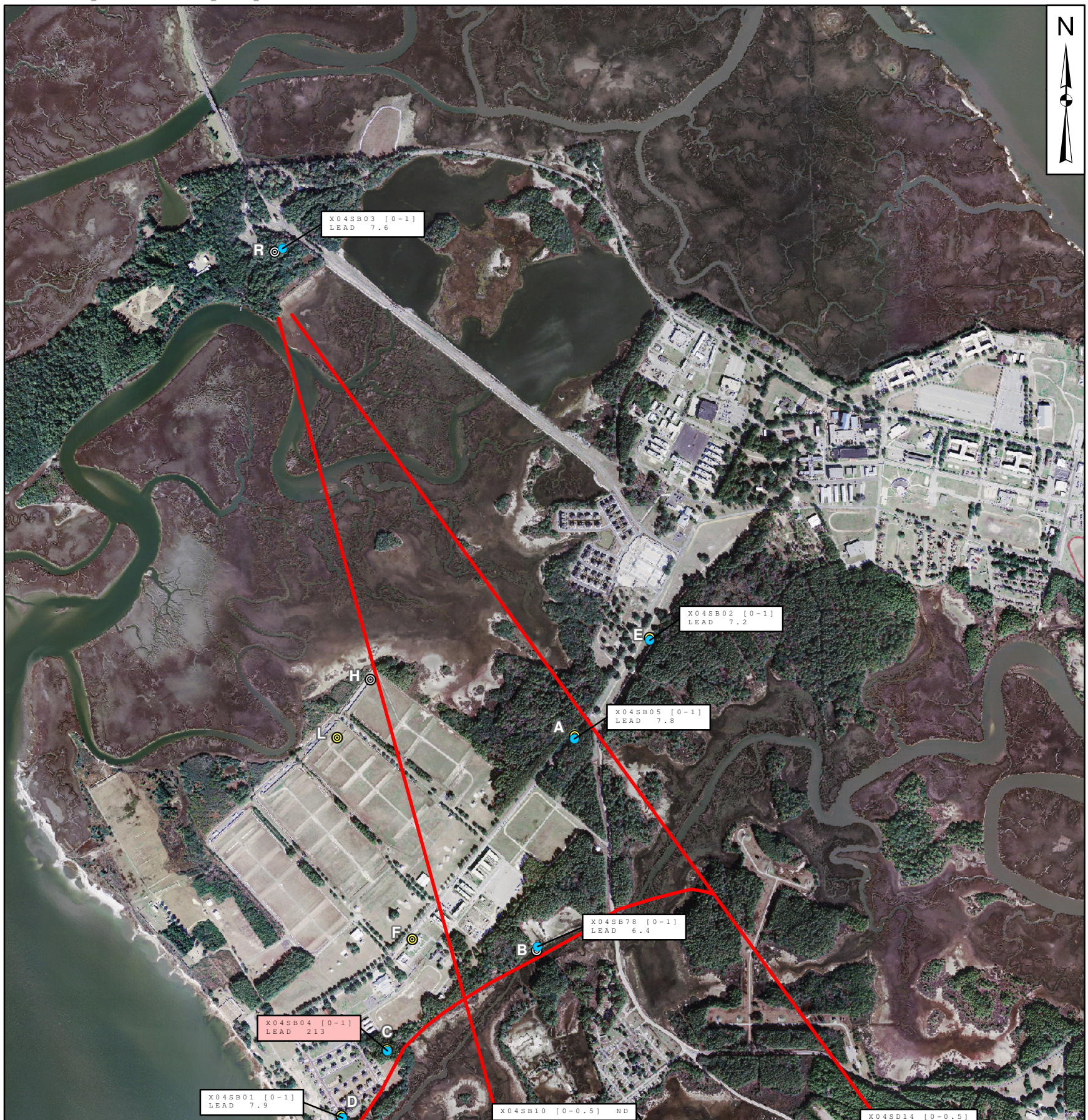
- Concrete Core Location
- Former Aerial Bombing Target Location

| | |
|---|---|
| DRAWN BY | DATE |
| J. ENGLISH | 04/28/10 |
| CHECKED BY | DATE |
| M. BLANKEN | 05/20/10 |
| COST/SCHED AREA | |
| SCALE | |
| AS NOTED | |

CONCRETE CORE LOCATION MAP
UXO 3 - AERIAL BOMBING TARGET AT PARADE DECK
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER | |
| CTO 0089 | |
| APPROVED BY | DATE |
| ___ | ___ |
| APPROVED BY | DATE |
| ___ | ___ |
| FIGURE NO. | REV |
| FIGURE 6-4 | 0 |

P:\GIS\PARRISISLAND_MCRD\MAPDOCS\MXD\UXO4_NON-XRF_TAGS.MXD 06/29/10 TW




## Legend

- Sediment Sample Location
- Surface Soil Sample Location
- Concrete Firing Position
- Non-Permament Firing Position
- UXO 4 Site Boundary

Sample Location — Depth in feet

X04SB01 [0-1]
LEAD 7.9 — Result in mg/kg

X04SB04 [0-1]
LEAD 213 — Exceeds PAL (minimum criteria)

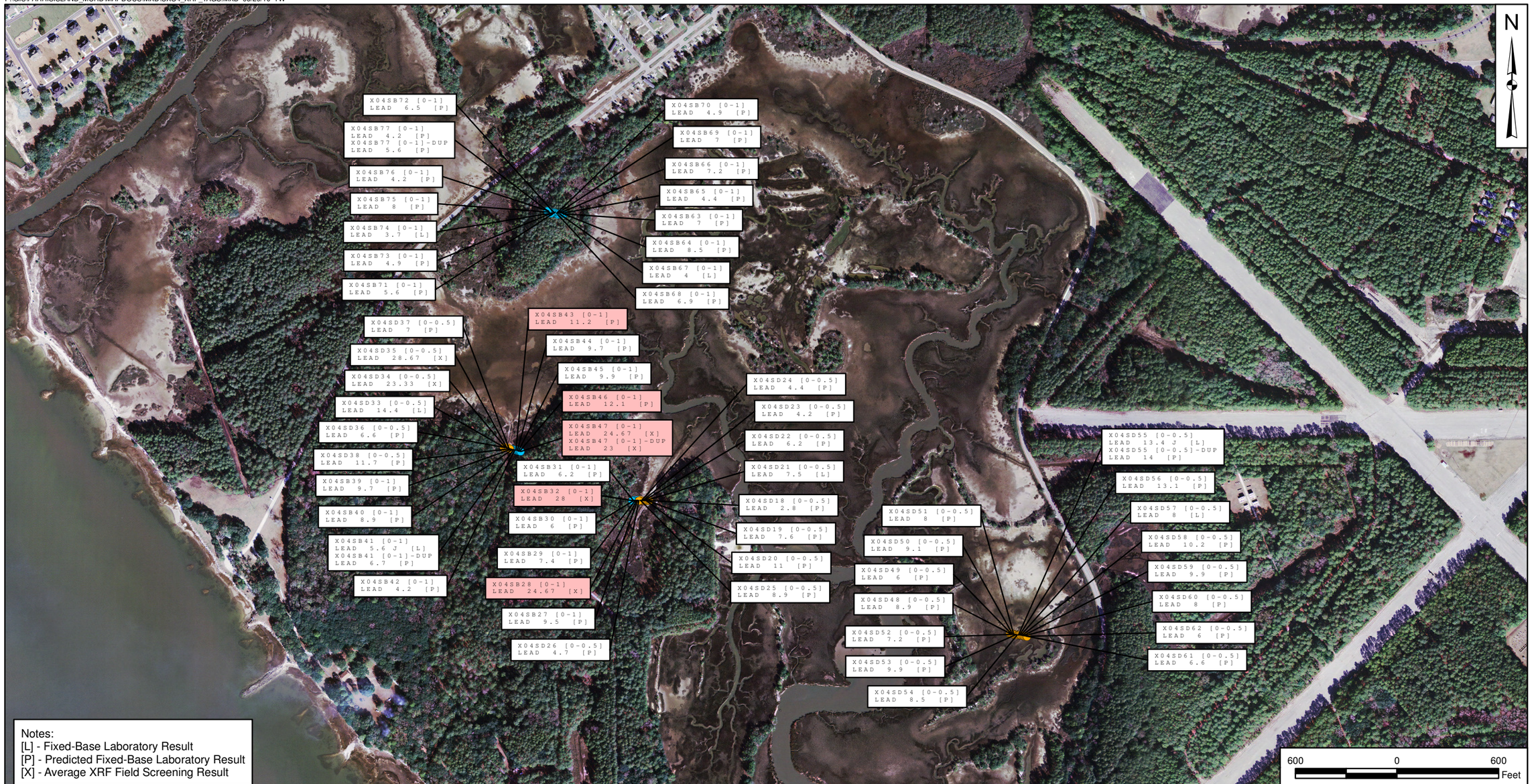
| | |
|---|---|
| DRAWN BY | DATE |
| K. MOORE | 05/25/10 |
| CHECKED BY | DATE |
| N. ROCHNA | 06/29/10 |
| COST/SCHED AREA | |
| SCALE | |
| AS NOTED | |

DEPARTMENT OF THE NAVY · UNITED STATES MARINE CORPS

# POSITIVE DETECTIONS - SURFACE SOIL AND SEDIMENT
## FIRING POINTS AND IMPACT AREA
## UXO 4 - FIELD ARTILLERY WEST MAIN RANGE
## MCRD PARRIS ISLAND
## PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER | |
| CTO 089 | |
| APPROVED BY | DATE |
| ___ | ___ |
| APPROVED BY | DATE |
| ___ | ___ |
| FIGURE NO. | REV |
| FIGURE 7-9 | 0 |

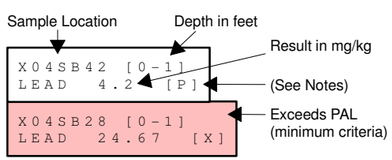
P:\GIS\PARRISISLAND_MCRD\MAPDOCS\MXD\UXO4_XRF_TAGS.MXD 06/29/10 TW




Notes:
[L] - Fixed-Base Laboratory Result
[P] - Predicted Fixed-Base Laboratory Result
[X] - Average XRF Field Screening Result

## Legend

- Sediment Sample Location
- Surface Soil Sample Location



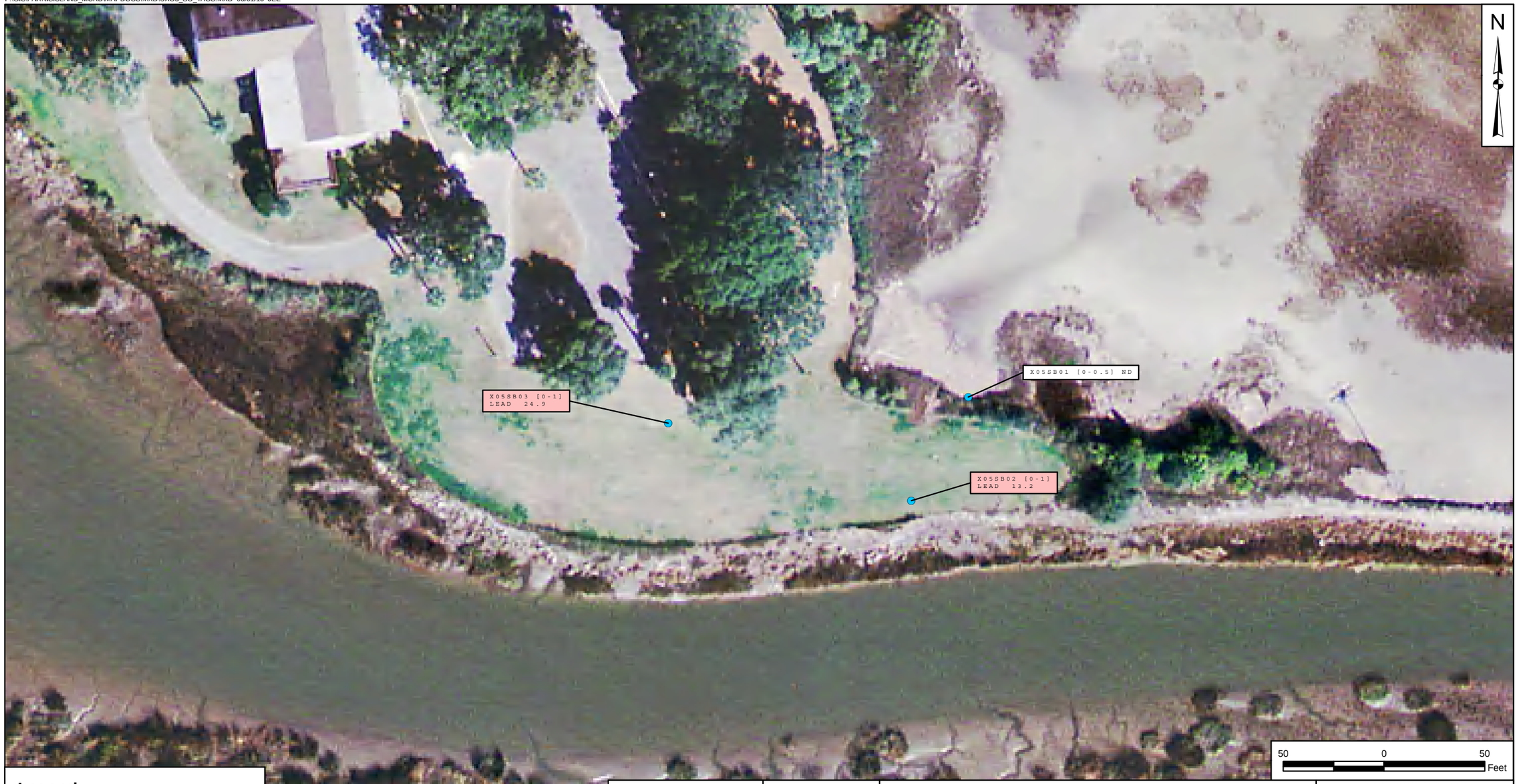

| DRAWN BY | DATE |
|---|---|
| K. MOORE | 05/20/10 |
| CHECKED BY | DATE |
| N. ROCHNA | 06/29/10 |
| COST/SCHED AREA | |
| SCALE | |
| AS NOTED | |

DEPARTMENT OF THE NAVY · UNITED STATES MARINE CORPS

POSITIVE DECTIONS - SURFACE SOIL AND SEDIMENT
XRF SCREENING AREAS
UXO 4 - FIELD ARTILLERY WEST MAIN RANGE
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| CONTRACT NUMBER | |
|---|---|
| CTO 089 | |
| APPROVED BY | DATE |
| ___ | ___ |
| APPROVED BY | DATE |
| ___ | ___ |
| FIGURE NO. | REV |
| FIGURE 7-10 | 0 |

P:\GIS\PARRISISLAND_MCRD\MAPDOCS\MXD\UXO5_SO_TAGS.MXD 06/01/10 JEE




## Legend

- Surface Soil Sample Location

Sample Location — Depth in feet

X05SB03 [0-1]
LEAD 24.9

Exceeds PAL (minimum criteria)

Result in mg/kg

| | |
|---|---|
| DRAWN BY | DATE |
| K. MOORE | 05/20/10 |
| CHECKED BY | DATE |
| M. BLANKEN | 06/01/10 |
| COST/SCHED AREA | |
| SCALE | AS NOTED |

POSITIVE DETECTIONS - SURFACE SOIL
UXO 5 - FIELD ARTILLERY EAST SHRAPNEL RANGE
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

| | |
|---|---|
| CONTRACT NUMBER | CTO 089 |
| APPROVED BY | DATE |
| ___ | ___ |
| APPROVED BY | DATE |
| ___ | ___ |
| FIGURE NO. | REV |
| FIGURE 8 - 7 | 0 |

P:\GIS\PARRISISLND_MCRD\MAPDOCS\MXD\UXO6_SD_TAGS.MXD 06/01/10 JEE

| | |
|---|---|
| DRAWN BY K. MOORE | DATE 05/24/10 |
| CHECKED BY M. BLANKEN | DATE 06/01/10 |
| REVISED BY | DATE |
| SCALE AS NOTED | |

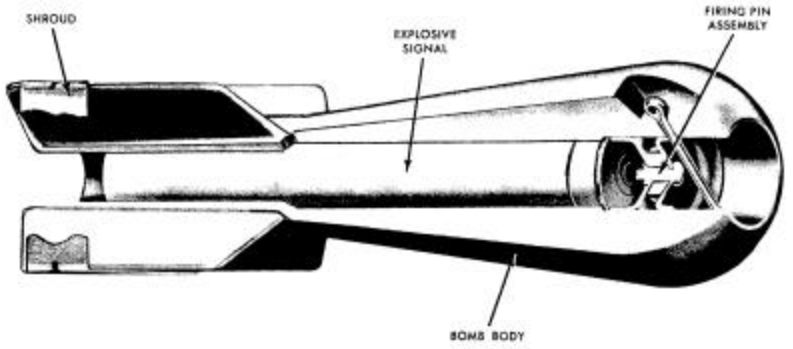
POSITIVE DETECTIONS - SEDIMENT
UXO 6 - FIELD ARTILLERY EAST SHRAPNEL RANGE
MCRD PARRIS ISLAND
PARRIS ISLAND, SOUTH CAROLINA

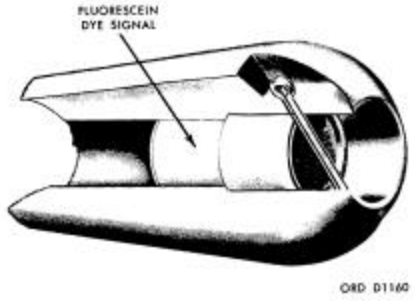
| | |
|---|---|
| CONTRACT NUMBER CTO 089 | |
| APPROVED BY ___ | DATE ___ |
| APPROVED BY ___ | DATE ___ |
| FIGURE NO. FIGURE 8 - 8 | REV 0 |

# APPENDIX C

# MUNITIONS SPECIFICATIONS

# MINIATURE PRACTICE BOMBS
# AN-Mk 5 Mod 1, AN-Mk 23, AN-Mk 43




*Description.* These bombs are used for low-altitude horizontal, or dive-bombing practice. The three bombs are similar in physical appearance, but differ basically in the metal used to cast the body. Bombs are used with the AN-Mk 4 practice bomb signal that is a blank 10-gauge shotgun shell (extended length). Signals contain a black powder expelling charge and a red phosphorous pyrotechnic mixture. These bombs also are used with the MK5 signal that contains a fluorescein dye and is actuated by impact on water. When the Mk5 signal is installed, the firing pin assembly is not used.

**Over-all length** .....8.25 inches
**Body Diameter**.....2.18 inches
**Fin Dimension** .....2.5 inches
**Weight** .....AN-Mk 5 Mod 1 - 2 lb. 11 oz. $\pm$ 1 oz
AN-Mk 23 -3 lb. $\pm$ 2 oz
AN-Mk 43 - 4 lb. 7 oz. $\pm$ 2 oz.
**Signal**.....AN-Mk 4, Black powder/pyro-Technic charge Mk 5, Fluorescein dye

**Reference:** OP 1280, *Aircraft Bombs*, February 1945; TM 9-1325-200, *Bombs and Bomb Components*, April 1966

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CHG SPOTTING BOMB MK7 MOD0 **Reported Weight :** 2.5000 **Unit :** LB
**NSN :** 1325000384636 **DODIC:** **Reported Weight (lbs):** 2.5000
**Status:** PARTIAL **Calculated Weight (lbs):** 2.4905 99.62 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| 439736 | STD | CHG SPOTTING BOMB MK7 MOD0 | M | | 2.5000 | LB | 1 | | | |
| 439736 | STD | CHG SPOTTING BOMB MK7 MOD0 | C | | 2.5000 | LB | 1 | | | |
| 447678 | STD | TUBE | P | I | 0.5004 | LB | 1 | 0.500400 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| | STD | SILVER SOLDER | B | B | 0.0635 | GM | 1 | | UNKNOWN | |
| | ALT | COPPER BRAZING (ALT) | B | B | 0.0894 | GM | 1 | | UNKNOWN | |
| | STD | SYNTHETIC PRIMER | B | B | 1.7318 | GM | 1 | | AXS-946 | |
| | STD | PROJ CAVITY PAINT | B | B | 1.7318 | GM | 1 | | OS-1356 | |
| | STD | ENAMEL RED | B | B | 1.7318 | GM | 1 | | 3-67 | |
| | ALT | LACQUER RED (ALT) | B | B | 2.3616 | GM | 1 | | 3-162 | |
| | STD | PAINT BLACK | B | B | 1.7318 | GM | 1 | | UNKNOWN | |
| | STD | PROTECTIVE COATING CLEAR | B | B | 2.4560 | GM | 1 | | UNKNOWN | |
| 447679 | STD | LOADING END | P | I | 43.5541 | GM | 1 | 0.096037 | UNKNOWN | //NOS/// |
| | STD | STEEL | Mtl | I | | | | | UNKNOWN | //NOS/// |
| | STD | SILVER SOLDER | B | B | 0.0635 | GM | 1 | | UNKNOWN | |
| | ALT | COPPER BRAZING (ALT) | B | B | 0.0894 | GM | 1 | | UNKNOWN | |
| | STD | THREAD LUTING | B | B | 0.0433 | GM | 1 | | OS-852 | |
| | ALT | NRC COMPOUND (ALT) | B | B | 0.0433 | GM | 1 | | 50-11-10 | |
| | STD | SYNTHETIC PRIMER | B | B | 0.1709 | GM | 1 | | AXS-946 | |
| | STD | PROJ CAVITY PAINT | B | B | 0.1709 | GM | 1 | | OS-1356 | |
| | STD | ENAMEL RED | B | B | 0.1709 | GM | 1 | | 3-67 | |
| | ALT | LACQUER RED (ALT) | B | B | 0.2331 | GM | 1 | | 3-162 | |
| 447202 | STD | GASKET | P | I | 2.6611 | GM | 1 | 0.005868 | UNKNOWN | //NOS/// |
| | STD | LEAD ALLOY | Mtl | I | | | | | UNKNOWN | //NOS/// |
| 447203 | STD | CAP | P | I | 13.8537 | GM | 1 | 0.030547 | SAE-1020 | //1020/// |
| | STD | STEEL | Mtl | I | | | | | SAE-1020 | //1020/// |
| | STD | IRON (7439-89-6) (99%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.45%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.21%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.05%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | ZINC PLATED | B | B | 0.1227 | GM | 1 | | 46-P-2 | |
| | ALT | CADMIUM PLATING (ALT) | B | B | 0.0914 | GM | 1 | | NDS46-P-1 | |
| | STD | CADMIUM (7440-43-9) (99%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CHG SPOTTING BOMB MK7 MOD0 **Reported Weight :** 2.5000 **Unit :** LB
**NSN :** 1325000384636 **DODIC:** **Reported Weight (lbs):** 2.5000
**Status:** PARTIAL **Calculated Weight (lbs):** 2.4905 99.62 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | THREAD LUTING | B | B | 0.1345 | GM | 1 | | OS-852 | |
| | ALT | NRC COMPOUND (ALT) | B | B | 0.1345 | GM | 1 | | 50-11-10 | |
| | STD | SYNTHETIC PRIMER | B | B | 0.0582 | GM | 1 | | AXS-946 | |
| | STD | ENAMEL RED | B | B | 0.0582 | GM | 1 | | 3-67 | |
| | ALT | LACQUER RED (ALT) | B | B | 0.0793 | GM | 1 | | 3-162 | |
| 447685 | STD | TOP | P | I | 46.4375 | GM | 1 | 0.102395 | UNKNOWN | //NOS/// |
| | STD | STEEL | Mtl | I | | | | | UNKNOWN | //NOS/// |
| | STD | SILVER SOLDER | B | B | 0.0635 | GM | 1 | | UNKNOWN | |
| | ALT | COPPER BRAZING (ALT) | B | B | 0.0894 | GM | 1 | | UNKNOWN | |
| | STD | SYNTHETIC PRIMER | B | B | 0.1811 | GM | 1 | | AXS-946 | |
| | STD | PROJ CAVITY PAINT | B | B | 0.1811 | GM | 1 | | OS-1356 | |
| | STD | ENAMEL RED | B | B | 0.1811 | GM | 1 | | 3-67 | |
| | ALT | LACQUER RED (ALT) | B | B | 0.2469 | GM | 1 | | 3-162 | |
| 452835 | STD | SEAT | P | I | 55.8915 | GM | 1 | 0.123241 | VENDOR ITEM | //1010/// |
| | STD | STEEL | Mtl | I | | | | | VENDOR ITEM | //1010/// |
| | STD | ZINC PLATED | B | B | 0.4850 | GM | 1 | | 46-P-2 | |
| | ALT | CADMIUM PLATING (ALT) | B | B | 0.3015 | GM | 1 | | NDS46-P-1 | |
| | STD | CADMIUM (7440-43-9) (99%) | Cmpd | B | | | | | | |
| | STD | SILVER SOLDER | B | B | 0.0635 | GM | 1 | | UNKNOWN | |
| | ALT | COPPER BRAZING (ALT) | B | B | 0.0894 | GM | 1 | | UNKNOWN | |
| | STD | SYNTHETIC PRIMER | B | B | 0.1920 | GM | 1 | | AXS-946 | |
| | STD | PROJ CAVITY PAINT | B | B | 0.1920 | GM | 1 | | OS-1356 | |
| | STD | ENAMEL RED | B | B | 0.1920 | GM | 1 | | 3-67 | |
| | ALT | LACQUER RED (ALT) | B | B | 0.2618 | GM | 1 | | 3-162 | |
| 439736*1 | STD | BLACK PWDR | P | X | 1.0000 | LB | 1 | 1.000000 | 4-P-3 | |
| | STD | BLACK PWDR | Mtl | X | | | | | 4-P-3 | |
| | STD | POTASSIUM NITRATE (7757-79-1) (74%) | Cmpd | X | | | | | MIL-P-156 | ///1// |
| | STD | CHARCOAL (7440-44-0) (15.6%) | Cmpd | X | | | | | JAN-C-178 | ///1// |
| | STD | SULFUR (7704-34-9) (10.4%) | Cmpd | X | | | | | MIL-S-14929 | /1//// |
| 439736*1 | ALT | BLACK PWDR (ALT) | P | X | 1.0000 | LB | 1 | | VENDOR ITEM | |
| | STD | BLACK PWDR | Mtl | X | | | | | VENDOR ITEM | |
| | STD | BLACK PWDR (100%) | Cmpd | X | | | | | VENDOR ITEM | |
| 447208 | STD | CTG CAL .38 SPL BLANK | C | | | | 1 | | | |
| 447208*1 | STD | CASE | P | I | 63.5000 | GR | 1 | 0.009072 | UNKNOWN | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CHG SPOTTING BOMB MK7 MOD0 **Reported Weight :** 2.5000 **Unit :** LB
**NSN :** 1325000384636 **DODIC:** **Reported Weight (lbs):** 2.5000
**Status:** PARTIAL **Calculated Weight (lbs):** 2.4905 99.62 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| | STD | VARNISH | B | B | | | 1 | | OS-1433 | /B//// |
| | STD | PROPANE (74-98-6) (30%) | Cmpd | B | | | | | | |
| | STD | HEPTANE (142-82-5) (30%) | Cmpd | B | | | | | | |
| | STD | ACETONE (67-64-1) (30%) | Cmpd | B | | | | | | |
| | STD | VM&P NAPHTHA (8032-32-4) (15%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (15%) | Cmpd | B | | | | | | |
| | STD | HEAVY AROMATIC SOLVENT (64742-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | PROP | P | X | | | 1 | | UNKNOWN | |
| | STD | PROP | Mtl | X | | | | | UNKNOWN | |
| 447208*2 | STD | DISC | P | I | 7.0000 | GR | 1 | 0.001000 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| | STD | VARNISH | B | B | 0.0012 | GR | 1 | | OS-1433 | /B//// |
| | STD | PROPANE (74-98-6) (30%) | Cmpd | B | | | | | | |
| | STD | HEPTANE (142-82-5) (30%) | Cmpd | B | | | | | | |
| | STD | ACETONE (67-64-1) (30%) | Cmpd | B | | | | | | |
| | STD | VM&P NAPHTHA (8032-32-4) (15%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (15%) | Cmpd | B | | | | | | |
| | STD | HEAVY AROMATIC SOLVENT (64742-94-5) (5%) | Cmpd | B | | | | | | |
| 447208*3 | STD | PRIMER PERC | C | | | | 1 | | | |
| | STD | PRIMER MIX | P | X | | | 1 | | UNKNOWN | |
| | STD | UNKNOWN PEP | Mtl | X | | | | | UNKNOWN | |
| GA398792 | STD | FUZE BOMB MK247 MOD0 | C | | 0.6250 | LB | 1 | | OS-3786 | |
| GA398792*1 | STD | COLLAR | P | I | 48.0250 | GM | 1 | 0.105895 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*2 | STD | GUIDE | P | I | 10.0267 | GM | 1 | 0.022109 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*3 | STD | ARMING STEM | P | I | 13.2064 | GM | 1 | 0.029120 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*4 | STD | BODY | P | I | 0.2565 | LB | 1 | 0.256500 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*5 | STD | NUT | P | I | 9.7843 | GM | 1 | 0.021574 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*6 | STD | END DISC | P | I | 2.6334 | GM | 1 | 0.005807 | UNKNOWN | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CHG SPOTTING BOMB MK7 MOD0 **Reported Weight :** 2.5000 **Unit :** LB
**NSN :** 1325000384636 **DODIC:** **Reported Weight (lbs):** 2.5000
**Status:** PARTIAL **Calculated Weight (lbs):** 2.4905 99.62 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*7 | STD | FIRING PIN SPRING | P | I | 1.1002 | GM | 1 | 0.002426 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*8 | STD | FIRING PIN | P | I | 62.4320 | GM | 1 | 0.137663 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*9 | STD | KEY RING | P | I | 1.1850 | GM | 1 | 0.002613 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*10 | STD | SAFETY PIN | P | I | 3.2114 | GM | 1 | 0.007081 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*11 | STD | DRIVE SCREW | P | I | 0.5462 | GM | 1 | 0.001204 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*12 | STD | ATTACHMENT PLATE | P | I | 7.6266 | GM | 1 | 0.016817 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*13 | STD | ARMING VANE | P | I | 3.6085 | GM | 1 | 0.007957 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| GA398792*14 | STD | COTTER PIN | P | I | 2.3394 | GM | 1 | 0.005158 | UNKNOWN | |
| | STD | UNKNOWN MATERIAL | Mtl | I | | | | | UNKNOWN | |
| | | | | | | | | **2.490483** | | |

# BOMB, PRACTICE, 100-POUND, MK15

TM 9-1325-200/NAVWEPS OP 3530/TO 11-1-28, April 1966

2–52. Bomb, Practice: 100-Pound, MK15 Mods 2, 3 and 4

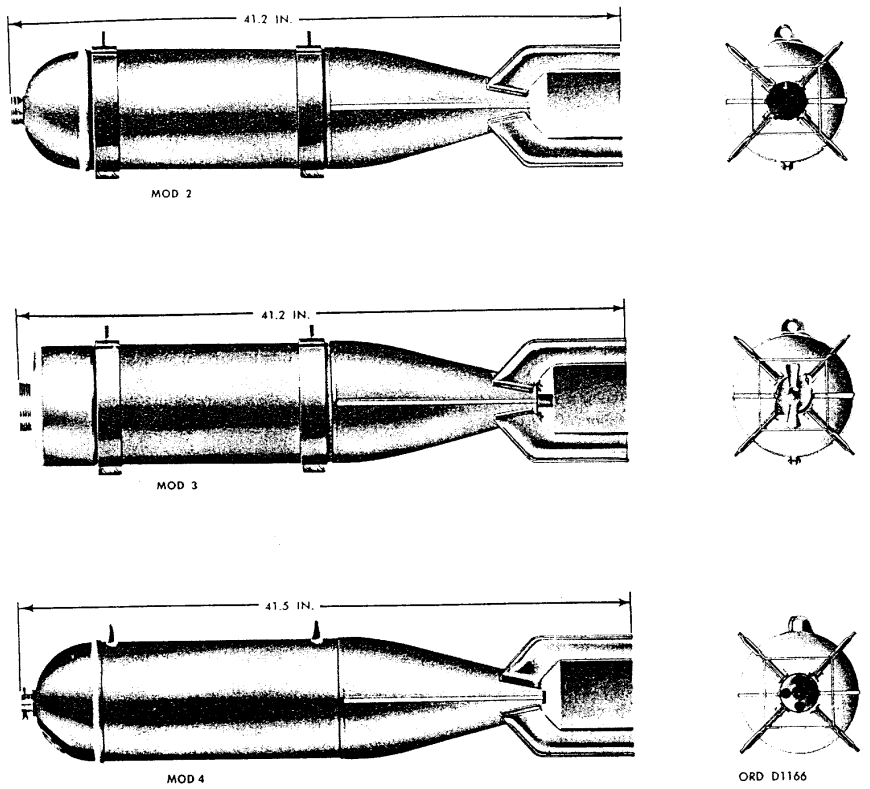



*Figure 2–62. Bomb, practice: 100-pound, MK15 Mods 2, 3, and 4.*

*Table 2-50. Bomb, Practice: 100 pound, MK15 Mods 2, 3, and 4*

| Mark<br>Mod | 15<br>2 | 15<br>3 | 15<br>4 |
|---|---|---|---|
| Length of Assembled bomb (in)... | 41.2..... ..... | 41.2..... | 41.5 |
| Diameter of Body (in)..... | 8.0..... | 8.0..... | 8.0 |
| Fin Span (in)..... | 11.24..... | 11.24..... | 11.24 |
| Weight of Assembled Bomb (lb): | | | |
| Loaded with Wet Sand..... | 100.0..... | 100.0..... | 97.0 |
| Loaded with Water..... | 56.0..... | 67.0..... | 60.0 |

| | | | |
|---|---|---|---|
| | | | |



*Table 2-50. Bomb, Practice: 100 pound MK15 Mods 2, 3, and 4 - Continued*

| Mark<br>Mod | 15<br>2 | 15<br>3 | 15<br>4 |
|---|---|---|---|
| Wet Sand Filler lb)..... | 76.0..... | 77.4..... | 76.0 |
| Water Filler (lb)..... | 39.0..... | 40.0..... | 39.0 |
| Water Filler (gal)..... | 4.6..... | 4.7..... | 4.6 |
| Signal..... | None..... | MK 7 Mod 0..... | MK 4 Mods 0,1,2,3,4 |
| Fuze..... | None..... | MK 247 Mod 0..... | None |
| Firing-Pin Assembly..... | None..... | None..... | MK 1 Mod 0 |
| Arming-Wire Assembly.....…. | MK 1 or AN-M6A2 | MK 1 or AN-M6A2 | No Arming Wire |

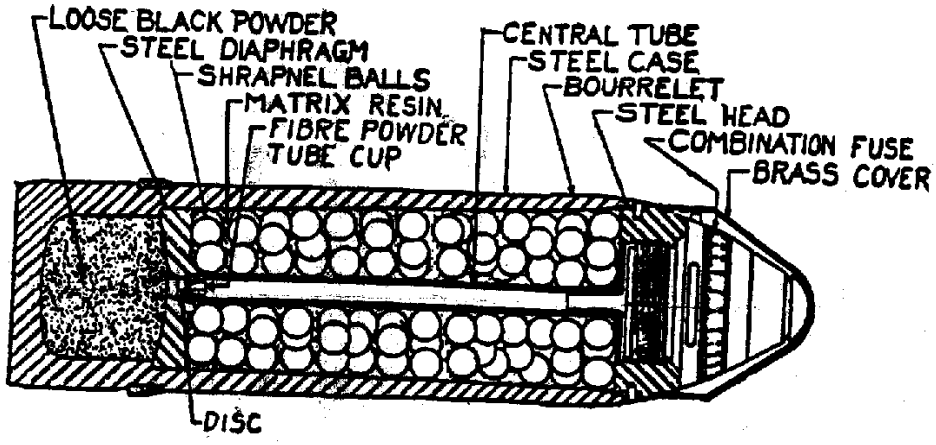
*a. Description.* Practice bomb MK15 Mod 2 (fig. 2-62 and table 2-50) is identical to the Mod 3 except that it is not adapted for the use of a fuze and signal. It is filled with water or a mixture of sand and water (fig. 2-63) for spotting purposes. For training purposes, a small washer may be soldered to the nose of the bomb to simulate a fuze. The end of an arming wire (which is normally inserted in the fuze of service type bombs) is then secured to the washer. For armed releases, the washer is torn free of the bomb by the arming wire; for safe releases, the arming wire remains secured to the washer. When used against armored-deck target boats, it is filled with water and released from an altitude of less than 7,000 feet.

*b. Bomb, Practice: MK 15 Mod 3.* Practice bomb MK15 Mod 3 has a light cased, cylindrical body with a threaded filling hole in its rounded nose. A box-fin assembly consisting of four metal vanes attached to a cone is welded to the aft end of the body. The bomb has two metal suspension band assemblies (each consisting of a circular clamp, a suspension lug, and two cap screws) for tightening the band to the bomb. The bands may be adjusted for double suspension of the bomb by orienting to suit the rack or shackle to which the bomb is to be attached. A flat nose attachment that reduces ricochet of the bomb at entrance angles as low as 90 degrees is used during antisubmarine practice. The attachment is secured in place by a cap which threads onto the filling hose. The bomb is used with practice bomb signal MK7 Mod 0 and inert fuze MK247 Mod 0, both of which are secured to the aft end of the bomb.

*c. Bomb, Practice, 100-pound: MK15 Mod 4.* The practice bomb MK15 Mod 4 is a light-cased, cylindrical bomb with a round nose and an integral box fin and cone. A flash tube, extending throughout its transverse axis, housed a pyrotechnic signal and firing-pin assembly. Two suspension lugs are welded to the bomb body 14 inches apart. A filling hole is located off center on the bomb nose and is sealed by a filler cap similar to those used on automobile gas tanks. The firing-pin assembly consists of two shallow metal cups, separated by a spacer which housed the firing pin. A cotter-pin through the nose end of the flash tube and two recesses in the lip of the forward cup locks the firing-pin assembly and signal in place.

*d. Functioning.* Upon impact of the bomb with the target, the signal is detonated, producing a flash and a large puff of smoke, which permits observation of the bombing accuracy.

# PROJECTILE, 75mm, SHRAPNEL, MK I




*Description.* This projectile consists of a steel case, near the base of which a shoulder is formed on the interior surface. A base charge of 3 ounces of black powder is packed in the base of the projectile beneath a diaphragm of steel which rests on the shoulder. This diaphragm also supports a flash tube, the upper end of which is flared out into a smaller thin diaphragm. Between the two diaphragms is held a charge of melted resin which holds 270 lead balls suspended within it. These balls average 42 to the pound, the 270 totaling 6 pounds, 7 ounces. Above the lower diaphragm, the interior of the shrapnel case is gradually enlarged in diameter so that it tapers outward from the base to head. The top of the case is closed by a steel head which fastens to the case with a fine thread, and which is adapted to the fuze with a coarse thread. The shrapnel is issued fuzed with the 21-second Combination Fuze M1907M, which is set at safe, and covered with a metallic moisture proof cap.

*Function.* The flame from the magazine charge of the fuze flashes down the central tube and ignites the black powder base charge. Explosion of this charge forces the lower diaphragm matrix and balls, and flash tube upward, blowing off the fuze and the head as a unit, the rupture occurring at the fine threads between the head and the case. It is painted red and stenciled in black with the designations of weapon, and complete round.

| | |
|---|---|
| **Fuze** | M1907M 21-sec Combination Time fuze |
| **Cartridge Case** | M18 |
| **Propelling Charge** | A normal charge of 1.69 pounds of powder which imparts a muzzle velocity of about 1,755 feet per second. |
| **Primer** | M1B1A1 |
| **Guns** | This round is issued for the 75mm field gun only. |

**Reference:** TM 9-1904, *Ammunition Inspection Guide*, March 1944

**100. SHELL, FIXED, H.E., M48, SUPERCHARGE, W/FUZE, P.D., M57, 75-MM GUNS, M4, AN-M5, AND M5A1,** is provided for the 75-mm Aircraft Guns M4, AN-M5, and M5A1. It is similar to the corresponding rounds authorized for the other 75-mm guns. However, it is fitted with a single-action superquick Fuze M57. When fired in the 75-mm aircraft guns, this round produces a flash; it will only be issued for aircraft guns until the new aircraft round, described in paragraph 101, is available for issue.

**101. SHELL, FIXED, H.E., M48, SUPERCHARGE, FLASHLESS, W/FUZE, P.D., M57, 75-MM AIRCRAFT GUNS,** is the same as that described in paragraph 100, except that 1 percent potassium sulfate has been added to the propelling charge powder to make it flashless when fired in the 75-mm aircraft guns.

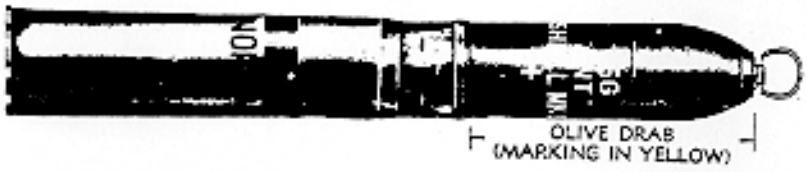



*Figure 65 — SHELL, Fixed, H.E., Mk. I, Flashless, Unfuzed, 75-mm Gun (Adapted for FUZE, P.D., M46 or M47)*

**102. SHELL, FIXED, H.E., MK. I, FLASHLESS, UNFUZED, 75-MM GUN (ADAPTED FOR FUZE, P.D., M46 OR M47)** (fig. 65), has a shell of early design which no longer is manufactured and will be available as a substitute for the round with the M48 Shell in field, antitank, and tank guns only until the present supply is exhausted. The Mk. I Shell has a somewhat larger high-explosive filler than the M48, but less effective ballistic qualities. The base is square and the nose is shaped in a short ogive which ends about 2¾ inches in front of the bourrelet. At this point, the nose is cut, machined, and threaded internally to hold an adapter and booster assembly. This assembly is screwed into the shell during manufacture, the booster seating in a narrow well in the shell bursting charge. The booster charge in turn is covered by a steel or brass casing which forms a socket or seat for the fuze. The rounds are shipped unfuzed, the adapter being closed by a plug which is removed just prior to fuzing. Selective quick or delay functioning is provided for by making two or more single-action fuzes available for separate issue, for assembling to the shell as required in the field. Like the M48, the Mk. I Shell







has been assembled in several types of rounds. In this round, the M18 or M18B1 Cartridge Case is fitted with the 75-grain M22 Primer (or modifications) as loaded with 1.35 pounds (a normal charge) of flashless propelling powder. The M46 and M47 Fuzes are authorized for use with the round.

**DATA**

| | | | |
|---|---|---|---|
| Weight of complete round | 16.04 lb* | Width of rotating band | 0.49 in. |
| Length of complete round | 22.60 in.* | Type of base | Square |
| Length of projectile | 10.49 in.* | Radius of ogive | 1.49 cal. |
| Length of cartridge case | 13.82 in. | Muzzle velocity | 1,722 ft per sec† |
| | | Maximum range (at 42 deg) | 8,865 yd† |

*—For unfuzed rounds; fuze weights are: M47, 0.74 pound; M46, 0.77 pound.
†—For M2, M1916, and M1917 Guns; muzzle velocity in M1897A4 Guns is 1,784 feet per second; in M3 Guns, 1,814 feet per second.

**103. SHELL, FIXED, H.E., MK. I, FLASHLESS, REDUCED CHARGE, UNFUZED, 75-MM GUN (ADAPTED FOR FUZE, P.D., M46 OR M47),** has the same shell, cartridge case, and primer as for the round described in paragraph 102. However, the propellant consists of a reduced charge (0.56 lb) of flashless powder. Muzzle velocity of the round is 1,075 feet per second in M2, M1916, and M1917 Guns; 1,115 feet per second in M1897A4 Guns; and 1,135 feet per second in M3 Guns. Maximum range is 6,570 yards in M2, M1916, and M1917 Guns. Weight of the round is 15.25 pounds; other data given in paragraph 102 apply also to this round.

**104. SHELL, FIXED, H.E., MK. I, UNFUZED, 75-MM GUNS (ADAPTED FOR FUZE, P.D., M46 OR M47),** is similar to the round described in paragraph 102 except that the propelling powder is not flashless. Otherwise the description and data given in that paragraph apply equally to this round.

**105. SHELL, FIXED, H.E., MK. I, REDUCED CHARGE, UNFUZED, 75-MM GUN (ADAPTED FOR FUZE, P.D., M46 OR M47),** is the same as that described in paragraph 103, except that the propelling charge is not flashless. The description and data therein apply equally to this round.

**106. SHELL, FIXED, SMOKE, HC, B.I., M89, 75-MM GUNS, M2 AND M3** (fig. 66), is provided for the 75-mm tank guns, for screening purposes which cannot be adequately provided for by the Mk. II Smoke Shell. Components of the complete round consist of the M18 or M18B1 Cartridge Case, the 150-grain M31 Primer (or modifications) and a canister-like projectile. No fuze is required, the filler being ignited by the propelling charge upon firing. The round is intended for firing at low velocities; hence, only 0.1625 pound of

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 %

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| 75-1-183 | STD | CTG 75MM HE M48 | M | | 18.3500 | LB | 1 | | MIL-S-20532 | |
| 71-2-91A | STD | CASE CTG M5A1 | P | I | 2.4500 | LB | 1 | 2.450000 | MIL-C-50 | //260/// |
| | STD | COPPER ALLOY | Mtl | I | | | | | MIL-C-50 | //260/// |
| | STD | COPPER (7440-50-8) (70%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (29.88%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.07%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| | STD | STENCIL INK | B | B | | | 1 | | TT-I-558 | |
| | STD | KETONES (N/A) (30%) | Cmpd | B | | | | | | |
| | STD | PROP (N/A) (25%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (10%) | Cmpd | B | | | | | | |
| | STD | PIGMENT (N/A) (10%) | Cmpd | B | | | | | | |
| | STD | ACRYLIC RESIN (N/A) (5%) | Cmpd | B | | | | | | |
| 71-2-91A | ALT | CASE CTG M5A1 (ALT) | P | I | 2.4500 | LB | 1 | | QQ-C-591 | |
| | STD | COPPER SILICON ALLOY | Mtl | I | | | | | QQ-C-591 | |
| | STD | COPPER (7440-50-8) (92.85%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (3.3%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (1.5%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.9%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.8%) | Cmpd | I | | | | | | |
| | STD | NICKEL (7440-02-0) (0.6%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.05%) | Cmpd | I | | | | | | |
| | STD | STENCIL INK | B | B | | | 1 | | TT-I-558 | |
| | STD | KETONES (N/A) (30%) | Cmpd | B | | | | | | |
| | STD | PROP (N/A) (25%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (10%) | Cmpd | B | | | | | | |
| | STD | PIGMENT (N/A) (10%) | Cmpd | B | | | | | | |
| | STD | ACRYLIC RESIN (N/A) (5%) | Cmpd | B | | | | | | |
| 8839474 | STD | PRIMER PERC M1B1A2 | C | | | | 1 | | MIL-P-46292 | |
| 8838081 | STD | HEAD | P | I | 297.3503 | GR | 1 | 0.042479 | ASTM-B16 | //360//LACQUER/ |
| | STD | BRASS | Mtl | I | | | | | ASTM-B16 | //360//LACQUER/ |
| | STD | LACQUER CELL NITRATE | B | B | 0.0140 | GR | 1 | | MIL-L-10287 | /1 OR 2//// |
| | STD | ISOBUTYL ACETATE (110-19-0) (29.9%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (15.5%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | XYLENE (1330-20-7) (12.4%) | Cmpd | B | | | | | | |
| | STD | ISOBUTYL ALCOHOL (78-83-1) (4%) | Cmpd | B | | | | | | |
| | STD | ISOPROPYL ALCOHOL (67-63-0) (3%) | Cmpd | B | | | | | | |
| 9298013 | STD | BODY | P | I | 1.2451 | OZ | 1 | 0.077819 | ASTM-B135 | //332/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B135 | //332/// |
| | STD | COPPER (7440-50-8) (63.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (34.35%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (2%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.15%) | Cmpd | I | | | | | | |
| | STD | LACQUER CELL NITRATE | B | B | 0.1782 | GR | 1 | | MIL-L-10287 | /1 OR 2//// |
| | STD | ISOBUTYL ACETATE (110-19-0) (29.9%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (15.5%) | Cmpd | B | | | | | | |
| | STD | XYLENE (1330-20-7) (12.4%) | Cmpd | B | | | | | | |
| | STD | ISOBUTYL ALCOHOL (78-83-1) (4%) | Cmpd | B | | | | | | |
| | STD | ISOPROPYL ALCOHOL (67-63-0) (3%) | Cmpd | B | | | | | | |
| | STD | SEALING COMPOUND | B | B | 0.5547 | GR | 1 | | MIL-S-22473 | //AVV/// |
| | STD | DIMETHACRYLATE ESTER (N/A) (94%) | Cmpd | B | | | | | | |
| | STD | CATALYST (N/A) (3.2%) | Cmpd | B | | | | | | |
| | STD | TERTIARY AMINE (635-46-1) (2.8%) | Cmpd | B | | | | | | |
| | STD | LACQUER PURPLE | B | B | 0.5910 | GR | 1 | | MIL-L-296 | |
| | STD | NITROCELLULOSE (9004-70-0) (44%) | Cmpd | B | | | | | | |
| | STD | CASTOR OIL (8001-78-3) (21.5%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (14.5%) | Cmpd | B | | | | | | |
| | STD | METHYL ISOBUTYL KETONE (108-10-1) (9.2%) | Cmpd | B | | | | | | |
| | STD | DIBUTYL PHTHALATE (84-74-2) (5%) | Cmpd | B | | | | | | |
| | STD | ISOPROPYL ALCOHOL (67-63-0) (3.3%) | Cmpd | B | | | | | | |
| | STD | METHYL ISOBUTYL CARBINOL (108-11-2) (2.4%) | Cmpd | B | | | | | | |
| | STD | METHYL VIOLET DYE (1325-82-2) (0.1%) | Cmpd | B | | | | | | |
| 9298061 | STD | LINER | P | I | 0.2458 | GM | 1 | 0.000542 | MIL-P-60169 | /1//// |
| | STD | PAPER SEALING | Mtl | I | | | | | MIL-P-60169 | /1//// |
| | STD | LACQUER PURPLE | B | B | 0.2671 | GM | 1 | | MIL-L-296 | |
| | STD | NITROCELLULOSE (9004-70-0) (44%) | Cmpd | B | | | | | | |
| | STD | CASTOR OIL (8001-78-3) (21.5%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (14.5%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | METHYL ISOBUTYL KETONE (108-10-1) (9.2%) | Cmpd | B | | | | | | |
| | STD | DIBUTYL PHTHALATE (84-74-2) (5%) | Cmpd | B | | | | | | |
| | STD | ISOPROPYL ALCOHOL (67-63-0) (3.3%) | Cmpd | B | | | | | | |
| | STD | METHYL ISOBUTYL CARBINOL (108-11-2) (2.4%) | Cmpd | B | | | | | | |
| | STD | METHYL VIOLET DYE (1325-82-2) (0.1%) | Cmpd | B | | | | | | |
| 8838012 | STD | CUP BATTERY | P | I | 17.0000 | GR | 1 | 0.002429 | ASTM-B19 | //260/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B19 | //260/// |
| | STD | COPPER (7440-50-8) (70%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (29.88%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.07%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| 8838015 | STD | PLUG FIRING | P | I | 36.0000 | GR | 1 | 0.005143 | ASTM-B16 | //360/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B16 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (36.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (2.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | BLACK PWDR CL 1 | P | X | 5.1800 | GM | 1 | 0.011422 | MIL-P-223 | ///1// |
| | STD | BLACK PWDR CL 1 | Mtl | X | | | | | MIL-P-223 | ///1// |
| | STD | POTASSIUM NITRATE (7757-79-1) (74%) | Cmpd | X | | | | | MIL-P-156 | ///1// |
| | STD | CHARCOAL (7440-44-0) (15.6%) | Cmpd | X | | | | | JAN-C-178 | ///1// |
| | STD | SULFUR (7704-34-9) (10.4%) | Cmpd | X | | | | | MIL-S-14929 | |
| | STD | GRAPHITE (7782-42-5) (0%) | Cmpd | X | | | | | MIL-G-155 | //C/// |
| 8831157 | STD | PRIMER PERC M61 ASSY | C | | 0.0026 | LB | 1 | | MIL-P-20449 | |
| | STD | PRIMER MIX #70 | P | X | 1.0000 | GR | 1 | 0.000143 | 9282793 | ///1// |
| | STD | PRIMER MIX #70 | Mtl | X | | | | | 9282793 | ///1// |
| | STD | POTASSIUM CHLORATE (3811-04-9) (53%) | Cmpd | X | | | | | MIL-P-150 | //A/1// |
| | STD | LEAD THIOCYANATE (592-87-0) (25%) | Cmpd | X | | | | | MIL-L-65 | |
| | STD | ANTIMONY SULFIDE (1345-04-6) (17%) | Cmpd | X | | | | | MIL-A-159 | ///1// |
| | STD | TNT (118-96-7) (5%) | Cmpd | X | | | | | MIL-T-248 | /1 OR 2//// |
| 8831160 | STD | COVER | P | I | 0.0094 | GR | 1 | 0.000001 | MIL-P-60169 | /3//// |
| | STD | PAPER SEALING | Mtl | I | | | | | MIL-P-60169 | /3//// |
| 8831159 | STD | ANVIL | P | I | 5.8000 | GR | 1 | 0.000829 | ASTM-B19 | //260/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B19 | //260/// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | COPPER (7440-50-8) (70%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (29.88%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.07%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| 8831158 | STD | CUP PRIMER | P | I | 11.4000 | GR | 1 | 0.001629 | ASTM-B19 | //260/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B19 | //260/// |
| | STD | COPPER (7440-50-8) (70%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (29.88%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.07%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| | STD | LACQUER CELL NITRATE | B | B | 0.0260 | GR | 1 | | MIL-L-10287 | /1//// |
| | STD | ISOBUTYL ACETATE (110-19-0) (29.9%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (15.5%) | Cmpd | B | | | | | | |
| | STD | XYLENE (1330-20-7) (12.4%) | Cmpd | B | | | | | | |
| | STD | ISOBUTYL ALCOHOL (78-83-1) (4%) | Cmpd | B | | | | | | |
| | STD | ISOPROPYL ALCOHOL (67-63-0) (3%) | Cmpd | B | | | | | | |
| 71-9-126 | STD | CHG PROP ASSY | C | | 1.0800 | LB | 1 | | | |
| 71-9-128E | STD | TWINE TYING | P | I | 6.0532 | GM | 1 | 0.013347 | MIL-C-453 | /A//A// |
| | STD | SILK CORD | Mtl | I | | | | | MIL-C-453 | /A//A// |
| 71-9-128F | STD | TWINE TYING RETAINER | P | I | 1.7655 | GM | 2 | 0.007786 | MIL-C-453 | /A//B// |
| | STD | SILK CORD | Mtl | I | | | | | MIL-C-453 | /A//B// |
| 71-9-128G | ALT | TWINE TYING RETAINER (ALT) | P | I | 2.0177 | GM | 1 | | MIL-C-453 | /A//B// |
| | STD | SILK CORD | Mtl | I | | | | | MIL-C-453 | /A//B// |
| 71-9-127A | STD | CHG ASSY BASE 1 | C | | 0.3960 | LB | 1 | | MIL-C-20327 | |
| 71-9-127B | STD | CHG BASE CHG 1 | P | X | 0.3750 | LB | 1 | 0.375000 | JAN-P-309 | /2//// |
| | STD | PROP M1 | Mtl | X | | | | | JAN-P-309 | /2//// |
| | STD | NITROCELLULOSE (9004-70-0) (84.5%) | Cmpd | X | | | | | MIL-N-244 | |
| | STD | DINITROTOLUENE (25321-14-6) (9.5%) | Cmpd | X | | | | | MIL-D-204 | |
| | STD | DIBUTYLPHTHALATE (84-74-2) (5%) | Cmpd | X | | | | | MIL-D-218 | |
| | STD | DIPHENYLAMINE (122-39-4) (1%) | Cmpd | X | | | | | MIL-D-98 | |
| 71-9-128A | STD | BAG BASE CHG 1 | P | I | 7.4366 | GM | 1 | 0.016398 | PA-PD-384 | //1,2 OR 3/G// |
| | STD | SILK CLOTH | Mtl | I | | | | | PA-PD-384 | //1,2 OR 3/G// |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.3935 | GR | 1 | | 7-7 | ///B// |
| 71-9-128A | ALT | BAG BASE CHG 1 (ALT) | P | I | 3.9015 | GM | 1 | | MIL-C-20313 | //C/// |
| | STD | COTTON CLOTH | Mtl | I | | | | | MIL-C-20313 | //C/// |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.3935 | GR | 1 | | 7-7 | ///B// |
| 71-9-128A | ALT | BAG BASE CHG 1 (ALT) | P | I | 7.4366 | GM | 1 | | PA-PD-384 | //1,2 OR 3/E// |
| | STD | SILK CLOTH | Mtl | I | | | | | PA-PD-384 | //1,2 OR 3/E// |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.3955 | GR | 1 | | 7-7 | ///B// |
| 71-9-128A | ALT | BAG BASE CHG 1 (ALT) | P | I | 10.5910 | GM | 1 | | PA-PD-89 | |
| | STD | RAYON CLOTH | Mtl | I | | | | | PA-PD-89 | |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.3935 | GR | 1 | | 7-7 | ///B// |
| 71-9-128A | ALT | BAG BASE CHG 1 (ALT) | P | I | 4.6410 | GM | 1 | | MIL-C-12800 | |
| | STD | ACRYLIC CLOTH | Mtl | I | | | | | MIL-C-12800 | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.3935 | GR | 1 | | 7-7 | ///B// |
| 71-9-127C | STD | CHG ASSY INCREM 2 | C | | 0.1380 | LB | 1 | | | |
| 71-9-127D | STD | CHG INCREM CHG 2 | P | X | 0.1250 | LB | 1 | 0.125000 | JAN-P-309 | /2//// |
| | STD | PROP M1 | Mtl | X | | | | | JAN-P-309 | /2//// |
| | STD | NITROCELLULOSE (9004-70-0) (84.5%) | Cmpd | X | | | | | MIL-N-244 | |
| | STD | DINITROTOLUENE (25321-14-6) (9.5%) | Cmpd | X | | | | | MIL-D-204 | |
| | STD | DIBUTYLPHTHALATE (84-74-2) (5%) | Cmpd | X | | | | | MIL-D-218 | |
| | STD | DIPHENYLAMINE (122-39-4) (1%) | Cmpd | X | | | | | MIL-D-98 | |
| 71-9-128B | STD | BAG INCREM CHG 2 | P | I | 2.9746 | GM | 1 | 0.006559 | PA-PD-384 | //1,2 OR 3/G// |
| | STD | SILK CLOTH | Mtl | I | | | | | PA-PD-384 | //1,2 OR 3/G// |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2277 | GR | 1 | | 7-7 | ///B// |
| 71-9-128B | ALT | BAG INCREM CHG 2 (ALT) | P | I | 2.9746 | GM | 1 | | PA-PD-384 | //1,2 OR 3/E// |
| | STD | SILK CLOTH | Mtl | I | | | | | PA-PD-384 | //1,2 OR 3/E// |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2277 | GR | 1 | | 7-7 | ///B// |
| 71-9-128B | ALT | BAG INCREM CHG 2 (ALT) | P | I | 4.2364 | GM | 1 | | PA-PD-89 | |
| | STD | RAYON CLOTH | Mtl | I | | | | | PA-PD-89 | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2277 | GR | 1 | | 7-7 | ///B// |
| 71-9-128B | ALT | BAG INCREM CHG 2 (ALT) | P | I | 24.0838 | GR | 1 | | MIL-C-20313 | //C/// |
| | STD | COTTON CLOTH | Mtl | I | | | | | MIL-C-20313 | //C/// |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2277 | GR | 1 | | 7-7 | ///B// |
| 71-9-128B | ALT | BAG INCREM CHG 2 (ALT) | P | I | 1.8564 | GM | 1 | | MIL-C-12800 | |
| | STD | ACRYLIC CLOTH | Mtl | I | | | | | MIL-C-12800 | |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2277 | GR | 1 | | 7-7 | ///B// |
| 71-9-127E | STD | CHG ASSY INCREM 3 | C | | 0.1690 | LB | 1 | | | |
| 71-9-127F | STD | CHG INCREM CHG 3 | P | X | 0.1560 | LB | 1 | 0.156000 | JAN-P-309 | /2//// |
| | STD | PROP M1 | Mtl | X | | | | | JAN-P-309 | /2//// |
| | STD | NITROCELLULOSE (9004-70-0) (84.5%) | Cmpd | X | | | | | MIL-N-244 | |
| | STD | DINITROTOLUENE (25321-14-6) (9.5%) | Cmpd | X | | | | | MIL-D-204 | |
| | STD | DIBUTYLPHTHALATE (84-74-2) (5%) | Cmpd | X | | | | | MIL-D-218 | |
| | STD | DIPHENYLAMINE (122-39-4) (1%) | Cmpd | X | | | | | MIL-D-98 | |
| 71-9-128C | STD | BAG INCREM CHG 3 | P | I | 3.1605 | GM | 1 | 0.006969 | PA-PD-384 | //1,2 OR 3/G// |
| | STD | SILK CLOTH | Mtl | I | | | | | PA-PD-384 | //1,2 OR 3/G// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2346 | | 1 | | 7-7 | ///B// |
| 71-9-128C | ALT | BAG INCREM CHG 3 (ALT) | P | I | 1.9724 | GM | 1 | | MIL-C-12800 | |
| | STD | ACRYLIC CLOTH | Mtl | I | | | | | MIL-C-12800 | |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2364 | GR | 1 | | 7-7 | ///B// |
| 71-9-128C | ALT | BAG INCREM CHG 3 (ALT) | P | I | 1.6581 | GM | 1 | | MIL-C-20313 | //C/// |
| | STD | COTTON CLOTH | Mtl | I | | | | | MIL-C-20313 | //C/// |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2346 | GR | 1 | | 7-7 | ///B// |
| 71-9-128C | ALT | BAG INCREM CHG 3 (ALT) | P | I | 4.5011 | GM | 1 | | PA-PD-89 | |
| | STD | RAYON CLOTH | Mtl | I | | | | | PA-PD-89 | |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2346 | GR | 1 | | 7-7 | ///B// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| 71-9-128C | ALT | BAG INCREM CHG 3 (ALT) | P | I | 3.1605 | GM | 1 | | PA-PD-384 | //1,2 OR 3/E// |
| | STD | SILK CLOTH | Mtl | I | | | | | PA-PD-384 | //1,2 OR 3/E// |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | 0.2346 | GR | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | | | 1 | | 7-7 | ///B// |
| 71-9-127G | STD | CHG ASSY INCREM 4 | C | | 0.3280 | LB | 1 | | | |
| 71-9-128H | STD | CHG INCREM CHG 4 | P | X | 0.3120 | LB | 1 | 0.312000 | JAN-P-309 | /2//// |
| | STD | PROP M1 | Mtl | X | | | | | JAN-P-309 | /2//// |
| | STD | NITROCELLULOSE (9004-70-0) (84.5%) | Cmpd | X | | | | | MIL-N-244 | |
| | STD | DINITROTOLUENE (25321-14-6) (9.5%) | Cmpd | X | | | | | MIL-D-204 | |
| | STD | DIBUTYLPHTHALATE (84-74-2) (5%) | Cmpd | X | | | | | MIL-D-218 | |
| | STD | DIPHENYLAMINE (122-39-4) (1%) | Cmpd | X | | | | | MIL-D-98 | |
| 71-9-128D | STD | BAG INCREM CHG 4 | P | I | 4.8338 | GM | 1 | 0.010659 | PA-PD-384 | //1,2 OR 3/G// |
| | STD | SILK CLOTH | Mtl | I | | | | | PA-PD-384 | //1,2 OR 3/G// |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2967 | GR | 1 | | 7-7 | ///B// |
| 71-9-128D | ALT | BAG INCREM CHG 4 (ALT) | P | I | 2.5359 | GM | 1 | | MIL-C-20313 | //C/// |
| | STD | COTTON CLOTH | Mtl | I | | | | | MIL-C-20313 | //C/// |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2967 | GR | 1 | | 7-7 | ///B// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| 71-9-128D | ALT | BAG INCREM CHG 4 (ALT) | P | I | 4.8338 | GM | 1 | | PA-PD-384 | //1,2 OR 3/E// |
| | STD | SILK CLOTH | Mtl | I | | | | | PA-PD-384 | //1,2 OR 3/E// |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2967 | GR | 1 | | 7-7 | ///B// |
| 71-9-128D | ALT | BAG INCREM CHG 4 (ALT) | P | I | 6.8841 | GM | 1 | | PA-PD-89 | |
| | STD | RAYON CLOTH | Mtl | I | | | | | PA-PD-89 | |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2967 | | 1 | | 7-7 | ///B// |
| 71-9-128D | ALT | BAG INCREM CHG 4 (ALT) | P | I | 3.0166 | GM | 1 | | MIL-C-12800 | |
| | STD | ACRYLIC CLOTH | Mtl | I | | | | | MIL-C-12800 | |
| | STD | INK MARKING LNDRY | B | B | | | 1 | | TT-I-542 | |
| | STD | DIETHYLENE GLYCOL MO (112-34-5) (81%) | Cmpd | B | | | | | | |
| | STD | 2-BUTOXY ETHANOL (111-76-2) (9%) | Cmpd | B | | | | | | |
| | STD | C.I. SOLVENT BLACK 7 (8005-02-5) (0%) | Cmpd | B | | | | | | |
| | ALT | INK PRINTERS (ALT) | B | B | | | 1 | | VENDOR ITEM | |
| | STD | FLUSHED ALKALI BLUE (N/A) (12%) | Cmpd | B | | | | | | |
| | STD | THREAD SILK | B | B | 0.2967 | GR | 1 | | 7-7 | ///B// |
| 71-9-203 | STD | RETAINER ASSY M3A1 | C | | | | 1 | | | |
| 71-9-203G | STD | WIRE RETAINER | P | I | | | 2 | | ASTM-B159 | //510/// |
| | STD | BRONZE | Mtl | I | | | | | ASTM-B159 | //510/// |
| | STD | COPPER (7440-50-8) (94.36%) | Cmpd | I | | | | | | |
| | STD | TIN (7440-31-5) (5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.3%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.19%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | IRON (7439-89-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.05%) | Cmpd | I | | | | | | |
| 71-9-203H | STD | RETAINER RING | P | I | | | 2 | | 57-172-1 | //260/// |
| | STD | BRASS | Mtl | I | | | | | 57-172-1 | //260/// |
| | STD | COPPER (7440-50-8) (70%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (29.88%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.07%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| 75-14-445A | STD | SHELL HE 75MM M48 W/SUPP CHG LDNG ASSY | C | | 12.4100 | LB | 1 | | MIL-L-20336 | |
| 75-14-445B | STD | CHG BURSTING | P | X | 1.0400 | LB | 1 | 1.040000 | JAN-T-248 | //1/// |
| | STD | TNT | Mtl | X | | | | | JAN-T-248 | //1/// |
| | STD | TNT (118-96-7) (100%) | Cmpd | X | | | | | JAN-T-248 | //1/// |
| 75-2-269G | STD | MPTS ASSY | C | | 10.9700 | LB | 1 | | PA-PD-348 | |
| 75-2-269A | STD | BODY SHELL | P | I | 10.7500 | LB | 1 | 10.750000 | MIL-S-10520 | //TABLE 1/// |
| | STD | STEEL | Mtl | I | | | | | MIL-S-10520 | //TABLE 1/// |
| | STD | IRON (7439-89-6) (98.61%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.9%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.2%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.2%) | Cmpd | I | | | | | | |
| | STD | BORON (7440-42-8) (0.05%) | Cmpd | I | | | | | | |
| | STD | PHOSPHATE COATING | B | B | | | 1 | | PA-PD-191 | //1/// |
| | STD | PHOSPHORIC ACID (7664-38-2) (11%) | Cmpd | B | | | | | | |
| | STD | NICKEL CARBONATE (3333-67-3) (0.1%) | Cmpd | B | | | | | | |
| | STD | ACID PROOF PAINT | B | B | | | 1 | | JAN-P-450 | /1 OR 2//// |
| | STD | ENAMEL GREEN | B | B | | | 1 | | MIL-E-10687 | |
| | STD | ALIPHATIC PETROLEUM (64742-89-8) (30%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (7.5%) | Cmpd | B | | | | | | |
| | STD | ISOBUTYL ACETATE (110-19-0) (7.5%) | Cmpd | B | | | | | | |
| | STD | XYLENE (1330-20-7) (5%) | Cmpd | B | | | | | | |
| | ALT | LACQUER GREEN (ALT) | B | B | | | 1 | | MIL-L-11195 | |
| | STD | ACETONE (67-64-1) (40.5%) | Cmpd | B | | | | | | |
| | STD | PROPANE (74-98-6) (10%) | Cmpd | B | | | | | | |
| | STD | N-BUTANE (106-97-8) (10%) | Cmpd | B | | | | | | |
| | STD | ISOBUTANE (75-28-5) (10%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | XYLENE (1330-20-7) (7.5%) | Cmpd | B | | | | | | |
| | STD | DIACETONE ALCOHOL (123-42-2) (7.5%) | Cmpd | B | | | | | | |
| | STD | N-BUTYL ALCOHOL (71-36-3) (2.5%) | Cmpd | B | | | | | | |
| | STD | METHYL ETHYL KETONE (78-93-3) (2.5%) | Cmpd | B | | | | | | |
| | STD | ISOPROPYL ALCOHOL (67-63-0) (2.5%) | Cmpd | B | | | | | | |
| | STD | ISOBUTYL ACETATE (110-19-0) (2.5%) | Cmpd | B | | | | | | |
| | STD | SILICONE COMPOUND | B | B | | | 1 | | VENDOR ITEM | //GE-81508/// |
| | STD | FUMED SILICA (112945-52-5) (7.5%) | Cmpd | B | | | | | | |
| | STD | SILICONE FLUID/POLYD (63148-62-9) (0%) | Cmpd | B | | | | | | |
| | ALT | SILICONE GREASE (ALT) | B | B | | | 1 | | VENDOR ITEM | //DC-6/// |
| | STD | FILLED METHYLPHENYL (N/A) (100%) | Cmpd | B | | | | | | |
| | STD | STENCIL INK YELLOW | B | B | | | 1 | | TT-I-558 | |
| | STD | MINERAL SPIRITS (64475-85-0) (45%) | Cmpd | B | | | | | | |
| | STD | ALIPHATIC HYDROCARBON (N/A) (20%) | Cmpd | B | | | | | | |
| | STD | ALCOHOLS (N/A) (5%) | Cmpd | B | | | | | | |
| 75-2-269B | STD | BAND ROTATING | P | I | 0.1700 | LB | 1 | 0.170000 | MIL-B-20292 | //220/// |
| | STD | COPPER ALLOY | Mtl | I | | | | | MIL-B-20292 | //220/// |
| | STD | COPPER (7440-50-8) (90%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (9.9%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.05%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| 75-2-269E | STD | COVER BASE | P | I | 0.0400 | LB | 1 | 0.040000 | QQ-S-640 | //1009/// |
| | STD | STEEL | Mtl | I | | | | | QQ-S-640 | //1009/// |
| | STD | IRON (7439-89-6) (99.19%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.6%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.15%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.04%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.03%) | Cmpd | I | | | | | | |
| | STD | PHOSPHATE COATING | B | B | | | 1 | | PA-PD-191 | //1/// |
| | STD | PHOSPHORIC ACID (7664-38-2) (11%) | Cmpd | B | | | | | | |
| | STD | NICKEL CARBONATE (3333-67-3) (0.1%) | Cmpd | B | | | | | | |
| | STD | ENAMEL GREEN | B | B | | | 1 | | MIL-E-10687 | |
| | STD | ALIPHATIC PETROLEUM (64742-89-8) (30%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (7.5%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | ISOBUTYL ACETATE (110-19-0) (7.5%) | Cmpd | B | | | | | | |
| | STD | XYLENE (1330-20-7) (5%) | Cmpd | B | | | | | | |
| | ALT | LACQUER GREEN (ALT) | B | B | | | 1 | | MIL-L-11195 | |
| | STD | ACETONE (67-64-1) (40.5%) | Cmpd | B | | | | | | |
| | STD | PROPANE (74-98-6) (10%) | Cmpd | B | | | | | | |
| | STD | N-BUTANE (106-97-8) (10%) | Cmpd | B | | | | | | |
| | STD | ISOBUTANE (75-28-5) (10%) | Cmpd | B | | | | | | |
| | STD | XYLENE (1330-20-7) (7.5%) | Cmpd | B | | | | | | |
| | STD | DIACETONE ALCOHOL (123-42-2) (7.5%) | Cmpd | B | | | | | | |
| | STD | N-BUTYL ALCOHOL (71-36-3) (2.5%) | Cmpd | B | | | | | | |
| | STD | METHYL ETHYL KETONE (78-93-3) (2.5%) | Cmpd | B | | | | | | |
| | STD | ISOPROPYL ALCOHOL (67-63-0) (2.5%) | Cmpd | B | | | | | | |
| | STD | ISOBUTYL ACETATE (110-19-0) (2.5%) | Cmpd | B | | | | | | |
| 75-14-468 | STD | DEEP CAVITY ACCESSORIES | C | | | | 1 | | | |
| 75-14-468K9 | STD | LINER | P | I | 0.0350 | LB | 1 | 0.035000 | QQ-A-561 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-561 | //1100/// |
| | STD | ALUMINUM (7429-90-5) (98.78%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| 75-14-468K9 | ALT | LINER (ALT) | P | I | 0.0350 | LB | 1 | | QQ-A-359 | //3003/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-359 | //3003/// |
| | STD | ALUMINUM (7429-90-5) (97.23%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (1.25%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.7%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.6%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.13%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| 75-14-468H5 | STD | SPACER | P | I | 0.0110 | LB | 1 | 0.011000 | MIL-B-20890 | /1//// |
| | STD | CNTR BOARD | Mtl | I | | | | | MIL-B-20890 | /1//// |
| | STD | GLUE | B | B | 0.1600 | GR | 1 | | MIL-G-20469 | //2/// |
| | STD | POLYVINYL ACETATE PO (9003-20-7) (50%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| 75-14-468A6 | STD | SUPPL CHG ASSY | C | | 0.3300 | LB | 1 | | | |
| 75-14-468E8 | STD | BODY | P | I | 0.0240 | LB | 1 | 0.024000 | QQ-A-561 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-561 | //1100/// |
| | STD | ALUMINUM (7429-90-5) (98.78%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| | STD | STENCIL INK | B | B | | | 1 | | TT-I-558 | |
| | STD | KETONES (N/A) (30%) | Cmpd | B | | | | | | |
| | STD | PROP (N/A) (25%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (10%) | Cmpd | B | | | | | | |
| | STD | PIGMENT (N/A) (10%) | Cmpd | B | | | | | | |
| | STD | ACRYLIC RESIN (N/A) (5%) | Cmpd | B | | | | | | |
| | STD | CEMENT SYNTHETIC | B | B | 0.5850 | GR | 1 | | MIL-C-2749 | |
| | ALT | GLUE (ALT) | B | B | 0.5850 | GR | 1 | | VENDOR ITEM | //EC266/// |
| | STD | POLYVINYL ACETATE PO (9003-20-7) (50%) | Cmpd | B | | | | | | |
| | ALT | ADHESIVE SYNTHETIC RUBBER (ALT) | B | B | 0.5850 | GR | 1 | | MIL-A-13883 | /1 OR 2//// |
| | STD | ALIPHATIC PETROLEUM (64742-89-8) (44%) | Cmpd | B | | | | | | |
| | STD | ACETONE (67-64-1) (26%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (8%) | Cmpd | B | | | | | | |
| | STD | ZINC OXIDE (1314-13-2) (0%) | Cmpd | B | | | | | | |
| | STD | MAGNESIUM OXIDE (1309-48-4) (0%) | Cmpd | B | | | | | | |
| 75-14-468E8 | ALT | BODY (ALT) | P | I | 0.0240 | LB | 1 | | QQ-A-411 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-411 | //1100/// |
| | STD | ALUMINUM (7429-90-5) (98.78%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| | STD | STENCIL INK | B | B | | | 1 | | TT-I-558 | |
| | STD | KETONES (N/A) (30%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | PROP (N/A) (25%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (10%) | Cmpd | B | | | | | | |
| | STD | PIGMENT (N/A) (10%) | Cmpd | B | | | | | | |
| | STD | ACRYLIC RESIN (N/A) (5%) | Cmpd | B | | | | | | |
| | STD | CEMENT SYNTHETIC | B | B | 0.5850 | GR | 1 | | MIL-C-2749 | |
| | ALT | GLUE (ALT) | B | B | 0.5850 | GR | 1 | | VENDOR ITEM | //EC266/// |
| | STD | POLYVINYL ACETATE PO (9003-20-7) (50%) | Cmpd | B | | | | | | |
| | ALT | ADHESIVE SYNTHETIC RUBBER (ALT) | B | B | 0.5850 | GR | 1 | | MIL-A-13883 | /1 OR 2//// |
| | STD | ALIPHATIC PETROLEUM (64742-89-8) (44%) | Cmpd | B | | | | | | |
| | STD | ACETONE (67-64-1) (26%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (8%) | Cmpd | B | | | | | | |
| | STD | ZINC OXIDE (1314-13-2) (0%) | Cmpd | B | | | | | | |
| | STD | MAGNESIUM OXIDE (1309-48-4) (0%) | Cmpd | B | | | | | | |
| 75-14-468E8 | ALT | BODY (ALT) | P | I | 0.0240 | LB | 1 | | QQ-A-359 | //3003/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-359 | //3003/// |
| | STD | ALUMINUM (7429-90-5) (97.23%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (1.25%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.7%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.6%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.13%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | STENCIL INK | B | B | | | 1 | | TT-I-558 | |
| | STD | KETONES (N/A) (30%) | Cmpd | B | | | | | | |
| | STD | PROP (N/A) (25%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (10%) | Cmpd | B | | | | | | |
| | STD | PIGMENT (N/A) (10%) | Cmpd | B | | | | | | |
| | STD | ACRYLIC RESIN (N/A) (5%) | Cmpd | B | | | | | | |
| | STD | CEMENT SYNTHETIC | B | B | 0.5850 | GR | 1 | | MIL-C-2749 | |
| | ALT | GLUE (ALT) | B | B | 0.5850 | GR | 1 | | VENDOR ITEM | //EC266/// |
| | STD | POLYVINYL ACETATE PO (9003-20-7) (50%) | Cmpd | B | | | | | | |
| | ALT | ADHESIVE SYNTHETIC RUBBER (ALT) | B | B | 0.5850 | GR | 1 | | MIL-A-13883 | /1 OR 2//// |
| | STD | ALIPHATIC PETROLEUM (64742-89-8) (44%) | Cmpd | B | | | | | | |
| | STD | ACETONE (67-64-1) (26%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (8%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | ZINC OXIDE (1314-13-2) (0%) | Cmpd | B | | | | | | |
| | STD | MAGNESIUM OXIDE (1309-48-4) (0%) | Cmpd | B | | | | | | |
| 75-14-468F3 | STD | DISC CLOSING | P | I | 0.0040 | LB | 1 | 0.004000 | QQ-A-561 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-561 | //1100/// |
| | STD | ALUMINUM (7429-90-5) (98.78%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| | STD | LACQUER CELL NITRATE RED | B | B | 1.4600 | GR | 1 | | 3-158 | ///B// |
| | STD | ISOBUTYL ACETATE (110-19-0) (20%) | Cmpd | B | | | | | | |
| | STD | ZINC CHROMATE (13530-65-9) (5%) | Cmpd | B | | | | | | |
| | STD | XYLENE (O-,M-,P- IS (1330-20-7) (5%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (5%) | Cmpd | B | | | | | | |
| | STD | TALC (14807-96-6) (5%) | Cmpd | B | | | | | | |
| | STD | SILICA CRYSTALLINE (14808-60-7) (5%) | Cmpd | B | | | | | | |
| | STD | SILICA CRYSTALLINE (14808-60-7) (5%) | Cmpd | B | | | | | | |
| | STD | ISOPROPYL ALCOHOL (67-63-0) (5%) | Cmpd | B | | | | | | |
| | STD | ISOBUTYL ALCOHOL (78-83-1) (5%) | Cmpd | B | | | | | | |
| | STD | ETHYL BENZENE (100-41-4) (5%) | Cmpd | B | | | | | | |
| | STD | DI-SEC-OCTYL PHTHALA (117-81-7) (5%) | Cmpd | B | | | | | | |
| | STD | COLLODION (WET NITRO (9004-70-0) (5%) | Cmpd | B | | | | | | |
| | STD | BENZIN (8032-32-4) (5%) | Cmpd | B | | | | | | |
| | STD | STENCIL INK BLACK | B | B | | | 1 | | TT-I-558 | |
| | STD | KETONES (N/A) (30%) | Cmpd | B | | | | | | |
| | STD | PROP (N/A) (25%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (10%) | Cmpd | B | | | | | | |
| | STD | PIGMENT (N/A) (10%) | Cmpd | B | | | | | | |
| | STD | ACRYLIC RESIN (N/A) (5%) | Cmpd | B | | | | | | |
| 75-14-468D8 | STD | PAD | P | I | 0.0060 | LB | 1 | 0.006000 | C-F-206 | ///12R3// |
| | STD | WOOL FELT | Mtl | I | | | | | C-F-206 | ///12R3// |
| | STD | CEMENT SYNTHETIC | B | B | 0.5850 | GR | 1 | | MIL-C-2749 | |
| | ALT | GLUE (ALT) | B | B | 0.5850 | GR | 1 | | VENDOR ITEM | //EC266/// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | POLYVINYL ACETATE PO (9003-20-7) (50%) | Cmpd | B | | | | | | |
| | ALT | ADHESIVE SYNTHETIC RUBBER (ALT) | B | B | 0.5850 | GR | 1 | | MIL-A-13883 | /1 OR 2//// |
| | STD | ALIPHATIC PETROLEUM (64742-89-8) (44%) | Cmpd | B | | | | | | |
| | STD | ACETONE (67-64-1) (26%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (8%) | Cmpd | B | | | | | | |
| | STD | ZINC OXIDE (1314-13-2) (0%) | Cmpd | B | | | | | | |
| | STD | MAGNESIUM OXIDE (1309-48-4) (0%) | Cmpd | B | | | | | | |
| 75-14-468R8 | ALT | PAD (ALT) | P | I | 0.0040 | LB | 1 | | C-F-206 | ///12R3// |
| | STD | WOOL FELT | Mtl | I | | | | | C-F-206 | ///12R3// |
| | STD | CEMENT SYNTHETIC | B | B | 0.5850 | GR | 1 | | MIL-C-2749 | |
| | ALT | GLUE (ALT) | B | B | 0.5850 | GR | 1 | | VENDOR ITEM | //EC266/// |
| | STD | POLYVINYL ACETATE PO (9003-20-7) (50%) | Cmpd | B | | | | | | |
| | ALT | ADHESIVE SYNTHETIC RUBBER (ALT) | B | B | 0.5850 | GR | 1 | | MIL-A-13883 | /1 OR 2//// |
| | STD | ALIPHATIC PETROLEUM (64742-89-8) (44%) | Cmpd | B | | | | | | |
| | STD | ACETONE (67-64-1) (26%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (8%) | Cmpd | B | | | | | | |
| | STD | ZINC OXIDE (1314-13-2) (0%) | Cmpd | B | | | | | | |
| | STD | MAGNESIUM OXIDE (1309-48-4) (0%) | Cmpd | B | | | | | | |
| 75-14-468G6 | STD | TAB | P | I | 0.0010 | LB | 1 | 0.001000 | JAN-P-127 | /2/B/// |
| | STD | TAPE ADHESIVE | Mtl | I | | | | | JAN-P-127 | /2/B/// |
| 75-14-468M6 | ALT | TAB (ALT) | P | I | 0.0010 | LB | 1 | | PPP-T-60 | |
| | STD | TAPE PRESSURE SENSITIVE | Mtl | I | | | | | PPP-T-60 | |
| 75-14-468B6 | STD | CHG | P | X | 0.3000 | LB | 1 | 0.300000 | | |
| | STD | CHG MIX (TNT 98.5%) | Mtl | X | | | | | | |
| | STD | TNT (118-96-7) (98.5%) | Cmpd | X | | | | | MIL-T-248 | //1/// |
| | STD | BARIUM STEARATE (6865-35-6) (1.5%) | Cmpd | X | | | | | JAN-B-366 | |
| 73-2-146A | STD | FUZE PD M51A5 | C | | 2.1200 | LB | 1 | | MIL-F-10373 | |
| 73-2-154A | STD | BOOSTER M21A4 ASSY | C | | 0.7200 | LB | 1 | | MIL-B-20361 | |
| 73-2-155C | STD | CUP BOOSTER | P | I | 315.7648 | GR | 1 | 0.045110 | QQ-A-591 | //A360/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-591 | //A360/// |
| | STD | ALUMINUM (7429-90-5) (87.1%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (9%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (1.3%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.6%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | ZINC (7440-66-6) (0.5%) | Cmpd | I | | | | | | |
| | STD | NICKEL (7440-02-0) (0.5%) | Cmpd | I | | | | | | |
| | STD | MAGNESIUM (7439-95-4) (0.5%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.35%) | Cmpd | I | | | | | | |
| | STD | TIN (7440-31-5) (0.15%) | Cmpd | I | | | | | | |
| 73-2-155C | ALT | CUP BOOSTER (ALT) | P | I | 315.7648 | GR | 1 | | QQ-A-359 | //3003/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-359 | //3003/// |
| | STD | ALUMINUM (7429-90-5) (97.23%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (1.25%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.7%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.6%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.13%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| 73-2-155D | STD | PELLET BOOSTER | P | X | 351.0000 | GR | 1 | 0.050144 | MIL-P-46464 | /2//// |
| | STD | TETRYL PELLETS | Mtl | X | | | | | MIL-P-46464 | /2//// |
| | STD | TETRYL (479-45-8) (98%) | Cmpd | X | | | | | MIL-T-339 | //1/A OR B// |
| | STD | CALCIUM STEARATE (1592-23-0) (0.75%) | Cmpd | X | | | | | MIL-C-263 | |
| | STD | BARIUM STEARATE (6865-35-6) (0.75%) | Cmpd | X | | | | | MIL-B-366 | |
| | STD | GRAPHITE (7782-42-5) (0.5%) | Cmpd | X | | | | | MIL-G-155 | //1 OR 2/// |
| 73-2-156A | STD | BODY ASSY | C | | | | 1 | | | |
| 73-2-114B | STD | BODY | P | I | 3,569.4806 | GR | 1 | 0.509936 | QQ-B-626 | //360/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-626 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (35.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (3.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| 73-2-155G | STD | PIN ROTOR STOP | P | I | 7.2859 | GR | 1 | 0.001041 | QQ-S-763 | /302//// |
| | STD | STAINLESS STEEL | Mtl | I | | | | | QQ-S-763 | /302//// |
| | STD | IRON (7439-89-6) (67.675%) | Cmpd | I | | | | | | |
| | STD | CHROMIUM (7440-47-3) (18%) | Cmpd | I | | | | | | |
| | STD | NICKEL (7440-02-0) (9%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (2%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (1%) | Cmpd | I | | | | | | |
| | STD | MOLYBDENUM (7439-98-7) (1%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | SILICON (7440-21-3) (1%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.15%) | Cmpd | I | | | | | | |
| | STD | NITROGEN (7727-37-9) (0.1%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.045%) | Cmpd | I | | | | | | |
| | STD | SULPHUR (7704-34-9) (0.03%) | Cmpd | I | | | | | | |
| 73-2-155F | STD | PIN ROTOR PIVOT | P | I | 15.3722 | GR | 1 | 0.002196 | QQ-S-763 | /302//// |
| | STD | STAINLESS STEEL | Mtl | I | | | | | QQ-S-763 | /302//// |
| | STD | IRON (7439-89-6) (67.675%) | Cmpd | I | | | | | | |
| | STD | CHROMIUM (7440-47-3) (18%) | Cmpd | I | | | | | | |
| | STD | NICKEL (7440-02-0) (9%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (2%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (1%) | Cmpd | I | | | | | | |
| | STD | MOLYBDENUM (7439-98-7) (1%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (1%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.15%) | Cmpd | I | | | | | | |
| | STD | NITROGEN (7727-37-9) (0.1%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.045%) | Cmpd | I | | | | | | |
| | STD | SULPHUR (7704-34-9) (0.03%) | Cmpd | I | | | | | | |
| 73-2-114C | STD | PIN CENTRIFUGAL | P | I | 19.4376 | GR | 1 | 0.002777 | QQ-B-626 | //360/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-626 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (35.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (3.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.0550 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 73-2-144E | STD | PIN CENTRIFUGAL LOCK | P | I | 6.1450 | GR | 1 | 0.000878 | QQ-B-626 | //360/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-626 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (35.05%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | LEAD (7439-92-1) (3.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.0280 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 73-2-113Q | STD | SPRING CENTRIFUGAL PIN | P | I | 0.3405 | GR | 1 | 0.000049 | QQ-W-470 | //NOS/// |
| | STD | STEEL WIRE | Mtl | I | | | | | QQ-W-470 | //NOS/// |
| | STD | IRON (7439-89-6) (98.485%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.85%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.4%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.21%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.03%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.025%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0170 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 73-2-114D | STD | SPRING CENTRIFUGAL LOCK PIN | P | I | 1.0947 | GR | 1 | 0.000156 | QQ-W-470 | //NOS/// |
| | STD | STEEL WIRE | Mtl | I | | | | | QQ-W-470 | //NOS/// |
| | STD | IRON (7439-89-6) (98.485%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.85%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.4%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.21%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.03%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.025%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0304 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 73-2-155K | STD | SCREW CENTRIFUGAL PIN | P | I | 13.9080 | GR | 1 | 0.001987 | QQ-B-626 | //360/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-626 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (35.05%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | LEAD (7439-92-1) (3.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.0853 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 73-2-155K | ALT | SCREW CENTRIFUGAL PIN (ALT) | P | I | 12.0609 | GR | 1 | | QQ-S-633 | //1020/// |
| | STD | STEEL | Mtl | I | | | | | QQ-S-633 | //1020/// |
| | STD | IRON (7439-89-6) (99%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.45%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.21%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.05%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0853 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 73-2-155K | ALT | SCREW CENTRIFUGAL PIN (ALT) | P | I | 10.6247 | GR | 1 | | QQ-Z-363 | //AG40A/// |
| | STD | ZINC ALLOY | Mtl | I | | | | | QQ-Z-363 | //AG40A/// |
| | STD | ZINC (7440-66-6) (95.7%) | Cmpd | I | | | | | | |
| | STD | ALUMINUM (7429-90-5) (3.9%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.25%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MAGNESIUM (7439-95-4) (0.038%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.005%) | Cmpd | I | | | | | | |
| | STD | CADMIUM (7440-43-9) (0.004%) | Cmpd | I | | | | | | |
| | STD | TIN (7440-31-5) (0.003%) | Cmpd | I | | | | | | |
| 73-2-113C | STD | PLUG BODY | P | I | 2.2170 | GR | 3 | 0.000950 | QQ-B-613 | //260/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-613 | //260/// |
| | STD | COPPER (7440-50-8) (70%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (29.88%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.07%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | CHROMATE COATING | B | B | 0.0154 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 73-2-113R | ALT | PLUG BODY (ALT) | P | I | 3.6517 | GR | 3 | | QQ-B-613 | //260/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-613 | //260/// |
| | STD | COPPER (7440-50-8) (70%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (29.88%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.07%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| 73-2-114F | STD | SCREW LOCK PIN CLOSING | P | I | 59.6758 | GR | 1 | 0.008525 | QQ-B-626 | //360/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-626 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (35.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (3.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.1087 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 73-2-113A | STD | ROTOR ASSY | C | | | | 1 | | | |
| 73-2-113B | STD | ROTOR | P | I | 542.7252 | GR | 1 | 0.077534 | QQ-B-626 | //360/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-626 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (35.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (3.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.3050 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 73-2-113B | ALT | ROTOR (ALT) | P | I | 174.4475 | GR | 1 | | QQ-A-591 | //380/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-591 | //380/// |
| | STD | ALUMINUM (7429-90-5) (81.55%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (8.5%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (3.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (3%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (2%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.5%) | Cmpd | I | | | | | | |
| | STD | NICKEL (7440-02-0) (0.5%) | Cmpd | I | | | | | | |
| | STD | TIN (7440-31-5) (0.35%) | Cmpd | I | | | | | | |
| | STD | MAGNESIUM (7439-95-4) (0.1%) | Cmpd | I | | | | | | |
| 73-2-113B | ALT | ROTOR (ALT) | P | I | 542.7974 | GR | 1 | | MIL-B-12128 | //260/// |
| | STD | BRASS | Mtl | I | | | | | MIL-B-12128 | //260/// |
| | STD | COPPER (7440-50-8) (70%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (29.88%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.07%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| 73-2-113B | ALT | ROTOR (ALT) | P | I | 575.0302 | GR | 1 | | JAN-C-768 | //210/// |
| | STD | COPPER ALLOY | Mtl | I | | | | | JAN-C-768 | //210/// |
| | STD | COPPER (7440-50-8) (95%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (4.92%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.05%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.03%) | Cmpd | I | | | | | | |
| 73-2-113M | STD | PIN ROTOR LOCK | P | I | 2.7831 | GR | 1 | 0.000398 | QQ-B-626 | //260/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-626 | //260/// |
| | STD | COPPER (7440-50-8) (70%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (29.88%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.07%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.0145 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 73-2-113L | STD | LOCK ROTOR LOCK PIN | P | I | 1.9042 | GR | 1 | 0.000272 | QQ-B-626 | //360/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-626 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (35.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (3.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.0108 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 8797749 | STD | DETONATOR M17 ASSY | C | | 10.5000 | GR | 1 | | MIL-D-46406 | |
| | STD | INTERMEDIATE CHG (LEAD AZIDE) | P | X | 4.0800 | GR | 1 | 0.000583 | MIL-L-3055 | /1//// |
| | STD | LEAD AZIDE | Mtl | X | | | | | MIL-L-3055 | /1//// |
| | STD | LEAD AZIDE (13424-46-9) (100%) | Cmpd | X | | | | | MIL-L-3055 | /1//// |
| | STD | TETRYL | P | X | 1.2300 | GR | 1 | 0.000176 | MIL-T-339 | //1/A// |
| | STD | TETRYL | Mtl | X | | | | | MIL-T-339 | //1/A// |
| | STD | TETRYL (479-45-8) (100%) | Cmpd | X | | | | | MIL-T-339 | //1/A// |
| 8797745-3 | STD | CUP DETONATOR | P | I | 4.5000 | GR | 1 | 0.000643 | QQ-A-561 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-561 | //1100/// |
| | STD | ALUMINUM (7429-90-5) (98.78%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| | STD | BITUMINOUS COATING | B | B | 0.0069 | GR | 1 | | MIL-C-450 | /1 OR 2//// |
| 8795797-1 | STD | DISC DETONATOR | P | I | 0.0300 | GR | 1 | 0.000004 | QQ-A-561 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-561 | //1100/// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | ALUMINUM (7429-90-5) (98.78%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| | STD | ADHESIVE PLASTIC | B | B | 0.0531 | GR | 1 | | VENDOR ITEM | |
| | STD | POLYAMIDE RESIN (68410-23-1) (10%) | Cmpd | B | | | | | | |
| | STD | EPOXY RESIN (10%) | Cmpd | B | | | | | | |
| | STD | DIETHYLENE TRIAMINE (111-40-0) (5.5%) | Cmpd | B | | | | | | |
| 8797036-1 | STD | DISC DETONATOR CLOSING | P | I | 0.1800 | GR | 1 | 0.000026 | QQ-A-561 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-561 | //1100/// |
| | STD | ALUMINUM (7429-90-5) (98.78%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| | STD | LACQUER CELL NITRATE | B | B | 0.0057 | GR | 1 | | MIL-L-10287 | /1//// |
| | STD | ISOBUTYL ACETATE (110-19-0) (29.9%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (15.5%) | Cmpd | B | | | | | | |
| | STD | XYLENE (1330-20-7) (12.4%) | Cmpd | B | | | | | | |
| | STD | ISOBUTYL ALCOHOL (78-83-1) (4%) | Cmpd | B | | | | | | |
| | STD | ISOPROPYL ALCOHOL (67-63-0) (3%) | Cmpd | B | | | | | | |
| 73-2-156L | STD | COVER & DISC ASSY | C | | | | 1 | | | |
| 73-2-113P | STD | COVER ROTOR | P | I | 162.6250 | GR | 1 | 0.023233 | QQ-B-613 | //230/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-613 | //230/// |
| | STD | COPPER (7440-50-8) (85%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (14.9%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.05%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.8711 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 73-2-113P | ALT | COVER ROTOR (ALT) | P | I | 151.0089 | GR | 1 | | QQ-S-640 | //1009/// |
| | STD | STEEL | Mtl | I | | | | | QQ-S-640 | //1009/// |
| | STD | IRON (7439-89-6) (99.19%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.6%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.15%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.04%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.03%) | Cmpd | I | | | | | | |
| 73-2-155H | STD | DISC ROTOR COVER | P | I | 0.1743 | GR | 1 | 0.000025 | JAN-P-157 | |
| | STD | PAPER ONIONSKIN | Mtl | I | | | | | JAN-P-157 | |
| | STD | VARNISH | B | B | 0.5256 | GR | 1 | | TT-V-91 | /2/B/// |
| | STD | PROPANE (74-98-6) (30%) | Cmpd | B | | | | | | |
| | STD | HEPTANE (142-82-5) (30%) | Cmpd | B | | | | | | |
| | STD | ACETONE (67-64-1) (30%) | Cmpd | B | | | | | | |
| | STD | VM&P NAPHTHA (8032-32-4) (15%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (15%) | Cmpd | B | | | | | | |
| | STD | HEAVY AROMATIC SOLVENT (64742-94-5) (5%) | Cmpd | B | | | | | | |
| 73-2-155H | ALT | DISC ROTOR COVER (ALT) | P | I | 1.8769 | GR | 1 | | QQ-B-626 | //210/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-626 | //210/// |
| | STD | COPPER (7440-50-8) (95%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (4.92%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.05%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.03%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.1851 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| | STD | VARNISH | B | B | 0.5256 | GR | 1 | | TT-V-91 | /2/B/// |
| | STD | PROPANE (74-98-6) (30%) | Cmpd | B | | | | | | |
| | STD | HEPTANE (142-82-5) (30%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | ACETONE (67-64-1) (30%) | Cmpd | B | | | | | | |
| | STD | VM&P NAPHTHA (8032-32-4) (15%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (15%) | Cmpd | B | | | | | | |
| | STD | HEAVY AROMATIC SOLVENT (64742-94-5) (5%) | Cmpd | B | | | | | | |
| 73-2-155H | ALT | DISC ROTOR COVER (ALT) | P | I | 0.5363 | GR | 1 | | QQ-A-591 | //380/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-591 | //380/// |
| | STD | ALUMINUM (7429-90-5) (81.55%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (8.5%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (3.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (3%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (2%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.5%) | Cmpd | I | | | | | | |
| | STD | NICKEL (7440-02-0) (0.5%) | Cmpd | I | | | | | | |
| | STD | TIN (7440-31-5) (0.35%) | Cmpd | I | | | | | | |
| | STD | MAGNESIUM (7439-95-4) (0.1%) | Cmpd | I | | | | | | |
| | STD | VARNISH | B | B | 0.5256 | GR | 1 | | TT-V-91 | /2/B/// |
| | STD | PROPANE (74-98-6) (30%) | Cmpd | B | | | | | | |
| | STD | HEPTANE (142-82-5) (30%) | Cmpd | B | | | | | | |
| | STD | ACETONE (67-64-1) (30%) | Cmpd | B | | | | | | |
| | STD | VM&P NAPHTHA (8032-32-4) (15%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (15%) | Cmpd | B | | | | | | |
| | STD | HEAVY AROMATIC SOLVENT (64742-94-5) (5%) | Cmpd | B | | | | | | |
| 73-2-155A | STD | BOOSTER CLOSING CUP ASSY | C | | | | 1 | | | |
| 73-2-155L | STD | CUP BOOSTER CLOSING | P | I | 3.4332 | GR | 1 | 0.000490 | JAN-G-439 | //210/// |
| | STD | GILDING METAL | Mtl | I | | | | | JAN-G-439 | //210/// |
| | STD | COPPER (7440-50-8) (95%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (5%) | Cmpd | I | | | | | | |
| | STD | TETRYL | P | X | 3.7800 | GR | 1 | 0.000540 | | |
| | STD | CHG TETRYL | Mtl | X | | | | | | |
| | STD | TETRYL (479-45-8) (98%) | Cmpd | X | | | | | MIL-T-339 | //A/// |
| | STD | GRAPHITE (7782-42-5) (2%) | Cmpd | X | | | | | MIL-G-48771 | //1 OR 2/// |
| 8798219 | STD | FUZE PD M48A3 ASSY | C | | 1.4100 | LB | 1 | | MIL-F-60348 | |
| 8798221 | STD | TUBE FLASH | P | I | 273.0000 | GR | 1 | 0.039001 | QQ-T-830 | //1137/// |
| | STD | STEEL TUBING | Mtl | I | | | | | QQ-T-830 | //1137/// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | IRON (7439-89-6) (98%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (1.5%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.36%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.11%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | ZINC CHROMATE | B | B | 0.7020 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| | ALT | CADMIUM CHROMATE (ALT) | B | B | 0.7650 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8798221 | ALT | TUBE FLASH (ALT) | P | I | 273.0000 | GR | 1 | | ASTM-A108 | //1035/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A108 | //1035/// |
| | STD | IRON (7439-89-6) (98%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.75%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.35%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.05%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | ZINC CHROMATE | B | B | 0.7020 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| | ALT | CADMIUM CHROMATE (ALT) | B | B | 0.7650 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8798221 | ALT | TUBE FLASH (ALT) | P | I | 273.0000 | GR | 1 | | AMS-5082 | //1035/// |
| | STD | STEEL | Mtl | I | | | | | AMS-5082 | //1035/// |
| | STD | IRON (7439-89-6) (98%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.75%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.35%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.05%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | ZINC CHROMATE | B | B | 0.7020 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| | ALT | CADMIUM CHROMATE (ALT) | B | B | 0.7650 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| 9234456 | STD | SCREW BOTTOM CLOSING | P | I | 1.5600 | GR | 1 | 0.000223 | ASTM-B211 | //2024/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | ASTM-B211 | //2024/// |
| | STD | ALUMINUM (7429-90-5) (92.2%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (4.3%) | Cmpd | I | | | | | | |
| | STD | MAGNESIUM (7439-95-4) (1.5%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.6%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.5%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.25%) | Cmpd | I | | | | | | |
| | STD | CHROMIUM (7440-47-3) (0.1%) | Cmpd | I | | | | | | |
| | STD | TITANIUM (7440-32-6) (0.05%) | Cmpd | I | | | | | UNKNOWN | |
| 8798220 | STD | OGIVE | P | I | 785.0000 | GR | 1 | 0.112145 | ASTM-A109 | //T1-T3/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A109 | //T1-T3/// |
| | STD | IRON (7439-89-6) (99.08%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.6%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.25%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.035%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.035%) | Cmpd | I | | | | | | |
| | STD | ZINC CHROMATE | B | B | 4.0990 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| | ALT | CADMIUM CHROMATE (ALT) | B | B | 4.4780 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| | STD | LACQUER | B | B | 0.9900 | GR | 1 | | PA-PD-575 | |
| | STD | ACETONE (67-64-1) (40.5%) | Cmpd | B | | | | | | |
| | STD | PROPANE (74-98-6) (10%) | Cmpd | B | | | | | | |
| | STD | N-BUTANE (106-97-8) (10%) | Cmpd | B | | | | | | |
| | STD | ISOBUTANE (75-28-5) (10%) | Cmpd | B | | | | | | |
| | STD | XYLENE (1330-20-7) (7.5%) | Cmpd | B | | | | | | |
| | STD | DIACETONE ALCOHOL (123-42-2) (7.5%) | Cmpd | B | | | | | | |
| | STD | N-BUTYL ALCOHOL (71-36-3) (2.5%) | Cmpd | B | | | | | | |
| | STD | METHYL ETHYL KETONE (78-93-3) (2.5%) | Cmpd | B | | | | | | |
| | STD | ISOPROPYL ALCOHOL (67-63-0) (2.5%) | Cmpd | B | | | | | | |
| | STD | ISOBUTYL ACETATE (110-19-0) (2.5%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| 8798232 | STD | HEAD LOADING ASSY | C | | 1,157.0000 | GR | 1 | | | |
| 8798233 | STD | CUSHION DETONATOR | P | I | 0.1500 | GR | 1 | 0.000021 | HH-C-576 | |
| | STD | CORK | Mtl | I | | | | | HH-C-576 | |
| 8798234 | STD | SCREW DET RETAINING | P | I | 7.5000 | GR | 1 | 0.001071 | ASTM-B211 | //2011/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | ASTM-B211 | //2011/// |
| | STD | ALUMINUM (7429-90-5) (92.3%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (5.5%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.7%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.4%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.4%) | Cmpd | I | | | | | | |
| | STD | BISMUTH (7440-69-9) (0.4%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.3%) | Cmpd | I | | | | | | |
| 8798234 | ALT | SCREW DET RETAINING (ALT) | P | I | 7.5000 | GR | 1 | | ASTM-B221 | //2024/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | ASTM-B221 | //2024/// |
| | STD | ALUMINUM (7429-90-5) (92.2%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (4.3%) | Cmpd | I | | | | | | |
| | STD | MAGNESIUM (7439-95-4) (1.5%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.6%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.5%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.25%) | Cmpd | I | | | | | | |
| | STD | CHROMIUM (7440-47-3) (0.1%) | Cmpd | I | | | | | | |
| | STD | TITANIUM (7440-32-6) (0.05%) | Cmpd | I | | | | | UNKNOWN | |
| 8798235 | STD | MPTS HEAD ASSY | C | | | | 1 | | | |
| 8798236 | STD | DISC CLOSING | P | I | 0.7000 | GR | 1 | 0.000100 | ASTM-B209 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | ASTM-B209 | //1100/// |
| | STD | ALUMINUM (7429-90-5) (98.79%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| 8798237 | STD | HEAD | P | I | 2.1600 | OZ | 1 | 0.135000 | ASTM-B211 | //2011/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | ASTM-B211 | //2011/// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | ALUMINUM (7429-90-5) (92.3%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (5.5%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.7%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.4%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.4%) | Cmpd | I | | | | | | |
| | STD | BISMUTH (7440-69-9) (0.4%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.3%) | Cmpd | I | | | | | | |
| 8798238 | STD | SUPPORT FIRING PIN | P | I | 7.0000 | GR | 1 | 0.001000 | ASTM-B36 | //210/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B36 | //210/// |
| | STD | COPPER (7440-50-8) (95%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (5%) | Cmpd | I | | | | | | |
| 8798239 | STD | WASHER CLOSING DISC | P | I | 3.0000 | GR | 1 | 0.000429 | ASTM-B209 | //2024/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | ASTM-B209 | //2024/// |
| | STD | ALUMINUM (7429-90-5) (92.2%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (4.3%) | Cmpd | I | | | | | | |
| | STD | MAGNESIUM (7439-95-4) (1.5%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.6%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.5%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.25%) | Cmpd | I | | | | | | |
| | STD | CHROMIUM (7440-47-3) (0.1%) | Cmpd | I | | | | | | |
| | STD | TITANIUM (7440-32-6) (0.05%) | Cmpd | I | | | | | UNKNOWN | |
| 9234572 | STD | PIN FIRING | P | I | 10.7000 | GR | 1 | 0.001529 | ASTM-B316 | //2017/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | ASTM-B316 | //2017/// |
| | STD | ALUMINUM (7429-90-5) (93%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (4%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.7%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.7%) | Cmpd | I | | | | | | |
| | STD | MAGNESIUM (7439-95-4) (0.6%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.25%) | Cmpd | I | | | | | | |
| | STD | TITANIUM (7440-32-6) (0.15%) | Cmpd | I | | | | | UNKNOWN | |
| | STD | CHROMIUM (7440-47-3) (0.1%) | Cmpd | I | | | | | | |
| 9234572 | ALT | PIN FIRING (ALT) | P | I | 10.7000 | GR | 1 | | ASTM-B211 | //2024/// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | ASTM-B211 | //2024/// |
| | STD | ALUMINUM (7429-90-5) (92.2%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (4.3%) | Cmpd | I | | | | | | |
| | STD | MAGNESIUM (7439-95-4) (1.5%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.6%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.5%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.25%) | Cmpd | I | | | | | | |
| | STD | CHROMIUM (7440-47-3) (0.1%) | Cmpd | I | | | | | | |
| | STD | TITANIUM (7440-32-6) (0.05%) | Cmpd | I | | | | | UNKNOWN | |
| 8797763 | STD | DETONATOR M24 ASSY | C | | 10.0000 | GR | 1 | | MIL-D-46256 | |
| | STD | PRIMER MIX | P | X | 0.8600 | GR | 1 | 0.000123 | | |
| | STD | PRIMER MIX KCLO3 33.4% | Mtl | X | | | | | | |
| | STD | POTASSIUM CHLORATE (3811-04-9) (33.4%) | Cmpd | X | | | | | MIL-P-150 | //A/2// |
| | STD | ANTIMONY SULFIDE (1345-04-6) (33.3%) | Cmpd | X | | | | | MIL-A-159 | ///A OR B// |
| | STD | LEAD AZIDE (13424-46-9) (28.3%) | Cmpd | X | | | | | MIL-L-3055 | /1//// |
| | STD | CARBORUNDUM (409-21-2) (5%) | Cmpd | X | | | | | VENDOR ITEM | |
| | STD | CHG LOWER (LEAD AZIDE) | P | X | 2.7700 | GR | 1 | 0.000396 | MIL-L-3055 | |
| | STD | LEAD AZIDE | Mtl | X | | | | | MIL-L-3055 | |
| | STD | LEAD AZIDE (13424-46-9) (100%) | Cmpd | X | | | | | MIL-L-3055 | |
| 8797745-10 | STD | CUP DETONATOR | P | I | 4.6000 | GR | 1 | 0.000657 | QQ-A-561 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-561 | //1100/// |
| | STD | ALUMINUM (7429-90-5) (98.78%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.0607 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| 8795797-1 | STD | DISC DETONATOR | P | I | 0.0300 | GR | 1 | 0.000004 | QQ-A-561 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-561 | //1100/// |
| | STD | ALUMINUM (7429-90-5) (98.78%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| | STD | ADHESIVE PLASTIC | B | B | 0.0531 | GR | 1 | | VENDOR ITEM | |
| | STD | POLYAMIDE RESIN (68410-23-1) (10%) | Cmpd | B | | | | | | |
| | STD | EPOXY RESIN (10%) | Cmpd | B | | | | | | |
| | STD | DIETHYLENE TRIAMINE (111-40-0) (5.5%) | Cmpd | B | | | | | | |
| 8797765 | STD | WASHER RETAINER | P | I | 0.1000 | GR | 1 | 0.000014 | JAN-C-367 | |
| | STD | FUZE CLOTH | Mtl | I | | | | | JAN-C-367 | |
| 8797765 | ALT | WASHER RETAINER (ALT) | P | I | 0.1000 | GR | 1 | | C-F-206 | /2//20S// |
| | STD | WOOL FELT | Mtl | I | | | | | C-F-206 | /2//20S// |
| 8797766 | STD | RETAINER | P | I | 1.3000 | GR | 1 | 0.000186 | QQ-A-225/5 | //2017/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-225/5 | //2017/// |
| | STD | ALUMINUM (7429-90-5) (93%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (4%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.7%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.7%) | Cmpd | I | | | | | | |
| | STD | MAGNESIUM (7439-95-4) (0.6%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.25%) | Cmpd | I | | | | | | |
| | STD | TITANIUM (7440-32-6) (0.15%) | Cmpd | I | | | | | UNKNOWN | |
| | STD | CHROMIUM (7440-47-3) (0.1%) | Cmpd | I | | | | | | |
| 8797766 | ALT | RETAINER (ALT) | P | I | 1.3000 | GR | 1 | | QQ-A-250/2 | //3003/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-250/2 | //3003/// |
| | STD | ALUMINUM (7429-90-5) (97.22%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (1.25%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.7%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.6%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.13%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| 9234457 | STD | BODY LOADING ASSY | C | | 6,100.0000 | GR | 1 | | MIL-F-60349 | |
| 9234573 | STD | SEAL BODY | P | I | 0.4900 | GR | 1 | 0.000070 | L-T-80 | |
| | STD | ALUMINUM TAPE | Mtl | I | | | | | L-T-80 | |
| 8798222 | STD | BODY MPTS | C | | | | 1 | | | |
| 8798223 | STD | BODY | P | I | 5,307.0282 | GR | 1 | 0.758162 | ASTM-A108 | //1117/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A108 | //1117/// |
| | STD | IRON (7439-89-6) (98%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (1.15%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.17%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.11%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | ZINC CHROMATE | B | B | 4.3890 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| | ALT | CADMIUM CHROMATE (ALT) | B | B | 4.7950 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8798223 | ALT | BODY (ALT) | P | I | 5,307.0282 | GR | 1 | | MIL-S-13048 | //1117/// |
| | STD | STEEL | Mtl | I | | | | | MIL-S-13048 | //1117/// |
| | STD | IRON (7439-89-6) (98%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (1.15%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.17%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.11%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | ZINC CHROMATE | B | B | 4.3890 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| | ALT | CADMIUM CHROMATE (ALT) | B | B | 4.7950 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8798224 | STD | INTERRUPTER | P | I | 42.0000 | GR | 1 | 0.006000 | ASTM-B16 | //360/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B16 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (36.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (2.1%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 2.1000 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 8798225-1 | STD | SPRING TENSION | P | I | 1.9000 | GR | 1 | 0.000271 | ASTM-A228 | //NOS/// |
| | STD | STEEL WIRE | Mtl | I | | | | | ASTM-A228 | //NOS/// |
| | STD | IRON (7439-89-6) (98.5%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.85%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.4%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.2%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.03%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.02%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0734 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8798225-1 | ALT | SPRING TENSION (ALT) | P | I | 1.9000 | GR | 1 | | ASTM-A227 | //TABLE 2/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A227 | //TABLE 2/// |
| | STD | IRON (7439-89-6) (98.21%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.8%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.65%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.25%) | Cmpd | I | | | | | | |
| | STD | BORON (7440-42-8) (0.05%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0734 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8798225-1 | ALT | SPRING TENSION (ALT) | P | I | 1.9000 | GR | 1 | | ASTM-A229 | //1095/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A229 | //1095/// |
| | STD | IRON (7439-89-6) (98.55%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.97%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.4%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.05%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 %

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0734 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8798226 | STD | RETAINER SETTING SLEEVE | P | I | 30.4500 | GR | 1 | 0.004350 | ASTM-B16 | //360/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B16 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (36.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (2.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 4.5500 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 8798227 | STD | WASHER SETTING SLEEVE | P | I | 29.5990 | GR | 1 | 0.004229 | ASTM-A109 | //T1-T3/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A109 | //T1-T3/// |
| | STD | IRON (7439-89-6) (99.08%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.6%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.25%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.035%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.035%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0401 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| | ALT | ZINC CHROMATE (ALT) | B | B | 0.0367 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| 8798228 | STD | SETTING SLEEVE ASSY | C | | 85.0000 | GR | 1 | | | |
| 8798229 | STD | SLEEVE SETTING | P | I | 61.6400 | GR | 1 | 0.008806 | ASTM-B16 | //360/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B16 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (36.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (2.1%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 2.0000 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 8798230 | STD | CUP SPRING | P | I | 15.0000 | GR | 1 | 0.002143 | ASTM-B16 | //360/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B16 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (36.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (2.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 1.2000 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 8798231 | STD | SPRING INTERRUPTER | P | I | 1.9400 | GR | 1 | 0.000277 | ASTM-A228 | //NOS/// |
| | STD | STEEL WIRE | Mtl | I | | | | | ASTM-A228 | //NOS/// |
| | STD | IRON (7439-89-6) (98.5%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.85%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.4%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.2%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.03%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.02%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0618 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8797864-3 | STD | DELAY PLUNGER M1 ASSY | C | | 1,166.4000 | GR | 1 | | MIL-P-20378 | |
| 8797869 | STD | WASHER LOCK CHECK | P | I | 30.0000 | GR | 1 | 0.004286 | ASTM-B36 | //210/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B36 | //210/// |
| | STD | COPPER (7440-50-8) (95%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | ZINC (7440-66-6) (5%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.2098 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 8797870 | STD | SUPPORT PLUNGER | P | I | 39.0000 | GR | 1 | 0.005572 | ASTM-A108 | //1137/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A108 | //1137/// |
| | STD | IRON (7439-89-6) (98%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (1.5%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.36%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.11%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | ZINC CHROMATE | B | B | 0.1990 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| | ALT | CADMIUM CHROMATE (ALT) | B | B | 0.2140 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8797870 | ALT | SUPPORT PLUNGER (ALT) | P | I | 39.0000 | GR | 1 | | QQ-S-633 | //1038/// |
| | STD | STEEL | Mtl | I | | | | | QQ-S-633 | //1038/// |
| | STD | IRON (7439-89-6) (98.78%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.75%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.39%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.05%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | ZINC CHROMATE | B | B | 0.1990 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| | ALT | CADMIUM CHROMATE (ALT) | B | B | 0.2140 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8797871 | STD | SPRING PLUNGER RESTRAINING | P | I | 10.1000 | GR | 1 | 0.001443 | ASTM-A228 | //NOS/// |
| | STD | STEEL WIRE | Mtl | I | | | | | ASTM-A228 | //NOS/// |
| | STD | IRON (7439-89-6) (98.5%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | CARBON (7440-44-0) (0.85%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.4%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.2%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.03%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.02%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0707 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8797872 | STD | PIN GUIDE | P | I | 4.0000 | GR | 1 | 0.000571 | ASTM-B16 | //360/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B16 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (36.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (2.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.2400 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 9204747 | ALT | PIN GUIDE (ALT) | P | I | 3.6900 | GR | 1 | | AISI-4140 | //4140/// |
| | STD | STEEL | Mtl | I | | | | | AISI-4140 | //4140/// |
| | STD | IRON (7439-89-6) (97.2%) | Cmpd | I | | | | | | |
| | STD | CHROMIUM (7440-47-3) (0.95%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.88%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.41%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.28%) | Cmpd | I | | | | | | |
| | STD | MOLYBDENUM (7439-98-7) (0.2%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.04%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.9389 | GR | 1 | | QQ-P-416 | /1//3// |
| | STD | CADMIUM (7440-43-9) (99%) | Cmpd | B | | | | | | |
| 8797873 | STD | FIRING PIN ASSY | C | | 245.0000 | GR | 1 | | | |
| 8797874 | STD | HOUSING PLUNGER | P | I | 239.0000 | GR | 1 | 0.034144 | ASTM-A569 | //TABLE 1/// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | STEEL | Mtl | I | | | | | ASTM-A569 | //TABLE 1/// |
| | STD | IRON (7439-89-6) (99%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.53%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.2%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.17%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.06%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 1.5290 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| | ALT | ZINC CHROMATE (ALT) | B | B | 1.4000 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| | STD | STENCIL INK | B | B | | | 1 | | TT-I-558 | |
| | STD | KETONES (N/A) (30%) | Cmpd | B | | | | | | |
| | STD | PROP (N/A) (25%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (10%) | Cmpd | B | | | | | | |
| | STD | PIGMENT (N/A) (10%) | Cmpd | B | | | | | | |
| | STD | ACRYLIC RESIN (N/A) (5%) | Cmpd | B | | | | | | |
| 8797874 | ALT | HOUSING PLUNGER (ALT) | P | I | 239.0000 | GR | 1 | | ASTM-A109 | //T1-T3/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A109 | //T1-T3/// |
| | STD | IRON (7439-89-6) (99.08%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.6%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.25%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.035%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.035%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 1.5290 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| | ALT | ZINC CHROMATE (ALT) | B | B | 1.4000 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| | STD | STENCIL INK | B | B | | | 1 | | TT-I-558 | |
| | STD | KETONES (N/A) (30%) | Cmpd | B | | | | | | |
| | STD | PROP (N/A) (25%) | Cmpd | B | | | | | | |
| | STD | TOLUENE (108-88-3) (10%) | Cmpd | B | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | PIGMENT (N/A) (10%) | Cmpd | B | | | | | | |
| | STD | ACRYLIC RESIN (N/A) (5%) | Cmpd | B | | | | | | |
| 8797875 | STD | PIN FIRING | P | I | 6.0000 | GR | 1 | 0.000857 | ASTM-A108 | //1117/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A108 | //1117/// |
| | STD | IRON (7439-89-6) (98%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (1.15%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.17%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.11%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0440 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| | ALT | ZINC CHROMATE (ALT) | B | B | 0.0403 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| 8797875 | ALT | PIN FIRING (ALT) | P | I | 6.0000 | GR | 1 | | QQ-W-461 | //1035/// |
| | STD | STEEL WIRE | Mtl | I | | | | | QQ-W-461 | //1035/// |
| | STD | IRON (7439-89-6) (98%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.75%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.35%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.05%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0440 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| | ALT | ZINC CHROMATE (ALT) | B | B | 0.0403 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| 8797876 | STD | PLUNGER BODY ASSY | C | | 799.8000 | GR | 1 | | | |
| 8797877 | STD | BODY PLUNGER | P | I | 741.4000 | GR | 1 | 0.105916 | ASTM-B16 | //360/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B16 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (36.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (2.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.8600 | GR | 1 | | MIL-C-5541 | ///3// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 8797878 | STD | LOCK CENT PLUNGER PIN | P | I | 6.0000 | GR | 1 | 0.000857 | ASTM-A109 | //T1-T3/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A109 | //T1-T3/// |
| | STD | IRON (7439-89-6) (99.08%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.6%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.25%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.035%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.035%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.2500 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| | ALT | ZINC CHROMATE (ALT) | B | B | 0.2800 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| 8797878 | ALT | LOCK CENT PLUNGER PIN (ALT) | P | I | 6.0000 | GR | 1 | | ASTM-A569 | //TABLE 1/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A569 | //TABLE 1/// |
| | STD | IRON (7439-89-6) (99%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.53%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.2%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.17%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.06%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.2500 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| | ALT | ZINC CHROMATE (ALT) | B | B | 0.2800 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| 8797878 | ALT | LOCK CENT PLUNGER PIN (ALT) | P | I | 6.0000 | GR | 1 | | ASTM-A366 | //1008/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A366 | //1008/// |
| | STD | IRON (7439-89-6) (99.025%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.4%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | NICKEL (7440-02-0) (0.2%) | Cmpd | I | | | | | | |
| | STD | CHROMIUM (7440-47-3) (0.15%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.1%) | Cmpd | I | | | | | | |
| | STD | MOLYBDENUM (7439-98-7) (0.06%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.035%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.03%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.2500 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| | ALT | ZINC CHROMATE (ALT) | B | B | 0.2800 | GR | 1 | | ASTM-B633 | /2//3// |
| | STD | ZINC CHROMATE (13530-65-9) (99%) | Cmpd | B | | | | | | |
| 8797879 | STD | PIN LOCK PIVOT | P | I | 5.0000 | GR | 1 | 0.000714 | ASTM-A108 | //1018/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A108 | //1018/// |
| | STD | IRON (7439-89-6) (98.99%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.75%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.17%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.05%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0827 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8797879 | ALT | PIN LOCK PIVOT (ALT) | P | I | 5.0000 | GR | 1 | | QQ-W-461 | //1020/// |
| | STD | STEEL WIRE | Mtl | I | | | | | QQ-W-461 | //1020/// |
| | STD | IRON (7439-89-6) (99%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.45%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.21%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.05%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0827 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8797880 | STD | RETAINER SPRING | P | I | 8.0000 | GR | 2 | 0.002286 | ASTM-B36 | //210/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B36 | //210/// |
| | STD | COPPER (7440-50-8) (95%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | ZINC (7440-66-6) (5%) | Cmpd | I | | | | | | |
| | STD | CHROMATE COATING | B | B | 0.0325 | GR | 1 | | MIL-C-5541 | ///3// |
| | STD | CHROMIC ACID (7738-94-5) (5%) | Cmpd | B | | | | | | |
| | STD | HEXAVALENT CHROMIUM (0.5%) | Cmpd | B | | | | | | |
| | STD | WATER (7732-18-5) (0%) | Cmpd | B | | | | | | |
| | STD | SODIUM SILICO FLUORI (16893-85-9) (0%) | Cmpd | B | | | | | | |
| | STD | POTASSIUM FERRICYANI (13746-66-2) (0%) | Cmpd | B | | | | | | |
| 8797881 | STD | SPRING CENTRIFUGAL PIN | P | I | 0.7000 | GR | 2 | 0.000200 | ASTM-A228 | //NOS/// |
| | STD | STEEL WIRE | Mtl | I | | | | | ASTM-A228 | //NOS/// |
| | STD | IRON (7439-89-6) (98.5%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.85%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.4%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.2%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.03%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.02%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0452 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8797881 | ALT | SPRING CENTRIFUGAL PIN (ALT) | P | I | 0.7000 | GR | 2 | | ASTM-A227 | //TABLE 2/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A227 | //TABLE 2/// |
| | STD | IRON (7439-89-6) (98.21%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.8%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.65%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.25%) | Cmpd | I | | | | | | |
| | STD | BORON (7440-42-8) (0.05%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0452 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8797881 | ALT | SPRING CENTRIFUGAL PIN (ALT) | P | I | 0.7000 | GR | 2 | | QQ-W-423 | /302//// |
| | STD | STAINLESS WIRE | Mtl | I | | | | | QQ-W-423 | /302//// |
| | STD | IRON (7439-89-6) (69.775%) | Cmpd | I | | | | | | |
| | STD | CHROMIUM (7440-47-3) (18%) | Cmpd | I | | | | | | |
| | STD | NICKEL (7440-02-0) (9%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (2%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48 **Reported Weight :** 18.3500 **Unit :** LB
**NSN :** 1315000284664 **DODIC:** C027 **Reported Weight (lbs):** 18.3500
**Status:** OFFICIAL **Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | SILICON (7440-21-3) (1%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.15%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.045%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.03%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.0452 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8797882 | STD | PIN CENTRIFUGAL PLUNGER | P | I | 15.0000 | GR | 2 | 0.004286 | ASTM-A108 | //1137/// |
| | STD | STEEL | Mtl | I | | | | | ASTM-A108 | //1137/// |
| | STD | IRON (7439-89-6) (98%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (1.5%) | Cmpd | I | | | | | | |
| | STD | CARBON (7440-44-0) (0.36%) | Cmpd | I | | | | | | |
| | STD | SULFUR (7704-34-9) (0.11%) | Cmpd | I | | | | | | |
| | STD | PHOSPHORUS (7723-14-0) (0.04%) | Cmpd | I | | | | | | |
| | STD | CADMIUM CHROMATE | B | B | 0.1400 | GR | 1 | | QQ-P-416 | /2//3// |
| | STD | CADMIUM (7440-43-9) (49.22%) | Cmpd | B | | | | | | |
| | STD | CHROMIUM (7440-47-3) (22.77%) | Cmpd | B | | | | | | |
| 8844434-2 | STD | DELAY ELEMENT M2 ASSY | C | | 41.9100 | GR | 1 | | MIL-D-46486 | |
| 8844432 | STD | HOLDER PRIMER | P | I | 19.9500 | GR | 1 | 0.002850 | ASTM-B16 | //360/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B16 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (36.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (2.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| 8840607 | STD | PRIMER PERC M54 ASSY | C | | 2.4400 | GR | 1 | | MIL-P-13392 | |
| | STD | PRIMER MIX #70 | P | X | 0.1700 | GR | 1 | 0.000024 | 9282793 | ///1// |
| | STD | PRIMER MIX #70 | Mtl | X | | | | | 9282793 | ///1// |
| | STD | POTASSIUM CHLORATE (3811-04-9) (53%) | Cmpd | X | | | | | MIL-P-150 | //A/1// |
| | STD | LEAD THIOCYANATE (592-87-0) (25%) | Cmpd | X | | | | | MIL-L-65 | |
| | STD | ANTIMONY SULFIDE (1345-04-6) (17%) | Cmpd | X | | | | | MIL-A-159 | ///1// |
| | STD | TNT (118-96-7) (5%) | Cmpd | X | | | | | MIL-T-248 | /1 OR 2//// |
| 8840604 | STD | CUP | P | I | 0.7400 | GR | 1 | 0.000106 | JAN-G-383 | //210/// |
| | STD | GILDING METAL | Mtl | I | | | | | JAN-G-383 | //210/// |
| | STD | COPPER (7440-50-8) (95%) | Cmpd | I | | | | | | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | ZINC (7440-66-6) (4.92%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.05%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.03%) | Cmpd | I | | | | | | |
| | STD | SHELLAC | B | B | 0.0260 | GR | 1 | | JAN-S-732 | /1//2// |
| | STD | ETHYL ALCOHOL (64-17-5) (87.5%) | Cmpd | B | | | | | | |
| | STD | METHYL ALCOHOL (67-56-1) (3%) | Cmpd | B | | | | | | |
| | STD | HEXONE (108-10-1) (1%) | Cmpd | B | | | | | | |
| | STD | ETHYL ACETATE (141-78-6) (1%) | Cmpd | B | | | | | | |
| | STD | VARNISH | B | B | 0.0260 | GR | 1 | | MIL-V-13750 | |
| | STD | XYLENE (1330-20-7) (50%) | Cmpd | B | | | | | | |
| | STD | PARA-PHENYL PHENOL-F (N/A) (25%) | Cmpd | B | | | | | | |
| | STD | OIL (25%) | Cmpd | B | | | | | | |
| 8840606 | STD | DISC | P | I | 0.0800 | GR | 1 | 0.000011 | JAN-P-224 | /1//// |
| | STD | PAPER FOILING | Mtl | I | | | | | JAN-P-224 | /1//// |
| 8840605 | STD | ANVIL | P | I | 1.4500 | GR | 1 | 0.000207 | QQ-B-626 | //240/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-626 | //240/// |
| | STD | COPPER (7440-50-8) (80%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (19.9%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.05%) | Cmpd | I | | | | | | |
| 8840605 | ALT | ANVIL (ALT) | P | I | 1.4500 | GR | 1 | | QQ-B-613 | //220/// |
| | STD | BRASS | Mtl | I | | | | | QQ-B-613 | //220/// |
| | STD | COPPER (7440-50-8) (90%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (9.9%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.05%) | Cmpd | I | | | | | | |
| 8840605 | ALT | ANVIL (ALT) | P | I | 1.4500 | GR | 1 | | QQ-W-321 | //268/// |
| | STD | BRASS WIRE | Mtl | I | | | | | QQ-W-321 | //268/// |
| | STD | COPPER (7440-50-8) (66.25%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (33.55%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (0.15%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.05%) | Cmpd | I | | | | | | |
| 8844433 | STD | DELAY HOLDER ASSY | C | | 16.9400 | GR | 1 | | | |
| | STD | BLACK PWDR CL 1 | P | X | 0.3200 | GR | 1 | 0.000046 | MIL-P-223 | ///1// |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | BLACK PWDR CL 1 | Mtl | X | | | | | MIL-P-223 | ///1// |
| | STD | POTASSIUM NITRATE (7757-79-1) (74%) | Cmpd | X | | | | | MIL-P-156 | ///1// |
| | STD | CHARCOAL (7440-44-0) (15.6%) | Cmpd | X | | | | | JAN-C-178 | ///1// |
| | STD | SULFUR (7704-34-9) (10.4%) | Cmpd | X | | | | | MIL-S-14929 | |
| | STD | GRAPHITE (7782-42-5) (0%) | Cmpd | X | | | | | MIL-G-155 | //C/// |
| 8844431 | STD | HOLDER DELAY | P | I | 16.0000 | GR | 1 | 0.002286 | ASTM-B16 | //360/// |
| | STD | BRASS | Mtl | I | | | | | ASTM-B16 | //360/// |
| | STD | COPPER (7440-50-8) (61.5%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (36.05%) | Cmpd | I | | | | | | |
| | STD | LEAD (7439-92-1) (2.1%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.35%) | Cmpd | I | | | | | | |
| | STD | SHELLAC | B | B | 0.5600 | GR | 1 | | JAN-S-732 | /1//1 OR 2// |
| | STD | ETHYL ALCOHOL (64-17-5) (87.5%) | Cmpd | B | | | | | | |
| | STD | METHYL ALCOHOL (67-56-1) (3%) | Cmpd | B | | | | | | |
| | STD | HEXONE (108-10-1) (1%) | Cmpd | B | | | | | | |
| | STD | ETHYL ACETATE (141-78-6) (1%) | Cmpd | B | | | | | | |
| | STD | VARNISH | B | B | 0.5600 | GR | 1 | | MIL-V-13750 | |
| | STD | XYLENE (1330-20-7) (50%) | Cmpd | B | | | | | | |
| | STD | PARA-PHENYL PHENOL-F (N/A) (25%) | Cmpd | B | | | | | | |
| | STD | OIL (25%) | Cmpd | B | | | | | | |
| 8840608 | STD | RELAY M7 ASSY | C | | 0.0003 | LB | 1 | | MIL-R-46453 | |
| 8844437 | STD | WASHER RELAY | P | I | 0.0704 | GR | 1 | 0.000010 | QQ-A-561 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | QQ-A-561 | //1100/// |
| | STD | ALUMINUM (7429-90-5) (98.78%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| | STD | INTERMEDIATE CHG (LEAD AZIDE) | P | X | 1.4300 | GR | 1 | 0.000204 | MIL-L-3055 | /1//// |
| | STD | LEAD AZIDE | Mtl | X | | | | | MIL-L-3055 | /1//// |
| | STD | LEAD AZIDE (13424-46-9) (100%) | Cmpd | X | | | | | MIL-L-3055 | /1//// |
| | ALT | LEAD AZIDE (ALT) | P | X | 1.4300 | GR | 1 | | MIL-L-14758 | |
| | STD | LEAD AZIDE | Mtl | X | | | | | MIL-L-14758 | |

# DAC - MIDAS Detailed Structure For An Item

**Nomenclature :** CTG 75MM HE M48
**NSN :** 1315000284664 **DODIC:** C027
**Status:** OFFICIAL

**Reported Weight :** 18.3500 **Unit :** LB
**Reported Weight (lbs):** 18.3500
**Calculated Weight (lbs):** 17.9740 97.95 **%**

| Drawing # | Std./Alt. | Nomenclature (Material) | Type | Material Code | Reported Weight | Unit | Factor | Factored Weight (Lb) | Specification | TGCS |
|---|---|---|---|---|---|---|---|---|---|---|
| | STD | LEAD AZIDE (13424-46-9) (100%) | Cmpd | X | | | | | MIL-L-14758 | |
| | ALT | LEAD AZIDE (ALT) | P | X | 1.4300 | GR | 1 | | MIL-L-46225 | |
| | STD | LEAD AZIDE | Mtl | X | | | | | MIL-L-46225 | |
| | STD | LEAD AZIDE (13424-46-9) (100%) | Cmpd | X | | | | | MIL-L-46225 | |
| 8840625-3 | STD | CUP FLAT BOTTOM RELAY | P | I | 0.7374 | GR | 1 | 0.000105 | ASTM-B209 | //1100/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | ASTM-B209 | //1100/// |
| | STD | ALUMINUM (7429-90-5) (98.79%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.47%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.47%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.12%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (0.05%) | Cmpd | I | | | | | | |
| 8840625-3 | ALT | CUP FLAT BOTTOM RELAY (ALT) | P | I | 0.7374 | GR | 1 | | ASTM-B209 | //3003/// |
| | STD | ALUMINUM ALLOY | Mtl | I | | | | | ASTM-B209 | //3003/// |
| | STD | ALUMINUM (7429-90-5) (97.225%) | Cmpd | I | | | | | | |
| | STD | MANGANESE (7439-96-5) (1.25%) | Cmpd | I | | | | | | |
| | STD | IRON (7439-89-6) (0.7%) | Cmpd | I | | | | | | |
| | STD | SILICON (7440-21-3) (0.6%) | Cmpd | I | | | | | | |
| | STD | COPPER (7440-50-8) (0.125%) | Cmpd | I | | | | | | |
| | STD | ZINC (7440-66-6) (0.1%) | Cmpd | I | | | | | | |

**17.974013**

# APPENDIX D

# FIELD STANDARD OPERATING PROCEDURES AND FIELD FORMS

# Appendix D-1

# Field Standard Operating Procedures

| TETRA TECH NUS, INC. | STANDARD OPERATING PROCEDURES | Number GH-2.8 | Page 1 of 12 |
|---|---|---|---|
| | | Effective Date 09/03 | Revision 3 |
| | | Applicability Tetra Tech NUS, Inc. | |
| | | Prepared Earth Sciences Department | |
| Subject GROUNDWATER MONITORING WELL INSTALLATION | | Approved D. Senovich | |

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## 1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper monitoring well design, installation, and development.

## 2.0 SCOPE

This procedure is applicable to the construction of monitoring wells. The methods described herein may be modified by project-specific requirements for monitoring well construction. In addition, many regulatory agencies have specific regulations pertaining to monitoring well construction and permitting. These requirements must be determined during the project planning phases of the investigation, and any required permits must be obtained before field work begins. Innovative monitoring well installation techniques, which typically are not used, will be discussed only generally in this procedure.

## 3.0 GLOSSARY

Monitoring Well - A well which is screened, cased, and sealed which is capable of providing a groundwater level and groundwater sample representative of the zone being monitored. Some monitoring wells may be constructed as open boreholes.

Piezometer - A pipe or tube inserted into the water bearing zone, typically open to water flow at the bottom and to the atmosphere at the top, and used to measure water level elevations. Piezometers may range in size from 1/2-inch-diameter plastic tubes to well points or monitoring wells.

Potentiometric Surface - The surface representative of the level to which water will rise in a well cased to the screened aquifer.

Well Point (Drive Point) - A screened or perforated tube (Typically 1-1/4 or 2 inches in diameter) with a solid, conical, hardened point at one end, which is attached to a riser pipe and driven into the ground with a sledge hammer, drop weight, or mechanical vibrator. Well points may be used for groundwater injection and recovery, as piezometers (i.e., to measure water levels) or to provide groundwater samples for water quality data.

## 4.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction. The driller may also be responsible for obtaining, in advance, any required permits for monitoring well installation and construction.

Field Geologist - The field geologist supervises and documents well installation and construction performed by the driller, and insures that well construction is adequate to provide representative groundwater data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

## 5.0 PROCEDURES

### 5.1 Equipment/Items Needed

Below is a list of items that may be needed when installing a monitoring well or piezometer:

- Health and safety equipment (hard hats, safety glasses, etc.) as required by the Site Safety Officer.
- Well drilling and installation equipment with associated materials (typically supplied by the driller).
- Hydrogeologic equipment (weighted engineer's tape, water level indicator, retractable engineers rule, electronic calculator, clipboard, mirror and flashlight - for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).
- Drive point installation tools (sledge hammer, drop hammer, or mechanical vibrator; tripod, pipe wrenches, drive points, riser pipe, and end caps).

### 5.2 Well Design

The objectives and intended use for each monitoring well must be clearly defined before the monitoring system is designed. Within the monitoring system, different monitoring wells may serve different purposes and, therefore, require different types of construction. During all phases of the well design, attention must be given to clearly documenting the basis for design decisions, the details of well construction, and the materials used. The objectives for installing the monitoring wells may include:

- Determining groundwater flow directions and velocities.
- Sampling or monitoring for trace contaminants.
- Determining aquifer characteristics (e.g., hydraulic conductivity).

Siting of monitoring wells shall be performed after a preliminary estimation of the groundwater flow direction. In most cases, groundwater flow directions and potential well locations can be determined by an experienced hydrogeologist through the review of geologic data and the site terrain. In addition, data from production wells or other monitoring wells in the area may be used to determine the groundwater flow direction. If these methods cannot be used, piezometers, which are relatively inexpensive to install, may have to be installed in a preliminary investigative phase to determine groundwater flow direction.

#### 5.2.1 Well Depth, Diameter, and Monitored Interval

The well depth, diameter, and monitored interval must be tailored to the specific monitoring needs of each investigation. Specification of these items generally depends on the purpose of the monitoring system and the characteristics of the hydrogeologic system being monitored. Wells of different depth, diameter, and monitored interval can be employed in the same groundwater monitoring system. For instance, varying the monitored interval in several wells, at the same location (cluster wells) can help to determine the vertical gradient and the depths at which contaminants are present. Conversely, a fully penetrating well is usually not used to quantify or vertically locate a contaminant plume, since groundwater samples collected in wells that are screened over the full thickness of the water-bearing zone will be representative of average conditions across the entire monitored interval. However, fully penetrating wells can be used to establish the existence of contamination in the water-bearing zone. The well diameter desired depends upon the hydraulic characteristics of the water-bearing zone, sampling requirements, drilling method and cost.

The decision concerning the monitored interval and well depth is based on the following (and possibly other) information:

- The vertical location of the contaminant source in relation to the water-bearing zone.
- The depth, thickness and uniformity of the water-bearing zone.
- The anticipated depth, thickness, and characteristics (e.g., density relative to water) of the contaminant plume.
- Fluctuation in groundwater levels (due to pumping, tidal influences, or natural recharge/discharge events).
- The presence and location of contaminants encountered during drilling.
- Whether the purpose of the installation is for determining existence or non-existence of contamination or if a particular stratigraphic zone is being investigated.
- The analysis of borehole geophysical logs.

In most situations where groundwater flow lines are horizontal, depending on the purpose of the well and the site conditions, monitored intervals are 20 feet or less. Shorter screen lengths (5 feet or less) are usually required where flow lines are not horizontal, (i.e., if the wells are to be used for accurate measurement of the potentiometric head at a specific point).

Many factors influence the diameter of a monitoring well. The diameter of the monitoring well depends on the application. In determining well diameter, the following needs must be considered:

- Adequate water volume for sampling.
- Drilling methodology.
- Type of sampling device to be used.
- Costs.

Standard monitoring well diameters are 2, 4, 6, or 8 inches. Drive points are typically 1-1/4 or 2 inches in diameter. For monitoring programs which require screened monitoring wells, either a 2-inch or 4-inch-diameter well is preferred. Typically, well diameters greater than 4 inches are used in monitoring programs in which open-hole bedrock monitoring wells are used. With smaller diameter wells, the volume of stagnant water in the well is minimized, and well construction costs are reduced; however, the sampling devices that can be used are limited.

In specifying well diameter, sampling requirements must be considered (up to a total of 4 gallons of water may be required for a single sample to account for full organic and inorganic analyses, and split samples), particularly if the monitored formation is known to be a low-yielding formation. The unit volume of water contained within a monitoring well is dependent on the well diameter as follows:

| Casing Inside Diameter (Inch) | Standing Water Length to Obtain 1 Gallon Water (Feet) |
|---|---|
| 2 | 6.13 |
| 4 | 1.53 |
| 6 | 0.68 |

If a well recharges quickly after purging, then well diameter may not be an important factor regarding sample volume requirements.

Pumping tests for determining aquifer characteristics may require larger diameter wells (for installation of high capacity pumps); however, in small-diameter wells in-situ permeability tests can be performed during drilling or after well installation is completed.

### 5.2.2 Riser Pipe and Screen Materials

Well materials are specified by diameter, type of material, and thickness of pipe. Well screens require an additional specification of slot size. Thickness of pipe is referred to as "Schedule" for polyvinyl chloride (PVC) casing and is usually Schedule 40 (thinner wall) or 80 (thicker wall). Steel pipe thickness is often referred to as "Strength". Standard Strength is usually adequate for monitoring well purposes. With larger diameter pipe, the wall thickness must be greater to maintain adequate strength. The required thickness is also dependent on the method of installation; risers for drive points require greater strength than wells installed inside drilled borings.

The selection of well screen and riser materials depends on the method of drilling, the type of subsurface materials the well penetrates, the type of contamination expected, and natural water quality and depth. Cost and the level of accuracy required are also important. The materials generally available are Teflon, stainless steel, PVC galvanized steel, and carbon steel. Each has advantages and limitations (see Attachment A of this guideline for an extensive presentation on this topic). The two most commonly used materials are PVC and stainless steel. Properties of these two materials are compared in Attachment B. Stainless steel is a good choice where trace metals or organic sampling is required; however, costs are high. Teflon materials are extremely expensive, but are relatively inert and provide the least opportunity for water contamination due to well materials. PVC has many advantages, including low cost, excellent availability, light weight, ease of manipulation, and widespread acceptance. The crushing strength of PVC may limit the depth of installation, but the use of Schedule 80 materials may overcome some of the problems associated with depth. However, the smaller inside diameter of Schedule 80 pipe may be an important factor when considering the size of bailers or pumps required for sampling or testing. Due to this problem, the minimum well pipe size recommended for Schedule 80 wells is 4-inch I.D.

Screens and risers may have to be decontaminated before use because oil-based preservatives and oil used during thread cutting and screen manufacturing may contaminate samples. Metal pipe may corrode and release metal ions or chemically react with organic constituents, but this is considered a minor issue. Galvanized steel is not recommended where samples may be collected for metals analyses, as zinc and cadmium levels in groundwater samples may become elevated from leaching of the zinc coating.

Threaded, flush-joint casing is most often preferred for monitoring well applications. PVC, Teflon, and steel can all be obtained with threaded joints. Welded-joint steel casing is also acceptable. Glued PVC may release organic contaminants into the well, and therefore, should not be used if the well is to be sampled for organic constituents.

When the water-bearing zone is in consolidated bedrock, such as limestone or fractured granite, a well screen is often not necessary (the well is simply an open hole in bedrock). Unconsolidated materials, such as sands, clay, and silts require a screen. A screen slot size of 0.010 or 0.020 inch is generally used when a screen is necessary, and the annular borehole space around the screened interval is artificially packed with an appropriately sized sand, selected based on formation grain size. The slot size controls the quantity of water entering the well and prevents entry of natural materials or sand pack. The screen shall pass no more than 10 percent of the pack material, or in-situ aquifer material. The site geologist shall specify the combination of screen slot size and sand pack which will be compatible with the water-bearing zone, to maximize groundwater inflow and minimize head losses and movement of fines into the wells. For example, as a standard procedure, a Morie No. 1 or No. 10 to No. 20 U.S. Standard Sieve size filter pack is typically appropriate for a 0.020-inch slot screen; however, a No. 20 to No. 40 U.S. Standard Sieve size filter pack is typically appropriate for a 0.010-inch slot screen.

### 5.2.3 Annular Materials

Materials placed in the annular space between the borehole and riser pipe and screen include a sand pack when necessary, a bentonite seal, and cement-bentonite grout. The sand pack is usually a medium- to coarse-grained poorly graded, silica sand and should relate to the grain size of the aquifer sediments. The quantity of sand placed in the annular space is dependent upon the length of the screened interval, but should always extend at least 1 foot above the top of the screen. At least 1 to 3 feet of bentonite pellets or equivalent shall be placed above the sand pack. Cement-bentonite grout (or equivalent) is then placed to extent from the top of the bentonite pellets to the ground surface.

On occasion, and with the concurrence of the involved regulatory agencies, monitoring wells may be packed naturally (i.e., no artificial sand pack installed). In this case, the natural formation material is allowed to collapse around the well screen after the well is installed. This method has been used where the formation material itself is a relatively uniform grain size, or when artificial sand packing is not possible due to borehole collapse.

Bentonite expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets, extending to the surface. The grout effectively seals the remaining borehole annulus and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom upward, to prevent bridging, and to provide a better seal. In shallow boreholes that don't collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

Grout is a general term which has several different connotations. For all practical purposes within the monitoring well installation industry, grout refers to the solidified material which is installed and occupies the annular space above the bentonite pellet seal. Grout, most of the time, is made up of one or two assemblages of material, (e.g., cement and/or bentonite). A cement-bentonite grout, which is the most common type of grout used in monitoring well completions, normally is a mixture of cement, bentonite, and water at a ratio of one 90-pound bag of Portland Type I cement, plus 3 to 5 pounds of granular or flake-type bentonite, and 6-7 gallons of water. A neat cement consists of one ninety-pound bag of Portland Type I cement and 6-7 gallons of water. A bentonite slurry (bentonite and water mixed to a thick but pumpable mixture) is sometimes used instead of grout for deep well installations where placement of bentonite pellets is difficult. Bentonite chips are also occasionally used for annular backfill in place of grout.

In certain cases, the borehole may be drilled to a depth greater than the anticipated well installation depth. For these cases, the well shall be backfilled to the desired depth with bentonite pellets/chips or sand. A short (1- to 2-foot) section of capped riser pipe sump is sometimes installed immediately below the screen, as a silt reservoir, when significant post-development silting is anticipated. This will ensure that the entire screen surface remains unobstructed.

### 5.2.4 Protective Casing

When the well is completed and grouted to the surface, a protective steel casing is typically placed over the top of the well. This casing generally has a hinged cap and can be locked to prevent vandalism. The protective casing has a larger diameter than the well and is set into the wet cement grout over the well upon completion. In addition, one hole is drilled just above the cement collar through the protective casing which acts as a weep hole for the flow of water which may enter the annulus during well development, purging, or sampling.

A protective casing which is level with the ground surface (flush-mounted) is used in roadway or parking lot applications where the top of a monitoring well must be below the pavement. The top of the riser pipe is placed 4 to 5 inches below the pavement, and a locking protective casing is cemented in place to 3 inches below the pavement. A large diameter, manhole-type protective collar is set into the wet cement around the well with the top set level with or slightly above the pavement. An appropriately-sized id is placed over the protective sleeve. The cement should be slightly mounded to direct pooled water away from the well head.

## 5.3 Monitoring Well Installation

Pertinent data regarding monitoring well installation shall be recorded on log sheets as depicted and discussed in SOP SA-6.3. Attachments to this referenced SOP illustrate terms and physical construction of various types of monitoring wells.

### 5.3.1 Monitoring Wells in Unconsolidated Sediments

After the borehole is drilled to the desired depth, well installation can begin. The procedure for well installation will partially be dictated by the stability of the formation in which the well is being placed. If the borehole collapses immediately after the drilling tools are withdrawn, then a temporary casing must be installed and well installation will proceed through the center of the temporary casing, and continue as the temporary casing is withdrawn from the borehole. In the case of hollow-stem auger drilling, the augers will act to stabilize the borehole during well installation.

Before the screen and riser pipe are lowered into the borehole, all pipe and screen sections should be measured with an engineer's rule to ensure proper placement. When measuring sections, the threads on one end of the pipe or screen must be excluded while measuring, since the pipe and screen sections are screwed flush together.

After the screen and riser pipe are lowered through the temporary casing, the sand pack can be installed. A weighted tape measure must be used during the installation procedure to carefully monitor installation progress. The sand is slowly poured into the annulus between the riser pipe and temporary casing, as the casing is withdrawn. Sand should always be kept within the temporary casing during withdrawal in order to ensure an adequate sand pack. However, if too much sand is within the temporary casing (greater than 1 foot above the bottom of the casing) bridging between the temporary casing and riser pipe may occur. Centralizers may be used at the geologist's discretion, one above and one below the screen, to assure enough annular space for sand pack placement.

After the sand pack is installed to the desired depth (at least 1 foot above the top of the screen), then the bentonite pellet seal (or equivalent), can be installed in the same manner as the sand pack. At least 1 to 3 feet of bentonite pellets should be installed above the sand pack. Pellets should be added slowly and their fall monitored closely to ensure that bridging does not occur.

The cement-bentonite grout is then mixed and tremied into the annulus as the temporary casing or augers are withdrawn. Finally, the protective casing can be installed as detailed in Section 5.2.4.

### 5.3.2 Confining Layer Monitoring Wells

When drilling and installing a well in a confined aquifer, proper well installation techniques must be applied to avoid cross contamination between aquifers. Under most conditions, this can be accomplished by installing double-cased wells. This is accomplished by drilling a large-diameter boring through the upper aquifer, 1 to 5 feet into the underlying confining layer, and setting and pressure grouting or tremie grouting a large-diameter casing into the confining layer. The grout material must fill the space between the native material and the outer casing. A smaller diameter boring is then continued through the confining layer for

installation of the monitoring well as detailed for overburden monitoring wells. Sufficient time (determined by the field geologist), must be allowed for setting of the grout prior to drilling through the confined layer.

### 5.3.3 Bedrock Monitoring Wells

When installing bedrock monitoring wells, a large diameter boring is drilled through the overburden and approximately 5 –10 feet into bedrock. A casing (typically steel) is installed and either pressure grouted or tremie grouted in place. After the grout has cured, a smaller diameter boring is continued into bedrock to the desired depth. If the boring does not collapse, the well can be left open, and a screen is not necessary. If the boring collapses, then a screen is required and can be installed as detailed for overburden monitoring wells. If a screen is to be used, then the casing which is installed through the overburden and into the bedrock does not require grouting and can be removed when the final well installation is completed.

### 5.3.4 Drive Points

Drive points can be installed with either a sledge hammer, drop hammer, or a mechanical vibrator. The screen section is threaded and tightened onto the riser pipe with pipe wrenches. The drive point is simply pounded into the subsurface to the desired depth. If a heavy drop hammer is used, then a tripod and pulley setup is required to lift the hammer. Drive points typically cannot be manually driven to depths exceeding 10 feet.

Direct push sampling/monitoring point installation methods, using a direct push rig or drilling rig, are described in SOP SA-2.5.

### 5.3.5 Innovative Monitoring Well Installation Techniques

Certain innovative sampling devices have proven advantageous. These devices are essentially screened samplers installed in a borehole with only small-diameter tubes extending to the surface. This reduces drilling costs, decreases the volume of stagnant water, and provides a sampling system that minimizes cross-contamination from sampling equipment. Four manufacturers of these samplers include Timco Manufacturing Company, Inc., of Prairie du Sac, Wisconsin, BARCAD Systems, Inc., of Concord, Massachusetts, Westbay Instruments Ltd. of Vancouver, British Columbia, Canada and the University of Waterloo at Waterloo, Ontario, Canada.. Each manufacturer offers various construction materials.

## 5.4 Well Development Methods

The purpose of well development is to stabilize and increase the permeability of the gravel pack around the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water is removed from the well. Sequential measurements of pH, conductivity, turbidity, and temperature taken during development may yield information (stabilized values) regarding whether sufficient development has been performed. The selection of the well development method shall be made by the field geologist and is based on the drilling methods, well construction and installation details, and the characteristics of the formation that the well is screened in. The primary methods of well development are summarized below. A more detailed discussion may be found in Driscoll (1986).

### 5.4.1 Overpumping and Backwashing

Wells may be developed by alternatively drawing the water level down at a high rate (by pumping or bailing) and then reversing the flow direction (backwashing) so that water is passing from the well into the formation. This back and forth movement of water through the well screen and gravel pack serves to

remove fines from the formation immediately adjacent to the well, while preventing bridging (wedging) of sand grains. Backwashing can be accomplished by several methods, including pouring water into the well and then bailing, starting and stopping a pump intermittently to change water levels, or forcing water into the well under pressure through a water-tight fitting ("rawhiding"). Care should be taken when backwashing not to apply too much pressure, which could damage or destroy the well screen.

### 5.4.2 Surging with a Surge Plunger

A surge plunger (also called a surge block) is approximately the same diameter as the well casing and is aggressively moved up and down within the well to agitate the water, causing it to move in and out of the screens. This movement of water pulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack. There are two basic types of surge plungers; solid and valved surge plungers. In formations with low yields, a valved surge plunger may be preferred, as solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

### 5.4.3 Compressed Air

Compressed air can be used to develop a well by either of two methods: backwashing or surging. Backwashing is done by forcing water out through the screens, using increasing air pressure inside a sealed well, then releasing the pressurized air to allow the water to flow back into the well. Care should be taken when using this method so that the water level does not drop below the top of the screen, thus introducing air into the formation and reducing well yield. Surging, or the "open well" method, consists of alternately releasing large volumes of air suddenly into an open well below the water level to produce a strong surge by virtue of the resistance of water head, friction, and inertia. Pumping of the well is subsequently done using the air lift method.

### 5.4.4 High Velocity Jetting

In the high velocity jetting method, water is forced at high velocities from a plunger-type device and through the well screen to loosen fine particles from the sand pack and surrounding formation. The jetting tool is slowly rotated and raised and lowered along the length of the well screen to develop the entire screened area. Jetting using a hose lowered into the well may also be effective. The fines washed into the screen during this process can then be bailed or pumped from the well.

## 6.0 RECORDS

A critical part of monitoring well installation is recording of all significant details and events in the site logbook or field notebook. The geologist must record the exact depths of significant hydrogeological features, screen placement, gravel pack placement, and bentonite placement.

A Monitoring Well Sheet (see Attachments to SOP SA-6.3) shall be completed, ensuring the uniform recording of data for each installation and rapid identification of missing information. Well depth, length, materials of construction, length and openings of screen, length and type of riser, and depth and type of all backfill materials shall be recorded. Additional information shall include location, installation date, problems encountered, water levels before and after well installation, cross-reference to the geologic boring log, and methods used during the installation and development process. Documentation is very important to prevent problems involving questionable sample validity. Somewhat different information will need to be recorded, depending on whether the well is completed in overburden (single- or double-cased), as a cased well in bedrock, or as an open hole in bedrock.

The quantities of sand, bentonite, and grout placed in the well are also important. The geologist shall calculate the annular space volume and have an idea of the quantity of material needed to fill the annular

space. Volumes of backfill significantly higher than the calculated volume may indicate a problem such as a large cavity, while a smaller backfill volume may indicate a cave-in or bridging of the backfill materials. Any problems with rig operation or down-time shall be recorded and may affect the driller's final fee.

## 7.0 REFERENCES

Scalf, M. R., J. F. McNabb, W. J. Dunlap, R. L. Cosby, and J. Fryberger, 1981. Manual of Groundwater Sampling Procedures. R. S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. EPA, Ada, Oklahoma.

Barcelona, M. J., P. P. Gibb and R. A. Miller, 1983. A Guide to the selection of Materials for Monitoring Well Construction and Groundwater Sampling. ISWS Contract Report 327, Illinois State Water Survey, Champaign, Illinois.

U.S. EPA, 1980. Procedures Manual for Groundwater Monitoring of Solid Waste Disposal Facilities. Publication SW-611, Office of Solid Waste, U.S. EPA, Washington, D.C.

Driscoll, Fletcher G., 1986. Groundwater and Wells. Johnson Division, St. Paul, Minnesota, 1989.

## ATTACHMENT A

### RELATIVE COMPATIBILITY OF RIGID WELL CASING MATERIAL (PERCENT)

| Potentially-Deteriorating Substance | Type of Casing Material | | | | | | |
|---|---|---|---|---|---|---|---|
| | PVC 1 | Galvanized Steel | Carbon Steel | Lo-carbon Steel | Stainless Steel 304 | Stainless Steel 316 | Teflon* |
| Buffered Weak Acid | 100 | 56 | 51 | 59 | 97 | 100 | 100 |
| Weak Acid | 98 | 59 | 43 | 47 | 96 | 100 | 100 |
| Mineral Acid/ High Solids Content | 100 | 48 | 57 | 60 | 80 | 82 | 100 |
| Aqueous/Organic Mixtures | 64 | 69 | 73 | 73 | 98 | 100 | 100 |
| Percent Overall Rating | 91 | 58 | 56 | 59 | 93 | 96 | 100 |

Preliminary Ranking of Rigid Materials:

1 Teflon®
2 Stainless Steel 316
3. Stainless Steel 304
4 PVC 1
5 Lo-Carbon Steel
6 Galvanized Steel
7 Carbon Steel

* Trademark of DuPont

### RELATIVE COMPATIBILITY OF SEMI-RIGID OR ELASTOMERIC MATERIALS (PERCENT)

| Potentially-Deteriorating Substance | Type of Casing Material | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PVC Flexible | PP | PE Conv. | PE Linear | PMM | Viton®* | Silicone | Neoprene | Teflon®* |
| Buffered Weak Acid | 97 | 97 | 100 | 97 | 90 | 92 | 87 | 85 | 100 |
| Weak Acid | 92 | 90 | 94 | 96 | 78 | 78 | 75 | 75 | 100 |
| Mineral Acid/ High Solids Content | 100 | 100 | 100 | 100 | 95 | 100 | 78 | 82 | 100 |
| Aqueous/Organic Mixtures | 62 | 71 | 40 | 60 | 49 | 78 | 49 | 44 | 100 |
| Percent Overall Rating | 88 | 90 | 84 | 88 | 78 | 87 | 72 | 72 | 100 |

Preliminary Ranking of Semi-Rigid or Elastomeric Materials:

1 Teflon®
2 Polypropylene (PP)
3. PVC Flexible/PE Linear
4 Viton®
5 PE Conventional
6 Plexiglas/Lucite (PMM)
7 Silicone/Neoprene

* Trademark of DuPont

Source: Barcelona et al., 1983

## ATTACHMENT B

### COMPARISON OF STAINLESS STEEL AND PVC FOR MONITORING WELL CONSTRUCTION

| Characteristic | Stainless Steel | PVC |
|---|---|---|
| Strength | Use in deep wells to prevent compression and closing of screen/riser. | Use when shear and compressive strength are not critical. |
| Weight | Relatively heavier. | Light-weight; floats in water. |
| Cost | Relatively expensive. | Relatively inexpensive. |
| Corrosivity | Deteriorates more rapidly in corrosive water. | Non-corrosive -- may deteriorate in presence of ketones, aromatics, alkyl sulfides, or some chlorinated hydrocarbons. |
| Ease of Use | Difficult to adjust size or length in the field. | Easy to handle and work with in the field. |
| Preparation for Use | Should be steam cleaned if organics will be subsequently sampled. | Never use glue fittings -- pipes should be threaded or pressure fitted. Should be steam cleaned when used for monitoring wells. |
| Interaction with Contaminants* | May sorb organic or inorganic substances when oxidized. | May sorb or release organic substances. |

* See also Attachment A.

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| | | Effective Date 09/03 | Revision 2 |
| | | Applicability Tetra Tech NUS, Inc. | |
| | | Prepared Earth Sciences Department | |
| Subject WELL ABANDONMENT | | Approved D. Senovich | |

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## 1.0 PURPOSE

Well abandonment is that procedure by which any monitoring well is permanently closed. Abandonment procedures are designed to prevent fluids from entering or migrating within the monitoring well. Therefore, an abandoned monitoring well must be sealed in such a manner that it can not act as a conduit for migration of contaminants from the ground surface to the water table or between aquifers.

It is important that the appropriate state or local agency be notified of monitoring well abandonment. The application of and adherence to this SOP must be tailored to applicable state, local, and Federal regulatory requirements.

## 2.0 SCOPE

The methods described in this procedure shall be used for all projects requiring well abandonment where specific state, local, or Federal regulations are unavailable. An abandoned well shall be filled and sealed so that it will not act as a pathway for the interchange of water between the surface and subsurface or present a hazard to the environment.

## 3.0 GLOSSARY

Well - Any constructed access point to an aquifer, confined or unconfined, including, but not limited to, test borings, hydropunch holes, monitoring points, and production wells.

Abandon - To permanently discontinue the use of a well. Any well shall require abandonment when it is no longer serving as a monitoring point or is in such a state of disrepair that continued use for the purpose of obtaining groundwater is impracticable, or when it has been permanently disconnected from any water supply system or irrigation system.

## 4.0 RESPONSIBILITIES

Project Manager - It shall be the responsibility of the Project Manager and/or Project Hydrogeologist to determine the applicability of well abandonment, based on the established scope and objective of the project and program-specific requirements. It shall be the responsibility of the Project Manager (or designee) to ensure that the procedures established for well abandonment are thoroughly specified and/or referenced in the relevant project planning documents. It shall be the responsibility of the Project Manager to ensure that the Field Operations Leader is familiar with the proper procedures for well abandonment and confirm the supervising project geologist or the subcontractor performing the well abandonment are qualified to perform such activities.

Field Operations Leader (FOL) - It shall be the responsibility of the Field Operations Leader to ensure that all field technicians and/or drilling personnel are thoroughly familiar with this Standard Operating Procedure. It shall be the responsibility of the FOL to ensure that the procedures identified in this SOP are used during well abandonment.

## 5.0 PROCEDURES

### 5.1 General

Well abandonment is warranted when the project team has reason to believe, on the basis of local conditions, that the well is causing or is a potential source of pollution to an aquifer; is a production well that is producing water that is polluted; or does not have a certificate of potability, if required. Wells may

also be abandoned once their designed purposes have been fulfilled and are determined to no longer be of use.

Well abandonment is conducted to eliminate physical hazards, prevent groundwater contamination, prevent intermixing of aquifer waters, and conserve aquifer yield and hydrostatic head.

Please note Federal, state, and local regulations concerning this activity may vary. Therefore, applicable regulatory requirements should be reviewed to determine the need for Licensed/Certified Well Drillers to complete/oversight this activity.

## 5.2 Material for Sealing

Acceptable sealing materials include concrete, portland cement grout, sodium-base bentonite clay, or combinations of these materials. These materials are defined as follows:

- Concrete may be used for filling the upper part of a well or water bearing formation, or plugging short sections of casing and filling large diameter wells.

- Portland cement grout is superior for sealing small openings, penetrating any annular space outside the casing, and for filling voids in the surrounding formation. Portland cement grout shall be composed of one bag of Type I cement per 6 to 8 gallons of water. Two parts sand to one part cement may be added.

- Bentonite clay, when applied as a heavy mud-laden fluid under pressure, has most of the advantages of cement grout, but under some conditions may be carried away into the surrounding formation. A bentonite clay mixture shall be composed of not less than 2 pounds of clay per gallon of water. Bentonite clay may not be used where it will come in contact with water of a pH below 5.0 or total dissolved solids (TDS) content greater than 1,000 mg/L or both. Bentonite may also be added to cement grout to add flexibility.

Fill materials include clay, silt, sand, gravel, crushed stone, or a mixtures of these materials may be used as a filler in sealing a well when used in conjunction with the sealing materials described above. Organic material may not be used and fill material may be required to be disinfected or certified clean prior to use. Spent drilling muds or drill cuttings are not to be used to seal a well.

## 5.3 Procedures for Sealing Wells

### 5.3.1 Preliminary Considerations

Several factors should be considered to determine the appropriate well abandonment method. These factors include:

- Conditions of the well.
- Details of well construction, including casing material, diameter of casing, depth of well, and well plumbness.
- Obstructions within the well that may interfere with filling or sealing.
- Hydrogeologic setting.
- Level of contamination and the zone or zones where it occurs.
- Regulatory requirements.

Degraded wells may not permit casing removal by pulling. Also, the casing material may dictate whether a casing can be removed intact. Stainless steel will have a higher tensile strength than PVC and may hold

together while pulling the casing; PVC well casing may break under pulling and may need to be overdrilled to remove it. The depth of the well and well plumbness may limit casing removal depending on whether a casing is pulled or overdrilled. In some cases, casings can be left in-place if they are properly filled with appropriate backfill.

The formation lithology influences the selection of casing removal. Unconsolidated materials can be drilled with hollow-stem augering techniques whereas consolidated materials cannot. Unconsolidated materials may also cave-in during well casing removal.

### 5.3.2 Filling and Sealing Procedures

Drilled wells (all wells not dug) shall be filled with sealing material or a combination of sealing material and fill material.

In some cases, well casing removal is necessary for well abandonment. If the borehole is unstable and may cave-in, sealing material will be emplaced simultaneously during casing removal. If the well is not grouted, casing may be pulled with hydraulic jacks or a drilling rig. It may also be pulled by sandlocking. Sandlocking consists of lowering a pipe wrapped with burlap approximately 2/3 of the well depth and filling the burlap wrap with sand. The pipe is slowly lifted and locks the sand, pulling the casing. Well casings can also be removed by overdrilling. Wells can be overdrilled with larger diameter hollow steam or solid stem augers or direct rotary techniques, using air or mud. Augers used for overdrilling should be at least 2 inches larger in diameter than the diameter of the well casing.

If well casing is in poor condition or is grouted in place, the casing may be ripped or perforated and filled and pressure grouted in place.

Abandoned wells shall be filled with the appropriate filling and sealing material placed from the bottom of the well upward. When Portland cement grout or concrete is used, it shall be placed in continuous operation using a tremie pipe. Sealing material shall be placed in the interval or intervals to be sealed by methods that prevent free fall, dilution, and/or separation of aggregates from cementing material.

A well constructed in unconsolidated material in an unconfined groundwater zone shall be filled and sealed by placing fill material in the well to the level of the water table, and filling the remainder of the well with sealing material. If the water table is at a depth greater than 40 feet, a minimum of 40 feet of sealing material shall be required.

A well which penetrates several aquifers or formations shall be filled and sealed in such a way as to prevent the vertical movement of water from one aquifer or formation to another. If the casing has been removed, sealing material shall be placed opposite the confining formations and from the surface down to the first confining formation. Sand and other suitable fill material may be placed opposite the producing aquifer. Ideally, the entire well can be filled with sealing material. If the casing has not been removed, the entire well shall be fill with sealing material.

A well penetrating creviced or cavernous rock shall be filled using coarse fill material opposite the cavernous or creviced rock portions of the well. Sealing material shall extend from the top of the unfractured rock portion of the well or base of the casing, whichever is deeper, to the surface. The minimum depth of sealing material may not be less than 10 feet.

In the case where wells penetrate specific aquifers where conditions necessitate the sealing of specific aquifers or formations, the annular space in the area of the specific aquifer or formation shall be sealed during the abandonment of the well.

A dug well exceeding 24 inches in diameter shall be filled and sealed by placing fill material (excluding clay or silt) in the well to a level approximately 5 feet below the land surface, and placing a 3 foot plug of sealing material above the fill. The remainder of the well shall be back filled with soil material.

## 6.0 REFERENCES


Maryland Department of the Environment (MDE Regulations); Title 26, Subtitle 04; Regulation of Water Supply, Sewage Disposal, and Solid Waste; Chapter 4--Well Construction.

U.S. EPA, February 1990. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells.

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## 1.0 GENERAL

This Standard Operating Procedure (SOP) was prepared in accordance with applicable U.S. Army Corps of Engineers procedures and policies governing field activities where Munitions and Explosives of Concern [MEC], Material Potentially Presenting an Explosive Hazard [MPPEH] and/or Chemical Warfare Material (CWM) could be encountered. All personnel conducting operations under this SOP must read and understand applicable parts of references listed in section 9.1 below prior to commencing any work described within this SOP. Other documents supporting this SOP include project-specific Work Plans and Health and Safety Plans which are prepared for the purpose of accomplishing work that contain a Munitions and Explosives of Concern [MEC] or CWM component [MEC includes Unexploded Ordnance (UXO), Discarded Military Munitions (DMM) and Munitions Constituents (MC)].

## 2.0 PURPOSE

This SOP applies to all operations involving MEC and/or CWM support during field operations at various sites where Tetra Tech NUS (TtNUS) personnel are present. It provides procedural requirements for any activity involving MEC and CWM, as well as detailed procedures for the location, identification, documentation, and emergency response actions pertaining to MEC/CWM activities.

## 3.0 APPLICABILITY

This SOP applies to persons who may visit any site where TtNUS is performing work that involve some MEC or CWM component. Compliance with the content of this SOP is mandatory for all TtNUS personnel, subcontractors, and visitors to any site where MEC/CWM activities are in progress.

## 4.0 RESPONSIBILITIES

**Project Manager**

Effective implementation of this SOP at the project level will be the ultimate responsibility of the assigned TtNUS Project Manager. The Project Manager is responsible for ensuring that all applicable rules and regulations are complied with, and that all necessary safety precautions are taken to conduct operations in accordance with this SOP. To fulfill this responsibility, the assigned Project Manager is required to ensure that appropriately-qualified technical staff are involved in all stages of project planning and field work, as well as for ensuring that appropriate resources are marshaled and used on his/her assigned projects. For projects involving MEC and/or CWM, this will involve ensuring that a suitably qualified and experienced UXO Technician and a site Health and Safety Officer are part of the project team. In some cases, the assigned UXO Technician may also serve as the project site Health and Safety Officer.

It is also the responsibility of the Project Manager to ensure that all personnel conducting field activities in accordance with this SOP have proper training (including hazard control briefings) and, if required, the proper certifications for the job being performed.

**UXO Technician**

A suitably qualified and experienced UXO Technician will be included as part of the project team where these types of concern are known or suspected to exist. The UXO Technician will be primarily responsible for advising the Project Manager on all MEC/CWM matters, including the measures that will be necessary to effectively implement and adhere to this SOP. Other specific duties will include:

- Providing technical expertise and input into project planning activities and documents such as the project-specific Work Plan and Health and Safety Plan
- Assessing worksite areas for MEC/CWM concerns prior to the initiation of any other onsite activities

- Participating in the development and conductance of site specific training sessions and daily tailgate meetings to communicate MEC/CWM matters to the field personnel
- Maintaining a sound familiarity with the contents of this SOP, the contents of the references listed in section 9.1, and keeping current with new information and technology pertinent to MEC/CWM matters

**Site Health and Safety Officer**

A suitably qualified and experienced health and safety professional will be assigned to all projects that involve fieldwork. Project-specific responsibilities will include:

- Effectively implementing the requirements and restrictions specified in the project-specific Health and Safety Plan
- Ensuring that all personnel participating in onsite activities have satisfied all appropriate medical and training qualifications prior to participating in any onsite activities.
- Conduct initial site-specific health and safety training for all personnel participating in onsite activities.
- Conduct tail-gate safety briefings prior to the initiation of all tasks, but not less than daily.
- On certain projects, these duties may be assigned to the UXO Technician. This would be considered acceptable on field projects where the predominant concern is contact with MEC and/or CWM, and minimal health concerns or requirements (e.g., chemical exposures or monitoring) exist.

**Corporate Health and Safety Manager**

Perform periodic project audits and evaluations to determine the ongoing effectiveness of this SOP to address MEC/CWM concerns, and review and evaluate this SOP to determine any revisions that are appropriate.

## 5.0 LOCATION OF OPERATIONS

MEC and/or CWM concerns may exist at TtNUS project sites throughout the continental United States and abroad. Wherever the installation/site is located, it will be necessary to ensure that project planning activities include collecting available historical information that may be pertinent to these issues, as well as identifying and addressing contract/client-specific requirements and any location-specific requirements (e.g., State, local-level, or host-nation requirements). A detailed site description, discussion of known and/or suspected contamination sources, and results of previous studies will be provided to field personnel as part of their field mobilization and initial site-specific training activities.

The initial project evaluation must involve the performance of a preliminary risk assessment, including the investigation of probable contaminants, potential transport pathways, the identification of potential receptors, and a preliminary evaluation of human health and environmental concerns. Preliminary identification of applicable or relevant and appropriate requirements (ARARs) will also be made available to field personnel conducting activities at the installation.

## 6.0 PERSONNEL QUALIFICATIONS AND REQUIREMENTS

6.1 Personnel Qualifications: Qualifications of those personnel actively involved in MEC/CWM operations shall be as follows:

a. UXO personnel shall be graduates of a military EOD School of the United States. Graduate of a military EOD school of Canada, Great Britain, Germany, or Australia. Graduate of a formal training course of instruction or EOD assistant course as stated in DDESB TP-18.

b. The Senior UXO Supervisor (SUXOS) will have at least 10 years in military EOD/UXO Experience, of which more than 5 years will be in a supervisory position.

c. UXO personnel are responsible for maintaining current status with training and medical surveillance requirements, as specified in the project-specifc Health and Safety Plans and OSHA 29 CFR 1010.120, paragraphs (e) and (f).

6.2 Personnel Requirements: During any activity where the possibility that MEC and/or CWM may be encountered (no matter how remote), the following requirements will be met:

a. One UXO-qualified technician will be required to support each field team engaged in operations in areas that might contain MEC/CWM.

b. One UXO-qualified technician will be present at the site during all activities to provide MEC/CWM support in the event their services are required.

## 7.0 PERSONNEL LIMITS

The activities to be conducted under most contracts will not normally be conducted in areas requiring maximum personnel limitations except for intrusive MEC activities. Work will not be permitted unless at least two persons are present in the work area. The provisions of 29 CFR 1910.120 concerning personnel qualifications and requirements will be followed while working on-site. Any additional personnel limitation requirements specified by the client or the project work location (e.g., state, local ordnance, host nation, etc.) will also be identified and adhered to at all times.

7.1 Personnel Limits for MEC Operations:

a. MEC Avoidance Operations – One UXO Technician (UXO Technician III or UXO Technician II)

b. MEC Intrusive Operations - Two UXO Technicians (one UXO Technician III and one UXO Technician II or I)

## 8.0 MATERIAL LIMITS

The properties and configurations of specific explosive materials are not addressed in this SOP. That level of detail is required to be addressed in project-specific Work Plans and Health and Safety Plans. This SOP must be maintained onsite along with these project-specific documents to aid in appropriate communication and implementation activities. Bulk liquids to be used for decontamination of equipment will be maintained in 2-gallon containers or less. Material Safety Data Sheets (MSDSs) will be kept on file in the TtNUS Command Post for any chemical substances brought to the project site by TtNUS and TtNUS subcontractor personnel. This is addressed in greater detail in section 5. of the TtNUS Health and Safety Guidance Manual.

## 9.0 SAFETY REQUIREMENTS

9.1 Referenced Safety Requirements: The safety requirements that apply to the MEC/CWM operations covered under this SOP are:

a. OSHA 29 CFR 1910.120 and 1926.65 – Hazardous Waste Operations and Emergency Response (HAZWOPER). Available online at: http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=0&p_keyvalue=OSHA_Std_toc.html

b. US Army Corps of Engineers Engineering Regulation 385-1-92, *Safety and Occupational Health Document Requirements for Hazardous, Toxic and Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OE) Activities.* Available online at: http://www.usace.army.mil/inet/usace-docs/eng-regs/er385-1-92/entire.pdf

c. US Army Corps of Engineers Engineering Pamphlet (EP) 385-1-95a, *Basic Safety Concepts and Consideration for OE Operations.* Available online at: http://www.usace.army.mil/inet/usace-docs/eng-pamphlets/ep385-1-95a/entire.pdf

d. US Army Corps of Engineers Engineering Manual (EM) 385-1-1, *Safety and Health Requirements.* Available on line at: http://www.usace.army.mil/publications/eng-manuals/em385-1-1/toc.htm.

e. US Army Corps of Engineers Data Item Description OE – 025.02, *Personnel/Work Standards* Available on line at: http://www.hnd.usace.army.mil/oew/policy/dids/FY04DIDs/OExxx/oe025_02.pdf

f. US Army Corps of Engineers Engineering Pamphlet (EP) 1110-1-18, *Ordnance and Explosive (OE) Response*. Available on line at: http://www.usace.army.mil/inet/usace-docs/eng-pamphlets/ep1110-1-18/entire.pdf

g. US Army Corps of Engineers Engineering Pamphlet (EP) 75-1-2, *Unexploded Ordnance Support for Hazardous, Toxic and Radioactive Waste and Construction Activities.* Available on line at: http://www.usace.army.mil/inet/usace-docs/eng-pamphlets/ep75-1-2/entire.pdf

h. US Army Corps of Engineers Engineering Pamphlet (EP) 75-1-3, *Recovered Chemical Warfare Material (RCWM) Response Process.* Available on line at: http://www.usace.army.mil/usace-docs/eng-pamphlets/ep75-1-3/entire.pdf

i. US Army Technical Manual 9-1300-206 (TM 9-1300-206), *Ammunition and Explosive Hazards.*

j. Technical Manual 60A-1-1-31, *Explosive Ordnance Disposal Procedures, General Information on EOD Disposal Procedures.*

9.2 Specific Safety Requirements:

a. All site operations will be suspended if any site worker encounters an item of suspected MEC/CWM. Site work will remain suspended until the item is inspected and cleared by the UXO Technician.

b. All site operations will be suspended if so ordered by an authorized client representative (i.e., Installation Range Control and/or Safety Office).

c. Buddy System –
   i. Escort/Avoidance - A minimum of two personnel, at least one a UXO-qualified technician will be present all sites where MEC is suspected or present.
   ii. Intrusive – A minimum of two UXO – qualified personnel [One Technician III and one Technician II or I] will conduct intrusive removal operations, with third person observing from a safe area to contact emergency support, if required.

d. Standard work practices as outlined in project-specific Health and Safety Plans and/or Work Plans will be observed.

9.3 Inherent MEC/CWM Hazards: MEC/CWM operations have inherent safety and health risks associated with the various field activities conducted. All planned activities will be conducted in accordance with the requirements of the references listed in Section 9.1 above, as safety is the primary consideration in all MEC/CWM activities. Every effort should be made to determine all hazards associated with the site through a thorough research of archives, past site/range uses, and any other available information. Some of the hazards to consider are:

a. Propellant, Explosives, and Pyrotechnics (PEP)
b. Depleted Uranium (DU)
c. White Phosphorus (WP)
d. Corrosive chemicals (acids and bases) and decontamination agents
e. Toxic gases, liquids and solids
f. Corroded and damaged containers, munitions bodies, drums, etc.
g. Fuze conditions
h. Etiological agents

## 10.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Task-specific PPE will be identified in project-specific Health and Safety Plans. Typical PPE for project sites where the principle concern is for MEC/CWM will include the items listed below. Items marked with an asterisk (*) will be available and will be used as specified in the Health and Safety Plan and/or as determined by the TtNUS Site Health and Safety Officer.

a. Safety glasses

b. Safety shoes (and protective over boots or steel-toed rubber boots). NOTE: During geophysical survey operations, the UXO technicians will not wear steel-toed boots as they interfere with the magnetometer survey; however, around heavy equipment and activities where foot and overhead hazards may exist, steel-toed boots and hard hats will be worn.

c. Cotton clothing (with protective coveralls*)

d. Gloves (type to be specified for each project task in the Health and Safety Plan and/or by the site Health and Safety Officer)

e. Respiratory protection equipment* (29CFR1910.134)

f. Hearing protection*

g. Hard hats*

## 11.0 EMERGENCY RESPONSE AND CONTINGENCY PLANS

11. Emergency Contacts: The identification of (and means to communicate with) appropriate local emergency response agencies must be identified as part of project planning/mobilization activities, and these agencies must be contacted prior to the initiation of any onsite work. These initial communications must determine the capabilitities of these agencies to respond to foreseeable emergency situations, their willingness to respond, and their locations/driving directions/phone numbers. These details must be specified in the project-specific Health and Safety Plan and posted in the site Command Center/Field office.

At a minimum, the names and means of communication (phone number, radio frequency, etc.) of the following parties must be included in the project-specific Emergency Contacts procedure:

a. Local Emergency Fire Response that will respond (i.e., local Fire Department)

b. Emergency Medical Assistance (Hospital, Emergency Room, and ambulance service that will respond)

c. Installation Safety Office or other client safety/emergency response contact

d. Installation EOD Office/Detachment

e. Installation Environmental Office

The senior TtNUS managing employee onsite (Project Manager, Site Manager, Site Supervisor, Field Operations Leader) is responsible for initiating these calls in the event of an emergency where such support is needed. If the Project Manager is not onsite at the time of an emergency event, he/she must be added to the above list of contacts.

In the event of an emergency, all site personnel will be evacuated to a predetermined location away from the work place. Emergency Response Planning will be addressed in the project-specific Health and Safety Plan and will be in accordance with either 29 CFR 1910.38(a) or 1910.120(l). TtNUS will utilize the Installations Base Fire Protection and Emergency Services in emergencies or potential emergencies.

11.2 Contingency Plans: The following contingency plans will be implemented:

a. Pre-Planning – Upon arrival at the site/installation, the TtNUS Field Operations Leader (FOL) and/or the Site Safety Officer will meet with the Base or local Fire Protection Department, Base Security Personnel or local Police Department, and onsite and/or offsite Emergency services to notify them of the activities that are to be undertaken, when, and where. All site personnel will be required to follow established base/local emergency procedures and will rely on base/local services to handle emergency calls when needed.

b. Emergency Escape Procedures and Assignments – Upon notification of a site emergency that requires evacuation, all site personnel will proceed to predetermined locations based on emergency location and wind direction. An alternate assembly point will be designated in case personnel cannot reach these locations without danger to their lives and health. These primary and alternate escape routes and meeting places will be designated during the daily hazard control briefing. Personnel will be trained to remain at the assembly points until directed to either resume work or to leave the site.

c. Procedures to Account for Site Personnel – The site work force is typically small enough that accounting for personnel will not be a problem via visual head counting. On projects with larger field team sizes, roll calls will be taken using the daily sign in logs, logbook entries, or the tail-gate briefing sheets. Accounting for personnel will be the Field Operations Leader's responsibility.

d. Rescue and Medical Duties – TtNUS personnel will not be authorized to participate in emergency rescue operations. Typical first aid response equipment that is to be on hand at a project site includes suitable first aid kit, an emergency eye wash station, and at least one Five lbs Class ABC fire extinguisher.

e. Activation of Emergency Response Procedures - Should an emergency occur which requires the support of outside services, the appropriate contacts will be made by the senior TtNUS managing employee onsite (Project Manager, Site Manager, Site Supervisor, Field Operations

Leader). A list of appropriate contacts will be posted at the Command Post. Cellular phones, land-line phones, or hand-held radios will be the primary means of communication.

f. Airborne Chemical Release Contingency Plan –

(1) Chemical Release Monitoring – every member of the site team will be responsible for observing and reporting any gross chemical releases or conditions that could lead to releases. Air monitoring will be performed as described in the project-specific Work Plans and Health and Safety Plans.

(2) Responses to Measured Airborne Chemical Releases – the readings on monitoring instrumentation will be compared to the action levels specified in the project-specific Work Plans and Health and Safety Plans. The primary purpose of appropriate real-time monitoring instruments will be monitor worker breathing zone areas for the protection of employee health. The project-specific Health and Safety Plan will specify actions that are to be taken in the event that monitoring instrument readings indicate that detected concentrations may represent a health threat to onsite workers. Area and perimeter monitoring as well as sample screening activities may also be called for in the Work Plan or Health and Safety Plan, but these are *secondary* purposes for the use of these instruments.

Unless otherwise specified in a project-specific Health and Safety Plan, the following monitoring instrument action levels and response measures will be observed on MEC/CWA sites:

| Parameter | Action Level |
|---|---|
| Total Organic Vapors | Any sustained level above background |
| Airborne particulates | Readings >2.5 $mg/m^3$ |
| Flammable Vapors | 10% of the Lower Explosive Limit (LEL) |

If such levels are noted at site perimeters or adjacent to neighboring residential or commercial property, the TtNUS Field Operations Leader and/or the Site Safety Officer will notify the appropriate client or base contacts.

g. Liquid Release Monitoring – All field team members will be responsible for observing and reporting any liquid chemical releases or conditions that could lead to a release. If field operations on site result in a release of liquid chemicals in the absence of vapors, field personnel will attempt to contain the liquid by means of berms constructed with available equipment. If the work team cannot control the spill, they will leave the area for the assembly point quickly, without panic. The TtNUS Field Operations Leader and/or the Site Safety Officer will notify the appropriate client/base contact. This is not considered to be a significant probability during operations. However, in the unlikely instance that it should occur, field personnel may effect these types of defensive efforts, providing that such a response does not appear to present a chemical overexposure or other personal health or safety threat.

## 12.0 TYPICAL CLIENT/FACILITY SAFETY POINTS OF CONTACT

The following positions are typically encountered on MEC/CWA projects. Communication and coordination with these positions should be implemented and maintained throughout all project activities (from pre-field operations planning through to project close-out).

a. Installation Safety Management Office

b. Installation Ordnance Officer and/or EOD Officer

c. Installation Radiation Officer

d. Installation Environmental Office

## 13.0 TOOLS AND EQUIPMENT

Tools and equipment necessary to safely and effectively accomplish the objectives of a project will be detailed in the project-specific Work Plans and Health and Safety Plans. Items commonly required for MEC/CWM operations are presented below:

### 13.1 Personal Protective Equipment

a. Respiratory Protective Equipment (i.e., air purifying or air supplied devices)

b. Dermal (chemical resistant) protective equipment (e.g., coveralls, gloves, eye and face protection)

c. Physical safety PPE (hard hats, hearing protection, safety glasses, safety shoes, etc.)

### 13.2 Air Monitoring Equipment

a. Explosive/$O_2$ Meter (Combustible Gas Indicator)

b. Direct reading Organic Vapor Analyzer (PID or FID)

c. Direct reading particulate meter

d. Radiation Survey Meters and TLD Badges

### 13.3 Geophysical/Hydrology Survey Instrumentation

a. Magnetometers (Cesium Vapor, Schonstedt)

b. Electromagnetic Terrain Conductivity Meter (EM-31)

c. Time-Domain Electromagnetic All-Metals Detector (EM-61)

d. Water Level Indicator/Recorder

e. pH/Temperature/Conductivity Meter for water samples (Horiba, etc.

f. Survey Equipment (transit, tripod, level, etc.) as required

### 13.4 Support Equipment

a. Schonstedt Magnetic Locators (GA-52Cx or equivalent passive instrument) will be used for anomaly detection MEC activities. The GA-52Cx detects the magnetic field of any ferromagnetic object.

b. Schonstedt MG-220 Magnetic Gradiometer (Down-Hole Magnetometer or equivalent) will be used to conduct down hole anomaly checks. The MG-220 detects the magnetic field of any ferromagnetic object as it is lowered into a borehole.

c. Marking tape, pin flags, stakes, utility spray paints, etc.

**13.5 CWM Support Equipment**

a. Suitable monitoring equipment capable of detecting agents of concern

**13.6 Decontamination Equipment**

As required by the level of protection for each site. See Site Health and Safety Plan for specifics.

**13.7 Hand Tools/ Miscellaneous Equipment**

As may be required.

## 14.0 ENVIRONMENTAL CONCERNS

The field operations covered by this SOP will be performed in such a manner as to minimize the effects of pollution of air, water, or land and to control noise and dust emissions within reasonable limits.

Every effort will be made to:

a. Protect the land areas and to preserve them in their existing condition.

b. Protect water resources, including measures for run-off or run-off controls if applicable.

c. Implement sediment control measures, where warranted. These measures will also be implemented to control erosion.

Usually, field operations will generate solid and liquid waste (Investigative Derived Waste – IDW) requiring onsite handling and possible offsite disposal. The major types of waste to be generated, their environmental concerns, and their handling and disposition are summarized below:

a. Personal and equipment decontamination containers disposed offsite following a thorough decontamination. Liquid waste will be included with well purging and development fluids.

b. Personal Protective Equipment (PPE) will be double-bagged and will be the responsibility of TtNUS to dispose of according to applicable regulations. Disposal will normally be offsite.

It is not anticipated that any chemical releases will occur during the field activities.

The MSDSs for chemicals being brought onto the installation for use in field operations will be listed on a site-specific Chemical Inventory and maintained at the TtNUS Field Command Post. Copies of these documents are to be made available to client and offsite representatives who may be called upon to respond to an emergency event.

## 15.0 MEC/CWM PROCEDURES FOR FIELD OPERATIONS

15.1 General – field procedures for work on any installation can include any or all of the following tasks:

a. Initial entry into suspect areas

b. CWM operations

c. Surface and subsurface sampling

d. Monitoring well installation

e. Exploratory trenching

f. Geophysical surveys

g. Other miscellaneous operations

15.2 Initial Entry – initial entry into suspect areas requires a UXO-qualified technician with a magnetometer (GA-52Cx or equivalent) to screen a path into the area. The screened area is marked with lanes using either pin flags with plastic pins or marking tape. Suspect items on the surface and subsurface magnetic anomalies will be marked, usually with a different color tape or flag, and will be avoided by team members. The site where the work is to be conducted will be thoroughly screened for MEC/CWM contamination prior to any work commencing. All personnel will stay within the cleared areas and not venture out into areas not screened. If an area that has magnetic anomalies cannot be avoided, the UXO-qualified technician will hand excavate down to the anomaly to check to see if a hazard exists. Before excavation begins, the immediate area will be cleared of non-essential personnel outside of what could be a fragmentation zone (as determined by the UXO Technician). If the excavation reveals a hazard, the emergency notification procedures in paragraph 11.0 will apply.

15.3 CWM Operations - prior to conducting CWM operations, an Emergency Response Plan as required by 29CFR1910.120 and DA Pam 50-6 will be developed and implemented. Most of the information required to develop this plan should be obtained from the installation safety office; however, as a minimum, the following elements will be addressed:

a. Pre-emergency planning and procedures for reporting incidents to appropriate government agencies for potential chemical exposure, person injuries, fire/explosions, environmental spills and releases, and discovery of radioactive materials.
b. Personnel roles, lines of authority, communications.
c. Posted instructions and list of emergency contacts: physicians, nearby notified medical facility, fire and police departments, ambulance service, state/local/federal environmental agencies, Certified Industrial Hygienist (CIH), and installation commander.
d. Emergency recognition and prevention.
e. Site topography, layout and prevailing weather conditions.
f. Criteria and procedures for site evacuation (emergency alerting procedures/employee alarm system, emergency PPE and equipment, safe distance, place of refuge (assembly area), evacuation routes, site security and control).
g. Specific procedures for decontamination and medical treatment of injured personnel.
h. Route maps to nearest pre-notified medical facility.
i. Criteria for initiating community alert program, contacts and responsibilities.
j. Critique of emergency responses and follow-up.
k. Material Safety Data Sheets (MSDS) for each hazardous substance anticipated to be encountered on site would be made accessible to site personnel at all times.

15.4 Sampling – sampling will be conducted in accordance with established protocols and methodologies. Site-specific sampling requirements will be presented in the project-specific Work Plans and/or in other project-specific documents such as Field Sampling and Analysis Plans and Quality Assurance Plans.

Prior to initiating any sampling activities, an UXO-qualified technician will screen sites potentially contaminated with MEC/CWM. A magnetometer will be used to screen entry into a suspect area as in paragraph 15.2 above. Lanes will be marked and suspect items and subsurface anomalies will be identified and avoided. The immediate sampling area will be surface-screened prior to the introduction of the sampling team into the area.

Prior to any subsurface intrusive sampling, another check with a magnetometer needs to be accomplished. A magnetometer can be used for collecting subsurface samples not greater than 1 foot. If excavation of a borehole or hand auguring hole is to exceed this depth, a MG-230 Magnetic Gradiometer (down hole magnetometer) shall be utilized with readings taken at one foot intervals.

If an anomaly is detected, the location will be marked and avoided. If appropriate and acceptable, an alternate sampling location (in a cleared area) will be designated. If the sampling location cannot be relocated them the UXO-qualified technician will hand excavate down to the anomaly to determine if it is hazardous. If it is not hazardous, the object will be set aside and the sampling event will continue. If the object has been determined to be hazardous or suspect, the sampling team will move out of the area and the emergency procedures listed in paragraph 11.0 will be implemented.

15.5 Monitoring Well Installation – the area within a radius twice the size of the largest equipment used around the borehole and access path will be screened with a magnetometer and be cleared of anomalies. Once this is accomplished, the areas around borehole sites will be marked using colored marking tape and/or pin flags. Heavy equipment such as front-end loaders, backhoes, and bulldozers will not be used to develop or establish drill sites. The following action will be followed:

a. A magnetometer will be used directly over the borehole site to check for buried items down to 1 foot. After a surface check, the UXO-qualified technician will hand auger down to a depth of one foot and check down the hole using the MG-220 magnetometer, in one foot increments.

b. Once the hand-auguring hole has been cleared, the drill rig will be positioned over the proposed borehole. Drilling will commence to a depth of one foot, the drill auger will be removed from the borehole, the drill crew chief and UXO personnel will make observations of the soil from the core barrel and the soil removed from the hole by hand auger (if needed). The drilling log and lithologic log will be maintained in accordance with standard practices, noting any metal objects that may be found.

c. The drilling derrick will be secured and drill rig moved to a position at least 20 feet from the borehole.

d. The borehole will be checked again with the MG-220 magnetometer.

e. If an anomaly is present, the borehole will be abandoned and another location selected. The new borehole should be at least six feet from the original borehole. If an anomaly is not detected and the clearance is given, the drill rig shall be positioned back over the borehole, and drilling will proceed to the next interval.

f. Repeat above steps at intervals of 1 foot, until a depth of 30 feet in impact areas or as determined in others is reached. At the maximum depth plus one foot, a magnetometer reading shall be taken with the MG-220 set on the maximum sensitivity. The instrument will detect larger objects (approaching 100 lbs.) that could be expected to penetrate to depths of 10 feet or more.

15.6 Exploratory Trenching and Excavation – at times, exploratory trenching may be required to determine the lateral extent of a landfill, burial pit, or subsurface geophysical anomaly. Trenching and excavation to uncover a subsurface area will be conducted using a backhoe, an excavator, or sometimes a front-end loader. **Any trenching or excavation activities (regardless of depth) must be done in accordance with OSHA 29 Subpart P requirements, which must be considered and addressed in the project-specific Health and Safety Plan.**

On project sites where excavation activities are within the scope of work *and* a MEC/CWM concern exists, the following additional procedures will be utilized to conduct these operations:

a. The surface of the area to be trenched or excavated will first be swept with a magnetometer. Anomalies will be hand excavated to determine if hazardous.

b. No more than 0.5 feet of surface soil will then be gingerly removed (scraped) from the area of concern.

c. The heavy equipment will be removed at least 20 feet away from the area, and the area will be checked with a magnetometer. If the area is a trench, the entire length of the trench will be checked with a magnetometer and the excavation can continue six inches at a time.

d. Anomalies will continue to be uncovered by hand excavation until the desired results are obtained and the trench/area is abandoned and refilled.

e. If excavation depths reach 4 feet, suitable means of access/egress must be provided (e.g., ladders) and atmospheric monitoring must be performed prior to any entries. To avoid entry into the excavation, the MG220 may be used. Area will be checked in 1 foot intervals. Once again after the proper depth of soil is excavated, the heavy equipment is removed from the area (>20 feet) and the area is rechecked with the magnetometer.

f. The above procedures are followed until the desired depth is reached and/or the desired results are obtained.

15.7 Geophysical Surveys – there are several instruments that can be used to conduct geophysical surveys. The GA-52Cx (Schonstedt) and the MG-220 are magnetometers and are passive instruments. The Geonics Terrain Conductivity Meter (EM-31) is an active instrument and is commonly used to measure subsurface terrain conductivity. This information can be used geophysical surveys, as well as for locating voids, discontinuities in soil structures such as boundaries of disposal pits and buried conducting objects. An Ordnance Safety Analysis of the Geonics Model EM-61 Non-Contacting Terrain Conductivity Meter was conducted by the Naval Surface Warfare Center at the request of TtNUS in April 1993. The analysis concluded, in summary, that the "Geonics EM-61 poses no ordnance safety hazard when operated in the normal survey mode, where the device is held at hip height." However, the Geonics EM-61 should not be used with the boom on the ground if ordnance is present or suspected.

When using the magnetometer or the EM-61, a UXO-qualified technician will conduct a surface sweep of the area to be surveyed to ensure that no surface ordnance or other hazards exist. The

magnetometer is a passive instrument; therefore, no special ordnance safety precautions are required.

Manufacture recommended procedures for the EM-61 must be followed to ensure safe operation during the geophysical survey. Standard survey protocols and quality assurance methods will also be required during survey operations.

15.8 Miscellaneous Operations – A UXO Technician will be present for any and all field activities that are in areas suspected to contain MEC and/or CWM. These areas also include those areas covered with water and creeks, canals, etc.

Operations that involve the inspection, hazard classification, segregation, and final disposal of UXO, DMM, MC and related scrap will not be covered in this SOP. Demilitarization is not authorized unless specific work plans, SOPs, health and safety plans and other established procedures are written and approved addressing these operations.

## 16.0 HAZARD CONTROL BRIEF

A Health and Safety Hazard Control Briefing (i.e., tailgate meetings) will be conducted daily prior to the start of onsite activities. The briefing will be detailed and will cover the information in the Safe Work Permits for the anticipated tasks for the day, as well as applicable portions of this SOP. Additional briefings will be conducted as necessary for tasks that become necessary during the course of a workday, if they were not covered in the morning briefing. These briefings are in addition to (not in place of) the site-specific health and safety training that is required for all onsite personnel prior to their participation in any onsite activities.

The following information will be given during the daily briefings:

a. Overview of task(s) to be performed and review of appropriate Safe Work Permits with task participants.

b. Overview of the day's objectives, as well as general site hazards

- Unexploded Ordnance Hazards
- Chemical Warfare Agents and Materials
- Physical Hazards

c. Overview of Standard Work Practices pertinent to the day's planned activities

d. Review of any worker incidents or near-miss events, including a review of corrective/preventive measures to prevent recurrence

e. Overview of Emergency Response Actions, evacuation routes and assembly points

## 17.0 SECURITY

Field activities under various TtNUS contracts are typically unclassified and normal security measures apply in accordance with above references (section 9.1 above). TtNUS personnel and their subcontractors will check in with the appropriate client/installation's security office and may be issued security badges for entry into certain work areas. This SOP will not cover special security requirements for projects involving MEC/CWM as most installations have established policies and procedures on reporting and securing recovered items that are MEC and/or CWM. The TtNUS Project Manager will incorporate all security procedures required by the installation into the site work plan.

# 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 ID, date, time, analysis to be performed, preservative, matrix, sampler, and the analytical laboratory. A sample label will be attached to each sample container. The label for each container will contain identical information.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Writing utensil (indelible ink black pen)**
**Disposable medical-grade gloves (e.g. latex, nitrile)**
**Sample logsheets**
**Required sample containers**: All sample containers for analysis by fix-based laboratories will be supplied and deemed certified clean by the laboratory.
**Preprinted 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 the field activities.

- Contract Task Order number (CTO JM10)
- Project location (Marine Corps Recruit Depot [MCRD] Parris Island)
- Sample location
- Preservative
- Analysis to be performed
- Matrix type
- Laboratory name

3.2 Complete the label by filling in the sample ID and time of collection at the well head during sample collection event.

3.3 Select the containers that are appropriate for a given sample. Complete the associated sample label and affix to the sample container.

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

3.5 Check to determine if the information printed on the label is correct.

3.6 Place the sample container in a Ziplock plastic 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**

<table>
<tr><td colspan="3">Tetra Tech NUS, Inc.<br>661 Andersen Drive<br>Pittsburgh, 15220<br>(412)921-7090<br>Project:<br>Location:<br>CTO:</td></tr>
<tr><td colspan="2">Sample No:</td><td>Matrix:</td></tr>
<tr><td>Date:</td><td>Time:</td><td>Preserve:</td></tr>
<tr><td colspan="3">Analysis:</td></tr>
<tr><td colspan="2">Sampled by:</td><td>Laboratory</td></tr>
</table>

# 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 Marine Corps Recruit Depot (MCRD) Parris Island. 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

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

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

## 3.0 SAMPLE IDENTIFICATION NOMENCLATURE

### 3.1 Samples

All 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 Sample Numbering Scheme

Use a sample tracking number consisting of a four- or five-segment alpha-numeric code that identifies the sample's associated Unexploded Ordnance (UXO) site, sample matrix, sample location, sample depth interval (solids), sample collection date (aqueous), and for aqueous samples, where applicable, whether a sample is filtered.

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

| AN or ANN | AA | NNN or NN | XXXX (solids) | MMDDYY (aqueous) | -F (aqueous) |
|---|---|---|---|---|---|
| UXO Site Number | Matrix | Sample Location Number | Depth interval, in inches | Date - Month, date, and year sample collected | Filtered |

**Character Type:**

A = Alpha

N = Numeric

**UXO Number (ANN):**

UXO 3 = X3

UXO 4 = X4

UXO 5 = X5

UXO 6 = X6

UXO 7 = X7

UXO 8 = X8

**Matrix Code (AA):**

GW = Groundwater Sample

IS = Increment Sample

SB = Subsurface Soil Sample

SD = Sediment Sample

SS = Surface Soil Sample

TW = Temporary Well Groundwater Sample

**Location Number (NNN or NN):**

Well identification number (i.e., temporary well X3TW01 = 01)

**Depth Interval (XX):**

This code section will be used with solid samples to record the depth interval of the sample that was collected, in inches.

**Date (MMDDYY):**

This code section will be used with aqueous samples to record the date when the sample is collected, month, date, and year. This is utilized in lieu of a sample round designation.

**Filtered Samples (-F):**

Groundwater samples that will be collected and analyzed for dissolved metals will be filtered in the field with a 0.45 micron filter and designated with a "-F" to indicate that it was filtered in the field.

### 3.1.2 Examples of Sample Nomenclature

A surface soil sample (from 0 to 1 foot below ground surface) collected from UXO 3, soil boring sample location 101, would be labeled as X3SS101-0012.

A sediment sample (from 0 to 6 inches below ground surface) collected from UXO 6, sediment sample location 101, would be labeled as X6SD101-0006.

A temporary well groundwater sample collected from UXO 7, well X7TW01, on December 19, 2011 would be labeled as X7TW01-121911.

A temporary well groundwater sample collected from UXO 7, well X7TW01, on December 19, 2011 and field filtered for dissolved metals analysis would be labeled as X7TW01-121911-F.

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

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

### 3.2.1 QC Sample Numbering

Use the QC code consisting of a four-segment alpha-numeric code that identifies the UXO Site number, sample matrix, QC type, and the number of this type of QC sample collected at that particular UXO Site during the investigation.

| AN or ANN | AA | AA or AAA | NN |
|---|---|---|---|
| UXO Site Number | Matrix | QC Type | Sequence Number (per sampling event) |

**Character Type:**

A = Alpha

N = Numeric

**QC Types:**

DUP = Field Duplicate

RB = Rinsate Blank

Record the time of sampling on the Chain-of-Custody Form, labels, and tags for field duplicate samples with 0000 so that the samples are "blind" to the laboratory. Record notes detailing the sample number, time, date, and type on the sample log sheets and 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 field duplicate collected at UXO 3 for a sediment sample would be designated as X3SDDUP-01.

The first rinsate blank collected at UXO 4 for a temporary well groundwater sample would be designated as X4TWRB-01.

# 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 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.

## 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.

### 3.4 Chain-of-Custody Form

The Chain-of-Custody (COC) form 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. Each COC is numbered. This form must accompany any samples collected for laboratory chemical analysis. A copy of a blank COC form is attached at the end of this SOP.

The Tetra Tech 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 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 it is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transit to the laboratory. The custody seals are signed and dated by the samplers and affixed across the opening edges of each cooler (two seals per cooler) 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

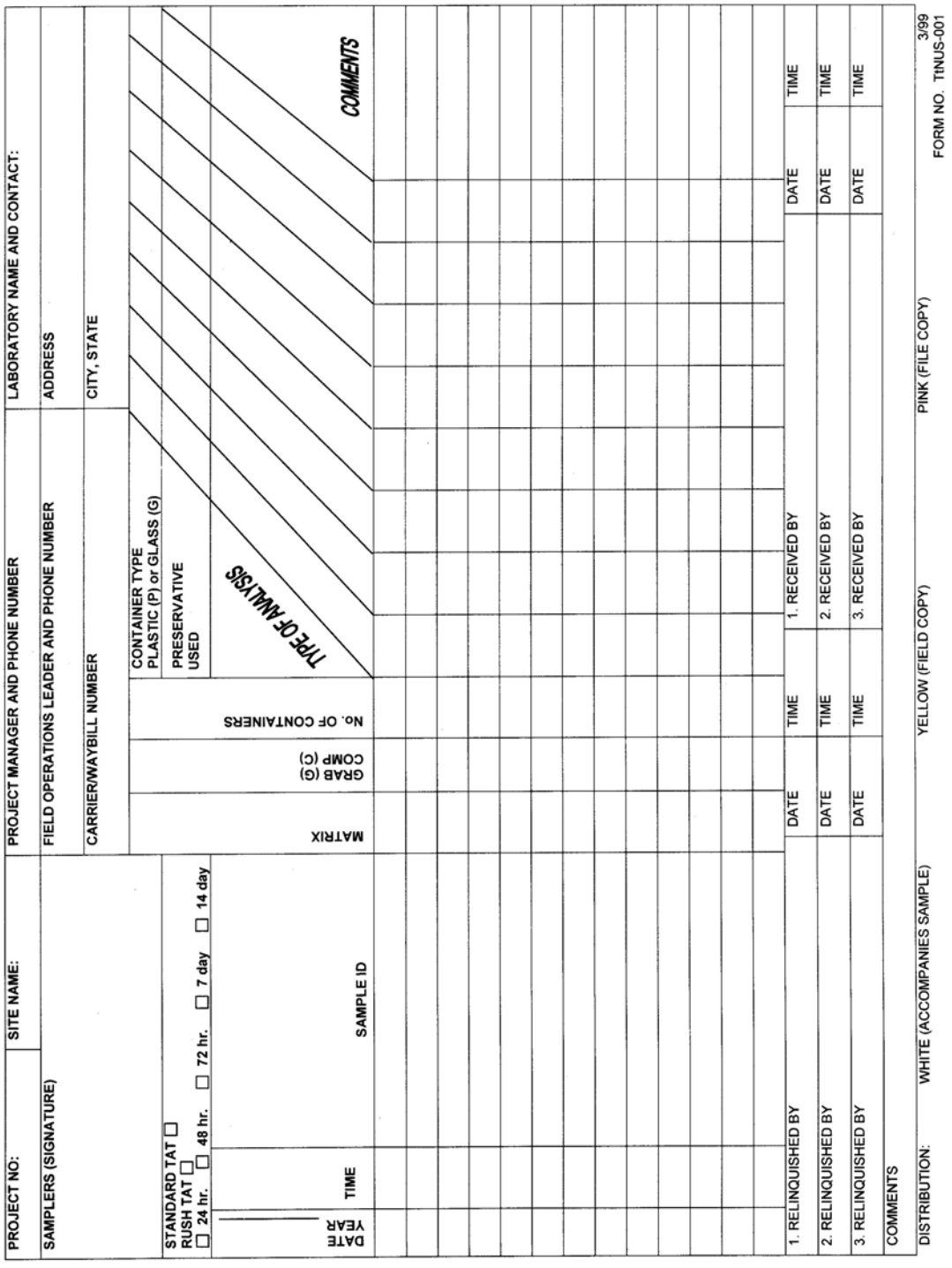
The Soil and Sediment Sample Log Sheets are used to document the sampling of soils and sediments. The surface water sample log sheets are used to document the sampling of surface waters.

## 4.0 ATTACHMENTS

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

## ATTACHMENT 1

## CHAIN-OF-CUSTODY RECORD




## ATTACHMENT 2

Tetra Tech NUS, Inc.

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

**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):**

## ATTACHMENT 4

## SURFACE WATER SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

## SURFACE WATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Stream
[] Spring
[] Pond
[] Lake
[] Other: _____
[] QA Sample Type: _____

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

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

**SAMPLING DATA:**

| | Color | pH | S.C. | Temp. | Turbidity | DO | Salinity | ORP |
|---|---|---|---|---|---|---|---|---|
| Date: | Visual | Standard | mS/cm | Degrees C | NTU | mg/l | % | mV |
| Time: | | | | | | | | |
| Depth: | | | | | | | | |
| Method: | | | | | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Preservative | Container Requirements | Collected |
|---|---|---|---|
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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 less than 6 degrees Celsius (< 6°C), but not be frozen. 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
# NUMBER SOP-05

# LITHOLOGIC SOIL SAMPLE LOGGING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the standard procedures and technical guidance on the logging of soil cores collected at Marine Corps Recruit Depot (MCRD) Parris Island.

## 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**

## 3.0 RESPONSIBILITIES

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

## 4.0 PROCEDURES FOR BOREHOLE AND 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" and "gravel" 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 inchΦ-1/2 inchΦ)" 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

Describe soil colors 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. Break or split soil samples vertically to render the colors clearly visible. Samplers tend to smear the sample surface, creating color variations between the sample interior and exterior.

Use the term "mottled" 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 noncohesive (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. Break the sample in half and push the thumb 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, classify it as a soft decomposed rock rather than a hard soil. The designations used to describe the consistency of cohesive soils are shown in the above-listed table.

### 4.4 Weight Percentages

In nature, soils 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 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 approach for this would be to call 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, use the following table.

| 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

## 4.0 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 @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): ____

Remarks: _____

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

# STANDARD OPERATING PROCEDURE

# SOP-06

# SOIL CORING AND SAMPLING USING 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 hand augering techniques.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Disposable medical-grade gloves (e.g., latex, nitrile)**
**Writing utensil (preferably black pen with indelible ink)**
**Indelible marker**
**Stainless Steel Auger Buckets**
**Stainless Steel Extension Rods**
**Cross Handle**
**Required decontamination materials**
**Bentonite pellets**
**Sealable polyethylene bags**
**Sample labels**
**Shipping containers** (containing ice)
**Disposable plastic trowels or stainless steel trowels**
**Stainless steel mixing bowls**
**Sample containers:** Sample containers are certified clean by the laboratory supplying the containers.
**Soil Sample Log Forms**
**Daily Activity Logs**
**Chain-of-Custody Form**
**Soil Boring Log**

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

Hand Augers may be employed to collect the soil cores. 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.

3.1 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 or rock layers and the collapse of the borehole normally contribute to its limiting factors.

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

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

3.3. Turn the hand auger sampler into the ground to a depth of 1 foot. The 0 to 1 foot depth soil interval is considered to be the surface soil. For subsurface samples, continue to turn the hand auger sampler into the ground to a depth of 3 feet. The 1 to 3 feet depth soil interval is considered to be the subsurface soil.

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

3.5 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the sample material from the bucket bit and place into a sealable polyethylene bag. Note in a field notebook or on a standardized data sheet any changes in the color, texture or odor of the soil.

3.6 Thoroughly homogenize the sample material and write sample ID, date, and time on the bag with an indelible marker.

3.7 Complete required information on the Soil Sample Log Sheet (copy attached at the end of this SOP). Update the Chain-of-Custody (COC) form.

3.8 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, and hydrated with potable water.

3.9 Decontaminate all soil sampling equipment in accordance with SOP-04 before collecting the next sample.

3.10 Soil samples shipped to a fixed-base laboratory for analysis will be in sample containers supplied by the laboratory. The sample labels will be completed and affixed to the sample container. The samples will then be packaged and shipped to the laboratory in accordance with SOP-19.

## 4.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet
2. Soil Boring Log Sheet

# ATTACHMENT 1

## 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-07

# SUBSURFACE SOIL AND GROUNDWATER SAMPLING USING DIRECT PUSH TECHNOLOGY

## 1.0 PURPOSE

This procedure provides general guidance and reference information on direct push technology (DPT). DPT is designed to collect soil and groundwater samples without using conventional drilling techniques. The advantage of using DPT over conventional drilling includes the generation of little or no drill cuttings, ability to sample in locations with difficult accessibility, reduced overhead clearance requirements, no fluid introduction during probing, and typical lower costs per sample than with conventional techniques. Disadvantages include a maximum penetration depth of approximately 15 to 40 feet in dense soils (although it may be as much as 60 to 80 feet in certain types of geological environments), reduced capability of obtaining accurate water-level measurements, and the inability to install permanent groundwater monitoring wells.

The methods described herein are specific for soil, groundwater, and soil gas samples at Marine Corps Recruit Depot (MCRD) Parris Island. Guidelines by Southern Division, Naval Facilities Engineering Command (South Div NAVFAC, 1997) and the State of South Carolina should be consulted.

## 2.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction.

Field Geologist - The Tetra Tech Field Geologist supervises and documents DPT activity performed by the driller, and insures that the soil and groundwater samples collected accurately representative the desired media and sample interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

All Field Personal – All field personal including, the drilling contractor personnel and other field staff, must have all of the health and safety training required to perform the work, as specified in the Health and Safety Plan (HASP). All field personnel shall be aware of the potential presence of underground utilities.

Proper utility clearance must be obtained by the Tetra Tech Project Manager (PM) prior to any DPT activity.

Unexploded Ordnance (UXO) clearance to six feet will be required for subsurface samples. Every two feet the drill rig shall be withdrawn and a downhole magnetometer used to check for UXO. If the presence of any UXO is suspected, the drilling location will be shifted two feet and drilling resumed. A trained UXO technician will be part of the Tetra Tech field team.

## 3.0 REQUIRED EQUIPMENT/ITEMS

The list of equipment and items required for DPT sampling includes, but is not limited to:

Health and safety equipment as required by the HASP and the Site Safety Officer.

DPT Rig is supplied by the drilling subcontractor and may include the following:

- 4-foot x 2-inch diameter macrocore sampler
- Probe sampling adapters
- Disposable acetate liners for soil macrocore sampler
- Cast aluminum or steel drive points
- Geoprobe® AT-660 Series Large Bore Soil Sampler, or equivalent
- Stainless steel screen point groundwater sampler (Geoprobe®, HydroPunch™, or equivalent)

55-gallon drums to containerize IDW (supplied by the drilling subcontractor).

Required decontamination materials including distilled water, deionized water, paper towels, and stainless steel clamps.

Writing utensil (preferably black ink), non-latex gloves, bound field logbook, chain-of-custody forms, sample labels, boring log, sample logsheets, engineer's tape (or equivalent), and stainless-steel spoon or trowel.

Required sample containers with appropriate preservative: All sample containers for analysis by fixed-base laboratories will be supplied and deemed certified clean by the laboratory. Additional sampling equipment as needed, such as photo-ionization detector (PID), flame-ionization detector (FID), Ziplock bags, calculator, wristwatch, and timer, and cooler (containing ice). peristaltic pump, inertial lift pump, silicon tubing, polyethylene (PE) tubing, water quality meter with a flow through cell, LaMotte 2020 Turbidity Meter (or equivalent), water level indicator, 0.45 micron filter cartridge, trip blanks, and bucket to collect development/purge water.

## 4.0 GLOSSARY

Direct Push Technologies (DPT) -DPT refers to sampling tools and sensors that are driven directly into the ground without the use of conventional 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 machines utilizing DPT to collect subsurface environmental samples. Geoprobe® relies on a relatively small amount of static weight (vehicle) combined with percussion as the energy for advancement of a tool string. The Geoprobe® equipment can be mounted in a multitude of vehicles for access to all types of environmental sites.

HydroPunch™ is a manufacturer of stainless steel and Teflon® sampling tools that are capable of collecting representative groundwater and/or soil samples without requiring the installation of a groundwater monitoring well or conventional soil boring. HydroPunch™ is an example of DPT sampling equipment.

Flame Ionization Detector (FID) - A portable instrument for the measurement of many combustible organic compounds and a few inorganic compounds in air at parts per million levels. The basis for the detection is the ionization of gaseous species utilizing a flame as the energizing source.

Photoionization Detector (PID) - A portable instrument for the measurement of many combustible organic compounds and a few inorganic compounds in air at parts per million levels. The basis for the detection is the ionization of gaseous species utilizing ultraviolet radiation as the energizing source.

## 5.0 DPT SOIL SAMPLING PROCEDURES

### General

The common methodology for the investigation of the vadose zone is soil boring drilling and soil sampling. However, drilling soil borings can be very expensive. Generally the advantage of DPT for subsurface soil sampling is the reduced cost of disposal of drilling cuttings and shorter sampling times.

### DPT Sampling Methodologies

There are several methods for the collection of soil samples using DPT drilling. The most common method is discussed in the following section. Variations of the following method may be conducted upon approval of the Tetra Tech PM in accordance with the project-specific plan.

Macrocore samplers fitted with detachable aluminum or steel drive points are driven into the ground using hydraulic pressure. If there is concrete or pavement over a sampling location, a Roto-hammer is used to drill a minimum 1.5-inch diameter hole through the surface material. A Roto-hammer may also be used if very dense soils are encountered.

The sampler is advanced continuously in 4-foot intervals, or less if desired. No soil cuttings are generated because the soil which is not collected in the sampler is displaced within the formation.

The sampler is retracted from the hole, and the 4-foot continuous sample is removed from the outer coring tube. The sample is contained within an inner acetate liner.

- Attach the metal trough from the Geoprobe® Sampling Kit (or equivalent) firmly to the tail gate of a vehicle. If a vehicle with a tail gate is not available, secure the trough on another suitable surface.
- Place the acetate liner containing the soils in the trough.
- While wearing cut-resistant gloves (constructed of leather or other suitable material), cut the acetate liner through its entire length using the double-bladed knife. Then remove the strip of acetate from the trough to gain access to the collected soils. **Do not** attempt to cut the acetate liner while holding it in your hand.
- Field screen the sample with an FID or PID (according to manufacturer's Standard Operating Procedure [SOP]) and observe/examine the sample. If appropriate, transfer the sample to sample bottles for laboratory analysis. If additional volume is required, push an additional boring adjacent to the first and composite/mix the same interval. Field compositing is usually not acceptable for sample requiring volatile organic compounds (VOCs) analysis.
- Once sampling has been completed, the hole is backfilled with bentonite chips or bentonite cement grout, depending upon project requirements. Asphalt or concrete patch is used to cap holes through paved or concrete areas. All holes should be finished smooth to existing grade.
- In the event the direct push van, truck, or track mounted rig cannot be driven to a remote location or a sampling location with difficult accessibility, sampling probes may be advanced and sampled manually or with air/electric operated equipment (e.g., jack hammer).
- Sampling equipment is decontaminated prior to collecting the next sample.

## 6.0 GROUNDWATER SAMPLING PROCEDURES

The most common methodology for the investigation of groundwater is the installation and sampling of permanent monitoring wells. If only groundwater screening is required, the installation and sampling of temporary well points may be performed. The advantage of temporary well point installation using DPT is

reduced cost due to no or minimal disposal of drilling cuttings and well construction materials, and shorter installation/times sampling. Two disadvantages of DPT drilling for well point installation are:

- In aquifers with low yields, well points may have to be sampled without purging or development.
- If volume requirements are high, this method can be time consuming for low yield aquifers.

### 6.1 Sampling Equipment

Equipment needed for temporary well installation and sampling using DPT includes, but is not limited to the following:

- 2-foot x 1 -inch diameter mill-slotted (0.005 to 0.02-inch) well point Connecting rods
- Roto-hammer with 1.5-inch bit Mechanical jack
- 1/4-inch outside diameter (OD) PE tubing
- 3/8-inch OD PE tubing
- Peristaltic pump
- Standard decontamination equipment and solutions

### 6.2 DPT Sampling Methodologies

Once the water table has been encountered, a stainless steel screen point groundwater sampler (Geoprobe®, HydroPunch™, or equivalent) will be driven by DPT to collect a groundwater sample at the water table.

- The screen point will be allowed to equilibrate for at least 15 minutes.
- Once equilibration occurs, measurement of the static water level will be taken. This initial water level measurement will be used to assess the amount of water present in the screen point and to determine the amount of silt and/or sand infiltration.
- Development of the screen point will be accomplished using a peristaltic pump.
- Insert the intake end of a length of dedicated PE tubing to the bottom of the screen point and attach a length of silicon tubing (approximately 1 foot) to the discharge end of the PE tubing. The silicon tubing will be threaded around the rotor of the pump and out of the pump.
- The PE tubing will be lifted and lowered slightly while the pump is operating. The maximum pump rate will be approximately 2 liters per minute during development; however the yield of the formation will dictate the pumping rate.
- Measurement of pH, specific conductance, turbidity, dissolved oxygen (DO), oxidation reduction potential (ORP), salinity, and temperature shall be recorded every 5 to 10 minutes during the development process using a water quality meter and flow-through cell, with the exception of turbidity. Turbidity measurements will be taken with a Lamotte Turbidity Meter from water

collected from a T-connector with a valve inserted in the pump discharge tubing prior to entering the flow-through cell.

- After removal of sediment from the bottom of the screen point, the screen point will be pumped until discharge water is visibly clear and no further sediments are being generated.
- Stabilization is achieved after two consecutive readings taken at 5 to 10 minutes intervals of the following field parameters has occurred:

    - pH +/- 0.1 standard units
    - Turbidity +/- 10% for values greater than 1 NTU
    - Specific conductance +/- 3%
    - Temperature +/- 3%
    - ORP +/- 10 millivolts
    - DO +/- 10%

- Samples will be collected using the peristaltic pump set at 0.2 liters per minute or lower, depending on the yield of the formation. Samples will be collected directly from the pump discharge. The pump shall continuously operate between development, purging, and sampling.

- If the above condition(s) have not been met after three well volumes have been removed, this will be recorded on the field sample form and the groundwater sample will be collected.

- Record the sample date and time (using military time) on a Tetra Tech Groundwater Sample Log Sheet and on a chain-of-custody form.

- Record the sample date and time (using military time) on an adhesive-backed sample label and affix the sample label securely to the sample container.

- With the pump continuing to run, allow the pump discharge to flow gently down the inside of the sample container with minimal turbulence when filling sample containers. Avoid immersing the discharge tube into the sample as the sample container is being filled.

- Cap each container immediately after filling.

- Place the sample container into a ziplock bag and then into a cooler containing ice.

- Repeat the last four steps for each sample container collected.

- The pump rate should not be adjusted after sampling has commenced. If it becomes necessary to adjust the pump rate, document the change on the Tetra Tech Groundwater Sample Log Sheet.

- All samples will be collected into pre-preserved bottles (if required) supplied by an approved laboratory. The hierarchy of filling sample containers is as follows:

    - Explosives
    - Total metals
    - Dissolved metals

- This hierarchy takes into consideration the volatilization sensitivity of groundwater samples. For turbid samples, a single-use, disposable, in-line 0.45-micron filter cartridge shall be used to collect dissolved metals samples. Attach the filter cartridge to the discharge end of the pump tubing. Prior to filling containers with filtered sample, rinse the filter cartridge with approximately 100 milliliters (mL) of water from the boring to be sampled. Direct the discharge from the filter cartridge into the sample bottle and collect the filtered sample. The laboratory will supply all sample containers, and the laboratory will pre-preserve sample containers where appropriate.

- Once all of the sample containers have been filled, the pump shall be shut off. Record the sample date and time (in military time) on an adhesive-backed sample label and affix the sample label securely to the sample container. Record the end time for sampling on a Tetra Tech Groundwater Sample Log Sheet.

- Once collection of samples is complete, the driller shall remove the screen point and the screen point will be decontaminated in accordance with the procedures outlined in the decontamination SOP.

- If needed, continuous soil and groundwater sampling using DPT below the water table shall be done in accordance with those procedures outlined above.

- After the groundwater samples have been collected, the driller shall retract the screen point sampler from the borehole and proceed to abandon the borehole with a grout pump using a cement bentonite grout mix from the bottom up to the ground surface.

- When advancing a boring using DPT and refusal is encountered, the boring shall be deemed complete, drilling shall cease, and the borehole shall be abandoned with a grout pump using a cement bentonite grout mixture.

# STANDARD OPERATING PROCEDURE
# NUMBER SOP-08

# INCREMENTAL SAMPLING (IS) METHODOLOGY FOR SOIL AND/OR SEDIMENT FOR THE MILITARY MUNITIONS RESPONSE PROGRAM

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for collecting incremental sampling (IS) methodology surface soil and/or sediment samples using a hand operated coring device to support the field investigations at Marine Corps Recruit Depot (MCRD) Parris Island UXO 5 – Firing Point T. This SOP is compliant with United States Environmental Protection Agency (USEPA) SW-846 Method 8330B, Appendix A, and United States Army Corps of Engineers (USACE) guidance documents.

The most widely known description of IS for environmental use is SW-846 Method 8330B, Appendix A. The specific sample collection and processing procedures described in Method 8330B were based primarily on studies by the USACE Cold Regions Research and Engineering Laboratory (CRREL). These studies were designed to demonstrate and develop the methodology for application to the investigation of explosive compounds at active military testing and training ranges.

This technique will assist in estimating mean munitions constituent (MC) concentrations which can be used to assess whether potential MC:

- Are present within the sampled area at an average concentration greater than the analytical method detection limit or reporting limit;
- May pose an unacceptable risk to human health, or ecological receptors;
- May contribute to significant contaminant concentrations to groundwater; and
- Concentrations exceed mean background or ambient concentrations unrelated to munitions activities.

A Sampling Unit (sometimes synonymous with a Decision Unit) is the area and depth of soil to be represented by the IC samples. Sampling Units must be delineated so that the mean analyte concentrations obtained are directly relevant to well defined project objectives. Typical Sampling Units could be as small as 3 feet by 3 feet or as large as 300 feet by 300 feet.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for IS soil and/or sediment sampling.

**Disposable medical-grade gloves (e.g., latex, nitrile)**

**Indelible marker**

**CRREL coring device (or equivalent), with properly sized CRREL coring shoe** (size predetermined before sampling commences, based on number of increments, sample depth interval, and required sample size)

**Plastic storage bags**

**Sample tags**

**Shipping containers** (containing ice)

**Sample containers:** Sample containers are certified clean by the laboratory supplying the containers.

**Field Forms:** Soil and Sediment Sample Log (SOP-06)

**Electronic label maker**

## 3.0 SAMPLING PROCEDURES

Hand coring will be employed to collect incremental soil cores of cohesive soils and/or sediments using a coring device and properly-sized coring shoe (or equivalent). This will ensure that increments of soil or sediment are collected in a consistent manner from across the entire Sampling Unit. This consistency maximizes the representativeness of the IS sample. Although the use of a hand trowel or hand auger may be unavoidable for some material, such tools are not recommended because they do not control the amount of material per increment and uniform increments are critical to IS. If the soils and/or sediments are not cohesive, this SOP should not be used and an alternate procedure should be followed that ensures a representative sampling scheme that is appropriate for the situation at hand.

Practical limitations and unforeseen field conditions may require modifying the delineation of Sampling Units as defined during planning. Conditions of this nature may include the presence of pavement, buildings, or exposed bedrock surface without soil. In general, significantly changing the total sampling area should be avoided if possible. Changes and their rationale should be fully described in field task modification requests (FTMRs) and project reports.

A 1 to 2 kilogram (dry weight) IS sample usually ensures that sufficient IS mass has been collected to adequately represent the Sampling Unit mean concentration. An adjustment is necessary to incorporate project-specific soil densities and moisture contents (if known) into the determination for the proper volume of increments needed in order to meet this target mass requirement, where 1 kilogram (dry

weight) represents a minimum requirement and 2 kilograms (dry weight) represents a recommended maximum amount for each IS sample.

The sampler will wear clean, disposable, medical-grade gloves and the coring device will be decontaminated between Sampling Units.

## 3.1 INCREMENT SAMPLING PROCEDURES

3.1.1 The correct size coring shoe (or equivalent) was determined based on the number of sample increments required, the sampling depth, and the average density of the soil or sediment. Since a 1 to 2 kilogram (dry weight) IS sample is preferred, the following table matches the project-specific need to the correct coring shoe size (or equivalent auger diameter and depth).

**Coring Device Size Selection Based on Number of Increments and Sample Depth**

| Number of Increments | Sample Depth (inches) | Soil Density* (g/cc) | Minimum Corer Diameter - 1,000 grams total (nearest ¼ inch) | Maximum Corer Diameter - 2,000 grams total (nearest ¼ inch) |
|---|---|---|---|---|
| 50 (10 x 5) | 2 | 1.5 | 0.75 | 1.00 |

* Assumed soil density = 1.50 grams per cubic centimeter (g/cc) and assumed percent moisture is less than 10 percent. At the discretion of the Tetra Tech FOL, the coring device size may be adjusted based on site conditions that differ from these assumptions, but must be the same throughout the entire Sampling Unit.

3.1.2 Grid off the Sampling Unit by gridding off the 200 foot wide by 50 foot long investigation area into 50 increments of equal size (10 squares wide by 5 squares long, resulting in each grid cell being 20 feet wide and 10 feet long). Stakes, flagging, or other means of clear visual reference should be used so the field sampler can accurately identify each grid.

3.1.3 Starting in one cell (a corner cell is recommended), systematically sample each grid cell as described in Steps 3.1.3.1 through 3.1.3.4. A successful systematic increment collection scheme is to start in one corner of the Sampling Unit and work in a back-and-forth path, traveling to each successive cell until an increment has been collected from each grid cell.

3.1.3.1 Upon entering a grid cell, locate the center of the grid cell from which to obtain an increment. Clear the area to be sampled of any surface debris (herbaceous vegetation, twigs, rocks, litter, etc.).

3.1.3.2 Turn the coring device into the ground to the depth of the selected shoe. Remove the coring device and visually verify that the entire core was retained. If the coring device is not filled with soil, collect remaining soil from the hole to fill the coring device with the intended soil volume.

3.1.3.3 Eject the soil increment into a labeled sample container such as a plastic bag, 2-liter wide-mouth container, or other suitable container which must be large enough to hold all of the increments to be collected from the Sampling Unit.

3.1.3.4 Field triplicate samples must be collected at a minimum frequency of 1 per 10 IS samples in order to provide precision data that will be used to support the data evaluation process. Field triplicates for IS are not field split samples; rather, they must be independently collected incremental samples from the same Sampling Unit. This will be accomplished by collecting the first replicate at each interval from 5 feet away in a northeast direction from the original IS sample and by collecting the second replicate from 5 feet away in a southeast direction from the original IS sample.

3.1.4 Repeat steps 3.1.3.1 to 3.1.3.4 in the designated Sampling Unit until the entire sample grid has been collected.

3.1.5 For each of the triplicate ISs, package the entire lot of collected soil or sediment and send to the laboratory for processing and analysis.

3.1.6 Complete the required information on the electronic Soil and Sediment Sample Log Sheet (an example is attached at the end of this SOP). Note the location of each aliquot in the "OBSERVATIONS/NOTES" section of the Soil and Sediment Sample Log Sheet. Only the notes added within the sample analysis block on the Soil and Sediment Sample Log Sheet will be visible on the Chain-of-Custody form for review by laboratory personnel.

3.1.7 Decontaminate the coring device in the field between each IS Sampling Unit.

Note: Collection of rinsate blanks is unnecessary because the contamination in these blanks is typically negligible.

## 4.0 REFERENCES

GPL Laboratories, LLC, 2009. SOP No. G.22: General Laboratory Multi Incremental Sampling (MIS) sub-sampling procedure. January.

US Army Corps of Engineers (USACE), 2004. Field Sampling Tools for Explosives Residues Developed at CRREL. ERDC/CRREL TN-04-1. April.

USACE. 2007, Protocols for Collection of Surface Soil Samples at Military Training and Testing Ranges for the Characterization of Energetic Munitions Constituents. ERDC/CRREL TR-07-10. July.

USACE, 2009. Interim Guidance 09-02: Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program. July.

United States Environmental Protection Agency (USEPA), 2006. SW-846 Method 8330B, Appendix A. Office of Solid Waste and Emergency Response, Washington, DC. October.

## 5.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

# ATTACHMENT 1

## 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): | | | | |
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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-09

# SEDIMENT SAMPLING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for sediment sampling in streams and other waterways.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for sediment sampling.

**Sediment Sample Log Forms**: A copy of this form is attached at the end of this SOP.
**Writing utensil (preferably black pen with indelible ink)**
**Indelible marker**
**Bound field logbook**
**Disposable plastic trowels**
**Survey stakes and flagging:** Used to mark sampling locations after completion of sampling.
**Labeled sample containers**: See SOP-01 for sample labeling procedures. Sample containers are certified clean by the laboratory supplying the containers.
**Sealable polyethylene bags**
**Shipping containers** (containing ice)
**Disposable medical-grade gloves (e.g., latex, nitrile)**
**Chain-of-Custody Form**

## 3.0 SEDIMENT SAMPLE LOCATION SELECTION

In general, sediments composed of fine-grained materials with greater surface area available for adsorption are more desirable for sample selection. The fined-grained materials may act as a sink or reservoir for adsorbing heavy metals and organic contaminants even if surface runoff concentrations are below detection limits. Therefore, it is important to locate the specific sampling points where the sediment has the greatest percentage of fine particles. The sampling personnel will determine specific sampling locations with these goals in mind.

## 4.0 SEDIMENT SAMPLING PROCEDURES

4.1 The sampler will wear clean, disposable medical-grade gloves. Clear vegetative matter or debris, if present, from the sample location using a disposable sampling trowel or spoon. Use the trowel to dig up and homogenize the sediment in an 18-inch-diameter circular area that is 6 inches deep. Stir the sediment within the circular area; do not move the sediment outside the circle. Also, do not dig or stir sediment that is deeper than 6 inches below the ground surface, until the next depth interval is sampled.

- Use the same trowel to scoop the homogenized sediment into the requisite labeled sample container(s).

4.2 Record the sample time (using military time) on the Sediment Sample Log Form and sample container labels. Record all other information required on the labels as specified by SOP-01.

4.3 Place the labeled sample container into a sealable polyethylene bag and then place the bag holding the sample container into a cooler containing ice.

4.4 Record date, sampling site, site conditions, location map, and other information (e.g., presence and flow rate of water in channel) on the Sediment Collection Log Sheet. Enter the sample information onto the Chain-of-Custody Form in accordance with SOP-03.

4.5 Using an indelible marker, write the sample identification on a survey stake, and drive the stake into the ground at the sample location. Tack a piece of brightly colored flagging to the stake. In addition, tie a piece of flagging to an overhead tree branch or other eye-level object to improve the ability to relocate the sampling site in the future.

## 5.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

## ATTACHMENT 1

## SOIL AND SEDIMENT SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

**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-10

# LARGE WATER BODY SEDIMENT SAMPLING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for sediment sampling in large water bodies from a motor powered work boat.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for sediment sampling.

**Sediment Sample Log Forms**: See Attachment to this SOP.
**Writing utensil (preferably black pen with indelible ink)**
**Indelible marker**
**Bound field logbook**
**Stainless steel trowels**
**Large stainless steel bowls**
**Aluminum Foil**
**Clamshell dredge 15 pound or 25 pound dredge with rope:** If the 25 pound dredge is needed, a winch and boom will be required.
**Global Positioning System (GPS):** Used to locate and mark sampling locations.
**Labeled sample containers**: See SOP-01 for sample labeling procedures. Sample containers are certified clean by the laboratory supplying the containers.
**Decontamination equipment:** See SOP-19 for decontamination equipment.
**Sealable polyethylene bags**
**Shipping containers** (containing ice)
**Disposable medical-grade gloves (e.g., latex, nitrile)**
**Otter plastic gloves (e.g., nitrile)**
**Chain-of-Custody Form**
**Personal floatation devices (life jackets)**
**18-ft wide-bodied, flat-bottomed boat powered by an outboard motor**

## 3.0 SEDIMENT SAMPLE LOCATION SELECTION

Sediment samples shall be collected throughout a study area in a grid like pattern or at locations established by the FOL. The sample locations x-y coordinates will be electronically loaded in to a hand held global positioning system (GPS) unit. These coordinates are then used to navigate to and locate the sampling locations using the GPS unit.

## 4.0 SEDIMENT SAMPLING PROCEDURES

4.1 The work boat will be loaded with all necessary equipment in order to find sampling locations, collect the samples, and clean the sampling equipment, minimizing the number of times required to return to shore.

4.2 The sampler will wear clean, disposable medical-grade gloves with outer nitrile type gloves. Attach the clamshell dredge to a tie line or rope, spread the sampling jaws and place the spring loaded keeper pin into the jaw arms of the dredge, thus locking the jaws open. Lower the dredge into the water, and down to the river bottom in one smooth motion allowing the dredge to sink steadily to the river bottom. The jaws will automatically close when the retrieval is initiated. Retrieve the dredge with sediment and before opening place the dredge into a clean stainless steel bowl. Carefully open the jaws and allow the dredge to empty the sediment in to the stainless steel bowl. Use the trowel to homogenize the sediment in the stainless steel bowl. Use the same trowel to scoop the homogenized sediment into the requisite labeled sample container(s).

4.3 Record the sample time (using military time) on the Sediment Sample Log Form and sample container labels. Record all other information required on the labels as specified by SOP-01.

4.4 Place the labeled sample container into a sealable polyethylene bag and then place the bag holding the sample container into a cooler containing ice.

4.5 Record date, sampling site, site conditions, location map, and other information (e.g., depth to the river bottom) on the Sediment Collection Log Sheet. Enter the sample information onto the Chain-of-Custody form in accordance with SOP-03.

4.6 Using the GPS unit, survey in the sample location in order to relocate the sampling site in the future.

## 5.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

## ATTACHMENT 1

## SOIL AND SEDIMENT SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

**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-11

# TEMPORARY MONITORING WELL INSTALLATION AND ABANDONMENT

## 1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper design and installation of temporary groundwater monitoring wells. The methods described herein are specific for temporary monitoring well construction at Marine Corps Recruit Depot (MCRD) Parris Island.

## 2.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction. The drilling contractor personnel must have all the health and safety training required to perform the work, as specified in the health and safety plan. All well drilling activities shall be performed under the direct supervision of a driller licensed in the State of South Carolina. The driller is also responsible for obtaining, in advance, any required permits for drilling and monitoring well installation and construction for the State of South Carolina.

Field Geologist - The Field Geologist supervises and documents well installation and construction performed by the driller and ensures that the screen interval for each monitoring well is properly placed to provide representative groundwater data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

Site Safety Officer (SSO) – The SSO is responsible for clearing the drill site for underground and overhead utilities or other potentially hazardous obstructions.

## 3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well installation:

**Health and safety equipment** as required by the Health and Safety Plan (HASP) and the SSO.

**Well drilling and installation equipment** with associated materials (typically supplied by the driller). Wells can be installed using direct push techniques (DPT) drilling methods or hollow-stem auger (HSA). The preferred method is DPT, but if DPT is not feasible, HSA will be used.

**Hydrogeologic equipment** (weighted engineer's tape, water-level indicator, retractable engineer's rule, electronic calculator, clipboard, mirror and flashlight for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, boring logs, soil sample log forms, chain-of-custody records, sample coolers with ice, and a field notebook).

## 4.0 WELL DESIGN, CONSTRUCTION, AND ABANDONMENT

Temporary wells shall be constructed using nominal 1-inch ID, PVC riser and nominal 1-inch ID, PVC factory slotted screen (0.010 slot) pre-packed screen. Clean silica sand of U.S. Standard Sieve Size No. 20 to 40 will be used for the sand pack, 100 percent certified pure sodium bentonite will be used for the seal above the sand pack and hydrated.

DPT - The temporary well will be installed by driving a nominal 3-inch ID drill casing (with an expendable tip) to the desired depth. After the casing has been advanced to approximately 8 feet below the first water bearing zone, a 10-foot-long screen attached to the riser pipe will be lowered to the bottom through the casing. The casing will then be withdrawn from the ground, exposing the pre-pack screen to the formation material. The saturated formation material may collapse around the screen, and the remaining annular space around the screen will be filled with silica sand to at least 1 to 2 feet above the screen. The depths of backfill materials will be constantly monitored, if possible, during well installation using a weighted stainless-steel or fiberglass tape measure. A bentonite seal will then be installed to the ground surface or at least ten feet above the sand-pack completing the temporary well construction.

HSA – The temporary well will be installed by driving a nominal 3 ½ or 4 ½ -inch ID drill HSA to the desired depth if DPT is not feasible. After the HSA has been advanced to approximately 8 feet below the first water bearing zone, a 10-foot-long screen attached to the riser pipe will be lowered to the bottom through the HSA. The HSA will then be withdrawn from the ground, exposing the pre-pack screen to the formation material. The saturated formation material may collapse around the screen, and the remaining annular space around the screen will be filled with silica sand to at least 1 to 2 feet above the screen. The depths of backfill materials will be constantly monitored, if possible, during well installation using a weighted stainless-steel or fiberglass tape measure. A bentonite seal will then be installed to the ground surface or at least ten feet above the sand-pack completing the temporary well construction.

The annular space at the ground surface will be covered with plastic sheeting around the riser if needed to prevent infiltration of surface runoff or rainwater into the annulus. The riser pipe will be capped to prevent rain water from entering into the well and will remain in place until the point is abandoned.

Once the well has been sampled by Tetra Tech personnel, the Subcontractor shall abandon the well in accordance with State of South Carolina regulations. This requires that the PVC screen and riser be removed from the boring and the boring backfilled with cement/bentonite grout from the bottom up using a tremie pipe.

## 5.0 DOCUMENTATION OF FIELD ACTIVITIES

A critical part of monitoring well installation is recording of significant details and events in the site logbook, on field forms, and in a field logbook. Details of borehole logging are contained in SOP-05.

## 6.0 ATTACHMENTS

1. Overburden Monitoring Well Sheet

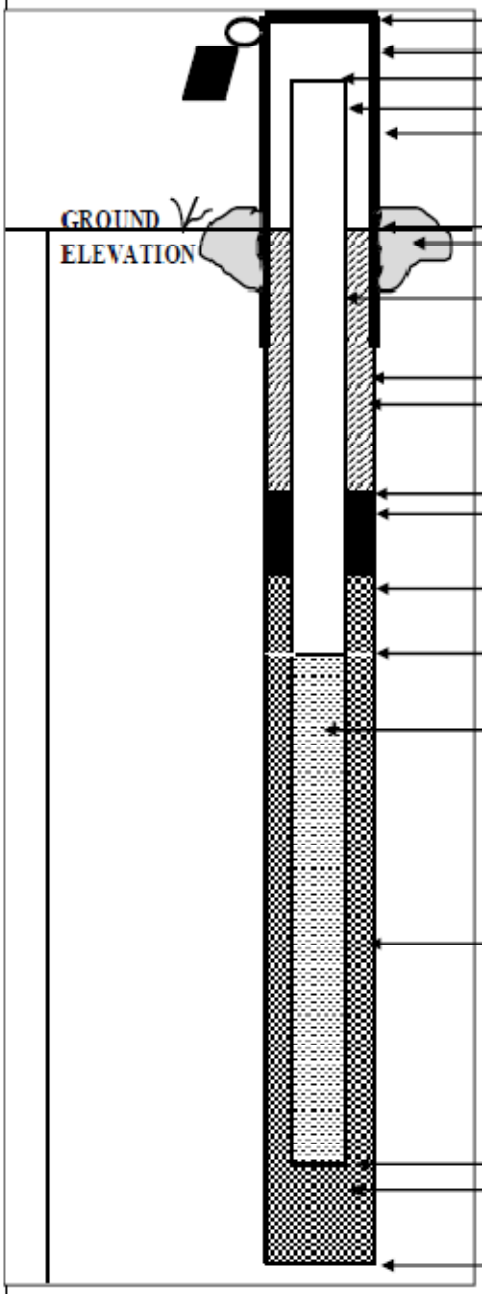
## ATTACHMENT 1

## OVERBURDEN MONITORING WELL SHEET

BORING NO.: _____

Tetra Tech NUS, Inc. **TEMPORARY OVERBURDEN MONITORING WELL SHEET**

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | | DRILLING Co.: | | BORING No.: | |
| PROJECT No.: | | DRILLER: | | DATE COMPLETED: | |
| SITE: | | DRILLING METHOD: | | NORTHING: | |
| GEOLOGIST: | | DEV. METHOD: | | EASTING: | |




ELEVATION OF TOP OF SURFACE CASING: _____
STICK -UP TOP OF SURFACE CASING: _____
ELEVATION OF TOP OF RISER PIPE: _____
RISER STICK-UP ABOVE GROUND SURFACE: _____
I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

GROUND ELEVATION: _____
TYPE OF SURFACE SEAL: _____

RISER PIPE I.D.: _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____
TYPE OF SEAL: _____

ELEVATION / DEPTH OF SEAL: _____ / _____
TYPE OF SEAL: _____

ELEVATION / DEPTH TOP OF FILTER PACK: _____ / _____

ELEVATION / DEPTH TOP OF SCREEN: _____ / _____

TYPE OF SCREEN: _____

SLOT SIZE X LENGTH: _____

I.D. OF SCREEN: _____

TYPE OF FILTER PACK: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____ / _____
ELEVATION / DEPTH BOTTOM OF FILTER PACK: _____ / _____
TYPE OF BACKFILL BELOW WELL: _____
ELEVATION / DEPTH OF BOREHOLE: _____ / _____

# STANDARD OPERATING PROCEDURE

# SOP-12

# TEMPORARY WELL DEVELOPMENT

## 1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper development of temporary wells. The methods described herein are specific for monitoring wells located at Marine Corps Recruit Depot (MCRD) Parris Island.

## 2.0 RESPONSIBILITIES

The drilling contractor or Tetra Tech personnel shall provide adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of developing monitoring wells. The field personnel must have all the health and safety training required to perform the work, as specified in the Health and Safety Plan (HASP).

## 3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well development:

**Health and safety equipment** as required by the HASP and the site safety officer (SSO).

**Well development equipment with associated materials** (supplied by the driller or Tetra Tech)
Peristaltic and/or 0.75" submersible bladder pump.

**Hydrogeologic equipment** (water-level indicator, electronic calculator, clipboard, paint and ink marker, well development forms, and a field notebook).

## 4.0 PROCEDURES

Development of the temporary wells will be accomplished using a peristaltic pump or bladder pump and polyethylene (PE) tubing.

4.1 Insert the intake end of a length of PE tubing to the bottom of the screen point and attach a length of silicon tubing (approximately 1 foot) to the discharge end of the PE tubing. The silicon tubing

will be threaded around the rotor of the pump and out of the pump. Or attach PE twin-line tubing to the bladder pump and lower in to well to approximately two feet off the bottom of the well. The bladder pump will be activated using an environmental standard compressed gas cylinder and control system.

4.2 The PE tubing or bladder pump will be lifted and lowered slightly while the pump is operating. The maximum pump rate will be approximately 2 liters per minute during development. However, the yield of the formation will dictate the pumping rate.

4.3 Measurement of pH, specific conductance, turbidity, dissolved oxygen (DO), oxidation-reduction potential (ORP), and temperature shall be recorded every 5 to 10 minutes during the development process using a water quality meter and flow-through cell.

4.4 The temporary monitoring well will be pumped until discharge water is visibly clear, the turbidity readings do not improve over time, or the well screen goes dry.

4.5 Sampling will commence in accordance with SOP-13 through SOP-16.

## 5.0 ATTACHMENTS

1. Monitoring Well Development Record

## ATTACHMENT 1

## MONITORING WELL DEVELOPMENT RECORD

Tetra Tech NUS, Inc.

**MONITORING WELL DEVELOPMENT RECORD**

Page ___ of ___

Well: _____ Depth to Bottom (ft.): _____ Responsible Personnel: _____
Site: _____ Static Water Level Before (ft.): _____ Drilling Company: _____
Date Installed: _____ Static Water Level After (ft.): _____ Project Name: _____
Date Developed: _____ Screen Length (ft.): _____ Project Number: _____
Dev. Method: _____ One Well Volume (gal/L): _____ PID Readings: Bore Hole____ppm
Pump Type: _____ Casing ID (in.): _____ PID Readings: Breathing Zone____ppm

| Time | Cumulative Water Volume (Gal.) | Flow Rate (mL/min.) | Water Level Readings (Ft. below TOC) | Temperature (Degrees C) | pH | Specific Conductance (Units____) | Turbidity (NTU) | Remarks (odor, color, etc.) |
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# STANDARD OPERATING PROCEDURE

# SOP-13

# MEASUREMENT OF WATER LEVELS IN MONITORING WELLS

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes procedures for determining water levels in monitoring wells.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following equipment and field forms are required for determining water levels in monitoring wells.

**Ground Water Level Measurement Form**: A copy of the Ground Water Level Measurement Form is attached.

**Bound field logbook**

**Well key**

**Writing utensil**

**Electronic water-level indicator**: The water-level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 foot.

**Decontamination supplies**: SOP-19 describes decontamination procedures including decontamination supplies.

## 3.0 WATER-LEVEL MEASUREMENT PROCEDURES

3.1 Check the operation of the electronic water-level indicator or interface meter.

3.2 Record the well identification (ID), date, and time (using military time) on the Ground Water-Level Measurement Form.

3.3 Unlock the well and remove the well cap.

3.4 Place the well cap on a clean piece of plastic.

3.5 Ensure that the water-level indicator probe has been decontaminated before use, in accordance with the procedures outlined in SOP-19.

3.6 Slowly lower the probe into the well riser pipe until an audible and/or visible signal is produced, indicating contact with the water surface.

3.7 Read the ground water-level measurement from the top of the inner casing at the surveyed reference point to the nearest 0.01 foot.

3.8 Record the water-level measurement on the Ground Water Level Measurement Form.

3.9 Wind the meter cable measuring tape back onto the spool.

3.10 Replace the well cap and lock.

3.11 Decontaminate the meter's probe and cable following the procedures outlined in SOP-19.

3.12 Containerize any decontamination fluids and PPE in accordance with the procedures described in SOP-17.

## 4.0 ATTACHMENTS

1. Ground Water Level Measurement Sheet

## ATTACHMENT 1

## GROUND WATER LEVEL MEASUREMENT SHEET

Tetra Tech NUS, Inc.

**GROUNDWATER LEVEL MEASUREMENT SHEET**

**Project Name:** _____ **Project No.:** _____
**Location:** _____ **Personnel:** _____
**Weather Conditions:** _____ **Measuring Device:** _____
**Tidally Influenced:** Yes ___ No ___ **Remarks:** _____

| Well or Piezometer Number | Date | Time | Elevation of Reference Point (feet)* | Total Well Depth From TOC (feet)* | Water Level Indicator Reading (feet)* | Groundwater Elevation (feet)* | Comments |
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* All measurements to the nearest 0.01 foot

Page ___ of ___

# STANDARD OPERATING PROCEDURE

# SOP-14

# LOW-FLOW WELL PURGING AND STABILIZATION

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for well purging and stabilization utilizing low-flow techniques.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow purging.

**Low-Flow Purge Data Sheet:** A copy of this form is attached at the end of this SOP.
**Bound field logbook**
**Writing utensil**
**Well key**
**Electronic water-level indicator:** The water-level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 foot.
**Submersible Bladder Pump:** QED Sample Pro or equivalent using twin bonded ¼-inch polyethylene (PE) tubing.
**Electronic Programmable Controller, MP-10:** This controller regulates air flow in a bladder pump.
**Cylinder of compressed nitrogen with regulator:** Compressed gas serves as the power source for the bladder pump.
**Peristaltic Pump**: Using siliclastic tubing and ¼-inch PE tubing.
**Water-quality meters:** These units measure and display field parameters in the field including turbidity, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, and specific conductance (see SOP-15).
**Flow-through cell adapter for water-quality meter**
**Purge water containers**
**Graduated cylinder and stopwatch:** Used to calculate flow rate.
**Decontamination supplies:** SOP-19 describes required decontamination supplies.
**Disposable medical-grade gloves (e.g., latex, nitrile)**

## 3.0 PROCEDURES FOR WELL PURGING

3.1 Prior to mobilizing to the site, clean, check for proper operation, and calibrate above equipment in accordance with manufacturer requirements as necessary.

3.2 Measure the static water-level of the well with respect to the top of the PVC riser. Record the information on the Groundwater Sample Log Sheet (see SOP-16) and the Low-Flow Purge Data Sheet.

3.3 Purge wells using either a submersible bladder pump or surface peristaltic pump. For wells with depths to water level exceeding the capacity of the peristaltic pump (about 27 feet to water), use a submersible bladder pump to purge and sample the well. Follow steps 3.5 through 3.9 for bladder pump procedures; skip to step 3.10 for peristaltic pump procedures.

3.4 Connect the pump controller to the well pump air supply by following the instructions in the pump control manual. The pump controller must be turned off when it is being connected.

3.5 Connect the nitrogen cylinder to the pump controller. The nitrogen cylinder valve must be closed and the regulator line pressure set at zero pounds per square inch (psi) when it is being connected.

3.6 Following the instructions found in the water-quality meter manual, connect the flow-through cell to the pump discharge line (at the well cap).

3.7 Place the discharge tubing from the flow-through cell to direct the purge water discharge into the graduated cylinder or purge water container.

3.8 Following the instructions in the pump controller manual, start pumping water from the well.

3.9 Peristaltic pump may also be used to purge and sample groundwater monitoring wells. Attach well tubing to the input side of the pump via the siliclastic tubing and the out from the pump to the input side of the flow through cell.

3.10 Start with the initial pump rate set at approximately 0.1 liters per minute. Use the graduated cylinder and stopwatch to measure the pumping rate. Adjust pumping rates as necessary (the pumping rate shall not exceed 0.5 liters per minute) to prevent drawdown from exceeding 0.3 foot

during purging. If the well goes dry during the purge process allow it to recover 80% then proceed to sample the well in accordance with SOP-16.

3.11 Measure the well water level using the water-level meter every 5 to 10 minutes pending the pumping rate. Typically, higher the flow rate the shorter the time period between measurements. Record the well water level on the Low-Flow Purge Data Form (attached at the end of this SOP).

3.12 Every 5 to 10 minutes, record on the Low-Flow Purge Data Form the water-quality parameters (pH, specific conductance, temperature, turbidity, ORP, and DO) measured by the water-quality meter and turbidity meter. If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low-Flow Purge Data Form.

3.13 Measure the flow rate using a graduated cylinder. Remeasure the flow rate any time the pump rate is adjusted.

3.14 During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles is an indication that connections are not tight. If bubbles are observed, check for loose connections.

3.15 Stabilization is achieved and sampling can begin when three consecutive readings, taken at 5- to 10-minute intervals, are within the following limits:

- pH $\pm$ 0.1 standard units
- Specific conductivity $\pm$ 5%
- Temperature $\pm$ 0.2 degrees C
- Turbidity less than 10 NTUs
- ORP $\pm$ 10%
- DO $\pm$ 10%

If the above conditions have still not been met after the well has been purged for 2 hours, purging will be considered complete and sampling can begin.

Record the final well stabilization parameters from the Low-Flow Purge Data From onto the Groundwater Sample Log Form.

If there is a need to leave a well during purging, there are two options:

- One, if the sampler must move for 30 minutes or less but still has a clear line of sight to the well; the sampler may leave the pump running and watch the well from a distance until he or she is able to return to the well.

- Two, if for whatever reason, the sampler must stop purging for an extended period of time or a clear line of sight cannot be maintained, the pump and cell will be shut down. All equipment and supplies will be loaded into the sample vehicle, and the well will be secured before the sampler departs.

In both cases, the time purging was stopped and restarted will be noted on the Low-Flow Purge Data Form.

3.16 Rinse the flow-through cell, the water-quality meter probes, and the turbidity cell with analyte-free water and pack the cell and meters for transport.

## 4.0 ATTACHMENTS

1. Low-Flow Purge Data Sheet

## ATTACHMENT 1

## LOW-FLOW PURGE DATA SHEET

Tetra Tech NUS, Inc.

**LOW FLOW PURGE DATA SHEET**

PROJECT : _____ WELL ID.: _____
PROJECT NUMBER: _____ DATE: _____
PROJECT SITE NAME: _____ WEATHER: _____

| Time (Hrs.) | Water Level (Ft. below TOC) | Volume (gal/L) | Flowrate (mL/min) | pH (S.U.) | Cond. (mS/cm) | Turb. (NTU) | DO (mg/L) | Temp. (Celsius) | ORP (mV) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
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Pump Intake Depth _____

Water Quality Meter (S/N) _____
Control Box Type (S/N) _____
Turbidity Meter (S/N) _____

SIGNATURE(S): _____

PAGE__OF__

# STANDARD OPERATING PROCEDURE
# NUMBER SOP-15

# CALIBRATION AND CARE OF WATER QUALITY METERS

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures for the calibration and maintenance of field instruments used to measure water quality and for the proper documentation of calibration and maintenance at Marine Corps Recruit Depot (MCRD) Parris Island. The YSI 556 MPS Environmental Monitoring System (or equivalent) will be used to measure pH, temperature, oxidation-reduction potential (ORP), specific conductance, and dissolved oxygen (DO). The turbidity in water will be measured using a LaMotte 2020e (or equivalent). The procedures for the YSI 556 MPS are provided in Section 3 and Section 4 provides the procedures for the LaMotte 2020e.

## 2.0 FIELD FORMS AND EQUIPMENT LIST

The following logbooks, forms, equipment, and supplies are required:

**Site logbook**
**Equipment calibration log sheet**
**YSI Model 556 MPS with on board barometer and Sonde**: multi-parameter water-quality meter with flow through cell.
**LaMotte 2020e Turbidity Meter**
**Equipment manuals**
**Calibration kits**
**Deionized water, paper towels, spray bottle, etc.**
**Disposable medical-grade gloves (e.g., latex, nitrile)**

## 3.0 YSI PROCEDURES

This section describes the calibration procedure for the YSI Model 556 MPS. The meter is supplied with an instruction manual. The manual will be on site and will be used as the calibration guidance document for the meter's calibration. This procedure will list requirements for frequency of calibration and checks to be performed on the meter.

The YSI Model 556 MPS and Sonde is a multi-parameter, water-quality meter that with the flow through cell attached, the meter has the ability to measure water-quality parameters in ground water via a pump discharge line. By performing the measurements in the discharge line coming directly from the well, the parameters are measured before the ground water comes in contact with the atmosphere. The parameters measured by the YSI for this field effort are as follows:

- DO
- Specific Conductivity
- Temperature
- pH
- ORP

### 3.1 Documentation

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 the frequency of calibration, type of standards used, and checks performed on calibration during the course of using the equipment. An Equipment Calibration Log must be maintained for each measuring device that requires calibration. Entries must be made for each day the equipment is used. A blank Equipment Calibration Log form is attached at the end of this SOP.

### 3.2 Calibration

The following YSI parameters DO, conductivity, and pH must be calibrated prior to the start of each day of use. Calibration and calibration checks will be documented in the field logbook and on the Equipment Calibration Log. The name, lot number, and expiration date for all calibration buffers and standards used will be recorded on the Equipment Calibration Log. The meter's model, serial number, and name of rental company will also be recorded on the equipment calibration form.

### 3.3 Tips for Good Calibration

- The DO calibration is a water-saturated air calibration. Make certain to loosen the calibration cup seal to allow pressure to equilibrate before calibrating.

- Make certain that sensors are completely submersed in solution and readings are stable when calibration values are entered.

- Use a small amount of calibration solution (previously used solution may be used, then discarded for this purpose) to pre-rinse the sonde.

- Fill a bucket with ambient temperature water to rinse the sonde between calibration solutions.

- Make sure to rinse and dry the probe between calibration solutions. This will reduce carry-over contamination and increase the accuracy of the calibration.

### 3.4 MAINTENANCE

The YSI Meter will be rented for the duration of the field effort. Therefore, little field maintenance will be required. For any maintenance other than the routine cleaning, calibrating, or battery charging, the instrument should be returned to the vendor and a replacement sent immediately to the job site.

#### 3.4.1 Meter Storage

For this field effort, the meter storage will be short term [i.e. over night or between work shifts (4-day break)]. During these breaks, charge the meter. Place one-half inch of tap or distilled water in the meter calibration cup thread the cup onto the sonde. The key for short-term storage of probes is to use a minimal amount of water so the calibration cup will remain at 100 percent humidity. The water level must be low enough so that none of the probes are actually immersed. Proper storage of the sonde between usages will extend its life and will also ensure that the unit is ready for use as quickly as possible for the next application.

**Multi-parameter short term storage key points:**

- Use enough water to provide humidity but not enough to cover the probe surfaces.
- Make sure the storage vessel is sealed to minimize evaporation.
- Check periodically to make certain that water is still present.

#### 3.4.2 Probe Cleaning

- Rinse the probe thoroughly with potable water.
- Rinse and soak the probe in deionized water.
- If stronger cleaning is required, Wash the probe in a mild solution of Liquinox and water and wipe with paper towels and/or cotton swabs.

Note: Reagents that are used to calibrate and check the YSI may be hazardous. Review the health and safety plan, Appendix D of the equipment manual, and Material Safety Data Sheets (MSDSs), all of which are on file in the field trailer.

## 4.0 LAMOTTE TURBIDITY METER PROCEDURES

This section describes the calibration procedure for the LaMotte 2020e turbidity meter. The meter is supplied with an instruction manual. The manual will be on site and will be used as the calibration guidance document for the meter's calibration.

4.1 Calibrate the LaMotte 2020e prior to the start of each day of use.

4.2 Document the calibration in the field logbook and on the Equipment Calibration Log. Record on the Equipment Calibration Log the name, lot number, and expiration date for all calibration standards used.

4.3 Record the meter's model, serial number, and name of rental company on the equipment calibration form.

## ATTACHMENTS

1. Equipment Calibration Log

# ATTACHMENT 1
# EQUIPMENT CALIBRATION LOG

Tetra Tech NUS, Inc.

## 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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# STANDARD OPERATING PROCEDURE
# SOP-16

# GROUNDWATER SAMPLING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for collecting groundwater samples from permanent and temporary monitoring wells. Low-flow sampling techniques will be used for groundwater sampling at Marine Corps Recruit Depot (MCRD) Parris Island.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow sampling of monitoring wells:

**Writing utensil** (preferably black ink)

**Stainless steel Geoprobe Screen Point Groundwater Sampler** (or equivalent)

**Groundwater Sample Log Form**: A copy of this form is attached at the end of this SOP.

**Low Flow Purge Data Sheet**: A copy of this form is attached at the end of this SOP.

**Bound field log book**

**Chain-of-Custody Form**

**Bladder pump:** With accessories: twin bonded PE ¼-inch tubing, MP-10 control box, nitrogen gas cylinder, and nitrogen regulator.

**Peristaltic pump:** Silicon and ¼-inch PE tubing.

**Required sample containers with appropriate preservative**: All sample containers for analysis by fixed-base laboratories will be supplied and deemed certified clean by the laboratory.

**Surgical gloves**

**Water-level indicator**

**0.45-micron filter cartridge:** If the metal analysis requires field filtering.

**Bucket:** to collect development/purge water

**Calculator, wristwatch, and timer**

**Stainless steel clamps**

**Plastic storage bags**

**Shipping containers with ice**

## 3.0 SAMPLING PROCEDURES

3.1 Groundwater sampling may be initiated when the well has been purged and stabilized in accordance with SOP-12.

3.2 Record the sample start time (using military time) on the Groundwater Sample Log Sheet. Record the field measurements for pH, oxidation-reduction potential (ORP), specific conductance, temperature, dissolved oxygen (DO), and turbidity.

3.3 With the pump continuing to run, disconnect the flow-through cell from the pump discharge tube and immediately start filling sample bottles directly from the pump discharge. All sample containers will be supplied by the laboratory, and the laboratory will pre-preserve all sample containers, where appropriate.

3.4 Allow the pump discharge to flow gently down the inside of the container with minimal turbulence when filling sample containers. Avoid immersing the discharge tube into the sample as the sample container is being filled.

3.5 Cap each container immediately after filling.

3.6 Record the sample time on the Groundwater Sample Log Form, the sample label, and the sample label.

3.7 Place the tagged sample container into a plastic storage bag and then into a cooler containing ice.

3.8 Enter the proper information on the Chain-of-Custody Form for each sample container (see SOP-03).

3.9 Repeat steps 3.3 through 3.9 for each sample container collected.

3.10 The pump rate should not be adjusted after sampling has commenced. If it becomes necessary to adjust the pump rate, document the change on the Groundwater Sample Log Form.

3.11 All samples will be collected into pre-preserved bottles (if required) supplied by an approved laboratory. All samples will be collected in the following sequence (where applicable):

- Other organics
- Metals
- Other Inorganics
- Filtered Metals

3.12 Filtered aliquots of groundwater may be collected and analyzed for dissolved metals. Without turning off the pump, attach a disposable, inline, 0.45-um filter cartridge at the end of the discharge tube. Fill sample containers marked for dissolved metals so that the laboratory knows that these aliquots are distinct sample fractions and that the results should be reported as dissolved analytes.

3.13 Repeat steps 3.5 through 3.9 for the filtered sample containers.

3.14 After completion of sample collection, remove the bladder pump (if bladder pump is used for sampling) from the well and decontaminate the pump following the procedures in SOP-19.

3.15 Proceed to abandon the temporary well as per SOP-11.

3.16 All equipment should be cleaned and packed into the sample vehicle, along with the sample cooler for transport. Disposable gloves, tubing, and other equipment should be placed in a plastic trash bag and handled as investigation-derived waste (SOP-17).

## 4.0 ATTACHMENTS

1. Groundwater Sample Log Sheet

## ATTACHMENT 1

## GROUNDWATER SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

### GROUNDWATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Domestic Well Data
[] Monitoring Well Data
[] Other Well Type: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____
Type of Sample:
[] Low Concentration
[] High Concentration

**SAMPLING DATA:**

| Date: / Time: / Method: | Color (Visual) | pH (S.U.) | S.C. (mS/cm) | Temp. ($^0$C) | Turbidity (NTU) | DO (mg/l) | Salinity (%) | Other |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

**PURGE DATA:**

| Date: | Volume | pH | S.C. | Temp. | Turbidity | DO | Salinity | Other |
|---|---|---|---|---|---|---|---|---|
| Method: | | | | | | | | |
| Monitor Reading (ppm): | | | | | | | | |
| Well Casing Diameter & Material Type: | | | | | | | | |
| Total Well Depth (TD): | | | | | | | | |
| Static Water Level (WL): | | | | | | | | |
| One Casing Volume(gal/L): | | | | | | | | |
| Start Purge (hrs): | | | | | | | | |
| End Purge (hrs): | | | | | | | | |
| Total Purge Time (min): | | | | | | | | |
| Total Vol. Purged (gal/L): | | | | | | | | |

**SAMPLE COLLECTION INFORMATION:**

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

**Circle if Applicable:**

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

**Signature(s):**

# STANDARD OPERATING PROCEDURE
# NUMBER SOP-17

# MANAGEMENT OF INVESTIGATION-DERIVED WASTE

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes how investigation-derived waste (IDW) will be collected and managed during the field investigations at Marine Corps Recruit Depot (MCRD) Parris Island. The following types of IDW will be generated during this investigation:

- Residual soil remaining from subsurface DPT drilling activities
- Well development water and purge water related to monitoring well installation and sampling
- Decontamination solutions
- Personal protective equipment and clothing (PPE)
- Miscellaneous trash and incidental items

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Health and safety equipment (with PPE)**
**Decontamination equipment**
**Field logbook and indelible ink pen**
**Plastic sheeting and/or tarps**
**55-gallon drums with sealable lids**
**IDW labels for drums**
**Wastewater container tanks**
**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.

## 3.1 Liquid and Soil Wastes

Liquid wastes that will be generated during the site activities include well development water, well purge water (collected during low-flow sampling), and decontamination solutions from drilling and sampling equipment. Soil wastes may include soil cuttings generated during borehole drilling.

3.1.1 Transfer wastewaters, including monitoring well purge water, to 55-gallon drums. Purge water will be collected at the well using 5-gallon spill proof containers which will then be used to transport the waste water to the 55-gallon drums marshaled at a central location on the MCRD Parris Island facility for proper disposal.

3.1.2 Place waste soils in 55-gallon drums staged at the location of generation. Waste soils will remain in the drums until groundwater sampling and removal of the temporary monitoring well at that location are completed. To the extent possible, return waste soils to the empty boreholes from which they were derived. Excess soil that cannot be returned to the boreholes will be containerized, marshaled at the same location as the waste water drums, and sampled for waste characterization. Based on the characterization results, drums of waste soil will be transported and appropriately disposed off site by the IDW subcontractor at a Navy-approved disposal facility.

3.1.3 The location and number of drums used for the completion of work will be documented in the field note book. Each drum will be labeled and the following information will be placed on the label.

- Contents (soil or water)
- Site (i.e., UXO 3, 4, 5, 6, 7, or 8)
- Location (MCRD Parris Island)
- Volume of waste in the drum
- Date and time the waste was placed in the drum
- The MCRD Parris Island Point of Contact (POC) name and contact phone number

## 3.2 PPE, Pump Discharge Tubing, Direct-Push Technology (DPT) Sample Liners, and Incidental Trash

All PPE wastes, pump discharge tubes, DPT sample liners, and incidental trash materials (e.g., wrapping or packing materials from supply cartons, waste paper) must be decontaminated (if contaminated), double bagged, securely tied shut, and placed in a designated waste receptacle at MCRD Parris Island.

# STANDARD OPERATING PROCEDURE

# SOP-18

# GLOBAL POSITIONING SYSTEM

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide the Field Technicians 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 Geo to range pole)
- GeoBeacon

- Indelible marker
- 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 4.2 or later. Download to personal computer from: http://www.microsoft.com/windowsmobile/en-us/downloads/eulas/eula_activesync45_1033.mspx?ProductID=76

- 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 far domed end in the top of the cradled, 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/activesync/default.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-19

# 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 at Marine Corps Recruit Depot (MCRD) Parris Island.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Waterproof pens**
**Non-latex rubber or plastic gloves**
**Cotton gloves**
**Field logbook**
**Potable water**
**Deionized water**
**LiquiNox detergent**
**Brushes, spray bottles, paper towels, etc.**
**55-gallon drum or other 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. For heavy drilling equipment, the subcontractor will use high pressure steam rinse to decontaminate drilling tools. For these larger tools, skip to Step 3.6 of this SOP; otherwise, continue with the next step for smaller drilling tools used for soil sampling.

3.3 Wash the equipment with a solution of LiquiNox detergent. Prepare the LiquiNox wash solution in accordance with the instructions on the LiquiNox container. Collect the LiquiNox wash solution into a container. Use brushes or sprays as appropriate for the equipment to remove debris. If

oily residue has accumulated on the sampling equipment, remove the residue with an isopropanol wash and repeat the Liquinox 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. To collect a rinsate blanks, collect the deionized water rinsate into the appropriate sample container.

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

3.7 Document decontamination by recording it in the field logbook.

3.8 Containerize decontamination solutions in accordance with the procedures described in the SAP.

# Appendix D-2

# Field Forms

Tetra Tech NUS, Inc.

# BORING LOG



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 | Sampler BZ | Borehole** | Driller BZ** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): ____

Remarks: _____

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

Tetra Tech NUS, Inc.

# CONTAINER SAMPLE & INSPECTION SHEET



Project Site Name: _____
Project Number: _____
Site Identification: _____
Container Number(s): _____
Sample Type: [] Grab
[] Composite

Sample ID No. _____
Sampled By: _____
C.O.C. No.: _____
Concentration: [] High
[] Medium
[] Low

## CONTAINER SOURCE

**DRUM:**
[] Bung Top
[] Lever Lock
[] Bolted Ring
[] Other _____

**TANK:**
[] Plastic
[] Metal
[] Other _____

**OTHER:** _____

## CONTAINER DESCRIPTION

**COLOR:** _____

**CONDITION:** _____

**MARKINGS:** _____

**VOL. OF CONTENTS:** _____

**OTHER:** _____

## CONTAINER DISPOSITION

**SAMPLED:** _____

**OPENED BUT NOT SAMPLED:**
Reason _____
_____

**NOT OPENED:**
Reason _____
_____

## CONTENTS DESCRIPTION

**SINGLE PHASED:** _____
_____

**MULTIPHASE :**

| | Layer 1 | Layer 2 | Layer 3 |
|---|---|---|---|
| Phase (Sol. or Liq.) | _____ | _____ | _____ |
| Color | _____ | _____ | _____ |
| Viscosity | L, M or H | L, M or H | L, M orH |
| % of Total Volume | _____ | _____ | _____ |

**MONITOR READING:**

**SAMPLE and /or INSPECTION DATE & TIME:**
_____HRS.
**METHOD:**_____

**SAMPLER(S) and / or INSPECTOR(S) SIGNATURE:**

**ANALYSIS:**

# Tetra Tech NUS, Inc.

**PROJECT:** _____ **JOB #:** _____
**LOCATION:** _____ **DATE:** _____
**PROJECT MANAGER:** _____ **FOL:** _____

## DAILY ACTIVITIES CHECKLIST

**Startup Checklist**

| Activity | Yes | No | N/A |
|---|---|---|---|
| Pertinent site activities/information entered into site logbook | | | |
| All onsite personnel listed in logbook | | | |
| Required medical information onsite for all workers (TtNUS and Subcontractors) | | | |
| Required MSDS's onsite | | | |
| Proper equipment calibrations performed (list equipment) | | | |
| 1 _____ | | | |
| 2 _____ | | | |
| 3 _____ | | | |
| 4 _____ | | | |
| Calibration logs filled out | | | |
| Tailgate H&S meeting held prior to beginning field activities | | | |
| Required work permits filled out/signed | | | |
| Required utility clearances obtained | | | |
| Required PPE onsite and in use | | | |
| Information required to be posted is in place (OSHA poster, hospital route, key phone numbers, etc.) | | | |

**Exit Checklist**

| Activity | Yes | No | N/A |
|---|---|---|---|
| Logbooks completely and comprehensively filled out | | | |
| Field forms complete and accounted for/properly filed | | | |
| Samples properly packaged/shipped | | | |
| COCs faxed to appropriate in-house personnel | | | |
| All equipment accounted for, on charge if needed, and properly secured | | | |
| All personnel accounted for | | | |
| Arrangements made for upcoming work (permits, clearances, equipment, etc.) | | | |
| Site properly secured | | | |

Note - not all items listed apply to every job, and some additional requirements may apply on a job-specific basis.

Tetra Tech NUS, Inc.

# DAILY ACTIVITIES RECORD

**PROJECT NAME:** _____ **PROJECT NUMBER:** _____

**CLIENT:** _____ **LOCATION:** _____

**DATE:** _____ **ARRIVAL TIME:** _____

**Tt NUS PERSONNEL:** _____ **DEPARTURE TIME:** _____

**CONTRACTOR:** _____ **DRILLER:** _____

| ITEM | QUANTITY ESTIMATE | QUANTITY TODAY | PREVIOUS TOTAL QUANTITY | CUMULATIVE QUANTITY TO DATE |
|---|---|---|---|---|
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COMMENTS: _____

_____

_____

_____

APPROVED BY:

_____ _____

Tt NUS REPRESENTATIVE DRILLER

DATE: _____

# Tetra Tech NUS, Inc.

**PROJECT:** _____ **LOCATION:** _____

**JOB & CTO #:** _____ **MOBILIZATION DATE:** _____

**PROJECT MANAGER:** _____ **RETURN DATE:** _____

## FIELD PROJECT DEMOBILIZATION CHECKLIST

### TRAVEL

___ Airline reservations
___ Hotel reservations/BOQs
___ Vehicle rental
___ Itinerary
___ Phone/pager number

### DRILLING/DPT/SURVEY

**Subcontractor**
___ POC phone #/address
___ Drill Specification RFP
___ Contact (time & place to meet)
___ Confirm subcontract w/ TtNUS Procurement
___ Health and Safety documentation for all personnel on site
___ Copy of Drillers license
___ Well / boring permits

**Utilities (2 weeks lead time)**
___ Contact Site POC (Date:_____)
___ Contact Local "Call Before You Dig"
___ Utility Clearance Form

**Forms**
___ Boring logs / Test Pit logs
___ Well construction / development forms
___ Daily activity forms
___ IDW inventory
___ IDW drum labels
___ Chemical Inventory
___ MSDS's

### EQUIPMENT MOBILIZATION

___ Equipment Requisition form completed / equipment ordered
___ 3rd Party rental / misc. equipment ordered
___ Equipment calibration forms
___ Span / calibration gas and regulator

### SAMPLING

**Forms**
___ Sample log sheets
___ Low-flow purge data sheets
___ COC records
___ COC seals
___ Sample labels (from database group)

**Laboratory**
___ POC address/phone#
___ Order bottles / preservatives
___ Shipping address, also check Sat. address
___ Bottle & preservation req'ts from lab
___ _____

### MISCELLANEOUS

**Schedule**
___ Plan field operations w/ Project manager

**Documents for Field Program**
___ Logbook(s)
___ Field Sampling plan
___ Health & Safety plan
___ Maps
___ H & S Guidance Manual

**Authorization**
___ Kick-off meeting held
___ Gov't rate letter
___ H&S/OSHA 40-hour certifcate
___ 8-Hour Refresher Training Certificate
___ Medical Clearance Letter
___ Supervisory Training Certificate
___ Health & Safety Clearance Letter
___ Full-size OSHA Poster

### HYDROGEOLOGY EQUIPMENT

___ Slug test/pumping test forms
___ Groundwater elevation data sheets
___ Graph paper
___ Data Logger/transducer/data cable
___ Existing well construction & water level data
___ M-Scope, slug

### SHIPPING

**Forms**
___ FedEx Airbills, local dropoff location & hours
___ FedEx Gov. Acct# (1771-8058-0)
___ Lab Shipping Labels
___ Warehouse Shipping Labels
___ Blank Labels

**Supplies**
___ Tape
___ Packing materials
___ Baggies, Large garbage bags

### OTHER

___ Site POC name/phone #
___ Personnel information to POC
___ Mobilization schedule to POC
___ Site access authorizations
___ Field office / trailer arrangements made
___ Electric, phone hookups arranged
___ Steel-toed boots, safety glasses, & hard hat
___ First aid equipment
___ Insect repellent
___ _____
___ _____

Note - not all items listed apply to every job, and some additional requirements may apply on a job-specific basis.

Tetra Tech NUS, Inc.

# EQUIPMENT CALIBRATION LOG

PROJECT NAME : ______________________

SITE NAME: ______________________

PROJECT No.: ______________________

INSTRUMENT NAME/MODEL: ______________________

MANUFACTURER: ______________________

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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# TETRA TECH NUS
# FIELD TASK MODIFICATION REQUEST FORM

| | | |
|---|---|---|
| Project/Installation Name | Project Number | Project Mod. Number |
| Modification To (e.g. Work Plan) | Site/Sample Location | Date |
| Activity Description: | | |
| Reason for Change: | | |
| Recommended Disposition: | | |
| Field Operations Leader (Signature) | | Date |
| Approved Disposition: | | |
| Project Manager (Signature) | | Date |
| Distribution:<br><br>Program/Project File –<br>Project Manager –<br>Field Operations Leader – | | Other: |

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

# FIELD ANALYTICAL LOG SHEET
# GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc. **Page __ of __**

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Field Form Checked as per QA/QC Checklist (initials): _____

**SAMPLING DATA:**

| Date: / Time: | **Color** (Visual) | **pH** (S.U.) | **S.C.** (mS/cm) | **Temp.** ($^0$C) | **Turbidity** (NTU) | **DO** (mg/l) | **Salinity** (%) | **ORP (Eh)** **(+/- mv)** |
|---|---|---|---|---|---|---|---|---|
| Method: | | | | | | | | |

**SAMPLE COLLECTION/ANALYSIS INFORMATION:**

**ORP (Eh) (+/- mv)**

Electrode Make & Model:_____

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

**Dissolved Oxygen:**

Equipment: Chemetrics Test Kit

Concentration: _____ ppm

| Range Used: | Range | Method | Concentration ppm |
|---|---|---|---|
| ☐ | 0 to 1 ppm | K-7510 | |
| ☐ | 1 to 12 ppm | K-7512 | |

Analysis Time: _____

Equipment: HACH Digital Titrator OX-DT

Analysis Time: _____

| Range Used: | Range | Sample Vol. | Cartridge | Multiplier |
|---|---|---|---|---|
| ☐ | 1-5 mg/L | 200 ml | 0.200 N | 0.01 |
| ☐ | 2-10 mg/L | 100 ml | 0.200 N | 0.02 |

| Titration Count | Multiplier | Concentration |
|---|---|---|
| _____ | **x** 0.01 | = mg/L |
| _____ | **x** 0.02 | = mg/L |

Notes:

**Carbon Dioxide:**

Equipment: Chemetrics Test Kit

Concentration: _____ ppm

| Range Used: | Range | Method | Concentration ppm |
|---|---|---|---|
| ☐ | 10 to 100 ppm | K-1910 | |
| ☐ | 100 to 1000 ppm | K-1920 | |
| ☐ | 250 to 2500 ppm | K-1925 | |

Analysis Time: _____

Equipment: HACH Digital Titrator CA-DT

| Range Used: | Range | Sample Vol. | Cartridge | Multiplier |
|---|---|---|---|---|
| ☐ | 10-50 mg/L | 200 ml | 0.3636 N | 0.1 |
| ☐ | 20-100 mg/L | 100 ml | 0.3636 N | 0.2 |
| ☐ | 100-400 mg/L | 200 ml | 3.636 N | 1.0 |
| ☐ | 200-1000 mg/L | 100 ml | 3.636 N | 2.0 |

| Titration Count | | Concentration |
|---|---|---|
| _____ | **x** 0.1 | = mg/L |
| _____ | **x** 0.2 | = mg/L |
| _____ | **x** 1.0 | = mg/L |
| _____ | **x** 2.0 | = mg/L |

Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

Notes:

**Hydrogen, dissolved**

Equipment: Bubble strip sampling field method

Start stripper at _____ (time)

End stripper at _____ (time)

Total stripper time _____

Pump rate _____ milliliters/minute

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

# FIELD ANALYTICAL LOG SHEET
# GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc. **Page __ of __**

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

## Alkalinity:

Equipment: Chemetrics Test Kit Concentration: _____ ppm

| Range Used: | Range | Method | Concentration ppm |
|---|---|---|---|
| ☐ | 10 to 100 ppm | K-9810 | |
| ☐ | 50 to 500 ppm | K-9815 | |
| ☐ | 100 to 1000 ppm | K-9820 | |

Analysis Time: _____

Filtered: ☐

Equipment: HACH Digital Titrator AL-DT

| Range Used: | Range | Sample Vol. | Cartridge | Multiplier | Titration Count | Multiplier | Concentration |
|---|---|---|---|---|---|---|---|
| ☐ | 10-40 mg/L | 100 ml | 0.1600 N | 0.1 | _____ & _____ | x 0.1 = | mg/L |
| ☐ | 40-160 mg/L | 25 ml | 0.1600 N | 0.4 | _____ & _____ | x 0.4 = | mg/L |
| ☐ | 100-400 mg/L | 100 ml | 1.600 N | 1.0 | _____ & _____ | x 1.0 = | mg/L |
| ☐ | 200-800 mg/L | 50 ml | 1.600 N | 2.0 | _____ & _____ | x 2.0 = | mg/L |
| ☐ | 500-2000 mg/L | 20 ml | 1.600 N | 5.0 | _____ & _____ | x 5.0 = | mg/L |
| ☐ | 1000-4000 mg/L | 10 ml | 1.600 N | 10.0 | _____ & _____ | x 10.0 = | mg/L |

| Parameter: | Hydroxide | Carbonate | Bicarbonate |
|---|---|---|---|
| Relationship: | | | |

Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

Notes:

## Ferrous Iron ($Fe^{2+}$):

Equipment: DR-850 DR-8 _ _ Range: 0 - 3.00 mg/L Concentration: _____ ppm

Program/Module: 500nm 33

Analysis Time: _____

Equipment: IR-18C Color Wheel Range: 0 - 10 mg/L

Notes: Filtered: ☐

## Hydrogen Sulfide ($H_2S$):

Range: 0 - 5 mg/L

Equipment: HS-C Other: _____ Concentration: _____ ppm

Exceeded 5.0 mg/L range on color chart: ☐ Analysis Time: _____

Notes:

## Sulfide ($S^{2-}$):

Equipment: Chemetrics Test Kit Range: 0 - 10 mg/L Concentration: _____ ppm

| Range Used: | Range | Method | Concentration ppm |
|---|---|---|---|
| ☐ | 0 to 1 ppm | K-9510 | |
| ☐ | 1 to 10 ppm | K-9510 | |

Analysis Time: _____

Filtered: ☐

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.70 mg/L

Program/Module: 610nm 93

Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

# FIELD ANALYTICAL LOG SHEET
# GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc. **Page __ of __**

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

**Sulfate ($SO_4^{2-}$):**

Equipment: DR-850 DR-8 _ _ Range: 0 - 70 mg/L Concentration: _____ ppm

Program/Module: _____ 91 Analysis Time: _____

Standard Solution: ☐ Results: _____ Filtered: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Notes:

**Nitrate ($NO_3^-$-N):**

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.50 mg/L (1) Concentration: _____ ppm

Program/Module: 55 Analysis Time: _____ Filtered: ☐

Standard Solution: ☐ Results: _____ Nitrite Interference Treatment: ☐ Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Alternate forms: $NO_2$ _____ $NaNO_2$ _____ mg/L

Notes (1): If results are over limit use dilution method at step 3, 5ml sample 10ml DI result X3, range up to 1.5mg/L

Notes:

**Nitrite ($NO_2^-$-N):** Concentration: _____ ppm

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.350 mg/L Analysis Time: _____ Filtered: ☐

Program/Module: 62

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

**Manganese ($Mn^{2+}$):** Concentration: _____ ppm

Equipment: DR-850 DR-8 _ _ Range: 0 - 20.0 mg/L Analysis Time: _____ Filtered: ☐

Program/Module: 525nm 41

Standard Solution: ☐ Results: _____ Digestion: ☐ Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Equipment: HACH MN-5 Range: 0 - 3 mg/L

Notes:

**QA/QC Checklist:**

All data fields have been completed as necessary: ☐

Correct measurement units are cited in the SAMPLING DATA block: ☐

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☐

Multiplication is correct for each *Multiplier* table: ☐

Final calculated concentration is within the appropriate *Range Used* block: ☐

Alkalinity *Relationship* is determined appropriately as per manufacturer (HACH) instructions: ☐

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☐

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: ☐

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☐

# LOW FLOW PURGE DATA SHEET

**PROJECT SITE NAME:** _____ **WELL ID.:** _____

**PROJECT NUMBER:** _____ **DATE:** _____

| Time (Hrs.) | Water Level (Ft. below TOC) | Flow (mL/Min.) | pH (S.U.) | S. Cond. (mS/cm) | Turb. (NTU) | DO (mg/L) | Temp. (Celsius) | ORP mV | Salinity % or ppt | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
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**SIGNATURE(S):** _____ **PAGE___OF___**

Tetra Tech NUS, Inc.

# MONITORING WELL DEVELOPMENT RECORD



Well: _____ Depth to Bottom (ft.): _____ Responsible Personnel: _____
Site: _____ Static Water Level Before (ft.): _____ Drilling Co.: _____
Date Installed: _____ Static Water Level After (ft.): _____ Project Name: _____
Date Developed: _____ Screen Length (ft.): _____ Project Number: _____
Dev. Method: _____ Specific Capacity: _____
Pump Type: _____ Casing ID (in.): _____

| Time | Estimated Sediment Thickness (Ft.) | Cumulative Water Volume (Gal.) | Water Level Readings (Ft. below TOC) | Temperature (Degrees C) | pH | Specific Conductance (Units _____) | Turbidity (NTU) | Remarks (odor, color, etc.) |
|---|---|---|---|---|---|---|---|---|
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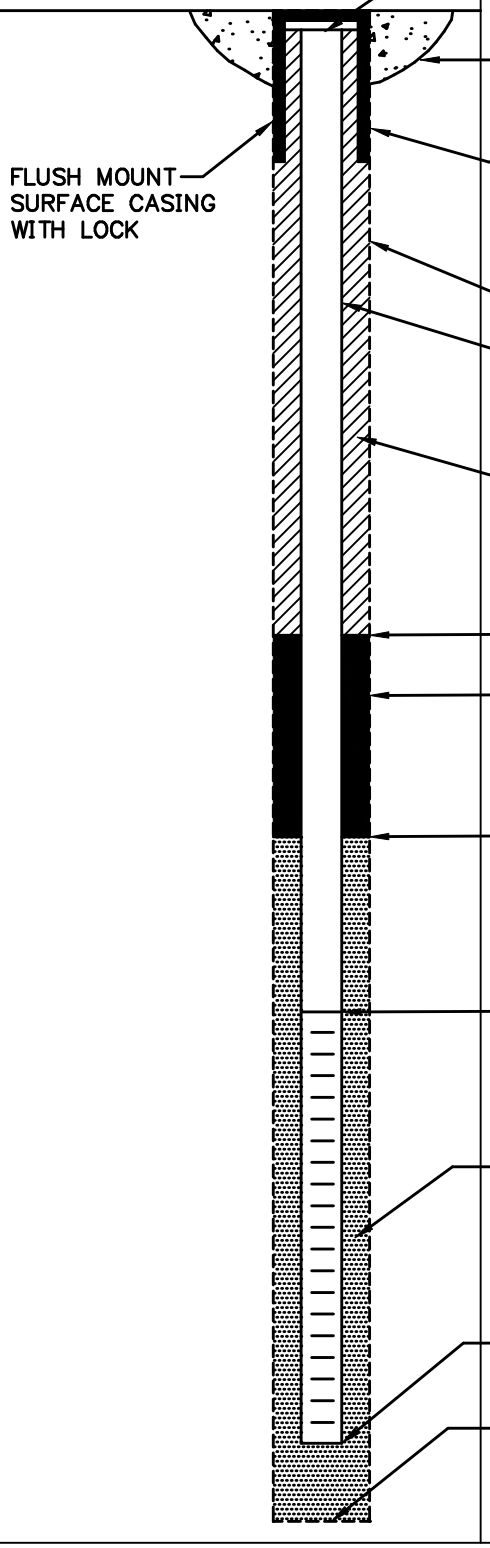
WELL NO.: _____

Tetra Tech NUS, Inc.

# OVERBURDEN
# MONITORING WELL SHEET
# FLUSH - MOUNT

| | | |
|---|---|---|
| PROJECT _____ | LOCATION _____ | DRILLER _____ |
| PROJECT NO. _____ | BORING _____ | DRILLING METHOD _____ |
| DATE BEGUN _____ | DATE COMPLETED _____ | |
| FIELD GEOLOGIST _____ | | DEVELOPMENT METHOD _____ |
| GROUND ELEVATION _____ | DATUM _____ | |




ELEVATION TOP OF RISER: _____

TYPE OF SURFACE SEAL: _____

_____

TYPE OF PROTECTIVE CASING: _____

_____

I.D. OF PROTECTIVE CASING: _____

DIAMETER OF HOLE: _____

TYPE OF RISER PIPE: _____

_____

RISER PIPE I.D.: _____

TYPE OF BACKFILL/SEAL: _____

_____

ELEVATION/DEPTH TOP OF SEAL: _____ / _____

TYPE OF SEAL: _____

_____

ELEVATION/DEPTH TOP OF SAND: _____ / _____

ELEVATION/DEPTH TOP OF SCREEN: _____ / _____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

TYPE OF SAND PACK: _____

_____

DIAMETER OF HOLE IN BEDROCK: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____ / _____

ELEVATION / DEPTH BOTTOM OF SAND: _____ / _____

ELEVATION/DEPTH BOTTOM OF HOLE: _____ / _____

BACKFILL MATERIAL BELOW SAND: _____

_____

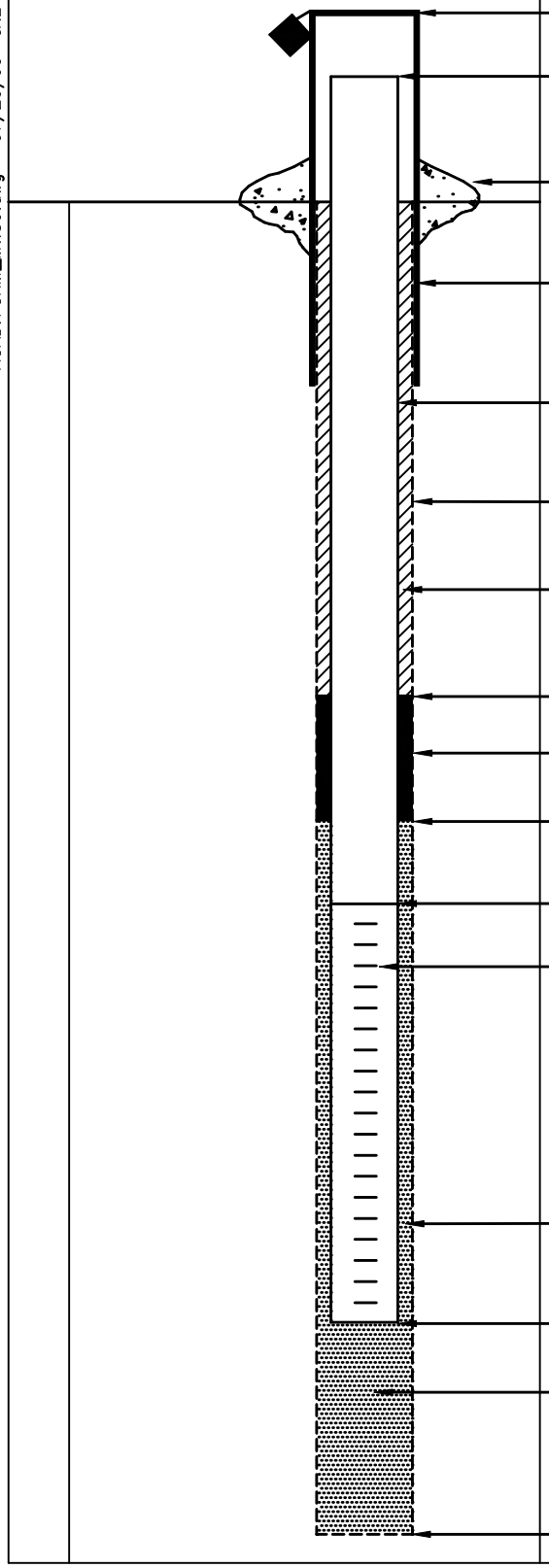
ACAD: FORM_MWFM.dwg 07/20/99 INL

WELL NO.: _____

Tetra Tech NUS, Inc.

# OVERBURDEN
# MONITORING WELL SHEET
# STICK-UP

| | | |
|---|---|---|
| PROJECT _____ | LOCATION _____ | DRILLER _____ |
| PROJECT NO. _____ | BORING _____ | DRILLING METHOD _____ |
| DATE BEGUN _____ | DATE COMPLETED _____ | |
| FIELD GEOLOGIST _____ | | DEVELOPMENT METHOD _____ |
| GROUND ELEVATION _____ | DATUM _____ | |



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: ____/____

ELEVATION/HEIGHT OF TOP OF RISER PIPE: ____/____

TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____

TYPE OF SURFACE CASING: _____

RISER PIPE I.D.: _____

TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

TYPE OF BACKFILL: _____

ELEVATION/DEPTH TOP OF SEAL: ____/____

TYPE OF SEAL: _____

DEPTH TOP OF SAND PACK: _____

ELEVATION/DEPTH TOP OF SCREEN: ____/____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

I.D. OF SCREEN: _____

TYPE OF SAND PACK: _____

ELEVATION/DEPTH BOTTOM OF SCREEN: ____/____

ELEVATION/DEPTH BOTTOM OF SAND PACK: ____/____

BACKFILL MATERIAL BELOW SAND: _____

ELEVATION/DEPTH OF HOLE: ____/____

ACAD:FORM_MWSU.dwg 07/20/99 INL

# Tetra Tech NUS, Inc.

**PROJECT:** _____ **LOCATION:** _____

**JOB & CTO #:** _____ **MOBILIZATION DATE:** _____

**PROJECT MANAGER:** _____ **RETURN DATE:** _____

## FIELD PROJECT PRE-MOBILIZATION CHECKLIST

### TRAVEL

___ Airline reservations
___ Hotel reservations/BOQs
___ Vehicle rental
___ Itinerary
___ Phone/pager number

### DRILLING/DPT/SURVEY

**Subcontractor**
___ POC phone #/address
___ Drill Specification RFP
___ Contact (time & place to meet)
___ Confirm subcontract w/ TtNUS Procurement
___ Health and Safety documentation for all personnel on site
___ Copy of Drillers license
___ Well / boring permits

**Utilities (2 weeks lead time)**
___ Contact Site POC (Date:_____)
___ Contact Local "Call Before You Dig"
___ Utility Clearance Form

**Forms**
___ Boring logs / Test Pit logs
___ Well construction / development forms
___ Daily activity forms
___ IDW inventory
___ IDW drum labels
___ Chemical Inventory
___ MSDS's

### EQUIPMENT MOBILIZATION

___ Equipment Requisition form completed / equipment ordered
___ 3rd Party rental / misc. equipment ordered
___ Equipment calibration forms
___ Span / calibration gas and regulator

### SAMPLING

**Forms**
___ Sample log sheets
___ Low-flow purge data sheets
___ COC records
___ COC seals
___ Sample labels (from database group)

**Laboratory**
___ POC address/phone#
___ Order bottles / preservatives
___ Shipping address, also check Sat. address
___ Bottle & preservation req'ts from lab
___ _____

### MISCELLANEOUS

**Schedule**
___ Plan field operations w/ Project manager

**Documents for Field Program**
___ Logbook(s)
___ Field Sampling plan
___ Health & Safety plan
___ Maps
___ H & S Guidance Manual

**Authorization**
___ Kick-off meeting held
___ Gov't rate letter
___ H&S/OSHA 40-hour certifcate
___ 8-Hour Refresher Training Certificate
___ Medical Clearance Letter
___ Supervisory Training Certificate
___ Health & Safety Clearance Letter
___ Full-size OSHA Poster

### HYDROGEOLOGY EQUIPMENT

___ Slug test/pumping test forms
___ Groundwater elevation data sheets
___ Graph paper
___ Data Logger/transducer/data cable
___ Existing well construction & water level data
___ M-Scope, slug

### SHIPPING

**Forms**
___ FedEx Airbills, local dropoff location & hours
___ FedEx Gov. Acct# (1771-8058-0)
___ Lab Shipping Labels
___ Warehouse Shipping Labels
___ Blank Labels

**Supplies**
___ Tape
___ Packing materials
___ Baggies, Large garbage bags

### OTHER

___ Site POC name/phone #
___ Personnel information to POC
___ Mobilization schedule to POC
___ Site access authorizations
___ Field office / trailer arrangements made
___ Electric, phone hookups arranged
___ Steel-toed boots, safety glasses, & hard hat
___ First aid equipment
___ Insect repellent
___ _____
___ _____

Note - not all items listed apply to every job, and some additional requirements may apply on a job-specific basis.

Tetra Tech NUS, Inc.

# QA SAMPLE LOG SHEET



Project Site Name: _____ Sample ID Number: _____
Project Number: _____ Sampled By: _____
Sample Location: _____ C.O.C. Number: _____
QA Sample Type:

[] Trip Blank [] Rinsate Blank
[] Source Water Blank [] Other Blank _____

**SAMPLING DATA:**

Date: _____
Time: _____
Method: _____

**WATER SOURCE:**

[] Laboratory Prepared [] Tap
[] Purchased [] Fire Hydrant
[] Other _____

**PURCHASED WATER INFORMATION (If Applicable as Source or Rinsate Water):**

Product Name: _____
Supplier: _____
Manufacturer: _____
Order Number: _____
Lot Number: _____
Expiration Date: _____

**RINSATE INFORMATION (If Applicable):**

Media Type: _____
Equipment Used: _____
Equipment Type:
[] Dedicated
[] Reusable

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Preservative | Container Requirements | Collected |
|---|---|---|---|
| Volatiles | Cool 4°C & HCl | | YES / NO |
| Semivolatiles | Cool 4°C | | YES / NO |
| Pesticide / PCB | Cool 4°C | | YES / NO |
| Metals | Cool 4°C & $HNO_3$ | | YES / NO |
| Cyanide | Cool 4°C & NaOH | | YES / NO |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**OBSERVATIONS / NOTES:**

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



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

**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 |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

**MS/MSD**

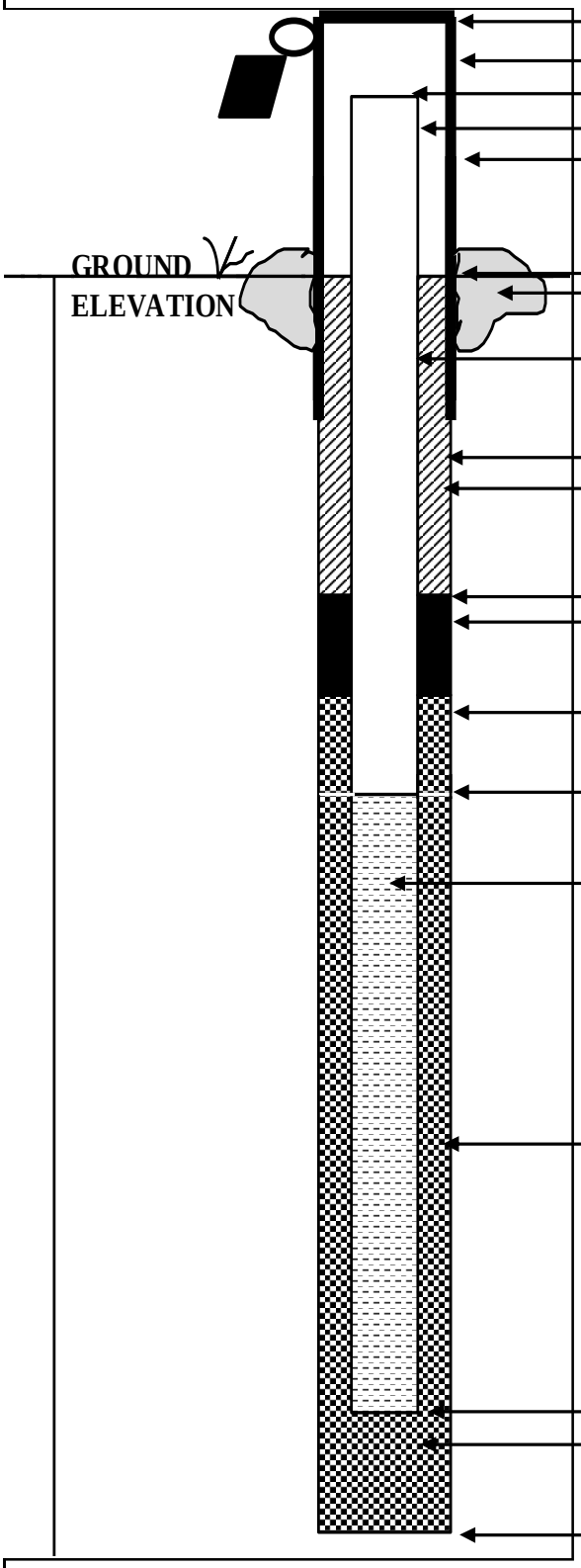
**Duplicate ID No.:**

**Signature(s):**

BORING NO.: _____

Tetra Tech NUS, Inc. **TEMPORARY OVERBURDEN MONITORING WELL SHEET**

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | | DRILLING Co.: | | BORING No.: | |
| PROJECT No.: | | DRILLER: | | DATE COMPLETED: | |
| SITE: | | DRILLING METHOD: | | NORTHING: | |
| GEOLOGIST: | | DEV. METHOD: | | EASTING: | |




ELEVATION OF TOP OF SURFACE CASING: _____

STICK -UP TOP OF SURFACE CASING: _____

ELEVATION OF TOP OF RISER PIPE: _____

RISER STICK-UP ABOVE GROUND SURFACE: _____

I.D. OF SURFACE CASING: _____

TYPE OF SURFACE CASING: _____

GROUND ELEVATION: _____

TYPE OF SURFACE SEAL: _____

RISER PIPE I.D.: _____

TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

TYPE OF SEAL: _____

ELEVATION / DEPTH OF SEAL: _____ / _____

TYPE OF SEAL: _____

ELEVATION / DEPTH TOP OF FILTER PACK: _____ / _____

ELEVATION / DEPTH TOP OF SCREEN: _____ / _____

TYPE OF SCREEN: _____

SLOT SIZE X LENGTH: _____

I.D. OF SCREEN: _____

TYPE OF FILTER PACK: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____ / _____

ELEVATION / DEPTH BOTTOM OF FILTER PACK: _____ / _____

TYPE OF BACKFILL BELOW WELL: _____

ELEVATION / DEPTH OF BOREHOLE: _____ / _____

# APPENDIX E

# LABORATORY ACCREDITATIONS AND STANDARD OPERATING PROCEDURES

# Appendix E-1

# Laboratory Accreditations

D H E C

PROMOTE PROTECT PROSPER

C. Earl Hunter, Commissioner

*Promoting and protecting the health of the public and the environment*

October 12, 2011

CAREY J BOCKLET
GEL ENGINEERING LLC
PO BOX 30712
CHARLESTON, SOUTH CAROLINA 29417

Laboratory I. D. 10120

Dear Carey J Bocklet:

Your amended certificate and associated parameter list(s) are enclosed. These documents now represent the certificate of record for your laboratory. Any certificate(s) and associated parameter list(s) received prior to your receipt of these documents are now null and void and should be destroyed. Please be reminded that all environmental data submitted to the Department is reviewed to ensure that the reporting laboratory possesses the necessary certification. Data reported by laboratories without the proper certification will be addressed by the affected enforcement programs.

If you have any questions, or problems are detected concerning your certificate, please contact this office within ten (10) working days.

Sincerely,

Carol F. Smith

Carol F. Smith, Director
Office of Environmental Laboratory Certification
Bureau of Environmental Services

Enclosures

D H E C

PROMOTE PROTECT PROSPER

South Carolina Department of Health and Environmental Control

# Environmental Laboratory Certification Program

In accordance with the provisions of Regulation 61-81, entitled "State Environmental Laboratory Certification Regulations"

***GEL ENGINEERING LLC***
***2040 SAVAGE RD***
***CHARLESTON, SOUTH CAROLINA 29407***

*is hereby certified to perform analyses as documented on the attached parameter list(s). This certification does not guarantee validity of data generated, but indicates the laboratory's adherence to prescribed methodology, quality control, records keeping, and reporting procedures. This certificate is the property of S.C. DHEC and must be surrendered upon demand. This certificate is non-transferable and is valid only for the parameters and methodology listed on the attached parameter list(s).*

***Laboratory Director: CAREY J BOCKLET***
***Certifying Authority: SC***
***Date of Issue: September 27, 2011***
***Date of Expiration: December 26, 2013***
***Certificate Number: 10120001***

Director
Office of Environmental Laboratory Certification

CR-010021 2/11

**SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL**
**ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM**

*GEL ENGINEERING LLC (Laboratory ID 10120)*
*Laboratory Director: CAREY J BOCKLET*
*Certifying Authority: SC*
*Certificate Number: 10120001*

*Date of Issue: September 27, 2011*
*Expiration Date: December 26, 2013*

**CLEAN WATER ACT**

**INORGANIC - DEMAND**

| | |
|---|---|
| BIOCHEMICAL OXYGEN DEMAND(BOD) | SM 5210B (18TH) |
| CARBONACEOUS BOD | SM 5210B (18TH) |
| CHEMICAL OXYGEN DEMAND (COD) | EPA 410.4 (1993) |
| CHEMICAL OXYGEN DEMAND (COD) | HACH 8000 (1979) |
| DISSOLVED OXYGEN | SM 4500OG (18TH) |
| TOTAL ORGANIC CARBON (TOC) | SM 5310B (18TH) |

**INORGANIC - MINERAL**

| | |
|---|---|
| ACIDITY | SM 2310B(4A) (18TH) |
| ALKALINITY | SM 2320B (18TH) |
| CHLORIDE | EPA 300.0 (1993) |
| FLUORIDE | EPA 300.0 (1993) |
| HARDNESS, TOTAL (AS CACO3) | SM 2340B (18TH) |
| HARDNESS, TOTAL (AS CACO3) | SM 2340C (18TH) |
| HYDROGEN-ION CONC. (PH) | SM 4500HB (18TH) |
| SPECIFIC CONDUCTANCE | EPA 120.1 (1982) |
| SPECIFIC CONDUCTANCE | SM 2510B (18TH) |
| SULFATE | EPA 300.0 (1993) |

**INORGANIC - MISCELLANEOUS**

| | |
|---|---|
| ADSORBABLE ORGANIC HALIDES (AOX) | EPA 1650C |
| BROMIDE | EPA 300.0 (1993) |
| COLOR | SM 2120B (18TH) |
| CYANIDE | EPA 335.4 (1993) |
| CYANIDE AMEN. TO CHLORINATION | SM 4500CNC,G (18TH) |
| OIL & GREASE | EPA 1664A |
| PHENOLICS, TOTAL RECOVERABLE | EPA 420.4 (1993) |
| RESIDUAL CHLORINE | SM 4500CLG (18TH) |
| SULFIDE | SM 4500S2D (18TH) |
| SULFITE | SM 4500SO3B (18TH) |
| SURFACTANTS (MBAS) | SM 5540C (18TH) |
| TURBIDITY | EPA 180.1 (1993) |

**INORGANIC - NUTRIENT**

| | |
|---|---|
| AMMONIA-NITROGEN | EPA 350.1 (1993) |
| KJELDAHL-NITROGEN | EPA 351.2 (1993) |
| NITRATE-NITRITE (N02&N03) | EPA 300.0 (1993) |
| NITRATE-NITRITE (N02&N03) | EPA 353.2 (1993) |
| NITRATE-NITROGEN | EPA 300.0 (1993) |
| NITRITE-NITROGEN | EPA 300.0 (1993) |
| ORTHOPHOSPHATE | EPA 300.0 (1993) |
| PHOSPHORUS | EPA 365.4 (1974) |
| TOTAL ORGANIC NITROGEN | EPA TKN-NH3-N |

## SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
## ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

*GEL ENGINEERING LLC (Laboratory ID 10120)*
*Laboratory Director: CAREY J BOCKLET*
*Certifying Authority: SC*
*Certificate Number: 10120001*

*Date of Issue: September 27, 2011*
*Expiration Date: December 26, 2013*

### CLEAN WATER ACT

#### INORGANIC - RESIDUE

| | |
|---|---|
| RESIDUE, FILTERABLE (TDS) | SM 2540C (18TH) |
| RESIDUE, NONFILTERABLE (TSS) | SM 2540D (18TH) |
| RESIDUE, TOTAL (TS) | SM 2540B (18TH) |
| RESIDUE, VOLATILE (VS) | EPA 160.4 (1979) |

#### INORGANIC - TRACE METAL

| | |
|---|---|
| ALUMINUM | EPA 200.7 (1994) |
| ALUMINUM | EPA 200.8 (1994) |
| ANTIMONY | EPA 200.7 (1994) |
| ANTIMONY | EPA 200.8 (1994) |
| ARSENIC | EPA 200.7 (1994) |
| ARSENIC | EPA 200.8 (1994) |
| BARIUM | EPA 200.7 (1994) |
| BARIUM | EPA 200.8 (1994) |
| BERYLLIUM | EPA 200.7 (1994) |
| BERYLLIUM | EPA 200.8 (1994) |
| BORON | EPA 200.7 (1994) |
| BORON | EPA 200.8 (1994) |
| CADMIUM | EPA 200.7 (1994) |
| CADMIUM | EPA 200.8 (1994) |
| CALCIUM | EPA 200.7 (1994) |
| CALCIUM | EPA 200.8 (1994) |
| CHROMIUM | EPA 200.7 (1994) |
| CHROMIUM | EPA 200.8 (1994) |
| CHROMIUM, HEXAVALENT | SM 3500CRD (18TH) |
| COBALT | EPA 200.7 (1994) |
| COBALT | EPA 200.8 (1994) |
| COPPER | EPA 200.7 (1994) |
| COPPER | EPA 200.8 (1994) |
| GOLD | EPA 200.7 (1994) |
| GOLD | EPA 200.8 (1994) |
| IRON | EPA 200.7 (1994) |
| IRON | EPA 200.8 (1994) |
| LEAD | EPA 200.7 (1994) |
| LEAD | EPA 200.8 (1994) |
| MAGNESIUM | EPA 200.7 (1994) |
| MAGNESIUM | EPA 200.8 (1994) |
| MANGANESE | EPA 200.7 (1994) |
| MANGANESE | EPA 200.8 (1994) |
| MERCURY | EPA 1631E (2002) |
| MERCURY | EPA 245.2 (1974) |
| MOLYBDENUM | EPA 200.7 (1994) |
| MOLYBDENUM | EPA 200.8 (1994) |
| NICKEL | EPA 200.7 (1994) |
| NICKEL | EPA 200.8 (1994) |

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
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**CLEAN WATER ACT**

**INORGANIC - TRACE METAL**

| | |
|---|---|
| PALLADIUM | EPA 200.7 (1994) |
| PALLADIUM | EPA 200.8 (1994) |
| PLATINUM | EPA 200.7 (1994) |
| PLATINUM | EPA 200.8 (1994) |
| POTASSIUM | EPA 200.7 (1994) |
| POTASSIUM | EPA 200.8 (1994) |
| SELENIUM | EPA 200.7 (1994) |
| SELENIUM | EPA 200.8 (1994) |
| SILICA, DISSOLVED | EPA 200.8 (1994) |
| SILVER | EPA 200.7 (1994) |
| SILVER | EPA 200.8 (1994) |
| SODIUM | EPA 200.7 (1994) |
| SODIUM | EPA 200.8 (1994) |
| THALLIUM | EPA 200.7 (1994) |
| THALLIUM | EPA 200.8 (1994) |
| TIN | EPA 200.7 (1994) |
| TIN | EPA 200.8 (1994) |
| TITANIUM | EPA 200.7 (1994) |
| VANADIUM | EPA 200.7 (1994) |
| VANADIUM | EPA 200.8 (1994) |
| ZINC | EPA 200.7 (1994) |
| ZINC | EPA 200.8 (1994) |

**PCBS AND PESTICIDES**

| | |
|---|---|
| ORGANOCHLORINE PESTICIDES & PCBS - GC/E | EPA 608 |

**SEMI-VOLATILES**

| | |
|---|---|
| BASE/NEUTRALS AND ACIDS - GC/MS | EPA 625 |

**VOLATILES (VOCS)**

| | |
|---|---|
| PURGEABLES - GC/MS | EPA 624 |

**SAFE DRINKING WATER ACT**

**DISINFECTION BY-PRODUCTS**

| | |
|---|---|
| BROMIDE | EPA 300.0 (1993) |

**INORGANIC - MINERAL**

| | |
|---|---|
| ALKALINITY | SM 2320B (18TH) |
| CHLORIDE | EPA 300.0 (1993) |
| FLUORIDE | EPA 300.0 (1993) |

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
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*Certifying Authority: SC*
*Certificate Number: 10120001*

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## SAFE DRINKING WATER ACT

### INORGANIC - MINERAL

| | |
|---|---|
| HYDROGEN-ION CONC. (PH) | EPA 150.1 (1983) |
| SPECIFIC CONDUCTANCE | SM 2510B (18TH) |
| SULFATE | EPA 300.0 (1993) |

### INORGANIC - MISCELLANEOUS

| | |
|---|---|
| RESIDUAL CHLORINE | SM 4500CLG (18TH) |
| TURBIDITY | EPA 180.1 (1993) |
| TURBIDITY | SM 2130B (18TH) |

### INORGANIC - NUTRIENT

| | |
|---|---|
| NITRATE-NITRITE (N02&N03) | EPA 300.0 (1993) |
| NITRATE-NITRITE (N02&N03) | EPA 353.2 (1993) |
| NITRATE-NITROGEN | EPA 300.0 (1993) |
| NITRITE-NITROGEN | EPA 300.0 (1993) |

### INORGANIC - RADIOLOGICAL

| | |
|---|---|
| URANIUM | EPA 200.8 (1994) |

### INORGANIC - RESIDUE

| | |
|---|---|
| RESIDUE, FILTERABLE (TDS) | SM 2540C (18TH) |

### INORGANIC - TRACE METAL

| | |
|---|---|
| ALUMINUM | EPA 200.7 (1994) |
| ALUMINUM | EPA 200.8 (1994) |
| ANTIMONY | EPA 200.8 (1994) |
| ARSENIC | EPA 200.8 (1994) |
| BARIUM | EPA 200.7 (1994) |
| BARIUM | EPA 200.8 (1994) |
| BERYLLIUM | EPA 200.7 (1994) |
| BERYLLIUM | EPA 200.8 (1994) |
| CADMIUM | EPA 200.7 (1994) |
| CADMIUM | EPA 200.8 (1994) |
| CALCIUM | EPA 200.7 (1994) |
| CHROMIUM | EPA 200.7 (1994) |
| CHROMIUM | EPA 200.8 (1994) |
| COPPER | EPA 200.7 (1994) |
| COPPER | EPA 200.8 (1994) |
| IRON | EPA 200.7 (1994) |
| LEAD | EPA 200.8 (1994) |
| MANGANESE | EPA 200.7 (1994) |
| MANGANESE | EPA 200.8 (1994) |

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

*GEL ENGINEERING LLC (Laboratory ID 10120)*
*Laboratory Director: CAREY J BOCKLET*
*Certifying Authority: SC*
*Certificate Number: 10120001*

*Date of Issue: September 27, 2011*
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**SAFE DRINKING WATER ACT**

**INORGANIC - TRACE METAL**

| | |
|---|---|
| MERCURY | EPA 245.2 (1974) |
| NICKEL | EPA 200.7 (1994) |
| NICKEL | EPA 200.8 (1994) |
| SELENIUM | EPA 200.8 (1994) |
| SILVER | EPA 200.7 (1994) |
| SILVER | EPA 200.8 (1994) |
| SODIUM | EPA 200.7 (1994) |
| THALLIUM | EPA 200.8 (1994) |
| ZINC | EPA 200.7 (1994) |
| ZINC | EPA 200.8 (1994) |

**SYNTHETIC ORGANIC COMPOUNDS (SOCS)**

| | |
|---|---|
| EDB, DBCP AND 1,2,3 TCP BY MICROEXT.-GC | EPA 504.1 (1995) |

**SOLID & HAZARDOUS WASTES**

**HERBICIDES**

| | |
|---|---|
| CHLORINATED HERBICIDES BY GC | EPA 8151A |

**INORGANIC - DEMAND**

| | |
|---|---|
| TOTAL ORGANIC CARBON (TOC) | EPA 9060A |

**INORGANIC - HAZARDOUS WASTE CHARACTERISTICS**

| | |
|---|---|
| CORROSIVITY - TOWARDS STEEL | EPA 1110A |
| IGNITABILITY (PENSKY MARTENS) | EPA 1010A |
| IGNITABILITY (SETAFLASH) | EPA 1020B |
| SYNTHETIC PREC. LEACHING PROC. | EPA 1312 |
| TCLP - BOTTLE EXTRACTION | EPA 1311 |
| TCLP - ZERO HEADSPACE | EPA 1311 |

**INORGANIC - MINERAL**

| | |
|---|---|
| CHLORIDE | EPA 9056A |
| FLUORIDE | EPA 9056A |
| HYDROGEN-ION CONC. (PH) | EPA 9040C |
| HYDROGEN-ION CONC. (PH) (SOIL AND WAST | EPA 9045D |
| SPECIFIC CONDUCTANCE | EPA 9050A |
| SULFATE | EPA 9056A |

**INORGANIC - MISCELLANEOUS**

| | |
|---|---|
| BOMB PREPARATION METHOD | EPA 5050 |

**SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL**
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**SOLID & HAZARDOUS WASTES**

**INORGANIC - MISCELLANEOUS**

| | |
|---|---|
| BROMIDE | EPA 9056A |
| CYANIDE | EPA 9012B |
| CYANIDE AMEN. TO CHLORINATION | EPA 9012B |
| CYANIDE DISTILLATION | EPA 9010C |
| CYANIDE EXTRACTION PROCEDURE | EPA 9013 |
| EXTRACT. ORGANIC HALIDES IN SOLIDS (EOX | EPA 9023 |
| PAINT FILTER LIQUIDS TEST | EPA 9095B |
| PHENOLICS, TOTAL RECOVERABLE | EPA 9066 |
| SULFIDE | EPA 9034 |
| SULFIDE DISTILLATION | EPA 9030B |
| TOTAL ORGANIC HALIDES (TOX) | EPA 9020B |

**INORGANIC - NUTRIENT**

| | |
|---|---|
| NITRATE-NITROGEN | EPA 9056A |
| NITRITE-NITROGEN | EPA 9056A |
| ORTHOPHOSPHATE | EPA 9056A |

**INORGANIC - TRACE METAL**

| | |
|---|---|
| ALUMINUM | EPA 6010C |
| ALUMINUM | EPA 6020A |
| ANTIMONY | EPA 6010C |
| ANTIMONY | EPA 6020A |
| ARSENIC | EPA 6010C |
| ARSENIC | EPA 6020A |
| BARIUM | EPA 6010C |
| BARIUM | EPA 6020A |
| BERYLLIUM | EPA 6010C |
| BERYLLIUM | EPA 6020A |
| CADMIUM | EPA 6010C |
| CADMIUM | EPA 6020A |
| CALCIUM | EPA 6010C |
| CALCIUM | EPA 6020A |
| CHROMIUM | EPA 6010C |
| CHROMIUM | EPA 6020A |
| CHROMIUM, HEXAVALENT | EPA 7196A |
| COBALT | EPA 6010C |
| COBALT | EPA 6020A |
| COPPER | EPA 6010C |
| COPPER | EPA 6020A |
| IRON | EPA 6010C |
| IRON | EPA 6020A |
| LEAD | EPA 6010C |
| LEAD | EPA 6020A |
| LITHIUM | EPA 6010C |

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## SOLID & HAZARDOUS WASTES

### INORGANIC - TRACE METAL

| | |
|---|---|
| LITHIUM | EPA 6020A |
| MAGNESIUM | EPA 6010C |
| MAGNESIUM | EPA 6020A |
| MANGANESE | EPA 6010C |
| MANGANESE | EPA 6020A |
| MERCURY | EPA 7470A |
| MERCURY | EPA 7471B |
| MOLYBDENUM | EPA 6010C |
| MOLYBDENUM | EPA 6020A |
| NICKEL | EPA 6010C |
| NICKEL | EPA 6020A |
| OSMIUM | EPA 6010C |
| OSMIUM | EPA 6020A |
| POTASSIUM | EPA 6010C |
| POTASSIUM | EPA 6020A |
| SELENIUM | EPA 6010C |
| SELENIUM | EPA 6020A |
| SILICA, TOTAL | EPA 6010C |
| SILICA, TOTAL | EPA 6020A |
| SILVER | EPA 6010C |
| SILVER | EPA 6020A |
| SODIUM | EPA 6010C |
| SODIUM | EPA 6020A |
| STRONTIUM | EPA 6010C |
| STRONTIUM | EPA 6020A |
| THALLIUM | EPA 6010C |
| THALLIUM | EPA 6020A |
| TIN | EPA 6010C |
| TIN | EPA 6020A |
| VANADIUM | EPA 6010C |
| VANADIUM | EPA 6020A |
| ZINC | EPA 6010C |
| ZINC | EPA 6020A |

### PCBS AND PESTICIDES

| | | |
|---|---|---|
| ORGANOCHLORINE PESTICIDES BY GC | EPA 8081B | EPA 3535A |
| ORGANOCHLORINE PESTICIDES BY GC | EPA 8081B | EPA 3541 |
| ORGANOCHLORINE PESTICIDES BY GC | EPA 8081B | EPA 3580A |
| ORGANOCHLORINE PESTICIDES BY GC | EPA 8081B | EPA 3550C |
| ORGANOCHLORINE PESTICIDES BY GC | EPA 8081B | EPA 3510C |
| POLYCHLORINATED BIPHENYLS BY GC | EPA 8082A | EPA 3550C |
| POLYCHLORINATED BIPHENYLS BY GC | EPA 8082A | EPA 3541 |
| POLYCHLORINATED BIPHENYLS BY GC | EPA 8082A | EPA 3580A |
| POLYCHLORINATED BIPHENYLS BY GC | EPA 8082A | EPA 3535A |
| POLYCHLORINATED BIPHENYLS BY GC | EPA 8082A | EPA 3510C |

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**SOLID & HAZARDOUS WASTES**

**SEMI-VOLATILES**

| | | |
|---|---|---|
| EDB & DBCP BY MICROEXTRACTION AND GC | EPA 8011 | |
| POLYNUCLEAR AROMATIC HYDROCARBONS BY HP | EPA 8310 | EPA 3580A |
| POLYNUCLEAR AROMATIC HYDROCARBONS BY HP | EPA 8310 | EPA 3510C |
| POLYNUCLEAR AROMATIC HYDROCARBONS BY HP | EPA 8310 | EPA 3550C |
| SEMIVOLATILE ORGANICS BY GC/MS | EPA 8270D | EPA 3580A |
| SEMIVOLATILE ORGANICS BY GC/MS | EPA 8270D | EPA 3510C |
| SEMIVOLATILE ORGANICS BY GC/MS | EPA 8270D | EPA 3550C |
| TPH - DIESEL RANGE ORGANICS (DRO) | EPA 8015C (DRO) | EPA 3580A |
| TPH - DIESEL RANGE ORGANICS (DRO) | EPA 8015C (DRO) | EPA 3535A |
| TPH - DIESEL RANGE ORGANICS (DRO) | EPA 8015C (DRO) | EPA 3550C |
| TPH - DIESEL RANGE ORGANICS (DRO) | EPA 8015C (DRO) | EPA 3510C |
| TPH - DIESEL RANGE ORGANICS (DRO) | EPA 8015C (DRO) | EPA 3541 |

**VOLATILES (VOCS)**

| | | |
|---|---|---|
| VOLATILE ORGANICS BY GC/MS | EPA 8260B | EPA 5030B |
| VOLATILE ORGANICS BY GC/MS | EPA 8260B | EPA 5035 |
| VOLATILE ORGANICS BY GC/MS | EPA 8260B | EPA 3585 |

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CLEAN WATER ACT

----------PCBS AND PESTICIDES----------

EPA 608

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
GAMMA-BHC (LINDANE)
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)
TOXAPHENE

----------SEMI-VOLATILES----------

EPA 625

1,2,4-TRICHLOROBENZENE
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DINITROTOLUENE (2,6-DNT)
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-METHYL-4,6-DINITROPHENOL
2-NITROPHENOL
3,3-DICHLOROBENZIDINE
4,4'-DDD

EPA 625

4,4'-DDE
4,4'-DDT
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROPHENYL PHENYL ETHER
4-NITROPHENOL
ACENAPHTHENE
ACENAPHTHYLENE
ALDRIN
ANTHRACENE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZYL BUTYL PHTHALATE
BETA-BHC
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-CHLOROISOPROPYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
CHRYSENE
DELTA-BHC
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIBENZO(A,H)ANTHRACENE
DIELDRIN
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
ENDOSULFAN SULFATE
ENDRIN ALDEHYDE
FLUORANTHENE
FLUORENE
HEPTACHLOR
HEPTACHLOR EPOXIDE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROETHANE
INDENO(1,2,3-CD)PYRENE
ISOPHORONE
N-NITROSODI-N-PROPYLAMINE
NAPHTHALENE
NITROBENZENE (NB)
PENTACHLOROPHENOL
PHENANTHRENE

EPA 625

PHENOL
PYRENE

----------VOLATILES (VOCS)----------

EPA 624

1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
2-CHLOROETHYLVINYL ETHER
BENZENE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CIS-1,3-DICHLOROPROPENE
DICHLORODIFLUOROMETHANE
ETHYLBENZENE
METHYLENE CHLORIDE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL CHLORIDE
XYLENE, TOTAL

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SAFE DRINKING WATER ACT

---SYNTHETIC ORGANIC COMPOUNDS (SOCS)---

EPA 504.1 (1995)

1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)

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SOLID & HAZARDOUS WASTES

----------HERBICIDES----------

EPA 8151A

2,4,5-T
2,4,5-TP (SILVEX)
2,4-D
2,4-DB
DALAPON
DICAMBA
DICHLORPROP
DINOSEB
MCPA
MCPP

----------PCBS AND PESTICIDES----------

EPA 8081B
EPA 3510C

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
GAMMA-CHLORDANE
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
TOXAPHENE

EPA 8081B
EPA 3535A

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
GAMMA-CHLORDANE
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR

EPA 8081B
EPA 3541

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
GAMMA-CHLORDANE
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
TOXAPHENE

EPA 8081B
EPA 3550C

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
GAMMA-CHLORDANE
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
TOXAPHENE

EPA 8081B
EPA 3580A

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
GAMMA-CHLORDANE
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
TOXAPHENE

EPA 8082A
EPA 3510C

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

EPA 8082A
EPA 3535A

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

EPA 8082A
EPA 3541

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

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SOLID & HAZARDOUS WASTES

----------PCBS AND PESTICIDES----------

EPA 8082A
EPA 3550C

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

EPA 8082A
EPA 3580A

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

----------SEMI-VOLATILES----------

EPA 8011

1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)

EPA 8015C (DRO)
EPA 3510C

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8015C (DRO)
EPA 3535A

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8015C (DRO)
EPA 3541

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8015C (DRO)
EPA 3550C

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8015C (DRO)
EPA 3580A

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8270D
EPA 3510C

1,1'-BIPHENYL
1,2,4,5-TETRACHLOROBENZENE
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DINITROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3,5-TRINITROBENZENE (1,3,5-TNB)
1,3-DICHLOROBENZENE
1,3-DINITROBENZENE (1,3-DNB)
1,4-DICHLOROBENZENE
1,4-DINITROBENZENE
1,4-NAPHTHOQUINONE
1,4-PHENYLENEDIAMINE
1-NAPHTHYLAMINE
2,3,4,6-TETRACHLOROPHENOL
2,4,5-TRICHLOROPHENOL
2,4,6-TRIBROMOPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DICHLOROPHENOL
2,6-DINITROTOLUENE (2,6-DNT)
2-ACETYLAMINOFLUORENE
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-FLUOROBIPHENYL
2-METHYLNAPHTHALENE
2-METHYLPHENOL
2-NAPHTHYLAMINE
2-NITROANILINE
2-NITROPHENOL
2-PICOLINE (2-METHYLPYRIDINE)
3,3-DICHLOROBENZIDINE

EPA 8270D
EPA 3510C

3,3-DIMETHYLBENZIDINE
3-METHYLCHOLANTHRENE
3-METHYLPHENOL
3-NITROANILINE
4,4'-DDD
4,4'-DDE
4,4'-DDT
4,6-DINITRO-2-METHYLPHENOL
4-AMINOBIPHENYL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
4-NITROQUINOLINE-1-OXIDE
5-NITRO-O-TOLUIDINE
7,12-DIMETHYLBENZ(A)ANTHRACENE
A,A-DIMETHYLPHENETHYLAMINE
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ALDRIN
ALPHA-BHC
ANILINE
ANTHRACENE
ARAMITE
ATRAZINE
BENZALDEHYDE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZOIC ACID
BENZYL ALCOHOL
BETA-BHC
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-CHLOROISOPROPYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CARBAZOLE

EPA 8270D
EPA 3510C

CHLOROBENZILATE
CHRYSENE
DELTA-BHC
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIALLATE
DIBENZO(A,H)ANTHRACENE
DIBENZO(A,E)PYRENE
DIBENZOFURAN
DIELDRIN
DIETHYL PHTHALATE
DIMETHOATE
DIMETHYL PHTHALATE
DIMETHYLAMINOAZOBENZENE
DIPHENYLAMINE
DISULFOTON
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ETHYL METHANESULFONATE
FAMPHUR
FLUORANTHENE
FLUORENE
GAMMA-BHC (LINDANE)
HEPTACHLOR
HEPTACHLOR EPOXIDE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
HEXACHLOROPHENE
HEXACHLOROPROPENE
INDENO(1,2,3-CD)PYRENE
ISODRIN
ISOPHORONE
ISOSAFROLE
KEPONE
METHAPYRILENE
METHYL METHANESULFONATE
METHYL PARATHION
N-NITROSODI-N-BUTYLAMINE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIETHYLAMINE

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SOLID & HAZARDOUS WASTES

----------SEMI-VOLATILES----------

EPA 8270D
EPA 3510C

N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
N-NITROSOMETHYLETHYLAMINE
N-NITROSOMORPHOLINE
N-NITROSOPIPERIDINE
N-NITROSOPYRROLIDINE
NAPHTHALENE
NITROBENZENE (NB)
O,O,O-TRIETHYLPHOSPHOROTHIOATE
O-TOLUIDINE
PARATHION
PENTACHLOROBENZENE
PENTACHLORONITROBENZENE
PENTACHLOROPHENOL
PHENACETIN
PHENANTHRENE
PHENOL
PHORATE
PRONAMIDE
PYRENE
PYRIDINE
SAFROLE
TETRAETHYL DITHIOPYROPHOSPHATE
THIONAZIN

EPA 8270D
EPA 3550C

1,1'-BIPHENYL
1,2,4,5-TETRACHLOROBENZENE
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DINITROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3,5-TRINITROBENZENE (1,3,5-TNB)
1,3-DICHLOROBENZENE
1,3-DINITROBENZENE (1,3-DNB)
1,4-DICHLOROBENZENE
1,4-DINITROBENZENE
1,4-NAPHTHOQUINONE
1,4-PHENYLENEDIAMINE
1-NAPHTHYLAMINE
2,3,4,6-TETRACHLOROPHENOL

EPA 8270D
EPA 3550C

2,4,5-TRICHLOROPHENOL
2,4,6-TRIBROMOPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DICHLOROPHENOL
2,6-DINITROTOLUENE (2,6-DNT)
2-ACETYLAMINOFLUORENE
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-FLUOROBIPHENYL
2-METHYLNAPHTHALENE
2-METHYLPHENOL
2-NAPHTHYLAMINE
2-NITROANILINE
2-NITROPHENOL
2-PICOLINE (2-METHYLPYRIDINE)
3,3-DICHLOROBENZIDINE
3,3-DIMETHYLBENZIDINE
3-METHYLCHOLANTHRENE
3-METHYLPHENOL
3-NITROANILINE
4,4'-DDD
4,4'-DDE
4,4'-DDT
4,6-DINITRO-2-METHYLPHENOL
4-AMINOBIPHENYL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
4-NITROQUINOLINE-1-OXIDE
5-NITRO-O-TOLUIDINE
7,12-DIMETHYLBENZ(A)ANTHRACENE
A,A-DIMETHYLPHENETHYLAMINE
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ALDRIN
ALPHA-BHC

EPA 8270D
EPA 3550C

ANILINE
ANTHRACENE
ARAMITE
ATRAZINE
BENZALDEHYDE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZOIC ACID
BENZYL ALCOHOL
BETA-BHC
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-CHLOROISOPROPYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CARBAZOLE
CHLOROBENZILATE
CHRYSENE
DELTA-BHC
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIALLATE
DIBENZO(A,H)ANTHRACENE
DIBENZO(A,E)PYRENE
DIBENZOFURAN
DIELDRIN
DIETHYL PHTHALATE
DIMETHOATE
DIMETHYL PHTHALATE
DIMETHYLAMINOAZOBENZENE
DIPHENYLAMINE
DISULFOTON
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ETHYL METHANESULFONATE
FAMPHUR
FLUORANTHENE
FLUORENE

EPA 8270D
EPA 3550C

GAMMA-BHC (LINDANE)
HEPTACHLOR
HEPTACHLOR EPOXIDE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
HEXACHLOROPHENE
HEXACHLOROPROPENE
INDENO(1,2,3-CD)PYRENE
ISODRIN
ISOPHORONE
ISOSAFROLE
KEPONE
METHAPYRILENE
METHYL METHANESULFONATE
METHYL PARATHION
N-NITROSODI-N-BUTYLAMINE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIETHYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
N-NITROSOMETHYLETHYLAMINE
N-NITROSOMORPHOLINE
N-NITROSOPIPERIDINE
N-NITROSOPYRROLIDINE
NAPHTHALENE
NITROBENZENE (NB)
O,O,O-TRIETHYLPHOSPHOROTHIOATE
O-TOLUIDINE
PARATHION
PENTACHLOROBENZENE
PENTACHLORONITROBENZENE
PENTACHLOROPHENOL
PHENACETIN
PHENANTHRENE
PHENOL
PHORATE
PRONAMIDE
PYRENE
PYRIDINE
SAFROLE
TETRAETHYL DITHIOPYROPHOSPHATE
THIONAZIN

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

GEL ENGINEERING LLC (Laboratory ID 10120)
Certifying Authority: SC
Certificate Number: 10120001

Date of Issue: September 27, 2011
Expiration Date: December 26, 2013

SOLID & HAZARDOUS WASTES

----------SEMI-VOLATILES----------

EPA 8270D
EPA 3580A

1,1'-BIPHENYL
1,2,4,5-TETRACHLOROBENZENE
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DINITROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3,5-TRINITROBENZENE (1,3,5-TNB)
1,3-DICHLOROBENZENE
1,3-DINITROBENZENE (1,3-DNB)
1,4-DICHLOROBENZENE
1,4-DINITROBENZENE
1,4-NAPHTHOQUINONE
1,4-PHENYLENEDIAMINE
1-NAPHTHYLAMINE
2,3,4,6-TETRACHLOROPHENOL
2,4,5-TRICHLOROPHENOL
2,4,6-TRIBROMOPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DICHLOROPHENOL
2,6-DINITROTOLUENE (2,6-DNT)
2-ACETYLAMINOFLUORENE
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-FLUOROBIPHENYL
2-METHYLNAPHTHALENE
2-METHYLPHENOL
2-NAPHTHYLAMINE
2-NITROANILINE
2-NITROPHENOL
2-PICOLINE (2-METHYLPYRIDINE)
3,3-DICHLOROBENZIDINE
3,3-DIMETHYLBENZIDINE
3-METHYLCHOLANTHRENE
3-METHYLPHENOL
3-NITROANILINE
4,4'-DDD
4,4'-DDE
4,4'-DDT
4,6-DINITRO-2-METHYLPHENOL

EPA 8270D
EPA 3580A

4-AMINOBIPHENYL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
4-NITROQUINOLINE-1-OXIDE
5-NITRO-O-TOLUIDINE
7,12-DIMETHYLBENZ(A)ANTHRACENE
A,A-DIMETHYLPHENETHYLAMINE
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ALDRIN
ALPHA-BHC
ANILINE
ANTHRACENE
ARAMITE
ATRAZINE
BENZALDEHYDE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZOIC ACID
BENZYL ALCOHOL
BETA-BHC
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-CHLOROISOPROPYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CARBAZOLE
CHLOROBENZILATE
CHRYSENE
DELTA-BHC
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIALLATE
DIBENZO(A,H)ANTHRACENE
DIBENZO(A,E)PYRENE

EPA 8270D
EPA 3580A

DIBENZOFURAN
DIELDRIN
DIETHYL PHTHALATE
DIMETHOATE
DIMETHYL PHTHALATE
DIMETHYLAMINOAZOBENZENE
DIPHENYLAMINE
DISULFOTON
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ETHYL METHANESULFONATE
FAMPHUR
FLUORANTHENE
FLUORENE
GAMMA-BHC (LINDANE)
HEPTACHLOR
HEPTACHLOR EPOXIDE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
HEXACHLOROPHENE
HEXACHLOROPROPENE
INDENO(1,2,3-CD)PYRENE
ISODRIN
ISOPHORONE
ISOSAFROLE
KEPONE
METHAPYRILENE
METHYL METHANESULFONATE
METHYL PARATHION
N-NITROSODI-N-BUTYLAMINE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIETHYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
N-NITROSOMETHYLETHYLAMINE
N-NITROSOMORPHOLINE
N-NITROSOPIPERIDINE
N-NITROSOPYRROLIDINE
NAPHTHALENE
NITROBENZENE (NB)

EPA 8270D
EPA 3580A

O,O,O-TRIETHYLPHOSPHOROTHIOATE
O-TOLUIDINE
PARATHION
PENTACHLOROBENZENE
PENTACHLORONITROBENZENE
PENTACHLOROPHENOL
PHENACETIN
PHENANTHRENE
PHENOL
PHORATE
PRONAMIDE
PYRENE
PYRIDINE
SAFROLE
TETRAETHYL DITHIOPYROPHOSPHATE
THIONAZIN

EPA 8310
EPA 3510C

ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

EPA 8310
EPA 3550C

ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
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**Certificate Number: 10120001**

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SOLID & HAZARDOUS WASTES

----------SEMI-VOLATILES----------

EPA 8310
EPA 3550C

BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

EPA 8310
EPA 3580A

ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

----------VOLATILES (VOCS)----------

EPA 8260B
EPA 3585

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE

EPA 8260B
EPA 3585

1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROBENZENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2,4-TRIMETHYLBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE
1,3-DICHLOROPROPANE
1,4-DICHLOROBENZENE
1,4-DIOXANE
2,2-DICHLOROPROPANE
2-CHLOROETHYLVINYL ETHER
2-CHLOROTOLUENE
2-HEXANONE
2-NITROPROPANE
4-BROMOFLUOROBENZENE
4-CHLOROTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACETONITRILE
ACROLEIN
ACRYLONITRILE
ALLYL CHLORIDE
BENZENE
BENZYL CHLORIDE
BROMOBENZENE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CHLOROPRENE
CIS-1,2-DICHLOROETHENE

EPA 8260B
EPA 3585

CIS-1,3-DICHLOROPROPENE
CIS-1,4-DICHLORO-2-BUTENE
CYCLOHEXANE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
DIETHYL ETHER
ETHYL ACETATE
ETHYL METHACRYLATE
ETHYLBENZENE
HEXACHLOROBUTADIENE
IODOMETHANE
ISOBUTYL ALCOHOL
ISOPROPYLBENZENE
METHACRYLONITRILE
METHYL ACETATE
METHYL ETHYL KETONE (MEK)
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLCYCLOHEXANE
METHYLENE CHLORIDE
N-BUTANOL
N-BUTYLBENZENE
N-PROPYLBENZENE
NAPHTHALENE
P-ISOPROPYLTOLUENE
PENTACHLOROETHANE
PROPIONITRILE
SEC-BUTYLBENZENE
STYRENE
TERT-BUTYLBENZENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE
VINYL CHLORIDE
XYLENE, TOTAL

EPA 8260B
EPA 5030B

1,1,1,2-TETRACHLOROETHANE

EPA 8260B
EPA 5030B

1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROBENZENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2,4-TRIMETHYLBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE
1,3-DICHLOROPROPANE
1,4-DICHLOROBENZENE
1,4-DIOXANE
2,2-DICHLOROPROPANE
2-CHLOROETHYLVINYL ETHER
2-CHLOROTOLUENE
2-HEXANONE
2-NITROPROPANE
4-BROMOFLUOROBENZENE
4-CHLOROTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACETONITRILE
ACROLEIN
ACRYLONITRILE
ALLYL CHLORIDE
BENZENE
BENZYL CHLORIDE
BROMOBENZENE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
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SOLID & HAZARDOUS WASTES

----------VOLATILES (VOCS)----------

EPA 8260B
EPA 5030B

CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CHLOROPRENE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE
CIS-1,4-DICHLORO-2-BUTENE
CYCLOHEXANE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
DIETHYL ETHER
ETHYL ACETATE
ETHYL METHACRYLATE
ETHYLBENZENE
HEXACHLOROBUTADIENE
IODOMETHANE
ISOBUTYL ALCOHOL
ISOPROPYLBENZENE
METHACRYLONITRILE
METHYL ACETATE
METHYL ETHYL KETONE (MEK)
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLCYCLOHEXANE
METHYLENE CHLORIDE
N-BUTANOL
N-BUTYLBENZENE
N-PROPYLBENZENE
NAPHTHALENE
P-ISOPROPYLTOLUENE
PENTACHLOROETHANE
PROPIONITRILE
SEC-BUTYLBENZENE
STYRENE
TERT-BUTYLBENZENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE

EPA 8260B
EPA 5030B

VINYL CHLORIDE
XYLENE, TOTAL

EPA 8260B
EPA 5035

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROBENZENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2,4-TRIMETHYLBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE
1,3-DICHLOROPROPANE
1,4-DICHLOROBENZENE
1,4-DIOXANE
2,2-DICHLOROPROPANE
2-CHLOROETHYLVINYL ETHER
2-CHLOROTOLUENE
2-HEXANONE
2-NITROPROPANE
4-BROMOFLUOROBENZENE
4-CHLOROTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACETONITRILE
ACROLEIN
ACRYLONITRILE
ALLYL CHLORIDE
BENZENE
BENZYL CHLORIDE
BROMOBENZENE
BROMOCHLOROMETHANE

EPA 8260B
EPA 5035

BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CHLOROPRENE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE
CIS-1,4-DICHLORO-2-BUTENE
CYCLOHEXANE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
DIETHYL ETHER
ETHYL ACETATE
ETHYL METHACRYLATE
ETHYLBENZENE
HEXACHLOROBUTADIENE
IODOMETHANE
ISOBUTYL ALCOHOL
ISOPROPYLBENZENE
METHACRYLONITRILE
METHYL ACETATE
METHYL ETHYL KETONE (MEK)
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLCYCLOHEXANE
METHYLENE CHLORIDE
N-BUTANOL
N-BUTYLBENZENE
N-PROPYLBENZENE
NAPHTHALENE
P-ISOPROPYLTOLUENE
PENTACHLOROETHANE
PROPIONITRILE
SEC-BUTYLBENZENE
STYRENE
TERT-BUTYLBENZENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE

EPA 8260B
EPA 5035

TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE
VINYL CHLORIDE
XYLENE, TOTAL

The American Association for Laboratory Accreditation

World Class Accreditation

# *Accredited DoD ELAP Laboratory*

A2LA has accredited

## GEL LABORATORIES, LLC

*Charleston, SC*

for technical competence in the field of

## Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (QSM v4.1); accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 22nd day of August 2011.

President & CEO
For the Accreditation Council
Certificate Number 2567.01
Valid to June 30, 2013

*For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.*

***Joint IAF-ILAC-ISO Communiqué***
***on the***
***Management Systems Requirements of ISO/IEC 17025:2005,***
***General requirements for the competence of testing and calibration laboratories***

A laboratory's fulfilment of the requirements of ISO/IEC 17025:2005 means the laboratory meets both the technical competence requirements and **management system requirements** that are necessary for it to consistently deliver technically valid test results and calibrations. The **management system requirements** in ISO/IEC 17025:2005 (Section 4) are written in language relevant to laboratory operations and meet the principles of ISO 9001:2008 **Quality Management Systems — Requirements** and are aligned with its pertinent requirements.

| IAF Chair | ILAC Chair | ISO Secretary General |
|---|---|---|

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

GEL LABORATORIES, LLC
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ENVIRONMENTAL

Valid To: June 30, 2013 Certificate Number: 2567.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, 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)) accreditation is granted to this laboratory to perform the following radiochemical tests in various matrices, including soils, drinking water, wastewater, groundwater, fiber air filters, vegetation, animal tissues and milk.

| | Preparation SOP | Analytical SOP |
|---|---|---|
| Alpha Spectrometry:<br>Alpha: Am-241, Am-243, Cf-252, Cm-242, Cm-243/244, Cm-245/246, Np-237, Po-208, Po-209, Po-210, Pu-236, Pu-238, Pu-239/240, Pu-242, Pu-244, Th-228, Th-229, Th-230, Th-232, U-232, U-233/234, U-235/236, U-238 | GL-RAD-A-011,<br>GL-RAD-A-016,<br>GL-RAD-A-032,<br>GL-RAD-A-036,<br>GL-RAD-A-038 | GL-RAD-I-009 |
| Radon Emanation:<br>Ra-226 | GL-RAD-A-008,<br>GL-RAD-A-028 | GL-RAD-I-007 |
| Gamma Spectrometry:<br>Gamma: 46 to 1836 keV,<br>I-129,<br>I-131,<br>Ni-59 | GL-RAD-A-006,<br>GL-RAD-A-013,<br>GL-RAD-A-022 | GL-RAD-I-001 |
| Kinetic Phosphorescence Analyzer<br>Total Uranium | GL-RAD-A-023 | GL-RAD-B-018 |



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| | Preparation SOP | Analytical SOP |
|---|---|---|
| Gas Flow Proportional Counting: | | |
| Beta: Cl-36, I-131, Pb-210, Ra-228, Sr-89, Sr-90, Total Radium | GL-RAD-A-004, GL-RAD-A-009, GL-RAD-A-010, GL-RAD-A-017, GL-RAD-A-018, GL-RAD-A-029, GL-RAD-A-030, GL-RAD-A-033, GL-RAD-A-044, GL-RAD-A-054 | GL-RAD-I-006, GL-RAD-I-015, GL-RAD-I-016 |
| Gross Alpha/Gross Beta: | GL-RAD-A-001, GL-RAD-A-001B, GL-RAD-A-001C, GL-RAD-A-056 | GL-RAD-I-006, GL-RAD-I-015, GL-RAD-I-016 |
| 48 hour Gross Alpha | GL-RAD-A-047 | GL-RAD-I-006, GL-RAD-I-015, GL-RAD-I-016 |
| Liquid Scintillation Spectrometry: | | |
| Beta: C-14, Ca-45, Fe-55, H-3, Ni-63, P-32, Pm-147, Pu-241, S-35, Se-79, Tc-99 | GL-RAD-A-002, GL-RAD-A-003, GL-RAD-A-005, GL-RAD-A-007, | GL-RAD-I-004, GL-RAD-I-014, GL-RAD-I-017 |
| Alpha: Rn-222 | GL-RAD-A-019, GL-RAD-A-020, GL-RAD-A-022, GL-RAD-A-031, GL-RAD-A-035, GL-RAD-A-040, GL-RAD-A-048, GL-RAD-A-049, GL-RAD-A-050 | |
| ICP-MS | | |
| Uranium Isotopes | GL-MA-E-008 | GL-MA-E-014 |
| Tc-99 | GL-RAD-A-005, GL-RAD-A-055 | GL-RAD-B-034 |

Additionally, in recognition of the successful completion of the A2LA evaluation process, including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, 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), accreditation is granted to this laboratory to perform recognized EPA, Standard Methods for the Examination of Water and Wastewater, ASTM, Department of Energy (DOE), California and Connecticut test methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Atomic Absorption/ICP-AES Spectrometry, ICP/MS, Gas Chromatography, Gas Chromatography/Mass Spectrometry, Gravimetry, High Performance Liquid Chromatography, Ion Chromatography, Methylene Blue Active Substances, Misc.- Electronic Probes (pH, $O_2$), Oxygen Demand, Hazardous Waste Characteristics Tests, Spectrophotometry (Visible), Spectrophotometry (Automated), IR Spectrometry, Titrimetry, Total Organic Carbon, Total Organic Halide, Turbidity, Liquid Chromatography/Mass Spectrometer/Mass Spectrometer and Various Radiochemistry Techniques

| Parameter/Analyte | Nonpotable Water | Solid Hazardous Waste (Liquids and Solids) |
|---|---|---|
| Metals | | |
| Aluminum | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Antimony | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C |
| Arsenic | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Barium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Beryllium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Boron | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Cadmium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Calcium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Chromium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Cobalt | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Copper | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Iron | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Lead | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Lithium | EPA 200.8/6020/6020A | EPA 6020/6020A |
| Magnesium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Manganese | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Mercury | EPA 1631E/7470/7470A/245.1/245.2 | EPA 7470/7470A/7471A/7471B |
| Molybdenum | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Nickel | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Phosphorous | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Potassium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |

| Parameter/Analyte | Nonpotable Water | Solid Hazardous Waste (Liquids and Solids) |
|---|---|---|
| Selenium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Silicon[1] | EPA 200.7/6010B/6010C modified | EPA 6010B/6010C modified |
| Silica as SiO2 | EPA 200.7/6010B/6010C | EPA 6010B/6010C |
| Silver | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C |
| Sodium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Strontium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Thallium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Tin | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C |
| Titanium | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| Tungsten | ---------- | EPA 6020/6020A |
| Vanadium | EPA 200.7/6010B/6010C | EPA 6010B/6010C |
| Zinc | EPA 200.7/200.8/6010B/6010C/6020/6020A | EPA 6010B/6010C/6020/6020A |
| | | |
| General Chemistry | | |
| Acidity | SM 2310 B/EPA 305.1 | ---------- |
| Adsorbable Organic Halogens (AOX) | EPA 1650 | ---------- |
| Alkalinity | SM 2320B/EPA 310.1 | ---------- |
| Ammenable Cyanide | EPA 9012A/9012B/EPA 335.1 | EPA 9012A/9012B |
| Ammonia Nitrogen | EPA 350.1 | ---------- |
| Biochemical oxygen demand | SM 5210 B/EPA 405.1 | ---------- |
| Bromide | EPA 9056A/EPA 300.0 | EPA 9056A[3] |
| Carbonaceous BOD | SM 5210 B | ---------- |
| Chemical Oxygen Demand (COD) | EPA 410.4 | ---------- |
| Chloride | EPA 9056A/EPA 300.0 | EPA 9056A[3] |
| Chlorine (residual) | SM 4500Cl-G/EPA 330.5 | ---------- |
| Chromium VI | EPA 7196A/SM 3500Cr-B | EPA 7196A |
| Color | SM 2120B/EPA 110.2 | ---------- |
| Corrosivity toward Steel | ---------- | EPA 1110/1110A |
| Cyanide | EPA 9012A/9012B/335.3/335.4 | EPA 9012A/9012B |
| Density | ---------- | ASTM D 5057 |
| Extractable Organic Halides (EOX) | ---------- | EPA 9023 |
| Filterable residue | SM 2540C | ---------- |
| Fluoride | EPA 9056A/EPA 300.0 | EPA 9056A[3] |
| Ignitability | EPA 1010/1020A/1020B | EPA 1010/1020A/1020B |
| Hardness | SM 2340B/SM 2340C/EPA 130.2 | ---------- |
| Kjeldahl Nitrogen | EPA 351.2 | ---------- |
| MBAS/Surfactants | SM 5540C/EPA 425.1 | ---------- |
| Nitrate (as N) | EPA 9056A/EPA 300.0 | EPA 9056A[3] |
| Nitrate-nitrite (as N) | EPA 9056A/EPA 300.0 | EPA 9056A[3] |

| Parameter/Analyte | Nonpotable Water | Solid Hazardous Waste (Liquids and Solids) |
|---|---|---|
| Nitrite (as N) | EPA 9056A/EPA 300.0 | EPA 9056A[3] |
| Nonfilterable residue | SM 2540D | ---------- |
| Oil & Grease | EPA 1664A | EPA 1664A |
| Organic Nitrogen | TKN – Ammonia EPA 351.2 – EPA 350.1 | ---------- |
| Orthophosphate (as P) | EPA 9056A/EPA 300.0 | EPA 9056A[3] |
| Paint Filter Liquids Test | ---------- | EPA 9095A/9095B |
| Perchlorate | EPA 314.0/6850 | EPA 6850 |
| pH | SM 4500-$H^+$ B/ EPA 9040B /9040C/9041A/ EPA 150.1 | EPA 9040B/9040C/9045C/9045D |
| Reactive Cyanide | Sec 7.3.3 SW846 | Sec 7.3.3 SW846 |
| Reactive Sulfide | Sec 7.3.4 SW846 | Sec 7.3.4 SW846 |
| Residue-Volatile | SM 2540E/EPA 160.4 | ---------- |
| Residue-Settleable | SM 2540F | ---------- |
| Specific conductance | EPA 9050A/EPA 120.1 | ---------- |
| Sulfate | EPA 9056A/EPA 300.0 | EPA 9056A[3] |
| Sulfite | SM 4500-SO3 B | ---------- |
| Sulfide | EPA 9030B/9034 | EPA 9030B/9034 |
| Total, fixed, and volatile residue | SM 2540G | ---------- |
| Total Nitrate-Nitrite | EPA 353.2 | ---------- |
| Total Organic Carbon (TOC) | EPA 9060/9060A/ SM 5310D/415.1 | EPA 9060/9060A[2] |
| Total Organic Halides (TOX) | EPA 9020B | EPA 9020B[2] |
| Total Petroleum Hydrocarbons | EPA 1664A | EPA 1664A |
| Total Phenolics | EPA 9066/EPA 420.4 | ---------- |
| Total Phosphorous | EPA 365.4 | ---------- |
| Total residue | SM 2540B | ---------- |
| Turbidity | EPA 180.1/SM 2130 | EPA 180.1/SM 2130 |
| | | |
| Organic Analytes | | |
| 1,2-Dibromo-3-chloropropane (DBCP) | EPA 504.1/8011/8260B | EPA 8260B |
| 1,2 Dibromoethane (EDB) | EPA 504.1/8011/8260B | EPA 8260B |
| | | |
| Purgeable Organics (Volatiles) | | |
| Acetone | EPA 624/8260B | EPA 8260B |
| Acetonitrile | EPA 624/8260B | EPA 8260B |
| Acrolein (Propenal) | EPA 624/8260B | EPA 8260B |
| Acrylonitrile | EPA 624/8260B | EPA 8260B |
| Allyl Chloride | EPA 624/8260B | EPA 8260B |
| Benzene | EPA 624/8260B | EPA 8260B |
| Benzyl chloride | EPA 624/8260B | EPA 8260B |
| Bromobenzene | EPA 624/8260B | EPA 8260B |
| Bromochloromethane | EPA 624/8260B | EPA 8260B |
| Bromodichloromethane | EPA 624/8260B | EPA 8260B |
| Bromoform | EPA 624/8260B | EPA 8260B |
| Bromomethane | EPA 624/8260B | EPA 8260B |
| 2-Butanone (Methyl Ethyl Ketone) | EPA 8015B/8015C/624/8260B | EPA 8260B |

| Parameter/Analyte | Nonpotable Water | Solid Hazardous Waste (Liquids and Solids) |
|---|---|---|
| n-Butyl alcohol | EPA 8015B/8015C/624/8260B | EPA 8260B |
| n-Butylbenzene | EPA 624/8260B | EPA 8260B |
| Sec-Butylbenzene | EPA 624/8260B | EPA 8260B |
| Tert-Butylbenzene | EPA 624/8260B | EPA 8260B |
| Carbon disulfide | EPA 624/8260B | EPA 8260B |
| Carbon tetrachloride | EPA 624/8260B | EPA 8260B |
| Chlorobenzene | EPA 624/8260B | EPA 8260B |
| Chloroethane | EPA 624/8260B | EPA 8260B |
| 2-Chloroethyl vinyl ether | EPA 624/8260B | EPA 8260B |
| Chloroform | EPA 624/8260B | EPA 8260B |
| Chloromethane | EPA 624/8260B | EPA 8260B |
| Chloroprene | EPA 624/8260B | EPA 8260B |
| 2-Chlorotoluene | EPA 624/8260B | EPA 8260B |
| 4-Chlorotoluene | EPA 624/8260B | EPA 8260B |
| Dibromochloromethane | EPA 624/8260B | EPA 8260B |
| Dibromomethane | EPA 624/8260B | EPA 8260B |
| 1,2-Dichlorobenzene | EPA 624/8260/625/8270C/8270D | EPA 8260/8270C/8270D |
| 1,3-Dichlorobenzene | EPA 624/8260/625/8270C/8270D | EPA 8260/8270C/8270D |
| 1,4-Dichlorobenzene | EPA 624/8260/625/8270C/8270D | EPA 8260/8270C/8270D |
| Dichlorodifluoromethane | EPA 624/8260B | EPA 8260B |
| 1,1-Dichloroethane | EPA 624/8260B | EPA 8260B |
| 1,2-Dichloroethane | EPA 624/8260B | EPA 8260B |
| 1,1-Dichloroethene | EPA 624/8260B | EPA 8260B |
| cis-1,2-Dichloroethene | EPA 624/8260B | EPA 8260B |
| trans-1,2-Dichloroethene | EPA 624/8260B | EPA 8260B |
| 1,2-Dichloropropane | EPA 624/8260B | EPA 8260B |
| 1,3-Dichloropropane | EPA 624/8260B | EPA 8260B |
| 2,2-Dichloropropane | EPA 624/8260B | EPA 8260B |
| 1,1-Dichloropropene | EPA 624/8260B | EPA 8260B |
| cis-1,3-Dichloropropene | EPA 624/8260B | EPA 8260B |
| trans-1,3-Dichloropropene | EPA 624/8260B | EPA 8260B |
| cis-1,4-Dichloro-2-butene | EPA 624/8260B | EPA 8260B |
| trans-1,4-Dichloro-2-butene | EPA 624/8260B | EPA 8260B |
| Diethyl ether | EPA 624/8260B | EPA 8260B |
| 1,4-Dioxane | EPA 624/8260B | EPA 8260B |
| Ethyl Acetate | EPA 8015B/8015C/624/8260B | EPA 8015B/8015C/8260B |
| Ethyl Benzene | EPA 624/8260B | EPA 8260B |
| Ethyl methacrylate | EPA 624/8260B | EPA 8260B |
| 2-Hexanone | EPA 624/8260B | EPA 8260B |
| Hexachlorobutadiene | EPA 624/8260/625/8270C/8270D | EPA 8260/8270C/8270D |
| Isopropylbenzene | EPA 624/8260B | EPA 8260B |
| 4-Isopropyltoluene | EPA 624/8260B | EPA 8260B |
| Iodomethane | EPA 624/8260B | EPA 8260B |
| Isobutyl Alcohol | EPA 8015B/8015C/624/8260B | EPA 8260B |
| Methacrylonitrile | EPA 624/8260B | EPA 8260B |
| Methylene chloride | EPA 624/8260B | EPA 8260B |
| Methyl methyacrylate | EPA 624/8260B | EPA 8260B |
| 4-Methyl-2-pentanone | EPA 624/8260B | EPA 8260B |
| Methyl tert butyl ether (MTBE) | EPA 624/8260B | EPA 8260B |
| Naphthalene | EPA 624/8260B/625/8270C/8270D/8310 | EPA 8260B/8270C/8270D/8310 |

| Parameter/Analyte | Nonpotable Water | Solid Hazardous Waste (Liquids and Solids) |
|---|---|---|
| 2-Nitropropane | EPA 624/8260B | EPA 8260B |
| n-Propylbenzene | EPA 624/8260B | EPA 8260B |
| Pentachloroethane | EPA 624/8260B | EPA 8260B |
| Propionitrile | EPA 624/8260B | EPA 8260B |
| Styrene | EPA 624/8260B | EPA 8260B |
| 1,1,1,2-Tetrachloroethane | EPA 624/8260B | EPA 8260B |
| 1,1,2,2-Tetrachloroethane | EPA 624/8260B | EPA 8260B |
| Tetrachloroethene | EPA 624/8260B | EPA 8260B |
| Toluene | EPA 624/8260B | EPA 8260B |
| 1,1,1-Trichloroethane | EPA 624/8260B | EPA 8260B |
| 1,1,2-Trichloroethane | EPA 624/8260B | EPA 8260B |
| Trichloroethene | EPA 624/8260B | EPA 8260B |
| Trichlorofluoromethane | EPA 624/8260B | EPA 8260B |
| 1,2,3-Trichlorobenzene | EPA 624/8260B | EPA 8260B |
| 1,2,3-Trichloropropane | EPA 624/8260B | EPA 8260B |
| 1,2,4-Trichlorobenzene | EPA 624/8260B/625/8270C/8270D | EPA 8260B/8270C/8270D |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | EPA 624/8260B | --- |
| 1,2,4-Trimethylbenzene | EPA 624/8260B | EPA 8260B |
| 1,3,5-Trimethylbenzene | EPA 624/8260B | EPA 8260B |
| Trihalomethanes | EPA 624/8260B | EPA 8260B |
| Vinyl acetate | EPA 624/8260B | EPA 8260B |
| Vinyl chloride | EPA 624/8260B | EPA 8260B |
| Xylenes, total | EPA 624/8260B | EPA 8260B |
| o-Xylene | EPA 624/8260B | EPA 8260B |
| m+p-Xylene | EPA 624/8260B | EPA 8260B |
| | | |
| Semivolatile Compounds | | |
| Acenaphthene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Acenaphthylene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Acetophenone | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2-Acetylaminofluorene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 4-Aminobiphenyl | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Aniline | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Anthracene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Aramite | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Atrazine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Benzidine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Benzoic acid | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Benzo (a) anthracene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Benzo (b) fluoranthene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Benzo (k) fluoranthene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Benzo (ghi) perylene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Benzo (a) pyrene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| p-Benzoquinone | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Benzyl alcohol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Bis (2-chloroethoxy) methane | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Bis (2-chloroethyl) ether | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Bis (2-chloroisopropyl) ether | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Bis (2-ethylhexyl) phthalate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 4-Bromophenyl phenyl ether | EPA 625/8270C/8270D | EPA 8270C/8270D |

| Parameter/Analyte | Nonpotable Water | Solid Hazardous Waste (Liquids and Solids) |
|---|---|---|
| Butyl benzyl phthalate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Carbazole | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 4-Chloroaniline | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Chlorobenzilate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 4-Chloro-3-methylphenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2-Chloronaphthalene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2-Chlorophenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 4-Chlorophenyl phenyl ether | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Chrysene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| n-Decane | EPA 625/8270C/8270D | -------- |
| Diallate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Dibenzo (a,h) anthracene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Dibenzofuran | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Dibenzo (a,e) pyrene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 1,2-Dichlorobenzene | EPA 624/8260B/625/8270C/8270D | EPA 8260B/8270C/8270D |
| 1,3-Dichlorobenzene | EPA 624/8260B/625/8270C/8270D | EPA 8260B/8270C/8270D |
| 1,4-Dichlorobenzene | EPA 624/8260B/625/8270C/8270D | EPA 8260B/8270C/8270D |
| 3,3'-Dichlorobenzidine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2,4-Dichlorophenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2,6-Dichlorophenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 3,3'-Dimethylbenzidine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Diethyl phthalate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Dimethoate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 1,3-Dinitrobenzene | EPA 625/8270C/8270D/8330A/8330B | EPA 8270C/8270D/8330A/8330B |
| 1,4-Dinitrobenzene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Disulfoton | EPA 625/8270C/8270D | EPA 8270C/8270D |
| p-Dimethylaminoazobenzene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 7,12-Dimethylbenz(a)anthracene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Alpha-,alpha-Dimethylphenethylamine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2,4-Dimethylphenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Dimethyl phthalate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Di-n-butyl phthalate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Di-n-octyl phthalate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2,4-Dinitrophenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2,4-Dinitrotoluene | EPA 625/8270/8330A/8330B | EPA 8270/8330A/8330B |
| 2,6-Dinitrotoluene | EPA 625/8270/8330A/8330B | EPA 8270/8330A/8330B |
| Diphenylamine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 1,2-Diphenylhydrazine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Ethyl methanesulfonate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Famphur | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Fluoroanthene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Fluorene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Hexachlorobenzene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Hexachlorobutadiene | EPA 624/8260B/625/8270C/8270D | EPA 8260B/8270C/8270D |
| Hexachlorophene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Hexachloropropene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Hexachlorocyclopentadiene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Hexachloroethane | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Indeno (1,2,3-cd) pyrene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |

| Parameter/Analyte | Nonpotable Water | Solid Hazardous Waste (Liquids and Solids) |
|---|---|---|
| Isodrin | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Isophorone | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Isosafrole | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Kepone | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Methapyrilene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 3-Methylcholanthrene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2-Methyl-4,6-Dinitrophenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Methyl methanesulfonate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 1-Methylnaphthalene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2-Methylnaphthalene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Methyl Parathion | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2-Methylphenol (o-cresol) | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 3/4-Methylphenols(m/p cresols) | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Naphthalene | EPA 624/8260B/625/8270C/8270D/8310 | EPA8260B/8270C/8270D/8310 |
| 1,4-Naphthoquinone | EPA 625/8270C/8270D | ---------- |
| 1-Naphthylamine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2-Naphthylamine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2-Nitroaniline | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 3-Nitroaniline | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 4-Nitroaniline | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Nitrobenzene | EPA 625/8270C/8270D/8330A/8330B | EPA 8270C/8270D/8330A/8330B |
| 5-Nitro-o-toluidine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2-Nitrophenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 4-Nitrophenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Nitroquinoline-1-oxide | EPA 625/8270C/8270D | EPA 8270C/8270D |
| N-Nitrosodietheylamine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| N-Nitrosodimethylamine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| N-Nitrosodi-n-butylamine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| N-Nitrosodi-n-propylamine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| N-Nitrosodiphenylamine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| N-Nitrosodimethylethylamine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| N-Nitrosomorpholine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| N-Nitrosopiperidine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| N-Nitrosopyrrolidine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| n-Octadecane | ---------- | EPA 8270C/8270D |
| o,o,o-Triethyl phosphorothioate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| o-Toluidine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Parathion, ethyl | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Pentachlorobenzene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Pentachloronitrobenzene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Pentachlorophenol | EPA 8270C/8270D/8151A | EPA 8270C/8270D/8151A |
| Phenacetin | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Phenanthrene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Phenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 1,4-Phenylenediamine | EPA 625/8270C/8270D | ---------- |
| Phorate | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2-Picoline (2-Methylpyridine) | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Pronamide (Kerb) | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Pyrene | EPA 625/8270C/8270D/8310 | EPA 8270C/8270D/8310 |
| Pyridine | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Safrole | EPA 625/8270C/8270D | EPA 8270C/8270D |

| Parameter/Analyte | Nonpotable Water | Solid Hazardous Waste (Liquids and Solids) |
|---|---|---|
| Sulfotepp | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 1,2,4,5-Tetrachlorobenzene | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2,3,4,6-Tetrachlorophenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| Thionazin (Zinophos) | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 1,2,4-Trichlorobenzene | EPA 624/8260B/625/8270C/8270D | EPA 8260B/8270C/8270D |
| 2,4,5-Trichlorophenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 2,4,6-Trichlorophenol | EPA 625/8270C/8270D | EPA 8270C/8270D |
| 1,3,5-Trinitrobenzene | EPA 625/8270C/8270D/8330A/8330B | EPA 8270C/8270D/8330A/8330B |
| | | |
| Pesticides & PCBs | | |
| Aldrin | EPA 608/8081A/8081B | EPA 8081A/8081B |
| alpha-BHC | EPA 608/8081A/8081B | EPA 8081A/8081B |
| alpha-Chlordane | EPA 608/8081A/8081B | EPA 8081A/8081B |
| beta-BHC | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Chlordane (technical) | EPA 608/8081A/8081B | EPA 8081A/8081B |
| delta-BHC | EPA 608/8081A/8081B | EPA 8081A/8081B |
| gamma-BHC | EPA 608/8081A/8081B | EPA 8081A/8081B |
| gamma-Chlordane | EPA 608/8081A/8081B | EPA 8081A/8081B |
| 4,4'-DDD | EPA 608/8081A/8081B | EPA 8081A/8081B |
| 4,4'-DDE | EPA 608/8081A/8081B | EPA 8081A/8081B |
| 4,4'-DDT | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Dieldrin | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Endosulfan I | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Endosulfan II | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Endonsulfan sulfate | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Endrin | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Endrin aldehyde | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Endrin ketone | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Heptachlor | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Heptachlor epoxide | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Methoxychlor | EPA 608/8081A/8081B | EPA 8081A/8081B |
| Toxaphene | EPA 608/8081A/8081B | EPA 8081A/8081B |
| PCB-1016 (Aroclor) | EPA 608/8082/8082A | EPA 8082/8082A |
| PCB-1221 | EPA 608/8082/8082A | EPA 8082/8082A |
| PCB-1232 | EPA 608/8082/8082A | EPA 8082/8082A |
| PCB-1242 | EPA 608/8082/8082A | EPA 8082/8082A |
| PCB-1248 | EPA 608/8082/8082A | EPA 8082/8082A |
| PCB-1254 | EPA 608/8082/8082A | EPA 8082/8082A |
| PCB-1260 | EPA 608/8082/8082A | EPA 8082/8082A |
| PCB-1262 | EPA 608/8082/8082A | EPA 8082/8082A |
| PCB-1268 | EPA 608/8082/8082A | EPA 8082/8082A |
| Total Aroclors | EPA 608/8082/8082A | EPA 8082/8082A |
| | | |
| FID Compounds | | |
| Ethyl acetate | EPA 8015B/8015C/624/8260B | EPA 8015B/8015C/8260B |
| Ethylene Glycol | EPA 8015B/8015C | EPA 8015B/8015C |
| Isobutyl Alcohol | EPA 8015B/8015C/624/8260B | EPA 8260B |
| Isopropyl Alcohol (2-Propanol) | EPA 8015B/8015C | ---------- |
| Methanol | EPA 8015B/8015C | EPA 8015B/8015C |
| Diesel Range Organics (DRO) | EPA 8015B/8015C/CA-LUFT/ CT-ETPH | EPA 8015B/8015C/CA-LUFT/ CT-ETPH |

| Parameter/Analyte | Nonpotable Water | Solid Hazardous Waste (Liquids and Solids) |
|---|---|---|
| Gas Range Organics (GRO) | EPA 8015B/8015C/CA-LUFT | EPA 8015B/8015C/CA-LUFT |
| | | |
| Herbicides | | |
| 2,4-D | EPA 8151A | EPA 8151A |
| 2,4-DB | EPA 8151A | EPA 8151A |
| Dalapon | EPA 8151A | EPA 8151A |
| Dicamba | EPA 8151A | EPA 8151A |
| Dichloroprop | EPA 8151A | EPA 8151A |
| Dinoseb | EPA 8151A | EPA 8151A |
| MCPA | EPA 8151A | EPA 8151A |
| MCPP | EPA 8151A | EPA 8151A |
| 2,4,5-T | EPA 8151A | EPA 8151A |
| 2,4,5-TP (Silvex) | EPA 8151A | EPA 8151A |
| Pentachlorophenol | EPA 8151A | EPA 8151A |
| Nitrosamines, Nitroaromatics | | |
| 1,3-Dinitrobenzene | EPA 625/8270C/8270D/8330A/8330B | EPA 8270C/8270D/8330A/8330B |
| 2,4-Dinitrotoluene | EPA 625/8270C/8270D/8330A/8330B | EPA 8270C/8270D/8330A/8330B |
| 2,6-Dinitrotoluene | EPA 625/8270C/8270D/8330A/8330B | EPA 8270C/8270D/8330A/8330B |
| 2,4,6-Trinitrotoluene | EPA 8330A/8330B | EPA 8330A/8330B |
| 2-Amino-4,6-Dinitrotoluene | EPA 8330A/8330B | EPA 8330A/8330B |
| 2-Nitrotoluene | EPA 8330A/8330B | EPA 8330A/8330B |
| 3-Nitrotoluene | EPA 8330A/8330B | EPA 8330A/8330B |
| 3,5-Dinitroaniline | | EPA 8330B (Solids Only) |
| 4-Amino-2,6-Dinitrotoluene | EPA 8330A/8330B | EPA 8330A/8330B |
| 4-Nitrotoluene | EPA 8330A/8330B | EPA 8330A/8330B |
| Nitrobenzene | EPA 625/8270C/8270D/8330A/8330B | EPA 8270C/8270D/8330A/8330B |
| Nitroglycerine | EPA 8330A/8330B | EPA 8330A/8330B |
| Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) | EPA 8330A/8330B | EPA 8330A/8330B |
| Pentaerythritoltetranitrate (PETN) | EPA 8330A/8330B | EPA 8330A/8330B |
| hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) | EPA 8330A/8330B | EPA 8330A/8330B |
| Tetryl (methyl-2,4,6-trinitrophenylnitramine) | EPA 8330A/8330B | EPA 8330/8330B |
| | | |
| Radiochemistry | | |
| Barium 133 | DOE 4.5.2.3 | DOE 4.5.2.3 |
| Cesium 134 | DOE 4.5.2.3/EPA 901.1 | DOE 4.5.2.3 |
| Cesium 137 | DOE 4.5.2.3/EPA 901.1 | DOE 4.5.2.3 |
| Cobalt-60 | DOE 4.5.2.3/EPA 901.1 | DOE 4.5.2.3 |
| Gamma Emitters | DOE 4.5.2.3/EPA 901.1 | DOE 4.5.2.3 |
| Gross Alpha | EPA 900.0/9310 | EPA 9310 |
| Gross Beta | EPA 900.0/9310 | EPA 9310 |
| Radioactive Iodine | DOE 4.5.2.3/EPA 901.1/902.0 | DOE 4.5.2.3 |
| Radium-226 | EPA 903.1/DOE Ra-04 | DOE Ra-04 |
| Radium-228 | EPA 904.0/9320/DOE 4.5.2.3 | DOE 4.5.2.3/EPA9320 |
| Total Radium | EPA 9315 | EPA 9315 |
| Radon | SM7500 Rn-B | --- |
| Strontium-89 | EPA 905.0 | DOE Sr-01 |
| Strontium-90 | EPA 905.0/DOE Sr-02 | DOE Sr-02 |

| Parameter/Analyte | Nonpotable Water | Solid Hazardous Waste (Liquids and Solids) |
|---|---|---|
| Thorium | EMSL-LV | EMSL-LV |
| Tritium | EPA 906.0 | --- |
| Uranium | ASTM D5174-02/D5174-97/DOE U-02/EPA 6020/6020A | DOE U-02/EPA 6020/6020A |
| Zinc-65 | EPA 901.1/DOE 4.5.2.3 | DOE 4.5.2.3 |
| | | |
| Preparatory and Clean-up Methods | | |
| Toxicity Characteristic Leaching Procedure (Inorganics, Extractable Organics, Volatile Organics) | --- | EPA 1311 |
| Synthetic Precipitation Leaching Procedure | --- | EPA 1312 |
| Waste Extraction Test (W.E.T.) | --- | CCR Chapter 11, Article 5, Appendix II |
| Anion Preparation | --- | EPA 9056A[3] |
| Cyanide Distillation | EPA 9010B/9010C | EPA 9010B/9010C[3] |
| Sulfide Distillation | EPA 9030B | EPA 9030B |
| Metals Digestion | EPA 200.2, 3005A, 3010A | EPA 3050B |
| Alkaline Digestion for Hexavalent Chromium | --- | EPA 3060A |
| Bomb Preparation for Solid Waste | --- | EPA 5050 |
| Mercury Preparation | EPA 245.1/245.2/7470/7470A | EPA 7471A/7471B |
| Separatory Funnel Liquid-Liquid Extraction | EPA 3510C | --- |
| Continuous Liquid-Liquid Extraction | EPA 3520C | --- |
| Solid Phase Extraction | EPA 3535A | --- |
| Automated Soxhlet Extraction | --- | EPA 3541 |
| Ultrasonic Extraction | --- | EPA 3550C |
| Waste Dilution | --- | EPA 3580A |
| Waste Dilution for Volatile Organics | --- | EPA 3585 |
| Purge and Trap for Volatile Organics | EPA 5030A/5030B/5030C | EPA 5035/5035A |
| Alumina Clean-up | --- | EPA 3610B/3611B |
| Florisil Clean-up | --- | EPA 3620B/3620C |
| Silica Gel Clean-up | --- | EPA 3630C |
| Gel Permeation Clean-up | --- | EPA 3640A |
| Sulfur Clean-up | --- | EPA 3660B |
| Sulfuric Acid/Permanganate Clean-up | --- | EPA 3665A |

Additionally, in recognition of the successful completion of the A2LA evaluation process (including an assessment of the laboratory's compliance with the 2003 NELAC Chapter 5 Requirements), accreditation is granted to this laboratory to perform the following bioassay analyses on bone, tissue, urine, fecal, and nasal swabs.

| | Preparation SOP | Analytical SOP |
|---|---|---|

| Bioassy Analysis | | |
|---|---|---|
| Alpha Spectrometry:<br>Alpha: Am-241, Cm-242, Cm-243/244, Cm 245/246,Cf-252, Np-237, Po-208, Po- 209, Po-210, Pu-236, Pu-238, Pu-239/240, Pu-242, Pu-244, Th-228, Th-229, Th-230, Th-232, U-232, U-233/234, U-235/236, U-238 | GL-RAD-B-001, GL-RAD-B-002, GL-RAD-B-003, GL-RAD-B-010, GL-RAD-B-012, GL-RAD-B-013, GL-RAD-B-017 | GL-RAD-B-009 |
| Liquid Scintillation Spectrometry:<br>C-14, Gross Alpha, H-3, Ni-63, Pu-241, Tc-99 | GL-RAD-B-001, GL-RAD-B-008, GL-RAD-B-011, GL-RAD-B-012, GL-RAD-B-013, GL-RAD-B-016, GL-RAD-B-020, GL-RAD-B-023 | GL-RAD-I-004, GL-RAD-I-014, GL-RAD-I-017 |
| Gas Flow Proportional Counting:<br>Beta: Sr-90 | GL-RAD-B-001 | GL-RAD-I-006, GL-RAD-I-015, GL-RAD-I-016 |
| Gross Alpha/Gross Beta | GL-RAD-B-022 | GL-RAD-I-006 |
| Kinetic Phosphorescence Analyzer<br>Total Uranium | GL-RAD-B-019 | GL-RAD-B-018 |
| Radon Emanation:<br>Ra-226 | GL-RAD-B-002 | GL-RAD-I-007 |
| Refractometer<br>Specific Gravity | GL-RAD-B-027 | GL-RAD-B-027 |
| ICP-MS<br>Uranium Isotopes | GL-RAD-B-035 | GL-RAD-B-027 |
| Gamma Spectrometry:<br>Gamma: Ni-59, 46 to 1836 keV | GL-RAD-B-020, GL-RAD-A-013 | GL-RAD-I-001 |

Finally, accreditation is also granted to this laboratory to perform the following tests on children's toys:

| Chemical | |
|---|---|
| Lead in Paint by ICP | 16 CFR part 1303 (using GL-MA-E-009 and GL-MA-E-013) |

[1] - Calculated from silica determination

[2] – Applicable only to liquid 'Solid Hazardous Waste', where liquids may include aqueous, non-aqueous, and oily wastes. Solids may include soils, sediments, sludges, tissues, filters and any matrix deemed non-liquid.

[3] – The referenced method is modified to include a simple prep for non-aqueous and/or solid matrix samples.

# Appendix E-2

# Laboratory Standard Operating Procedures

# (On CD)

**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

# FOR

# pH

## (GL-GC-E-008 REVISION 20)

APPLICABLE TO METHODS:
EPA 150.1, SW-846 Method 9040B/9040C,
SW-846 Method 9041A, SW-846 Method 9045C/9045D
Exhibit D Semivolatiles, OLMO4.2, 10.1.4.1 and
Standard Methods 18th through 21st Editions, 4500-$H^+$

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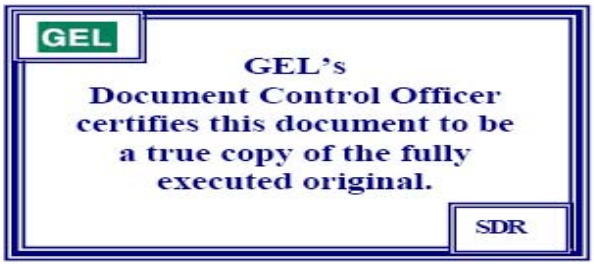

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## 1.0 STANDARD OPERATING PROCEDURE FOR pH

## 2.0 METHOD CODE

2.1 Matrix - Water or multiphase waste where at least 20% of the sample is aqueous

2.1.1 EPA 150.1

2.1.2 Standard Methods 18th through 21st Editions, 4500-$H^+$

2.1.3 SW-846 Method 9040B/9040C

2.2 Matrix – Solids and Sludges

2.2.1 SW-846 Method 9045C/9045D

2.3 Matrix - Liquid samples, where measurement by the methods listed in 2.1 is not possible, and oils

2.3.1 SW-846 Method 9041A (pH paper method) - This procedure is described in Section 22.1 of this SOP.

## 3.0 METHOD OBJECTIVE/PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the procedures used to determine pH.

## 4.0 METHOD SUMMARY

4.1 For Methods EPA 150.1, Standard Methods 4500-$H^+$, SW-846 9040B/9040C, and SW-846 9045C/9045D: The pH of a sample is determined electrometrically using either a glass electrode in combination with a reference potential or a combination electrode.

4.2 For SW-846 Method 9041A: The pH is determined with pH paper. Skip directly to Section 22.1 for this procedure.

## 5.0 APPLICABLE MATRICES

5.1 Groundwater

5.2 Drinking water

5.3 Domestic and industrial wastewater

5.4 Soil

5.5 Sludge

5.6 Oil

**NOTE:** Clients may request that this analysis be performed on miscellaneous liquid or solid samples. In these cases the procedure is modified as necessary.

## 6.0 HOLDING TIME

The Environmental Protection Agency (EPA) ruled on April 4, 1995, that the holding time for pH analysis is 15 minutes or less. Since transport of the samples to the laboratory for analysis exceeds this holding time, analysis occurs upon arrival.

## 7.0 SAMPLE CONTAINER/PRESERVATION/COLLECTION/STORAGE REQUIREMENTS

7.1 Samples can be collected in plastic or glass containers with no headspace.

7.2 Samples are unpreserved.

7.3 Samples are refrigerated at 0° ≤ 6° C until the start of analysis in accordance with GL-SR-E-001 for Sample Receipt, Login, and Storage.

## 8.0 INTERFERENCES/LIMITATIONS

8.1 Sodium error at pH levels greater than 10 can be reduced or eliminated by using a low sodium error electrode.

8.2 Oily material or particulate matter can coat the electrode and impair response. This is removed by gentle wiping and distilled water rinsing or by soaking in 10% hydrochloric acid if needed.

8.3 Temperature affects the pH of different samples in different ways. For this reason both pH and temperature should be recorded at time of analysis.

8.4 The Environmental Protection Agency (EPA) ruled on April 4, 1995, that the holding time for pH analysis is 15 minutes or less. Since transport of the samples to the laboratory for analysis exceeds this holding time, analysis occurs upon arrival.

## 9.0 PERFORMANCE CHARACTERISTICS

9.1 Method range: 0 to 14 pH units (s.u.)

9.2 Calibration range: 4 to 10 pH units (s.u.)

**NOTE:** Add a pH 2 buffer for acidic or a pH 12 buffer for caustic wastes when a sample is to be analyzed for corrosivity characterization.

9.3 Method precision: Refer to current SPC limits

9.4 Method accuracy: Refer to current SPC limits

## 10.0 DEFINITIONS

10.1 AlphaLIMS: The Laboratory Information Management System used at GEL Laboratories, LLC.

10.2 Buffer Solution: Solutions with known pH values that are used to perform daily calibrations of the pH meter.

10.3 Calibration Standard (CAL): A solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards and surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

10.4 Continuing Calibration Verification (CCV) Standard: An aliquot of reagent water or other blank to which known quantities of the method analytes are added in the laboratory. The CCV is analyzed exactly like a sample, periodically throughout the run sequence. Its purpose is to determine whether the analytical sequence is in control during sample analysis. It may be prepared from the same source as the calibration standards, and is usually of varied concentration.

10.5 Laboratory Duplicate (DUP, LCSD, MSD, PSD): Aliquots of a sample taken from the same container and processed in the same manner under identical laboratory conditions. The aliquot is analyzed independently from the parent sample and the results are compared to measure precision and accuracy.

10.6 Laboratory Control Standard (LCS): An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the

laboratory. The LCS is analyzed exactly like a sample, and whether the laboratory is capable of making accurate and precise measurements.

10.7 Statistical Process Control (SPC) Limits: Statistically derived limits that establish acceptable ranges for recoveries of analytes of interest, including LCS, MS, MSD, PS, PSD, and internal standards.

10.8 Stock Standard Solution: A concentrated solution containing one or more method analytes prepared in the laboratory using certified reference materials or purchased from a reputable commercial source.

## 11.0 ANALYST VERIFICATION

Technicians and analysts do not analyze samples without supervision until trained by qualified personnel and upon successful analysis of a proficiency sample. Training records are maintained as quality records.

## 12.0 DOCUMENTATION OF DATA

12.1 Sample preparation data are recorded in AlphaLIMS.

12.2 As analytical data are obtained they are recorded in AlphaLIMS.

## 13.0 SAFETY PRECAUTIONS AND HAZARD WARNINGS

13.1 Wear eye protection with side shields while performing procedures in the laboratory.

13.2 Treat all chemicals and samples as potential health hazards, and limit exposure to these chemicals to the lowest level possible. GEL maintains a current awareness file of OSHA regulations regarding the safe handling of the chemicals in the laboratory as well as a reference file of Material Safety Data Sheets (MSDS). These documents and client sample MSDSs are maintained in the laboratory.

13.3 Personal protective equipment

13.3.1 Approved gloves are required when handling chemicals or samples.

13.3.2 To prevent clothes and skin from being exposed to corrosive materials, wear a lab coat.

13.4 Prior to handling radioactive samples analysts must have had radiation safety training and understand their full responsibilities in radioactive sample handling. Some general guidelines follow:

13.4.1 Wear a dosimeter at all times while working in the lab to monitor radioactive exposure.

13.4.2 Wear a plastic apron over lab coat when working with radioactive samples.

13.4.3 Protect counter tops with counter paper or work from radioactive sample handling trays.

13.4.4 Prohibit admittance to immediate work area.

13.4.5 Post signs indicating radioactive samples are in the area.

13.4.6 Take swipes of the counter tops upon completion of work. Deliver those swipes to the designated swipe count box.

13.4.7 Segregate radioactive wastes. Radioactive waste containers are obtained from Waste Management.

13.5 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

13.5.1 Segregate solid wastes from liquid wastes in the satellite area containers.

13.5.2 Segregate oil wastes from water-soluble wastes in the satellite area containers.

13.6 Never leave gas cylinders unchained or untied, including when they are on the moving carts.

13.7 In the event of an accident or medical emergency, call for help immediately. When time and safety permit, an accident report form should be completed and turned in to the safety committee.

13.8 Fire escape routes are posted in the lab and all personnel should be familiar with them. In addition, fire safety equipment such as fire extinguishers is located in the lab. Training is available on the proper operation of this equipment.

## 14.0 SAMPLE RECEIPT FOR ANALYSIS

14.1 Login personnel are responsible for delivering samples for pH analysis to the pH work area in accordance with GL-SR-E-001 for Sample Receipt, Login, and Storage.

14.2 Analysts and technicians are responsible for retrieving their own samples when the sample custodian is not available.

## 15.0 INSTRUMENTATION/EQUIPMENT/GLASSWARE

15.1 Orion Model 370 PerpHect Ion-Selective pH meter

15.2 Orion 9272 or any other comparable combination pH electrode

15.3 Temperature compensation probe (ATC) Orion 927005 or equivalent

15.4 Beakers (minimum capacity needed, 25 mL)

15.5 Magnetic stir plate

15.6 Stirrer magnets

15.7 If Method 9045C/9045D is being used:

15.7.1 Centrifuge

15.7.2 Centrifuge tubes (minimum capacity, 50 mL)

15.7.3 Top-loader balance

15.7.4 Spatula

15.7.5 Separatory funnel (optional)

15.8 If Method 9041A is being used:

15.8.1 Wide range pH strips

15.8.2 Narrow range pH strips

## 16.0 REAGENTS

16.1 pH 4 Calibrating Buffer

16.2 pH 7 Calibrating Buffer (Two sources are required. A second source is needed for a LCS).

**NOTE:** If the client specifies, a pH 2 buffer will be run as the LCS for a corrosivity batch containing acidic samples. For a corrosivity batch containing caustic samples, a pH 12 buffer will be run.

16.3 pH 10 Calibrating Buffer

16.4 ASTM Type II Deionized (DI) water

16.5 10% Hydrochloric acid (HCL)

## 17.0 PREPARATION OF SAMPLES

Sample preparation for soils, sludges, oils, miscellaneous solids, and liquids where less than 20% of the sample is aqueous:

**NOTE:** No sample preparation is required when more than 20% of the sample is aqueous. To determine if the sample is > 20% aqueous, look at the sample in the container. If the sample clearly has an aqueous portion that appears to be at least ¼ of the sample volume, proceed with section 22.0. If there is a question concerning the % volume of liquid material in a sample container, request assistance from an experienced analyst or technician.

17.1 Place a beaker or centrifuge tube on the top-loader balance. Tare the balance.

**NOTE**: The balance must be verified in accordance with GL-LB-E-002 for Balances.

17.2 Transfer 20 g soil/sediment to the container. Add 20 mL of DI water and stir or shake for 5 minutes.

17.3 The mixture is allowed to stand for about one hour to allow most of the suspended material to settle out. Alternatively, the sample may be filtered or centrifuged for at least 5 minutes.

17.4 The aqueous layer is decanted for pH measurement using the calibration pH electrode as described in Section 22.0.

**NOTE:** If the sample is hygroscopic or another problematic matrix, begin the procedure again using 20 g of sample and 40 mL of DI water.

**NOTE:** If the sample is classified as a waste material, the mixed suspension is either allowed to stand for 15 minutes or filtered or centrifuged for at least 5 minutes.

**NOTE:** If the supernatant is multiphasic, decant the oily phase or use a separatory funnel to obtain the aqueous phase to use for the pH determination.

**NOTE:** If limited sample volume is received, use smaller 1:1 ratio of grams of sample to mL of DI water for the pH determination.

## 18.0 PREPARATION OF STANDARDS

18.1 Documentation of standards is maintained in accordance with GL-LB-E-007 for Laboratory Standards Documentation.

18.2 Laboratory Control Sample(s): Commercially available pH buffer of 7.00 ± 0.01 @ 25°C. This must be from a different source than the calibrating pH 7 buffer.

18.3 Calibration standards:

18.3.1 pH buffers: 4, 7, and 10 pH units.

**NOTE:** If a sample is being analyzed for corrosivity, the pH meter check must also include buffers of pH 2 and pH 12. These additional buffers are not for calibration, but for checks only.

18.3.2 The buffers for calibration are stored in the Immediates area in the cabinets near the pH meter.

18.3.3 Buffers are discarded when they exceed the manufacturer's expiration date.

## 19.0 INSTRUMENT/EQUIPMENT START-UP PROCEDURES

The combination pH electrode must be plugged into the pH BNC jack on the rear part of the meter. The temperature compensating electrode is plugged into the ATC jack. A diagram for this is shown on page 7 of the Model 370 Instruction Manual. Make sure the LogR mode is off.

## 20.0 QUALITY CONTROL (QC) REQUIREMENTS

20.1 The pH calibration must be checked by measuring the pH of all buffers used to calibrate the meter. The pH must be within 0.05 pH units of the pH 4, pH 7, and pH 10 buffer solution values and within 0.1 pH units of the pH 2 and pH 12 buffer solution values. The slope value must read 92%-102%. If not, the calibration must be repeated until these criteria are met.

20.2 Frequency of QC:

20.2.1 A matrix duplicate is run for every group of $\leq$ 10 samples and for each set of ten samples in batches with > 10 samples.

20.2.2 A laboratory control sample is run once per batch unless specified otherwise by the client.

20.2.3 A continuing calibration verification (CCV) is run after every 5 samples and after the last sample in the run.

20.3 Acceptance limits:

20.3.1 Matrix relative percent difference (RPD): Refer to current SPC limits.

20.3.2 LCS: must be ± 0.05 s.u.

20.3.3 CCV must be ± 0.05 s.u.

20.4 Handling out-of-control situations:

All QC data are calculated as soon as the results for the QC samples are known.

20.4.1 If the matrix RPD falls outside of the SPC limits, reanalyze that sample.

20.4.2 If the LCS RPD, or LCS recovery falls outside of the SPC limits, the pH meter is to be recalibrated and all samples bracketed by the LCS and LCS DUP must be reanalyzed.

## 21.0 RUN SEQUENCE

21.1 Calibration standards: pH 4, 7 and 10 buffer solutions

21.2 pH 7 LCS (2$^{nd}$ Source Standard)

21.3 CCV (Continuing Calibration Verification)

21.4 Samples 1 through x where x $\leq$ 10

21.5 Sample x duplicate

21.6 Repeat steps 21.3 through 21.5 for every group of 10 samples in the batch. Run an additional CCV after the last analytical sample in the run.

## 22.0 PROCEDURE

22.1 For sample analysis by SW-846 Method 9041A, "pH Paper Method," for solvents and other samples that could possibly damage the electrodes, paper pH strips may be used to determine pH. Wide range pH strips are listed as 0-14 pH units. Narrow range pH strips come in five different pH unit ranges: 0-2.5, 2.5-4.5, 4.0-7.0, 6.5-10.0, and 11.0-13.0 pH units.

**NOTE:** This method is not considered to be as accurate for pH measurement as pH meters; for this reason, pH measurements taken by Method 9041A cannot be used to define a waste as alkaline and non-corrosive.

**NOTE:** If a sample masks color changes on the pH paper, this method is not reliable.

22.1.1 Place a wide range pH strip into a small aliquot of sample.

22.1.2 The color change of the wide range pH strip is compared to the color patterns listed on the pH strip box. Use this value to determine which narrow range pH strips to use. Select the appropriate narrow range strip.

22.1.3 Place the narrow range pH strip into a small aliquot of sample. Compare the color change to the color pattern on the narrow range strip box.

22.1.4 Record the pH in AlphaLIMS.

**NOTE:** Each batch of pH paper must be calibrated (checked) against certified pH buffers. The paper must read within 0.5 pH units of the certified pH of the buffer. This calibration is recorded in the pH calibration log.

22.1.5 Analyze each sample in duplicate by repeating steps 22.1.1 through 22.1.3.

22.1.6 Using a thermometer verified in accordance with GL-QS-E-007 for Thermometer Verification, measure the temperature of one of the sample aliquots used during narrow range pH analysis. This is the temperature of the sample at the time the pH was measured.

22.1.7 Record the temperature of the sample in AlphaLIMS.

22.2 Calibration for methods using a pH meter:

22.2.1 Before the meter is calibrated, the combination pH electrode is checked to make sure it is filled with Orion No. 810007 Internal Filling Solution. No filling solutions containing silver are used.

22.2.2 After unit is switched on, confirm LogR mode is off. (If it's on the symbol "LogR" is on the display screen.)

22.2.3 Press the CAL key to initiate calibration sequence. CAL is displayed for 2 seconds. Press scroll (↑,↓) keys until 3 PT is displayed. Press the YES key to accept. The 4 annunciator will be displayed. Using a fresh aliquot of pH 4 buffer, add a small stirring magnet to the beaker and place on top of a magnetic stirrer. Adjust to maintain a slow, steady rate of stirring. Place electrode in pH 4 buffer. Reading will be displayed


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and updated as calibration continues. When the READY light comes on, press the YES key.

22.2.4 The 7 annunciator will be displayed. Rinse electrode with DI water and place into pH 7 buffer. Add small stirring magnet and stir as indicated above. Reading will be displayed and updated as calibration continues. When the READY light comes on, press the YES key.

22.2.5 The 10 annunciator will be displayed. Proceed as with pH 4 and pH 7 buffers.

22.2.6 SLP will be displayed in the upper field while the calculated slope is displayed. Record this slope reading in LIMS. Meter will automatically proceed to measure mode.

22.3 Sample analysis by methods using a pH meter:

22.3.1 After the meter is calibrated using section 22.2, the unit will proceed to measure mode. The sample pH and temperature is automatically displayed.

22.3.2 Shake each sample prior to analysis. Approximately 40 mL of sample is poured into a beaker.

**NOTE:** If the sample was prepared as described in 17.1, decanted layer is the sample aliquot.

22.3.3 Place the beaker containing the sample on a magnetic stirring plate and add a clean magnetic stirring bar. Adjust the stir control to maintain a slow, steady rate of stirring.

22.3.4 Lower the pH electrode and the temperature compensating probe into the sample.

22.3.5 When the "Ready" status is displayed, record the pH, temperature, and time for the sample into the appropriate columns of the pH data entry screen in AlphaLIMS.

22.3.6 Repeat steps 22.3.2 through 22.3.5 with successive sample aliquots until the pH values obtained differ by < 0.1 pH units.

22.3.7 Run the samples in the sequence described in section 21.0.

**NOTE:** If only a few samples are ready to be run at a time, a duplicate sample is run for each set, regardless of whether or not few samples have been run since the last set of QC. The reason for this is to prove electrode repeatability throughout the day.

22.3.8 After all the pH samples present have been analyzed pH electrode is rinsed with DI water and placed back in the pH 7 buffer for storage.

22.4 Calculation/reporting of results:

22.4.1 Each sample result has a corresponding temperature and run time. These are recorded in AlphaLIMS. The final pH reading obtained for a sample after the criteria in 22.3.6 have been met is the one that is reported.

22.4.2 When submitting data for data entry, record the analyst's name, date of analysis, time, temperature, and pH values in AlphaLIMS.

22.4.3 After every duplicate sample value is recorded, the RPD (relative percent difference) of the sample and the duplicate are calculated. This is done by subtracting the lower value from the higher value, dividing by the average of the two and multiplying by 100 as shown in this formula:

$$\frac{\text{High value - Low value}}{\text{Average of the two values}} \times 100 = \text{RPD}$$

22.4.4 If the RPD is within the current control limits for pH, the duplicate is acceptable.

22.4.5 If the RPD is greater than the control limit, the sample and the duplicate are rerun. If the RPD is outside of the acceptance limits after being rerun, the pH meter is recalibrated and all samples analyzed prior to this duplicate and after the last acceptable duplicate are reanalyzed.

22.4.6 LCS RPDs are calculated using the formula described in 22.4.3.

22.4.7 LCS recoveries are calculated using this formula:

$$\frac{\text{actual value obtained}}{\text{theoretical value}} \times 100 = \%\ \text{LCS recovery}$$

## 23.0 INSTRUMENT/EQUIPMENT SHUT-DOWN PROCEDURES

23.1 After all the samples have been run, both the pH electrode and temperature compensating probe are rinsed thoroughly with DI water.

23.2 The electrode and probe are placed in a beaker filled with pH 7 buffer.

## 24.0 DATA REVIEW, VALIDATION, AND APPROVAL PROCEDURE

Refer to GL-LB-E-005 and GL-GC-E-092 for data review and validation procedures.

## 25.0 DATA TRANSMITTAL

When a batch is issued "DONE" status, the data become available to reporting personnel.

## 26.0 RECORDS MANAGEMENT

All data associated with the performance of this procedure, including relevant logbooks, are maintained as quality records in accordance with GL-QS-E-008 for Quality Records Management and Disposition.

## 27.0 ROUTINE INSTRUMENT/EQUIPMENT MAINTENANCE

27.1 The combination pH electrode is drained and refilled with the appropriate filling solution as needed.

27.2 For problems that occur during operation, refer to the troubleshooting checklists located in the Orion Ross pH Electrode Instruction Manual or the Orion Model EA 940 Expandable Ion Analyzer Instruction Manual.

## 28.0 LABORATORY WASTE HANDLING AND DISPOSAL

For the proper disposal of sample and reagent wastes from this procedure, refer to the Laboratory Waste Management Plan, GL-LB-G-001.

## 29.0 METHOD VARIATION

The pH test paper method SW-846 9041A is used only for miscellaneous samples. For safety reasons, the interference screening procedure described in section 3.1 of SW-846 9041A has not been included in this SOP.

## 30.0 REFERENCES

30.1 Method for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Method 150.1, “pH, Electrometric”.

30.2 Orion Model 370 PerpHect Ion Selective pH Meter Instruction Manual

30.3 Orion 9272 pH Electrode Instruction Manual

30.4 Test Methods for Evaluating Solid Waste: Laboratory Manual Physical/ Chemical Methods, Volume 1C, SW-846, 3rd Edition, June 1997. USEPA Office of Solid Waste and Emergency Response, Washington, DC. 20460:

30.4.1 Method 9045D, “Soil and Waste pH,” Revision 4, August 2002.

30.4.2 Method 9045C, “Soil and Waste pH,” Revision 3, January 1995.

30.4.3 Method 9040C. “pH Electrometric Measurement,” Revision 3, August 2002.

30.4.4 Method 9040B, “pH Electrometric Measurement,” Revision 2, January 1995.

30.4.5 Method 9041A, “pH Paper Method,” Revision 1, July 1992.

30.5 Standard Methods, 18th through 21st Editions, Method 4500-$H^+$, "pH value."

30.6 Exhibit D, Semivolatiles, Section 10.1.4.1, OLMO4.2

## 31.0 HISTORY

Revision 19: Changed slope value to 92%-102% in quality control requirements section.

Revision 20: Change LCS requirement to ± 0.05 pH units.

**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

## FOR

# TOTAL CARBON AND TOTAL ORGANIC CARBON ANALYSIS

# USING THE DOHRMANN DC-190 BOAT SAMPLER

## (GL-GC-E-062 REVISION 12)

APPLICABLE TO METHODS:
EPA SW-846 Method 9060 Modified/9060A Modified
EPA 415.1 Modified
Lloyd Kahn Method

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## 1.0 STANDARD OPERATING PROCEDURE FOR TOTAL CARBON AND TOTAL ORGANIC CARBON ANALYSIS USING THE DOHRMANN DC-190 BOAT SAMPLER

## 2.0 METHOD CODE

2.1 EPA SW-846 Method 9060 Modified/9060A Modified

2.2 EPA 415.1 Modified

2.3 Lloyd Kahn Method

## 3.0 METHOD OBJECTIVE/PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the procedure used to determine the concentrations of total carbon and total organic carbon in solid samples using the Dohrmann DC-190 TOC Analyzer combined with a 183 Boat Sampling Module.

## 4.0 METHOD SUMMARY

For TOC analysis, a portion of sample is first checked for the presence of inorganic carbon. If inorganic carbon is present, it is removed by acidification. A portion of the acidified sample is then combusted in the sampler furnace at 800° C. All remaining carbon in the sample is converted to $CO_2$, which is measured by the non-dispersive infrared detector.

## 5.0 APPLICABLE MATRICES

5.1 Soil

5.2 Sludge

**NOTE:** Clients may request that this analysis be performed on miscellaneous liquid or solid samples. In these cases, the procedure is modified as necessary.

## 6.0 HOLDING TIME

Holding time is 28 days from the time and date of collection until the start of analysis for methods EPA SW-846 9060/9060A and EPA 415.1. The holding time is 14 days if the required method used is the Lloyd Kahn method.

## 7.0 SAMPLE CONTAINER/PRESERVATION/COLLECTION/STORAGE REQUIREMENTS

7.1 Samples should be stored in sealed containers, preferably glass.

7.2 Samples should be stored at 0° $\leq$ 6° C and kept free of sunlight and atmospheric oxygen.

## 8.0 INTERFERENCES/LIMITATIONS

8.1 Carbonates and bicarbonates must be removed to provide an accurate total organic carbon result.

8.2 Acidifying and sparging the sample may drive off some volatile organic substances.

## 9.0 PERFORMANCE CHARACTERISTICS

9.1 Calibration range: 100 to 20000 mg/L

9.2 Method detection limit (MDL): Refer to current MDL study.

9.3 Method precision: Refer to current SPC limits.

9.4 Method accuracy: Refer to current SPC limits.

## 10.0 DEFINITIONS

10.1 AlphaLIMS: The Laboratory Information Management System used at GEL Laboratories, LLC.

10.2 Calibration Standard (CAL): A solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards and surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

10.3 Continuing Calibration Blank (CCB): An aliquot of reagent water or other blank matrix that is analyzed after each CCV. The CCB is used to determine whether the analytical sequence is in control during sample analysis.

10.4 Continuing Calibration Verification (CCV) Standard: An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The CCV is analyzed exactly like a sample, periodically throughout the run sequence. Its purpose is to determine whether the analytical sequence is in control during sample analysis. It may be prepared from the same source as the calibration standards, and is usually of varied concentration.

10.5 Independent Calibration Blank (ICB): An aliquot of reagent water or other blank matrix that is analyzed after each ICV. The ICB is used to determine whether there is carryover contamination after injection of the mid-level ICV.

10.6 Independent Calibration Verification (ICV): A solution of method analytes of known concentrations that is used to fortify an aliquot of blank or sample matrix. The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

10.7 Inorganic Carbon: The sum of the carbonates and bicarbonates found in a sample.

10.8 Laboratory Control Standard (LCS): An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

10.9 Laboratory Duplicate (DUP, LCSD, MSD or PSD): Aliquots of a sample taken from the same container and processed in the same manner under identical laboratory conditions. The aliquot is analyzed independently from the parent sample and the results are compared to measure precision and accuracy.

10.10 Spike (Matrix Spike or Post Spike): An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS or PS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS or PS corrected for background concentrations.

10.11 Method Blank (MB): An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment,

solvents, reagents, internal standards, and surrogates that are used with other samples. The MB is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

10.12 Method Detection Limit (MDL): The minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero.

10.13 Statistical Process Control (SPC) Limits: Statistically derived limits that establish acceptable ranges for recoveries of analytes of interest, including LCS, MS, MSD, PS, PSD and internal standards.

10.14 Stock Standard Solution: A concentrated solution containing one or more method analytes prepared in the laboratory using certified reference materials or purchased from a reputable commercial source.

## 11.0 ANALYST VERIFICATION

Technicians and analysts do not analyze client samples without supervision until they have been fully trained and have demonstrated the ability to generate acceptable data. Training records are maintained as quality records.

## 12.0 DOCUMENTATION OF DATA

12.1 Sample preparation data are recorded in AlphaLIMS.

12.2 As data are acquired, computer printouts of the data are generated. These dated hard copies of the data are maintained in the DC-190 Hardcopy binder. Results are entered into AlphaLIMS.

## 13.0 SAFETY PRECAUTIONS AND HAZARD WARNINGS

13.1 Wear safety glasses while in the laboratory.

13.2 Treat all chemicals and samples as potential health hazards, and limit exposure to these chemicals to the lowest level possible. GEL maintains a current awareness file of OSHA regulations regarding the safe handling of the chemicals in the laboratory as well as a reference file of Material Safety Data Sheets (MSDS.) These documents and client sample MSDS forms are maintained in the laboratory.

## 14.0 SAMPLE RECEIPT FOR ANALYSIS

14.1 The analyst/technician gives a list of samples needed to the sample custodian. The sample custodian removes the appropriate samples from the cooler and either delivers them to the analyst/technician or places them on the "pick-up" shelf in the main cooler.

14.2 Analysts and technicians are responsible for retrieving their own samples after normal working hours.

## 15.0 INSTRUMENTATION/EQUIPMENT/GLASSWARE

15.1 Instrumentation:

15.1.1 Dohrmann DC-190 High Temperature TOC Analyzer

15.1.2 Dohrmann 183 Boat Sampling Module with sample dilution chamber

15.1.3 Printer

15.2 Equipment:

15.2.1 Analytical balance with 1 mg accuracy
15.2.2 Porcelain mortar and pestle
15.2.3 Platinum sample boat
15.2.4 50 µL syringe
15.2.5 Zero grade oxygen tank with regulator
15.2.6 Tweezers
15.2.7 50 mL glass beakers
15.2.8 Industrial-grade paint shaker
15.2.9 Disposable aluminum weigh pans
15.2.10 Sonicator
15.2.11 25 mL plastic cups

15.3 Glassware
15.3.1 50 mL glass beakers

## 16.0 REAGENTS

16.1 Potassium acid phthalate, $KHC_8H_4O_4$ (also known as potassium hydrogen phthalate), used for the preparation of standards.

16.1.1 Primary TOC standard solution (20,000 mg/L)
16.1.1.1 Weigh 4.25 g of potassium acid phthalate and dilute to a 100 mL volume with DI water in a 100 mL volumetric flask. This yields a 20,000 mg/L solution.
16.1.1.2 The standard expires one year after from the date prepared.

16.1.2 4,000 mg/L TOC working standard
16.1.2.1 Transfer 20 mL of the primary TOC stock standard solution to a 100 mL volumetric flask and dilute to 100 mL with DI water.
16.1.2.2 Standard expires one year after preparation.
16.1.2.3 This standard is used for the CCV and for spiking purposes.

16.1.3 1,000 mL TOC working standard
16.1.3.1 Transfer 5 mL of the primary TOC stock standard solution to a 100 mL volumetric flask and dilute to 100 mL with DI water.
16.1.3.2 Standard expires one year after preparation.

16.1.4 100 mg/L TOC working standard
Transfer 0.5 mL of the primary TOC stock standard solution to a 100 mL volumetric flask and dilute to 100 mL with DI water. Expires one year after preparation.

16.1.5 Secondary TOC stock standard solution (20,000 mg/L concentration)
Follow procedure outlined in section 16.1.1.1 using a different lot of potassium acid phthalate. Expires one year after preparation.

16.1.6 4,000 mg/L TOC ICV standard

16.1.6.1 Transfer 20 mL of the secondary TOC stock standards solution to a 100 mL volumetric flask and dilute to 100 mL with DI water.

16.1.6.2 This standard expires one year after preparation.

16.1.6.3 This standard is used for the ICV.

16.2 Sodium sulfate, $Na_2SO_4$

16.2.1 Sodium sulfate is the material used for the method blank. It is taken through the same process as the samples described in section 17.0.

16.2.2 Sodium sulfate is also used to dilute samples as described in section 17.3.

16.3 Solid Reference Material (SRM)

16.3.1 The SRM is purchased commercially and is used as the LCS. The concentration of the SRM varies from lot to lot but should typically be in the mid-range of the calibration standards (4,000 to 14,000 mg/kg).

16.3.2 The SRM expires one year from the date of receipt or by the manufacturer's expiration due date, whichever comes first.

16.3.3 The SRM is taken through the same process as samples described in section 17.0. Expires in 2 years or the manufacturer's expiration date whichever is sooner.

16.4 Reagent preparation

16.4.1 20% Phosphoric acid solution

16.4.1.1 Partially fill a 100 mL volumetric flask with DI water.

16.4.1.2 Add 20 mL concentrated phosphoric acid.

16.4.1.3 Dilute to volume with DI water and store in a suitable container.

## 17.0 PREPARATION OF SAMPLES

17.1 Sample homogenization

Shake all samples vigorously, and remove portions from several different layers of the jar.

**NOTE:** If the sample contains clumps, several of these must be taken out and ground with a mortar and pestle, a blender, or other grinding device.

17.2 Inorganic carbon check (for TOC analysis only)

17.2.1 For TOC analysis, first determine whether the samples contain inorganic carbon by adding a few drops of 20% phosphoric acid solution to a portion of the sample.

17.2.2 If any fizzing is observed, the samples are assumed to contain inorganic carbon.

17.2.2.1 Any samples that fizz initially are treated by placing approximately 1.5 g of sample in a beaker and adding enough 20% phosphoric acid to completely cover the sample.

17.2.2.2 All samples are placed in the drying oven at 40° C for approximately 12 hours or overnight. Samples that do not

react (fizz) when initially tested with 20% phosphoric acid are not treated with the additional volume of acid, but are dried.

17.2.2.3 Place the samples in the oven at 40° C for 12 hours. This step is for drying of the sample and not removing inorganic carbon.

17.2.3 If no fizzing is observed, do not add additional acid, but proceed with drying.

17.3 Sample dilution

17.3.1 For samples known to contain over 20,000 mg C/kg, the samples must be diluted before analysis.

17.3.2 Place a plastic cup on the balance. Tare the balance. Add the recorded amount of sodium sulfate and sample to the plastic cup. Repeat with any subsequent samples if any in batch.

17.3.3 Scrape out the sodium sulfate and sample and grind with a mortar and pestle.

17.4 Store the sample in the plastic cup and cover with Parafilm until time of analysis.

## 18.0 PREPARATION OF STANDARDS

Documentation of TOC standards and their preparation is maintained in AlphaLIMS in accordance with GL-LB-E-007 for Laboratory Standards Documentation. Refer to Section 163.1 of this SOP for recipes used to prepare the standards.

## 19.0 INSTRUMENT/EQUIPMENT START-UP PROCEDURES

19.1 Turn on gas at cylinder. If flow is not 30 to 35 psi, adjust at regulator.

19.2 Make sure boat gas flow switch is in the "ON" position.

19.3 Make sure gas flow line from boat sampler is fed into the scrubber.

19.4 Check to see that the furnace power switch is on and the green temperature light is on. If not, flip the switch to the "ON" position.

19.5 If the furnace has just been turned on, a red temperature light will glow until the furnace reaches its operating temperature of approximately 800° C.

19.6 Instrument parameter setup:

19.6.1 Press "BOAT" on the front panel of the instrument. The concentration units should be listed as "µg/g." If not, press "Enter."

19.6.2 Press "TC" to select total carbon analysis. (When running solids, all inorganic carbon must be removed manually.)

19.6.3 Press "Main" to get to the main menu, and then press "1" to display the system status.

19.6.4 The flow rate should read 195 - 205 cc/min. This is not measured going into the boat sampler, but the pressure there should be almost exactly the same.

19.6.5 If the flow rate is out of range, adjust using the regulator on the oxygen tank.

19.6.6 The dryer temperature should be 0 - 10° C. If not, consult the DC-190 Operations Manual.

19.6.7 The furnace temperature listed on the system status screen is not important because it refers to the catalyst combustion furnace, not the boat sampler furnace.

19.7 If the samples to be run are known to have high levels of carbon, the stopcock allowing oxygen into the dilution chamber is opened.

## 20.0 QUALITY CONTROL (QC) REQUIREMENTS

20.1 Instrument QC

20.1.1 An initial calibration verification (ICV) is analyzed immediately after the calibration standards. This standard must be made from a different source than the calibration standards.

20.1.2 An initial calibration blank (ICB) is analyzed following the ICV.

20.1.3 A continuing calibration verification (CCV) is analyzed after every 8 analytical samples and after the last analytical samples in the run.

20.1.4 A continuing calibration blank (CCB) is analyzed after every CCV.

20.2 Batch QC

20.2.1 A matrix spike and matrix duplicate are analyzed for every batch of $\leq$ 10 samples and for each set of ten samples in batches with > 10 samples.

20.2.1.1 The duplicate is a separate portion of one sample taken through the prep process.

20.2.1.2 The matrix spike is a post-spike where 40 µL of the 4,000 mg/L TOC working standard is added to the sample after it is already placed in the boat for analyis. The final nominal concentration of the spike is dependent on the weight of the sample used.

20.2.2 A method blank and laboratory control sample (LCS) are analyzed at least once for every batch of 20 or less samples.

20.2.2.1 The method blank is a portion of sodium sulfate taken through the sample preparation process.

20.2.2.2 For solid batches, the LCS is usually a solid standard from a standards supplier that is taken through the same process as the samples.

20.2.2.3 LCS duplicates are analyzed if required by contract.

20.3 Acceptance limits:

20.3.1 ICV recovery must be 80-120% for all batches. If not, the ICV should be remade and reanalyzed. If the ICV continues to be out of range, the primary calibration standard should be remade and reanalyzed.

20.3.2 CCV recovery must be 80-120% for all batches. If the CCV continues to be out of range, the instrument must be recalibrated.

20.3.3 Matrix relative percent difference (RPD): Refer to current SPC limits.

20.3.4 Matrix spike recovery: Refer to current SPC limits.

20.3.5 Method blank: Must be less than the CRDL. Some clients may have specific requirements such as MB < ½ PQL. This will be communicated in the client set up.

20.3.6 LCS: Refer to current SPC limits.

20.3.7 LCS RPD: Refer to current SPC limits.

20.3.8 Calibration Blank and ICBs must be < 25 ppm to be acceptable.

## 21.0 SUGGESTED RUN SEQUENCE

21.1 Two 4,000 mg/L calibration standards

21.2 Two DI water calibration blanks

21.3 Sample range check standards: 20,000 mg/L, 1,000 mg/L, 100 mg/L

21.4 ICV 4,000 mg/L standard made from 2$^{nd}$ source

21.5 ICB

21.6 LCS

21.7 Method Blank

21.8 LCS duplicate, analyzed only if required by client contract.

21.9 Sample

21.10 Sample duplicate

21.11 Sample spike

21.12 Three more samples

21.13 CCV

21.14 CCB

21.15 Eight more samples

21.16 CCV

21.17 CCB

21.18 Repeated for every set of 8 samples including QCs.

## 22.0 PROCEDURE

22.1 Instrument Calibration:

22.1.1 Place boat sampler under septum syringe port.

22.1.2 Using a syringe, inject 40 µL of 4,000 mg/L TOC standard onto the boat.

22.1.3 Press “Start/Stop.”

22.1.3.1 “Enter ID #” will appear on the screen. Enter the last 6 digits of the ID number of the sample or the concentration of the standard, and then press “Enter.”

22.1.3.2 The screen should now read “Sample mass (mg)?” Enter the weight of the sample or standard in mg and then press “Enter.”

**NOTE:** For liquid standards, the volume in µL is entered as mg.

22.1.3.3 After pressing enter, the red "INJECT" light should glow for approximately eight seconds.

22.1.3.4 The "INJECT" light will now start to glow and the instrument will sound a warning. Push the boat into the furnace at this time.

22.1.3.5 The "ACQUIRE" light will now glow, signaling that the instrument is now measuring the peak area of the standard.

22.1.3.6 When the peak returns to baseline, the instrument sounds another warning and the screen reads "Continue (y/n)?" Press "YES."

22.1.3.7 Repeat steps 22.1.3.2 through 22.1.3.5 with another 40 µL injection of 4,000 mg/L standard.

22.1.3.8 If the result for the second analysis comes out to be $\leq$ 4% of the first result, the average of the two can be calculated. If the results are not within 4% of each other, another injection of the standard is run.

22.1.3.9 Once two suitable results are obtained; all non-usable results must be deleted. To do this, first press "MAIN" to get to the main menu.

22.1.3.10 Press "2" to go into the "Auxiliary functions" screen.

22.1.3.11 Press "1" to go into the "Omit an outlier" function.

22.1.3.12 The screen should now read "How many." Enter in the number of results to be omitted, and press "Enter."

22.1.3.13 The screen should now read "Omit repeat #?" Enter the number of the first repeat to be omitted and press "Enter." Repeat this procedure for all outliers.

22.1.3.14 Once all outliers have been omitted the instrument prints out an average and a standard deviation value for the two selected values.

22.1.3.15 Press "CALIBRATE."

22.1.3.16 Press "5" to program in the new calibration factor.

22.1.4 The calibration process is repeated using DI water as a standard.

22.1.4.1 Omitting all outliers, select two blanks that have low readings (Carryover from the 4,000 mg/L standard may cause the first one or two shots to read high).

22.1.4.2 Once the average for the two blanks has been obtained press "CALIBRATE."

22.1.4.3 Press "6" to update the system blank based on the two blanks selected.

22.2 Check standard analysis:

22.2.1 A series of standards is now run to verify the two-point calibration procedure.

22.2.1.1 A 20,000, 1,000, and 100 mg/L standard are all run using the same procedure for the calibration procedures described above.

22.2.1.2 Each standard is run until one result comes within 20% of the known value. All outliers are omitted as described above.

22.2.1.3 A 4,000 mg/L second source standard is analyzed to verify the primary standard.

22.3 Sample analysis:

22.3.1 Weighing procedure:

22.3.1.1 Lift the sample boat out of the combustion tube by pulling it underneath the boat hatch, then lifting it out using a pair of tweezers.

22.3.1.2 Place the boat on the balance, then press the "TARE" button.

22.3.1.3 Weigh out 20 to 40 mg of prepared sample into the boat.

22.3.1.4 Enter the ID # of the sample and the amount weighed out.

22.3.2 After the sample has been placed in the combustion tube, wait approximately one minute for the baseline to return to normal before starting the analysis sequence.

22.3.3 The sample is analyzed in duplicate (EPA 415.1) or quadruplicate (SW-846 9060/9060A) until the results have an RPD that meets SPC acceptance limits.

22.3.4 The Lloyd Kahn method requires that one sample per ≤ 20 be analyzed in quadruplicate. All other samples may be analyzed in duplicate.

22.3.5 The sample spike is prepared by injecting 40 µL of 4,000 mg/L standard onto a recorded weight of sample.

**NOTE:** If TIC (total inorganic carbon) is needed, the samples are to be analyzed for both TC (total carbon) and TOC (total organic carbon). The TIC results are then calculated as described in GL-GC-E-107. TIC = TC – TOC (all in mg/kg).

22.4 Once the last sample has been run, turn off the oxygen flow at the tank.

22.5 If the boat sampler is expected to be used again in the next few days, the boat furnace should be left on. The boat should be left in the furnace to prevent it from becoming contaminated.

## 23.0 DATA REVIEW, VALIDATION, AND APPROVAL PROCEDURE

Refer to GL-GC-E-092 for General Chemistry Data Review and Packaging and GL-LB-E-005 for Data Review and Validation.

## 24.0 DATA TRANSMITTAL

When a batch is issued "DONE" status, it is made available to reporting personnel.

## 25.0 RECORDS MANAGEMENT

All data associated with the performance of this procedure, including relevant logbooks, are maintained as quality records in accordance with GL-QS-E-008 for Quality Records Management and Disposition.

## 26.0 ROUTINE INSTRUMENT/EQUIPMENT MAINTENANCE

Refer to section 7 of the DC-190 High Temperature TOC Analyzer Operation Manual for all periodic and unscheduled maintenance.

## 27.0 LABORATORY WASTE HANDLING AND DISPOSAL

For the proper disposal of sample and reagent wastes from this procedure, refer to the Laboratory Waste Management Plan, GL-LB-G-001.

## 28.0 METHOD VARIATION

28.1 SW-846 Method does not list solids as a matrix, so this method has been modified, as cited in reference 30.3, to accommodate the analysis of solids.

28.2 No blender is used to homogenize solid samples.

## 29.0 REFERENCES

29.1 Test Methods for Evaluating Solid Wastes, Volume 1B, Method 9060 "Total Organic Carbon," SW-846, Third Edition, November 1986.

29.2 Test Methods for Evaluating Solid Wastes, Volume 1B, Method 9060A "Total Organic Carbon," SW-846, Third Edition, Revision 1, August 2002.

29.3 Dohrmann DC-190 High Temperature TOC Analyzer Operation Manual, Edition 4, August 1992.

29.4 "Guidance for Sampling of and Analyzing for Organic Contaminants in Sediments", December 1987, Pacific Northwest National Laboratories, Richland, Washington, for U.S. Environmental Protection Agency, Criteria and Standards Division.

29.5 EPA Method 415.1, Organic Carbon, Total (Combustion or Oxidation), 1974.

29.6 Determination of Total Organic Carbon in Sediment (Lloyd Kahn Method); July 27, 1988.

## 30.0 HISTORY

Revision 12: Added note on the calculation of TIC results.

**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

# FOR

# ACID DIGESTION OF TOTAL RECOVERABLE OR DISSOLVED METALS IN SURFACE AND GROUNDWATER SAMPLES FOR ANALYSIS BY ICP OR ICP-MS

## (GL-MA-E-006 REVISION 9)

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## 1.0 STANDARD OPERATING PROCEDURE FOR ACID DIGESTION OF TOTAL RECOVERABLE OR DISSOLVED METALS IN SURFACE AND GROUNDWATER SAMPLES FOR ANALYSIS BY ICP OR ICP-MS

## 2.0 PURPOSE

To describe the manner in which surface and groundwater samples for Inductively Coupled Plasma (ICP) and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) analysis are digested by EPA SW-846 Method 3005A. Samples digested by this procedure are applicable for analysis by SW-846 methods.

## 3.0 DISCUSSION

This procedure deviates from Method 3005A as follows: sample and reagent volumes are half of the method recommendations.

3.1 Total Recoverable Metals - The entire sample is acidified with nitric acid at the time of collection. This sample is then refluxed with nitric acid and hydrochloric acid until the volume is reduced. The sample is diluted to a final volume, and then is ready for analysis.

3.2 Dissolved Metals - The sample is filtered at the time of collection. The liquid phase is acidified at the time of collection with nitric acid. Samples for dissolved metals do not need to be digested, as long as the acid concentration in the standards matches the acid concentration in the samples. Water samples that require lab filtration are filtered from non-preserved fractions and acidified to a pH <2 with $HNO_3$. A method blank is filtered with the samples for contamination QC purposes. The acidified aliquots are held at least 16 hours before digestion.

3.3 The samples are tested using pH strips to verify the correct pH values of <2 before preparation. If samples do not have the correct pH, samples are acidified to a pH <2 with $HNO_3$. The acidified aliquots are held at least 16 hours before digestion.

## 4.0 DEFINITIONS

4.1 Blank - Type I water that has been taken through the digestion process. The blank is used to determine the amount of background contamination.

4.2 Laboratory Control Sample (LCS) - A certified reference material that has been taken through the digestion process. The LCS is used to determine digestion accuracy and to determine if the digestion process is in control.

4.3 Laboratory Control Sample Duplicate (LCS DUP) - A duplicate of the LCS. The LCS DUP is used to determine reproducibility and to indicate precision.

4.4 Matrix Spike (MS) - A sample that has added to it a known amount of solution containing known concentrations of analytes. The MS is used to determine the presence or absence of interferences and matrix effects in the digested sample.

4.5 Matrix Spike Duplicate (MSD) - A duplicate of the MS. The MSD indicates reproducibility.

4.6 Sample Duplicate (DUP) – A duplicate of a sample. The DUP indicates reproducibility.

4.7 Type II water - Water that conforms to the following performance specifications:

| | |
|---|---|
| Electrical resistivity, min., | 1.0 |
| Total organic carbon, max., µg/L | 50 |
| Sodium, max., µg/L | 5 |
| Chlorides, max., µg/L | 5 |
| Total silica, max., µg/L | 3 |

Type II water is dispensed throughout the laboratory through a centralized distribution system.

4.8 Type I water - Water that conforms to the following performance specifications:

| | |
|---|---|
| Electrical resistivity, min., | 16.67 |
| Total organic carbon, max., µg/L | 100 |
| Sodium, max., µg/L | 1 |
| Chlorides, max., µg/L | 1 |
| Total silica, max., µg/L | 3 |

Type I water is dispensed within the metals prep lab by the "MilliQ" water system.

4.9 $HNO_3$ - Concentrated reagent grade 70.9% nitric acid.

4.10 HCl - Concentrated reagent grade 37% hydrochloric acid.

## 5.0 PROCEDURES

A batch consists of samples of the same matrix and quality control (QC) samples that are digested together. Each of the quality control samples listed in section 4.1 through 4.6 must be included in each batch at the frequency listed or as per client request. The blank, LCS and/or LCS DUP are digested at a frequency of one in 20 or per batch, whichever is more frequent. The MS, MSD and/or DUP are digested at a frequency of one in 20 or per batch, whichever is more frequent, or per specific client/program requirements.

5.1 Glassware preparation:

5.1.1 Glassware that has been cleaned according to "Glassware Preparation" (GL-LB-E-003) is soaked in a water and acid mixture for at least 30 minutes.

5.1.2 After soaking, the glassware is rinsed with copious quantities of Type II or Type I water, then inverted over clean, absorbent paper or onto a rack for drying.

5.2 Label Teflon beakers or centrifuge tube with the sample numbers in the batch.

5.3 Mix the sample to achieve homogeneity. Transfer a 50 mL aliquot of sample to the appropriately labeled beaker with a graduated cylinder. (If centrifuge tube is used, it must be calibrated before usage).

5.4 Quality control samples are prepared prior to digestion.

5.4.1 The beaker or tube to be used for the blank, MS, MSD and/or DUP, LCS and/or LCS DUP is labeled.

5.4.2 Unless otherwise noted, at least 50 mL of the sample is transferred to the MS, MSD and/or DUP beaker or tube.

5.4.3 Unless otherwise noted, 50 mL of Type I water is transferred to the LCS and/or LCS DUP beaker or tube.

5.4.4 The MS, MSD, LCS, and/or LCS DUP are spiked with known amounts of spiking solution.

5.4.5 The Teflon beaker or centrifuge tube to be used for the blank is labeled. 50 mL of Type I water is transferred to the beaker or tube. No spike or sample is added to the blank.

5.5 Sample digestion:

5.5.1 Add 1 mL of $HNO_3$ and 2.5 mL of HCl to the samples and quality control samples.

5.5.2 Cover the sample with a watchglass and heat the sample to 90 to 95° C until the sample volume is reduced to 7.5 to 10mL.

5.5.3 Do not allow the sample to go to dryness. Do not allow the sample to boil.

5.5.4 Remove the sample from the hot plate or block.

5.5.5 Allow the sample to cool.

5.5.6 If the sample contains particulate material that could clog the nebulizer, if necessary, you may filter or centrifuge the sample.

5.5.6.1 Be advised that filtration is a common cause of contamination. If a sample is filtered any QC associated with the sample must also be filtered. Additionally, if any sample in the batch is filtered the method blank and laboratory control sample must also be filtered.

5.5.7 Transfer the sample to a labeled centrifuge tube.

5.5.8 Dilute the sample to 50 mL with Type I water.

5.5.9 Cap the samples, organize them into a storage container, and label the storage container with the batch number of the sample group.

## 6.0 SAFETY, HEALTH AND ENVIRONMENTAL HAZARDS

**WARNING**

CONCENTRATED HCl AND $HN0_3$ ARE EXTREMELY CORROSIVE AND CAN CAUSE SEVERE BURNS TO THE SKIN

6.1 Wear eye protection with side shields while performing procedures in the laboratory.

6.2 All chemicals and samples should be treated as a potential health hazard and exposure to these chemicals must be reduced to the lowest level possible. GEL maintains a current awareness file of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of the chemicals. A reference file of Material Safety Data Sheets (MSDS) and individual client sample MSDSs are also maintained.

6.3 Personal protective equipment

6.3.1 Disposable gloves are worn and changed frequently when working with acids, glassware, or samples. Dirty gloves pose a contamination hazard to the samples. Gloves that have holes can be dangerous to the wearer by allowing acids and toxic metals to come in contact with the skin.

6.3.2 Hood doors are pulled down partially while digesting samples. Acidified samples can splash and pop as they are being heated.

6.3.3 To protect clothes and skin from being exposed to corrosive material, wear a lab jacket.

6.4 Prior to handling radioactive samples analysts must have had radiation safety training and understand their full responsibilities in radioactive sample handling. Some general guidelines follow:

6.4.1 Wear plastic apron over lab coat when working with radioactive samples.

6.4.2 Protect counter tops with counter paper or work from radioactive sample handling trays.

6.4.3 Prohibit admittance to immediate work area.

6.4.4 Post signs indicating radioactive samples are in the area.

6.4.5 Take swipes of the counter tops upon completion of work. Deliver those swipes to the designated swipe count box.

6.4.6 Segregate radioactive wastes. Radioactive waste containers are obtained from the Waste Management.

6.5 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

6.5.1 Segregate solid wastes from liquid wastes in the satellite area containers.

6.5.2 Segregate oil wastes from water-soluble wastes in the satellite area containers.

6.6 In the event of an accident or medical emergency call for help immediately. When time and safety permit, an accident report form should be completed and turned in to the safety committee.

6.7 Fire escape routes are posted in the lab and all personnel should be familiar with them. In addition, fire safety equipment such as fire extinguishers is located in the lab. Training is available on the proper operation of this equipment.

## 7.0 RECORDS MANAGEMENT

7.1 Upon completion of batch preparation, digestion data shall be entered into the LIMS Prep Logbook (see Appendix 1) following the guidelines in GL-LB-E-008 for “Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Record Keeping Devices.”

7.2 Data to be entered into the logbook includes analyst name, prep data and time, initial volume or weight with units, and final volume with units.

7.3 Standards and reagents may also be entered into the logbook and fall under the guidelines of GL-LB-E-015 for “Control of Laboratory Standards,” and GL-LB-E-007 for “Laboratory Standards Documentation.”

7.4 Upon entry of prep data, obtain a printout of the logbook. The analyst listed on the logbook should sign and date the page near their printed initials. The logbook page is kept with the samples with which it is associated.

7.5 The entry of correct prep data is peer reviewed (correct dates, times, weights, volumes, SOP/revision, spikes, spike amounts and reagent information, etc.) Once data is reviewed, the batch is statused to DONE in LIMS, the logbook is signed and dated by the reviewer and the batch is ready for analysis.

7.6 Before a batch is to be peer reviewed, commit the analyst, date, time, initial volume, initial volume units, final volume, and final volume units into the Laboratory Information Management System.

## 8.1 LABORATORY WASTE

For the proper disposal of sample and reagent wastes from this procedure, refer to the Laboratory Waste Management Plan, GL-LB-G-001.

## 9.0 REFERENCES

9.1 Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 3005A, Revision 1, July 1992.

9.2 1992 Annual Book of ASTM Standards, D1193-91, "Standard Specification for Reagent Water"

# APPENDIX 1: PREP LOGBOOK

(for illustrative purposes only)

## Prep LogBook

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Analyst: | AIM | | | Type | Sample Id | Lot. Id | Spike Amount | Spike Units |
| Batch: | 10607 | | | LCS | 10000223152 | 5385 | .25 | mL |
| Prep Date: | 07-FEB-2000 14:00 | | | LCS | 10000223152 | 5386 | .25 | mL |
| Lab SOP: | GL-MA-E-013 | | | MS | 10000223155 | 5385 | .25 | mL |
| | | | | MS | 10000223155 | 5386 | .25 | mL |
| | | | | MSD | 10000223154 | 5385 | .25 | mL |
| | | | | MSD | 10000223154 | 5386 | .25 | mL |

| Type | Sample Id | Parent Sample | Method | Initial Wt. | Final Volume | Prep Factor | Comments | Matrix |
|---|---|---|---|---|---|---|---|---|
| MB | 10000223151 | | 200.2/200.7 Full List For QC | 50mL | 50mL | 1 | | Water |
| SAMPLE | 21426001 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| LCS | 10000223152 | | 200.2/200.7 Full List For QC | 50mL | 50mL | 1 | | Water |
| SAMPLE | 21426002 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| SAMPLE | 21426003 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| SAMPLE | 21426004 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| SDILT | 10000223153 | 21426004 | 200.2/200.7 Full List For QC | 50mL | 50mL | 1 | | Water |
| MSD | 10000223154 | 21426004 | 200.2/200.7 Full List For QC | 50mL | 50mL | 1 | | Water |
| MS | 10000223155 | 21426004 | 200.2/200.7 Full List For QC | 50mL | 50mL | 1 | | Water |

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**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

# FOR

# ACID DIGESTION OF TOTAL METALS IN AQUEOUS SAMPLES AND EXTRACTS FOR ANALYSIS BY ICP AND ICP-MS

## (GL-MA-E-008 REVISION 13)

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## 1.0 STANDARD OPERATING PROCEDURE FOR ACID DIGESTION OF TOTAL METALS IN AQUEOUS SAMPLES AND EXTRACTS FOR ANALYSIS BY ICP AND ICP-MS

## 2.0 PURPOSE

To describe the manner in which aqueous samples and extracts for Inductively Coupled Plasma (ICP) and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) analysis are digested by EPA SW-846 Method 3010A. Samples digested by this procedure are applicable for analysis by SW-846 methods.

## 3.0 DISCUSSION

Total Metals - The sample is refluxed with nitric acid until the color is light or the color has stabilized and the volume is reduced. The sample is refluxed with hydrochloric acid. The sample is then diluted to a final volume and is ready for analysis. This procedure deviates from method 3010A as follows: sample and reagent volumes are half of the method recommendations. GEL does not perform FLAA analysis and does not prep silver as required by Method 7760 for FLAA analysis. Samples prepared by this method may be analyzed for all the listed metals:

| | | | |
|---|---|---|---|
| Aluminum | Cobalt | Nickel | Tin |
| Antimony | Chromium | Phosphorus | Thorium (ICP-MS Only) |
| Arsenic | Copper | Lead | Titanium |
| Barium | Iron | Sulfur | Thallium |
| Beryllium | Potassium | Sodium | Uranium |
| Boron | Magnesium | Selenium | Vanadium |
| Calcium | Manganese | Silver | Zinc |
| Cadmium | Molybdenum | Strontium | Lithium ( ICP-MS Only) |

**NOTE:** All samples logged as miscellaneous liquids or samples extracted by TCLP are diluted 10x during prep.

## 4.0 DEFINITIONS

4.1 Tumble blank (TB) - A TB is the extraction fluid used in the TCLP extraction that has gone through entire process.

4.2 Method Blank (MB) - Type I water that has been taken through the digestion process. The blank is used to determine the amount of background contamination.

4.3 Laboratory Control Sample (LCS) - A certified reference material that has been taken through the digestion process. The LCS is used to determine digestion accuracy and to determine if the digestion process is in control.

4.4 Laboratory Control Sample Duplicate (LCS DUP) - A duplicate of the LCS. The LCS DUP is used to determine reproducibility and to indicate precision.

4.5 Matrix Spike (MS) - A sample that has added to it a known amount of solution containing known concentrations of analytes. The MS is used to determine the presence or absence of interferences and matrix effects in the digested sample. Spikes and spike duplicates are prepared in the TCLP lab prior to preservation. Only when limited volumes permit, are spikes performed in the metals prep area.

4.6 Matrix Spike Duplicate (MSD) - A duplicate of the MS. The MSD indicates reproducibility. Spikes and spike duplicates are prepared in the TCLP lab prior to preservation. Only when limited volumes permit, are spikes performed in the metals prep area.

4.7 Sample Duplicate (DUP) – A duplicate of a sample. The DUP indicates reproducibility.

4.8 Type II water - Water that conforms to the following performance specifications:

| | |
|---|---|
| Electrical resistivity, min. | 1.0 |
| Total organic carbon, max., µg/L | 50 |
| Sodium, max., µg/L | 5 |
| Chlorides, max., µg/L | 5 |
| Total silica, max., µg/L | 3 |

Type II water is dispensed throughout the laboratory through a centralized distribution system.

4.9 Type I water - Water that conforms to the following performance specifications:

| | |
|---|---|
| Electrical resistivity, min. | 16.67 |
| Total organic carbon, max., µg/L | 100 |
| Sodium, max., µg/L | 1 |
| Chlorides, max., µg/L | 1 |
| Total silica, max., µg/L | 3 |

Type I water is dispensed within the metals prep lab by the "MilliQ" water system.

4.10 $HNO_3$ - Concentrated reagent grade 70.9% nitric acid.

4.11 HCl - Concentrated reagent grade 37% hydrochloric acid.

## 5.0 PROCEDURES

A batch consists of samples of the same matrix and quality control (QC) samples that are digested together. Each of the quality control samples listed in section 4.1 through 4.6, must be included in each batch at the frequency listed or as per client request. The blank, LCS and/or LCS DUP are digested at a frequency of one in 20 or per batch, whichever is more frequent. The MS, MSD and/or DUP are digested at a frequency of one in 20 or per batch, whichever is more frequent, or per specified client/program requirements.

5.1 Water samples which require lab filtration are filtered from non-preserved aliquots. After filtration they are acidified to pH<2 using HNO3. A method blank (MB) is filtered with the samples for to monitor possible contamination. The acidified aliquots are held at least 16 hours before continuing preparation for analysis.

5.2 All samples are tested for pH < 2, using pH test strips before sample preparation is initiated. If samples do not have the correct pH, samples are acidified to pH<2 using HNO3. The acidified aliquots are held at least 16 hours prior to preparation for analysis.

5.3 Glassware preparation:

5.3.1 Glassware that has been cleaned according to "Glassware Preparation" (GL-LB-E-003) is soaked in a water and acid mixture for at least 30 mins.

5.3.2 After soaking, the glassware is rinsed with copious quantities of Type II or Type I water, then inverted over clean, absorbent paper or onto a rack for drying.

5.4 Label 150 mL or equivalent Teflon® beakers or centrifuge tubes with the sample numbers in the batch. If centrifuge tube is used, it must first be calibrated.

5.5 Mix the sample to achieve homogeneity. Transfer a 50 mL aliquot of sample to the appropriately labeled beaker with a graduated cylinder or to a calibrated centrifuge tube.

5.6 Quality control samples are prepared prior to digestion.

5.6.1 The beaker or tube to be used for the blank, MS, MSD and/or DUP, LCS and/or LCS DUP is labeled.

5.6.2 Unless otherwise noted, at least 50 mL of the sample is transferred to the MS, MSD and/or DUP beaker or tube.

5.6.3 Unless otherwise noted, 50 mL of Type I water is transferred to the LCS and/or LCS DUP beaker or tube.

5.6.4 The MS, MSD, LCS and/or LCS DUP are spiked with known amounts of spiking solution.

5.6.5 The beaker or tube to be used for the blank is labeled. 50 mL of Type I water is transferred to the beaker or tube. No spike or sample is added to the blank.

5.7 Sample digestion:

5.7.1 Add 1.5 mL of $HNO_3$ to the samples and quality control samples.

5.7.2 Cover the sample with a watch glass and heat the sample to near boiling, at a temperature of 90 - 95 °C, until the sample volume is reduced to a low volume (2.5 mL).

5.7.3 Do not allow the sample to go to dryness, or to boil.

**NOTE**: If a sample is allowed to go to dryness, low recoveries will result. Should this occur, discard the sample and re-prepare.

5.7.4 Remove the sample from the hot plate or block.

5.7.5 Allow the sample to cool.

5.7.6 Add another 1.5 mL portion of $HNO_3$ to the samples and QC samples.

5.7.7 Cover the samples with a watch glass and return the samples to the hot plate or block. Continue refluxing, evaporating to 1-1/2 mL volume.

5.7.8 Repeat steps 5.7.1 through 5.7.7 until the digestion is complete, which is generally indicated when the digestate is light in color or does not change in appearance with continued refluxing.

5.7.9 Remove the sample from the hot plate or block.

5.7.10 Allow the sample to cool.

5.7.11 Add 2.5 mL HCl to the sample and reflux for 15 minutes to dissolve any precipitate or residue resulting from evaporation.

5.7.12 Dilute the sample to 50 mL with Type I water.


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5.7.13 Transfer the sample to a labeled centrifuge tube.

5.7.14 If the sample contains particulate material that could clog the nebulizer, if necessary, you may filter or centrifuge the sample.

5.7.14.1 Be advised that filtration is a common cause of contamination. If a sample is filtered any QC associated with the sample must also be filtered. Additionally, if any sample in the batch is filtered the method blank and laboratory control sample must also be filtered.

5.7.15 Cap the samples, organize them into a storage container, and label the storage container with the batch number of the sample group.

## 6.0 SAFETY, HEALTH AND ENVIRONMENTAL HAZARDS

**WARNING**

CONCENTRATED HCl AND $HNO_3$ ARE EXTREMELY CORROSIVE AND CAN CAUSE SEVERE BURNS TO THE SKIN.

6.1 Wear eye protection with side shields while performing procedures in the lab.

6.2 All chemicals and samples should be treated as a potential health hazard and exposure to these chemicals must be reduced to the lowest level possible. GEL maintains a current awareness file of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of the chemicals. A reference file of Material Safety Data Sheets (MSDS) and individual client sample MSDSs are also maintained.

6.3 Personal protective equipment

6.3.1 Disposable gloves are worn and changed frequently when working with acids, glassware, or samples. Dirty gloves pose a contamination hazard to the samples. Gloves that have holes can be dangerous to the wearer by allowing acids and toxic metals to come in contact with skin.

6.3.2 Hood doors are pulled down partially while digesting samples. Acidified samples can splash and pop as they are being heated.

6.3.3 To protect clothes and skin from being exposed to corrosive material, wear a lab jacket.

6.4 Prior to handling radioactive samples analysts must have had radiation safety training and understand their full responsibilities in radioactive sample handling. Some general guidelines follow:

6.4.1 Wear plastic apron over lab coat when working with radioactive samples.

6.4.2 Protect counter tops with counter paper or work from radioactive sample handling trays.

6.4.3 Prohibit admittance to immediate work area.

6.4.4 Post signs indicating radioactive samples are in the area.

6.4.5 Take swipes of the counter tops upon completion of work. Deliver those swipes to the designated swipe count box.

6.4.6 Segregate radioactive wastes. Radioactive waste containers are obtained from the Waste Management.

## 7.0 RECORDS MANAGEMENT

7.1 Upon completion of batch preparation, digestion data shall be entered into the LIMS Prep Logbook (see Appendix 1) following the guidelines in GL-LB-E-008 for "Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Record Keeping Devices."

7.2 Data to be entered into the logbook includes analyst name, prep data and time, initial volume or weight with units, and final volume with units.

7.3 Standards and reagents may also be entered into the logbook and fall under the guidelines of GL-LB-E-015 for "Control of Laboratory Standards," and GL-LB-E-007 for "Laboratory Standards Documentation."

7.4 Upon entry of prep data, obtain a printout of the logbook. The analyst listed on the logbook should sign and date the page near their printed initials. The logbook page is kept with the samples with which it is associated.

7.5 The entry of correct prep data is peer reviewed (correct dates, times, weights, volumes, SOP/revision, spikes, spike amounts and reagent information, etc.) Once data is reviewed, the batch is statused to DONE in LIMS, the logbook is signed and dated by the reviewer and the batch is ready for analysis.

## 8.0 LABORATORY WASTE

For the proper disposal of sample and reagent wastes from this procedure, refer to the Laboratory Waste Management Plan, GL-LB-G-001.

## 9.0 REFERENCES

9.1 Test Method for Evaluating Solid Waste, Laboratory Manual Physical/ Chemical Methods, SW-846 Method 3010A, Revision 1, July 1992.

9.2 1992 Annual Book of ASTM Standards, Standard D 1193-91, "Standard Specification for Reagent Water."


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# APPENDIX 1: SAMPLE DIGESTION LOG

(for illustrative purposes only)

**Prep LogBook**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analyst: | AIM | Type | Sample Id | Lot Id | Spike Amount | Spike Units |
| Batch: | 10607 | LCS | 10000023152 | 5385 | .25 | mL |
| Prep Date: | 07-FEB-2000 14:00 | LCS | 10000023152 | 5386 | .25 | mL |
| Lab SOP: | GL-MA-E-013 | MS | 10000023155 | 5385 | .25 | mL |
| | | MS | 10000023155 | 5386 | .25 | mL |
| | | MSD | 10000023154 | 5385 | .25 | mL |
| | | MSD | 10000023154 | 5386 | .25 | mL |

| Type | Sample Id | Parent Sample | Method | Initial Wt. | Final Volume | Prep Factor | Comments | Matrix |
|---|---|---|---|---|---|---|---|---|
| MB | 10000023151 | | 200.2/200.7 Full List Fee QC | 50mL | 50mL | 1 | | Water |
| SAMPLE | 21426001 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| LCS | 10000023152 | | 200.2/200.7 Full List Fee QC | 50mL | 50mL | 1 | | Water |
| SAMPLE | 21426002 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| SAMPLE | 21426003 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| SAMPLE | 21426004 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| SDILT | 10000023153 | 21426004 | 200.2/200.7 Full List Fee QC | 50mL | 50mL | 1 | | Water |
| MSD | 10000023154 | 21426004 | 200.2/200.7 Full List Fee QC | 50mL | 50mL | 1 | | Water |
| MS | 10000023155 | 21426004 | 200.2/200.7 Full List Fee QC | 50mL | 50mL | 1 | | Water |

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**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

# FOR

# ACID DIGESTION OF

# SEDIMENTS, SLUDGES, AND SOILS

## (GL-MA-E-009 REVISION 21)

APPLICABLE TO METHODS:
EPA SW-846 3050B Modified
16 CFR part 1303 Modified

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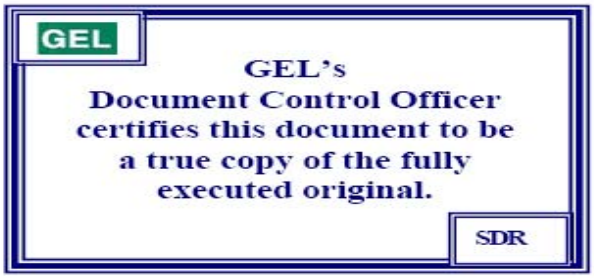

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# 1.0 STANDARD OPERATING PROCEDURE FOR ACID DIGESTION OF SEDIMENTS, SLUDGES, AND SOILS

## 2.0 METHOD CODE

2.1 EPA SW-846 3050B Modified

2.2 16 CFR Part 1303 Modified

## 3.0 METHOD OBJECTIVE/PURPOSE

To describe the manner in which sediments, sludges, and soils for Inductively Coupled Plasma (ICP) and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) analysis are digested by EPA SW-846 Method 3050B Modified. Samples digested by this procedure are applicable for analysis by SW-846 methods 6010B and 6020. Included in this standard operating procedure is guidance for paint and jewelry preparation.

## 4.0 METHOD SUMMARY

A representative portion of sample is digested with nitric acid and hydrogen peroxide. This digestate is then refluxed with hydrochloric acid for ICP analysis only. Samples prepared by this method may be analyzed for all the listed metals. Other metals may be analyzed if they pass control standard criteria:

| | | | |
|---|---|---|---|
| Aluminum | Chromium | Lead | Thallium |
| Antimony (ICP Only) | Copper | Sulfur | Vanadium |
| Arsenic | Iron | Sodium | Zinc |
| Barium | Potassium | Selenium | Silver (ICP Only) |
| Beryllium | Manganese | Strontium | Titanium |
| Calcium | Nickel | Tin (ICP Only) | Phosphorus |
| Cadmium | Cobalt | Thorium (ICP-MS Only) | |
| Uranium (Isotopes 233, 234, 235, 236, and 238 via ICP-MS only) | Molybdenum | Lithium ( ICP-MS Only) | |

This method is not a “total” digestion technique for most samples. It is a very strong acid digestion that will dissolve all elements that could become “environmentally available” by design; elements bound in silicate structures (boron, silicon, silica) are not normally dissolved by this procedure as they are not usually mobile in the environment.

## 5.0 APPLICABLE MATRICES

5.1 Soils

5.2 Sludges

5.3 Sediments

5.4 Solid debris/powders

5.5 Heavy oils

5.6 Filters

5.7 Paints

5.8 Metal jewelry

## 6.0 HOLD TIME

Holding time is 180 days from the time and date of collection until the start of analysis unless otherwise specified by contract.

## 7.0 SAMPLE CONTAINER/PRESERVATION/COLLECTION/STORAGE REQUIREMENTS

Solid samples are not preserved but must be stored at 0°- 6° C.

## 8.0 INTERFERENCES

There are rarely any interferences with this digestion. If any are encountered, consult the group leader or quality officer before continuing.

## 9.0 PERFORMANCE CHARACTERISTICS

Method detection limits (MDLs) are performed annually and method detection limit verification (MDLVs) are performed quarterly.

## 10.0 DEFINITIONS

10.1 Blank: Type I water that has been taken through the digestion process. The blank is used to determine the amount of background contamination.

10.2 Laboratory Control Sample (LCS): A certified reference material that has been taken through the digestion process. The LCS is used to determine digestion accuracy and to determine if the digestion process is in control.

10.3 Laboratory Control Sample Duplicate (LCS DUP): A duplicate of the LCS. The LCS DUP is used to determine reproducibility and to indicate precision.

10.4 Matrix Spike (MS): A sample that has added to it a known amount of solution containing known concentrations of analytes. The MS is used to determine the presence or absence of interferences and matrix effects in the digested sample.

10.5 Matrix Spike Duplicate (MSD): A duplicate of the MS. The MSD indicates reproducibility.

10.6 Sample Duplicate (DUP): A duplicate of a sample. The DUP indicates reproducibility.

10.7 AlphaLIMS: The Laboratory Information Management System used at GEL.

10.8 National Institute of Standards and Technology (NIST): For the purpose of this method, the national scientific body responsible for the standardization and acceptability of analyte solutions.

## 11.0 ANALYST VERIFICATION

Before a technician/analyst is allowed to analyze samples without supervision, he or she is trained by qualified personnel and is required to successfully analyze a proficiency sample. Training records are maintained as quality records (Refer to GL-QS-E-008).

## 12.0 DOCUMENTATION OF DATA

Sample preparation data are recorded in AlphaLIMS.

## 13.0 SAFETY, HEALTH, AND ENVIRONMENTAL HAZARDS

**WARNING**

CONCENTRATED HYDROCHLORIC ACID AND NITRIC ACID ARE EXTREMELY CORROSIVE AND CAN CAUSE SEVERE BURNS TO THE SKIN.

CONCENTRATED 30% HYDROGEN PEROXIDE IS A VIOLENT OXIDIZER. KEEP AWAY FROM OPEN FLAMES, AND RINSE WITH WATER IF SKIN CONTACT OCCURS.

13.1 Wear eye protection with side shields while performing procedures in the lab.

13.2 Treat all chemicals and samples as potential health hazards, and reduce exposure to these chemicals to the lowest level possible. GEL maintains a current awareness file of OSHA regulations regarding the safe handling of the chemicals. A reference file of Material Safety Data Sheets (MSDS) and individual client sample MSDSs are also maintained.

13.3 Personal protective equipment

13.3.1 Disposable gloves are worn and changed frequently when working with acids, glassware, or samples. Dirty gloves pose a contamination hazard to the samples. Gloves that have holes can be dangerous to the wearer by allowing acids and toxic metals to come in contact with skin.

13.3.2 Hood doors are pulled down partially while digesting samples. Acidified samples can splash and pop as they are being heated.

13.3.3 To protect clothes and skin from exposure to corrosive material, wear a lab jacket.

13.4 Prior to handling radioactive samples, analysts must have had radiation safety training and must understand their full responsibilities in radioactive sample handling. Some general guidelines follow:

13.4.1 Wear plastic apron over lab coat when working with radioactive samples.

13.4.2 Protect counter tops with counter paper, or work from radioactive sample handling trays.

13.4.3 Prohibit admittance to immediate work area.

13.4.4 Post signs indicating radioactive samples are in the area.

13.4.5 Take swipes of the counter tops upon completion of work. Deliver those swipes to the designated swipe count box.

13.4.6 Segregate radioactive wastes. Radioactive waste containers are obtained from the Waste Management.

13.5 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

13.5.1 Segregate solid wastes from liquid wastes in the satellite area containers.

13.5.2 Segregate oil wastes from water-soluble wastes in the satellite area containers.

13.6 In the event of an accident or medical emergency, call for help immediately. When time and safety permit, an accident report form should be completed and turned in to the safety committee.

13.7 Fire escape routes are posted in the lab, and all personnel should be familiar with them. In addition, fire safety equipment such as fire extinguishers is located in the lab. Training is available on the proper operation of this equipment.

## 14.0 SAMPLE RECEIPT FOR ANALYSIS

14.1 The analyst/technician submits the list of samples needed to the sample custodian group. The sample custodian removes the appropriate sample from the cooler and scans it using the barcode scanner to the appropriate area of the lab. The analyst then takes custody of the samples and scans them to the sample batch. The samples are now ready to be prepared or analyzed.

14.2 Analysts/technicians are responsible for retrieving their own samples when the sample custodian is unavailable.

## 15.0 INSTRUMENT/EQUIPMENT/GLASSWARE

15.1 Equipment

15.1.1 Air displacement pipettes

15.1.1.1 5-10 mL with disposable tips

15.1.1.2 0.5-5 mL with disposable tips

15.1.1.3 100-1000 µL with disposable tips

15.1.1.4 10-100 µL with disposable tips

15.1.2 Environmental Express hot blocks or equivalent

15.1.3 Analytical balance capable of reading to three decimal places

15.1.4 Certified disposable 50 mL digestion tubes (polypropylene)

15.1.5 Ribbed disposable watch glasses (polypropylene)

15.1.6 Water resistant lab markers

15.1.7 Styrofoam trays to handle up to 25 digestion tubes

15.1.8 500 mL Nalgene squirt bottle

15.1.9 Teflon chips

15.1.10 1-inch white laboratory tape

15.1.11 Borosilicate beakers (various sizes)

15.1.12 Borosilicate watch glasses (various sizes)

## 16.0 REAGENTS

16.1 Nitric acid ($HNO_3$), concentrated high purity grade 70% nitric acid

16.2 Hydrochloric acid (HCl), concentrated high purity grade 37% hydrochloric acid

16.3 Hydrogen peroxide ($H_2O_2$), concentrated 30% hydrogen peroxide

16.4 Type I water, DI water that conforms to the following specifications:

| | |
|---|---|
| Electrical resisitivity, minimum | 16.67 |
| Total organic carbon, maximum, µg/L | 100 |
| Sodium, maximum, µg/L | 1 |
| Chlorides, maximum, µg/L | 1 |
| Total Silica, maximum, µg/L | 3 |

Type I water is dispersed with the metals prep lab by the "Milli Q" water system.

16.5 Multi-element spiking solutions are purchased from NIST-traceable vendors.

## 17.0 PREPARATION OF SAMPLES

A batch consists of samples of the same matrix and quality control (QC) samples that are digested together. Each of the quality control samples listed in steps 10.1 through 10.6 must be included in each batch at the frequency listed or as per client request. The blank, LCS, and/or LCS DUP are digested at a frequency of one in 20 or per batch, whichever is more frequent. The MS, MSD, and/or DUP are digested at a frequency of one in 20 or per batch, whichever is more frequent, or per specified client/program requirements.

17.1 Glassware preparation:

17.1.1 Glassware that has been cleaned according to GL-LB-E-003 for Glassware Preparation is soaked in a water and acid mixture for at least 30 minutes.

17.1.2 After soaking, the glassware is rinsed with copious quantities of Type I water and then inverted over clean, absorbent paper or onto a rack for drying.

17.2 Label the Teflon beakers or centrifuge tube with the sample numbers in the batch. If centrifuge tube is to be used for measuring initial and final volumes it must be calibrated before usage. Refer to GL-LB-E-026 for centrifuge tube testing procedure.

17.3 Refer to GL-LB-E-029 for subsampling instructions. Mix the sample to achieve homogeneity. Weigh approximately 0.5 g of sample. Transfer the weighed sample to the appropriately labeled Teflon beaker or centrifuge tube.

17.3.1 Sample aliquots should not be taken from the top of an unmixed sample because large particles tend to rise in solid matrixes and heavy materials tend to sink in liquid matrixes.

17.3.2 Powdered samples may be homogenized by gently rocking the sample side to side. Then a representative aliquot may be taken from the center of the powder.

17.3.3 Other matrixes must be stirred, turned or mixed before sampling.

17.4 Quality control samples are prepared prior to digestion.

17.4.1 The beaker or tube to be used for the blank, MS, MSD, and/or DUP, LCS, and/or LCS DUP is labeled.

17.4.2 Weigh approximately 0.5 g of sample and transfer to the MS, MSD, and/or DUP beaker or tube.

The MS, MSD, LCS, and/or LCS DUP are spiked with known amounts of spiking solution.

17.4.3 Select a LCS. The LCS is purchased for an outside vendor and comes with a certificate of certified values and recovery ranges. The LCS is logged into the AlphaLIMS system for traceability and for the use of nominal calculations. For analytes not certified in the Solid Reference Material (SRM), a series of 20 preparations and analyses are conducted and an average concentration is determined. A value of 3 times the standard

deviation is used as control limits for the LCS recovery for these analytes. Mix the LCS to achieve homogeneity. Weigh approximately 0.5 g of the sample and transfer to the LCS and/or LCS DUP Teflon beaker or centrifuge tube. For non-soil solid samples, a liquid LCS is used in combination with approximately 0.5 g of Teflon chips.

17.4.4 The blank beaker or tube is labeled and no water, spike, or sample is added to it. Approximately 0.5 g of Teflon chips is used.

17.5 If the samples are being prepared for ICP-MS analysis:

17.5.1 Add 2.5 mL nitric acid and Type I DI water to the samples and quality control samples.

17.5.2 Gently swirl the sample and acid mixture.

17.5.3 Cover the sample with a watch glass and heat the sample on a hot plate/block to 95° ± 5° C. Reflux the sample for 10 to 15 minutes.

17.5.4 Remove the sample from the hot plate or block and allow the sample to cool.

17.5.5 Add 2.5 mL of concentrated nitric acid, replace the watch glass, and reflux for 30 minutes. If brown fumes are generated indicating oxidation of the sample by nitric acid, repeat step 17.5.5 over and over until no brown fumes are given off by the sample.

17.5.6 Using a ribbed watch glass or vapor recovery system, allow the solution to evaporate to approximately 0.5 mL without boiling, or heat for 2 hours.

17.5.6.1 Remove the sample from the hot plate or block and allow the sample to cool.

17.5.6.2 Add 1.5 mL of hydrogen peroxide and 1.0 mL of Type I water. Return the sample to the hot plate or block and allow the peroxide reaction to occur. Continue to add hydrogen peroxide to the sample until the effervescence subsides. Do not add more than 5 mL hydrogen peroxide.

17.5.6.3 Cover the sample with a ribbed watchglass, heating the acid-peroxide digestate until the volume is reduced to approximately 2.5 mL, or heat at 95° ± 5° C without boiling for 2 hours.

17.5.6.4 Do not allow the sample to evaporate to dryness.

17.5.6.5 Remove the sample from step 17.5.6.3 from the hot plate or block.

17.5.6.6 Allow the sample to cool.

17.5.6.7 Dilute the sample to 50 mL with Type I water.

17.5.6.8 Cap and shake the sample.

17.5.6.9 Filter each sample with a 2.0 µm pore size plunger type filter (PTF grade) or allow to settle overnight.

17.5.6.10 Organize the samples in a storage container, and label the container with the batch number of the sample group.

17.6 If the samples are being prepared ICP analysis:

17.6.1 Add 1.25 mL nitric acid and 10 mL hydrochloric acid to the samples and quality control samples.

17.6.2 Gently swirl to mix.

17.6.3 Cover the sample with a watch glass and heat the sample on a hotplate/block to 95° ± 5° C. Reflux the sample for 30 minutes.

17.6.4 Remove the sample from the hotplate/block and allow to cool.

17.6.5 Dilute the sample to 50 mL with Type I water.

17.6.6 Cap and shake the sample.

17.6.7 Filter each sample with 2.0 µm pore size plunger type filter (PTF grade) or allow to sit overnight.

17.6.8 Organize the samples in a storage container, and label the container with the batch number of the sample group.

17.7 If the sample contains particulate material that could clog the nebulizer, you may filter or centrifuge the sample if necessary.

17.8 Be advised that filtration is a common cause of contamination. If a sample is filtered, any QC associated with the sample must also be filtered. Additionally, if any sample in the batch is filtered the method blank and laboratory control sample must also be filtered.

17.9 Filters may be prepared via this method. If the filters are small enough to fit inside the 50 mL digestion tubes, they can be treated as any solid prep materials. If the filters are too big to undergo adequate digestion using the 50 mL digestion tube, a borosilicate beaker will need to be used. All reagents and standards will need to be adjusted for any extra volumes needed. All filter analyses should be discussed and the process verified with the group/team leader prior to digestion. The group leader or project manager may have to contact the client to get the full description of what is required.

17.10 If testing paint for the U.S. Consumer Product Safety Commission's (CPSC) Product Testing Program, follow the preparation instructions below:

17.10.1 For testing of wet paint, apply a think coating to a glass slide and dry completely prior to testing by heating in an oven at a recommended 105° C until weight is stable.

17.10.2 For products coated with paint or a similar surface coating, remove and digest the coating separately from the substrate material for lead content. Care should be taken to remove as little of the substrate as possible. The scraped paint should be finely divided to help in digesting.

17.10.3 Scrape and weigh approximately 5 to 20 mg of paint from the product. If it is not possible to collect this much paint, it may be necessary to combine more than one unit of such product to collect sufficient paint.

17.10.4 Prepare samples and QC using procedure in section 17.6.

17.11 If testing metal jewelry for the U.S. Consumer Product Safety Commission's (CPSC) Product Testing Program, follow the preparation instructions below:

17.11.1 If the children's metal jewelry is coated with paint or a similar surface coating, the coating shall be removed and analyzed separately from the base metal for lead content. Care should be taken to remove as little of the substrate metal as possible. Ideally, the sample should contain only identical items, not a mix of several different items. An item such as a bracelet may be broken into its component parts such as bead, hook, pendant, with those component parts individually analyzed.

17.11.2 Weigh approximately 5 to 20 mg of the paint or coating from the jewelry item. If it is not possible to collect this much paint or coating, it may be necessary to combine more than one unit of such product to collect sufficient sample.

17.11.3 Prepare paint or coating and QC using procedure in section 17.6.

17.11.4 Weigh out a 30 to 50 mg piece of children's metal jewelry. Children's metal jewelry items generally weigh several grams, and an aliquot piece (with no paint or similar surface coating) will have to be clipped from items using metal cutters. Samples should be cut into several small pieces or ground to increase the rate of dissolution. If used, grinding apparatus must be thoroughly cleaned to prevent cross-contamination.

17.11.5 Prepare children's metal jewelry and QC using the procedure in section 17.6.

## 18.0 PREPARATION OF STANDARDS

Documentation of standards and their preparation is maintained in AlphaLIMS in accordance with GL-LB-E-007 for Laboratory Standards Documentation.

## 19.0 INSTRUMENT/EQUIPMENT START-UP PROCEDURE

Hot plates/blocks are allowed to come to the proper temperature before digestions are started. The temperatures are monitored before and after a daily digestion session.

## 20.0 QUALITY CONTROL (QC) REQUIREMENTS

20.1 Frequency of QC

20.1.1 A matrix spike (MS) and a matrix spike duplicate (MSD) or a sample duplicate (DUP) and a matrix spike are prepped for every batch of $\leq$ 20 samples

20.1.2 A method blank (MB) and a laboratory control standard (LCS) are prepped for every batch of $\leq$ 20 samples. A laboratory control standard duplicate (LCSD) is prepared if matrix QC is unavailable or upon client request.

20.2 Makeup of QC Samples

20.2.1 Sample duplicate (DUP) is a separate aliquot taken through the prep process exactly the same as the original sample.

20.2.2 Matrix spike and/or matrix spike duplicate is a separate aliquot of the sample to which appropriate spike volumes and solutions are added. The ID numbers and volumes of the spikes are recorded in the prep logbook.

20.2.3 The method blank (MB) is a reagent blank taken through the same prep process as the samples. Teflon chips are used to approximate matrix weights of 0.5 g.

20.2.4 The laboratory control standard (LCS) is a standard performed two different ways. For DOE-ALB clients, a purchased SRM is used at approximately 0.5 g and is taken through the same process as the samples. For all other clients, Teflon chips weighted to approximately 0.5 g are used. The chips and acid solution is spiked with the appropriate spike volumes and solutions. The ID number and volumes of the spikes are recorded in the prep logbook.

20.3 Handling Out-Of-Control Situations

If sample reactions cause popping or splattering of the digestate, discontinue the prep and contact team leader or group leader.

## 21.0 RUN SEQUENCE

Not applicable

## 22.0 PROCEDURE

Refer to section 17.0, Preparation of Samples

## 23.0 INSTRUMENT/EQUIPMENT SHUT-DOWN PROCEDURE

Before turning off the hotplate/blocks at the end of the day, a final monitoring temperature is recorded for each plate/block that was utilized.

## 24.0 METHOD VARIATION

24.1 This procedure deviates from method 3050B in that sample volumes are half the method recommendations.

24.2 The ICP procedure references a modified 3050B section 7.5 procedure. The modification eliminates the use of the Whatman 41 filters, thus eliminating contamination of common minerals.

## 25.0 DATA REVIEW, VALIDATION, AND APPROVAL PROCEDURE

25.1 Upon completion of batch preparation, digestion data shall be entered into the AlphaLIMS Prep Logbook (refer to Appendix 1) following the guidelines in GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Recordkeeping Devices.

25.2 Data to be entered into the electronic logbook include analyst name, prep data and time, initial volume or weight with units, and final volume with units.

25.3 Standards and reagents may also be entered into the logbook and fall under the guidelines of GL-LB-E-015 for Control of Laboratory Standards and GL-LB-E-007 for Laboratory Standards Documentation.

25.4 Upon entry of prep data, obtain a printout of the logbook. The analyst listed on the logbook should sign and date the page near their printed initials. The logbook page is kept with the samples with which it is associated.

25.5 The entry of correct prep data is peer reviewed (correct dates, times, weights, volumes, SOP/revision, spikes, spike amounts, and reagent information, etc.) Once data are reviewed, the batch is statused to DONE in AlphaLIMS, the logbook is signed and dated by the reviewer, and the batch is ready for analysis. A copy of the prep logbook sheet is kept in the metals prep lab and is bound and given a control number when sufficient numbers of sheets are collected.

## 26.0 RECORDS MANAGEMENT

Records generated as a result of this procedure are maintained as quality documents in accordance with GL-QS-E-008 for Quality Records Management and Disposition.

## 27.0 LABORATORY WASTE

For the proper disposal of sample and reagent wastes from this procedure, refer to the Laboratory Waste Management Plan, GL-LB-G-001.

## 28.0 REFERENCES

28.1 Test Method for Evaluating Solid Waste; Laboratory Manual Physical/ Chemical Methods, Method 3050B, "Acid Digestion of Sediments, Sludges, and Soils," Revision 2, December 1996.

28.2 1992 Annual Book of ASTM Standards, Standard D1193-91, "Standard Specification for Reagent Water."

28.3 16 CFR Part 1303

## 29.0 HISTORY

Revision 21: Updated performance characteristics section; MDLs are performed annually and MDLVs are performed quarterly.

# APPENDIX 1: SAMPLE PREP LOGBOOK

(For illustrative purposes only)

**Prep LogBook**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Analyst: | AJM | | | Type | Sample Id | Lot Id | Spike Amount | Spike Units |
| Batch: | 10607 | | | LCS | 1000023482 | 5385 | .25 | mL |
| Prep Date: | 07-FEB-2000 14:00 | | | LCS | 1000023482 | 5386 | .25 | mL |
| Lab SOP: | GL-MA-E-013 | | | MS | 1000023455 | 5385 | .25 | mL |
| | | | | MS | 1000023455 | 5386 | .25 | mL |
| | | | | MSD | 1000023454 | 5385 | .25 | mL |
| | | | | MSD | 1000023454 | 5386 | .25 | mL |

| Type | Sample Id | Parent Sample | Method | Initial Wt. | Final Volume | Prep Factor | Comments | Matrix |
|---|---|---|---|---|---|---|---|---|
| MB | 1000023451 | | 200.2/200.7 Full List For QC | 50mL | 50mL | 1 | | Water |
| SAMPLE | 21426001 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| LCS | 1000023482 | | 200.2/200.7 Full List For QC | 50mL | 50mL | 1 | | Water |
| SAMPLE | 21426002 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| SAMPLE | 21426003 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| SAMPLE | 21426004 | | 200.2/200.7 Selenium | 50mL | 50mL | 1 | | Waste Water |
| SDLT | 1000023453 | 21426004 | 200.2/200.7 Full List For QC | 50mL | 50mL | 1 | | Water |
| MSD | 1000023454 | 21426004 | 200.2/200.7 Full List For QC | 50mL | 50mL | 1 | | Water |
| MS | 1000023455 | 21426004 | 200.2/200.7 Full List For QC | 50mL | 50mL | 1 | | Water |

General Engineering Laboratories Page#_____

**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

# FOR

# MERCURY ANALYSIS USING THE PERKIN ELMER

# AUTOMATED MERCURY ANALYZER

## (GL-MA-E-010 REVISION 25)

APPLICABLE TO METHODS:

EPA SW-846 Methods: 7470A, 7471A, and 7471B
EPA Methods: 245.1, 245.2 and 245.5
EPA Methods 245.1 CLP-M, 245.2 CLP-M and 245.5 CLP-M
Standard Method 3112B, 18th through 21st Editions

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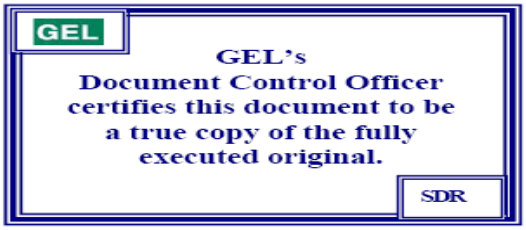

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## 1.0 STANDARD OPERATING PROCEDURE FOR MERCURY ANALYSIS USING THE PERKIN ELMER AUTOMATED MERCURY ANALYZER

## 2.0 METHOD OBJECTIVE AND SUMMARY

This standard operating procedure (SOP) describes the digestion and analysis procedures for the determination of mercury (Hg) in surface and saline waters, wastewaters, industrial effluents, sanitary sewage, soils, sediments, bottom deposits, sludges, oils, and TCLP extracts. This is a cold-vapor atomic absorption technique based on the absorption of radiation at 253.7 nm by mercury vapor. Samples are treated with nitric acid and sulfuric acid or hydrochloric acid in the presence of potassium permanganate and potassium persulfate to oxidize all mercury to the mercuric ($Hg^{++}$) form. The mercury is then reduced to its elemental state and evacuated from the sample. The mercury vapor passes through an optical cell positioned in the light source of an atomic absorption spectrophotometer. Absorbance is measured as a function of mercury concentration. This SOP is applicable for the following methods:

2.1 EPA SW-846 Methods 7470A, 7471A, and 7471B

2.2 EPA Methods 245.1, 245.2 and 245.5

2.3 EPA Methods 245.1 CLP-M, 245.2 CLP-M and 245.5 CLP-M

2.4 Standard Method 3112B, 18$^{th}$ through 21$^{st}$ Editions

## 3.0 METHOD APPLICABILITY

3.1 Calibration Range: The typical calibration range used for analysis of mercury is 0.2 µg/L to 10.0 µg/L. Other calibration ranges (e.g., 0.1 µg/L to 5.0 µg/L) may be used per client/contract request.

3.2 Tested Concentration Range: The range for the method is limited by calibration and can be extended by diluting the sample.

3.3 Method Detection Limit (MDL): The MDL is calculated using the procedure described in GL-LB-E-001 for The Determination of Method Detection Limits. The MDL is verified quarterly, or whenever there is a significant change in the instrument response.

3.4 Instrument Detection Limits (IDLs): IDLs are determined by calculating the average of the standard deviations of three analytical runs performed on three non-consecutive days from the analysis of a reagent blank solution with seven consecutive measurements per day. IDLs are performed quarterly.

3.5 Method Precision: Analytical precision can be determined by calculating the Relative Percent Difference (RPD) between a Laboratory Control Sample (LCS) and a Laboratory Control Sample Duplicate (LCSD) or a Matrix Spike (MS) and a Matrix Spike Duplicate (MSD).

3.6 Method Bias (Accuracy): Accuracy can be determined by calculating recoveries of a LCS and LCSD or an MS and MSD of a similar matrix.

## 4.0 DEFINITIONS

4.1 AlphaLIMS: The Laboratory Information Management System used at GEL.

4.2 Continuing Calibration Blank (CCB): An aliquot of reagent water or other blank matrix that is analyzed after each CCV. The CCB is used to determine whether the analytical sequence is in control during sample analysis.

4.3 Continuing Calibration Verification (CCV): A solution of the method analytes used to evaluate the performance of the instrument with respect to a defined set of criteria. The CCV concentration is varied throughout the calibration range.

4.4 Initial Calibration Blank (ICB): An aliquot of reagent water or other blank matrix that is analyzed after each ICV. The ICB is used to determine whether there is carryover contamination after injection of the mid-level ICV.

4.5 Initial Calibration Verification (ICV): A solution of method analytes of known concentrations that is used to fortify an aliquot of Blank or sample matrix. The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

4.6 Laboratory Control Sample (LCS): A certified reference material that has been taken through the digestion process. The LCS is used to determine digestion accuracy and to determine if the digestion is in control.

4.7 Laboratory Control Sample Duplicate (LCSD): A duplicate of the LCS. The LCSD is used to determine reproducibility and to indicate precision.

4.8 Method Blank (MB): Type I water that has been taken through the digestion process. The method blank is used to determine the amount of background contamination resulting from the digestion process.

4.9 Method Detection Limit (MDL): The minimum concentration of an analyte that can be measured and reported with 99% confidence that the concentration is greater than zero. The MDL is determined from analysis of a sample in a given matrix type containing the analyte.

4.10 Matrix Spike (MS): A sample that has added to it a known amount of solution containing known concentrations of analytes. The MS is used to determine the presence or absence of interferences and matrix effects in the digested sample.

4.11 Matrix Spike Duplicate (MSD): A duplicate of the MS. The MSD indicates reproducibility.

4.12 National Institute of Standards and Technology (NIST): For the purpose of this method, the national scientific body responsible for the standardization and acceptability of analyte solutions.

4.13 Sample Duplicate (DUP): A duplicate of a sample. The DUP indicates reproducibility.

4.14 Tumble Blank (TB): TCLP extraction fluid Type 1 or 2 that has been taken through the TCLP tumbling process. The tumble blank is used to determine the amount of background contamination resulting from the tumbling process.

4.15 Contract Required Detection Limit (CRDL): The lowest level in the calibration curve.

4.16 Serial Dilution (SDILT): A 1 to 5 sample dilution used to assess matrix suppression.

## 5.0 METHOD VARIATIONS

This SOP varies from the referenced methods by utilizing a smaller sample aliquot. Reagent amounts are adjusted accordingly.

## 6.0 SAFETY PRECAUTIONS AND WARNINGS

**WARNING**

HYDROXYLAMINE HYDROCHLORIDE MAY EXPLODE WHEN HEATED TO 140º C.

MERCURY COMPOUNDS ARE TOXIC IF INHALED OR ABSORBED THROUGH THE SKIN.

ADDITION OF HYDROCHLORIC ACID AND NITRIC ACID IN THE PROPORTIONS 3 TO 1 FORMS AQUA REGIA.

ADDITION OF HYDROXYLAMINE HYDROCHLORIDE /SODIUM CHLORIDE TO AQUA REGIA CAN CAUSE THE SPONTANEOUS RELEASE OF CHLORINE GAS. PERFORM DIGESTIONS USING AQUA REGIA UNDER A HOOD.

NITRIC ACID AND SULFURIC ACID ARE HIGHLY CORROSIVE.

CONTACT WITH OXIDIZERS MAY GENERATE EXPLOSIVE MIXTURES.

NITRIC ACID IS CORROSIVE AND A POISON.

MERCURY VAPORS ARE TOXIC. DIGEST SAMPLES AND STANDARDS UNDER A FUME HOOD.

WHEN DIGESTING SOIL, OIL, AND SEDIMENT, BE CAREFUL TO AVOID INHALING TOXIC NITRATES.

**WARNING**

PREVENT SKIN AND EYE CONTACT BY USING SPECIFIED PERSONAL PROTECTIVE EQUIPMENT WHEN MAKING STOCK REAGENTS.

WORK UNDER A HOOD TO PREVENT INHALATION WHEN MAKING STOCK REAGENTS.

6.1 Wear eye protection with side shields while performing procedures in the lab.

6.2 Treat all chemicals as potential health hazards, and limit exposure to these chemicals to the lowest level possible. GEL maintains a current awareness file of OSHA regulations regarding the safe handling of the chemicals in the laboratory as well as a reference file of Material Safety Data Sheets (MSDS). These documents and individual sample MSDS forms are maintained in the laboratory.

6.3 Personal protective equipment

6.3.1 Gloves are required when handling the chemicals in this procedure.

6.3.2 Work under a hood when using concentrated acids and bases.

6.4 Prior to handling radioactive samples analysts must have had radiation safety training and understand their full responsibilities in radioactive sample handling. Some general guidelines follow:

6.4.1 Protect counter tops with counter paper or work from radioactive sample handling trays.

6.4.2 Prohibit admittance to immediate work area.

6.4.3 Post signs indicating radioactive samples are in the area.

6.4.4 Take swipes of the counter tops upon completion of work. Deliver those swipes to the appropriate swipe count box.

6.4.5 Segregate radioactive wastes. Radioactive waste containers are obtained from Waste Management.

6.5 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

6.6 Never leave gas cylinders unchained or untied, including when they are on the moving carts.

6.7 In the event of an accident or medical emergency, call for help immediately. When time and safety permit, an accident report form should be completed and turned in to the safety committee.

6.8 Fire escape routes are posted in the lab and all personnel should be familiar with them. In addition, fire safety equipment such as fire extinguishers is located in the lab. Training is available on the proper operation of this equipment.

## 7.0 INTERFERENCES TO THE METHOD

7.1 Potassium permanganate is added to eliminate possible interference from sulfide. Concentrations as high as 20 mg/L of sulfide as sodium sulfide do not interfere with the recovery of added inorganic mercury from reagent water.

7.2 Copper has also been reported to interfere; however, copper concentrations as high as 10 mg/L had no effect on recovery of mercury from spiked samples.

7.3 Seawaters, brines, and industrial effluents high in chlorides may require additional permanganate (as much as 25 mL) because, during the oxidation step, chlorides are converted to free chlorine, which also absorbs at 253.7 nm.

7.4 Certain volatile organic materials that absorb at 253.7 nm may also cause interference.

## 8.0 APPARATUS AND MATERIALS

8.1 50 mL digestion tubes

8.2 Flask, Volumetric, (100 mL and 250 mL)

8.3 Variable and single volume pipette and micropipettes

8.4 Hot Block (Temperature controlled at 95° ± 3° C)

8.5 Non-mercury thermometers

8.6 Culture tubes

## 9.0 REAGENTS

9.1 Type I water - Water that conforms to the following performance specifications:

| | |
|---|---|
| Electrical resistivity, min., | 16.67 |
| Total organic carbon, max, µg/L | 100 |
| Sodium, max., µg/L | 1 |
| Chlorides, max., µg/L | 1 |
| Total silica, max., µg/L | 3 |

9.2 Type I water is dispensed within the metals prep lab by the "MilliQ" water system.

9.3 Nitric Acid ($HNO_3$), Concentrated, ACS grade certified for AA use.

9.4 Sulfuric Acid ($H_2SO_4$), Concentrated, ACS grade certified for AA use.

9.5 Hydrochloric Acid (HCl), Concentrated, ACS grade certified for AA use.

9.6 3% HCl: Dissolve 30 mL concentrated HCl in Type I water and dilute to 1000 mL. Volume may be scaled proportionately.

9.7 Potassium Permanganate Solution ($KMnO_4$), 5%: Dissolve 5 g potassium permanganate in Type I water and dilute to 100 mL. Volume and weight may be scaled up proportionally.

9.8 Potassium Persulfate Solution ($K_2S_2O_8$), 5%: Dissolve 5 g potassium persulfate in Type I water and dilute to 100 mL. Volume and weight may be scaled up proportionally.

9.9 Sodium Chloride-Hydroxylamine Hydrochloride Solution ($NaCl\text{-}NH_2OH\bullet HCl$): Dissolve 12 g of sodium chloride and 12 g of hydroxylamine hydrochloride in Type I water and dilute to 100 mL. (Hydroxylamine sulfate may be used in place of hydroxylamine hydrochloride.) Volume and weight may be scaled up proportionally.

9.10 Stannous Chloride Solution ($SnCl_2$), 1.1%: Dissolve 11 g stannous chloride in 3% hydrochloric acid and dilute to1 L. Volume and weight may be scaled proportionately.

9.11 Aqua Regia: Combine 3 parts of concentrated HCl and 1 part concentrated $HNO_3$. Prepare fresh before use.

**NOTE:** Due to the inherent dangers of working with full strength aqua regia, a 1+1 solution is prepared for use with the sample preparation.

9.12 Mercury Source Standard (Hg), 1000 ppm, from an Approved Vendor. Standards are received, labeled, prepared and stored according to GL-LB-E-007 for Laboratory Standards Documentation.

9.13 Liquid Nitrogen or Compressed Nitrogen at pressures 75 to 100 psi.

## 10.0 INSTRUMENTATION

10.1 Perkin Elmer FIMS400 and FIMS100 Automated Mercury Analyzers

10.2 Balance

## 11.0 SAMPLE HANDLING AND PRESERVATION REQUIREMENTS

11.1 Aqueous samples must be acidified to a pH < 2 with nitric acid. The samples are tested using pH strips to verify the correct pH values of < 2 before preparation. If samples do not have the correct pH, samples are acidified to a pH of < 2 with nitric acid. The acidified aliquots are held at least 16 hours before preparation. The suggested maximum holding time for these samples is 28 days. When performing CLP analyses, the holding time is 26 days from verified time of sample receipt.

11.2 Non-aqueous samples shall be refrigerated and analyzed as soon as possible. The preservation required for soil/sediment samples is maintenance at 0° ≤ 6°C until analysis. Water samples that require lab filtration are filtered from non-preserved

fractions and acidified to a pH < 2 with nitric acid. A method blank is filtered with the samples for contamination QC purposes. The acidified aliquots are held at least 16 hours before preparation.

11.3 TCLP extracts have a maximum holding time of 28 days before extraction and 28 days after extraction for a total of 56 days.

## 12.0 SAMPLE PREPARATION TECHNIQUES

12.1 Prior to determining the concentration of mercury, all samples, calibration standards, check standards, laboratory control samples, and blanks must be digested using the following procedures:

12.1.1 For standards preparation, see the mercury recipe section of the AlphaLIMS Standards Logbook.

12.1.2 Label each digestion tube with a sample number or lab Quality Control (QC) number. Establish a one to one relationship between client samples, QC samples, and digestion tubes.

12.2 Aqueous Sample Preparation by Methods EPA SW-846 7470A, EPA 245.1,EPA 245.2 and Standard Method 3112B

12.2.1 Transfer 20 mL of Type I water, 20 mL of a well mixed representative sample, or an aliquot of sample diluted to 20 mL with Type I water, to a labeled digestion tube. Record the volume of sample dispensed into the digestion tube in the Mercury Prep logbook.

12.2.2 For TCLP and MISC-L matrices, transfer 18 mL of Type I water, 2 mL of a well-mixed representative sample, or an aliquot of sample diluted to 20 mL final volume, to a labeled digestion tube. Record the volume of sample dispensed into the digestion tube in the Mercury Prep logbook.

12.2.3 The following calibration standards are required: 0.2, 0.5, 2.0, 5.0, 10.0 µg/L, ICV/CCV, ICB/CCB, and CRDL (Contract Required Detection Limit). Other calibration standards may be prepared per client request.

12.2.4 Add 0.5 mL concentrated nitric acid. Add the appropriate amount of spiking solution to each appropriate QC sample tube. Then add 1.0 mL concentrated sulfuric acid to each digestion tube and mix.

12.2.5 Add 3 mL of 5% potassium permanganate solution to each digestion tube and mix. Let sample stand for 15 minutes after addition of potassium permanganate. If sample does not maintain its brown/purple color, add an additional 3 mL aliquot of the 5% potassium permanganate to the sample and all associated QC. Record this additional aliquot on the comment section of the Mercury Prep logbook. If after the second aliquot is added, the sample is still not able to maintain its purple/brown color throughout the digestion process, then redigest the sample using an appropriate dilution.

12.2.6 Add 1.5 mL of 5% potassium persulfate solution to each digestion tube and mix. Cap each digestion tube and place in a hot block for two hours at 95° ± 3°C.

12.2.7 After two hours, remove digestion tubes from the hot block and allow to cool. Cooling can be facilitated by moving samples to the walk-in cooler for no greater than 90 minutes. When the samples have been cooled to room temperature, add 1 mL of sodium chloride-hydroxylamine hydrochloride solution to each digestion tube to reduce any excess potassium permanganate. Cap tubes and shake until the samples are fully reduced. The samples are now ready for analysis.

12.3 Sediment, Oil and Soil Sample preparation by Methods EPA SW-846 7471A, 7471B, and EPA 245.5

12.3.1 For method 7471A, weigh triplicate 0.2 g aliquots of a representative sample and place the aliquot into a digestion tube. For method 7471B, weigh 0.5 to 0.6 g of a representative sample and place the aliquot into a digestion tube. Record the weight in the Mercury Prep logbook. LCS water is used for oil or any other samples that are not a soil or in soil form. Refer to GL-LB-E-029 for specifics on subsampling.

12.3.2 The following calibration standards are required: 0.2, 0.5, 2.0, 5.0, 10.0 µg/L, ICV/CCV, ICB/CCB, and CRDL. Other calibration standards may be prepared per client specification.

12.3.3 Add 5 mL of Type I water to each tube. Add 3 mL of 1+1 aqua regia to each sample and associated QC and mix. Add the appropriate amount of spiking solution to each appropriate QC sample tube.

12.3.4 Place each digestion tube in a hot block at 95° ± 3° C for two minutes.

12.3.5 Remove digestion tubes from the hot block. Cool for at least 15 minutes. Then add 25 mL of DI water and 7.5 mL of 5% potassium permanganate solution and mix thoroughly.

12.3.6 Cap each digestion tube and again place each digestion tube in a hot block 95° ± 3° C for 30 minutes.

12.3.7 Remove tubes from the hot block and allow to cool to room temperature for at least 60 minutes.

**CAUTION:** This next step can cause chlorine gas to be generated. Perform the following step under a hood.

12.3.8 Uncap the digestion tubes under a hood. Add 2 mL of sodium chloride-hydroxylamine hydrochloride solution to each tube. Cap and shake until samples are fully reduced. Uncap and allow time for chlorine gas to evolve and vent from the digestates. The samples and standards are now ready for analysis.

12.4 Aqueous Sample Preparation by method 245.1 CLP-M and 245.2 CLP-M

**NOTE:** If client permits, the reduced volume sample preparation described in section 12.1.3 will be employed in order to reduce laboratory waste.

12.4.1 Transfer 20 mL of Type I water, 20 mL of a well-mixed representative sample, or an aliquot of sample (containing not more than 1.0 µg of

mercury) diluted to 20 mL with Type I water, to a labeled digestion tube. Record the volume of sample dispensed into the digestion tube in the Mercury Prep logbook.

12.4.2 For TCLP and MISC-L matrices, transfer 18 mL of Type I water, 2 mL of a well-mixed representative sample, or an aliquot of sample diluted to 20 mL final volume, to a labeled digestion tube. Record the volume of sample dispensed into the digestion tube in the Mercury Prep logbook.

12.4.3 The following calibration standards are required: 0.2, 0.5, 2.0, 5.0, 10.0 µg/L, ICV/CCV, ICB/CCB, and CRDL. Other calibration standards may be prepared per client specification.

12.4.4 Add 0.5 mL concentrated nitric acid. Add the appropriate amount of spiking solution to each appropriate QC sample tube. Then add 1.0 mL concentrated sulfuric acid to each digestion tube and mix.

12.4.5 Add 3 mL of 5% potassium permanganate solution to each digestion tube and mix. Let sample stand for 15 minutes after addition of potassium permanganate. If sample does not maintain its brown/purple color, add an additional 3 mL aliquot of the 5% potassium permanganate to the sample and all associated QC. Record this additional aliquot on the comment section of the Mercury Prep logbook. If after the second aliquot is added, the sample is still not able to maintain its purple/brown color throughout the digestion process, then redigest the sample using an appropriate dilution.

12.4.6 Add 1.5 mL of 5% potassium persulfate solution to each digestion tube and mix. Cap each digestion tube and place in a hot block for two hours at 95° ± 3° C.

12.4.7 After two hours, remove digestion tubes from the hot block and allow to cool. Cooling can be facilitated by moving samples to the walk-in cooler for no greater than 90 minutes. When the samples have been cooled to room temperature, add 1 mL of sodium chloride-hydroxylamine hydrochloride solution to each digestion tube to reduce any excess potassium permanganate. Cap tubes and shake until samples are fully reduced. The samples are now ready for analysis.

12.5 Soil/Sediment Sample Prep by method EPA 245.5 CLP-M

12.5.1 Weigh triplicate 0.2 g portions of a representative samples (for a total of approximately 0.6 g) and place all three aliquots into a digestion tube. Record each weight on the Mercury Prep logbook.

12.5.2 The following calibration standards are required: 0.2, 0.5, 2.0, 5.0, 10.0 µg/L, ICV/CCV, ICB/CCB, and CRDL. Other calibration standards may be prepared per client specification.

12.5.3 Add 5 mL of Type I Water to each tube. Add 3 mL of 1+1 Aqua regia to each sample and associated QC and mix. Add the appropriate amount of spiking solution to each appropriate QC sample tube.

12.5.4 Place each digestion tube in a hot block at 95 ± 3° C for two minutes.

12.5.5 Remove digestion tubes from the hot block. Cool for at least 15 minutes. Then add 25 mL of DI water and 7.5 mL of 5% potassium permanganate solution and mix thoroughly.

12.5.6 Cap each digestion tube and again place each digestion tube in a hot block at 95 ± 3° C for 30 minutes.

12.5.7 Remove tubes from the hot block and cool to room temperature for at least 60 minutes.

**CAUTION:** This next step can cause chlorine gas to be generated. Perform the following step under a hood.

12.5.8 Uncap the digestion tubes under a hood. Add 2 mL of sodium chloride-hydroxylamine hydrochloride solution to each tube. Cap and shake each tube until samples are fully reduced. Uncap and allow time for chlorine gas to evolve and vent from the digestates. The samples and standards are now ready for analysis.

## 13.0 PREPARATION OF STANDARD SOLUTIONS AND QUALITY CONTROL SAMPLES

13.1 Source standard solutions

Source standard solutions are purchased from a certified vendor. These standards are traceable to National Institute of Standards and Technology (NIST) standards. The source standards are received from Purchasing.

13.2 Intermediate and working standards must be PREPARED FRESH DAILY.

13.3 For guidance on standard documentation, refer to GL-LB-E-007 for Laboratory Standards Documentation.

13.4 For Kerr-McGee Samples, reprep and reanalyze the samples if MB or CCB is greater than the reporting limit (RL) and samples are between IDL and RL. If samples are less than IDL or greater than 10 times the RL they can be reported.

## 14.0 INSTRUMENT CALIBRATION AND PERFORMANCE

14.1 Instrument calibration is performed using the following prepared mercury standards: 0.0, 0.2, 0.5, 2.0, 5.0 and 10.0 µg/L.

14.2 An example of a data calculation based on fictitious information follows. Other concentrations may be employed for the calibration curve and ICV.

| CONCENTRATION | %RSD | INSTRUMENT RESPONSE |
|---|---|---|
| 0.0 µg/L | 8.2760 | 0.0007 |
| 0.2 µg/L | 0.7089 | 0.0023 |
| 0.5 µg/L | 1.3778 | 0.0059 |
| 2.0 µg/L | 1.6793 | 0.0243 |
| 5.0 µg/L | 0.5449 | 0.0600 |
| 10.0 µg/L | 1.6070 | 0.1160 |

14.3 Performing a linear regression on these data, using the instrument response as the independent variable and the concentration as the dependent variable results in a slope = 86.103, intercept = -0.0521, and a correlation "r" = 0.9998. Thus the concentration of a sample will be calculated by solving the equation:

Concentration (µg/L) = 86.103 (instrument response) – 0.05214

| TRUE VALUE | SAMPLE NAME | INSTRUMENT RESPONSE | CALCULATED LINEAR (µg /L) |
|---|---|---|---|
| 0.5 µg | ICV | 0.00580 | 0.4447 |
| 0.0 µg | ICB | 0.0002 | 0.02 |
| 0.2 µg | 0.2 CRDL | 0.0026 | 0.17 |

14.4 Report data to the appropriate number of significant figures.

14.5 Data are reported in µg/L, mg/L, µg/kg or mg/kg Hg depending on client preference. Sample units are defined before data are input into AlphaLIMS by the analyst.

14.6 Any sample concentration less than 100% of the highest recorded calibration standard is acceptable. If sample concentrations are over 100% of the high standard, then these samples must be re-analyzed at a dilution that will bring the sample concentration within the range. Dilutions are made with digested blanks.

14.7 A CRDL standard for CVAA is required to be run following calibration. The result of CRDL should be within 50%-150% of the accepted value. This is used for guidance only. For DOD QSM, the CRDL should fall within 80%-120% of the accepted value or per client request. When performing CLP analyses, the acceptance criteria for the CDRL standard have not yet been established by EPA.

14.8 The acceptable performance requirements for the mercury instrument are a verification of stability by showing that there is no drift, correlation coefficient of 0.995 or better, and ICV and CCV within the acceptance range prescribed in Section 16.2.

14.9 Proof of instrument performance during actual sample analysis is provided by records of the calibration curve, ICV, CCV, and CCB.

## 15.0 ANALYSIS AND INSTRUMENT OPERATION

15.1 Before actual operation, all samples, including standards and QC samples, are prepared and digested as described in Section 10. Instrument operation includes a calibration phase and a sample analysis phase. The two phases are usually run as one continuous procedure, but the instrument may be calibrated prior to loading and running samples. Also note that the analyst needs to monitor the process to ensure that the calibration is satisfactory prior to analyzing samples. If the calibration process is unsatisfactory it will need to be terminated, problems corrected, and the calibration rerun.

15.2 Turn on computer.

15.3 Input computer passwords.

15.4 Turn on Hg FIMS instrument and note that the autosampler initializes. Let it warm up for at least 30 minutes.

15.5 Prepare daily 1.1% stannous chloride reducing solution in 3% hydrochloric acid in amber bottle. Shake well and put in the appropriately labeled reductant reservoir bottle that feeds the instrument.

15.6 Fill other instrument reservoir bottle with 3% hydrochloric acid for instrument rinse and carrier acid.

15.7 Double-click AA WinLab Analysis icon.

15.8 For $Hg_2$ Click on the middle button [automated analysis] or for $Hg_3$ Click on Workspace "Jason".

15.9 Click [Sample Info] button.

15.10 The standards will be in positions 1 through 11, and they are already entered into the system, but don't show up here (1-BC, 2-0.2 ppb, 3-0.5 ppb, 4-2.0 ppb, 5-5.0 ppb, 6-10 ppb, 7-CCV, 8-CCB, 9-ICV, 10-ICB, 11-CRDL). Go to Autosampler location 12 to type in information from batch sheet.

15.11 At location 12, enter sample IDs from Batch Sheet following the naming convention outlined in the instrument user manual.

15.12 File: save as sample file info (name it with the "mmddyy," followed by W# for waters or S# for soils). (The # indicates the FIMS model used.)

15.13 For $Hg_{2:}$ Click [Auto] button or For $Hg_{3:}$

Make sure "Pumps off at end of analysis" and "Print log during analysis" are turned on Automated analysis control panel.

15.14 Double click on #1 cell, select the soil or water method as appropriate from the list [OK]. They are Water1 or Soil1 depending on matrices.

15.15 For $Hg_2$ Sample info file: browse, select your "mmddyy" [OK] or for $Hg_3$ perform the following:

15.15.1 In sample information editor, right click in the shaded box.

15.15.2 Go to parameter list

15.15.3 Highlight and remove "Analyze QC's Before"

15.15.4 Click "OK"

15.15.5 Save sample info file

15.16 Result data set name: browse, enter "mmddyy" [OK].

15.17 Double click on the line under "method" and click on the box under "use entire sample info file." An "x" will appear in the box.

15.18 Check the [Cont] icon button by clicking on the icon. Remove the FIMS cell, and then click on Autozero. Re-install the FIMS cell.

15.19 Load standards. Put standards in the autosampler rack.

15.20 Load samples beginning in position #12. Note that samples go in the 15 mL digestion tubes. A CCV and CCB must separate each group of 10 samples. All samples must be bracketed by a satisfactory CCV and CCB.

15.21 Install dry membrane filter, rough side up (in final assembly position). Screw cap on tightly.

15.22 Hook up and clamp pump tubing. Check all pump tubing daily.

15.23 Click [FIAS] button icon.

15.24 For $Hg_2$, to flush things out: Click [pump 1] (adjust to 100 rpm) and [pump 2] (adjust to 120 rpm for FIMS 400 only) icons or for $Hg_3$ perform the following:

15.24.1 Clamp, in a downward position, rinse pump to fill rinse line.

15.24.2 Pump turns on when analysis begins. However, raise and lower probe to begin pump for rinsing prior to analysis.

15.25 Adjust gas flow to 40 to 70 $cm^3$/min.

15.26 Verify flow rates of reductant (5 to 7 mL/min, red/red tubing) and carrier (9 to 11 mL/min, blue/yellow tubing) with DI water using graduated cylinders.

15.27 Cycle [valve fill/inject] to further flush things out. Give it a minute or so in each position. Unclick all three buttons and close the window.

15.28 In the "Automated Analysis" window click on "Analyze Tab" then click on [Analyze All].

## 16.0 EQUIPMENT AND INSTRUMENTATION MAINTENANCE

16.1 If there are problems: During the analysis the foreground window is usually the "Results" text window that is also automatically printed, and the background window is the "Automated Analysis" window. If you need to abort a run, you must wait for the hourglass mouse cursor to change to an arrow, then click on the "Automated Analysis" window to bring it to the foreground. Then unclick the [Analyze All] button. A dialog box will come up giving you a couple of options.

16.2 For non-routine maintenance procedures, refer to Perkin Elmer manual for troubleshooting.

16.3 Whenever instrument is serviced or adjusted, an entry needs to be made in the maintenance log. The entry includes the analyst's initials, date, nature of the problem, and actions taken to correct it.

## 17.0 DATA RECORDING, CALCULATIONS AND DATA REDUCTION

17.1 The concentration of mercury can be determined by comparing the response obtained from analyzing the sample digestate to the calibration curve. The sample concentration of mercury is matrix specific and is calculated as follows:

Aqueous Sample

17.1.1 Concentration (µg/L) = $\frac{(C)(D)(V_t)}{V_i}$

Where:

C = Concentration (µg/L) digestate

D = Dilution Factor

$V_t$ = Total Volume of sample digestate

$V_i$ = Initial Volume of sample in L

17.1.2 Non-aqueous Samples

$$\text{Concentration } (\mu g/kg) = \frac{(C)(D)(V_t)}{W(\%S)}$$

Where:

C = Concentration (µg/mL) digestate

D = Dilution Factor

$V_t$ = Total Volume of the sample digestate

W = Weight of the sample digested

%S = Percent Solids

## 18.0 QUALITY CONTROL REQUIREMENTS

18.1 Frequency of Quality Control Activities

18.1.1 ICV is performed immediately following each calibration and CCV is performed after every 10 analysis.

18.1.2 ICB is performed immediately following the ICV and CCB must follow each CCV.

18.1.3 A method blank is analyzed for each batch of 20 or less samples.

18.1.4 A matrix spike and matrix spike duplicate or matrix spike and a sample duplicate are analyzed for every 20 or less samples in a batch, or per client requirements. When performing CLP analyses, the requirement for matrix spike analysis is one per every sample delivery group (SDG) of 20 samples or less.

18.1.5 A LCS is analyzed with each batch of 20 or less samples. Additionally, a LCS duplicate also may be analyzed due to client specific requirements.

18.1.6 A SDILT is required with each batch of 20 or less samples, preferably the QC designated sample.

18.1.7 Linear Calibration Range (LCR) checks are performed on a 6 month basis. The high standard of the curve is read back against the calibration and must recover ± 10%. If this procedure fails, the problem must be investigated and rectified.

18.2 Acceptance Limits

18.2.1 Acceptance limits for the following methods are outlined below:

| Method/ Acceptance Criteria | SW-846 7471A<br>SW-846 7471B | SW-846 7470A<br>SM 3112B | EPA 245.1<br>EPA 245.5<br>EPA 245.2 | 245.1 CLP-M<br>245.5 CLP-M<br>245.2 CLP-M | DOD QSM |
|---|---|---|---|---|---|
| ICV | 90% - 110% | 90% - 110% | 95% - 105% | 90% - 110% | 90-110% |
| ICB | -0.2 µg/L to 0.2 µg/L | -0.2 µg/L to 0.2 µg/L | -0.2 µg/L to 0.2 µg/L | -0.2 µg/L to 0.2 µg/L | <LOD |
| CRDL | 70% - 130% advisory limits | 70% - 130% advisory limits | 70% - 130% advisory limits | 70% - 130% advisory limits | 80% - 120% to investigate and |

| | | | | | |
|---|---|---|---|---|---|
| | only | only | only | only | recalibrate |
| CCV | 80% - 120% | 80% - 120% | 90% - 110% | 80% - 120% | 80% - 120% |
| CCB | -0.2 µg/L to 0.2 µg/L | -0.2 µg/L to 0.2 µg/L | -0.2 µg/L to 0.2 µg/L | -0.2 µg/L to 0.2 µg/L | <LOD |
| Method Blank | -0.2 µg/L to 0.2 µg/L | -0.2 µg/L to 0.2 µg/L | -0.2 µg/L to 0.2 µg/L | -0.2 µg/L to 0.2 µg/L | ± ½ x RL |
| LCS | 80% - 120% (for non-SRM sources) certified SPC limits for SRM | 80% - 120% | 85% - 115% | 80% - 120% Certified SPC limits from ERA | 80% - 120% |
| Matrix Spikes | 80% - 120% | 75% - 125% | 75% - 125% | 75% - 125% | 80% - 120% |
| Sample Duplicates | 0 - 20%, when > 5 x RL, ± RL when < 5 x RL | 0 - 20%, when > 5 x RL, ± RL when < 5 x RL | 0 - 20%, when > 5 x RL, ± RL when < 5 x RL | 0 - 20%, when > 5 x RL, ± RL < 5 x RL | 0 - 20%, when > 5 x RL, ± RL < 5 x RL |
| Serial Dilution | <10% if > 25x IDL | <10% if > 25x IDL | < 10% if > 25x IDL | < 10% if > 25x IDL | < 10% if > 50x LOQ |
| Matrix Spike Dup | 0 - 20%, when > 5 x RL, ± RL when < 5 x RL | 0 - 20%, when > 5 x RL, ± RL when < 5 x RL | 0 - 20%, when > 5 x RL, ± RL when < 5 x RL | 0 - 20%, when > 5 x RL, ± RL < 5 x RL | 0 - 20%, when > 5 x RL, ± RL < 5 x RL |
| Post Spikes | 80% - 120% | 80% - 120% | 75% - 125% | 75% - 125% | 80% - 120% |
| Linear Calibration Range | 90% - 110% | 90% - 110% | 90% - 110% | 90% - 110% | 90% - 110% |

18.2.2 All reported sample concentrations must be less than the highest calibration standard. Samples greater than the highest calibration standard must be diluted to bring the concentration within range.

18.2.3 The ICV is prepared from a second standard source other than the source employed for initial calibration. Generally, the concentration of the ICV is 5.0 µg/L.

18.2.4 The method blank must have an absolute value below the CRDL for CLP analyses and have an absolute value below ½ RL for DOD QSM analyses.

18.2.5 All LCS recoveries must fall within the stated acceptance limits. Statistical process control limits are established for LCS soils.

18.2.6 Matrix spikes, matrix spike duplicates and sample duplicates are indicators of method performance for a specific sample matrix. Acceptance limits are based on guidelines outlined in the specific methods and are listed in the table above.

18.2.7 The serial dilution must be < 10% difference for sample concentrations that are > 25x the IDL or the MDL, depending on client specifications.

## 19.0 CORRECTIVE ACTION FOR OUT OF CONTROL OR UNACCEPTABLE DATA

19.1 ICV and/or CCV failure requires recalibration of the instrument and/or preparation of new standard solutions. Samples analyzed between calibration verification that fail must be reanalyzed. An ICV or CCV that has failed may be rerun provided there is an attributable cause known to have affected the check standard only and not the previous samples. Examples of an acceptable cause may be a sample tip out of solution during analysis, no solution in the sample cup or obvious carryover in the CCV from a very high sample immediately prior to the CCV. If the CCV is reanalyzed, the data must be lined through, initialed and dated, and the reason for the rerun must be documented on the raw data. In addition, corrective action should be taken to eliminate the cause of the initial CCV failure to prevent future occurrence.

19.2 ICB or CCB failure requires recalibration of the instrument and/or repreparation of the calibration blank. When analyzing under SW-846, a CCB may be accepted above the RDL level under two conditions: 1) the CCB is acceptable if the sample value is below the RDL and 2) the CCB is acceptable if the level of analyte in the CCB is less that 1/10 the analyte value in the lowest reported sample. For DOD QSM, acceptance criteria must be the absolute value less than the LOD or less than 10 x the lowest value of the samples bracketed by the blank.

19.3 Method blank results higher than the RDL and greater than 10% of any sample value in that batch which has concentrations above the RDL requires that batch be redigested, reanalyzed, and/or reported with the appropriate qualifier. If the method blank results are less than -1x RDL, there may be significant interference, calibration or contamination problems with the sample, or instrument or calibration standards that must be resolved before the batch can be reported. When performing CLP analyses, method blank results that have absolute values higher than the CRDL and greater than 10% of any sample in the batch require that the samples be redigested and reanalyzed.

19.4 LCS results outside of the upper and lower control limits can be reanalyzed for verification. If reanalysis is still outside the limits, the batch representing the failing LCS must be reprepped for reanalysis.

## 20.0 DATA REVIEW, APPROVAL, AND TRANSMITTAL

20.1 The printout from the instrument is attached to the Laboratory Information Management System (AlphaLIMS) data report, original batch sheet, and the Mercury Prep Logbook.

20.2 The metals department analyst reviews mercury data by verifying that the values from the printout agree with values entered into the mercury data run logbook, and with the values that appear on computer printed data report sheets. The calibration standards, the correlation coefficient, CCV, LCS, duplicates, and spikes are also reviewed to make sure values are within the limits.

20.3 Levels of review responsibility are described below:

20.3.1 Analyst Review: Mercury data are reviewed by the analyst after the run is complete and checked once more after data are entered in AlphaLIMS.

20.3.2 Peer Analyst Review: Another analyst familiar with mercury and its data reviews all data in detail.

20.4 Review of each level

20.4.1 Analyst Review: Analyst checks his/her own data and makes necessary corrections on any errors (i.e., writing wrong numbers, checks correlation coefficient again, dilution factors, and continuous calibration standards).

20.4.2 Peer Analyst Review: Reviews all data on the printout, data reported in the Mercury Data Run Logbook, Mercury Prep Logbook, and information that are on the computer printed data report. It is important at this level to check what preparation date was entered, dilution factors, concentrations of spikes, and CCVs. The Case Narrative Report is used to standardize items checked by peer analysts.

20.5 The complete data review process requires the use of the Mercury Prep Logbook, Prep data report, batch sheet, AlphaLIMS data report, raw instrument data, auto-run sequence record if the samples were analyzed using an autosampler, and Case Narrative Report

## 21.0 RECORDS

21.1 Prep data are recorded in accordance with Section 12 of this SOP.

21.2 Data from an analysis are recorded on a printout from the instrument and stored in digital format on the instrument computer or on the network server.

21.3 Reported values come from one sample run if the instrument calibration and other required instrument specifications are met. The data are reported as a raw value along with any dilution factors used.

21.4 Uploading data into AlphaLIMS

21.4.1 To upload data into AlphaLims for $Hg_2$ perform the following:

21.4.1.1 This can be done by double clicking on the icon AA WinLab Reformat.To open Design, double click “jeff.” Click OK.

21.4.1.2 Open data file by clicking Browse on the Reformat Design screen. Select appropriate data file and click OK.

21.4.1.3 Click save results button. When results are saved, exit AA WinLab Reformat.

21.4.1.4 Open Microsoft Excel: Click Create files macro. Enter data file name followed by .prn (ex. 051607w1.prn). Press Enter. Enter the AlphaLIMS initials of the analyst. Press enter. When prompted, press any key to complete.

21.4.1.5 Click the View Edit files macro. This will pull up the data file created in the previous step. Make any changes if necessary and save.

21.4.1.6 Click AlphaLIMS. Upload macro to upload data to AlphaLIMS.

21.4.1.7 Double click Runlogs shortcut icon on the desktop, then double click Archived Runlogs folder. Select the appropriate file. Print.

21.4.1.8 If any changes were made to the data file prior to uploading drag and drop the runlog folder into the Ultra edit program and make the appropriate corrections. Repeat 21.4.7 to retrieve the corrected runlog.

21.4.2 To Upload data into AlphaLims for $Hg_3$ perform the following:

21.4.2.1 Upload by double clicking data manager

21.4.2.2 Highlight the data for the current day

21.4.2.3 Click "Export" button

21.4.2.4 Use existing Design and browse

21.4.2.5 Highlight GEL_Upload.xpt and open

21.4.2.6 Click Finish

21.4.2.7 Open Microsoft Excel and follow SOP for Hg2. Refer to step 21.4.1.4.

## 22.0 RECORDS MANAGEMENT

All data associated with the performance of this procedure, including relevant logbooks, are maintained as quality records in accordance with GL-QS-E-008 for Quality Records Management and Disposition.

## 23.0 LABORATORY AND WASTE HANDLING AND DISPOSAL

23.1 Standard solutions that must be disposed of are transferred by the Waste Management Technician to be disposed of in accordance with the Laboratory Waste Management Plan, GL-LB-G-001.

23.2 Special caution must be taken when samples are radioactive. Handling, delivery, transfer, and disposal of radioactive samples and residues must follow the related SOPs. Persons handling radioactive materials must first pass the training course.

## 24.0 REFERENCES

24.1 Methods for the Determination of Metals in Environmental Samples, Supplement 1, EPA 600/R-94-111. Method 245.1, Revision 3.0, May 1994.

24.2 Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010. Method 245.5, Revision 2.3, April 1991.

24.3 Standard Methods for the Examination of Water and Wastewater, 18th through 21st Editions, Method 3112B.

24.4 USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration, Document Number ILM04.0 and ILM04.1.

24.5 Perkin Elmer FIMS400/FIMS100 Flow Injection Mercury System.

24.6 Test Methods for Evaluating Solid Waste: Laboratory Manual Physical/ Chemical Methods, Volume 1A, EPA SW-846, Final Update III, June 1997. USEPA Office of Solid Waste and Emergency Response, Washington, D.C. 20460.

24.7 Method 7470A, "Mercury in Liquid Waste (Manual Cold-Vapor Technique)," Revision 1, September 1994.

24.8 Method 7471A, “Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique),” Revision 1, September 1994.

24.9 Method 7471B, "Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique)," Revision 2, February 2002.

24.10 Methods for Chemical Analysis of Water and Wastes, 1983, (EPA-600/4-79/020-PB84-128677).

24.11 Method for the Determination of Metals in Environmental Samples, Method 245.2, 1974.

## 25.0 HISTORY

Revision 24: Updated section 12.3.1 to comply with multiple methods (7471A and 7471B).

Revision 25: Changed 95° ± 5° C to 95° ± 3° C to comply with audit finding.

**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

# FOR

# DETERMINATION OF METALS BY ICP

## (GL-MA-E-013 REVISION 20)

APPLICABLE TO METHODS:
EPA Method 200.7
EPA SW-846 Method 6010B
EPA SW-846 Method 6010C
and 200.7 CLP-M

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## 1.0 STANDARD OPERATING PROCEDURE FOR DETERMINATION OF METALS BY ICP

## 2.0 METHOD CODES

2.1 EPA SW-846 Method 6010B

2.2 EPA SW-846 Method 6010C

2.3 EPA Method 200.7

2.4 EPA Method 200.7 CLP-M (modified Contract Laboratory Program)

2.5 Customer contract specifications.

2.6 ASTM D4698-92

## 3.0 METHOD OBJECTIVE AND PURPOSE

This standard operating procedure (SOP) describes the procedure for the determination of metals with the Perkin Elmer (PE) Optima Model 4300.

## 4.0 METHOD APPLICABILITY AND METHOD SUMMARY

4.1 Analytes: Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, $SiO_2$, Sn, Sr, Ti, Tl, U, V, Zn, P, and S.

4.2 Applicable Matrices: These methods are applicable to the determinations of any of the analytes listed above for various matrices including waters, oils, soils, sludges, Toxicity Characteristic Leachate Procedure (TCLP) extracts and other more unusual types of sample which are generally classified as a miscellaneous matrix.

4.3 General Method Summary: After samples are prepared in accordance with the sample preparation SOP, they are analyzed by Inductively Coupled Plasma (ICP) as follows:

4.3.1 The instrument is calibrated with a minimum of two calibration points for each element to be analyzed. The points consist of a calibration blank solution to define the lower calibration point and at least one standard calibration solution at the analyte concentrations to define the higher calibration point(s). A correlation coefficient of 0.995 or better (0.998 or better for SW-846 Method 6010C) is required for each analyte if multiple standards are used or the instrument is recalibrated for the analyte of interest.

4.3.2 Prepared client samples, check standards, and quality control samples identified in section 21.1 are then analyzed. The check standards and quality control samples are used to determine the quality and acceptability of the analytical data.

4.3.3 Continuing Calibration Verification Samples (CCV) are analyzed a minimum of every 10 samples to ensure that the instrument is continuing to perform correctly.

## 5.0 METHOD SCOPE AND PERFORMANCE CHARACTERISTICS

5.1 Calibration Range: The calibration range consists of the concentrations between the calibration blank and that of the highest calibration standard for each analyte.

5.2 Tested Concentration Range: For ICP analyses, the upper limit of the linear range is determined by analyzing a linear range verification check standard, near the

expected linear range limit. The analytically determined concentration of this standard shall be within ± 10% of the true value (± 5% for CLP).

5.3 Method Detection Limit (MDL) studies for each analyte are performed and/or verified at least annually. These studies are conducted and calculated in accordance with SW-846, Chapter 1, Section 5.0, and GL-LB-E-001 for The Determination of Method Detection Limits. The Reported Quantitation Limit (RQL) reflects the current MDL study. If reporting data by CLP protocol, an Instrumental Detection Limit (IDL) study is performed quarterly in accordance with USEPA CLP, Inorganic Statement of Work, ILM04.0.

5.4 Instrument Detection Limits (IDLs) studies for each analyte are performed quarterly for each instrument. IDLs are determined by calculating the average of the standard deviations of three analytical runs performed on three non-consecutive days from the analysis of a reagent blank solution with seven consecutive measurements per day.

5.5 Method Precision: To assure analytical precision of methods used, MS/MSD or sample DUP, or LCS/LCSD are analyzed with each batch or as method requires.

5.6 Method Bias (Accuracy): Determined by calculating recoveries of LCS of a similar matrix.

## 6.0 DEFINITIONS

6.1 AlphaLIMS: The Laboratory Information Management System used at GEL Laboratories, LLC.

6.2 Continuing Calibration Blank (CCB): An aliquot of reagent water or other blank matrix that is analyzed after each CCV. The CCB is used to determine whether the analytical sequence is in control during sample analysis.

6.3 Continuing Calibration Verification (CCV) Standard: An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The CCV is analyzed exactly like a sample, periodically throughout the run sequence. Its purpose is to determine whether the analytical sequence is in control during sample analysis. It may be prepared from the same source as the calibration standards, and is usually of varied concentration.

6.4 Duplicate (DUP): A second aliquot of a sample that is treated the same as the original sample in order to determine the precision of the method.

6.5 Independent Calibration Blank (ICB): An aliquot of reagent water or other blank matrix that is analyzed after each ICV. The ICB is used to determine whether there is carryover contamination after injection of the mid-level ICV.

6.6 Independent Calibration Verification (ICV): A solution of method analytes of known concentrations that is used to fortify an aliquot of Blank or sample matrix. The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

6.7 Laboratory Control Standard (LCS): An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to

determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

6.8 Linear Calibration Range (LCR): The concentration range over which the instrument response is linear.

6.9 Method Blank (MB): An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. The MB is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

6.10 Method Detection Limit (MDL): The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero.

6.11 Spike (Matrix Spike or Post Spike): An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS or PS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS or PS corrected for background concentrations.

6.12 Statistical Process Control (SPC) Limits: Statistically derived limits that establish acceptable ranges for recoveries of analytes of interest, including LCS, MS, MSD, PS, PSD and internal standards.

6.13 Stock Standard Solution: A concentrated solution containing one or more method analytes prepared in the laboratory using certified reference materials or purchased from a reputable commercial source.

6.14 Limit of Detection (LOD): An analyte, method and matrix specific estimate of the minimum amount of a substance that can be reliably detected.GEL has established LOD = 2 x MDL.

6.15 Limit of Quantitation (LOQ): An analyte, method and matrix specific estimate of the minimum amount of a substance that can be reported with a specific level of confidence. The LOQ is set at or above the concentration of the lowest initial calibration standard. The laboratory must empirically demonstrate precision and bias at the LOQ. The LOQ and associated precision and bias must meet client requirements and must be reported. GEL uses the following guidance (LOD < LOQ):

When LOD < PQL, PQL = LOQ

When LOD > PQL, LOQ is raised to next lowest calibration standard.

6.16 Practical Quantitation Limit (PQL): The PQL is typically at or above the lowest point on an acceptable initial calibration curve. It may also be determined by multiplying the MDL by approximately 2 to 10. Concentrations of a target analyte determined to be greater than its PQL are defined as quantitative results. This limit is not used in DoD ELAP reporting.

## 7.0 INTERFERENCES TO THE METHOD

ICP analysis is subject to three types of interferences:

7.1 Physical interferences are those physical properties of a sample solution that prevent their introduction to the plasma with an efficiency equal to that of the calibration standards. This type of interference can be reduced through the use of an internal standard in accordance with the instrument operating manual, or by diluting the sample in reagent blank solution until the percent recovery is acceptable.

7.2 Chemical interferences are minimal in ICP Spectroscopy because the extremely high energy of the plasma breaks chemical bonds.

7.3 Interelement Spectral Interference can be overcome by use of Interelement Correction (IEC) factors. IECs are initially calculated when a new instrument or method is brought on-line. A quarterly verification is performed thereafter, when linear range verifications are performed. IECs may be checked as often as needed to ensure the correct factors are being used.

7.4 The IEC coefficients are calculated if the element interfered with is outside ± PQL when analyzing a single element standard at its linear range:

7.4.1 Perkin Elmer Optima ICPs: The interfering element uses the mg/L concentration. The IEC for Cd via PE software is ¯18/490, or ¯0.03673. The resulting IEC calculations can be verified by reanalyzing the single element standard, or by analyzing the ICSA standard. In either case, the non-spiked analyte concentration should be within ± 2x the PQL or ± 2x MDL for DoD QSM. IECs are calculated for all minerals at their linear range values and for commonly seen analytes that occur at high concentrations in environmental samples, i.e., manganese and zinc.

## 8.0 SAFETY PRECAUTIONS AND HAZARD WARNINGS

**WARNING**

PREVENT SKIN AND EYE CONTACT BY USING SPECIFIED PERSONAL PROTECTIVE EQUIPMENT WHEN MAKING STOCK REAGENTS.

WORK UNDER A HOOD TO PREVENT INHALATION WHEN MAKING STOCK REAGENTS.

8.1 Sample digestates are not extremely volatile or spontaneously combustible, but they are normally acidic and should be handled with care. Small spills may generally be wiped up with paper towels that can be disposed of in the trash. Larger spills may require the use of a mop. The mop head may have to be disposed of as potentially hazardous waste in accordance with the Laboratory Waste Management Plan, GL-LB-G-001. If the spilled digestates begin any obvious fuming or reacting, pour a generous amount of the acid neutralizer, located in each lab, onto the spill before attempting to clean it up.

8.1.1 Approved gloves will be worn to avoid skin contact with the digestate during clean-up.

8.1.2 Wear eye protection with side shields while performing procedures in the laboratory. An eyewash station is located in each analysis lab.

8.1.3 Do not persist in cleaning up a spill in the presence of strong fumes. Move out of the area, attempt to isolate the area, and notify your supervisor immediately.

8.2 These instruments use high voltage electricity and therefore should be shut completely down any time electronic components may be exposed to personnel or any liquids.

8.3 Prior to handling radioactive samples, analysts must have radiation safety training and must understand their full responsibilities in radioactive sample handling. Some general guidelines follow:

8.3.1 Protect counter tops with counter paper, or work from radioactive sample handling trays.

8.3.2 Prohibit admittance to immediate work area.

8.3.3 Post signs indicating radioactive samples are in the area.

8.3.4 Take swipes of the counter tops upon completion of work. Deliver those swipes to the designated swipe count box.

8.3.5 Segregate radioactive wastes. Radioactive waste containers are obtained from Waste Management.

8.3.6 For additional guidance, refer to GL-RAD-S-004 for Radioactive Material Handling, and GL-LB-G-001, the Laboratory Waste Management Plan.

8.4 Treat all chemicals and samples as potential health hazards, and limit exposure to these chemicals to the lowest level possible. GEL maintains a current awareness file of OSHA regulations regarding the safe handling of the chemicals in the laboratory as well as a reference file of Material Safety Data Sheets (MSDS). Individual sample MSDS forms provided by the clients are also maintained.

8.5 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

8.5.1 Segregate solid wastes from liquid wastes in the satellite area containers.

8.5.2 Segregate oil wastes from water-soluble wastes in the satellite area containers.

8.6 Never leave gas cylinders unchained or untied, even when they are on moving carts.

8.7 In the event of an accident or medical emergency, call for help immediately. When time and safety permit, an accident report form should be completed and turned in to the safety committee.

8.8 Fire escape routes are posted in the lab, and all personnel should be familiar with them. In addition, fire safety equipment such as fire extinguishers is located in the lab. Training is available on the proper operation of this equipment.

## 9.0 CAUTION WARNINGS

Special care should be taken when handling hydrofluoric acid to ensure that the acid does not come into contact with the skin.

## 10.0 APPARATUS AND MATERIALS; REAGENTS; EQUIPMENT AND INSTRUMENTS

10.1 Apparatus and Equipment

10.1.1 Replacement glass parts for the ICP such as quartz torch bodies, purge extension windows, injector tips, nebulizers, and spray chambers may be ordered from an approved vendor through GEL's Purchasing Agent.

10.1.2 High purity argon gas is provided to the ICP instruments, via a network of pipelines, into the lab from liquid storage tanks located outside the building. The argon is purchased from a GEL approved vendor.

10.1.3 Consumable materials such as tubing are often attainable from various scientific product companies. The GEL Purchasing Agent can help to find the best prices from an approved vendor. All orders are placed through GEL's Purchasing Agent.

10.2 Reagents, Chemicals, and Standards

10.2.1 Nitric acid, reagent grade and ultra pure

10.2.2 Hydrochloric acid, reagent grade and ultra pure

10.2.3 Lithium solution, 5% or 1%

10.2.4 Scandium solution, 1000 µg/mL

10.2.5 5% Cesium

10.2.6 Yttrium solution,1000 µg/mL

10.2.7 Other Chemicals: Additional compounds, surfactants, oils, cleaning agents, etc. may be routinely ordered through GEL's Purchasing Agent.

10.3 Instrumentation

10.3.1 PE Optima 5300DV with compatible PC and printer

10.3.2 PE Optima 4300DV with compatible PC and printer

10.3.3 Optima Autosampler

10.3.4 Polyscience6105 PE Chillers

10.3.5 Appropriate Nebulizer (i.e., Meinhard or Burgener Mira Mist)

## 11.0 SAMPLE HANDLING AND PRESERVATION REQUIREMENTS

11.1 Aqueous samples should be preserved with nitric acid to a pH of < 2 prior to receipt by the analyst. Sediment samples should be kept at $0^{o} \leq 6^{o}$ C prior to analysis.

11.2 Refer to GL-SR-E-001 for Sample Receipt, Login, and Storage.

## 12.0 SAMPLE PREPARATION TECHNIQUES

12.1 All samples, except drinking water with Turbidity <1 NTU and samples specifically exempted by contract, are prepared in accordance with the SOPs for Metals Digestion: GL-MA-E-006 (USEPA SW-846 Method 3005A), GL-MA-E-008 (USEPA SW-846 Method 3010A), GL-MA-E-009 (USEPA SW-846 Method 3050A), and GL-MA-E-012 (CLP Method ILM04.0). Other digestion procedures may also be used.

12.2 Additional filtration may be required to prevent clogging of sample introduction system. The method blank (MB) and laboratory control sample (LCS) should be filtered to check for contamination from the filtering process.

12.3 Sample spills should be handled as stated in Section 8.1.

## 13.0 EQUIPMENT AND INSTRUMENT MAINTENANCE

### Routine Preventative and Special Operational (Failure)

13.1 Routine Preventative Maintenance (PM) is recommended as follows:

| Frequency | Procedure |
|---|---|
| When Needed | Oil the peristaltic pump with silicon spray<br>Replace peripump sample introduction tubing<br>Change pump hoses on drain systems<br>Check drain waste collection containers and empty as needed<br>Clean/replace nebulizer<br>Clean/replace torch. Align according to manufacturer's specifications<br>Clean/replace air filters |

13.2 Non-Routine Maintenance Procedures (Special, Operational or Failure Mode Maintenance)

13.2.1 If the instrument will not function properly, refer to the troubleshooting section in the appropriate operator's manual.

13.2.2 If the analyst is unable to fix the instrument, call the GEL Instrument Technician, and if needed, the manufacturer's Service Department.

13.3 Refer to the ICP Maintenance Logbook for routine records. Preventative maintenance and service should be recorded in the maintenance logbook.

## 14.0 PREPARATION OF STANDARD SOLUTION AND QUALITY CONTROL SAMPLES

14.1 Source standards records are recorded in the Metals Source Standards Logbook, which is maintained in the Metals laboratory. The preparation of working standards is fully described in the "Maintain Reference Materials" application in AlphaLIMS.

14.2 Standards are receipted, labeled, prepared and stored in accordance with GL-LB-E-007 for Laboratory Standards Documentation and GL-LB-E-015 for Control of Laboratory Standards.

## 15.0 INSTRUMENT CALIBRATION

15.1 Calibration and sample analysis are conducted automatically using the autosampler. (Samples can also be analyzed manually.)

15.1.1 Profiling: All analytical channels were aligned within specifications during initial installation or realigned after relocation of the instrument by profiling daily, all elements will be peak-on-center. Profiling should be done after plasma warm-up prior to sample analysis and verified as needed during the day (more frequently on days with high temperature and humidity fluctuations).

15.1.1.1 Operate/Profile instrument using the procedures found in the corresponding ICP Operator's or Hardware Manual.

15.1.1.2 The PE Optima 4300/5300 is autoprofiled using a mercury lamp.

15.1.1.3 When an acceptable profile is attained, print the graphical profile and display and record the profile data in the appropriate profile logbook.

15.1.2 Standardization: Standardization is required every twenty-four when the instrument is in use. Additionally, restandardization and/or recalibration is required when calibration checks fail.

15.2 Calculations are described in the instrument manuals.

15.3 Calibration standards may vary according to method. A minimum of a blank and standard are required, but a typical calibration uses a blank and three standards of varying concentration. For the multiple standard curve, the correlation coefficient (r) must be equal to or greater than 0.995 (0.998 for 6010C).

15.4 For typical (recommended) calibration standards, refer to Appendix 2.

15.5 For continuing calibration requirements, refer to Section 21.

15.6 For actions concerning a calibration verification failing to meet requirements, refer to Section 21.3.

## 16.0 INSTRUMENT PERFORMANCE REQUIREMENTS

16.1 Before samples may be analyzed, the instrument must be calibrated and verified using a calibration standard readback analyses (for CLP only), an Initial Calibration Verification (ICV) which is prepared from an independent source, an Initial Calibration Blank (ICB), Interference Check Sample(s) (ICS-A, ICS-AB), Practical Quantitation Limit (PQL or CRI), and a Linear Range Verification (LR). These must meet the requirements stated in Section 21.2 for each analyte being reported, unless specified otherwise by the client or contract.

16.2 The instrument calibration and all continuing verification data are maintained on the printed hard copy and electronically saved onto the computer network. The printouts are kept in chronological order by instrument. Recent files are stored in the respective metals laboratories and older records are archived in the warehouse.

## 17.0 ANALYST AND METHOD VERIFICATION REQUIREMENTS

17.1 Analyst training is conducted in accordance with GL-HR-E-002 for Employee Training.

17.2 Method performance is verified by conducting MDL studies in accordance with GL-LB-E-001 for The Determination of Method Detection Limits, and by the evaluation of laboratory proficiency samples (audits).

## 18.0 ANALYSIS PROCEDURES AND INSTRUMENTAL OPERATION

18.1 All samples are introduced to the instrument via a peristaltic pump. The amount of sample entering the instrument is dependent on the pump speed, the diameter of the pump tubing, and the nebulizer efficiency.

18.2 Run Sequence

18.2.1 Calibration sequence (may vary slightly under different autosampler files/see Appendix 2 also).

| | | |
|---|---|---|
| 18.2.1.1 | S0 | (reagent blank, 3% HCl/1%$HNO_3$) |
| 18.2.1.2 | S0.1 | (100 ppb standard) |
| 18.2.1.3 | S0.5 | (500 ppb standard) |
| 18.2.1.4 | SCAL | (1000 ppb standard) |
| 18.2.1.5 | S10 | (20 to 50 ppm standard) |

18.2.2 The calibration verification steps include:

18.2.2.1 Calibration Standard Readbacks (required for CLP only)

18.2.2.2 ICV

18.2.2.3 ICB

18.2.2.4 PQL (low level ICV for 6010C)
18.2.2.5 CRI (required for CLP)
18.2.2.6 ICS-A
18.2.2.7 ICS-AB
18.2.2.8 LR1
18.2.2.9 LR2
18.2.2.10 CCV
18.2.2.11 CCB

18.2.3 Samples (10 samples or less)

18.2.4 Continuing Calibration Verification (CCV), Low Level Calibration Verification (PQL) required for SW-846 6010C, and Continuing Calibration Blank (CCB)

18.2.5 Repeat steps 18.2.3 and 18.2.4 through the end of the run or until applicable verification is out of specifications.

18.2.6 Final verification steps in order:

18.2.6.1 CRI (required for CLP only)
18.2.6.2 ICS-A (required for 200.7 or CLP only)
18.2.6.3 ICS-AB (required for 200.7 or CLP only)
18.2.6.4 CCV
18.2.6.5 PQL (required for SW-846 6010C)
18.2.6.6 CCB

**NOTE**: 6010C only requires there to be a closing low level continuing calibration standard (PQL). For ease of analysis, the PQL standard can be analyzed every 10 samples.

18.2.7 ICS-A and ICS-AB are analyzed at least every 8 hours for 200.7 analysis.

18.3 For data storage see section 23 and 24.

18.4 General operation of the instrument

18.4.1 The Perkin Elmer Optima 4300DV and 5300DV is a simultaneous, dual view, inductively coupled, argon plasma emission spectrometer. As configured for GEL, it is capable of analyzing 32 substances: Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Se, Si, $SiO_2$, Sr, Ti, Sn, Tl, U, V, and Zn. The operating software of the system is a menu driven type.

18.4.2 Typical Analytical Challenges

18.4.2.1 Sample Overrange: If an analyte is above the working linear range of the instrument, even if this element is not required, dilute the sample to an acceptable range and rerun, especially if the over ranged element is an interferant of the reported analyte. Dilutions are required if the value of an analyte exceeds 100% of the working linear range when the element of interest is being reported, or is interfering with an element that will be reported. Dilution factors must be taken into account when

reporting final values. Additionally, further rinse and/or an acidified rinse solution may be required before continuing with the next sample.

18.4.2.2 Torch/Sample Introduction Drift: Various changes in torch plasma conditions, sample introduction, or other external factors can have a great effect on the analysis.

18.4.2.2.1 If sample introduction drift is suspected several items should be reviewed. Check the peristaltic pump tubing for wear and replace as needed. Check the internal standard to make sure it is being introduced to the instrument at a constant rate. Check the nebulizer to ensure that it's free of clogs and that the spray is a continuous mist.

18.4.2.2.2 Profile drift may mimic torch/sample introduction drift. Reprofiling should be done routinely. Profile drift is a function of temperature and should be checked more frequently when large temperature swings are observed. During an analytical run profile drift is evident when a clean blank shows significant deviation from zero. As suggested by the manufacturer, two elements to track for this problem are Na and Al.

18.4.2.2.3 Tubing connections may become loose, allowing air to bubble into the sample path. Tighten or replace tubing connection as necessary.

18.4.2.3 Sample Matrix: The internal standard technique is used to correct for physical interferences. Each ICP has a Scandium (Sc) internal standard that is continuously fed through the sample introduction system via a peristaltic pump. Scandium is used as the internal standard. It is used at 10 ppm both radially and axially on the Optimas. In addition, the Optimas run yttrium at 2 ppm to reprocess as an internal standard if Sc is suspected in the sample.

18.5 Power switches and auxiliaries are addressed in detail in the appropriate operator's manual and/or hardware guide.

18.6 Start-up and shutdown procedures are addressed in detail in the appropriate operator's manual and/or hardware guide.

18.7 Sample quantity requirements vary based on several different factors such as nebulizer type, diameter of tubing, and pump rate.

18.8 Autosampler can be used with various nebulizers by attaching the sample introduction tube to the autosampler sample tube. The autosampler rinse should be setup by connecting the autosampler rinse tubing to the peristaltic pump in the instrument.

## 19.0 CALCULATIONS AND DATA REDUCTION METHODS

19.1 Any dilutions, concentrations, or preparation factors must be taken into account prior to reporting data to a client. The appropriate factors are entered into AlphaLIMS.

19.2 Care must be taken that the correct units are being employed. Analytical results originating from the ICPs are reported in ppb or µg/L.

## 20.0 DATA RECORDING

20.1 The Optima 4300 and 5300 data are stored on the Network as a CSV file and printed at the instrument as each sample is analyzed.

20.2 ICP samples and standards are generally analyzed in three replicates (minimum of 2), and the reported value is the average of the replicates. At times, one replicate may be removed due to an attributable cause. This attributable cause should be documented on the hard data (i.e. third replicate ran out of volume). The average of the two remaining replicates is subsequently recalculated prior to reporting the data to the client.

20.3 Data are retrieved by the data entry personnel where unused data can be eliminated, dilution factors entered, and conversions made prior to uploading to AlphaLIMS.

## 21.0 QUALITY CONTROL REQUIREMENTS

21.1 Frequency of Quality Control Activities (refer to Appendix 3)

21.1.1 The SCAL and S10 are analyzed immediately following the calibration. These analyses are sometimes called calibration standard readbacks. This step only applies to CLP analyses.

21.1.2 The Initial Calibration Verification (ICV) is performed following each calibration. The Continuing Calibration Verification (CCV) is performed following every ten or less samples. For CLP analysis the ICV is performed immediately following calibration. For CLP analyses the CCV is run prior to the analysis of any samples and follows every ten or less samples. Any quality control samples excluding the CCV and CCB are counted as samples. Therefore, a CLP analytical run should end with a final CCV and CCB. Additionally, no more than two hours should pass between analyzing successive CCVs that bracket reportable data.

21.1.3 An Initial Calibration Blank (ICB) is performed immediately following the ICV, and Continuing Calibration Blanks (CCB) must follow each CCV.

21.1.4 The PQL standard is analyzed after each calibration and recommended at least every 10 samples, between the CCV and CCB analyses for SW-846 Method 6010C. Method 6010C requires analysis at the end of every batch and only recommends analysis every 10 samples. This standard may also be labeled as a CRDL standard. For CLP work, the CRI is analyzed at the beginning and at the end of each analytical run, and at a minimum of two times per eight hours. For CLP analyses, the CRI is analyzed at two times the CRDL or two times the IDL, whichever is greater.

21.1.5 An Interference Check Standard is analyzed after the calibration. For CLP or 200.7 analysis, an ICSA and ICSAB must be performed before the final CCV, CCB. Interference check standards are analyzed at least every 8 hours per Method 200.7.

21.1.6 A method blank (MB) is performed for each batch of twenty or fewer samples, or more frequently per client contract requirement. For CLP analyses, the requirement is one method blank per twenty samples in an SDG.

21.1.7 A matrix spike (MS) and a sample duplicate (DUP), or a matrix spike (MS) and a matrix spike duplicate (MSD) are analyzed for each batch of 20 or fewer samples or per client or method requirements. For a matrix spike recovery to be applicable the sample value may not exceed four times the nominal concentration of the spike. For CLP analyses, the requirement is one MS/MSD or MS/DUP per twenty samples in an SDG.

21.1.8 A laboratory control sample (LCS) is normally analyzed with each batch of twenty or fewer samples. A LCS Duplicate (LCSD) is performed at the same frequency as the LCS when required by a specific program or client.

21.1.9 Serial dilutions are analyzed to indicate the presence or absence of interferences. The analyte concentrations must be greater than 50 times the detection limit for a serial dilution to be applicable. The serial dilution is generally performed at a 5x dilution of the test sample or requested by client contracts.

21.1.10 A serial dilution will be performed for each SDG of up to twenty samples.

21.1.11 When performing CLP analyses, a post-spike must be performed on the original sample when the matrix spike recovery falls outside the control limits and the sample result does not exceed 4x the spike added. Otherwise, post spikes are analyzed per client request.

21.1.12 Linear Range standards are analyzed after each calibration. These standards are labeled LR1 and LR2.

21.2 Acceptance Limits (refer to Appendix 4)

21.2.1 For CLP (ILMO) methods, the calibration standard readbacks must fall between 95% and 105% of the true value. If data are to be reported by CLP, a linear range verification check standard shall be performed and reported quarterly. The linear range standard shall be run during a routine analysis and the determined concentration shall fall within 5% of the true value.

21.2.2 ICV and CCV results must fall between 90% to 110% of the true values for work under EPA SW-846 Method 6010B/6010C. ICV must be between 95% to 105% of the true value for work under EPA Method 200.7 and USEPA CLP Method 200.7 CLP-M. The ICV/CCV Relative Standard Deviation (RSD) (minimum of 2 replicates) must be < 5% for all methods, with the exception of samples analyzed for Arizona. The RSD for AZ samples must be ≤ 3% RSD.

**NOTE:** The ICV is a second source standard and may be used as the CCV to show calibration verification.

21.2.3 The ICB and CCB results must have an absolute value less than or equal to the PQL results or the LOD for DoD QSM.

21.2.4 The PQL should fall within 70% to 130% of the accepted value or per client request and 80%-120% for DoD QSM work. For SW-846 Method 6010C, the PQL standard must be 70%-130% of the true value or recalibration is required. This also includes the low level continuing calibration verification standard analyzed every 10 samples or at the end of the analytical batch. Sample results can be evaluated for reporting if they are at least 2x the PQL for a given analyte. For CLP analysis no specific acceptance criteria have been established for the CRI, however an unofficial range of 50% to 150% has been set for guidance purposes. For CLP the CRI is exempted for Al, Ba, Ca, Fe, Na, and K.

21.2.5 The analytes for the ICS-AB results must fall between 80% and 120% of the true value. The analytes for the ICS-A must have an absolute value ± 2 times the CRDL and 80% to 120% for analytes present in the solution. For DoD QSM, the ICSA must have an absolute value ± LOD for all non-spiked analytes.

21.2.6 Method blank results should fall less than the RDL but no less than the negative RDL. Additionally, the method blank may exceed the RDL provided that the blank value is insignificant relative to the lowest value of the samples in the batch. Specifically, the blank value must fall less than 10 times the lowest value of the samples in the batch. For CLP analyses, the method blank must have an absolute value less than the CRDL or less than 10 times the lowest value of the samples in the batch. For DoD QSM the method blank must have an absolute value less than ½ RL or less than 10x the lowest value of the samples in the batch. Al, Fe, Mg, Ca, Na, and K must be less than RL. All failures must be reprepped.

21.2.7 Matrix spike and matrix spike duplicates recoveries should fall between 75% and 125% or per client contract. Matrix spike recoveries are applicable to those sample values that do not exceed four times the nominal concentration of the spike. Recoveries of one or more of the matrix spikes that fall outside recommended ranges may indicate an improper sample digestion, sample inhomogenity, or matrix interference. The LCS and LCSD are therefore used for indicators of sample digestion validity.

21.2.8 LCS and LCSD recoveries and RPDs must fall within process control limits as established by Statistical Process Control, manufacturer's certification, or method requirements.

21.2.9 Serial dilution results that agree within 10% of an initial raw value greater than 50 times the IDL suggest the absence of interference. Failures of a serial dilution should be noted, but are not considered pass/fail criteria. A criterion of greater than 50 times the MDL may be requested by some clients. The criterion of greater than 50 times the LOQ is used for DoD QSM.

21.2.10 The relative percent difference (RPD) between an MS and MSD or a sample and DUP should fall within ≤ 20% if the analyte level is sufficiently high (5x the CRDL for CLP analyses).

21.2.11 The LR1 and LR2 standards must fall within 90-110% of the known value. If any analyte fails to meet the 10% criteria, the working linear range is then defined as the high standard concentration used in the calibration curve.

21.2.12 Post spikes with recoveries between 75% and 125% under EPA Method 200.7 and SW-846 Method 6010B, and 80% and 120% under SW-846 6010C and DoD QSM suggest the absence of interferences.

21.3 Out-of-Control situations

21.3.1 ICV and/or CCV failure requires a recalibration of the instrument and/or repreparation of standard solutions. Samples bracketed by calibration verifications that are not acceptable for required analytes must be reanalyzed. An ICV or CCV that has failed may be rerun provided there is an attributable cause known to have affected the check standard only and not the previous samples. Examples of an acceptable cause may be a sample tip out of solution during analysis, an incorrectly prepared CCV, or obvious carryover in the CCV from a very high sample immediately prior to the CCV. If a CCV is reanalyzed, the data must be lined through, initialed and dated, and the reason for the rerun must be documented on the raw data. In addition, corrective action should be taken to eliminate the cause of the initial CCV failure to prevent future occurrence.

21.3.2 ICB and CCB failure requires recalibration of the instrument and/or repreparation of the calibration blank. When analyzing under SW-846, a CCB may be accepted above the RDL level under two conditions: 1) the CCB is acceptable if the sample value is below the RDL and 2) the CCB is acceptable if the level of analyte in the CCB is less than 1/10 the analyte value in the lowest reported sample. For DoD QSM, the ICB and CCB must have an absolute value less than the LOD or less than 10x value of the samples bracketed by the blank.

21.3.3 ICS failure requires that the interferences be corrected, via recalculation, of Interelement Correction Factors or selection of background correction factors so that the ICS can be read within the required limits before samples are analyzed. ICS failure at the end of an analysis period will require that the samples run for the affected analyte(s) during that period to be reanalyzed. For CLP analyses, in the event of an ICS failure, terminate the analysis, correct the problem, recalibrate the instrument, and reanalyze the analytical samples analyzed since the last good ICS.

21.3.4 Calibration standard readback failure requires that the instrument be recalibrated (for CLP only).

21.3.5 PQL failure should be evaluated, but no action is required if the results are outside of the 70% to 130% range for all methods unless otherwise specified by the client. DoD QSM analysis must have passing PQL recoveries or the instrument needs recalibration. For PQL recovery failures

for SW-846 Method 6010C, refer to section 21.2.4. Further failures need to be communicated to the client for guidance.

21.3.6 Matrix spikes, duplicates and spike duplicates are used only as indicators of method effectiveness on that sample and will not be used as acceptability criteria for the process, unless it's a special requirement of the client. For CLP analysis, matrix spikes and duplicates that are outside the acceptance criteria will be flagged according to the ILMO4.0 Inorganic Statement of Work. Post spikes are performed for the analytes in which matrix spikes or spike duplicates are outside the acceptance criteria. Exception is given to silver.

21.3.7 LCS and/or LCS duplicate results outside of established acceptance limits require the batch to be redigested and reanalyzed.

21.3.8 When analytical results suggest the presence of interference, the method listed in Section 21.1.9 must be employed. For CLP analyses, serial dilutions that suggest the presence of interference per Section 21.2.9 are flagged according to the ILM04.0 Inorganic Statement of Work E-24 Section 9.

21.3.9 The intensity and percent recovery of the internal standard are monitored per sample. There is no acceptance criterion per SW-846, 200.7, and ILMO methodology; however, the laboratory has adopted a ± 50% recovery criterion. If the internal standard fails to meet the criteria, reprocess the data using a different internal standard if available or dilute the sample within acceptable parameters.

21.4 Analytical data are evaluated for conformance with the requirements stated in Section 21.2 by the analyst during and/or after the analysis but before the data are entered into AlphaLIMS. Data may be accepted or rejected by the analyst at this point or by the data reviewer(s) as stated in Section 22.

21.5 Corrective actions taken for data not conforming to the requirements in Section 21.2 are stated in Section 21.3. If these corrective actions can be taken by the analyst prior to the acceptance of the data, then no nonconformance documentation is required. However, if these corrective actions include redigestion of the batch or sample and if the data have already been accepted, then a nonconformance/ corrective action report should be completed. This report includes the date, person requesting the action, sample(s) or batch(es) affected, and action requested, all provided by the requester. The person taking the action will provide any pertinent comments, a signature, and the date the action is completed. The disposition of the nonconformance will then be verified by the Group Leader and Quality Assurance Officer if pertinent. These reports will be kept on file in AlphaLIMS. Refer to GL-QS-E-004 for Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items.

## 22.0 DATA REVIEW, VALIDATION, AND APPROVAL PROCEDURES

22.1 The AlphaLIMS Data Report and the original batch sheet are provided to the ICP reviewer.

22.2 A knowledgeable person other than the originating analyst shall review the data within the day or specified time limit. When this review is completed and all of the

data are found to be acceptable, the reviewer signs and dates the batch data report. If the reviewer determines that the reviewed data are not acceptable and requires additional work or correction, they are returned to the Group Leader or representative with an appropriate explanation.

22.3 Listed below are the data review responsibilities at the Analyst, Peer Review and Validator levels:

22.3.1 Analyst Review is performed by the analyst who generated the data before the data are submitted for entry into AlphaLIMS. The analyst uploads the data to AlphaLIMS and completes the batch data report.

22.3.2 Peer Analyst Review is performed by an individual who did not perform the analysis but is familiar with the analytical method used and the reporting requirements. This person reviews the complete data report after all data are entered and ensures that any data entry corrections are made before the data are approved, and then signs the batch data report. If the data do not meet the necessary quality requirements and need further analysis, they are returned to the analyst.

22.3.3 Data Validation: For data requiring forms packages, the forms are generated per contract requirements and validated per GL-MA-E-017.

22.4 Specific items that are reviewed at each level include the following:

22.4.1 Analyst Review: Before data are submitted for entry into AlphaLIMS.

22.4.1.1 All analyses in the batch are completed with explanations of exceptions.

22.4.1.2 Any corrections and comments on the data are properly initialed and dated.

22.4.1.3 Proper standard identification numbers appear on the runlog to ensure traceability from the data to original source standards.

22.4.1.4 Data acceptance limit criteria identified in Section 21.2 are met or an explanation given.

22.4.2 Peer Analyst Review: before Data are statused to DONE in AlphaLIMS:

22.4.2.1 All data are complete and accurate in the AlphaLIMS Data Report.

22.4.2.2 Any exceptions or shortcomings have been sufficiently explained or corrected.

22.4.2.3 Data are reported in the proper units, or an explanation is given.

22.4.2.4 Prep factor and dilution calculations by AlphaLIMS are present in the data report and AlphaLIMS calculations are correct.

22.4.2.5 LCS and Spike Recoveries and RPD calculations by AlphaLIMS are correct and are within control limits.

22.4.3 Valildation: Before data are reported out of the lab:

22.4.3.1 Analyst and Peer Level reviews have been completed and any corrections or comments made.

22.4.3.2 Preparation data have been entered and reviewed by a peer.

22.4.3.3 Analytical data are present for all analyses.

22.4.3.4 Weight/Volume, dilution, spike recovery, RPD, and LCS recoveries appear to be calculated correctly.

22.4.3.5 All forms, raw data, and log sheets requested by the client are present.

22.4.3.6 Results are accurate on forms (refer to GL-MA-E-017).

22.5 Documentation and review process are reflected in the Data Review Flow Chart in Appendix 1.

## 23.0 DATA REPORT

23.1 To report data after the initial review process has been completed:

23.1.1 Enter the AlphaLIMS program through GEL home page and click on AlphaLIMS application.

23.1.2 Click on MAINTAIN BATCHES and type in the queue at SELECT A QUEUE (ICP for Industrial and ICPF for Federal).

23.1.3 Select batch number at SAMPLE ID column, and the run status will show whether data are ready to calculate.

23.1.4 When data are ready to calculate, click on CAL.

23.1.5 Click on SAVE to save the data.

23.1.6 Send data to review at STATUS column for quality purposes.

23.1.7 Print data, and initial and date for final review.

23.2 The Final Reviewer is responsible for changing the batch status to DONE in AlphaLIMS and initialing and dating the data report. The Final Reviewer is also responsible for making copies of the data report and run log. (ONLY FOR FEDERAL.)

## 24.0 RECORDS MANAGEMENT AND DOCUMENT CONTROL

24.1 Records of the instrumental analysis, operation, and maintenance are maintained as follows:

24.1.1 Run logs are accurate chronologies of what the instrument did during a specified period of time. They detail the standard name or sample number for each standardization or analysis, the analyst identification, and the date and time of each analysis or standardization. This information is periodically retrieved from the instrument data files, printed in chronological sequence, and maintained as documentation of the sequence of events and as a reference for the raw data.

24.1.2 Extraction/Digestion Logs are maintained in accordance with the established procedures in the areas where these processes are performed.

24.1.3 Instrument Maintenance Logs are chronological representations of all maintenance activities involving the instrument operation. This record is kept in bound composition books and consists of the details of the action, who performed it, when it was performed, and when instrument was returned to operation.

24.1.4 Batch Sheets accompany the batch of samples through digestion and analysis and then accompany the raw analytical data through data entry and data review until the batch status is changed to "DONE" in the laboratory. The person responsible for each of these actions initials and dates the batch sheet. This record is maintained in the Metals group files.

24.1.5 Batch Data Reports are generated from AlphaLIMS after the data are entered and attached to the batch sheet to be used in the peer review and validation. After the batch is reviewed, corrected if necessary, and updated to "DONE," the batch data report is stored with the batch sheet.

24.1.6 Raw instrument data are generated as the analyses are performed and are used in the data review process and kept in the Metals group files.

## 25.0 LABORATORY WASTE HANDLING AND DISPOSAL

All Laboratory wastes are handled and disposed in accordance with the Laboratory Waste Management Plan, GL-LB-G-001.

## 26.0 METHOD VARIATION

SW-846 requires that ICB and CCB results must agree within three standard deviations of the mean blank value. GEL uses the absolute value of the PQL for evaluating ICB and CCB results. The acceptance limits are further discussed in Appendix 4.

## 27.0 REFERENCES

27.1 Perkin Elmer Optima 4300DV Operator's Manual

27.2 Perkin Elmer Optima 4000 Series Hardware Guide

27.3 Perkin Elmer Optima 5300DV Operator's Manual

27.4 Test Methods for Evaluating Solid Waste: Laboratory Manual Physical/ Chemical Methods, Volume 1A, SW-846, 3rd Edition, Nov. 1986. Method 6010B, "Inductively Coupled Plasma-Atomic Emission Spectroscopy," Rev 2, Sept. 1994. USEPA Office of Solid Waste and Emergency Response, Washington, DC 20460.

27.5 Test Methods for Evaluating Solid Waste: Laboratory Manual Physical/ Chemical Methods, Volume 1A, SW-846, 3rd Edition, Nov. 1986. Method 6010C, "Inductively Coupled Plasma-Atomic Emission Spectroscopy," Rev 3, February 2007. USEPA Office of Solid Waste and Emergency Response, Washington, DC 20460.

27.6 EPA Method 200.7, Revision 4.4

27.7 USEPA CLP, Inorganic Statement of Work, ILM04.0

27.8 2001 Annual Book of ASTM Standards, D4698-92, "Standard Practice for Total Digestion of Sediment Samples for Chemical Analysis of Various Metals."

27.9 Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.1, April 22, 2009.

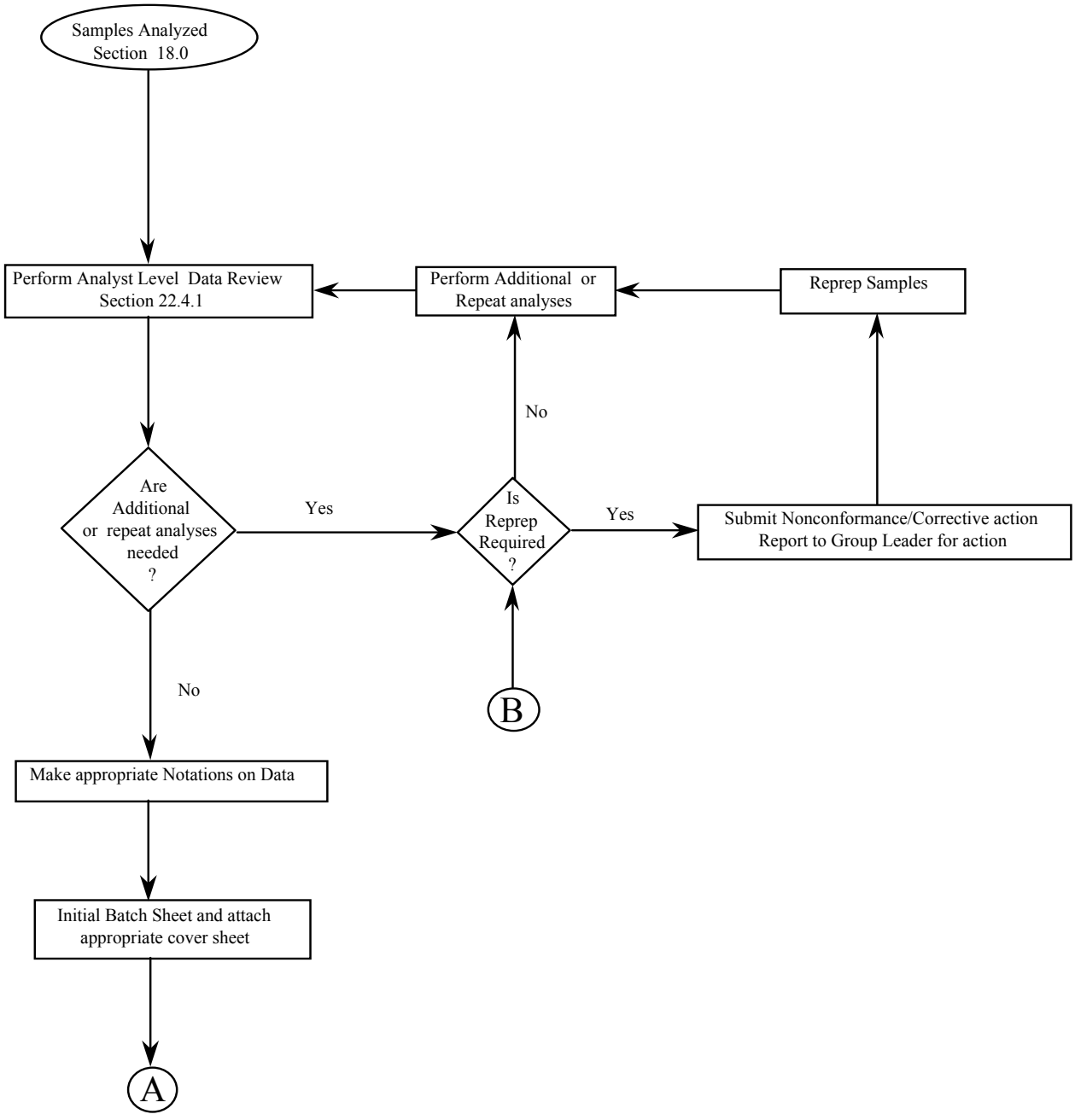
## 28.0 HISTORY

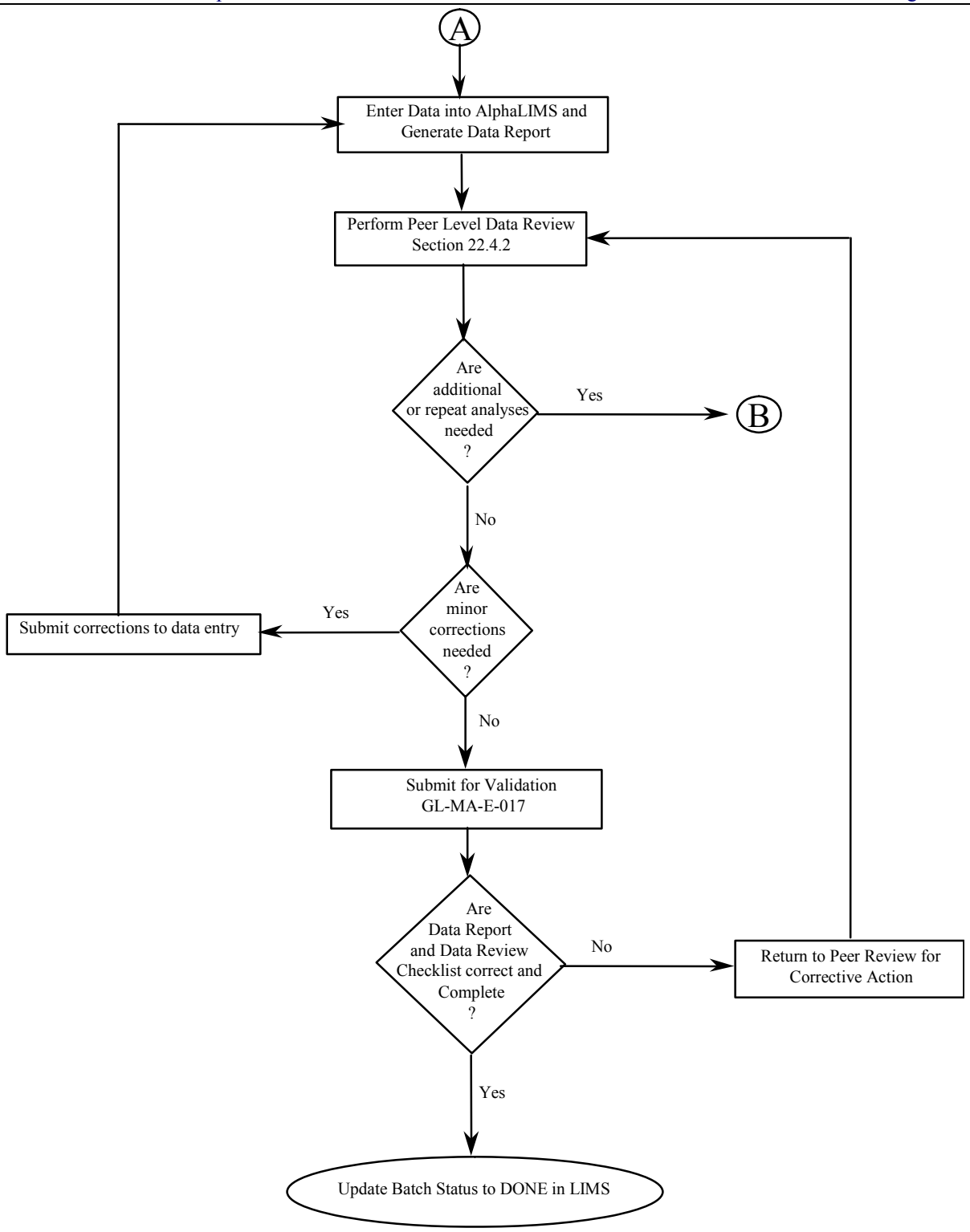
Revision 20: Added DoD QSM revision.

# APPENDIX 1: PRODUCTION FLOW CHART

**(For Illustrative Purposes Only)**

Data Review Flow Chart




A
Enter Data into AlphaLIMS and Generate Data Report
Perform Peer Level Data Review Section 22.4.2
Are additional or repeat analyses needed ?
Yes
B
No
Are minor corrections needed ?
Yes
Submit corrections to data entry
No
Submit for Validation GL-MA-E-017
Are Data Report and Data Review Checklist correct and Complete ?
No
Return to Peer Review for Corrective Action
Yes
Update Batch Status to DONE in LIMS

## APPENDIX 2: CALIBRATION STANDARDS FOR TRACE

(For Illustrative Purposes Only)

**S0** reagent blank (3% HCl / 1% $HNO_3$)

**S0.1** 0.1 ppm (100 ppb) As, Ba, Be, B, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Sr, Tl, U, V, Zn Sb, Mo, Ag, Sn, Ti

0.2 ppm (200 ppb) S

0.5 ppm (500 ppb) Si, P

1 ppm (1000 ppb) Al, Ca, Mg, K, Na

**S0.5** 0.5 ppm (500 ppb) As, Ba, Be, B, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Sr, Tl, U, V, Zn Sb, Mo, Ag, Sn, Ti

1 ppm (1000 ppb) S

2.5 ppm (2500 ppb) Si, P

5 ppm (5000 ppb) Al, Ca, Mg, K

**SCAL** 1 ppm (1000 ppb) As, Ba, Be, B, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Sr, Tl, U, V, Zn Sb, Mo, Ag, Sn, Ti

2 ppm (2000 ppb) S

5 ppm (5000 ppb) Si, P

10 ppm (10000 ppb) Al, Ca, Mg, K, Na

**S10** 50 ppm (50000 ppb) Ca, Al, Mg
20 ppm (20000 ppb) Fe, Na

(Analytes and concentrations may change with further method development)

## APPENDIX 3: FREQUENCY OF QUALITY CONTROL ACTIVITIES

(For Illustrative Purposes Only)

Frequency of Quality Control Activities

| Method/ Frequency | SW-846 6010B | EPA 200.7 | 200.7 CLP-M | SW-846 6010C |
|---|---|---|---|---|
| Calibration Std readbacks | Not required | Not required | 95% - 105% per calibration | Not required |
| Linear Range Std | Per calibration | Per calibration | Per calibration | Per calibration |
| ICV | Per calibration | Per calibration | Per calibration | Per calibration |
| ICB | Per calibration | Per calibration | Per calibration | Per calibration |
| PQL/CRI (CLP) | Per calibration | Per calibration | Per calibration; end of analytical run | Per calibration and at end of each analytical batch. |
| ICSA | Per calibration | Per calibration; every 8 hours after or end of analytical run | Per calibration; every 8 hours after or end of analytical run | Per calibration |
| ICSAB | Per calibration | Per calibration; every 8 hours after or end of analytical run | Per calibration; every 8 hours after or end of analytical run | Per calibration |
| CCV | Every 10 instrument runs | Every 10 instrument runs | Every 10 instrument runs | Every 10 instrument runs |
| CCB | Every 10 instrument runs | Every 10 instrument runs | Every 10 instrument runs | Every 10 instrument runs |
| Method Blank | 5% or per batch | 5% or per batch | 5% or per batch | 5% or per batch |
| LCS - liquid LCS - soil | 5% or per batch | 5% or per batch | 5% or per batch | 5% or per batch |
| Matrix Spikes | 5% or per request | 10% or per request | 5% or per request | 5% or per request |
| Sample Duplicates | 5% or per request | 5% or per request | 5% or per request | 5% or per request |
| Serial Dilutions | 5% or per request | 5% or per request | 5% or per request | 5% or per request |
| Matrix Spike Duplicates | 5% or per request | 10% or per request | 5% or per request | 5% or per request |
| Post Digestion Spikes | 5% or per request | 5% or per request | 5% or per request | 5% or per request |

# APPENDIX 4: ACCEPTANCE LIMITS

| Method/ Acceptance Criteria | SW-846 6010B | EPA 200.7 | 200.7 CLP-M | DOD QSM | SW-846 6010C |
|---|---|---|---|---|---|
| Calibration Std readbacks | Not required | Not required | 95% - 105% per calibration | Not required | Not required |
| Linear Range Std | ± 10% of true value | ± 10% of true value | ± 5% of true value | ± 10% of the true value | ± 10% of true value |
| ICV | 90% - 110% | 95% - 105% | 90% - 110% | 90%-110% | 90% - 110% |
| ICB | < absolute value of RL | < absolute value of RL | < absolute value of RL | < absolute value of LOD | < absolute value of RL |
| PQL/CRI (CLP) | 70% - 130% advisory limits only | 70% - 130% advisory limits only | 70% - 130% advisory limits only | 80%-120% or investigate and recalibrate | 70% - 130% or investigate and recalibrate |
| ICSA | 80-120% for major components, 2XRL for others | 80-120% for major components, 2XRL for others | 80-120% for major components, 2XRL for others | 80%-120% for major components, < ± LOD for non spiked | 80-120% for major components, 2XRL for others |
| ICSAB | 80%-120% | 80%-120% (may be requested) | 80%-120% | 80%-120% | 80%-120% |
| CCV | 90% - 110% | 90% - 110% | 90% - 110% | 90%-110% | 90% - 110% |
| CCB | ± RL | ± RL | ±RL | ± LOD | ± RL |
| Method Blank | ± RL | ± RL | ±RL | ±1/2 RL, except for Al, Fe, Ca, Mg, Na and K | ± RL |
| LCS - liquid LCS - soil | 80% - 120% current SPC limits | 85% - 115% current SPC limits | 85% - 115% current SPC limits | 80%-120% | 80% - 120% current SPC limits |
| Matrix Spikes | 75% - 125%, when applicable | 75% - 125%, when applicable | 75% - 125%, when applicable | 80%-120%, when applicable | 75% - 125%, when applicable |
| Sample Duplicates | 0% - 20% when greater than 5X RL, +/-RL when less than 5X RL | 0% - 20% when greater than 5X RL, +/-RL when less than 5X RL | 0% - 20% when greater than 5X RL, +/-RL when less than 5X RL | 0% - 20% when greater than 5X RL, +/-RL when less than 5X RL | 0% - 20% when greater than 5X RL, +/-RL when less than 5X RL |
| Serial Dilutions | 0% - 10% of initial raw value, when applicable | 0% - 10% of initial raw value, when applicable | 0% - 10% of initial raw value, when applicable | 0% - 10% of initial raw value, when > 50X LOQ | 0% - 10% of initial raw value, when applicable |
| Post Digestion Spikes | 75%-125%, when applicable | 75%-125%, when applicable | 75%-125%, when applicable | 75%-125% | 80%-120%, for all |
| Internal Standards | 50%-150%, then evaluate dilution | 50%-150%, then evaluate dilution | 50%-150%, then evaluate dilution | N/A | 50%-150%, then evaluate dilution |
| Matrix Spike Duplicate | 0% - 20% when greater than 5X RL, +/-RL when less than 5X RL | 0% - 20% when greater than 5X RL, +/-RL when less than 5X RL | 0% - 20% when greater than 5X RL, +/-RL when less than 5X RL | 0% - 20% when greater than 5X RL, +/-RL when less than 5X RL | 0% - 20% when greater than 5X RL, +/-RL when less than 5X RL |

**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

# FOR

# DETERMINATION OF METALS BY ICP-MS

APPLICABLE TO METHODS:
EPA Method 200.8
EPA SW-846 Method 6020 and 6020A

## (GL-MA-E-014 REVISION 24)

PROPRIETARY INFORMATION

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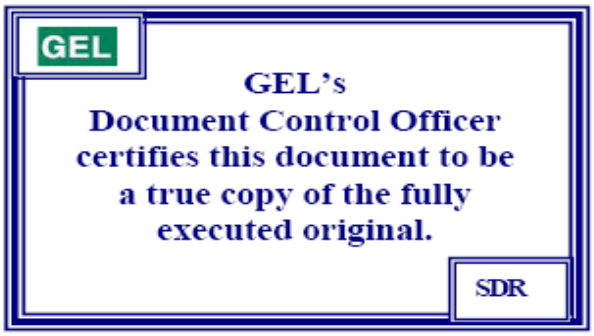

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## 1.0 STANDARD OPERATING PROCEDURE FOR DETERMINATION OF METALS BY ICP-MS

## 2.0 METHOD CODES

2.1 EPA SW-846 Method 6020

2.2 EPA SW-846 Method 6020A

2.3 EPA Method 200.8

2.4 ASTM D4698-92 Total Dissolution

## 3.0 METHOD OBJECTIVE AND PURPOSE

This standard operating procedure (SOP) describes the determination of metals using a Perkin Elmer ELAN ICP-MS Model 6100 Spectrometer or a Perkin Elmer ICP-MS Model 9000 Spectrometer. Prior to analysis, samples must be digested using appropriate sample preparation methods (such as Methods 3005, 3010, 3050, or 200.2) and other applicable requests.

## 4.0 METHOD APPLICABILITY AND METHOD SUMMARY

4.1 Analytes: Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Tl, U, $^{233}$U, $^{234}$U, $^{235}$U, $^{236}$U, $^{238}$U, isotopic U, V, and Zn. As well as client specific elements such as Os, Au, Pt, Pd, Cs, B, P, Sc, Ti, Ge, Sr, Zr, Hg and Th and others as needed.

4.2 Applicable Matrices: These methods are applicable to the determinations of any of the analytes listed above for various matrices including waters, oils, soils, sludges, biological tissues, Toxicity Characteristic Leaching Procedure (TCLP) extracts and other more unusual types of sample which are generally classified as a miscellaneous matrix.

4.3 General Method Summary: After the samples are prepared in accordance with the sample preparation SOP, they are analyzed by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) as follows:

4.3.1 The instrument is calibrated with a minimum of two calibration points for each element to be analyzed. The points consist of a calibration blank solution to define the lower calibration point and at least one standard calibration solution at the analyte concentrations to define the higher calibration point(s). A correlation coefficient of 0.995 or better (0.998 or better for SW-846 Method 6020A) is required for each analyte if multiple standards are used or the instrument is recalibrated for the analyte of interest.

4.3.2 Prepared client samples and numerous check standards and quality control samples, identified in Section 22.1 are then analyzed. The check standards and quality control samples are used to determine the quality and acceptability of the analytical data.

4.3.3 Continuing Calibration Verification standards (CCV) and Continuing Calibration Blanks (CCB) are analyzed a minimum of every 10 samples to ensure that the instrument is continuing to perform correctly. For 6020A, low level continuing calibration verification standards are analyzed in conjunction with the CCVs and CCBs.

4.4 Method Codes: Analyses must conform to SW-846 Method 6020, SW-846 Method 6020A, EPA Method 200.8, and/or customer contract specifications.

4.5 Radiochemistry conversion calculations for the uranium isotopes are included in Appendix 4.

## 5.0 METHOD SCOPE AND PERFORMANCE CHARACTERISTICS

5.1 Calibration Range: The range of concentrations between the calibration blank, typically 0, and that of the highest calibration standard for each analyte. Calibration standards vary according to method and equipment. A minimum of two, a blank and value standard, are required.

5.2 Linear Dynamic Range (LDR) standards are analyzed with each calibration. For ICP-MS analyses, the upper limit of the linear range for each analyte must be determined by observing the signal responses from a minimum of three different concentration standards, one of which is close to the upper limit of the linear range.

5.3 The linear calibration range that may be used for the analysis of samples should be judged by the analyst from the resulting data. The instrument is calibrated. The target LR should be prepared and analyzed. The sample results must fall within ± 10% of the target value. This LR value is entered into the instrument's software. Any hits below this value will be valid. Hits at or above this value will be flagged by the system and must be diluted to fall within the linear dynamic range.

5.4 Instrument Detection Limits (IDLs) in µg/L are determined by calculating the average of the standard deviation of the three runs on three non-consecutive days from the analysis of a reagent blank solution with seven consecutive measurements per day. Each measurement must be performed as though it were a separate analytical sample (i.e., each measurement must be followed by a rinse and/or any other procedure normally performed between the analysis of separate samples). IDLs must be determined at least every three months.

5.5 Method Detection Limit (MDL) studies for each analyte are performed and/or verified at least annually. These studies are conducted and calculated in accordance with SW-846, Chapter 1, paragraph 5.0, and GL-LB-E-001 for the Determination of Method Detection Limits. The relevant quantitation limits are established based on the most current MDL study. The current MDLs are maintained and can be found in the AlphaLIMS database.

5.6 Method Precision: To assure analytical precision of methods used, Laboratory Control Samples (LCS) are analyzed with each batch. LCS duplicates are analyzed with each batch when requested.

5.7 Method Bias (Accuracy) is determined by calculating recoveries of LCS of a similar matrix.

5.8 If uncertainty and total propagated uncertainty measurements are needed, they may be determined using GL-QS-E-014 for Quality Assurance Measurement Calculations and Processes.

## 6.0 DEFINITIONS

6.1 AlphaLIMS: The Laboratory Information Management System used at GEL Laboratories, LLC.

6.2 Analysis Date/Time: The date and military time (24-hour clock) of the introduction of the sample, standard, or blank into the analysis system.

6.3 Analytical Sample: Any solution of media introduced into an instrument on which an analysis is performed excluding instrument calibration, initial calibration verification (ICV), initial calibration blank (ICB), continuing calibration verification (CCV), and continuing calibration blank (CCB).

6.4 Calibration Standard (CAL): A solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

6.5 Continuing Calibration Blank (CCB): An aliquot of reagent water or other blank matrix that is analyzed after each CCV. The CCB is used to determine whether the analytical sequence is in control during sample analysis.

6.6 Continuing Calibration Verification (CCV) Standard: An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added. The CCV is analyzed exactly like a sample, periodically throughout the run sequence. Its purpose is to determine whether the analytical sequence is in control during the sample analysis. It may be prepared from the same source as the calibration standards, and is usually of varied concentrations.

6.7 Contract Required Detection Limit (CRDL): Minimum level of detection acceptable under the client project requirements or CLP Statement of Work.

6.8 Control Limits: A range within which specified measurement results must fall to be compliant. Control limits may be mandatory, requiring corrective action if exceeded, or advisory, requiring that noncompliant data be flagged.

6.9 Correlation Coefficient: A number (r) that indicates the degree of dependence between two variables (concentration-absorbance). The more dependent they are, the closer the value to one. Determined on the basis of the least squares line.

6.10 Data Qualifiers: The following qualifiers should be used in order to identify analytical situations that might need additional information stated in narrative before the release of the data.

U - Non-Detect. Below the Instrument or Method Detection Limit (depending upon specific project requirements)

B - Sample concentration value is between the MDL (or IDL) and the CRDL or analyte was detected in the Method Blank (Client Specific)

J - Sample concentration is between the MDL (or IDL) and the CRDL-client specific qualifier.

Blank - Concentration value is above the CRDL

* - An RPD value in the duplicate sample is out of criteria

N - A percent recovery value in the spike sample is out of criteria

E - A percent difference in the serial dilution sample is out of criteria because of the presence interference.

6.11 Duplicate: A second aliquot of a sample that is treated the same as the original sample in order to determine the precision of the method.

6.12 Initial Calibration Blank (ICB): An aliquot of reagent water or other blank matrix that is analyzed after each ICV. The ICB is used to determine whether there is carryover contamination.

6.13 Initial Calibration Verification (ICV): A solution of method analytes of known concentrations. The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

6.14 Instrument Performance Check Solution (IPC): A solution of one or more method analytes, surrogates, internal standards, or other test substances used to evaluate the performance of the instrument system with respect to a defined set of criteria.

6.15 Interferants: Substances that affect the analysis for the element of interest.

6.16 Internal Standard: Pure analyte(s) added to a sample, extract, or standard solution in known amounts and used to measure the relative responses of other method analytes.

6.17 Laboratory Control Standard (LCS): An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

6.18 Linear Calibration Range (LCR): The concentration range over which the instrument response is linear.

6.19 Method Blank (MB): An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. The MB is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

6.20 Method Detection Limit (MDL): The minimum concentration of an analyte that can be identified measured and reported with 99% confidence that the analyte concentration is greater than zero.

6.21 Serial Dilution: The dilution of a sample by a known factor. When corrected by the dilution factor, the diluted sample should agree with the original undiluted sample within the specified limits. Serial dilution may reflect the influence of interferants.

6.22 Spike (Matrix Spike or Post Spike): An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS or PS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS or PS corrected for background concentrations.

6.23 Limit of Detection (LOD): An analyte, method and matrix specific estimate of the minimum amount of a substance that can be reliably detected.GEL has established LOD = 2 x MDL.

6.24 Limit of Quantitation (LOQ): An analyte, method and matrix specific estimate of the minimum amount of a substance that can be reported with a specific level of confidence. The LOQ is set at or above the concentration of the lowest initial calibration standard. The laboratory must empirically demonstrate precision and bias at the LOQ. The LOQ and associated precision and bias must meet client requirements and must be reported. GEL uses the following guidance (LOD < LOQ):

When LOD < PQL, PQL = LOQ

When LOD > PQL, LOQ is raised to next lowest calibration standard.

6.25 Practical Quantitation Limit (PQL): The PQL is typically at or above the lowest point on an acceptable initial calibration curve. It may also be determined by multiplying the MDL by approximately 2 to 10. Concentrations of a target analyte determined to be greater than its PQL are defined as quantitative results. This limit is not used in DoD ELAP reporting.

6.26 Statistical Process Control (SPC) Limits: Statistically derived limits that establish acceptable ranges for recoveries of analytes of interest, including LCS, MS, MSD, PS and PSD.

6.27 Stock Standard Solution: A concentrated solution containing one or more method analytes prepared in the laboratory using certified reference materials or purchased from a reputable commercial source.

6.28 10% Frequency: A frequency specification during an analytical sequence allowing for not more than 10 analytical samples between required calibration verification measurement, as specified by the EPA methodology or CLP Statement of Work.

## 7.0 INTERFERENCES TO THE METHOD

7.1 Chemical interferences are minimal in ICP-MS Spectroscopy because the extremely high energy of the plasma breaks nearly all the chemical bonds. However, ICP-MS analysis is subject to the following three types of interferences:

7.1.1 Physical interferences are those physical properties of a sample solution that prevent their introduction to the plasma with efficiency equal to that of the calibration standards. This type of interference can be corrected via the bias correction calculation in SW-846, Chapter 1, paragraph 5.0, through the use of an internal standard in accordance with the instrument operating manual or by diluting the sample in reagent blank solution until the percent recovery falls with method guidelines.

7.1.2 Isobaric elemental interferences are caused by isotopes of different elements that form singly or doubly charged ions of the same nominal mass-to-charge ratio and that cannot be resolved by the mass spectrometer. If analytical isotopes are selected that may have an isobaric interference, then all data obtained under such conditions must be corrected by

measuring the signal from another isotope of the interfering element and subtracting the appropriate signal ratio from the isotope of interest.

7.1.3 Isobaric polyatomic ion interferences are caused by ions consisting of more than one atom that have the same nominal mass-to-charge ratio as the isotope of interest, and that cannot be resolved by the mass spectrometer in use. These ions are commonly formed in the plasma or interface system from support gases or sample components. Most of the common interferences have been identified and are listed in Method 200.8, Table 2 together with the method elements affected. Such interferences must be recognized, and when they cannot be avoided by the selection of alternative analytical isotopes or sample prep procedures, appropriate corrections must be made to the data.

## 8.0 SAFETY PRECAUTIONS AND HAZARD WARNINGS

8.1 PREVENT SKIN AND EYE CONTACT BY USING SPECIFIED PERSONAL PROTECTIVE EQUIPMENT WHEN MAKING STOCK REAGENTS.

8.2 WORK UNDER A HOOD TO PREVENT INHALATION WHEN MAKING STOCK REAGENTS.

8.3 Sample digestates are not extremely volatile or spontaneously combustible, but they are normally acidic and should be handled with care. Small spills may generally be wiped up with paper towels that can be disposed of in the trash. Larger spills may require the use of a mop, and the mop head may have to be disposed of as potentially hazardous waste in accordance with the Laboratory Waste Management Plan (GL-LB-G-001). If the spilled digestates begin any obvious fuming or reacting, pour a generous amount of the acid neutralizer, which is located in each lab, onto the spill before attempting to clean it up.

8.3.1 Gloves should be worn to avoid skin contact with digestate during clean-up.

8.3.2 Eye protection is required when handling samples and an eyewash station is located in each analysis lab.

8.3.3 Do not persist in cleaning up a spill in the presence of strong fumes. Move out of the area, try to isolate the area and notify your supervisor immediately.

8.4 Handling radioactive samples requires the use of gloves, a lab coat or an apron in addition to eye protection. Refer to GL-RAD-S-004 for Radioactive Material Handling

8.5 These instruments use high voltage electricity and therefore, should be shut completely down any time electronic components may be exposed to personnel or any liquids.

8.6 Wear eye protection with side shields while performing procedures in the lab.

8.7 All chemicals and samples should be treated as potential health hazards, and exposure to these chemicals must be reduced to the lowest level possible. GEL maintains a current awareness file of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of the chemicals in

the laboratory as well as a reference file of Material Safety Data Sheets (MSDS). These documents are maintained in the laboratory. Individual sample MSDS forms provided by the clients are kept in Login.

8.8 Personal protective equipment

8.8.1 Gloves are required when handling the chemicals in this procedure.

8.8.2 Work under a hood when using concentrated acids.

8.9 Prior to handling radioactive samples, analysts must have had radiation safety training and must understand their full responsibilities in radioactive sample handling. Some general guidelines follow:

8.9.1 Wear a lab coat when working with radioactive samples.

8.9.2 Prohibit admittance to immediate work area.

8.9.3 Protect counter tops with counter paper or work from radioactive sample handling trays.

8.9.4 Post signs indicating radioactive samples are in the area.

8.9.5 Take swipes of the counter tops upon completion of work. Deliver those swipes to the nearest swipe count box.

8.9.6 Segregate radioactive wastes. Radioactive waste containers are obtained from Waste Management.

8.10 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

8.10.1 Segregate solid wastes from liquid wastes in the satellite area containers.

8.10.2 Segregate oil wastes from water-soluble wastes in the satellite area containers

8.11 Never leave gas cylinders unchained or untied, including when they are on the moving carts.

8.12 In the event of an accident or medical emergency, call for help immediately. When time and safety permit, an accident report form should be completed and turned in to the safety committee.

8.13 Fire escape routes are posted in the lab; all personnel should be familiar with them. In addition, fire safety equipment such as fire extinguishers is located in the lab. Training is available on the proper operation of this equipment.

## 9.0 CAUTION WARNINGS

9.1 Because they can be health hazards, the exhaust gases from the plasma and vacuum systems must be eliminated through the laboratory's ventilation duct, which is attached to the instrument's exhaust vent. If inadequate ventilation occurs, pump-fluid vapor, ozone, and other toxic products of combustion can accumulate in the laboratory and cause bodily harm. Hydrofluoric acid (HF) fumes, if inhaled, extensively burn lung tissue. Ensure that the exhaust system established at installation continues to operate effectively.

9.2 Prepare sample and transfer acids using a hood to avoid fumes.

9.3 Store and prepare sample away from the instrument to minimize corrosion.

9.4 Clean up any spills quickly.

9.5 The drain vessel contains the spray chamber's effluent, which can be toxic. Corrosion of the vessel and connecting tube can result in leaks that damage the instrument or cause bodily harm.

9.5.1 Use the capped plastic drain vessel that was provided with the instrument. Never use glass.

9.5.2 Place the drain vessel on the instrument table below the peristaltic pump where the container is easy to check.

9.5.3 Check the drain vessel frequently. Empty it before it is three-fourths full.

9.5.4 Check the tubing and vessel for deterioration. If the tubing becomes brittle or cracked, replace it. Organic solvents cause more rapid deterioration than aqueous solutions.

9.6 The torch and interface remain hot after the plasma is turned off. Do not touch the torch box or interface cones for 10 minutes after the plasma has been shut off.

9.7 High voltages and radio frequencies are potential hazards of the ICP-MS. Shut the instrument down completely before removing any of the outside panels (to clean air filters, replace a fuse, etc.).

9.8 When changing the rotary pump oil, remember that the pump oil may be hot. The oil can cause a burn if allowed to contact the skin.

## 10.0 APPARATUS, MATERIALS, REAGENTS, EQUIPMENT, AND INSTRUMENTS

10.1 Apparatus and Equipment

10.1.1 Replacement special glass parts for the ICP-MS such as quartz torch bodies, injector tips and spray chambers may be ordered from a qualified vendor through the GEL Purchasing Agent and Inorganic Group Leader.

10.1.2 Replacement ICP-MS interface parts such as sampling cones, skimmer cones and ion-optics can be purchased from a qualified vendor through the GEL Purchasing Agent and Inorganic Group Leader.

10.1.3 Consumable materials such as tubing are often attainable from various scientific product companies. The GEL Purchasing Agent can help to find the best prices. These items may also be ordered from the instrument manufacturer if necessary. All orders must be placed through the GEL Purchasing Agent.

10.2 Reagents, Chemicals, and Standards

10.2.1 Reagents: Refer to Reagent Logbook

10.2.2 Standards: Refer to GL-LB-E-007 for Laboratory Standards Documentation and GL-LB-E-015 for Control of Laboratory Standards.

10.2.3 Other Chemicals: Additional compounds, surfactants, oils, cleaning agents, etc., may be routinely ordered through the GEL Purchasing Agent.

10.3 Instrumentation

10.3.1 Perkin Elmer ICPMS ELAN Model 6100 with IBM compatible PC, Monitor, Printer.

10.3.2 Perkin Elmer ICP-MS ELAN Model 9000 with IBM compatible PC Monitor, Printer.

10.3.3 CETAC Model ASX-500 Autosampler (PE 6100)

10.3.4 CETAC Model ASX-510 Autosampler with accessory autodiluter (PE 9000)

10.3.5 Neslab CFT75 recirculating bath provides cooling to the ICP-MS (PE 6100/ PE 9000)

10.3.6 CETAC ASXpress Rapid Sample Introduction System

## 11.0 SAMPLE HANDLING AND PRESERVATION REQUIREMENTS

11.1 Aqueous samples should be preserved with nitric acid to a pH of < 2 prior to receipt by the analyst. Solid samples should be kept at 0° ≤ 6° C prior to digestion.

11.2 Refer to GL-SR-E-001 for Sample Receipt, Login and Storage.

## 12.0 SAMPLE PREPARATION TECHNIQUES

12.1 All samples except drinking water with Turbidity < 1 NTU and samples specifically exempted by contract, are prepared in accordance with the following SOPs:

12.1.1 GL-MA-E-016 for Sample Preparation for Total Recoverable Elements by EPA Method 200.2 (USEPA Method 200.2)

12.1.2 GL-MA-E-006 for Acid Digestion of Total Recoverable or Dissolved Metals in Surface and Groundwater Samples for Analysis by ICP or ICP-MS (USEPA SW-846 Method 3005A)

12.1.3 GL-MA-E-008 for Acid Digestion of Total Metals in Aqueous Samples and Extracts for Analysis by ICP or ICP-MS (USEPA SW-846 Method 3010A)

12.1.4 GL-MA-E-009 for Acid Digestion of Sediments, Sludges and Soils (USEPA SW-846 Method 3050B)

12.1.5 GL-MA-E-021 for Total Digestion of Sediment Samples for Analysis by ICP or ICP-MS (ASTM D4698-92)

12.2 Additional filtration may be required to prevent clogging of sample introduction system.

12.3 All sample preparation records are stored in AlphaLIMS.

12.4 Sample spills should be handled as stated in Section 8.3.

## 13.0 EQUIPMENT AND INSTRUMENT MAINTENANCE

13.1 Routine Preventative and Special Operational (Failure)

13.2 Routine Preventative Maintenance (PM) Procedures are done as follows:

| Frequency | Procedure |
|---|---|
| When Needed | Clean nebulizer tip after use.<br>Replace peripump sample introduction tubing.<br>Change pump hoses on drain systems.<br>Check drain waste collection containers, and empty as necessary.<br>Check Neslab water level and add water if required.<br>Clean/replace interface cones.<br>Clean/replace nebulizer.<br>Clean/replace torch.<br>Check/replace water filter. |
| Quarterly | Change oil in interface rotary pump (or as needed).<br>Clean ion lenses 4-6 months (or as needed). |
| 6 Months | Clean air filters. |
| 12 months | Change pump oil in backing rotary pump.<br>Evaluate/replace EM (electron multiplier) |

13.3 Non-Routine Maintenance Procedures (Special, Operational or Failure Mode Maintenance)

13.3.1 If the instrument will not function properly see the trouble shooting section in the appropriate Maintenance Manual.

13.3.2 If the analyst is unable to determine cause/fix instrument, the GEL Service Engineer is called, and if needed, the manufacturer's customer support number may be found in the owner's maintenance manuals.

13.4 Refer to ICP-MS Maintenance Logbook for routine records. Service call records are also available.

## 14.0 PREPARATION OF STANDARD SOLUTION AND QUALITY CONTROL SAMPLES

14.1 Source standards records are recorded in AlphaLIMS.

14.2 Recommended Suppliers: Refer to source log and use Approved Vendors List maintained in Procurement.

14.3 Standards are receipted, labeled, prepared and stored in accordance with the GL-LB-E-007 for Laboratory Standards Documentation.

## 15.0 INSTRUMENT CALIBRATION

15.1 Samples may be analyzed manually or automatically.

15.1.1 Tuning for each instrument is performed daily according to the following directions and criteria.

15.1.2 PE 6100/ 9000: Aspirate a tuning solution consisting of 10 µg/L each of $^{9}$Be, $^{24}$Mg, $^{59}$Co, $^{115}$In and $^{208}$Pb. Perform 5 replicates. Manufacturer's recommended tune criteria are as follows:

| Parameter | Starting Point |
|---|---|
| $^{9}Be$ | ± 0.10 amu |
| $^{24}Mg$ | ± 0.10 amu |
| $^{59}Co$ | ± 0.10 amu |
| $^{115}In$ | ± 0.10 amu |
| $^{208}Pb$ | ± 0.10 amu |
| $Ba^{++}$ net intensity mean | < 0.05 or 5% |
| CeO net intensity mean | < 0.03 or 3% |
| Be, Mg, Co, In, Pb net intensity RSD | < 5% |
| Resolution at 10% peak height | < 0.9 amu |

15.1.3 Conduct additional tuning procedures as specified by client contract or other methodology.

15.1.4 If any of the preceding tune criteria does not meet the recommended requirements, investigate the problem, correct the situation, and reanalyze the tune sequence.

15.1.5 Standardization: Standardization is required on a daily basis.

15.2 Internal standards are used as appropriate for the analytes of interest. The internal standards are made in the appropriate acid and contain varying concentrations of such elements as $^{45}Sc$, $^{74}Ge$, $^{115}In$ and $^{175}Lu$. The internal standard solution is mixed in-line with the sample stream using a dedicated channel of the peristaltic pump. Internal standards may be added at the time of analysis as an alternative to in-line mixing. Alternate internal standards may be used to meet client needs.

15.3 Calculations are described in the instrument manual.

15.4 Calibration standards vary according to method and equipment. A minimum of two, a blank and value standard, is required.

15.5 For required quality control standards refer to Section 21.0.

15.6 For continuing calibration requirements refer to Section 21.0.

15.7 For what to do when initial or continuing calibrations fail to meet requirements, refer to Section 21.0.

## 16.0 INSTRUMENT PERFORMANCE REQUIREMENTS

16.1 Before samples may be analyzed to generate reportable data, the instrument must have been tuned and calibrated. Also, the Initial Calibration Verification (ICV), which is prepared from an independent source, Initial Calibration Blank (ICB), the Reportable Detection Limit (CRDL), the Interference Check Standards (ICS-A, ICS-AB), and the Linear Range Standards (LRS) must meet the requirements stated in Section 21.2 for each analyte being reported, unless otherwise required by methodology, clients or contracts.

16.2 The instrument calibration and all continuing verification data is maintained in the printed hard copy file. The printouts are kept in chronological order by instrument. Recent files are in the metals laboratory; older records are archived in short or long-term storage.

## 17.0 ANALYST AND METHOD VERIFICATION REQUIREMENTS

17.1 Analyst training is conducted and certified in accordance with the GL-HR-E-002 for Employee Training.

17.2 Method performance is verified by the conductance of MDL studies in accordance with GL-LB-E-001 for The Determination of Method Detection Limits, and by the evaluation of LCS and LCS duplicates for each batch of samples.

## 18.0 ANALYSIS PROCEDURES AND INSTRUMENTAL OPERATION

18.1 All samples are introduced in a set measured quantity, via a peristaltic pump, through a nebulizer into a spray chamber and carried with argon gas through the Radio Frequency (RF) field to generate analyte ions that are selected and measured by the quadruple mass spectrometer.

18.2 Run Sequence

18.2.1 Instrument Calibration executed in accordance with Section 16.

18.2.2 Initial Calibration Verification steps include:

18.2.2.1 ICV

18.2.2.2 ICB

18.2.2.3 CRDL (low level ICV for 6020A)

18.2.2.4 CRI (if required)

18.2.2.5 ICS-A

18.2.2.6 ICS-AB

18.2.2.7 CCV

18.2.2.8 CCB

18.2.2.9 LRS

18.2.2.10 CCV

18.2.2.11 CCB

18.2.3 Sample Run (10 samples or less)

18.2.4 Continuing Calibration Verification:

18.2.4.1 CCV

18.2.4.2 CRDL (for SW-846 Method 6020A only and analyzed at end of batch).

18.2.4.3 CCB

18.2.5 Repeat steps 18.2.3 and 18.2.4 until end of run or verification is out of specification. When the latter occurs, repeat step 18.2.1 and continue with steps 18.2.2 and 18.2.3.

18.2.6 Repeat steps 18.2.3 through 18.2.5 until the end of the run or verification is out of specification. When latter condition occurs, repeat 18.2.1 and continue sequentially through 18.2.7.

18.2.7 Final Verification Steps

18.2.7.1 CRI (if required)

18.2.7.2 ICS-A (if required)

18.2.7.3 ICS-AB (if required)

18.2.7.4 CCV

18.2.7.5 CRDL (for SW-846 Method 6020A only)

18.2.7.6 CCB

**NOTE**: Method 6020A only requires there to be a closing low level continuing calibration standard (CRDL). For ease of analysis, the CRDL standard can be analyzed every 10 samples.

18.3 For data storage refer to Section 24.1.

18.4 General operation of the instrument.

18.4.1 The Perkin Elmer Model 6100 and Perkin-Elmer Model 9000 are inductively-coupled argon plasma mass spectrometers. The ICP-MS is capable of determining analytes from m/z = 6 (Li) through m/z = 238 (U). The operating software of the system is based on Microsoft Windows.

18.4.2 Set-up

18.4.2.1 Attach the nebulizer argon line to the quick-connect on the nebulizer's argon tube and ensure that it is tightly in place.

18.4.2.2 Attach the nebulizer and endcap to the spray chamber.

18.4.2.3 Attach sample pump tubing to the front peristaltic pump (various sizes may be used depending on need), and attach feed end to endcap.

18.4.2.4 If running manually, place the suction end of the sample tubing in acidified rinse water; otherwise attach it to the autosampler.

18.4.2.5 Ensure that drain hose is connected to the spray chamber and properly plumbed through the drain peristaltic pump.

18.4.3 Run Procedure

18.4.3.1 Refer to the respective owner's manuals for specific instructions for tuning, sequence loading, and method development on each instrument; ELAN 6000/6100 software guide; ELAN 9000 software guide.

18.4.3.2 The owner's manual for each instrument is located in the ICP-MS laboratory.

18.4.4 Typical Analysis Problems

18.4.4.1 Sample Overrange: If a requested element is overrange for a sample, it is necessary to dilute the sample and rerun. Dilution factors must be taken into account when reporting final values.

18.4.4.2 Interferences: Although the ICP-MS can compensate for many interferences with appropriate correction factors, unpredicted interferences may still occur. If the analyst suspects this, then the sample should be diluted and rerun. Dilution factors must be taken into account when reporting final values.

18.4.4.3 Torch/Sample Introduction Drift: Various changes in torch plasma conditions or sample introduction can have a great effect on the detector counts. They must be corrected or the instrument must be re-standardized.

18.4.4.3.1 If oils or solid samples have been run, and the CCV is not acceptable, allow the instrument to rinse 15 to 20 minutes. If CCV is then acceptable, reanalyze the samples and continue. If the CCV again fails its requirements, re-standardize as necessary.

18.4.4.3.2 If sample introduction drift is suspected, check peristaltic pump tubing for collapse and replace as needed.

18.4.4.3.3 Tubing connections may become loose allowing air to bubble into the sample path. Tighten or replace tubing. If necessary, seal with Parafilm.

18.4.4.4 Serial dilution: If the analyte concentration is sufficiently high (minimally, a factor of 100 times above the IDL for non-DOE Clients, 100 x the MDL for DOE-Alb Clients, and 50 times the LOQ for DoD QSM in the original sample), an analysis of a five fold (1 + 4) dilution should agree within 10% of the original determination. If not, a chemical or physical interference effect should be suspected.

18.5 Power switches and auxiliaries

18.5.1 Each instrument has one main power switch. Refer to the respective maintenance manuals for the location (ELAN 6100 and ELAN 9000 Hardware Guide). This switch remains on except while servicing the instrument.

18.5.2 The computer system has 3 power cords all connected to a switchable power strip: the computer main, the monitor and the printer power cords. The power to these is left on while the instrument is not in use for short times (e.g. overnight).

18.5.2.1 The main computer switch is on the front of the CPU.

18.5.2.2 The ***monitor switch*** is on the front of the monitor itself.

**NOTE**: If the computer is left in use without an analyst present for an extended period of time, turn the monitor off to prevent screen burn-in.

18.5.2.3 The ***printer switch*** is on the lower front of the printer. Refer to printer manual for operating instructions.

18.5.3 Argon gas is provided through a manifold from the storage tank. Under normal conditions a constant argon flow is available.

18.5.4 Start-up

18.5.4.1 Before starting, ensure that the power is on and the vacuum system is switched on.

18.5.4.2 The owner's manual for each instrument provides specific instructions for ignition of the plasma (refer to Section 18.5.1 for software manuals).

18.5.4.3 The plasma should be steady and should not flicker.

18.5.4.4 Once ignition has occurred, levels may be adjusted; it is best to set levels appropriate to the method by loading or editing an appropriate tune file and allow 15 to 30 minutes for warm-up.

18.5.5 Shutdown

18.5.5.1 When the plasma is off, the instrument is either in Standby or Shutdown mode. The ICP-MS should be completely shut down only in case of major maintenance, relocation of the instrument, or when the lab is closed for an extended time.

18.5.5.2 Daily shutdown (if required): Refer to the respective owner's manual shutdown procedures (Refer to Section 18.5.1 for software manuals.)

18.6 Sample quantity requirements are approximately 5 mL for each run with the nebulizer. If out of specification or range, further sample may be necessary for reruns.

18.7 The autosampler can be used by attaching introduction tube to sample introduction system, and rinsing tubing to peristaltic pump and following autosampler table set-up and procedures. To define a sequence, refer to the appropriate software manual (refer to Section 18.5.1).

## 19.0 CALCULATIONS AND DATA REDUCTION METHODS

19.1 Any dilutions, concentrations, or preparation factors must be taken into account prior to reporting data to a client.

$$\text{Relative Percent Difference} = \frac{100 * |\text{Sample 1 Value} - \text{Sample 2 Value}|}{\frac{(\text{Sample 1 Value} + \text{Sample 2 Value})}{2}}$$

$$\text{Matrix Spike Recovery} = \frac{100 * (\text{Spike Value} * \text{DF} * \text{PF} - \text{Sample Value} * \text{DF} * \text{PF})}{\text{Spike Nominal Concentration} * \text{DF} * \text{PF}}$$

$$\text{Post Spike Recovery} = \frac{100 * (\text{Spike Value} - \text{Sample Value})}{\text{Spike Nominal Concentration}}$$

$$\text{LCS Recovery} = \frac{100 * (\text{Sample Value} * \text{DF} * \text{PF})}{\text{Nominal Concentration} * \text{DF} * \text{PF}}$$

Where: Sample Value = instrument reading for the sample
Spike Value = instrument reading for the spiked sample
DF = Dilution Factor
PF = Preparation Factor

Relative Error Ratio (RER) 2 sigma equation:

$$\text{RER} = \frac{|\text{Sample Activity} - \text{Duplicate Activity}|}{\sqrt{(\text{Sample 2 sigma TPU}/1.96)^2 + (\text{Duplicate 2 sigma TPU}/1.96)^2)}} = \leq 3$$

NOTE: Activity calculations can be found in Appendix 4 of this SOP. Two sigma TPU calculations can be found in SOP GL-QS-E-014.

19.2 Care must be taken that the correct units are being employed.

## 20.0 DATA RECORDING

20.1 ICP-MS data are generally stored to the hard disk drive of the ICP-MS computer system and printed at the instrument as each sample is analyzed.

20.2 ICP-MS samples are generally analyzed in three replicates (minimum of 2) and the reported value is the average of the replicates. The data for individual replicates is stored in the computer.

20.3 Data are processed locally by manual or programmable procedures to eliminate unused data, to enter dilution factors, and to enter relevant conversion factors prior to uploading to AlphaLIMS.

## 21.0 QUALITY CONTROL REQUIREMENTS

21.1 Frequency of Quality Control Activities (also refer to Appendix 1)

21.1.1 Initial Calibration Verification (ICV) is performed immediately following each calibration and Continuing Calibration Verification (CCV) is performed after at least every 10 samples.

21.1.2 Initial Calibration Blank (ICB) is performed immediately following the ICV and Continuing Calibration Blanks (CCB) must run with each CCV.

21.1.3 An Interference Check Standard (ICS) is analyzed at the beginning of each analytical run and at least once every twelve hours (if required). Additional requirements may be specified by client contract or methodology.

21.1.4 The PQL standard is analyzed after each calibration and recommended at least every 10 samples between the CCV and CCB analyses for SW-846 Method 6020A. Method 6020A requires analysis at the end of every batch and only recommends analysis every 10 samples. This standard may also be labeled as a CRDL standard. For CLP work, the CRI is analyzed at the

beginning and at the end of each analytical run, and at a minimum of two times per eight hours. For CLP analyses the CRI is analyzed at two times the CRDL or two times the IDL, whichever is greater.

21.1.5 A method blank (MB) is performed for each batch of 20 or fewer samples or per client requirement.

21.1.6 A matrix spike (MS) and a duplicate (DUP), or matrix spike and matrix spike duplicate (MSD) are analyzed for each batch of 20 or fewer samples or per client requirements.

21.1.7 A laboratory control sample (LCS) is analyzed with each batch of 20 or fewer samples. An LCS duplicate (LCS DUP) may be added if required by the client.

21.1.8 Serial dilutions or analytical spikes are analyzed to confirm the presence or absence of interferences when analyzing a new matrix type. The serial dilution is generally performed at a 5x of the test sample.

21.1.9 When performing CLP analyses, the serial dilution must be performed on a sample from each SDG of 20 samples or less.

21.1.10 When performing CLP analyses, a post-spike must be performed on the original sample when the matrix spike recovery falls outside the control limits and the sample result does not exceed 4x the spike added. Spike the unspiked aliquot of the sample at 2x the indigenous level or 2x the CRDL, whichever is greater. Post-spike analysis is not required for silver.

21.2 Acceptance Limits (also refer to Appendix 2)

21.2.1 ICV results must be between 90% and 110% of the true values for work under EPA SW-846 Method 6020A or EPA Method 200.8. CCV results must be between 90% and 110% of the true values for work under EPA Method 200.8 or SW846 Method 6020A.

**NOTE:** The ICV is the second source standard and may be used as the CCV as it also will show calibration verification.

21.2.2 ICB and CCB results must have an absolute value less than the Reporting Limit (RL). For DoD QSM analysis, the absolute value must be less than the LOD. If this is not the case, the reason for the out-of-control condition must be found and corrected, or any data reported must be 10 times greater than the absolute value for the element or less than the RL.

21.2.3 Interference Check Sample results must be monitored at the beginning of an analytical run or once every 12 hours, whichever is more frequent, for work under SW-846. The ISCA and ICSAB must recover 80-120% the reporting level for the spiked analysis and must have an absolute value less that 2x the reporting level for the non-spiked analyte. For DoD QSM, the ICSA must have an absolute value of less than the absolute value of the LOD analytes.

21.2.4 The Linear Range Standard (LRS) is analyzed within the calibration verification read back and must fall between 90% and 110% of the true values. Meeting these criteria allows target analyte concentration to be

reported up to the LRS concentration thus extending the calibration range of the instrument. Any sample concentrations above the LRS concentration will be diluted to fall below the concentration of the linear calibration range standard.

21.2.5 The intensities of all internal standards must be monitored for every analysis. When the intensity of any internal standard fails to fall between 30% and 120% (or 70% and 130% for SW-846 Method 6020A) of the intensity of that internal standard in the initial calibration then the sample must be diluted five fold (1 + 4) and reanalyzed with the addition of appropriate amounts of internal standards. The intensity levels of the internal standards for the calibration blanks (ICB and CCB) and instrument check standards (ICV and CCV) must agree within $\pm$ 20% of the intensity level of the internal standard of the original calibration solution. For work done under EPA Method 200.8, the internal standard responses of any one internal standard must not deviate more than 60% to 125% of the original response in the calibration blank. Four internal standards ($^{45}$Sc, $^{74}$Ge, $^{115}$In and $^{175}$Lu) are used to cover the mass ranges reported. Refer to Appendix 3 for list of internal standard/ analyte associations. Other exotic analytes may be used as needed. Refer to Section 15.2.

21.2.6 Method blank results must be lower than the PQL or less than 10% of the determined value of all samples in the batch. When performing work under EPA Method 200.8, if LRB (laboratory reagent blank) values are 10% or more of the analyte level determined for a sample or are 2.2 times the analyte MDL, then fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable LRB values have been obtained. For DoD QSM work, the absolute value must be less than ½ RL or less than 10% of the determined value of all samples in the batch. Al, Fe, Mg, Ca, Na, and K must be less than the RL.

21.2.7 LCS results, and LCS duplicate (if performed), must be within process control limits as established by Statistical Process Control, manufacturer's certification, or method requirements.

21.2.8 Matrix spikes with recoveries between 75% and 125% suggest the absence of interference for work under EPA Method 200.8. Matrix spikes with recoveries between 75% and 125% suggest the absence of interference for work under SW-846 Method 6020 and SW-846 Method 6020A. Matrix spikes with recoveries between 80% and 120% suggest the absence of inteferences for work under DoD QSM.

21.2.9 The relative percent difference (RPD) between a sample and a sample duplicate should be within ± 20% if the analyte concentration in the sample or duplicate is greater than 5 times the RL. If either the sample or duplicate concentration is less than 5 times the RL, the results should agree within the absolute value of the RL. Results less than the MDL or IDL are

not evaluated. The relative error ratio (RER) between a sample and a sample duplicate should be ≤ 3%.

21.2.10 Serial dilution results that agree within 10% of the original analytical results, if the original results are greater than 100 times the instrument detection limit or greater than 50 times the LOQ, suggest the absence of interference.

21.2.11 Post spikes with recoveries between 75% and 125% under EPA Method 200.8 and SW-846 Method 6020, and between 80% and 120% under SW-846 6020A suggest the absence of interference.

21.3 Out-of-Control Situations

21.3.1 ICV and/or CCV failure requires recalibration of the instrument and/or preparation of new standard solutions. Samples analyzed prior to or after calibration verifications that are not acceptable for required analytes must be reanalyzed. An ICV or CCV that has failed may be rerun once only if there is an attributable cause known to have affected the CCV only and not the previous samples. Examples of an acceptable cause may be a sample tip out of solution during analysis, an incorrectly prepared CCV, or obvious carryover in the CCV from a very high sample immediately prior to the CCV. If a CCV is reanalyzed, the data must be lined through, initialed and dated, and the reason for the rerun must be documented on the raw data. In addition, corrective action should be taken to eliminate the cause of the initial CCV failure to prevent future occurrence.

21.3.2 ICB and CCB failure requires recalibration of the instrument and/or calibration blank solution to be remade. The CCB is acceptable if the level of analyte in the corresponding sample(s) is 10 times greater or less than the PQL for the failing element. For DoD QSM work, the absolute values must be less than the LOD or less than 10% of the determined value of all samples in the batch.

21.3.3 ICS failure requires that the instrument be re-calibrated or the interferences be corrected, via recalculation, of Interelement Correction Factors so that the ICS can be read within the required limits before samples are analyzed. ICS failure at the end of an analysis period will require that the samples' ICSA run for the affected analyte(s) during that period to be reanalyzed. The ICSA and ICSAB must recover 80-120% for the spiked analytes and must have an absolute value less than 2x the reporting level for the non-spiked analytes. For DoD QSM, the ICSA must have an absolute value of less than the LOD for the non-spiked analytes.

21.3.4 LRS failures limit the reportable calibration range to the high standard in the calibration curve. Any sample concentration that falls above the high calibration standard will be diluted to fall within the calibration range.

21.3.5 Internal Standard failure requires one or more of the following: five-fold dilution of the sample, correction of the problem, termination of analysis, recalibration of the instrument, and/or reanalysis of the affected samples

depending on whether the failure is due to the samples or the instrumental drift.

21.3.6 Method blank results higher than the PQL and greater than 10% of any sample value in that batch that has concentrations above the PQL require that batch be redigested and reanalyzed. If the method blank results are less than -2x PQL there may be significant interference, calibration, or contamination problems with the sample, instrument, or calibration standards that must be resolved before the batch can be analyzed. For DoD QSM work, the absolute value must be less than ½ RL or less than 10% of the determined value of all samples in the batch. Al, Fe, Ca, Mg, Na, and K must be less than RL.

21.3.7 Matrix spikes, duplicates and spike duplicates are used only as indicators of method effectiveness on that sample and will not be used as acceptability criteria for the process, unless a special requirement of the client.

21.3.8 LCS and/or LCS duplicate results outside of established acceptance limits require the batch to be redigested and reanalyzed.

21.3.9 When analytical results suggest the presence of interference, one of the methods listed in Section 18.4.4.2 should be employed.

21.3.10 The CRDL standard should be evaluated, but no action is required if the results fall outside of the 70-130% advisory window. For DoD QSM, the CRDL standard must be 80-120% of the true value or recalibration is required. For SW-846 Method 6020A, the CRDL standard must be 70-130% of the true value or recalibration is required. This also includes the low level continuing calibration verification standard analyzed every 10 samples. Sample results can be evaluated for reporting if they are at least 2x the CRDL for a given analyte.

21.4 Corrective actions taken for data not conforming to the requirements in Section 21.2 are stated in Section 21.3. If these corrective actions can be taken by the analyst prior to the acceptance of the data, then no nonconformance documentation is required. However, if these corrective actions include redigestion of the batch or sample, if the data have already been accepted, or if the corrective action requires an instrument service call, then a nonconformance and/or corrective action report should be completed. This report includes the date, person requesting the action, sample(s) or batch(s) affected, and action requested, all provided by the requester. The person taking the action will provide any pertinent comments, their signature, and the date the action is completed. The disposition of the nonconformance will then be verified by the Quality Systems specialist. These reports will be kept on file. Refer to GL-QS-E-002 for Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items.

21.5 Analytical data are evaluated for conformance with the requirements stated in Section 21.2 by the analyst during and/or after the analysis, but before the data are entered into AlphaLIMS. Data may be accepted or rejected by the analyst at this point or by the data reviewer(s) as stated in Section 22.0.

## 22.0 DATA REVIEW, VALIDATION, AND APPROVAL PROCEDURES

22.1 After samples are analyzed, the data must go through the review process before it can be reported out of the lab. The analyst who performed the analysis will review the raw data prior to uploading it into AlphaLIMS. The upload process may be handled by the analyst or by a data entry clerk.

22.2 After the upload is complete, an AlphaLIMS data report is generated that will be passed (along with the batch sheet, data review checklist, and the raw data) to another analyst for a peer review. Discrepancies found in this review will be resolved before the batch data are passed and the status updated.

22.3 When this peer review is completed and all of the data are found to be acceptable, the reviewer signs and dates the batch data report and updates the status of the batch to done. If the sample is for a Federal client, the batch data report and all relevant information (dependent upon client contract) should be copied and delivered to the packaging group. If the reviewer determines that the reviewed data are not acceptable and requires additional work or correction, data are returned to the analyst or representative with an appropriate explanation.

22.4 Listed below are the data review responsibilities of the Analyst and Peer Reviewer:

22.4.1 Analyst Review is performed by the analyst who generated the data before the data are submitted for entry into AlphaLIMS. Analyst completes and attaches the run data cover sheet to the printout.

22.4.2 Peer Analyst Review is performed by an individual who did not perform the analysis but is familiar with the analytical method used and the reporting requirements. This person will review the complete data report after all data are entered, will ensure that any data entry corrections are made before data are approved, and will complete the reviewer portion of the data review check list. If the data do not meet the necessary quality requirements and need further analysis, they are returned to the analyst or representative.

22.5 A Third Review is performed for Data Packages (CLP/CLP-Like) and/or by client requirement. This review is by the Metals Team Validator or other qualified person.

22.6 Specific items that are reviewed at each level include the following:

22.6.1 Analyst Review: Before data is submitted for entry into AlphaLIMS.

22.6.1.1 All analyses in the batch are completed.

22.6.1.2 Any corrections and comments on the data are properly initialed and dated.

22.6.1.3 Proper standard identification numbers appear on the runlog to ensure traceability from the data to original source standards.

22.6.1.4 All data are complete and accurate in the AlphaLIMS data report.

22.6.1.5 Data acceptance limit criteria identified in Section 21.2 are met or an explanation given.

22.6.2 Peer Analyst Review: Before data are submitted for further review or update:

22.6.2.1 All data are complete and accurate in the AlphaLIMS Data Report.

22.6.2.2 Any exceptions or shortcomings have been sufficiently explained or corrected.

22.6.2.3 Data are reported in the proper units or an explanation is given.

22.6.2.4 Prep factor and dilution calculations by AlphaLIMS are present in the data report and AlphaLIMS calculations are correct.

22.6.2.5 LCS and Spike Recoveries and RPD calculations by AlphaLIMS are correct, and the values are within control limits.

22.7 When the data review is completed and the data have been reported out of the lab, they are bound with the batching sheet and kept on file in the lab.

22.8 The complete data review process requires the use of the Prep Log Book, Prep data report, batch sheet, AlphaLIMS data report, raw instrument data, and runlog.

## 23.0 DATA REPORTING

23.1 To report data after the review process has been completed:

23.1.1 Enter the AlphaLIMS program through an available terminal and select DATA MENU, BATCH ITEMS, CHANGE BATCH STATUS.

23.1.2 Enter the Batch Number and “Submit.”

23.1.3 Use the down arrow key to move the cursor down the new status column to the end. Change status from REVW to DONE and “Save.”

## 24.0 RECORDS MANAGEMENT AND DOCUMENT CONTROL

24.1 Records of the instrumental analysis, operation, and maintenance are maintained as follows:

24.1.1 Run logs are an accurate chronology of what the instrument did during a specified period of time. The logs detail the standard name or sample number for each standardization or analysis, the analyst identification, and the date and time of each analysis or standardization. This information is periodically retrieved from the instrument data files, printed in chronological sequence, and maintained as documentation of the sequence of events and as a reference for the raw data.

24.1.2 Extraction/Digestion Logs are maintained in accordance with the established procedures in the areas where these processes are performed.

24.1.3 Instrument Maintenance Logs are chronological representations of all maintenance activities involving the instrument operation. This record is kept in bound composition books and consists of the details of the action, who performed it, when it was performed, and when instrument was returned to operation.

24.1.4 Batch Sheets accompany the batch of samples through digestion and analysis and then accompany the raw analytical data through data entry and

data review until the batch status is changed to "DONE" in the laboratory. This record is maintained in the Metals group files.

24.1.5 Batch Data Reports are generated to be used in the peer data review. After the batch is reviewed, corrected if necessary, and updated to "DONE," the batch data report is stored with the Batch sheet.

24.1.6 Raw Instrument Data are generated as the analyses are performed and from AlphaLIMS after the data are entered and attached to the batch sheet to be used in the data review process and kept in the Metals group files.

## 25.0 LABORATORY WASTE HANDLING AND DISPOSAL: SAMPLES, EXTRACTS, DIGESTATES, AND REAGENTS

25.1 Standard solutions that must be disposed are taken to the Waste Disposal coordinator for disposal in accordance with Laboratory Waste Management Plan, GL-LB-G-001.

25.2 Sample digestates are stored in the lab for a specified period of time following analysis. At this time, they are composited into a waste container that is picked up by the Waste Management Technician for proper disposal.

25.3 Radioactive Waste:

25.3.1 Samples returned to sample storage

25.3.2 Drain waste collected in the radioactive waste carboy is dumped when full into the appropriate 55 gallon drum sitting outside the ICPMS laboratory. Ultimate disposal of liquid radioactive waste done by waste management department.

25.3.3 Implements, vials, gloves, etc., are wrapped and labeled with radioactive tape and placed in the radioactive waste container in high bay area.

25.3.4 Expired Standard Solutions: Refer to Section 25.1.

## 26.0 REFERENCES

26.1 Perkin Elmer ELAN 9000 Hardware Guide

26.2 Perkin Elmer ELAN 6100 Hardware Guide

26.3 Perkin Elmer ELAN 9000 Software Guide

26.4 Perkin Elmer ELAN 6000/6100 Software Guide

26.5 Test Methods for Evaluating Solid Waste: Laboratory Manual Physical/Chemical Methods. Volume 1A, USEPA SW-846, Third Edition, Revision 2, September 1994:

26.5.1 Method 6020A, "Inductively Coupled Plasma – Mass Spectrometry," Revision 1, February 2007.

26.5.2 Method 6020, "Inductively Coupled Plasma – Mass Spectrometry," Revision 0, September 1994.

26.5.3 Method 3005A, "Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by FLAA or ICP Spectroscopy", Revision 1, July 1992.

26.5.4 Method 3010A, "Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by FLAA or ICP Spectroscopy," Revision 1, July 1992.

26.5.5 Method 3050B, "Acid Digestion of Sediments, Sludges, and Soils", Revision 2, December 1996.

26.6 USEPA Method 200.8, "Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry," Revision 5.4, May 1994.

26.7 2001 Annual Book of ASTM Standard, D4698-92 "Standard Practice for Total Digestion of Sediment Sampler for Chemical Analysis of Various Metals."

26.8 Conversion Constants for Uranium Isotopes, Dr. Robert Litman, April 2009.

26.9 Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.2, October 25, 2010.

26.10 U.S. Department of Energy, Quality Systems for Analytical Services (DOE QSAS). Rev 2.6, November 2010.

## 27.0 HISTORY

Revision 24: Updated section on sample preparation techniques to include procedure GL-MA-E-016

Revision 23: Updated sections 15.2, 21.2.5 and Appendix 3 to four internal standards. Removed outdated SOP references.

Revision 22: Editorial corrections only.

# APPENDIX 1: FREQUENCY OF QUALITY CONTROL ACTIVITIES

(For illustrative purposes only)

Frequency of Quality Control Activities

| Method/ Frequency | SW-846 6020 | EPA 200.8 | SW-846 6020A |
|---|---|---|---|
| | | | |
| Calibration Std readbacks | Not required | Not required | Not required |
| Linear Range Std | Quarterly (may be more frequent per contract) | Quarterly (may be more frequent per contract) | Quarterly (may be more frequent per contract) |
| ICV | Per calibration | Per calibration | Per calibration |
| ICB | Per calibration | Per calibration | Per calibration |
| PQL/CRI (CLP) | Per calibration | Per calibration | Per calibration and at end of each analytical batch. |
| ICSA | Per calibration | Per calibration | Per calibration |
| ICSAB | Per calibration; every 12 hours after | Per calibration | Per calibration; every 12 hours after |
| CCV | Every 10 instrument runs | Every 10 instrument runs | Every 10 instrument runs |
| CCB | Every 10 instrument runs | Every 10 instrument runs | Every 10 instrument runs |
| Method Blank | 5% or per batch | 5% or per batch | 5% or per batch |
| LCS – liquid LCS – soil | 5% or per batch | 5% or per batch | 5% or per batch |
| Matrix Spikes | 5% or per request | 10% or per request | 5% or per request |
| Sample Duplicates | 5% or per request | 5% or per request | 5% or per request |
| Serial Dilutions | 5% or per request | 5% or per request | 5% or per request |
| Matrix Spike Duplicates | 5% or per request | 10% or per request | 5% or per request |
| Post-Digestion Spikes | 5% or per request | 10% or per request | 5% or per request |
| Linear Range Standard (LRS) | Per calibration | Per calibration | Per calibration |

## APPENDIX 2: ACCEPTANCE LIMITS

| Method/ Acceptance Criteria | SW-846 6020 | EPA 200.8 | DoD QSM | SW-846 6020A |
|---|---|---|---|---|
| Calibration Std readbacks | Not required | Not required | Not required | Not required |
| Linear Range Std | ± 10% of true value | ± 10% of true value | ± 10% of true value | ± 10% of true value |
| ICV | 90% - 110% | 90% - 110% | 90%-110% | 90% - 110% |
| ICB | < absolute value of RL | < absolute value of RL | < LOD | < absolute value of RL |
| PQL/CRI (CLP) | 70% - 130% advisory limits only | 70% - 130% advisory limits only | 80%-120% or investigate and recalibrate | 70% - 130% or investigate and recalibrate |
| ICSA | 80-120% for major components; ± 2x RL for non-spiked | 80-120% for major components; ± 2x RL for non-spiked | 80%-120% for major compounds; ± LOD for non-spiked | 80-120% for major components; ± 2x RL for non-spiked |
| ICSAB | 80%-120% | 80%-120% (may be requested) | 80%-120% | 80%-120% |
| CCV | 90% - 110% | 90% - 110% | 90%-110% | 90% - 110% |
| CCB | ± RDL | ± RDL | < LOD | ± RDL |
| Method Blank | ± RDL | ± RDL | ± ½ RL except for Al, Fe, Mg, Ca, Na, and K | ± RDL |
| LCS - liquid<br>LCS - soil | 80% - 120%<br>current SPC limits | 85% - 115%<br>current SPC limits | 80%-120% | 80% - 120%<br>current SPC limits |
| Matrix Spikes | 75% - 125%, when applicable | 75% - 125%, when applicable | 80%-120% | 75% - 125%, when applicable |
| Sample Duplicates | 0% - 20% when greater than 5X RL, ± RL when less than 5X RL | 0% - 20% when greater than 5X RL, ± RL when less than 5X RL | 0% - 20% when greater than 5X RL, ± RL when less than 5X RL | 0% - 20% when greater than 5X RL, ± RL when less than 5X RL |
| Serial Dilutions | 0% - 10% of initial raw value, when applicable | 0% - 10% of initial raw value, when applicable | 0% - 10% of initial raw value, when applicable (> 50x LOQ) | 0% - 10% of initial raw value, when applicable |
| Post-digestion spikes | 75%-125%, when applicable | 75%-125%, when applicable | 75%-125% | 80%-120%, when applicable |
| Internal Standards | 30%-120%, samples 80%-120% for ICB, ICV, CCV, CCB | 60%-125% for all | 30%-120% | 70%-130%, for all |
| Matrix Spike Duplicate | 0% - 20% when greater than 5X RL, ± RL when less than 5X RL | 0% - 20% when greater than 5X RL, ± RL when less than 5X RL | 0% - 20% when greater than 5X RL, ± RL when less than 5X RL | 0% - 20% when greater than 5X RL, ± RL when less than 5X RL |
| Linear Range Standard (LRS) | 90%-110%, or up to the high calibration standard | 90%-110%, or up to the high calibration standard | 90%-110%, or up to the high calibration standard | 90%-110%, or up to the high calibration standard |

## APPENDIX 2-Cont'd

| Method/ Acceptance Criteria | SW-846 6020 | EPA 200.8 | DoD QSM | SW-846 6020A |
|---|---|---|---|---|
| Sample Duplicates RER activity | ≤ 3% | ≤ 3% | ≤ 3% | ≤ 3% |

## APPENDIX 3: INTERNAL STANDARDS WITH ASSOCIATED ANALYTES/ISOTOPES

| IS $^{45}$Sc | IS $^{74}$Ge | IS $^{115}$In | IS $^{175}$Lu |
|---|---|---|---|
| $^{7}$Li | $^{66}$Zn | $^{88}$Sr | $^{133}$Cs |
| $^{9}$Be | $^{67}$Zn | $^{90}$Zr | $^{135}$Ba |
| $^{11}$B | $^{68}$Zn | $^{93}$Nb | $^{137}$Ba |
| $^{23}$Na | $^{75}$As | $^{98}$Mo | $^{139}$La |
| $^{24}$Mg | $^{77}$Se | $^{102}$Ru | $^{140}$Ce |
| $^{27}$Al | $^{82}$Se | $^{105}$Pd | $^{141}$Pr |
| $^{31}$P | $^{83}$Kr | $^{107}$Ag | $^{142}$Nd |
| $^{39}$K | | $^{111}$Cd | $^{152}$Sm |
| $^{43}$Ca | | $^{114}$Cd | $^{153}$Eu |
| $^{47}$Ti | | $^{120}$Sn | $^{158}$Gd |
| $^{51}$V | | $^{121}$Sb | $^{159}$Tb |
| $^{52}$Cr | | $^{123}$Sb | $^{195}$Pt |
| $^{53}$Cr | | | $^{197}$Au |
| $^{55}$Mn | | | $^{205}$Tl |
| $^{57}$Fe | | | $^{208}$Pb |
| $^{59}$Co | | | $^{232}$Th |
| $^{60}$Ni | | | $^{233}$U |
| $^{63}$Cu | | | $^{234}$U |
| $^{65}$Cu | | | $^{235}$U |
| | | | $^{236}$U |
| | | | $^{238}$U |

# APPENDIX 4: RADIOCHEMISTRY CONVERSION CALCULATIONS FOR URANIUM ISOTOPES

Conversion for liquids (µg/L x CF = pCi/L)

$^{233}$U (µg/L to pCi/L) = 9640.6
$^{234}$U (µg/L to pCi/L) = 6224.9
$^{235}$U (µg/L to pCi/L) = 2.1615
$^{236}$U (µg/L to pCi/L) = 64.698
$^{238}$U (µg/L to pCi/L) = 0.33627

Conversion for solids (mg/kg x CF = pCi/g)

$^{233}$U (mg/kg to pCi/g) = 9640.6
$^{234}$U (mg/kg to pCi/g) = 6224.9
$^{235}$U (mg/kg to pCi/g) = 2.1615
$^{236}$U (mg/kg to pCi/g) = 64.698
$^{238}$U (mg/kg to pCi/g) = 0.33627

**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

# FOR

# NITROAROMATICS AND NITRAMINES

# BY

# HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC)

## (GL-OA-E-033 REVISION 21)

APPLICABLE TO METHODS:
EPA SW-846 Methods 8330, 8330A and 8000C

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## 1.0 STANDARD OPERATING PROCEDURE FOR NITROAROMATICS AND NITRAMINES BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC)

## 2.0 METHOD CODES

2.1 EPA SW-846 Method 8000C

2.2 EPA SW-846 Method 8330A

2.3 EPA SW-846 Method 8330

## 3.0 METHOD SUMMARY, OBJECTIVE AND PURPOSE

3.1 This is a liquid chromatographic procedure for quantitatively determining trace analysis of explosives residues. The analytical guidance for the detection and quantitation of the applicable nitroaromatics and nitramines has been taken from Methods 8330A, 8330 and 8000C of "Test Methods for Evaluating Solid Waste,".

3.2 This method applies to groundwater, soil, leachates, and miscellaneous matrices. Referenced procedures are 8330A, 8330 and 8000C of "Test Methods for Evaluating Solid Waste,".

3.3 The following compounds can be quantitatively determined by this procedure:

| Compound Name | Abbreviation | CAS No. |
|---|---|---|
| Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine | (HMX) | 2691-41-0 |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine | (RDX) | 121-82-4 |
| 1,3,5-Trinitrobenzene | (1,3,5-TNB) | 99-35-4 |
| 1,3-Dinitrobenzene | (1,3-DNB) | 99-65-0 |
| Methyl-2,4,6-trinitrophenylnitramine | (Tetryl) | 479-45-8 |
| Nitrobenzene | (NB) | 98-95-3 |
| 2,4,6-Trinitrotoluene | (2,4,6-TNT) | 118-96-7 |
| 4-Amino-2,6-dinitrotoluene | (4-Am-DNT) | 19406-51-0 |
| 2-Amino-4,6-dinitrotoluene | (2-Am-DNT) | 355-72-78-2 |
| 2,4-Dinitrotoluene | (2,4-DNT) | 121-14-2 |
| 2,6-Dinitrotoluene | (2,6-DNT) | 606-20-2 |
| 2-Nitrotoluene | (2-NT) | 88-72-2 |
| 3-Nitrotoluene | (3-NT) | 99-08-1 |
| 4-Nitrotoluene | (4-NT) | 99-99-0 |
| 3,4-Dinitrotoluene | (3,4-DNT) | 610-39-9 |
| Pentaerythritol Tetranitrate | (PETN) | 78-11-5 |
| Nitroglycerin | | 55-63-0 |

3.4 This method provides the High Performance Liquid Chromatographic (HPLC) conditions for the detection of trace levels of explosive residue. Prior to use of this method, samples must undergo an extraction procedure. (Refer to Appendix 1 for solid 2 and Appendix 2 for liquids). A portion of the extract is injected into the HPLC system. The sample then passes through the reverse phase column that

performs analyte separation. The separated analytes then pass through the Diode Array Detector (DAD). The output of the detector is sent to the ChemStation Software package that collects, process, and quantifies the signals from the detector into usable data. Analyte confirmation is performed using a cyano column. Due to the co-elutions on the cyano column, confirmation analysis is for qualitative purposes only.

## 4.0 METHOD PERFORMANCE ANALYST VERIFICATION

4.1 For liquid and solid matrix method detection limits (MDLs) and practical quantitation limits (PQLs), refer to AlphaLIMS for current limits.

4.2 Method Precision: Refer to current statistical process control (SPC) charts for relative percent difference (RPD) limits.

4.3 Laboratory control sample (LCS) %Recovery and LCS-LCSD RPD: Refer to current SPC charts for % recovery limits and RPD.

4.4 Method Bias: Refer to SPC limits for current surrogate recovery.

4.5 Statistical process control (SPC) limits are determined semi-annually and stored in the laboratory AlphaLIMS database.

## 5.0 DEFINITIONS

5.1 Calibration Blank: A volume of reagent water without the analytes, internal standards, or surrogates used within the calibration curve.

5.2 Calibration Standard (CAL): A solution prepared from the primary stock solution. The CAL solutions are used to calibrate the instrument.

5.3 Check Standard (CCV/ICV): A solution of the method analytes used to evaluate the performance of the instrument with respect to a defined set of criteria. The check standard concentration is at the calibration midpoint and is prepared from a separate source than the calibration standards.

5.4 Initial Calibration Verification (ICV): A solution of target analytes with a concentration near the mid-point of the calibration range. It is created from a second source vendor, independent from the standard used for the initial calibration. It is analyzed following an initial calibration.

5.5 Continuing Calibration Verification (CCV): A solution of target analytes with a concentration near the mid-point of the calibration range. It can be created from the same source used for the initial calibration, or another second source vendor. It is analyzed following an initial calibration. It is analyzed to verify the initial calibration at a frequency described in the determinate method.

5.6 ChemStation: Software package used to control HPLC instruments including data acquisition and temporary storage.

5.7 DAD: Diode array detector

5.8 Field Duplicate (FD): Two separate samples collected at the same time, placed under identical conditions, and treated exactly the same way throughout the field and laboratory process.

5.9 HPLC: High performance liquid chromatography

5.10 Linear Calibration Range (LCR): The calibrated concentration range over which the instrument response is linear.

5.11 Laboratory Control Sample (LCS): An aliquot of reagent water to which a known quantity of the method analyte is added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine if methodology is in control.

5.12 Matrix Spike (MS): An aliquot of a known sample to which known quantities of the method analytes are added in the laboratory. The MS is analyzed like a sample and its purpose is to evaluate the accuracy of the method.

5.13 Method Blank (MB): An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents and reagents that are used with other samples. The method blank is used to determine if method analytes or other interferences are present in the laboratory environment.

5.14 Sample Duplicate (DUP): A duplicate of a selected sample. The DUP will demonstrate analytical precision.

5.15 Statistical Process Control (SPC) Limits: Statistically derived limits that establish acceptable ranges for recoveries of analytes of interest, including LCS, MS, MSD, PS, PSD and internal standards.

5.16 TARGET: Data Analysis Software used to process and store analytical data.

5.17 UV 3D: Three-dimensional view of the UV spectrum (used for compound verification.)

5.18 Reporting Limit (RL): The level at which a target analyte would meet the data quality objectives of the laboratory and/or a project, which may include establishing compliance with a regulatory and/or action limit.

## 6.0 METHOD VARIATION

6.1 Referenced procedure requires that each organization develop a method of verifying possible explosive compounds. By using the full spectrum of the DAD, positive verification can be supported by comparing the suspect compound spectrum against a compound standard spectrum. Positive verification can be accomplished by a second column confirmation analysis.

6.2 SW-846 method 8330A sample extraction method is incomplete, and detection limits are unattainable as described. GEL has developed an extraction technique that does obtain the required MDL for solids and is within the acceptable range for liquids. The use of solid phase extraction (SPE) may be employed for liquid samples using SW 846 Method 3535. The soil extraction technique is described in Appendix 1. The SPE technique is described in Appendix 2.

6.3 For soil extraction procedure: Due to the nature of the calculation in determining final concentration within AlphaLIMS, a correction factor is added to the prep data prior to entering the data. When soil samples are prepped, half of the extraction fluid is discarded in the filtering and transferring stage to the sample vial. Due to the loss of half of the fluid during the extraction procedure, the final volume is corrected to compensate for the loss. Normally the final volume would be 5 mL. However, since one half of the solution was discarded prior to finishing

the extraction, one half the amount of target analyte(s), if present, is also discarded. To compensate, the final volume entered into AlphaLIMS is 10 mL.

6.4 The final extract solvent for all samples is acetonitrile. If some of the standards were in methanol, some problems may be introduced into the sample analysis. These may include but are not limited to peak broadening, retention time shift, and poor elution of peaks. By using the same solvent for standards and samples, these problems and others are kept to a minimum.

## 7.0 SAFETY PRECAUTIONS AND WARNINGS

**WARNING**

ALL OF THESE COMPOUNDS ARE EITHER USED IN THE MANUFACTURE OF EXPLOSIVES OR ARE THE DEGRADATION PRODUCTS OF THE COMPOUNDS USED FOR THAT PURPOSE. WHEN MAKING STOCK SOLUTIONS FOR CALIBRATION, TREAT EACH COMPOUND WITH THE UTMOST CAUTION.

THIS METHOD IS RESTRICTED TO PERSONNEL EXPERIENCED WITH THE USE OF HPLC, SKILLED IN THE INTERPRETATION OF CHROMATOGRAMS, AND EXPERIENCED WITH EXPLOSIVE MATERIALS. WORK UNDER A HOOD TO PREVENT INHALATION WHEN MAKING STOCK REAGENTS.

**WARNING**

STANDARD PRECAUTIONARY MEASURES USED FOR HANDLING OTHER ORGANIC COMPOUNDS SHOULD BE SUFFICIENT FOR THE SAFE HANDLING OF THE ANALYTES TARGETED BY THIS METHOD. THE ONLY EXTRA CAUTION THAT SHOULD BE TAKEN IS WHEN IT IS NECESSARY TO HANDLE NEAT MATERIAL OR IN THE RARE CASE OF HIGHLY CONTAMINATED SOIL SAMPLES.

**WARNING**

ALL SAMPLES SHOULD BE SCREENED PRIOR TO SHIPMENT. ANY SAMPLES WITH A CONCENTRATION ABOVE 1% TOTAL EXPLOSIVES WILL BE PULLED FROM THE SYSTEM AND HELD IN THE HPLC ROOM. THE PROJECT MANAGER, TEAM LEADER, AND CLIENT WILL BE NOTIFIED. NO ACTION WILL BE TAKEN ON THE SAMPLE UNTIL A RESOLUTION AND SAFE HANDLING REQUIREMENTS ARE DETERMINED.

7.1 Wear eye protection with side shields while in the laboratory.

7.2 Treat all chemicals and samples as potential health hazards, and limit exposure to these chemicals to the lowest level possible. GEL maintains a current awareness file of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of chemicals. A reference file of Material Safety Data Sheets (MSDS) and individual client MSDS forms are also maintained.

7.3 Personal protective equipment

7.3.1 Gloves are required when handling the chemicals in this procedure. The gloves approved for this procedure are:

7.3.1.1 Nitrile gloves for concentrated acids and bases.

7.3.1.2 Latex gloves or equivalent will be worn at all times when handling any solvents or samples within the prep area.

7.3.1.3 For prolonged handling of solvents Chemi-Pro gloves should be worn.

7.3.1.4 For handling explosives with high concentrations (1 to 5%), leather gloves and face shield are required during the drying and grinding phase of the sample extraction.

7.3.1.5 For samples with high level explosives (greater then 5%), special instructions will be generated specifically for handling that sample and a copy retained with the data.

7.3.2 Work under a hood when using concentrated acids and bases.

7.4 Prior to handling radioactive samples analysts must have had radiation safety training and understand their full responsibilities in radioactive sample handling. Some general guidelines follow:

7.4.1 Wear a plastic apron over lab coat when working with radioactive samples.

7.4.2 Protect counter tops with counter paper or work from radioactive sample handling trays.

7.4.3 Prohibit admittance to immediate work area.

7.4.4 Post signs indicating radioactive samples are in the area.

7.4.5 Take swipes of the counter tops upon completion of work. Deliver those swipes to the designated swipe count box.

7.4.6 Segregate radioactive wastes in radioactive waste containers provided by Waste Management.

7.5 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

7.5.1 Segregate solid wastes from liquid wastes in the satellite area containers.

7.5.2 Segregate oil wastes from water-soluble wastes in the satellite area containers.

7.6 Never leave gas cylinders unchained or untied, even when they are on the cylinder carts. The helium and air tanks should be replaced when pressure drops to approximately 500 psi.

7.7 The compounds of interest are considered fire and explosion hazards in their pure form. When diluted to less then 33%, the primary hazard is the solvent, not the explosive material itself. If for any reason it is suspected that the explosives have recrystallized or particles of explosive exist in the sample, it will be treated as a pure explosive compound.

**NOTE:** The solvents used in the method are considered flammable and are handled in accordance with all MSDS sheets. The volume of solvents is minimized, but not to preclude performing routine analysis.

## 8.0 INTERFERENCES

8.1 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines, causing misinterpretation of the chromatograms. All of these materials must be demonstrated to be free from interferences, under the conditions of the analysis, by running method blanks.

Specific selection of reagents and purification of solvents by distillation in all-glass systems may be required.

8.2 Interferences from phthalates can best be minimized by avoiding contact with any plastic materials. Exhaustive cleanup of reagents and glassware may be required to eliminate background phthalate contamination.

8.3 Interferences co-extracted from the sample will vary considerably from source to source. Although a general cleanup technique is provided as part of the method, individual samples may require additional cleanup approaches to achieve the sensitivity required.

8.4 The chromatographic conditions described allow for a unique resolution of the specific explosive compounds covered by this method. Other explosive compounds, in addition to matrix artifacts, may interfere.

## 9.0 APPARATUS AND MATERIALS; REAGENTS; EQUIPMENT AND INSTRUMENTS

9.1 General items:

9.1.1 Microliter syringes

9.1.2 12 mL amber vials with Teflon-lined septum and screw caps

9.1.3 Graduated cylinders: 1000 mL, 25 mL, 10 mL

9.1.4 PTFE filters 0.45 µm or greater

9.1.5 5 mL and 10 mL syringes

9.1.6 20 mL scintillation vials

9.1.7 40 mL amber vials

9.1.8 Weigh boats, large and small capacity

9.1.9 Dropper bottle

9.1.10 Concentrator tubes or equivalent

9.1.11 Sieves, 30 mesh

9.1.12 Sep-Pak vacuum manifold

9.1.13 Sep-Pak reservoirs

9.1.14 Flow control valves

9.1.15 Sep-Pak Porapak RDX Cartridges (6cc/500mg)

9.1.16 Sep-Pak adapters

9.1.17 Tubing, Tefzel, 1/8-inch O.D.x 0.040 inch I.D.

9.1.18 Vacuum trap

9.1.19 Teflon liners

9.2 Chemicals: (Vendors listed are subject to change)

9.2.1 Acetonitrile ($CH_3CN$), HPLC grade or better (presently purchased from VWR)

9.2.2 Methanol ($CH_3OH$), HPLC grade or better (presently purchased from VWR)

9.2.3 8330 Standards (presently purchased from AccuStandard, Restek, and Absolute)

9.2.4 HPLC grade water or better

9.2.5 Surrogate: 3,4-Dinitrotoluene or suitable surrogate (presently purchased from AccuStandard).

9.2.6 Acetone ($CH_3COCH_3$), HPLC grade or better (presently purchased from VWR)

9.2.7 Isopropanol $(CH_3)_2CHOH$, HPLC grade or better (presently purchased from Burdick and Jackson).

9.2.8 Calcium chloride ($CaCl_2$), anhydrous form presently purchased from J.T. Baker: Dissolve 5 g $CaCl_2$ in 1 L DI water.

9.3 Equipment:

9.3.1 Phenomenex 5 µm ODS 250 x 4.6 mm C18 reverse phase column for primary analysis. Confirmation analysis may be performed using a Waters Nova-pak C8, 4 µm, 3.9 X 100 mm column in tandem with a Waters Nova-pak Cyano 4 µm, 3.7 X 100 mm column or a by only using a Phenomenex Develosil Cyano 250 x 4.6 mm column.

9.3.2 Gradient pumping system HP model 1100

9.3.3 Software capable of linear calculations

9.3.4 DAD HP model or equivalent

9.3.5 Ultrasonic sink with chiller

9.3.6 Vortex mixer

9.3.7 Drying oven without heat element

9.3.8 Computer, capable of running Windows-based programs and capable of controlling analytical instruments

9.3.9 Phenomenex Guard column Kit, Part # K10-4282, with C18 cartridges, Part# AJ0-4287.

**NOTE:** The apparatus listed above is the recommended instrumentation. The equipment listed is not all of the required equipment, but just a minimum needed to complete the analysis.

9.3.10 HPLC C
Computer: HP Kayak XC
Software: Agilent ChemStation for LC 3D Rev. A.08.03

9.3.11 HPLC D
Computer: DELL PowerEdge 1300
Software: Agilent ChemStation for LC 3D Rev. A.08.03

9.3.12 HPLC E
Computer: Compaq EVO
Software: Agilent ChemStation for LC 3D Rev. A.08.03

9.3.13 HPLC F
Computer: HP Compaq
Software: Agilent ChemStation for LC 3D Rev. A.09.03

## 10.0 SAMPLE HANDLING AND PRESERVATION REQUIREMENTS

10.1 Samples must be collected in an amber glass bottle with a Teflon-lined cap. The collection container must be washed with acetone, rinsed with hexane, and dried before use in order to minimize contamination.

10.2 Samples must be protected from light and stored at 0° ≤ 6°C after collection. All liquid samples have a holding date of seven days from the date of collection to the time of extraction. All solid samples have a holding date of 14 days from the date of collection to the time of extraction. Once extracted, the extract must be analyzed within 40 days of the extraction date. However, during this period of time, the extracts should be kept refrigerated at 0° ≤ 6°C in amber vials with Teflon-lined screw caps. When holding dates are missed, the data should be flagged and a NCR generated by the analyst.

10.3 If the sample is outside of the holding time window, notify applicable project manager for guidance.

## 11.0 SAMPLE PREPARATION TECHNIQUES

11.1 Refer to Appendix 1 for the extraction of solid explosive samples.

11.2 Refer to Appendix 2 for the extraction of liquid explosive samples by solid phase extraction method.

## 12.0 PREPARATION OF STANDARDS SOLUTIONS AND QUALITY CONTROL STANDARDS

12.1 Standard Solutions:

12.1.1 Source standard solutions are prepared commercially by AccuStandard or other certified suppliers for nitroaromatics and nitramines. They are stored in a breakseal amber vial or equivalent in the refrigerator at 0° ≤ 6°C. They are replaced according to the expiration date designated on the vial by the vendor, or one year from the date of receipt, whichever time period is shorter.

12.1.2 Calibration Standards are prepared at a minimum of five concentration levels for each compound. They are prepared by diluting the stock solution with a 1:1 (v/v) mixture of calcium chloride DI water and acetonitrile mixture. The concentration ranges for the calibration standards are found in AlphaLIMS. Refer to AlphaLIMS for appropriate protocols for making all calibration and quality control samples.

12.1.3 Calibration check standard is a standard from a different source and/or lot than the calibration standards. It is used to verify that the instrument is calibrated correctly. The reading of the check standard must be within 85% - 115% of the initial calibration. The stock for the check standards is commercially prepared by an approved vendor. It should be stored in a Teflon-lined screw cap vial at 0° ≤ 6°C. The concentrations of the

check standards should be prepared at the mid point of the curve. Refer to AlphaLIMS for current concentrations and recipe for preparing check standards. The calibration check standard is diluted with a 1:1 (v/v) mixture of calcium chloride DI water and acetonitrile.

**NOTE:** For DoD QSM projects the ICV/CCV criterion is as follows: All analytes $\pm$ 20% of expected value.

12.1.4 The surrogate, 3,4-dinitrotoluene or a suitable substitute is made from AccuStandard M-8330-IS-PAK. The analyte is at 1000 µg/mL.

12.1.5 1:1 (v/v) mixture of calcium chloride DI water and acetonitrile can be made by taking equal volumes of calcium chloride DI water and acetonitrile.

12.2 The source standards are received with certificates of analysis, which are maintained in Quality Systems. Upon arrival the source standard is given a unique identification number. The date received is written on the bottle and/or vial and initialed. The standard is then stored in the refrigerator at $0° \leq 6°C$ until needed. Refer to GL-OA-E-002 for Organic Standards Preparation and Traceability for explanation. The complete number is then logged into AlphaLIMS. The supplier, concentration, lot number, date opened, date received, and expiration date must also be entered, if available. The standard should be checked for signs of evaporation before use. After the standard has been opened, it is only usable until the expiration date assigned by the vendor, or one year from the date of receipt, unless it shows signs of deterioration before this time period has elapsed.

12.3 When a standard is prepared, an identification number is assigned to that standard. If another standard is prepared by diluting the first, the diluted standard must also be given a unique identification number.

12.4 All standards are maintained in the explosion proof refrigerator, number 22.

12.5 Holding times of specific calibration standards are defined in Method 8330. More specifically, those working standards prepared with the addition of water in the final step are to be used the same day as prepared. An expiration date of 24 hours is used for these standards.

12.5.1 No specifically defined holding time is mentioned for intermediate standards above 1000 µg/L or working standards that do not include the addition of water in their prep instructions in Method 8330A. GEL Laboratories assigns an expiration date to these standards equal to but not exceeding the earliest expiration date of any source standard used to make one of these working standards.

12.5.2 Section 7.6.2.2 of Method 8330A, Revision 2, December 1996, refers to the holding times of intermediate standards that cover a range of 2.5 to 1000 µg/L. Any intermediate standard falling within this range may be used for thirty days.

12.5.3 Expiration dates of standards are written on each standard's vial label and are recorded in AlphaLIMS.

12.6 Proper procedures for standard preparation are located in GL-OA-E-002 for Organic Standards Preparation and Traceability.

## 13.0 INSTRUMENT CALIBRATION AND PERFORMANCE

13.1 Instrument setup and configuration.

13.1.1 Recommended system setup for primary analysis.

13.1.2 Due to co-elution with 3,4-dinitrotoluene, nitroglycerin is performed under a separate method. The general gradient is:

| Time (min) | % Water | % MeOH |
|---|---|---|
| 0 | 55 | 45 |
| 28 | 50 | 50 |
| 30 | 50 | 100 |

**NOTE:** A separate LCS containing nitroglycerin and 3,4-dinitrotoluene is spiked when nitroglycerin is requested.

13.1.2.1 Initial flow rate set to 0.7 mL/min with a gradient of 52% methanol and 48% HPLC grade water. Gradient after this point is column dependent and will be generated upon installation of a new column. The general gradient is:

| Time (min) | % Water | % MeOH |
|---|---|---|
| 0 | 48 | 52 |
| 35 | 48 | 52 |

13.1.2.2 The DAD is programmed throughout the run cycle to shift monitoring wavelengths. Presently wavelengths 214, 224, 235, 254, and 264 nm are monitored and quantitated. With our present system we are capable of monitoring multiple signals. We have picked the above wavelengths due to their respective response factors.

13.1.2.3 The current injection volume is 100 µL. This volume is programmable and can be changed as necessary. Each time the injection volume is changed, the system must be recalibrated and new MDLs generated.

13.1.2.4 Recommended system set up for confirmation analysis:

| Time (min) | % Water | $CH_3CN$ |
|---|---|---|

| | | |
|---|---|---|
| 0 | 90 | 10 |
| 10 | 90 | 10 |
| 40 | 40 | 60 |
| 45 | 40 | 60 |
| 50 | 90 | 10 |

13.1.2.5 Currently, confirmation analysis is performed using a single Cyano column with a multipoint calibration. Analytes are considered confirmed when the representative responses from the primary analysis and confirmation analysis are within the respective retention time window. Also, the confirmation analyte mass normally is within a 30% difference from that of the primary analysis. However, due to matrix interference and co-eluting peaks, analytes may be considered suspect and are qualified accordingly and narrated.

13.1.2.6 If an analyte is detected whose concentration differs between the primary and confirmation analysis by more than 40%, then the results are qualified as follows. In cases where both columns and detectors indicate an acceptable peak in the appropriate retention time window and the percent difference is greater than 40% but less than 70%, the analyte is reported as a positive result. Due to the high percent difference between the two columns, it is indicated as such on the appropriate Form I or Certificate of Analysis (CoA) with a P qualifier.

In cases where both columns and detectors indicate an acceptable peak in the appropriate retention time window and the percent difference is greater than 70%, the analyte may be reported as a positive result, depending on the client. Some clients, including DOE-AL, require that all results be reported, including those with percent difference values above 70%. These results are qualified with a P qualifier as well. For all other clients, the analyte with a > 70% difference is not reported.

13.1.2.7 Samples with responses for analytes on both columns and detectors that indicated an acceptable peak within the retention time window and an acceptable concentration match may be qualified with an X qualifier on the appropriate Form I or CoA if the analyst believes the hit is a false positive. The analyst may feel that the hit is the result of matrix interference or that the hit is another analyte altogether. If the X qualifier is used, it is explained in the case narrative.

13.1.2.8 The following analytes co-elute on the Cyano:

a) 2,4-Dinitrotoluene, and 2,6-Dinitrotoluene;

b) m-,p-, and o-Nitrotoluene;

c) 2-Amino-4,6-dinitrotoluene and 4-amino-2,6-dinitrotoluene.

13.1.2.9 The values reported are from the primary analysis. The confirmation analysis is used for qualitative purposes only.

13.2 An external standard technique is used to calibrate the instrument. Calibration is obtained by analyzing the standards using the same method used for sample analysis. Each standard must contain the same analytes, but at different concentration levels. The calibration standards must be run in random order. The area counts of each peak, in addition to the concentration of that particular analyte are used to plot a calibration curve. All calibration standards are automatically updated into the present method by performing an automatic calibration update. The relative standard deviation (% RSD) for target analytes using average response factor must be < 20% and for target analytes using a linear calibration curve, the correlation coefficient (r ) must be 0.990 or greater, before the system can be considered calibrated. When the system is calibrated, a check standard prepared from a second source is used to verify the calibration. The analyte concentrations in this check must be within $\pm$ 15% of the true concentration.

**NOTE:** For DoD QSM projects the ICV/CCV criteria are as follows: All analytes $\pm$ 20% of expected value.

13.3 The HPLC$^{3D}$ ChemStation is an instrument control, data acquisition, and evaluation system for HP liquid chromatography instrumentation. The ChemStation and Target each offer the standard report calculations: ESTD, and ISTD. Quantification calibration features such as multiple level calibration, multiple signal calibration, multiple internal standards, multiple time reference peaks, and calibration bracketing are available. ChemStation is used for instrument control and data acquisition. Target software is used to process, evaluate and store data.

13.4 Prior to analysis of samples

13.4.1 The HPLC system must be stabilized prior to use. This is checked by observing the pump pressure ripple is within -2% to 2% range. This value assures proper mixing and shows that all solvents have been degassed.

13.4.2 Before samples can be analyzed, the baseline must be stable with little or no background noise. The UV lamp radiation level could take up to one hour to stabilize.

13.4.3 The continuing calibration check standard must pass ±15% of true value.

**NOTE:** For DoD QSM projects the ICV/CCV criterion is as follows: All analytes $\pm$ 20% of expected value.

13.5 Samples containing target analyte concentrations that exceed the linear range of the analyte calibration curve must be diluted. The dilution level should be

performed to place the highest analyte concentration between the middle and high points of the calibration curve (on column). If a sample is initially diluted and target analytes are not detected and non-target analytes are not interfering with the analysis, the sample must be reanalyzed at a lower dilution. Analysts should be aware that diluting samples will increase the detection limits for undetected analytes. Random dilutions without due cause are not acceptable.

13.6 A hard copy of the continuing calibration standard and runlog is maintained with each QC folder.

13.7 The calibration range for target analytes is currently 15 ng/mL to 10,000 ng/mL.

## 14.0 ANALYSIS AND INSTRUMENT OPERATION

14.1 Check standards and calibration standards are prepared as specified in current protocols. All standards are directly injected into the HPLC system by the auto sampler.

14.2 The run sequence is entered into the ChemStation software with the proper QC bracketing of each group of samples. Multiple injections from a sample vial are allowed. The following is a suggested sequence of QC and samples:

14.2.1 Instrument blank

14.2.2 Check standard

14.2.3 Method blank

14.2.4 LCS

14.2.5 LCS DUP

14.2.6 MS

14.2.7 MS DUP of 14.2.6

14.2.8 Parent sample of MS/MSD 14.2.6/14.2.7

14.2.9 Second sample

14.2.10 Third sample through fifth sample

14.2.11 Check standard

14.2.12 Sixth sample through fifteenth sample

14.2.13 Check standard

14.2.14 Repeat steps 14.2.11 through 14.2.13 for each additional 10 samples.

14.2.15 Always end sequence with a check standard

14.2.16 For batches of more than 20 samples repeat steps 14.2.2 through 14.2.14 as needed.

**NOTE 1:** Every analytical batch of 10 samples will be bracketed by the check standard. After every 10 samples, another check standard is analyzed.

**NOTE 2:** At least daily, prior to analyzing samples, an instrument blank is run to verify the instrument and solvents used by the instrument are suitable for analysis.

**NOTE 3:** Instrument blanks are generally not analyzed on a routine basis prior to or following the check standard. Instrument blanks are only analyzed prior to a

check standard if the samples are suspected to cause the check standard to fail due to interferences.

14.3 A runlog is generated daily for each group of samples analyzed, displaying which samples were analyzed and in what order they were analyzed.

14.4 General Operation of the HPLC System

14.4.1 Allow system to warm-up for 15 minutes after turning on all pumps and detectors to allow instruments to be flushed thoroughly and the detector's internal temperatures to equalize.

14.4.2 Once the instrument has been allowed to warm up, purge each channel for approximately 5 to 10 minutes of any air bubbles that may be present. Then allow the instrument to equilibrate to operational pressure for a minimum of 15 minutes or 5 times column void time. Monitor the pump pressure difference prior to starting analysis.

14.4.3 Verify column is preconditioned prior to starting the run sequence. A preconditioned column back pressure will be approximately 180 bar.

14.4.4 If back pressure exceeds 350 bar, column cleaning must be performed to prevent over pressurizing the system and possible column damage.

14.4.5 1 bar equals 14.50 psi at sea level.

14.5 System operation

14.5.1 Startup

14.5.1.1 Check all solvent containers and refill as necessary. Empty any waste containers that are greater then 3/4 full.

14.5.1.2 Check helium and air tanks. Replace if pressure is 500 psi or less.

14.5.1.3 Start system by selecting "System On" from the instrument sub- menu.

14.5.1.4 Monitor the pump pressure difference. When the difference is in the -2% to +2% range (usually stabilizes at + 0.5%), system is ready to start analysis.

14.5.2 System shutdown: To shut down the system, select "System Off" from instrument sub-menu. This will turn off all pumps and detectors. For long shutdowns also turn off both helium and air tanks.

14.6 The HPLC system may be configured for up to a 250 µL injection. This can be changed through the instrument sub-menu. The present method and MDLs are performed at a 100 µL injection volume. If the injection volume is changed, a new initial calibration must be run.

14.7 When running multiple samples:

14.7.1 Place all samples on sample tray (large external tray or smaller internal tray).

14.7.2 Verify run sequence against sample locations in the trays.

14.7.3 If performing a partial run, in Sequence Table, enter starting through ending sample to prevent possible overwriting of data. When starting a new sequence, this step is not required.

14.7.4 Start system by selecting "Run Sequence" from Run Control main menu.

14.8 System is designed for minimal maintenance. However, whenever repairs are required, consult manufacturer's technical manuals for guidance.

## 15.0 DATA RECORDING, CALCULATION, AND REDUCTION METHODS

15.1 Initial Calibration

15.1.1 Tabulate the area response versus the concentration of each compound and calculate calibration factors (CF). The CF is calculated as follows:

$$CF = Ax/Cx$$

Where:

Ax = Area of the compound being measured.

Cx = Concentration of the compound being measured.

**NOTE:** Calibration factor is used instead of response factor (RF) since this is an external standard procedure.

15.1.2 The average CF is calculated for each compound using the following formula:

$$\text{mean CF} = \overline{CF} = \frac{\sum_{i=1}^{n} CF_i}{n}$$

15.1.3 Using the CFs from the initial calibration, calculate the percent relative standard deviation (%RSD) for each compound. The %RSD is calculated as follows:

$$\%\,RSD = \frac{SD}{CF} X\,100$$

Where:

SD = standard deviation per compound

$$SD = \frac{\sum_{i=n}^{n} \left(CF_i - \overline{CF}\right)^2}{n - 1}$$

15.1.4 If the %RSD of any compound is 20% or less, then the relative response factor is assumed to be constant over the calibration range and the average relative response factor may be used for quantitation. If the %RSD for any compound is greater than 20%, then use one to the options in section 15.1.5. A minimum of five calibration standards must

be used. Presently, the HPLC laboratory uses seven concentration levels.

15.1.5 Given the large numbers of analytes analyzed in this method, it is likely that some analytes may exceed the 20% acceptance limits for RSD. In those instances, the following steps may be used:

15.1.5.1 Review the results of each standard (area counts, CFs and RSD) to ensure that the problem is not associated with one of the calibration levels. If the problem appears to be associated with a single standard, that one may be reanalyzed and the RSD recalculated.

15.1.5.2 Narrow the calibration range by deleting individual analyte end points. Remember that changing the lowest level calibration standard will change the practical quantitation limit. Consider the project specifications for regulatory limits and action levels to confirm that this option is possible. If it is necessary to eliminate midpoints, the whole standard must be dropped. Remember a minimum of 5 levels must be used per analyte.

15.1.5.3 The analyst may also chose to construct calibration curves of area versus concentration using first order regression fit of 5 five calibration points or more. The minimum acceptable correlation coefficient (r) for any compound using linear regression is 0.990. The analyst will only select linear regression or average response factor. Higher order curves such as quadratic curve must never be used.

15.1.5.4 Make certain that the instrument response is treated as the dependent variable (y) and the concentration as the independent variable (x). The regression will produce the slope and intercept terms for a linear equation in the form:

$$y = ax + b$$

Where:

y = instrument response

a = slope of the line (also called the “coefficient of x”)

x = concentration of the calibration standard

b = the intercept

**NOTE:** The linear equation used in Target and featured on the calibration form is not a conventional linear equation (slope intercept formula) and does not match the one found in SW-846 method 8000B. The x and y axes are inversed in Target, so that the instrument response is treated as the independent variable (x) and the concentration ratio is treated as the dependent variable (y). The equation used in Target to

calculate sample results is adjusted to account for the linear equation inversion and reciprocal slope. The adjusted calculation has been independently verified to produce valid results.

15.1.5.5 The analyst should not force the line through the origin, but have the intercept calculated from the data points. This means to not include the origin (0,0) as a calibration point.

15.1.5.6 The regression calculation will generate a coefficient of determination ($r^2$) that is a measure of the "goodness of fit" of the regression line of the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, $r^2$ should not be less than 0.990.

15.1.5.7 In calculating the sample concentrations, the regression equation is rearranged to solve for the concentration (x) as shown below:

$$X = \frac{(y - b)}{a}$$

15.1.6 Calibration curves must be verified using an initial calibration verification standard (ICV). This is a second source standard from the initial calibration. The response factor or true value (percent difference or drift) should not exceed ± 15%. If the ICV does not meet this criteria, corrective action should be taken (i.e., inject a different second source, perform instrument maintenance and reanalyze the initial calibration).

15.2 Continuing Calibration Verification

15.2.1 Before samples can be analyzed, the initial calibration must be verified at the beginning and end of each batch. This is accomplished by analyzing a calibration verification standard (CCV) that is near the midpoint of the calibration. The CCV is made from a second source.

15.2.2 At the beginning of each batch, an instrument blank is analyzed to demonstrate that the instrument is clean. This is followed by a CCV. If the response or calculated concentration for each analyte is within ± 15% of response obtained in the initial calibration, then the initial calibration is considered valid and may be used to quantitate sample results.

**NOTE:** For DoD QSM projects the ICV/CCV criterion is as follows: All analytes ± 20% of expected value.

15.2.3 Calibration verification of calibration curves involves the calculation of percent difference (for CF) and percent drift (for liner regression) of the instrument response between the initial calibration and each subsequent analysis of the verification standard.

$$\% \text{ Difference} = \frac{CF_v - \overline{CF}}{\overline{CF}}$$

$$\% \text{ Drift} = \frac{\text{Calculated concentration} - \text{Theoretical concentration}}{\text{Theoretical concentration}}$$

The % Difference or % drift calculated for the calibration verification standard must be within ± 15% for each analyte.

**NOTE:** For DoD QSM projects the ICV/CCV criterion is as follows: All analytes ± 20% of expected value.

15.2.4 The CCV must also be analyzed after every group of ten samples (or less) and at the end of each batch. Again, the % difference or % drift must be ± 15%. If at any time the CCV fails, a second analysis is performed. If the second standard also fails, the cause is investigated and corrected prior to running any additional samples. All samples not bracketed by a good check standard are reanalyzed to confirm the original data. If after corrections are made and the standard is still unacceptable, the analysis is stopped and the instrument must be recalibrated.

**NOTE:** For DoD QSM projects the ICV/CCV criterion is as follows: All analytes ± 20% of expected value.

15.3 All raw data files are magnetically backed up to the server; a computer print out is generated for the data review process. Sample data, runlogs and sequence logs are generated by the system before, during, or after the instrument has completed the analysis. For each group of samples, all data are placed in a folder according to SDG, and the SDG, batch number, date run, and instrument are placed on the tab. QC data are placed in a separate folder with batch number, date run, and instrument noted on the tab. Also placed in the folder are copies of the retention time window study for that day, the prep data report, any applicable nonconformance reports, and any other appropriate data.

15.4 The Target software is set up to calculate concentrations of sample extracts. When the raw data are entered into AlphaLIMS, a final data report is generated that will include all prep factors (but NOT a percent moisture for soils).

15.5 After completion of all reviews, all records are filed in the HPLC cabinet for approximately 6 months and then maintained in accordance with GL-QS-E-008 for Quality Records Management and Disposition.

15.6 Sample Result: (This calculation is performed by AlphaLIMS rather than the instrument software.)

$$SR = IV \bullet PF \bullet DF$$

Where:

IV = Instrument value

PF = Preparation factor

PF solid = (final extract weight/sample weight)

PF liquid = (final extract volume/sample volume)

DF = Dilution factor

SR = Sample result

## 16.0 QUALITY CONTROL REQUIREMENTS

16.1 Before sample analysis, the instrument must be calibrated and verified by a second source standard. A continuing calibration standard must be analyzed before and after each batch and after each group of 10 samples to verify calibration curve. This value must also be within ±15% of the true value. If at any time the standard fails, a second analysis is performed to verify first standard. If second standard also fails, the cause is investigated and corrected prior to running any additional samples. All samples not bracketed by good check standards are rerun to confirm the original data. If after, corrections are made and the standard still fails, analysis is stopped and the instrument must be recalibrated.

**NOTE:** For DoD QSM projects the ICV/CCV criterion is as follows: All analytes ± 20% of expected value.

16.2 A method blank is used to assess the preparation batch for possible contamination during the preparation and processing steps. The method blank shall be processed along with and under the same conditions as the associated samples to include all steps of the analytical procedure. All analytes of interest must be below present practical quantitation limit (PQL) to meet the quality control requirements. Any sample associated with a blank that does not meet these criteria shall be reprocessed in a subsequent preparation batch, except when the sample analysis resulted in a non-detect. If no sample volume remains, the results shall be reported with the appropriate data qualifying codes.

**NOTE:** For DoD QSM projects, the method blank criteria are as follows: No analytes should be detected at > ½ of the reporting limit (RL). For common laboratory contaminants, no analytes should be detected ≥ the RL.

16.3 A laboratory control sample (LCS) and/or duplicate are run for each batch of 20 samples or less. The accuracy and precision of the extraction procedure may be monitored with these samples. Sample duplicate and sample spike may be used for this purpose.

16.3.1 If the percent recovery in the matrix spike (MS) or matrix spike duplicate (MSD) falls outside the established SPC limits for recovery, the analyst should evaluate the LCS recoveries and method blank (MB) analyses. If the LCS and MB analyses do not indicate a problem with the preparation procedures, the MS recoveries may be attributed to matrix effect. Surrogate recovery data should also be used to evaluate the data. Recoveries of both MS compounds and surrogates that are outside the acceptance limits suggest more pervasive analytical problems

than problems with the recoveries of either matrix spikes or surrogates alone. Analysts are not required to reanalyze the matrix spikes for failing recoveries, however, they should seek additional technical support before deciding not to reanalyze matrix spikes samples.

16.3.2 If matrix spike and duplicate recoveries are unacceptable, but the LCS recoveries meet current control limits, the matrix spike and DUP may be rerun to verify matrix interference.

16.3.3 The interference is reported with a text comment added explaining matrix interference, and a nonconformance is submitted.

16.3.4 If sample spike and duplicate and LCS recoveries are outside of the acceptable range, the entire batch is re-extracted and rerun.

16.3.5 Most DOE clients have contract requirements that mandate that the data must have a passing LCS. If this is not met then the samples are re-extracted.

16.4 3,4-Dinitrotoluene (or other suitable surrogate) is added to all samples that undergo extraction. The surrogate is used to continuously monitor the sample extraction process. If the surrogate falls outside acceptable limits, a nonconformance report is submitted. That sample is re-extracted. If the surrogate recovery fails a second time, the failure is attributed to matrix interference. The data are reported with a text comment added to the data, and a nonconformance report is submitted.

16.5 A daily retention time window is generated from each check standard in an analytical sequence. These daily RT windows are determined from a previous retention time study. The retention times of the first CCV of each day must fall within the retention time window of the initial calibration for that calibration used. If they do not fall within the window, changes in the nature of the column and/or system are implied to the curve and must be investigated. If the after the attempting to correct the problem, if the first CCV is still out of the retention time range, the calibration must be regenerated. Refer to GL-OA-E-001 for Establishing Retention Time Windows for GC and HPLC Analysis.

16.6 All detected responses found on the C18 column, below or above the PQL, will be confirmed by injection on a CN or equivalent. The primary quantitation will be derived from the C18 column unless this is not in agreement with specific client requirements. When requested by certain clients (i.e., Navy), the reported value will be the lower concentration. The detection limit, however, will be the higher one. The spectral library may be used to further confirm the positive measurements.

16.7 Monthly analyses of check standards are performed at half the concentration and two times the concentration. This is used to verify that the instrument is within calibration specification. Due to co-elution and large concentrations for 2-Am-DNT/4-Am-DNT and 2,4-DNT/2,6-DNT, separate standards may be analyzed for the required two times the check standard verification.

16.8 Depending on the sample matrix or extraction procedure used, the sample extracts are prepared (diluted) prior to analysis in the following manner:

16.8.1 When liquid samples extracted using the "solid phase extraction (SPE)" (Appendix 2) procedure, the extract is diluted 1:1 with HPLC grade water. 500 µL of water and 500 µL of extract are combined in a 2 mL crimp top amber vial and capped. The solution is mixed using the Vortex mixer and is ready for analysis on the instrument.

16.8.2 When solid samples are extracted using the method in Appendix 1, the extract is diluted 1:1 with calcium chloride solution. 500 µL of extract is combined with 500 µL of 1:1 (v/v) calcium chloride/DI water in a 2 mL crimp top amber vial and capped. The solution is mixed using the vortex mixer and is then ready for analysis on the instrument.

16.8.3 When a dilution greater than 1:2 is required, the extract for all samples is diluted using 1:1 HPLC grade water to acetonitrile. This helps to maintain the proper ratio of acetonitrile and water for analysis.

16.8.4 For samples extracted using SPE, when a sample requires a large dilution, special criteria must be followed. When the sample is extracted using a 770 mL aliquot, the extract can be diluted up to a 1:40 dilution (an on column amount of 200,000 ng/mL). If the sample requires a larger dilution, then the sample in question must be re-extracted using a smaller sample aliquot. A 200 mL or 100 mL sample aliquot may be more suitable.

## 17.0 DATA REVIEW, APPROVAL, AND TRANSMITTAL

17.1 After a sample batch has been run, data are collected and raw values are entered into AlphaLIMS. A data review check is then generated (placing the batch into the DREV status). The analyst places the case narrative data review sheet along with the prep sheet and all raw data into a folder marked with the batch number, date run, and instrument used. After the analyst reviews the data and other folder contents, additional review is done by the group data reviewer or other qualified reviewer. The batch is then given a status of 'Done.'

17.2 Analyst review: The analyst checks all chromatographs and checks the computerized calculation of the percent recoveries for the spike, duplicate, LCSs and all surrogates. The analyst then verifies that the check standards pass for the analytes of interest. If a target compound is detected on the C18 column, that compound is checked against retention time windows. If it is within the acceptable range, the detected analyte is confirmed on the CN column. This review is then placed in the folder with the other raw data. The analyst then initials the appropriate documentation and passes it on for the data validation review.

17.3 Both reviews are done independently. If the analyst detects a target concentration above the DAD calibration range, the sample is rerun at a suitable dilution.

17.4 Second level review: The Data Validator or other qualified reviewer assures that the concentrations that appear as raw data are entered correctly into AlphaLIMS. The validator verifies that check standards are within ±15% of true values and that the LCS, its duplicate, and all surrogates are within acceptable ranges. The reviewer also checks date, time, dilution factors, and analyst initials against the data report. If everything is acceptable, the reviewer initials the documentation, and routes the data package to the appropriate person to issue a status of "Done" in the system.

**NOTE:** For DoD QSM projects the ICV/CCV criterion is as follows: All analytes ± 20% of expected value.

17.5 An archived data package will have the following items: all chromatographs of the calibration check standards, method blank, LCS, LCS DUP, samples and sample spike, and duplicate. The batch sheet, sample batch sheet, prep data sheet, retention time window spreadsheet, and the data report must be present. The instrument method, calibration table, calibration curves, run log, and any other appropriate data are also included.

17.6 Proper technique for standard preparation is contained in GL-OA-E-002 for Organic Standards Preparation and Traceability. In addition, after a protocol is entered into AlphaLIMS, the calculations are checked and verified by a peer or equivalent.

## 18.0 RECORDS MANAGEMENT

18.1 All data associated with the performance of this procedure, including relevant logbooks, are maintained as quality records in accordance with GL-QS-E-008 for the Quality Records Management and Disposition.

18.2 All Standards are recorded in AlphaLIMS.

## 19.0 LABORATORY WASTE HANDLING AND DISPOSAL

Sample and reagent wastes are handled and disposed in accordance with the Laboratory Waste Management Plan, GL-LB-G-001.

## 20.0 REFERENCES

20.1 Test Methods for Evaluating Solid Waste, EPA Manual SW-846, 3rd Edition. Method 8330, "Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC)," Revision 0, September 1994.

20.2 Hewlett-Packard Series 1100 Auto Sampler

20.3 Hewlett-Packard Series 1100 Diode Array Detector

20.4 Hewlett-Packard Series 1100 HPLC System

20.5 Hewlett-Packard ChemStation software

20.6 HPLC for Environmental Analysis, Hewlett-Packard Publication Number 12-5091-9750E, (5/94).

20.7 Target Data Analysis Software.

20.8 Data Validation Standard Operating Procedures for CLP Routine Analytical Services. USEPA Region IV Science and Ecosystem Support Division of Quality Assurance Athens, Georgia, Revision 21, July 1999.

20.9 Test Methods for Evaluating Solid Waste, EPA Manual SW-846, 3rd Edition. Method 8000C, "Determinative Chromatographic Separations," Revision 3, March 2003.

20.10 Test Methods for Evaluating Solid Waste, EPA Manual SW-846, 3rd Edition. Method 8330A, "Nitroaromatics and Nitraminies by High Performance Liquid Chromatography (HPLC)," Revision 1, February 2007.

20.11 Test Methods Evaluating Solid Waste, EPA Manual SW846, 3rd Edition. Method 3535A, "Solid-Phase Extraction (SPE), Revision 1, February 2007.

## 21.0 HISTORY

Revision 21: Updates made to Appendix 2 for solid phase extraction procedure for explosive liquid samples. Section 20.11 added to reference section.

Revision 20: Added computer and software specifications for HPLC C, HPLC D, HPLC E and HPLC F and updated method references per AZ audit observation.

Revision 19: Updated Appendix 1 and Appendix 2 per GEL internal audit findings.

# APPENDIX 1

# EXTRACTION PROCEDURE FOR EXPLOSIVE SOLID SAMPLES

**Setup:**

1. Perform daily calibration verification of open top balance.
2. Weigh 2.0 +/- 0.05g of a clean, dried solid matrix in a 2 oz. wide-mouth screw top bottle for each MB and LCS QC sample.
3. Rinse all glassware with $CH_3CN$ prior to use to prevent possible contamination.
4. Assure sufficient spiking solution and surrogate is prepared prior to starting analyses.
5. Record all data on prep sheet.

**Procedure:**

1. If screening results indicate less than 1% contamination, then no special handling requirements are required. If sample screening results are 1% or greater, special instructions are required before proceeding beyond this point.
2. Place between 5.0 and 10.0g of sample into small plastic weigh boat and place in drying cabinet. Drying cabinet encloses samples at room temperature and is vented to the atmosphere. Remove samples periodically to check for apparent dryness. This may take several hours to several days depending on the percent moisture content of a sample.
3. Sift sample through sieve (30 mesh). Transfer 2.0 g +/- 0.05 g of sample from sieve tray to scintillation vial.
4. Add 50 µL of 100 ppm surrogate intermediate standard to each sample and QC.
5. Add 100 µL of 100 ppm spike intermediate standard to LCS, LCS DUP, matrix spike, and if necessary, matrix spike DUP.
6. Add enough $CH_3CN$ to total 10 mL of liquid (surrogate, $CH_3CN$, and if appropriate, spiking solution) to each vial. Cap and gently stir to mix contents.
7. Mix sample on vortex mixer for 30 seconds or until sample is completely mixed with solvent which ever takes longer.
8. Switch on water chiller unit. Place all bottles into an ultrasonic bath and record date and time on batch preparation sheet. Sonicate samples for at least 18 hours. The water temperature is neither recorded or monitored but the chiller is checked for effective cooling by either touch or observation of ice forming on the probe.
9. After sonication is complete, allow the samples to settle for at least 30 minutes.
10. Using a 5 mL disposable syringe, remove approximately 5 mL of sample extract. Attach a 45 µm syringe filter and filter extract into a 12 mL amber vial with a Teflon-lined cap.

## APPENDIX 2

## SOLID PHASE EXTRACTION (SPE) PROCEDURE FOR EXPLOSIVE LIQUID SAMPLES

### Water Sample Preparation by SPE:

1. Mark the level of the sample on the outside of the sample container for later determination of the sample volume used. Shake the container for several minutes, with the cap tightly sealed, to ensure that any particulate matter is evenly distributed.
2. Prepare a Method Blank (MB) and a Laboratory Control Sample (LCS) from a 1-L volume of organic-free reagent water, or a volume of reagent water similar to that being used for the samples. The blank may be prepared in a graduated cylinder, or other suitable container.
3. Add 25uL of a 100ppm Surrogate intermediate standard to the samples in their original containers, the MB, LCS, and any Matrix Spikes associated to the extraction batch.
4. Shake the samples to mix the surrogate and allow the samples to stand for several minutes. This allows the surrogate to disperse in the samples, and will allow any particulate matter to settle, which will speed the filtration process.
5. Add 50uL of a 100ppm Spike intermediate standard to representative sample replicates in their original containers, and the LCS associated to the extraction batch. Mix the matrix spike samples, and LCS as described in Step 4 listed above.

### Cartridge Conditioning:

1. Remove the internal rack from the vacuum manifold.
2. Attach a disposable flow control Teflon valve liner to the end of a Porapak RDX SPE cartridge, and insert it into one of the manifold stopcock valves.
3. Fill the cartridge with 10mL of Acetonitrile, allowing gravity to pull the solvent through the sorbent bed. Do **not** allow the cartridge to go dry.
4. With a thin layer of solvent above the sorbent bed, add 30mL of reagent Water. Allow the water to flow through the sorbent bed under gravity flow. Stop the flow just before the cartridge goes dry. Close the manifold valve.
5. Dispose the discarded rinse solvents in the appropriate waste drum.

### Sample Loading onto SPE Cartridge:

1. Attach a tube adapter with a Teflon sample reservoir line to the top of the cartridge. Insert weighted end into sample container.
2. Engage the vacuum system to draw the sample through the cartridge a rate of approximately 10mL/min, until all of the sample has passed through the cartridge. Care shall be taken to ensure that the cartridge is not allowed to run dry during the sample loading process. If a cartridge runs dry, the preparation technician will notify the Group leader, and place a notation in the extraction log.
3. Once all of the sample has loaded, turn off the vacuum, and add 5mL of reagent water to the cartridge. Allow the reagent water to pass through the cartridge under gravity flow, or apply a vacuum to complete the process.
4. Shut off the flow once the water has been drawn through the cartridge.

**APPENDIX 2 (Cont'd)**

**SOLID PHASE EXTRACTION (SPE) PROCEDURE FOR EXPLOSIVE LIQUID SAMPLES**

## Sample Elution from the SPE Cartridge:

1. Remove the tube adapter from the cartridge.
2. Place a disposable collection tube under the cartridge in the vacuum manifold in which to collect the sample extract.
3. Add 5mL of Acetonitrile to the top of the cartridge, and allow it to pass through cartridge under gravity flow, collecting the solvent in the collection tube.
4. Pulse the vacuum system briefly to draw any remaining Acetonitrile through the cartridge.
5. Draw the eluted sample into a 5mL syringe. Rinse the collection tube with Acetonitrile. Bring the total volume in the syringe to 5mL. Transfer to a storage vial, and store extracts in a refrigerator.

# APPENDIX 3: EXPLOSIVES AND TNT DEGREDATION PRODUCTS METHOD 8330A

## Explosives:

| | |
|---|---|
| HMX | Bursting/High Explosives, Impurity in RDX manufacture |
| RDX | Bursting/High Explosives |
| Tetryl | Auxiliary Explosive, i.e., Initiators, Primers and Detonators |
| 2,4,6-TNT | Auxiliary Explosive, i.e., Initiators, Primers and Detonators |
| PETN | Auxiliary Explosive, i.e., Initiators, Primers and Detonators |

## TNT Metabolites:

| | |
|---|---|
| 1,3,5-TNB | Photochemical decomposition product |
| 1,3-DNB | Impurity in production grade TNT |
| NB | Reduction product |
| 2-Am-4,6-DNT | Anaerobic biodegradation product |
| 4-Am-2,6-DNT | Aerobic biodegradation product |
| 2,4-DNT | Impurity in production grade TNT |
| 2,6-DNT | Impurity in production grade TNT |
| 2-NT | Reduction product |
| 4-NT | Reduction product |
| 3-NT | Reduction product |

**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

## FOR

# DEFINITIVE LOW LEVEL ANALYSIS OF NITROAROMATIC EXPLOSIVES UTILIZING LIQUID CHROMATOGRAPHY/MASS SPECTROMETRY/ MASS SPECTROMETRY (LC/MS/MS) BY SW-846 METHOD 8321 MODIFIED (8321M)

## (GL-OA-E-056 REVISON 16)

APPLICABLE TO METHODS:
EPA SW-846 Methods 8000C, 8321A Modified

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## 1.0 STANDARD OPERATING PROCEDURE FOR DEFINITIVE LOW LEVEL ANALYSIS OF NITROAROMATIC EXPLOSIVES UTILIZING LIQUID CHROMATOGRAPHY/MASS SPECTROMETRY/MASS SPECTROMETRY (LC/MS/MS) BY SW-846 METHOD 8321 MODIFIED (8321M)

## 2.0 METHOD CODES

EPA SW-846 Methods 8000C, 8321A Modified, 8330, 8330A, and 8330B.

## 3.0 METHOD OBJECTIVE AND PURPOSE

3.1 Sample extracts are analyzed by atmospheric pressure chemical ionization liquid chromatography mass spectrometry mass spectrometry (APCI/LC/MS/MS). Chromatography is performed using a reverse phase column while analyte detection is achieved through a negative ion interface. Once ionized, the molecular ions are acquired by the first quadrupole, and passed to second quadrupole, more commonly called the collision cell. Here the molecular ions are fragmented into daughter ions, that are then passed into the third quadrupole. Finally, the third quadrupole allows the analyte specific daughter ions to pass to the detector, a photo-multiplier tube (PMT).

3.2 This method has been modified from SW-846 Method 8321A to include the analysis of nitroaromatic explosives by APCI/LC/MS/MS. Refer to Appendix 1.

3.3 This method has been modified on the basis of GEL's Performance Based Measurement System (PBMS).

## 4.0 METHOD APPLICABILITY AND METHOD SUMMARY

4.1 Refer to Table A-2 for a compound list of nitroaromatic explosives by APCI/LC/MS/MS.

4.2 This method applies to the following matrices:

4.2.1 Groundwater

4.2.2 Wastewater

4.2.3 Soil

4.2.4 Sludge

4.2.5 Miscellaneous matrices

## 5.0 METHOD SCOPE AND PERFORMANCE CHARACTERISTICS

Refer to Table A-2 for a compound list of Nitroaromatic Explosives by APCI/LC/MS/MS.

**NOTE:** At client request, ammonium picrate is reported through a conversion from picric acid. The conversion factor (1.074) is multiplied by the concentration of picric acid to yield the result.

## 6.0 DEFINITIONS

6.1 AlphaLIMS: The Laboratory Information Management System used at GEL Laboratories, LLC.

6.2 Calibration Standard (CAL): A solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards and

surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

6.3 Continuing Calibration Blank (CCB): An aliquot of reagent water or other blank matrix that is analyzed after each CCV. The CCB is used to determine whether the analytical sequence is in control during sample analysis.

6.4 Continuing Calibration Verification (CCV) Standard: An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The CCV is analyzed exactly like a sample, periodically throughout the run sequence. Its purpose is to determine whether the analytical sequence is in control during sample analysis. It may be prepared from the same source as the calibration standards, and is usually of varied concentration.

6.5 Detection Limit Verification Standard (CRI): An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The CRI is analyzed exactly like a sample, periodically throughout the run sequence. Its purpose is to determine whether the analytical sequence is in control at the low end of the calibration range during sample analysis. It may be prepared from the same source as the calibration standards. This standard is approximately 2 to 3 times the concentration of the MDL for each target analyte.

6.6 Independent Calibration Blank (ICB): An aliquot of reagent water or other blank matrix that is analyzed after each ICV. The ICB is used to determine whether there is carryover contamination after injection of the mid-level ICV.

6.7 Independent Calibration Verification (ICV): A solution of method analytes of known concentrations that is used to fortify an aliquot of Blank or sample matrix. The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

6.8 Instrument Performance Check Solution (IPC): A solution of one or more method analytes, surrogates, internal standards, or other test substances used to evaluate the performance of the instrument system with respect to a defined set of criteria.

6.9 Laboratory Control Standard (LCS): An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

6.10 Laboratory Duplicate (DUP, LCSD, MSD or PSD): Aliquots of a sample taken from the same container and processed in the same manner under identical laboratory conditions. The aliquot is analyzed independently from the parent sample and the results are compared to measure precision and accuracy.

6.11 Linear Calibration Range (LCR): The concentration range over which the instrument response is linear.

6.12 Method Blank (MB): An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment,

solvents, reagents, internal standards, and surrogates that are used with other samples. The MB is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

6.13 Method Detection Limit (MDL): The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero. Typically, the MDL is two to three times less than the PQL.

6.14 National Institute of Standards and Technology (NIST): For the purpose of this method, the national scientific body responsible for the standardization and acceptability of analyte solutions.

6.15 Practical Quantitation Limit (PQL): The lowest level in the calibration curve. With the prep factor applied, the PQL is referred to as the effective PQL.

6.16 Reporting Limit (RL): The level at which a target analyte would meet the data quality objectives of the laboratory and/or a project, which may include establishing compliance with a regulatory and/or action limit. The reporting limit may be equal the laboratory's practical quantitation limit (PQL).

6.17 Spike (Matrix Spike or Post Spike): An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS or PS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS or PS corrected for background concentrations.

6.18 Statistical Process Control (SPC) Limits: Statistically derived limits that establish acceptable ranges for recoveries of analytes of interest, including LCS, MS, MSD, PS, PSD and internal standards.

6.19 Stock Standard Solution: A concentrated solution containing one or more method analytes prepared in the laboratory using certified reference materials or purchased from a reputable commercial source.

6.20 Surrogate: A substance with properties similar to the analyte(s) of interest, but unlikely to be found in environmental samples. Surrogates are added to environmental samples and some quality control samples as a measure of efficiency.

## 7.0 INTERFERENCES TO THE METHOD

7.1 LC/MS/MS is a highly selective analysis that utilizes four means of compound discrimination: chromatographic separation, negative ion generations (where applicable), mass selection, and daughter fragmentation. It is theoretically possible that two different compounds could have the same retention time and generate the same ion. But, it is highly unlikely that these two compounds would fragment to the same daughter ion.

7.2 Method interferences may be caused by contaminants in solvent, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All of these materials must be routinely demonstrated to be free from interferences

under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. Raw LC/MS/MS data from all blanks, samples, and spikes must be evaluated for interferences. If an interference is detected, it is necessary to determine if the source of interference is in the preparation and/or cleanup of the samples and then take corrective action to eliminate the problem.

7.3 The use of high purity reagents, solvent, and gases helps to minimize interference problems.

7.4 Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe must be rinsed thoroughly between samples with the strongest organic solvent used in the method. The analyst must monitor method blanks to determine if the syringe rinsing is sufficient.

## 8.0 SAFETY PRECAUTIONS AND HAZARD WARNINGS

8.1 Treat all chemicals and samples as potential health hazards and limit exposure to these chemicals to the lowest level possible. GEL maintains a current awareness file of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of chemicals. A reference file of Material Safety Data Sheets (MSDS) and individual client MSDS forms are also maintained.

8.2 Personal protective equipment

8.2.1 Gloves are required when handling the chemicals in this procedure. Latex gloves are approved for this procedure.

8.2.2 Laboratory coats should also be worn.

8.3 Prior to handling radioactive samples, analysts must have had radiation safety training and must understand their full responsibilities in radioactive sample handling.

8.4 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

8.4.1 Segregate solid wastes from liquid wastes in the satellite area containers.

8.4.2 Segregate oil wastes from water-soluble wastes in satellite area containers.

8.5 Never leave gas cylinders unchained or untied, even when they are on moving carts.

8.6 In the event of an accident or medical emergency, call for help immediately. When time and safety permit, an accident report form should be completed and turned in to the GEL Safety Officer.

8.7 Fire escape routes are posted in the lab and all personnel should be familiar with them. In addition, fire safety equipment such as fire extinguishers is located throughout the lab. Training is available on the proper operation of this equipment.

## 9.0 CAUTION WARNINGS

Acetonitrile and methanol are flammable solvents. Safety precautions for these flammable solvents must be taken into consideration when dealing with this method.

## 10.0 APPARATUS, EQUIPMENT, AND INSTRUMENTS

10.1 Liquid Chromatography/Mass Spectrometry/Mass Spectrometry System

An analytical system complete with a ternary gradient, programmable high-pressure liquid chromatograph, and a column heater capable of maintaining a temperature of 40° ± 1° C. The liquid chromatography unit must be capable of accurate and repeatable flow rates of 0.2 mL/min to 1.0 mL/min. The mass spectrometer system must posses an atmospheric pressure chemical ionization (APCI) interface capable of operating at flow rates stated above. The mass spectrometer system must be capable of negative ion analysis and consist of three quadrupoles for daughter fragmentation.

10.2 Data System

A computer system must be interfaced to the mass spectrometer. The system must allow the continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program. The computer must have software that can search any LC/MS/MS data file for ions of a specific mass and that can plot such ion abundances versus time or scan number. This type of plot is defined as the Extracted Ion Current Profile (EICP). Software must also be available that allows integrating the abundances in any EICP between specific time or scan-number limits.

10.3 Autosampler: An autosampler that is capable of injecting 10 to 250 µL with a precision of 5% RSD and that can accommodate at least 24 samples.

10.4 Analytical balance: Used to accurately weigh target analyte for stock standard preparation (± 0.1 mg sensitivity).

10.5 Top loading balance: Used to accurately weigh samples in the sample preparation (± 10 mg sensitivity).

10.6 Pipettes: Pasteur, plastic or glass, disposable, graduated, 5 mL and 10 mL.

10.7 Vials: High-density polyethylene (HDPE) or glass, amber, 12 mL, for sampling and storage of calibration solutions.

10.8 Weigh boats: Plastic, disposable, for weighing eluent reagents.

10.9 Miscellaneous glassware for sample preparation.

10.10 LC-MS/MS#1
Computer: IBM IntelliStation M Pro
Software: MassLynx V3.5

10.11 LC-MS/MS #3
Computer: DELL Precision 360
Software: Analyst V1.4.2

10.12 LC-MS/MS #4
Computer: DELL Precision 370
Software: Analyst V1.4.2

## 11.0 REAGENTS, CHEMICALS, AND STANDARDS

11.1 Reagents

11.1.1 Reagent water: Distilled or deionized water, 17.8 Mohm or better, free of the anions of interest. Water should contain particles no larger than 0.20 microns.

11.1.2 Acetonitrile, reagent grade

11.1.3 Methanol, reagent grade

11.1.4 Ammonium formate, reagent grade

11.2 Standards

11.2.1 Standards are stored as specified in the appendices. All standards are assigned an expiration date of one year from receipt or the vendor's expiration date, whichever occurs sooner. Expiration dates for intermediates and working solutions are the same as for the parent stock standard, unless otherwise noted on the standard. Standards are monitored for degradation and replaced as necessary. Standards must be brought to room temperature before using.

11.2.2 Stock standard solution: A standard that is at a high concentration and is therefore stable enough to be stored for longer periods of time than other standard concentrations. All stock standards must be verified for accuracy before use.

11.2.3 Intermediate Standard Solutions: Intermediate standard solutions are prepared with the analyte of interest. Preparation details may vary due to differences in stock solutions.

11.2.4 Calibration Standards: Calibration levels are prepared from the intermediate standard. Refer to appendices for concentrations.

11.2.5 Second-Source Calibration Verification Standard Solution: This standard is obtained from a different vendor than are the calibration standards described in Sections 6.2 and 6.4. An intermediate solution is prepared from stocks, which is then used to prepare a working standard used to verify the initial calibration. In certain cases, a second source calibration verification may not be possible. In this case, a second stock standard is made to verify the initial stock concentration.

11.2.6 Spiking Solution: The solution is used to prepare laboratory control samples (LCSs) and matrix spike/matrix spike duplicates (MS/MSD) at the beginning of the sample preparation procedure. Spike concentrations can be found in the appendices.

11.2.7 Surrogate Standard: This standard is added to samples and QC to monitor the efficiency of the sample preparation procedure.

11.2.8 Internal Standard: The IS standard is added to all working samples, QC, and standards prior to analysis.

11.2.9 Sodium Rubidium Iodide Tuning Solution: A mixture of sodium iodide (NaI) and rubidium iodide (RbI). The tuning solution contains approximately 2 µg/µL of NaI and 0.05 µg/µL RbI in 50/50 2-propanol/water.

11.3 Nitrogen Gas, 99+%

11.4 Argon Gas, 99+%.

## 12.0 SAMPLE HANDLING AND PRESERVATION REQUIREMENTS

12.1 Samples must be collected in an amber glass bottle with a Teflon-lined cap. The collection containers are bought pre-cleaned from a certified vender.

12.2 All liquid samples have a holding date of seven days from the time of collection to be extracted while all solid samples have fourteen days from the collection date to be extracted for explosives. Samples are protected from light and stored at 0° ≤ 6° C after collection. Once extracted, the extract must be analyzed within forty days. However, during this period of time, the extracts are refrigerated at 0° ≤ 6° C. When holding dates are missed, the data are automatically flagged by the computer when the date is input.

## 13.0 SAMPLE PREPARATION TECHNIQUES

Refer to SW-846 EPA Method 8330A, Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC), Appendix 1, Appendix 2, Appendix 3, and GL-OA-E-033.

## 14.0 EQUIPMENT AND INSTRUMENT MAINTENANCE

14.1 Maintenance for the HPLC

14.1.1 Daily Maintenance

14.1.1.1 Solvents: Adequate volume of solvent needs to be maintained on a daily basis. Failure to do so may result in loss of prime on the LC. This is especially important for the needle wash solvent. Make sure that there is plenty of solvent in each reservoir before using. When a long acquisition run is set up, it is essential to calculate the amount of solvent that will be needed. Add an extra 20% of solvent to the reservoir to make sure the LC does not go dry during the run.

14.1.1.2 Column: The column must be properly equilibrated with the method specific solvent before batch analysis can occur. At the end of the day or an analysis, the column must be flushed with solvent, usually acetonitrile or methanol, to ensure longevity.

14.1.1.3 Sample Carousel: Make sure the sample carousel is calibrated. (The needle is drawing from the correct vial.)

14.1.1.4 Syringe: Check the operation of the sample syringe on a daily basis to ensure the syringe is drawing the proper amount of

sample. Make sure the syringe is free of bubbles and that the needle is injecting properly.

14.1.1.5 Solvent Lines and Pump: Prime the system daily or as needed to ensure proper solvent flow to the column. This is best accomplished by using the system preparation feature from the LC control window. Make sure the seal wash line/syringe wash line is primed and their reservoirs are full.

14.1.2 Weekly Maintenance

14.1.2.1 Waste Container: Check the waste container and dispose if needed. The satellite waste container should never be more than ¾ full. Always label waste properly.

14.1.2.2 Solvent filters: Check the solvent filters for dirt. If filters are dirty then replace with new clean filters.

14.1.3 Semi-annual Maintenance

14.1.3.1 Plunger seals: Inspect the plunger and plunger seals. If the pump has been losing prime or if the ripple delta is greater than 30 psi, the seals will need to be replaced.

14.1.3.2 Check valves: Inspect the inlet check valve cartridges. If the pump has been losing prime or if the ripple delta is greater than 30 psi and changing the seals did not fix the problem, the check valves will need to be replaced.

14.1.3.3 Filter: Replace the inline filter. This may need to be replaced sooner if the system is exhibiting high back pressures.

14.1.3.4 Syringe and injector. Inspect the syringe and injector needle. Replace needle if it is bent or damaged. Replace syringe if there are obvious signs of wear.

14.2 Maintenance for the Mass Spectrometer

14.2.1 Vacuum System Maintenance

14.2.1.1 Daily Maintenance

14.2.1.1.1 Vacuum Pressure: Check the analyzer pressure before the start of any analysis. If the reading is greater than $1 \times 10^{-4}$ torr, check for vacuum leaks. The most likely place for the system to develop a leak is around the ion source. An o-ring may not be sealing properly. It may be necessary to disassemble the source to check the conditions of the o-rings. Also check the oil levels of the rough pumps. Low oil levels in the pumps can cause loss of vacuum.

14.2.1.1.2 Rotary Pumps: The E2M28 pump, which backs the quadrupoles, should be ballast for 30 minutes at least once a week. Make sure oil levels in the

pumps are sufficient on a daily basis. Check for any leaks.

14.2.1.2 As Needed Maintenance

14.2.1.2.1 Oil Odor Element: Change the odor element monthly or whenever the pump emits an oily odor

14.2.1.2.2 Mist Element: Change the mist element annually.

14.2.1.2.3 Foreline Trap: Change the sorbent (activated alumina) when it becomes discolored (brown). The discolor will reach the region of the trap furthest from the pump (the vacuum side). The sorbent should be replaced when the instrument is vented and the pump is changed.

14.2.2 Mass Spectrometer Source Maintenance

As Needed Maintenance

14.2.2.1 Clean the sample cone, cone gas nozzle, and outer area of the source block with methanol. Before removing the sample cone, be sure to close the isolation valve. In the case of the API4000, clean the corona needle and skimmer plate when discoloration appears.

14.2.2.2 Clean the ion block when needed. A sign that the ion block needs cleaning is gradual loss of sensitivity. Also, you may see splits peaks and/or a rough unstable signal.

14.2.2.3 The hexapole lenses may need cleaning periodically. It is good to clean these lenses annually, but they may need more frequent cleaning depending of the type of samples run. Refer to the Micromass Manual for details on cleaning.

14.3 APCI Probe Maintenance

As Needed Maintenance

14.3.1 The APCI probe needs to be maintained at all times to ensure maximum sensitivity. Problems that may inform an analyst of needed maintenance are; an unstable ion beam (spray), peak broadening or tailing, low LC pump back pressure, high LC pump back pressure, and gas flow problems. Refer to the manual for troubleshooting tips.

14.3.2 The probe tip may need to be cleaned if dirty matrices are run, especially at low heater temperatures.

14.4 Computer Maintenance

14.4.1 Daily Maintenance

Check Disk Free Space. Check the disk drive free space to determine if there is enough room for the data from the autorun.

14.4.2 Weekly Maintenance

Backup Data System. The data should be copied to a backup directory and stored on the AlphaLIMS system.

## 15.0 PREPARATION OF STANDARD SOLUTION AND QUALITY CONTROL SAMPLES

15.1 Source Standard Solutions

Source standard solutions are purchased from certified vendors. These standards are traceable to National Institution of Standards and Technology (NIST) standards. The source standards are received from the company Purchasing Agent. The standard is given a unique identifying number for that day and is recorded in AlphaLIMS.

15.2 For guidance on standard documentation, refer to GL-LB-E-007 for Laboratory Standards Documentation.

15.3 For standards traceability refer to GL-OA-E-002 for Organic Standards Preparation and Traceability.

15.4 All standard solutions expire six months from date prepared/opened if the vendor provides no expiration date.

## 16.0 INSTRUMENT CALIBRATION

16.1 A mass calibration is performed as needed using a sodium iodide/rubidium iodide solution. Refer to Table 1 for the calibration masses. The tuning solution is introduced directly into the mass spectrometer using the ESI interface in positive mode. A mass range of 20 to 1100 amu, with at least six scans across each peak is utilized.

16.2 To verify the mass calibration, a mass calibration verification (tune) is performed daily by infusing a solution containing the analytes of interest. Four masses spanning the high, middle, and low mass range of the daughter ions are visually inspected. If the mass calibration has drifted, peaks in the observed mass range will not be present. The analyst must then perform a mass calibration as stated in section 16.1 above.

16.2.1 Upon performing a mass calibration, the analyst must recalibrate the instrument before proceeding with calibration verification standards and client samples.

16.2.2 Hard copy reports of daily tune data are stored in a logbook near each instrument in order that the analyst may evaluate daughter ion peaks for broadening and abundance characteristics when compared to previous observations.

16.2.3 These observations may indicate the need for maintenance or cleaning. To ensure that the current calibration is valid, the analyst must analyze a calibration verification standard which meets the method acceptance criteria.

16.3 Initial Calibration Curve

16.3.1 A minimum of five calibration points is required for explosives analysis unless a second order regression fit is used.

16.3.2 When an internal standard is used, the ratio of the area response of the target to the area response of the nearest internal standard is used. Refer to formulas in section 18.

16.3.3 Calibrations are modeled as average response factor and calibration curves. For average response factor the %RSD must be ≤ 20%. For least-square linear regression fits, a 1/X or 1/X2 weighting is used. The correlation coefficient (r) must be ≥ 0.990 unless otherwise stated. For second order regression fits, weighting can be used and the coefficient of determination ($r^2$) must be ≥ 0.990 unless otherwise stated. While second-order regression equations may be used, the intercept and degree of curvature should be examined to be sure that results would be reliable throughout the range of the curve.

16.3.4 Generally, it is not acceptable to remove points from a calibration for the purpose of meeting calibration criteria, unless the points are at the high or low ends of the curve. If a point is removed from the low end, the reporting limit may be adjusted accordingly. If a point is removed from the high end, the linear calibration range must be adjusted accordingly.

16.3.4.1 Whenever a point is removed, it must be clearly documented on the instrument log.

16.3.4.2 A point may be removed that is not the high or low point only if the reason can be clearly documented. Acceptable reasons include a misinjection of the standard by the autosampler or other documentable instrument failure. A minimum of five points is required for any calibration curve. A minimum of six points is required for any quadratic calibration curve.

16.3.5 All initial calibration points must be analyzed without any changes to instrument conditions.

16.4 Initial and Continuing Calibration Verification

16.4.1 Initial Calibration Verification (ICV)

An ICV standard is analyzed following the analysis of a new initial calibration, and must be created from a second source standard. The acceptance limits are 85-115%.

**NOTE**: For NNSA validated data, the ICV acceptance limits are 80-120%. If the the ICV recovery for any compound exceeds +/- 20%, the associated field sample data for that compound should be qualified, with the failure discussed in the case narrative. Reanalysis is not required.

16.4.2 Continuing Calibration Verification (CCV)

A CCV standard is analyzed at least once every 10 analytical samples, and at the end of each analytical sequence. The CCV may be of the same or different source as the calibration standards. The acceptance limits are 85-115%.

**NOTE:** For NNSA validated data, the CCV acceptance limits are 80-120%, with the following exceptions:

16.4.2.1 When the CCV recovery for any compound exceeds +/- 20%, the associated field sample data for that compound should be qualified, with the failure discussed in the case narrative. Reanalysis is not required.

16.4.2.2 If the CCV recovery for any compound exceeds +/- 30% in any two consecutive CCVs, significant drift is indicated. The appropriate corrective action must be taken (typically recalibration), but the field samples associated with the CCVs need not be reanalyzed. The affected field sample data shall be qualified and the failure shall be discussed in the case narrative.

16.4.2.3 If the CCV recovery for any compound exceeds +/- 50%, the appropriate corrective action must be taken (instrument maintenance and/or recalibration), and all field samples will be reanalyzed back to the most recent CCV for which the recovery was within +/- 30%.

16.4.3 Calibration Blanks (ICB and CCB)

A solvent blank is analyzed after the ICV and after the CCV. The result must be less than the reporting limit concentration.

**NOTE:** If target analytes are above the reporting limit, check for carryover from a possible high-level sample. Check the LC system for contamination, and perform the necessary step to achieve a successful blank.

16.4.4 Detection Limit Verification (CRI)

To demonstrate sensitivity and accuracy for the analysis of HE by LC-MS/MS at the MDL, a verification (CRI) standard at approximately two times the MDL concentration is run with every CCV during the analytical run. The CRI acceptance limits are 70-130 % for all target analytes. If any compound recovery from the CRI analysis are outside the control limits, the appropriate corrective action must be taken (typically recalibration), and all samples from that analytical bracket must be reanalyzed.

16.5 When using an internal standard, the response of the internal standard must be within 70-130% of the average response of the six points of the curve when analyzing explosives. If the response of the internal standard is outside this range, the samples must be reanalyzed. If the internal standard is still outside the limits, a comment about possible bias low or high bias results is included in the case narrative.

## 17.0 QUALITY CONTROL

17.1 Preparation Batch. The preparation batch consists of a group of no more than 20 samples of the same matrix processed on the same day. All samples in a batch must be initiated on the same day. Each batch must contain a Method Blank (MB), a Laboratory Control Sample (LCS), and an MS/MSD or sample/sample

duplicate pair. If insufficient sample is available to prepare an MS/MSD then a duplicate LCS (LCSD) or sample duplicate must be substituted. Additionally, each sample (including the QC samples) will be spiked with the appropriate surrogate compound(s) when applicable. Refer to the GEL Quality Control Policy for additional information regarding data quality assessments and batch processing requirements.

17.2 Method Blank (MB)

17.2.1 MB data are used to assess contamination from the laboratory environment and to characterize spectral background from the reagents used in sample processing.

17.2.2 When samples that are extracted together are analyzed on separate instruments or days, the MB associated with those samples must be analyzed on at least one of those instruments and/or days. A solvent blank should be analyzed on all other instruments/days on which any of the samples are analyzed.

17.2.3 The MB must not exhibit values that exceed the reporting limit for any target analyte. MB values > the RL indicate that laboratory or reagent contamination should be suspected. If a MB exhibits values greater than the RL, the following corrective actions are recommended:

**NOTE:** For DoD QSM projects the MB criteria are as follows: No analytes should be detected at > ½ of the RL. For common laboratory contaminants, no analytes should be detected ≥ the RL.

17.2.3.1 The MB may be reanalyzed once to determine if the contamination is instrument related (carryover, etc.). If the reanalysis confirms an instrument-related problem and that the MB has not been contaminated, analysis may proceed.

17.2.3.2 MB values > the RL that are associated with samples that do not exhibit concentrations > RL for the analyte observed in the MB may be reported.

17.2.3.3 Samples exhibiting positively detected analytes (i.e., greater than the RL) that were also detected in the associated MB may be reported if the sample results are at least 10 times the concentration detected in the MB.

17.2.3.4 Samples exhibiting positively detected analytes (i.e., greater than the RL) that were also detected in the associated MB, but are less than 10 times the concentration detected in the MB must be re-extracted and re-analyzed.

**NOTE:** If there is insufficient sample volume remaining, or if the holding time has expired, the client must be consulted prior to beginning re-extraction. The deficiency must be documented.

17.3 Laboratory Control Sample (LCS)

17.3.1 The LCS consists of an aliquot of blank matrix (deionized water, Ottawa sand, sodium sulfate, etc.) that is spiked with the same

analytes at the same concentration as the matrix spike sample. The LCS is used to assess the ability of the analytical system to produce acceptable results and undergoes all sample treatments that the associated samples undergo.

17.3.2 Calculate the percent recovery (%R) for each target analyte using the following equation:

$$\%R = \frac{\text{Found Value}}{\text{True Value}} \times 100$$

17.3.3 If the recovery of any analyte falls outside the required control limits, that analyte is judged out of control, and the source of the problem should be identified and resolved before continuing the analysis. The following corrective actions are recommended:

17.3.3.1 The LCS may be reanalyzed once to determine if the out-of- control result is instrument related. If upon reanalysis the out- of-control analytes are in control, analysis and reporting of the associated samples may proceed.

17.3.3.2 If the %R for any analyte in the LCS is below the lower control limit, or if the %R is above the upper control and the analyte was detected in the associated samples above the RL, all associated samples must be re-extracted and re-analyzed for that analyte.

**NOTE:** If there is insufficient sample volume remaining or if the holding time has expired for any sample associated with the LCS, the client must be consulted prior to beginning re-extraction. The deficiency must be fully documented and it must be noted in the final report.

17.3.3.3 If the %R for any analyte in the LCS is above the upper control limit, and the associated samples do not exhibit concentrations above the RL for that analyte, the sample results may be reported. This indicates that a high bias may exist for the batch for that analyte, but since the samples were free of detections, the potential high bias does not affect the sample result. The deficiency must be documented and noted in the final report.

**NOTE:** Certain client programs require re-extraction and re-analysis for all LCS failures. The Project Manager must be consulted to ensure that the client will accept data in this instance.

17.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

17.4.1 A matrix spike is a sample that is spiked with the target analytes and is used to assess the effect of the matrix on the target analytes. If there is insufficient sample volume to prepare an MSD or a sample duplicate, an LCSD must be prepared and analyzed. The accuracy of the MS and MSD is reported as %R and is calculated as follows:

$$\%R = \frac{C_s - C}{S} \bullet 100$$

Where

| | | |
|---|---|---|
| %R | = | percent recovery |
| $C_s$ | = | spiked sample concentration |
| C | = | unspiked sample concentration |
| S | = | concentration of the spike added to the sample |

17.4.2 The MSD, sample duplicate or LCSD is used to measure the precision of the analytical system. The precision is expressed as relative percent difference (RPD), and is calculated using the following equation:

$$RPD = \frac{|a - b|}{[(a + b)/2]} \times 100$$

Where:

RPD = Relative Percent Difference

a = Result of MS, sample of LCS

b = Result of MSD, sample duplicate or LCSD

17.4.3 The %R for the MS and MSD and the RPD for the MS/MSD should be within control limits. If they are not, look for objective evidence of matrix interference such as sample heterogeneity, chromatographic behavior, required dilutions or behavior of the sample during extraction. MS, MSD or MS/MSD RPD failures and sample matrix observations must be documented.

17.5 Surrogate

17.5.1 The surrogate is a compound that is similar in composition and performance to the target analytes but is not expected to be present in the samples being analyzed. The surrogate is spiked into all samples in the batch, including QC samples, at the same concentration. The recovery of the surrogate compound is used to assess the effectiveness of the extraction procedure and matrix effects. Surrogate recoveries must be within control limits.

17.5.2 If the surrogate recoveries are not within the control limits for the MB, LCS or LCSD, and/or samples, the following corrective actions are recommended:

17.5.2.1 The extract may be reanalyzed once to determine if the out-of- control result is instrument related. If upon reanalysis the out- of-control surrogate(s) is in control, analysis and reporting of the associated samples may proceed.

17.5.2.2 If the %R for the surrogate(s) is below the lower control limit, all associated samples must be re-extracted and re-analyzed for that analyte.

17.5.2.2.1 If there is insufficient sample volume remaining or if the holding time has expired for any associated sample, the client must be consulted prior to beginning re-extraction.

17.5.2.2.2 The deficiency must be fully documented, and it must be noted in the final report.

17.5.2.2.3 If the %R for the surrogate(s) is above the upper control limit and the associated samples do not exhibit concentrations above the RL for any target analyte, the sample results may be reported. This indicates that a high bias may exist for the batch, but since the samples were free of detections, the potential high bias does not affect the target analyte result(s). The deficiency must be documented and noted in the final report.

**NOTE:** Some client programs may require re-extraction and re-analysis for all QC surrogate failures.

17.6 Additional QC Measures

17.6.1 Instrument Blanks: Solvent blanks (IB) may also be used to check for contamination by carryover from a high-concentration sample into subsequent samples.

17.6.2 Carry-over concerns. The analyst should review the results for at least the next sample after a high-concentration sample. If the high-concentration analytes are not present in the subsequent samples, then the lack of carryover has been demonstrated. If there is evidence that carryover may have occurred, then the samples must be reanalyzed.

## 18.0 CALCULATIONS

18.1 Percent Relative Standard Deviation for Initial Calibration

$$\%RSD = \frac{SD}{RF} x100$$

RF = Mean of RFs from initial calibration for a compound.

SD = Standard deviation of RFs from initial calibration for a compound,

$$= \sqrt{\sum_{i=1}^{N} \frac{(RFi - \overline{RF})^2}{N-1}}$$

RFi = RF for each of the calibration levels

N = Number of RF values

18.2 Continuing calibration percent drift

$$\%Drift = \frac{C_{actual} - C_{found}}{C_{actual}} x100\%$$

$C_{actual}$ = Known concentration in standard

$C_{found}$ = Measured concentration using selected quantitation method

18.3 Concentration in the extract

The concentration of each identified analyte and surrogate in the extract is calculated by average response factor or a regression fit.

18.3.1 Linear Fit

$$C_{ex} = A + B\frac{(R_X C_{IS})}{R_{IS}} \qquad C_{ex} = \frac{(R_X - A)}{B}$$

$C_{ex}$ = Concentration in extract

$R_X$ = Response for Analyte

$R_{IS}$ = Response for internal standard

$C_{IS}$ = Concentration of internal standard

A = Intercept

B = Slope

18.3.2 Quadratic Fit

Instrument data reduction software performs the quadratic equation that has been validated by the Quality department. For more information see the owner's manuals or contact the instruments manufacturer.

18.3.3 Average response factor

$$C_{ex} = \frac{(A_X C_{IS})}{(A_{IS}\overline{RF})}$$

$C_{ex}$ = Concentration in extract

$C_{IS}$ = Concentration of internal standard

$\overline{RF}$ = Average RF

$A_X$ = Area of the extract

$A_{IS}$ = Area of the internal standard

18.4 Concentration Determination of an Aqueous Sample

$$\mu g / L = \frac{C_{ex} V_t}{V_o}$$

$V_t$ = Volume of the total extract in µL taking into account dilutions

$V_o$ = volume of water extracted

18.5 Concentration Determination of a Solid Sample

$$\mu g / kg = \frac{C_{ex} V_t}{W_o}$$

$V_t$ = Volume of the total extract in µL taking into account dilutions

$W_o$ = Weight of the solid extracted

18.6 LCS Percent Recovery

$$LCS\,\mathrm{Recovery} = \frac{SSR}{SA} X100$$

SSR = Spike Sample Result

SA = Spike added

18.7 MS/MSD Spike Recovery calculations

$$MatrixSpike\,\mathrm{Recovery} = \frac{SSR - SR}{SA} X100$$

SSR = Spike sample Result

SA = Spike added

SR = Sample Result

18.8 Relative percent difference calculation for the MS/MSD or sample/sample duplicate.

$$RPD = \frac{MS_R - MSD_R}{\frac{1}{2}(MS_R + MSD_R)} X100$$

RPD = Relative Percent Difference

$MS_R$ = Matrix Spike Result or Sample Spike Result

$MSD_R$ = Matrix Spike Duplicate Result or Sample Spike Duplicate Result.

## 19.0 INSTRUMENT PERFORMANCE REQUIREMENTS

19.1 Refer to Appendix A for instrument set up criteria for compound specific parameters.

19.1.1 Continuing calibration verification standards must meet the criteria in section 16. When a calibration verification standard fails to meet the criteria, all samples that were injected after the last standard that met the criteria must be evaluated to prevent misquantitations and possible false negative results. Sample reanalysis of sample extracts may be required. More frequent analysis of standards will minimize the number of sample extracts that will have to be reanalyzed if the standard verification criteria are not met.

19.1.2 If the standard analyzed after a group of samples exhibits a response for an analyte that is above the acceptance criteria and the analyte was not detected in a specific sample analyzed during the analytical shift, then the sample extracts do not require reanalysis. The

verification standard has demonstrated that the analyte would have been detected were it present due to the elevated response. In contrast, if the analyte with the high response in the verification standard is also detected in samples, then reanalysis of the sample is required since the sample results may be biased high and quantitation unreliable. Reanalyze the sample within acceptable bracketing verification standards.

19.2 Sample injections may continue for as long as the calibration verification standards and standards interspersed with the samples meet the quality control criteria in section 16. The sequence ends when the set of samples has been injected or when standards exceed the acceptance criteria.

19.2.1 If during the analysis of a sample group from a single client, the bracketing continuing verification standards do not meet the acceptance criteria, reanalysis of this group of samples is required. The reanalysis is required to confirm that the sample extracts (matrices) are causing the instrument response to fluctuate and standards to fail. The reanalysis must begin with an acceptable initial continuing calibration set of standards. If continuing verification standards fail during the analysis sequence, the failure is attributed to matrix. If the standards meet the acceptance criteria, then matrix interference is not confirmed and the acceptable standards and samples in between should be reported.

19.2.2 In addition, if multiple client sample extracts are analyzed in the analytical sequence where continuing verification standard failures occur, each client's samples must be reanalyzed after an acceptable initial calibration, initial continuing calibration, or continuing verification standard.

## 20.0 ANALYST AND METHOD VERIFICATION REQUIREMENTS

20.1 To establish that the analyst can perform the procedures in an acceptable manner and that the method generates data of acceptable bias and precision, the following operations are performed.

20.1.1 A quality control (QC) check standard must be prepared containing each analyte of interest. It must be prepared from pure standard material or purchased as a certified solution. It must be made from a source independent of that used for calibration.

20.1.2 Four samples must be prepared and analyzed by the same procedures used to prepare and analyze actual samples.

20.1.3 Calculate the average recovery (X) in µg/L, and the standard deviation of the recovery (S) in µg/L, for each analyte of interest using the four results.

20.1.4 For each analyte compare S and X with the corresponding acceptance criteria for precision and accuracy, respectively, given in the quality control table at the end of the method. If the S and X

for all analytes of interest meet the acceptance criteria, the system's performance is acceptable and analysis of actual samples can begin. If any individual S and X exceeds the precision limits or falls out of the range for accuracy, the system's performance is unacceptable for that analyte and a check standard for that analyte must be prepared and reanalyzed.

20.2 Method detection limits are also determined and documented annually. Precision and accuracy are matrix dependent and are documented by means of a laboratory control sample (LCS) and a matrix spike and matrix spike duplicate. (Refer to GL-LB-E-001 for the Determination of Method Detection Limits.)

20.3 Analysts are given continual performance evaluation samples as an ongoing assessment of their ability to perform this procedure.

## 21.0 ANALYTICAL PROCEDURES AND INSTRUMENT OPERATION

Standards, samples, blanks, and quality control sample extracts are introduced into the instrument via direct injection (autosampler). Samples containing target analyte concentrations that exceed the linear range of the analyte calibration curve must be diluted. The dilution level should be performed to place the highest analyte concentration between the middle and high points of the calibration curve (on column). If a sample is initially diluted and target analytes are not detected and non-target analytes are not interfering with the analysis, the sample must be reanalyzed at a lower dilution. Analysts should be aware that diluting samples will increase the detection limits for undetected analytes. Random dilutions without due cause are not acceptable. Samples should undergo appropriate clean up method, if applicable, prior to diluting for observed matrix problems.

## 22.0 CALCULATIONS AND DATA REDUCTION METHODS

The concentration of each analyte in an extract can be determined by comparing the response obtained from analyzing the extract to the calibration curve. The concentration of a specific analyte is matrix specific and is calculated as follows:

Aqueous Sample

$$\text{Concentration } (\mu g/L) = \frac{(C)(D)(V_t)}{1000V_i}$$

Where:

C = Concentration (µg/L) calculated by data system from total area substituted into the linear equation derived from the multilevel calibration

D = Dilution factor, if made prior to analysis. If not, D = 1.

$V_t$ = Total volume of the extract in mL

$V_i$ =Initial volume of sample in L

Nonaqueous Samples

$$\text{Concentration } (\mu g/kg) = \frac{(C)(D)(V_t)}{1000\ W}$$

Where:

C = Concentration (µg/mL) calculated by data system from total area substituted into the linear equation derived from the multilevel calibration

D = Dilution factor, if made prior to analysis. If not, D = 1.

$V_t$ = Total volume of the extract

W = Weight of the sample extracted

## 23.0 DATA RECORDING

Data are recorded and calculated by the instrument data acquisition system. They are stored on a remote server. The data are also entered into AlphaLIMS.

## 24.0 QUALITY CONTROL REQUIREMENTS

24.1 Before sample analysis begins, the instrument must have acceptable calibration curves. Each curve is verified by the analysis of second source continuing calibration standards. Each standard must meet the acceptance criteria for percent difference or drift. Continuing calibration verification standards must be analyzed at least after every twenty samples. It is recommended to analyze these verifications after every ten samples.

24.2 A method blank (MB) is used to assess the preparation batch for possible contamination during the preparation and processing steps. The MB shall be processed along with an under the same conditions as the associated samples to include all steps of the analytical procedure. All analytes of interest must be below the RL to meet the quality control requirements. Any sample associated with a MB that does not meet this criterion shall be reprocessed in a subsequent preparation batch, except when the sample analysis resulted in a non-detect. If no sample volume remains, the results shall be reported with the appropriate data qualifying codes.

**NOTE:** For DoD QSM projects the MB criteria are as follows: No analytes should be detected at > ½ of the RL. For common laboratory contaminants, no analytes should be detected ≥ the RL.

24.3 If the analyte of interest is present at a concentration between the MDL and RL, all data are qualified with a "J" flag and reported. If the analyte of interest is present at a concentration above the RL, and the samples contain the analyte of interest at a concentration of greater than 10 times the concentration found in the blank, the data are qualified with a "J" flag and reported. If the concentration found in the sample is less than 10 times that found in the blank and greater than the RL, the samples must be re-extracted. If the samples do not contain the analytes of interest, the data are reported.

24.4 The laboratory evaluates the effect of matrix on method performance by performing a matrix spike and matrix spike duplicate for each matrix up to 20 samples in the same batch. Matrix spike recovery limits are generated statistically using at least 15 result pairs of the same matrix. In addition, a

laboratory control sample (LCS) and its duplicate (when requested) are analyzed with each sample batch (up to 20 samples of the same matrix). The LCS consists of an aliquot of clean (control) matrix similar to the sample matrix and of the same weight or volume. The LCS is spiked with the same analytes at the same concentration as the matrix spike. When the results of the matrix spike analysis indicates a potential problem due to the sample matrix itself, the LCS results are used to verify that the laboratory can perform the analysis in a clean matrix. LCS recoveries are statistically generated using at least 15 results of the same matrix type. SPC limits are updated semi-annually.

24.5 The retention time (RT) window must be established using the initial calibration check standard. Refer to EPA Method 8321A "Solvent Extractable Nonvolatile. Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection." Due to the nature of LC/MS/MS per Method 8321A, the retention time of the analyte should be observed but is not significant in determining false positives.

24.6 Nonconformance

24.6.1 When running a calibration curve for more than one analyte at a time, some of the analytes may not meet the acceptance criteria. Additional standards containing the compounds that were not acceptable may be analyzed. If the curve still does not meet the acceptance criteria, maintenance should be performed or a new standard may be needed. Refer to section 16 for other options addressing the initial calibration.

24.6.2 If the continuing check standard fails any criteria, the analyst must take action to correct the situation. This may be performing any of the maintenance steps described in section 14 to get the instrument to meet its daily calibration. If all attempts fail, the analyst must analyze a new series of calibration standards, thus obtaining a new calibration curve.

24.6.3 If the standard analyzed after a group of samples exhibits a response for an analyte that is above the acceptance limit and the analyte was not detected in the specific samples analyzed during the analytical shift, then the extracts for those samples do not need to be reanalyzed. If an analyte above the QC limits was detected in a sample extract, reinjection of the extract is necessary.

24.7 If the percent recovery in the matrix or matrix spike duplicate falls outside the established SPC limits for recovery, the analyst should evaluate the LCS recoveries and method blank analyses. If the LCS and method blank analyses do not indicate a problem with the preparation procedures, the matrix spike recoveries may be attributed to matrix effect. Surrogate recovery data should also be used to evaluate the data. Recoveries of both matrix spike compounds and surrogates that are outside the acceptance limits suggests more pervasive analytical problems then problems with the recoveries of either matrix spikes or surrogates alone. Analysts are not required to reanalyze the matrix spikes for

failing recoveries, however they should seek additional technical support before deciding not to reanalyze matrix spikes samples.

24.8 If a surrogate in a sample falls outside the acceptable fixed range, the sample must be re-extracted. If the surrogate fails the second time, the failure is attributed to matrix interference and the data from the first extraction are reported. When a sample or batch is sent back to be re-extracted, a nonconformance form must be completed and given to the Quality Department. A copy of this form is given to the Organic Prep Group Leader and is also placed in the Nonconformance logbook. The form describes the reasons for re-extraction. (Refer to GL-QS-E-004 for Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items.)

## 25.0 DATA REVIEW, VALIDATION, AND APPROVAL PROCEDURES

25.1 Upon completion of a batch, the analyst enters the data. A data report is generated and it is placed in a folder along with the batch and all other raw data (chromatograms). This folder is given to the peer review analyst for reviewing.

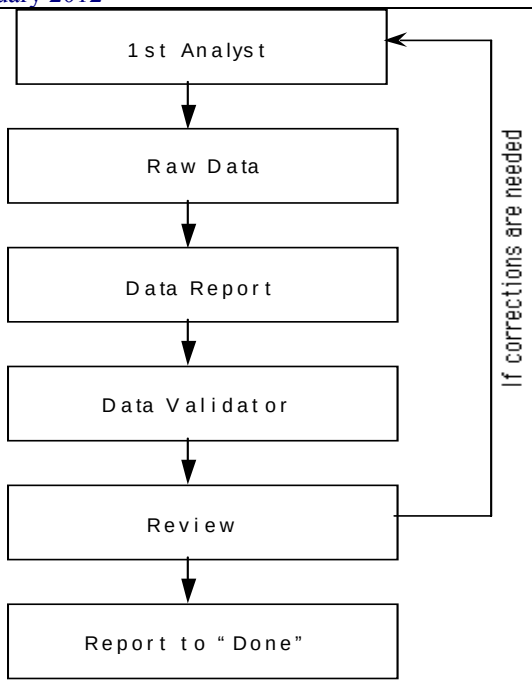
25.2 Levels of review and their responsibilities

25.2.1 First level review - The analyst must check all chromatograms and calculate the percent recoveries for the spike, duplicate, and all surrogate recoveries. The analyst must verify that the check standard passes for the analytes of interest. If a target compound confirms on the confirmation column, it must be checked to see if the retention time of the analyte is within the daily retention time window. The peak's shape must also be checked to ensure that it is indeed a peak and not noise. If the hit meets both of these requirements, its concentration should be reported. The analyst should also make sure that a review checklist is present.

25.2.2 Second level review - The data validator or other qualified reviewer must ensure that the concentration that appears in the external standards table is indeed what has been entered into the computer. The reviewer must verify that the calibration check standard is acceptable and that the LCS and its duplicate and the surrogates are all within acceptable ranges. The reviewer must also check the date analyzed, dilution factor, and time of analysis from the raw data against the data report. If everything is acceptable, the reviewer must then initial and date the quantitation report. The run log must also be dated and initialed. The data report is then issued a status of "Done."

25.2.3 To complete a review process, all chromatograms of the calibration check standard, blank, LCS and its duplicate, samples and the spike and/or duplicates of the sample must be present. The batch sheet, sample tracker log, and the data report should all be present.

25.3 A flow chart of the review process follows:




## 26.0 DATA TRANSMITTAL

After the review process is complete, Data Management receives the data.

## 27.0 RECORDS MANAGEMENT AND DOCUMENT CONTROL

All data associated with the activity described in this procedure, including relevant logbooks, are maintained as quality records in accordance with GL-QS-E-008 for Quality Records Management and Disposition.

## 28.0 LABORATORY WASTE HANDLING AND DISPOSAL: SAMPLES, EXTRACTS, DIGESTATES AND REAGENTS

For the proper disposal of sample and reagent wastes from this procedure, refer to the Laboratory Waste Management Plan GL-LB-G-001.

## 29.0 REFERENCES

29.1 Test Methods for Evaluating Solid Waste, EPA Manual SW-846, 3rd Edition. Method 8000C, "Determinative Chromatographic Separations," Revision 3, March 2003.

29.2 Test Methods for Evaluating Solid Waste, EPA Manual SW-846, 3rd Edition. Method 8321A, "Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromotography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviloet (UV) Detection." Revision 1, Update III, December 1996.

29.3 Test Methods for Evaluating Solid Waste, EPA Manual SW-846, 3rd Edition. Method 8330A, "Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromotography (HPLC)." Revision 1, February 2007.

29.4 Test Methods for Evaluating Solid Waste, EPA Manual SW-846, 3rd Edition. Method 8330B, "Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromotography (HPLC)." Revision 2, October 2006.

## 30.0 HISTORY

Revision 15: Revised CCV and CRI criteria per NNSA SOW.

Revision 14: SOP updated to clarify terminology.

Revision 13: SOP updated as part of DOECAP audit finding. Added computer and software references for LC-MS/MS #1, LC-MS/MS #3 and LC-MS/MS #4.

## TABLE 1

### Calibration Masses for NaI/RbI solution

| Amu |
|---|
| 22.9898 |
| 84.9118 |
| 172.8840 |
| 322.7782 |
| 472.6725 |
| 622.5667 |
| 772.4610 |
| 922.3552 |
| 1072.2494 |

Based on Rb = 85.467, I = 126.9045, Na=22.9897697

## APPENDIX A

# Determination of Nitroaromatic Explosives by APCI/LC/MS/MS

This appendix describes the sample preparation and analysis of nitroaramatic explosives in water and soil samples. Water sample preparation is done by either salting out or solid phase extraction, and solid sample preparation is done by sonication. A list of analytes is in Table A-2.

A.1 Method Summary

Nitroaromatic compounds are extracted from water samples using either the standard 8330 salting out procedure or by a solid phase extraction using Waters Poropak RDX phase cartridges. The extract is analyzed using atmospheric pressure chemical ionization liquid chromatography mass spectrometry mass spectrometry (APCI/LC/MS/MS). The analysis is performed in the negative ion mode using an internal standard quantitation. For chromatography a C18 reverse phase column is used with a water/methanol gradient.

A.2 Sample Handling and preservation

A.2.1 Water samples should be collected in one liter amber vials with Teflon-lined caps. Samples should be collected in duplicates.

A.2.2 Solid samples should be collected in 4 oz. wide mouth amber glass containers with Teflon-lined caps.

A.2.3 Samples are stored at $0 \leq 6°$ C. Sample extracts are stored at $0 \leq 6°$ C.

Holding times for water samples, from the day of collection, is 7 days. Holding time for solid samples, from the day of collection is 14 days. Extract holding times are 40 days from the completion of the prep.

A.3 Analytical Conditions

A.3.1 HPLC Column: A 250 X 4.0 mm, C18, 5 micron reverse phase column is used. A guard column is recommended with analysis. Alternate columns and gradients are acceptable if they provide acceptable performance.

A.3.2 Typical mass spectrometric conditions are listed in Table A-3 and A-6.

A.3.3 Typical HPLC conditions are listed in Table A-4 and A-7.

A.4 Reagents/Standards

Standards are stored at $0 \leq 6°$ C in amber vials. All standards should be made using Acetonitrile.

A.4.1 Stock standards solutions are commercially available in flame sealed ampoules.

A.4.2 A working standard is used to prepare the individual calibration standards.

A.4.3 Calibration Standards: Six calibration levels are prepared from the intermediate standard including QC samples. Refer to Table A-1 for typical calibration concentrations. Standards are prepared in a 1:1 mixture of DI water and acetonitrile. Additional calibration levels can be prepared at the analyst's discretion.

A.4.4 A Second source calibration standard is prepared from an intermediate standard. The concentration of this standard is near the middle of the curve. The analyst can determine the concentration of this standard based on method performance.

A.4.5 Spikes are prepared at a concentration of 500 µg/L.

A.4.6 The surrogate is 3,4-dinitrotoluene. The concentration of the surrogate in the final extract is 250 ng/mL. This final extract concentration can change based on analyst discretion if properly documented.

A.4.7 The internal standards employed for the analysis of the Primary explosives contain 1,3-dinitrobenzene-d4 and 2,6-dinitrotoluene-d3. This solution should be prepared at a concentration of 10 µg/mL for each IS. The final extract concentration of the IS is 500 ng/mL. This final extract concentration can change based on analyst discretion if properly documented.

A.4.7.1 Just before analysis, 500 µL of the extract is mixed with 500 µL of DI water, and transferred to an analytical vial. For the primary explosive analysis, 50 µL of IS is added. The secondary explosive analysis does not employ an internal standard. The extract is then mixed.

A.4.7.2 An injection volume of 50 µL is used for the primary explosive analysis, and 10 µL is used for the secondary explosive analysis. All standards, and sample extracts are introduced to LC/MS/MS system using the same instrumental conditions as the initial calibration.

A.5 Calibration and Standardization

A.5.1 For the analysis of the primary explosives, an internal standard method is used. For the analysis of the secondary explosives, an external standard method is used.

A.5.2 Three calibration options exist for this analysis, mean response factor, linear regression, and quadratic equations. For mean response fits, the percent RSD for each analyte must be $\leq 20\%$. For linear regression fits, a $1/X$ or $1/X^2$ weighing is used. The correlation coefficient (r) must be $\geq 0.990$. For quadratic fits, the coefficient of determination ($r^2$) must be $\geq 0.990$. While quadratic equations may be used, the intercept and degree of curvature should be examined to ensure that results would be reliable throughout the range of the curve. When a quadratic curve is used, there must be at least six calibration points employed.

A.5.3 Recovery limits for Quality Control samples are presented in table A-5 and A-8.

A.6 References

A.6.1 SW-846, Test Methods for Evaluating Solid Waste, Third Edition, Update III, December 1996, “Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection,” Method 8321A.

A.6.2 SW-846 EPA Method 8330A Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC), Rev. 1 February 2007.

A.7 Method Modifications

Not Applicable

## TABLE A-1

### Suggested Calibration Levels, µg/L

| ANALYTE | LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 | LEVEL 5 | LEVEL 6 | LEVEL 7 |
|---|---|---|---|---|---|---|---|
| Picric Acid | 50 | 100 | 500 | 1000 | 1500 | 2000 | 4000 |
| Nitroglycerin | 50 | 100 | 250 | 500 | 750 | 1000 | 2000 |
| All Analytes | 25 | 50 | 250 | 500 | 750 | 1000 | 2000 |
| Internal Standards | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| * Additional Target Analytes | 50 | 100 | 250 | 500 | 750 | 1000 | 2000 |

Calibration solutions ae prepared in 1:1 ACN DI water

## TABLE A-2

### Analyte, Characteristic Ions and Transitions

| Compound | CAS Number | Parent Ion (m/z) | Daughter Ion (m/z) |
|---|---|---|---|
| HMX | 2691-41-0 | 176 | 102 |
| RDX | 121-82-4 | 176 | 102 |
| Picric Acid | 88-89-1 | 229 | 212 |
| 1,3,5-Trinitrobenzene | 99-35-4 | 213 | 183 |
| 1,3-Dinitrobenzene | 99-65-0 | 168 | 138 |
| Tetryl | 479-45-8 | 241 | 181 |
| 2,4,6-Trinitrotoluene | 118-96-7 | 227 | 210 |
| Nitrobenzene | 98-95-3 | 123 | 46 |
| Nitroglycerin | 55-63-0 | 227 | 62 |
| 2,4-Dinitrotoluene | 121-14-2 | 182 | 152 |
| 2,6-Dinitrotoluene | 606-20-2 | 182 | 152 |
| 2-Amino-4,6-dinitrotoluene | 35572-78-2 | 197 | 180 |
| 4-Amino-2,6-dinitrotoluene | 19406-51-0 | 197 | 167 |
| 2-Nitrotoluene | 88-72-2 | 137 | 46 |
| 3-Nitrotoluene | 99-08-1 | 137 | 46 |
| 4-Nitrotoluene | 99-99-0 | 137 | 46 |
| PETN | 78-11-5 | 361 | 62 |

| | | | |
|---|---|---|---|
| 1,3-Dinitrobenzene-d4 (Internal Standard) | 54247-05-1 | 172 | 142 |
| 2,6-Dinitrotoluene-d3 (Internal Standard) | 93951-90-7 | 185 | 155 |
| 3,4-Dinitrotoluene (Surrogate) | 610-39-9 | 182 | 152 |
| *2,6-Diamino-4-Nitrotoluene | 59229-75-3 | 167 | 46 |
| *2,4-Diamino-6-Nitrotoluene | 6629-29-4 | 167 | 46 |
| *3,5- Dinitroaniline | 618-87-1 | 182 | 46 |
| *1,3,5-Triamino-2,4,6-Trinitrobenzene | 3058-38-6 | 258 | 240 |
| *Tri(o-cresyl)phosphate (TCP) | 78-30-8 | 369 | 91 |
| TNX | 13980-04-6 | 190 | 86 |
| DNX | 80251-29-2 | 160 | 46 |
| MNX | 5755-27-1 | 176 | 102 |

**NOTE**: Analytes denoted by "*" are considered the secondary explosive analytes or additional target analytes as described in Table A-1.

**TABLE A-3**

**Typical Mass Spectrometer Operating Conditions (Primary Explosives)**

| Parameter | Setting |
|---|---|
| Scan Mode | Centroid, Negative and Positive Ion |
| Interface | Atmospheric Pressure Chemical Ionization (APCI) |
| Corona Amps | 30 µA |
| Multiplier Voltage | 750 V |
| Source Temperature | 100° C |
| Vaporizer Temperature | 400° C |
| Desolvation Gas Flow | 0 L/hr |
| Cone Voltage | Varies |
| Cone Gas Flow | 0 L/hr |
| Collision Voltage | Varies |
| Collision Gas | Argon |
| Extractor | Varies |
| RF Lens | Varies |

**TABLE A-4**

**Typical HPLC Operating Conditions (Primary Explosives)**

| Parameter | Setting |
|---|---|
| Column | 250 X 4.0 mm C18 Phenomenex Ultracarb ODS (20) or equivalent |
| Column Temperature | 30° C |
| Sample Temperature | 20° C |
| Eluant Flow Rate | 0.7 mL/min |
| Eluant Identification | A = Water, 3.5 mM Ammonium Formate<br>B = Methanol |
| Solvent Program | 43% A/57% B |
| Injection Volume | 50 µL |
| Run Time | 30.0 Minutes |

**TABLE A-5**

**Quality Control Sample Recovery Limits (Primary and Secondary Explosives)**

| Compound | % Recovery |
|---|---|
| 1,3-Dinitrobenzene-d4 (IS) | 70 – 130 |
| 2,6-Dinitrotoluene-d3 (IS) | 70 – 130 |
| 3,4-Dinitrotoluene (Surrogate) | 50-150 or SPC limits |
| ICV/CCV (All analytes) | 85 – 115 (NNSA: 80-120%) |
| CRI (All analytes) | 70-130 |
| LCS (All analytes) | 50-150 or SPC limits |
| MS/MSD (All analytes except tetryl) | 50-150 or SPC limits |
| MS/MSD (Tetryl) | 30 – 120 or SPC limits |
| MS/MSD (All analytes) | RPD ≤ 20 or SPC limits |

**TABLE A-6**

**Typical API 4000 Mass Spectrometer Operating Conditions (Secondary Explosives)**

| Parameter | Setting |
|---|---|
| Scan Mode | Centroid, Negative and Positive Ion |
| Interface | Atmospheric Pressure Chemical Ionization (APCI) |
| Corona Amps | -5 µA |
| Multiplier Voltage | 2000 V |
| Source Temperature | 500° C |
| Vaporizer Temperature | 500° C |
| Desolvation Gas Flow | 0 L/hr |
| Collision Energy | Varies |
| Collision Gas | Nitrogen |
| Declustering Potential | Varies |
| Entrance Potential | -10.0 V |

**TABLE A-7**

**Typical HPLC Operating Conditions (Secondary Explosives)**

| Parameter | Setting |
|---|---|
| Column | YMC J'Sphere 150 x 4.6mm Id, S-4 µm, 8 nm |
| Column Temperature | 30° C |
| Sample Temperature | 20° C |
| Eluant Flow Rate | 1.0 mL/min |
| Eluant Identification | A= Water<br>B= Methanol |
| Solvent Program | 85% A/15% B w/gradient |
| Injection Volume | 10 µL |
| Run Time | 20 minutes |

**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

# FOR

# SAMPLE PROCESSING AND ANALYSIS OF NITROAROMATICS, NITROAMINES, AND NITRATE ESTERS BY SW-846 8330B

## (GL-OA-E-068 REVISION 4)

APPLICABLE TO METHOD:
EPA SW-846 Method 8330B

PROPRIETARY INFORMATION

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## 1.0 STANDARD OPERATING PROCEDURE FOR SAMPLE PROCESSING AND ANALYSIS OF NITROAROMATICS, NITROAMINES, AND NITRATE ESTERS BY SW-846 8330B

## 2.0 METHOD REFERENCE

EPA SW-846 8330B

## 3.0 METHOD OBJECTIVE AND PURPOSE

3.1 To describe the manner in which water, soil, or other solid samples are processed, extracted, and analyzed for EPA SW-846 8330B.

3.2 Using an incremental sampling procedure in the field, the soil or solid matrix is collected in 1 to 2 kilogram sample sizes. The laboratory processes the entire sample by drying, grinding, sieving, and subsampling prior to extraction. Analytes listed in the above-referenced method are partitioned from soil or solid matrices using a sonication extraction. The extract is filtered prior to analysis. These techniques prepare the sample such that analytes of interest are in solvent and at concentrations suitable for analysis using liquid chromatography.

3.3 The preferred method of extracting aqueous samples is by SW-846 3535 (solid-phase extraction). The use of solid-phase extraction has been shown to provide equal or superior results compared to the salting out procedure. This SOP will address method 3535 for aqueous samples. The salting out procedure cannot be used with this method.

## 4.0 METHOD SCOPE AND APPLICABLE MATRIX

4.1 Refer to Appendix II for compound list of nitroaromatic explosives by LCMSMS or HPLC.

4.2 This method applies to the following matrices:

4.2.1 Groundwater

4.2.2 Wastewater

4.2.3 Soil

4.2.4 Sediment

## 5.0 DISCUSSION

5.1 Method 8330B introduces several new concepts or changes to 8330 and 8330A. The soil sampling and analytical modifications in 8330B are collectively intended to decrease the effects of sampling and subsampling errors caused by the compositional and distributional heterogeneity typically encountered in solid environmental media at military training ranges. The method has been separated into 4 different phases: sampling, preparation, extraction, and analysis. This SOP applies to the extraction and analysis phases of the method. Sample analysis will be performed using LC/MS/MS or HPLC/DAD for analyte detection and quantitation. Field activities should be addressed in the client QAP or project scope.

5.2 If sample analysis is performed using HPLC/DAD, please refer to SOP GL-OA-E-033 for analytical details. Sample preparation and extraction for analysis by the HPLC will follow this SOP, however the analytical (primary and confirmation) analyses will follow standard 8330 procedures.

5.3 If sample analysis is performed using LCMSMS, please refer to SOP GL-OA-E-056 for analytical details. Aqueous sample extraction and analysis by the

LCMSMS will follow this SOP, however the instrument set up/maintenance will follow GL-OA-E-056. See GL-OA-E-071 for sample processing for 8330 B MIS procedures.

## 6.0 DEFINITIONS

6.1 Accuracy: The degree of agreement between an observed value and an accepted reference value.

6.2 AlphaLIMS: The Laboratory Information Management System used at GEL Laboratories, LLC.

6.3 Method Blank: Organic free, clean solid material (soil) for solid matrices and DI water for aqueous matrices to demonstrate that background contaminants are not introduced during the extraction process.

6.4 Internal Standard (ISTD): A known amount of standard added to a portion of the sample extract as a reference for evaluating and controlling the precision and bias of the applied analytical method.

6.5 Laboratory Control Sample (LCS): Standard reference material or fortified soil taken through the sample preparation process and extraction to demonstrate that the process is in control and to indicate accuracy.

6.6 Laboratory Control Sample Duplicate (LCS DUP): A duplicate of the LCS to indicate reproducibility and to indicate precision.

6.7 Matrix Spike and Matrix Spike Duplicate (MS and MSD): An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS are corrected for background concentrations.

6.8 Method Detection Limit (MDL): The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero. Typically, the MDL is two to three times less than the PQL.

6.9 Practical Quantitation Limit (PQL): The lowest level in the calibration curve. With the prep factor applied, the PQL is referred to as the effective PQL.

6.10 Relative Percent Difference (RPD): The difference between two duplicate samples, such as a MS/MSD, LCS/LCSD, or sample/sample DUP. It is determined by taking the difference between the two results and dividing by the average.

6.11 Sample Duplicate (DUP): A duplicate of a sample indicating reproducibility.

6.12 Spike: A solution added to the laboratory control samples and matrix spikes that contain compounds defined by the referenced method. For compounds and concentrations, refer to AlphaLIMS.

6.13 Stock Standard Solution: A concentrated solution containing one or more method analytes prepared in the laboratory using certified reference materials or purchased from a reputable commercial source.

6.14 Surrogate: A solution added to each sample and quality control sample to monitor the efficiency of the extraction process. It contains compounds similar to those being analyzed. For compounds and concentrations, refer AlphaLIMS.

6.15 Standard Reference Material: Solid material purchased from a vendor that contains analytes of interest at known concentrations. May be substituted for the LCS.

6.16 Subsample: A portion of the entire sample randomly collected and composited to create the sample weight used for the solvent extraction process. The subsample should be representative of the entire sample.

6.17 Independent Calibration Blank (ICB): An aliquot of reagent water or other blank matrix that is analyzed after each ICV. The ICB is used to determine whether there is carryover contamination after injection of the mid-level ICV.

6.18 Independent Calibration Verification (ICV): A solution of method analytes of known concentrations that is used to fortify an aliquot of Blank or sample matrix. The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

6.19 Continuing Calibration Verification (CCV): A standard of the same or different origin as the calibration standard is analyzed after every 10 injections. Refer to related appendices for CCV limits.

6.20 Instrument Performance Check Solution (IPC): A solution of one or more method analytes, surrogates, internal standards, or other test substances used to evaluate the performance of the instrument system with respect to a defined set of criteria.

6.21 Linear Calibration Range (LCR): The concentration range over which the instrument response is linear.

6.22 Statistical Process Control (SPC) Limits: Statistically derived limits which establish Acceptable Ranges for recoveries of analytes of interest, including LCS, MS, MSD, PS, PSD and internal standards.

6.23 Reporting Limit (RL): The level at which a target analyte would meet the data quality objectives of the laboratory and/or a project, which may include establishing compliance with a regulatory and/or action limit. The RL may be equal to the laboratory practical quantitation limit (PQL).

## 7.0 INTERFERENCES

7.1 Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be necessary. Refer to each method for specific guidance on quality control procedures.

7.2 Interferences co-extracted from the samples will vary considerably from source to source. If analysis of an extracted sample is prevented due to interferences, further cleanup of the sample extract may be necessary. Refer to cleanup procedures for guidance on the cleanup of sample extracts.

7.3 Tetryl decomposes rapidly in methanol/water solutions, as well as with heat. All aqueous samples expected to contain tetryl should be diluted with acetonitrile

prior to filtration and acidified to pH < 3 with aqueous sodium bisulfate. All samples expected to contain tetryl should not be exposed to temperatures above room temperature.

7.4 (HPLC only) Degradation products of tetryl may appear as a shoulder on the 2,4,6-TNT peak using the C18 separation. Peak heights rather than peak areas may be used when tetryl is present in concentrations that are significant relative to the concentration of 2,4,6-TNT.

7.5 Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe must be rinsed thoroughly between samples with the strongest organic solvent used in the method. The analyst must monitor method blanks to determine if the syringe rinsing is sufficient.

7.6 LC/MS/MS is a highly selective analysis that utilizes four means of compound discrimination: chromatographic separation, negative ion generations (where applicable), mass selection, and daughter fragmentation. It is theoretically possible that two different compounds could have the same retention time and generate the same ion. But, it is highly unlikely that these two compounds would fragment to the same daughter ion.

## 8.0 SAFETY, HEALTH, ENVIRONMENTAL HAZARDS AND POLLUTION PREVENTION

**WARNING**

ACETONITRILE IS FLAMMABLE AND TOXIC.

**WARNING**

PREVENT SKIN AND EYE CONTACT BY USING SPECIFIED PERSONAL PROTECTIVE EQUIPMENT WHEN MAKING STOCK REAGENTS.

WORK UNDER A HOOD TO PREVENT INHALATION WHEN MAKING STOCK REAGENTS.

8.1 Wear eye protection with side shields while working in the laboratory.

8.2 All chemicals and samples should be treated as potential health hazards, and exposure to these chemicals must be reduced to the lowest level possible. GEL maintains a current awareness file of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of the chemicals. A reference file of Material Safety Data Sheets (MSDS) and individual client sample MSDSs are also maintained.

8.3 Personal protective equipment

8.3.1 Gloves are required when working with solvents, standards and samples. Solvents, along with any solute in them, can absorb easily through the skin.

8.3.2 Work under a hood when using concentrated acids.

8.3.3 To protect clothes and skin from corrosive material, wear a lab coat.

8.4 Prior to handling radioactive samples analysts must have had radiation safety training and understand their full responsibilities in radioactive sample handling. Some general guidelines to follow:

8.4.1 To monitor radioactive exposure, wear a dosimeter at all times while working in the lab.

8.4.2 Wear a plastic apron over lab coat when working with radioactive samples.

8.4.3 Protect counter tops with counter paper or work from radioactive sample handling trays.

8.4.4 Prohibit admittance to immediate work area.

8.4.5 Post signs indicating radioactive samples are in the area.

8.4.6 Take swipes of the counter tops upon completion of work. Deliver those swipes to the designated swipe count box.

8.4.7 Segregate radioactive wastes. Radioactive waste containers are obtained from Waste Management.

8.5 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

8.5.1 Segregate solid wastes from liquid wastes in the satellite area containers.

8.5.2 Segregate oil wastes from water-soluble wastes in the satellite area containers.

8.6 In the event of an accident or medical emergency, call for help immediately. When time and safety permit, an accident report form should be completed and turned in to the safety committee.

8.7 Fire escape routes are posted in the lab, and all personnel should be familiar with them. In addition, fire safety equipment such as fire extinguishers is located in the lab. Training is available on the proper operation of this equipment.

## 9.0 APPARATUS AND MATERIALS

Unless otherwise indicated, all apparatus and materials are suggested only. See specific SOPs for apparatus (instrument) details. See specific details in each SOP for additional materials.

9.1 Glassware

9.1.1 Scintillation vials: 20 mL, glass.

9.1.2 Vials: 15 mL, glass, PTFE-lined cap

9.1.3 Vials: 40 mL, glass, PTFE-lined cap

9.1.4 Disposable pipettes: Pasteur

9.2 High-pressure injection syringe: 500 µL (Hamilton liquid syringe, or equivalent)

9.3 Temperature controlled ultrasonic bath or platform shaker

9.4 An analytical balance capable of accurately weighing 0.0001 g

9.5 Vortex mixer

9.6 Magnetic stirrer equipped with PTFE stirring bars

9.7 Mortar and pestle, mechanical grinder, or ring puck mill

9.8 Disposable cartridge filters: 045 um PTFE filter.

9.9 Pipets: Class A, glass, appropriate sizes

9.10 Sieve: 10 mesh (2 mm), 200 mesh (75 um ASTM Standard E11)

9.11 Graduated cylinders: 10 mL, 25 mL, and 1 L

9.12 Disposable syringes: Plastipak, 3 mL and 10 mL or equivalent

9.13 Vials: High-density polyethylene (HDPE) or glass, amber, 12 mL for sampling and storage of calibration solutions

9.14 Expray™: Color indicator screening test for trace explosives. Used for screening 1 of 3 groups of explosives.

## 10.0 REAGENTS AND STANDARDS

10.1 Standards are stored in the cooler at 0° ≤ 6° C. All standards are assigned an expiration date of one year from receipt or the vendor's expiration date, whichever occurs sooner. Expiration dates for intermediates and working solutions are the same as for the parent stock standard unless otherwise noted on the standard. Standards are monitored for degradation and replaced as necessary. Standards must be brought to room temperature before using.

10.2 Stock Standard Solution: A standard that is at a high concentration and is therefore stable enough to be stored for longer periods of time than other standard concentrations. All stock standards must be verified for accuracy before use.

10.3 Intermediate Standard Solutions: Intermediate standard solutions are prepared with the analyte of interest. Preparation details may vary due to differences in stock solutions.

10.4 Calibration Standards: Calibration levels are prepared from the intermediate standard. Refer to appendices for concentrations. Additional calibration levels can be prepared at the analyst's discretion.

10.5 Second-Source Calibration Verification Standard Solution: This standard is obtained from a different vendor than are the calibration standards described in 10.4. An intermediate solution is prepared from stocks, which is then used to prepare a working standard used to verify the initial calibration. In certain cases a second source calibration verification may not be possible. In this case, a second stock standard is made to verify the initial stock concentration.

10.6 Spiking Solution: The solution is used to prepare laboratory control samples (LCSs) and matrix spike / matrix spike duplicates (MS/MSD) at the beginning of the sample preparation procedure.

10.7 Surrogate Standard: This standard is added to samples and QC to monitor the efficiency of the sample preparation procedure.

10.8 Internal Standard: LCMSMS ONLY: The IS standard is added to all working samples, QC, and standards prior to analysis. The internal standards employed for the analysis of the primary explosives contain 1,3-dinitrobenzene-d4 and 2,6-dinitrotoluene-d3. This solution should be prepared at a concentration of 10 µg/mL for each IS. The final extract concentration of the IS is 500 ng/mL. This final extract concentration can change based on analyst discretion if properly documented.

10.9 Sodium Rubidium Iodide Tuning Solution: LCMSMS ONLY: A mixture of sodium iodide (NaI) and rubidium iodide (RbI). The tuning solution contains approximately 2 µg/µL of NaI and 0.05 µg/µL RbI in 50/50 2-propanol/water.

10.10 Nitrogen Gas, 99+%

10.11 Argon Gas, 99+%.

10.12 Reagents must meet ACS Analytical criteria. Reagents will not be stored in plastic containers.

10.13 Acetonitrile ($CH_3CN$), pesticide quality or equivalent

10.14 Reagent water: Distilled or deionized water 17.8 Mohm or better, free of the anions of interest. Water should contain particles no larger than 0.20 microns.

10.15 Methanol, reagent grade

10.16 Ammonium formate, reagent grade

10.17 Calcium chloride, $CaCl_2$: Prepare an aqueous solution containing 5 g/L of calcium chloride.

## 11.0 SAMPLE HANDLING AND PRESERVATION

11.1 All liquid samples have a holding date of seven days from the time of collection to be extracted. Solid samples have fourteen days from the collection date to be processed. After air-drying soil and sediment, the samples can be held at room temperature (22° $\pm$ 4° C) or cooler.

11.2 Samples are protected from light and stored at 0°$\leq$ 6° C after collection. Once extracted, the extract must be analyzed within forty days. However, during this period of time, the extracts are refrigerated at 0°$\leq$ 6° C.

11.3 If samples are not in appropriate containers or holding time has expired, initiate a Nonconformance Report (NCR). For instructions, refer to GL-QS-E-004 for Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items.

## 12.0 SAMPLE PREPARATION

12.1 All batches (up to 20 samples) will be extracted with a method blank (MB), laboratory control sample (LCS), matrix spike (MS), and matrix spike duplicate (MSD). If insufficient sample is provided, the MS/ MSD will be substituted with a laboratory control sample duplicate (LCSD). In addition, for soils using this method, all batches must contain at least one set of sample triplicate analysis and grinding blanks (if performed).

12.2 For aqueous sample preparation by solid phase extraction refer to Appendix 4 of this SOP.

12.3 The salting out procedure for aqueous samples may be used, however the solid-phase method is preferred.

## 13.0 EXTRACTION

13.1 For aqueous samples refer to Appendix 4 for processing aqueous samples.

13.2 For solid samples using MIS sampling technique, prepare 10 g of soil as described in GL-OA-E-071 section 12. For non MIS sampling techniques, refer to section 13.3 of this SOP.

13.2.1 Place the 10 g +/- 0.1 g subsample into a 2 oz. wide-mouth screw top bottle.

13.2.2 Add the appropriate volume of surrogate solution to each sample and quality control sample. If matrix spike samples are being processed at

this time, add the appropriate volume of matrix spike solution to the designated spike sample aliquots.

13.2.3 Add the appropriate make up volume of acetonitrile for a final total volume of 20 mL to each sample.

13.2.4 Cap each bottle with a PTFE-lined cap and vortex swirl for one minute.

13.2.5 Place each bottle into an ultrasonic bath for at least 18 hours of sonication. The water temperature is neither recorded or monitored but the chiller is checked for effective cooling by either touch or observation of ice forming on the probe.

13.2.6 After sonication is complete, allow the samples to settle for at least 30 minutes.

13.2.7 Using a 10-mL disposable syringe, remove 8.0 mL of the supernatant and filter through a 0.45 µm PTFE filter, discarding the first milliliter.

13.2.8 Filtered extracts are submitted to the HPLC analytical group for analysis.

13.2.9 Store extracts in a cooler at 0°≤ 6° C up to 40 days from extraction.

13.3 For solid samples collected using non MIS procedures refer to GL-OA-E-033 Appendix I. This procedure is the standard sample extraction for 8330 samples. A summary of this procedure is noted below.

13.3.1 Place 5 to 10 grams of solid sample in a small plastic weigh boat. Place in drying cabinet.

13.3.2 Upon drying, sieve dried sample through a 30 mesh sieve.

13.3.3 Transfer 2.0 grams ±0.05 grams from the sieve tray to a scintillation vial.

13.3.4 Add the appropriate volumes of surrogate to all client and quality control samples.

13.3.5 Add the appropriate volume of spike solution to the matrix spike samples and laboratory control samples.

13.3.6 Add enough acetonitrile to total 10 mL of liquid. Cap the vial and gently stir to mix contents.

13.3.7 Mix sample on a vortex mixer for 30 seconds or until sample is completely mixed with solvent.

13.3.8 Place all the samples into a chilled ultrasonic bath. Record the date and time on the batch sheet. Sonicate for at least 18 hours.

13.3.9 After sonication is complete, allow samples to settle for at least 30 minutes. Centrifuging may be necessary to obtain a clear solution.

13.3.10 Using a 5 mL disposable syringe, remove approximately 5 mL of the extract. Attach a 45 µm syringe filter and filter the extract into a 12 mL amber vial with a Teflon-lined cap.

13.3.11 Submit extracts with batch sheets to the analytical section for analysis.

## 14.0 PREPARATION OF STANDARD SOLUTIONS AND QUALITY CONTROL SAMPLES

14.1 Standards for aqueous sample spiking are purchased as direct use source standards at the appropriate concentration for fortifying quality control samples.

14.2 Solid standard reference material (SRM or LCS) for solid quality control purposes must be obtained from a vendor, or the laboratory may create a solid standard reference material. See Appendix 5 for details. The spiking solution should be added to the blank soil (potting soil) prior to the drying step if the laboratory chooses to create the SRM. The vendor SRM should be dried and ground as described in GL-OA-E-071 section 12.

14.3 Method blanks for solid matrices should be an organic free soil matrix. Regular potting soil from the local garden center seems to work best. Ottawa sand is not recommended due to the damage inflicted on the grinder and puck. The method blank must also be prepared as described in GL-OA-E-071section 12.

14.4 Analytical Source Standard Solutions

Source standard solutions are purchased from certified vendors. These standards are traceable to National Institution of Standards and Technology (NIST) standards. The source standards are received from the company Purchasing Agent. The standard is given a unique identifying number for that day and is recorded in AlphaLIMS.

14.5 For guidance on standard documentation, refer to GL-LB-E-007 for Laboratory Standards Documentation.

14.6 For standards traceability also refer to GL-LB-E-007.

14.7 All standard solutions expire six months from date prepared/opened if the vendor provides no expiration date.

## 15.0 QUALITY CONTROL REQUIREMENTS FOR PROCESSING AND EXTRACTION

15.1 A method blank must be processed, extracted, and analyzed under the same conditions of up to 20 client samples in a batch of the same matrix. This requirement applies to both soil and aqueous matrices.

15.2 A laboratory control sample (LCS) or standard reference material (SRM) containing all the reported analytes must be prepared and analyzed in exactly the same manner as field samples. The LCS must be included in each batch of up to 20 field samples of the same matrix. In-house laboratory control limits for the LCS must demonstrate the laboratory's ability to meet the project quality objectives. This requirement is for both soil and aqueous matrices.

15.3 A matrix spike (MS) and matrix spike duplicate (MSD) or sample duplicate are used for matrix evaluation only. The MS and duplicate are included in each batch of up to 20 samples of the same matrix. This requirement applies to both soil and aqueous matrices. The soil sample is spiked post grinding from the same ground sample that the parent subsample is taken.

15.4 A soil grinding blank using a clean solid matrix (potting soil) must be prepared (ground and subsampled) and analyzed in the same manner as a field sample.

15.4.1 Grinding blanks must be performed between each field sample grinding.

15.4.2 Grinding blanks may be analyzed individually or as a composite.

15.4.3 If the composite grinding blank exceeds the acceptance criteria (no target analyte concentration greater than ½ the reporting limit), all samples associated with the grinding composite shall be qualified with a "B" qualifier.

15.4.4 If any individual grinding blank is found to exceed the acceptance criteria, then the sample following that blank shall be "B" qualified.

15.4.5 All blank results must be reported and the affected samples must be flagged accordingly.

15.5 For each solid batch, a soil sample triplicate will be performed on a sample expected to contain the highest levels of explosives within the quantitation range of the method. Three 10-gram subsamples from a client field sample must be used. This procedure cannot be performed on any type of blank sample. The RSD (percent relative standard deviation) for the results above the reporting limit must not be more than 20%.

15.6 In order to minimize sample manipulation after processing, the analyst may subsample additional aliquots of each sample for possible re-extraction. Additional vials should be labeled and stored appropriately.

## 16.0 EQUIPMENT AND INSTRUMENT MAINTENANCE

16.1 Maintenance for the LC/MS/MS

See SOP GL-OA-E-056 for maintenance details for the LCMSMS.

16.2 Maintenance for the HPLC

See SOP GL-OA-E-033 for maintenance details for the HPLC.

## 17.0 INSTRUMENT CALIBRATION

17.1 See SOP GL-OA-E-033 for procedures to calibrate the HPLC.

17.2 See SOP GL-OA-E-056 for procedures to calibrate the LCMSMS.

## 18.0 ANALYTICAL QUALITY CONTROL REQUIREMENTS AND CONTINGENCIES

18.1 Method Blank (MB)

18.1.1 MB data are used to assess contamination from the laboratory environment and to characterize spectral background from the reagents used in sample processing.

18.1.1 When samples that are extracted together are analyzed on separate instruments or days, the method blank associated with those samples must be analyzed on at least one of those instruments and/or days. A solvent blank should be analyzed on all other instruments/days on which any of the samples are analyzed.

18.1.2 The MB must not exhibit values that exceed the reporting limit (RL) for any target analyte. MB values > the RL indicate laboratory or reagent contamination should be suspected. If a MB exhibits values greater than the RL, the following corrective actions are recommended:

18.1.2.1 The MB may be reanalyzed once to determine if the contamination is instrument related (carryover, etc.). If the reanalysis confirms an instrument-related problem and that the MB has not been contaminated, analysis may proceed.

18.1.2.2 MB values > the RL that are associated with samples that do not exhibit concentrations > RL for the analyte observed in the MB may be reported.

18.1.2.3 Samples exhibiting positively detected analytes (i.e., greater than the RL) that were also detected in the associated MB may be reported if the sample results are at least 10 times the concentration detected in the MB.

18.1.2.4 Samples exhibiting positively detected analytes (i.e., greater than the RL) that were also detected in the associated MB but are less than 10 times the concentration detected in the MB must be re-extracted and re-analyzed.

18.1.2.5 If there is insufficient sample volume remaining, or if the holding time has expired, the client must be consulted prior to beginning re-extraction. The deficiency must be documented.

**NOTE:** For DOD QSM projects the method blank criterion is < ½ the RL.

18.2 Laboratory Control Sample (LCS)

18.2.1 The LCS consists of an aliquot of blank matrix (deionized water or potting soil) that is spiked with the same analytes at the same concentration as the matrix spike sample. The LCS is used to assess the ability of the analytical system to produce acceptable results and undergoes all sample treatments that the associated samples undergo.

18.2.2 Calculate the percent recovery (%R) for each target analyte using the following equation:

$$\%R = \frac{\text{Found Value}}{\text{True Value}} \times 100$$

18.2.3 If the recovery of any analyte falls outside the established control limits, that analyte is judged out of control, and the source of the problem should be identified and resolved before continuing the analyses. The following corrective actions are recommended:

18.2.3.1 The LCS may be reanalyzed once to determine if the out of control result is instrument related. If upon reanalysis the out of control analytes are in control, analysis and reporting of the associated samples may proceed.

18.2.3.2 For non MIS sampling procedures if the %R for any analyte in the LCS is below the lower control limit, or if the %R is above the upper control and the analyte was detected in the associated samples above the RL, all associated samples must be re-extracted and re-analyzed for that analyte.

**NOTE:** If there is insufficient sample volume remaining or if the holding time has expired for any sample associated with the LCS, the client must be consulted prior to beginning re-extraction. The

deficiency must be fully documented and it must be noted in the final report.

18.2.3.3 If the %R for any analyte in the LCS is above the upper control limit, and the associated samples do not exhibit concentrations above the RL for that analyte, the sample results may be reported. This indicates a high bias may exist for the batch for that analyte, but since the samples were free of detections, the potential high bias does not affect the sample result. The deficiency must be documented and noted in the final report.

**NOTE:** Certain client programs require re-extraction and re-analysis for all LCS failures. The project manager must be consulted to ensure that the client will accept data in this instance.

18.2.3.4 The 8330B MIS sample processing procedure requires that the LCS (standard reference material, spiked prior to processing) be processed in the same manner as field samples. The sample drying, sieving, and grinding steps cannot be re-performed for unacceptable LCS recoveries processed with field samples. The method requires that the total volume ofsample received must be dried, sieved and ground. Representative aliquots are taken and 10 grams are extracted. The un-ground LCS and co-processed field samples are therefore "consumed" by the grinding step. Solvent re-extraction step is not representative of the full sample processing that occurred with unacceptable LCS recoveries.

18.2.3.5 The laboratory will report the data as qualified and narrate the LCS recoveries if the acceptance limits are not met in the initial ground sample batch. In addition, the laboratory will notify the project manager when data qualification is necessary for unacceptable LCS recoveries. The client may request other corrective action procedures prior to the laboratory submitting the final data report.

18.3 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

18.3.1 A matrix spike is a sample that is spiked with the target analytes and is used to assess the effect of the matrix on the target analytes. If there is insufficient sample volume to prepare a MSD or a sample duplicate, a LCSD must be prepared and analyzed. The accuracy of the MS and MSD is reported as %R and is calculated as follows:

$$\%R = \frac{C_s - C}{S} * 100$$

Where:

%R = percent recovery

$C_s$ = spiked sample concentration

C = unspiked sample concentration

S = concentration of the spike added to the sample

18.3.2 The MSD, sample duplicate or LCSD is used to measure the precision of the analytical system. The precision is expressed as relative percent difference (RPD), and is calculated using the following equation:

$$RPD = \frac{|a-b|}{[(a+b)/2]} \times 100$$

Where:

RPD = Relative Percent Difference

a = Result of MS, sample of LCS

b = Result of MSD, sample duplicate or LCSD

18.3.3 The %R for the MS and MSD and the RPD for the MS/MSD should be within control limits. If they are not, look for objective evidence of matrix interference such as sample heterogeneity, chromatographic behavior, LCS recoveries, method blank, required dilutions or behavior of the sample during extraction. MS, MSD or MS/MSD RPD failures and sample matrix observations must be documented.

18.4 Sample Triplicate Analysis (Soils only)

Sample triplicate analysis is performed using 3 subsamples from the same sample that is expected to contain target analyte concentrations within the linear range of the instrument. The percent relative standard deviation (%RSD) for sample concentrations greater than the reporting limit should be < 20%. This analysis is used to demonstrate that the grinding and subsampling techniques are generating a homogeneous matrix. Corrective action is required if the criterion is not met (e.g., the grinding process should be investigated to ensure that the samples are being reduced to a sufficiently small particle size).

18.5 Surrogate

18.5.1 The surrogate is a compound that is similar in composition and performance to the target analytes but is not expected to be present in the samples being analyzed. The surrogate is spiked into all samples in the batch, including QC samples, at the same concentration. The recovery of the surrogate compound is used to assess the effectiveness of the extraction procedure and matrix effects. Surrogate recoveries must be within control limits.

18.5.2 If the surrogate recoveries are not within the control limits for the MB, LCS or LCSD, and/or samples, the following corrective actions are recommended:

18.5.2.1 The extract may be reanalyzed once to determine if the out of control result is instrument related. If upon reanalysis the out of control surrogate(s) is in control, analysis and reporting of the associated samples may proceed.

18.5.2.2 If the %R for the surrogate(s) is below the lower control limit, all associated samples must be re-extracted and re-analyzed for that analyte.

18.5.2.2.1 If there is insufficient sample volume remaining or if the holding time has expired for any associated sample, the client must be consulted prior to beginning re-extraction.

18.5.2.2.2 The deficiency must be fully documented and it must be noted in the final report.

18.5.2.3 If the %R for the surrogate(s) is above the upper control limit, and the associated samples do not exhibit concentrations above the RL for any target analyte, the sample results may be reported. This indicates a high bias may exist for the batch, but since the samples were free of detections, the potential high bias does not affect the target analyte result(s). The deficiency must be documented and noted in the final report.

**NOTE:** Some client programs may require re-extraction and re-analysis for all QC surrogate failures.

18.6 Additional QC Measures

18.6.1 Instrument Blanks: Solvent blanks (IB) may also be used to check for contamination by carryover from a high-concentration sample into subsequent samples.

18.6.2 Carry-over concerns: The analyst should review the results for at least the next sample after a high-concentration sample. If the high-concentration analytes are not present in the subsequent samples, then the lack of carryover has been demonstrated. If there is evidence that carryover may have occurred, then the samples must be reanalyzed.

## 19.0 CALCULATIONS

19.1 Percent Relative Standard Deviation for Initial Calibration

$$\%RSD = \frac{SD}{RF} x100$$

RF = Mean of RFs from initial calibration for a compound.

SD = Standard deviation of RFs from initial calibration for a compound

$$= \sqrt{\sum_{i=1}^{N} \frac{(RFi - \overline{RF})^2}{N-1}}$$

RFi = RF for each of the calibration levels

N = Number of RF values

19.2 Continuing calibration percent drift

$$\%Drift = \frac{C_{actual} - C_{found}}{C_{actual}} x100\%$$

$C_{actual}$ = Known concentration in standard

$C_{found}$ = Measured concentration using selected quantitation method

19.3 Concentration in the extract

The concentration of each identified analyte and surrogate in the extract is calculated by average response factor or a regression fit.

19.3.1 Linear Fit

$$C_{ex} = A + B\frac{(R_X C_{IS})}{R_{IS}} \qquad C_{ex} = \frac{(R_X - A)}{B}$$

$C_{ex}$ = Concentration in extract

$R_X$ = Response for Analyte

$R_{IS}$ = Response for internal standard

$C_{IS}$ = Concentration of internal standard

A = Intercept

B = Slope

19.3.2 Quadratic Fit

Instrument data reduction software performs the quadratic equation that has been validated by the Quality department. For more information refer to the owner's manuals or contact the instrument's manufacturer.

19.3.3 Average response factor

$$C_{ex} = \frac{(A_X C_{IS})}{(A_{IS}\overline{RF})}$$

$C_{ex}$ = Concentration in extract

$\overline{C_{IS}}$ = Concentration of internal standard

$\overline{RF}$ = Average RF

$A_X$ = Area of the extract

$A_{IS}$ = Area of the internal standard

19.3.3.1 Concentration Determination of an Aqueous Sample

$$\mu g / L = \frac{C_{ex} V_t}{V_o}$$

$V_t$ = Volume of the total extract in µL taking into account dilutions

$V_o$ = volume of water extracted

$C_{ex}$ = Concentration in extract

19.3.3.2 Concentration Determination of a Solid Sample

$$\mu g / kg = \frac{C_{ex} V_t}{W_o}$$

$V_t$ = Volume of the total extract in µL taking into account dilutions

$W_o$ = Weight of the solid extracted

$C_{ex}$ = Concentration in extract

19.4 LCS Percent Recovery

$$LCS\ \text{Recovery} = \frac{SSR}{SA} X 100$$

SSR = Spike Sample Result

SA = Spike added

19.5 MS/MSD Spike Recovery calculations

$$MatrixSpike\ \text{Recovery} = \frac{SSR - SR}{SA} X 100$$

SSR = Spike sample Result

SA = Spike added

SR = Sample Result

19.6 Relative Percent Difference calculation for the MS/MSD or sample/sample duplicate.

$$RPD = \frac{MS_R - MSD_R}{\frac{1}{2}(MS_R + MSD_R)} X 100$$

RPD = Relative Percent Difference

$MS_R$ = Matrix Spike Result or Sample Spike Result

$MSD_R$ = Matrix Spike Duplicate Result or Sample Spike Duplicate Result.

19.7 Percent Relative Standard Deviation for triplicate analyses.

$$RSD = \frac{100}{\bar{x}} \sqrt{\sum^{n} \frac{(xi - \bar{x})^2}{n-1}}$$

n = number of replicates (3)

$x_i$ = result for target analyte

$\bar{x}$ = average result for target analyte

**20.0 INSTRUMENT PERFORMANCE REQUIREMENTS**

**NOTE:** Refer to SOP GL-OA-E-056 table A-1, A-2, and A-3 for typical instrument set-up parameters for the LCMSMS. See section 13.0 for instrument performance for the HPLC in SOP GL-OA-E-033.

20.1 Continuing calibration verification standards must meet the criteria in Table A-5 of SOP GL-OA-E-056 (LCMSMS only). When a calibration verification standard fails to meet the criteria, all samples that were injected after the last standard that met the criteria must be evaluated to prevent misquantitations and possible false negative results. Sample reanalysis of sample extracts may be

required. More frequent analysis of standards will minimize the number of sample extracts that will have to be reanalyzed if the standard verification criteria are not met.

20.2 If the standard analyzed after a group of samples exhibits a response for an analyte that is above the acceptance criteria, and the analyte was not detected in a specific sample analyzed during the analytical shift, then the sample extracts do not require reanalysis. The verification standard has demonstrated that the analyte would have been detected, were it present, due to the elevated response. In contrast, if the analyte with the high response in the verification standard is also detected in samples, then reanalysis of the sample is required since the sample results may be biased high and quantitation unreliable. Reanalyze the sample within acceptable bracketing verification standards.

20.3 For LCMSMS sample injections may continue for as long as the calibration verification standards and standards interspersed with the samples meet the quality control criteria. The sequence ends when the set of samples has been injected or when standards exceed the acceptance criteria. For HPLC, see section 16.0 of SOP GL-OA-E-033 for QC requirements.

20.4 If during the analysis of a sample group from a single client, the bracketing continuing verification standards do not meet the acceptance criteria, reanalysis of this group of samples is required. The reanalysis is required to confirm that the sample extracts (matrices) are causing the instrument response to fluctuate and standards to fail. The reanalysis must begin with an acceptable initial continuing calibration set of standards. If continuing verification standards fail during the analysis sequence, the failure is attributed to matrix. If the standards meet the acceptance criteria, matrix interference is not confirmed and the acceptable standards and samples in between should be reported.

20.5 In addition, if multiple client sample extracts are analyzed in the analytical sequence where continuing verification standard failures occur, each client's samples must be reanalyzed after either an acceptable initial calibration, initial continuing calibration, or continuing verification standard.

## 21.0 ANALYST AND METHOD VERIFICATION REQUIREMENTS

21.1 To establish that the analyst can perform the procedures in an acceptable manner and that the method generates data of acceptable bias and precision, the following operations are performed.

21.1.1 A quality control (QC) check standard must be prepared containing each analyte of interest. It must be prepared from pure standard material or purchased as a certified solution. It must be made from a source independent of that used for calibration.

21.1.2 Four samples must be prepared and analyzed by the same procedures used to prepare and analyze actual samples.

21.1.3 Calculate the average recovery (X) in µg/L, and the standard deviation of the recovery (S) in µg/L, for each analyte of interest using the four results.

21.1.4 For each analyte compare S and X with the corresponding acceptance criteria for precision and accuracy, respectively, given in the quality control table at the end of the method. If the S and X for all analytes of interest meet the acceptance criteria, the system's performance is acceptable and analysis of actual samples can begin. If any individual S and X exceeds the precision limits or falls out of the range for accuracy, the system's performance is unacceptable for that analyte and a check standard for that analyte must be prepared and reanalyzed.

21.2 Method detection limits are also determined and documented annually. Aqueous method detection limits and verifications are performed as stated in the GL-LB-E-001 for the Determination of Method Detection Limits.

21.3 Soil method detection limits are performed as described in the GL-LB-E-001 for MDLs, however the soil aliquots are spiked with the MDL solution prior to extraction. The method detection limit verification samples are spiked prior to the drying and grinding steps in this method.

21.4 Precision and accuracy are matrix dependent and are documented by means of a laboratory control sample (LCS) and a matrix spike and matrix spike duplicate. (Refer to GL-LB-E-001 for the Determination of Method Detection Limits.)

21.5 Analysts are given continual performance evaluation samples as an ongoing assessment of their ability to perform this procedure.

## 22.0 ANALYTICAL PROCEDURES AND INSTRUMENT OPERATION

Standards, samples, blanks, and quality control sample extracts are introduced into the instrument via direct injection (autosampler). Samples containing target analyte concentrations that exceed the linear range of the analyte calibration curve must be diluted. The dilution level should be performed to place the highest analyte concentration between the middle and high points of the calibration curve (on column). If a sample is initially diluted and target analytes are not detected and non-target analytes are not interfering with the analysis, the sample must be reanalyzed at a lower dilution. Analysts should be aware that diluting samples will increase the detection limits for undetected analytes. Random dilutions without due cause are not acceptable. Samples should undergo appropriate clean up methods prior to diluting for observed matrix problems.

## 23.0 INSTRUMENT PROCEDURES AND QUALITY CONTROL

23.1 Before sample analysis begins, the instrument must have acceptable calibration curves. Each curve is verified by the analysis of second source continuing calibration standards. Each standard must meet the acceptance criteria for percent difference or drift. Continuing calibration verification standards must be analyzed at least after every twenty samples. It is recommended to analyze these verifications after every ten samples.

23.2 If the analyte of interest is present at a concentration between the MDL and RL, all data are qualified with a "J" flag and reported. If the analyte of interest is present at a concentration above the RL and the samples contain the analyte of interest at a concentration of greater than 10 times the concentration found in the blank, the data are qualified with a "J" flag and reported. If the concentration found in the sample is less than 10 times that found in the blank and greater than

the RL, the samples must be re-extracted. If the samples do not contain the analytes of interest, the data are reported.

23.3 The retention time (RT) windows must be established per the standard operating procedure for the analysis method. See SOPs GL-OA-E-033 (HPLC) or GL-OA-E-056 (LCMSMS) for details.

23.4 Nonconformance

23.4.1 When analyzing a calibration curve for more than one analyte at a time, some of the analytes may not meet the acceptance criteria. Additional standards containing the compounds that were not acceptable may be analyzed. If the curve still does not meet the acceptance criteria, maintenance should be performed or a new standard may be needed. Refer to Section 17 for other options addressing the initial calibration.

23.4.2 If the continuing check standard fails any of the criteria, the analyst must take action to correct the situation. This may be performing any of the maintenance steps described in the appropriate SOP to get the instrument to meet its daily calibration. If all attempts fail, the analyst must analyze a new series of calibration standards, thus obtaining a new calibration curve.

23.4.3 If the standard analyzed after a group of samples exhibits a response for an analyte that is above the acceptance limit, and the analyte was not detected in the specific samples analyzed during the analytical shift, then the extracts for those samples do not need to be reanalyzed. If an analyte above the QC limits was detected in a sample extract, reinjection of the extract is necessary.

## 24.0 DATA RECORDING

Data are recorded and calculated by the instrument data acquisition system. They are stored on a remote server. The data are also entered into the Laboratory Information Management System (AlphaLIMS).

## 25.0 RECORDS MANAGEMENT

25.1 Documentation of Training

Extraction technicians and analysts must be properly trained to perform the contents of this SOP. Personnel will extract or analyze four laboratory control samples for this SOP as training commences. Training is documented per GL-HR-E-003 for Maintaining Technical Training Records.

25.2 Documentation of Extraction

25.2.1 In AlphaLIMS, complete the Sample Tracker Form. Record initial weight of the sample, final volume of the extract, amount of surrogate and spikes added, and any comments about the extraction process. Also record all reagent lot numbers and note any deviations from this standard operating procedure.

25.2.2 Print a hard copy to submit with the extracts.

25.2.3 Have the batch peer reviewed using data review sheet. Note all discrepancies about sample handling and preservation. (Appendix 1)

25.2.4 All documents are stored in AlphaLIMS.

25.3 Documentation of Standards

Refer to GL-LB-E-007 for Laboratory Standards Documentation.

## 26.0 DATA REVIEW, APPROVAL AND TRANSMITTAL FOR EXTRACTION AND ANALYTICAL GROUPS

26.1 Extraction Group: A review process is used to ensure the quality of the data. Extraction logs are peer reviewed by a second technician or Group Leader. When the reviewer is satisfied that the data have been entered correctly, a data report is generated from AlphaLIMS. The report along with the batch sheets are copied and submitted to the appropriate analytical area for analysis.

26.2 Analytical Group

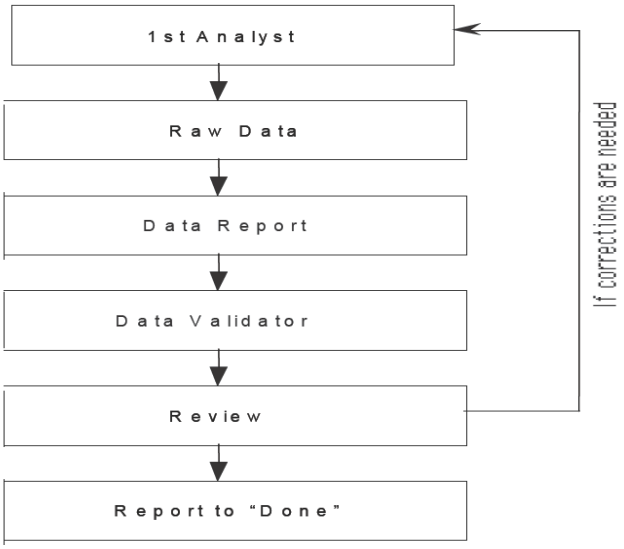
26.2.1 Levels of review and their responsibilities

26.2.1.1 First level review - The analyst must check all chromatograms. They will also calculate the percent recoveries for the spike, duplicate, and all surrogate recoveries. They must check to see if the check standard passes for the analytes of interest. If a target compound confirms on the confirmation column, it must be checked to see if the retention time of the analyte is within the daily retention time window. The peak's shape must also be checked to ensure that it is indeed a peak and not noise. If the hit meets both of these requirements, its concentration should be reported. The analyst should also make sure that a review checklist is present. Upon completion of a batch, the analyst enters the data. A data report is generated and it is placed in a folder along with the batch and all other raw data (chromatograms). This folder is given to the peer review analyst for reviewing.

26.2.1.2 Second level review - The data validator or other qualified reviewer must ensure that the concentration that appears in the external standards table is indeed what has been entered into the computer. They must check to see if the calibration check standard is acceptable and if the LCS and its duplicate and the surrogates are all within acceptable ranges. The reviewer must also check the date analyzed, dilution factor, and time of analysis from the raw data against the data report. If everything is acceptable, the reviewer must then initial and date the data report. The run log must also be dated and initialed. The data report is then sent to a status of "Done."

26.2.1.3 To complete a review process, all chromatograms of the calibration check standard, blank, LCS and its duplicate, samples and the spike and/or duplicates of the sample must be present. The batch sheet, sample tracker log, and the data report should all be present.

26.2.2 A flow chart of the review process follows:




## 27.0 REFERENCES

27.1 Test Methods for Evaluating Solid Waste: Laboratory Manual Physical/ Chemical Methods, Volume 1 (Part 2 and Part 3) Section B. SW-846, 3rd Edition. Method 8000B, "Determinative Chromatographic Separations," Rev. 3, December 1996.

27.2 Method 8321A SW-846, Test Methods for Evaluating Solid Waste, Rev. 1, Third Edition, Update III, December 1996, "Solvent Extractable Nonvolatile. Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (LC/TS/MS) or Ultraviolet Detection."

27.3 SW-846 EPA Method 8330A Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC), Rev. 1 February 2007.

27.4 SW-846 EPA Method 8330B Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography (HPLC), Rev. 2 October 2006.

## 28.0 WASTE MANAGEMENT

Laboratory waste is disposed in accordance with the Laboratory Waste Management Plan, GL-LB-G-001.

## 29.0 HISTORY

Revision 4: Updates made to comply with GEL internal audit finding and DOECAP identified issues.

# APPENDIX 1: DATA REVIEW CHECKLIST

## DATA REVIEW CHECKLIST FOR EXTRACTABLE ORGANICS

| QUALITY CRITERIA | YES | NO | COMMENTS |
|---|---|---|---|
| 1. Verify that samples have been extracted within hold time. | | | |
| 2. Verify that samples and QC on sample tracker correspond to batch sheet. | | | |
| 3. Verify that surrogate, spike, and solvents have been recorded on sample tracker. | | | |
| 4. If batch is BNA, did sample change color when acid and/or base was added? (Pink or Yellow) | | | |
| 5. Verify that there is a vial for every extract listed on the tracker. | | | |
| 6. Verify that the meniscus is marked on every vial. | | | |
| 7. Verify the vials are barcoded to ensure traceability. | | | |
| 8. Verify that surrogate and spike checks were made (addition was witnessed). | | | |
| 9. Verify paperwork is legible. Strikeovers are initialed and dated. | | | |
| 10. Verify AlphaLIMS data report with the written tracker for errors. | | | |
| 11. Verify that temperature monitoring was done. according to GL-LB-E-004. | | | |
| 12. Verify that no error messages were received while entering standards into database. | | | |
| REVIEWER'S SIGNATURE | | | |
| ANALYST_____DATE_____ | | | |
| PEER/GROUP LEADER_____DATE_____ | | | |

# APPENDIX 2: ANALYTE LIST

## TABLE A-1

| Compound | CAS Number |
|---|---|
| Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) | 2691-41-0 |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) | 121-82-4 |
| 1,3,5-Trinitrobenzene | 99-35-4 |
| 1,3-Dinitrobenzene | 99-65-0 |
| Tetryl | 479-45-8 |
| 2,4,6-Trinitrotoluene | 118-96-7 |
| Nitrobenzene | 98-95-3 |
| Nitroglycerin | 55-63-0 |
| 2,4-Dinitrotoluene | 121-14-2 |
| 2,6-Dinitrotoluene | 606-20-2 |
| 2-Amino-4,6-dinitrotoluene | 35572-78-2 |
| 4-Amino-2,6-dinitrotoluene | 19406-51-0 |
| 2-Nitrotoluene | 88-72-2 |
| 3-Nitrotoluene | 99-08-1 |
| 4-Nitrotoluene | 99-99-0 |
| Pentaerythritoltetranitrate (PETN) | 78-11-5 |
| 1,3-Dinitrobenzene-d4 (Internal Standard) | 99-65-0 |
| 2,6-Dinitrotoluene-d3 (Internal Standard) | 606-20-2 |
| 3,4-Dinitrotoluene (Surrogate) | 610-39-9 |
| 3,5- Dinitroaniline (LCMSMS only) | 618-87-1 |

# APPENDIX 3: QUALITY CONTROL SAMPLE RECOVERY LIMITS

## TABLE A-2

| Compound | % Recovery |
|---|---|
| 1,3-Dinitrobenzene-d4 (IS) | 70 – 130 |
| 2,6-Dinitrotoluene-d3 (IS) | 70 – 130 |
| 3,4-Dinitrotoluene (Surrogate) | 50-150 or SPC limits |
| CCV (All analytes) | 80 – 120 |
| Low Level Standard (DOD Requirement) | 80 – 120 |
| ICV (All analytes) | 70 – 130 (80-120: DOD QSM) |
| LCS (All analytes) | SPC limits |
| MS/MSD Recovery | SPC limits (for LCS) |
| MS/MSD RPD | SPC limits |
| Sample Triplicate | %RSD < 20% for results above the RL |

# APPENDIX 4: SOLID PHASE EXTRACTION (SPE) PROCEDURE FOR EXPLOSIVE LIQUID SAMPLES

## WATER SAMPLE PREPARATION BY SPE:

1. Transfer 770 mL of the water sample (using a 1 L graduated cylinder) into a 1 L volumetric flask or 1 L amber bottle.

**NOTE:** If a sample requires re-extraction due to compounds above the calibration range, then make sure to use an appropriate smaller volume (i.e., 500 mL, 200 mL, or smaller). The HPLC analyst will inform the Prep analyst with the proper amount to use.

2. Add 25 µL of 100 ppm surrogate intermediate standard to each sample and QC.
3. Add 50 µL of 100 ppm spike to the LCS and LCSD (if required) and MS/MSD (if there is enough sample available).
4. Cap all flasks and mix thoroughly to get all of the spiking solutions into the sample solution.

## CONDITION CARTRIDGES:

1. Remove the internal rack from the vacuum manifold.
2. Insert a Sep-Pak adapter into each Porapak RDX cartridge.
3. Connect the cartridges to the stopcock valves and then to the vacuum manifold.
4. Insert disposable Teflon liner into the flow control valve.
5. Connect Sep-Pak reservoirs to the adapters as needed.
6. Fill each reservoir with 15 mL of acetonitrile. Pulse the vacuum system to start the flow, then allow the acetonitrile to drip through by gravity feed.
7. Just before each reservoir runs dry, refill each reservoir with 30 mL of reagent water.
8. Turn on the vacuum system and adjust the flow rate with the flow control valves to draw the water through the cartridges. Do not let the flow rate exceed 10 mL/min. Close valves.
9. Dispose of the aqueous acetonitrile in the manifold into HPLC solvent waste drum.

## LOADING THE SAMPLES ONTO THE CARTRIDGES:

1. Connect the Tefzel tubing and Sep-Pak adapters to each Sep-Pak Cartridge. Then place the other end of the tubing into the 1 L volumetric flask or 1 L amber bottle containing the sample.
2. Turn on the vacuum system. Adjust the flow rate with the stopcocks to about 10 mL/min. If you choose to use the reservoirs then add more sample as needed. Empty the vacuum trap as needed. **Do not let the bed run dry during the sample loading**.
3. After all of the sample is loaded onto the column, apply full vacuum for a few minutes to remove any residual water.
4. Turn off the vacuum and open the bleed off valve.

## ELUTING THE SAMPLE FOR ANALYSIS:

1. Remove the reservoir and adapter from the cartridge.
2. Place 10 mL glass test tubes (culture tubes) in the vacuum manifold to collect the sample extract.
3. Transfer 5 mL of acetonitrile into the cartridge. Pulse the vacuum system to start the flow, then let the acetonitrile drip through by gravity alone. The flow rate will be about 1 mL/min.
4. After the acetonitrile stops dripping, turn on the vacuum system briefly to draw any remaining acetonitrile through the cartridge.
5. Open the manifold and remove the tubes.
6. Dilute to 5 mL volume with acetonitrile, cap and vortex thoroughly.
7. The samples are now ready for analysis.

# APPENDIX 5: LABORATORY GENERATED STANDARD REFERENCE MATERIAL (SRM)

## SOIL PREPARATION

1. Dry and sieve approximately 150 grams of standard retail potting soil.
2. From the sieved soil weigh out 100 grams and place in a shallow pan.
3. Add 1 mL of the intermediate spiking solution containing all compounds of interest.
4. Add an additional volume of approximately 25 mL of acetonitrile.
5. Gently mix the solvent, spike and soil ensuring that the soil is homogenous.
6. Allow the soil to dry.
7. Grind the 100 grams as required by the SOP.
8. Extract the ground soil using 10 grams.

**VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE**

# STANDARD OPERATING PROCEDURE

# FOR

# THE PRE-EXTRACTION PROCESSING OF SOIL SAMPLES COLLECTED USING MULTI-INCREMENTAL SAMPLING (MIS) TECHNIQUES

## (GL-OA-E-071 REVISION 2)

APPLICABLE TO METHOD:
EPA SW-846 Method 8330B

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# 1.0 STANDARD OPERATING PROCEDURE FOR THE PRE-EXTRACTION PROCESSING OF SOIL SAMPLES COLLECTED USING MULTI-INCREMENTAL SAMPLING TECHNIQUES

## 2.0 METHOD REFERENCE

EPA SW-846 8330B

## 3.0 METHOD OBJECTIVE AND PURPOSE

3.1 To describe the manner in which soil samples are processed prior to sample extraction and analysis for EPA SW-846 8330B. In addition, this SOP addresses the processing of soil samples for metals analysis by either SW-846 6010 or 6020.

3.2 Using an incremental sampling procedure in the field, the soil or solid matrix is collected in 1 to 2 kilogram sample sizes. The laboratory processes the entire sample by drying, grinding, sieving, and subsampling prior to extraction or digestion.

3.3 This procedure was developed to reduce the results variability often found in environmental sample duplicates collected by conventional methods.

## 4.0 METHOD SCOPE AND APPLICABLE MATRIX

4.1 This procedure (in full or part) may be used for processing soil samples for nitroaromatic explosive compounds or metals.

4.2 This method applies to the following matrices:

4.2.1 Soil

## 5.0 DISCUSSION

5.1 The soil sampling and analytical modifications in 8330B are collectively intended to decrease the effects of sampling and subsampling errors caused by the compositional and distributional heterogeneity typically encountered in solid environmental media at military training ranges. The 8330B method has been separated into 4 different phases: sampling, soil preparation, extraction, and analysis. This SOP applies to the soil preparation before extraction or digestion of the applicable method. Sample analysis can be performed using LCMSMS or HPLC for nitroaromatic explosive compounds or ICP or ICPMS for metals analysis. Field activities should be addressed in the client QAP or project scope.

5.2 This method has been modified on the basis of GEL's Performance Based Measurement System (PBMS).

## 6.0 DEFINITIONS

6.1 Accuracy: The degree of agreement between an observed value and an accepted reference value.

6.2 AlphaLIMS: The Laboratory Information Management System used at GEL Laboratories, LLC.

6.3 Method Blank: Organic free, clean solid material (soil) for solid matrices and DI water for aqueous matrices to demonstrate that background contaminants are not introduced during the extraction process.

6.4 Internal Standard (ISTD): A known amount of standard added to a portion of the sample extract as a reference for evaluating and controlling the precision and bias of the applied analytical method.

6.5 Laboratory Control Sample (LCS): Standard reference material or fortified soil taken through the sample preparation process and extraction to demonstrate that the process is in control and to indicate accuracy.

6.6 Laboratory Control Sample Duplicate (LCS DUP): A duplicate of the LCS to indicate reproducibility and to indicate precision.

6.7 Matrix Spike and Matrix Spike Duplicate (MS and MSD): An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS are corrected for background concentrations.

6.8 Method Detection Limit (MDL): The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero. Typically, the MDL is two to three times less than the PQL.

6.9 Practical Quantitation Limit (PQL): The lowest level in the calibration curve. With the prep factor applied, the PQL is referred to as the effective PQL.

6.10 Relative Percent Difference (RPD): The difference between two duplicate samples, such as a MS/MSD, LCS/LCSD, or sample/sample DUP. It is determined by taking the difference between the two results and dividing by the average.

6.11 Sample Duplicate (DUP): A duplicate of a sample indicating reproducibility.

6.12 Spike: A solution added to the laboratory control samples and matrix spikes that contain compounds defined by the referenced method. For compounds and concentrations, refer to AlphaLIMS. Spiking solutions purchased as source standards expire by vendor expiration date or one year from receipt or open date, whichever comes first. Spiking solutions created as working standards expire six months from the data opened or date prepared, whichever comes first. All spike solutions are screened prior to use in extractions.

6.13 Stock Standard Solution: A concentrated solution containing one or more method analytes prepared in the laboratory using certified reference materials or purchased from a reputable commercial source.

6.14 Surrogate: A solution added to each sample and quality control sample to monitor the efficiency of the extraction process. It contains compounds similar to those being analyzed. For compounds and concentrations, refer AlphaLIMS. Surrogate solutions purchased as source standards expire on the vendor expiration date or one year from receipt or open date, whichever comes first. Surrogate solutions created

as working standards expire six months from the date opened or date prepared, whichever comes first. All standards are screened prior to use in extractions.

6.15 Standard Reference Material: Solid material purchased from a vendor that contains analytes of interest at known concentrations. May be substituted for the LCS.

6.16 Subsample: A portion of the entire sample randomly collected and composited to create the sample weight used for the solvent extraction process. The subsample should be representative of the entire sample.

6.17 Independent Calibration Blank (ICB): An aliquot of reagent water or other blank matrix that is analyzed after each ICV. The ICB is used to determine whether there is carryover contamination after injection of the mid-level ICV.

6.18 Independent Calibration Verification (ICV): A solution of method analytes of known concentrations that is used to fortify an aliquot of Blank or sample matrix. The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

6.19 Continuing Calibration Verification (CCV): A standard of the same or different origin as the calibration standard is analyzed after every 10 injections. Refer to related appendices for CCV limits.

6.20 Instrument Performance Check Solution (IPC): A solution of one or more method analytes, surrogates, internal standards, or other test substances used to evaluate the performance of the instrument system with respect to a defined set of criteria.

6.21 Linear Calibration Range (LCR): The concentration range over which the instrument response is linear.

6.22 Statistical Process Control (SPC) Limits: Statistically derived limits which establish Acceptable Ranges for recoveries of analytes of interest, including LCS, MS, MSD, PS, PSD and internal standards.

## 7.0 INTERFERENCES

Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be necessary. Refer to each method for specific guidance on quality control procedures.

## 8.0 SAFETY, HEALTH, ENVIRONMENTAL HAZARDS AND POLLUTION PREVENTION

**WARNING**

ACETONITRILE IS FLAMMABLE AND TOXIC.

**WARNING**

PREVENT SKIN AND EYE CONTACT BY USING SPECIFIED PERSONAL PROTECTIVE EQUIPMENT WHEN MAKING STOCK REAGENTS.

WORK UNDER A HOOD TO PREVENT INHALATION WHEN MAKING STOCK REAGENTS.

8.1 Wear eye protection with side shields while working in the laboratory.

8.2 All chemicals and samples should be treated as potential health hazards, and exposure to these chemicals must be reduced to the lowest level possible. GEL maintains a current awareness file of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of the chemicals. A reference file of Material Safety Data Sheets (MSDS) and individual client sample MSDSs are also maintained.

8.3 Personal protective equipment

8.3.1 Gloves are required when working with solvents, standards and samples. Solvents, along with any solute in them, can absorb easily through the skin.

8.3.2 Work under a hood when using concentrated acids.

8.3.3 To protect clothes and skin from corrosive material, wear a lab coat.

8.4 Prior to handling radioactive samples analysts must have had radiation safety training and understand their full responsibilities in radioactive sample handling. Some general guidelines to follow:

8.4.1 To monitor radioactive exposure, wear a dosimeter at all times while working in the lab.

8.4.2 Wear a plastic apron over lab coat when working with radioactive samples.

8.4.3 Protect counter tops with counter paper or work from radioactive sample handling trays.

8.4.4 Prohibit admittance to immediate work area.

8.4.5 Post signs indicating radioactive samples are in the area.

8.4.6 Take swipes of the counter tops upon completion of work. Deliver those swipes to the designated swipe count box.

8.4.7 Segregate radioactive wastes. Radioactive waste containers are obtained from Waste Management.

8.5 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

8.5.1 Segregate solid wastes from liquid wastes in the satellite area containers.

8.5.2 Segregate oil wastes from water-soluble wastes in the satellite area containers.

8.6 In the event of an accident or medical emergency, call for help immediately. When time and safety permit, an accident report form should be completed and turned in to the safety committee.

8.7 Fire escape routes are posted in the lab, and all personnel should be familiar with them. In addition, fire safety equipment such as fire extinguishers is located in the lab. Training is available on the proper operation of this equipment.

8.8 Refer to the manufactures operator's manual for procedures to grind samples in the puck mill. Do not operate the puck mill without receiving the proper training and instructions for safe operation and handling of the pucks.

## 9.0 APPARATUS AND MATERIALS

**NOTE:** Unless otherwise indicated, all apparatus and materials are suggested only.

9.1 Glassware

9.1.1 Scintillation vials: 20 mL, glass.

9.1.2 Vials: 15 mL, glass, PTFE-lined cap

9.1.3 Vials: 40 mL, glass, PTFE-lined cap

9.1.4 Disposable pipettes: Pasteur

9.2 High-pressure injection syringe: 500 µL (Hamilton liquid syringe, or equivalent)

9.3 Temperature controlled ultrasonic bath or platform shaker

9.4 Balance capable of weighing up to 10 kg

9.5 Vortex mixer

9.6 Magnetic stirrer equipped with PTFE stirring bars

9.7 Mortar and pestle, mechanical grinder, or ring puck mill

9.8 Disposable cartridge filters: 0.45 um PTFE filter.

9.9 Pipets: Class A, glass, appropriate sizes

9.10 Sieve: 10 mesh (2 mm), 200 mesh (75 um ASTM Standard E11)

9.11 Expray™: Color indicator screening test for trace explosives. Used for screening 1 of 3 groups of explosives.

## 10.0 REAGENTS AND STANDARDS

10.1 Standards are stored in the cooler at 0° $\leq$ 6° C. All standards are assigned an expiration date of one year from date opened or the vendor's expiration date, whichever occurs sooner. Expiration dates for intermediates and working solutions are the same as for the parent stock standard unless otherwise noted on the standard. Standards are monitored for degradation and replaced as necessary. Standards must be brought to room temperature before using.

10.2 Stock Standard Solution: A standard that is at a high concentration and is therefore stable enough to be stored for longer periods of time than other standard concentrations. All stock standards must be verified for accuracy before use.

10.3 Second-Source Calibration Verification Standard Solution: This standard is obtained from a different vendor than are the calibration standards. An intermediate solution is prepared from stocks, which is then used to prepare a working standard used to verify the initial calibration. In certain cases a second source calibration verification may not be possible. In this case, a second stock standard is made to verify the initial stock concentration.

10.4 Spiking Solution: The solution is used to prepare laboratory control samples (LCSs) and matrix spike / matrix spike duplicates (MS/MSD) at the beginning of the sample preparation procedure.

10.5 Nitrogen Gas, 99+%

10.6 Argon Gas, 99+%.

10.7 Reagents must meet ACS Analytical criteria. Reagents will not be stored in plastic containers.

10.8 Acetonitrile ($CH_3CN$), pesticide quality or equivalent

10.9 Reagent water: Distilled or deionized water 17.8 Mohm or better, free of the anions of interest. Water should contain particles no larger than 0.20 microns.

10.10 Methanol, Reagent Grade

## 11.0 SAMPLE HANDLING AND PRESERVATION

11.1 Samples are protected from light and stored at 0°$\leq$ 6° C after collection.

11.2 Solid samples have fourteen days from the collection date to be processed. After air-drying soil and sediment, the samples can be held at room temperature (22° $\pm$ 4° C) or cooler.

11.3 If samples are not in appropriate containers or holding time has expired, initiate a Data Exception Report (DER). For instructions, refer to GL-QS-E-004 for Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items.

## 12.0 SAMPLE PREPARATION FOR NITROAROMATICS

**NOTE:** Refer to section 13.0 for preparing samples for metals analysis.

12.1 Sample Drying

12.1.1 Dry the entire soil sample in air at room temperature (22°C $\pm$ 4° C) to a constant weight, being careful not to expose the samples to direct sun light. Since solid sample sizes may be very large (1 kg or more), drying may be performed on large flat (cookie sheet) pans.

12.1.2 Spread the solid evenly as possible to facilitate drying. If samples require metals analysis and only one container was received, place parchment paper on the pan prior to spreading the sample for drying.

12.2 Sample Screening

12.2.1 Visually inspect the drying sample for crystalline energetic (chunks) and other non-soil looking material. If visual "chunks" of energetic materials are observed, the analyst should note the sample(s) and report the information to the Group Leader and Project Manager before grinding the dried sample. Clients may or may not notify the laboratory of the possibility of high levels of explosive material in their samples.

12.2.2 In addition to a visual observation, the analyst may perform a color indicating "spray" test on each sample, if available. The analyst should follow the manufacturer's instructions for completing the screening test, documenting the results (positive or negative) for each sample. The screening test may also be used to identify the most appropriate sample to use as the required triplicate analysis sample.

12.3 Temperature and Moisture Control

12.3.1 The room where sample drying is performed must be temperature controlled consistently (22° C ± 4° C) throughout the drying process. Moisture must also be controlled in order for soils to dry efficiently.

12.3.2 Record the date, time, and temperature daily while samples are drying. Document this information at least once in the morning and once in the afternoon.

12.3.3 Continuous temperature monitoring is advisable through an automated system. Moisture monitoring is also advisable but not required by the method or agencies.

12.4 Determining Sample Dryness

12.4.1 Check samples daily for dryness. Visually inspect the "dried" sample for moisture. Continue to air dry till the sample is noticeably dry. The technician may move the soil around to check for moisture such as using the flat side of a tongue depressor or spoon to carefully move the dry soil back and forth to check for moist pockets.

12.4.2 Once the sample is considered visually dry, weigh the soil in the drying tray on a top load balance capable of weights up to at least 10 kg. Ensure that the calibration weight check has been performed and documented prior to weighing samples. Record the date, time, and weight of the entire sample on the soil drying sheet.

12.4.3 Return the sample to the drying rack and reweigh the tray and sample after at least four hours. The sample is considered "dry" if a constant weight is obtained after 2 consecutive weighings within $\pm$ 5%.

12.5 Sieving

12.5.1 Once air dried, the entire sample, less large pebbles and sticks, is sieved through a 2 mm screen.

**NOTE:** Care should be taken not to exclude soil agglomerates, especially for clay like soils.

12.5.2 For clay like soils, the moist soil can be broken into smaller pieces with a gloved hand prior to drying coupled with applying pressure with a gloved hand or other instrument (e.g., spoon) to the dried material on top of the 2 mm screen.

**NOTE:** If this approach is used, care must be taken not to damage the screen or force legitimate > 2 mm material through. Another option is to break apart the dried agglomerates with a mortar and pestle. In addition, mosses and other types of vegetation should be physically shredded while sieving to release entrapped crystalline or fibrous residues.

12.5.3 Collect and weigh any portion of the sample that is unable to pass through the sieve. Record the unsieved weight on the soil processing batch sheet.

**NOTE:** Unless otherwise requested by the client or agency, vegetation will NOT be included in the sieving procedure by shredding through the 2mm sieve.

12.6 Aliquoting

12.6.1 From the final sieved soil, spread evenly across a clean drying pan with parchment paper.

12.6.2 Grid the pan into at least 30 squares.

12.6.3 Remove approximately .5 to 1 g in each square store in jar with Teflon lid.

12.6.4 This aliquot may be needed for other analyses at a later date.

12.6.5 A new sample number should be applied to the new aliquot and stored in the cooler at 0-6°.

12.6.6 Analyst should scan the original sample number to consumed. Continue on with the grinding process if needed on the remaining sample.

12.7 Grinding

**NOTE:** This step may not be required for metals analysis. See section 13.4 to obtain the metals aliquot prior to this grinding procedure. The client SAP should indicate if the metals analysis includes grinding. If the metals analysis includes grinding, refer to section 13.3.

12.7.1 Record the room temperature, date, and time prior to grinding each sample.

12.7.2 Record the sample number under the appropriate dish number used for each sample on the grinding blank log sheet.

12.7.3 Record the number of grind cycles for each sample in the applicable dish column on the grinding blank log sheet (refer to example in App.I). Refer to section 15.2 for the determination of grinding cycles for most soils. Each dish should be tested for the minimum number of grinding cycles to meet the 75 µm criterion.

12.7.4 Grind the entire sample in a puck mill grinder to a particle size less than 75 microns. Large sample volumes may require multiple grinding steps to process the entire sample. If multiple grindings are needed to process the entire sample, combine the fractions after each grinding cycle is complete. Samples should be ground using 60 second grinding intervals until the soil is ground to less than the 75 micron requirement. To prevent the ring mill from warming to temperatures where more volatile energetic compounds may be lost, 2-minute or longer cool down periods should be used between grinding cycles. For samples containing nitrocellulose (NC) based propellant residues, at least five 60-second grinding intervals are needed to adequately pulverize the same quantities of soil. Until the laboratory

can prove that less than 5 grinding cycles are sufficient to meet the 75 µm criterion for most soils, 5 grinding cycles will be used for all soils.

12.8 Puck and Dish Cleaning

12.8.1 The puck and dish should be cleaned between samples and before grinding blanks:

12.8.1.1 Clean the puck and dish with mild detergent and water.

12.8.1.2 Rinse with a small volume of methanol or isopropanol to facilitate drying. Ensure the dish and puck are dry prior to grinding the soil blanks.

12.9 Grinding Soil Blanks

12.9.1 To ensure that cross contamination does not occur during grinding, after the solvent rinse is performed, the technician will grind a clean organic free matrix (potting soil) between each field sample grind cycle. Grinding blanks will be collected in separate containers per dish used. See Appendix I.

12.9.2 Ensure that each individual blank is uniquely identified so that if the composite does not meet the specified criteria, the individual blanks can be analyzed to trace contamination from the associated samples.

12.9.3 The grinding blanks may be composited or analyzed individually. The laboratory will initially analyze grinding blanks as composites from the same dish.

12.9.4 To composite grinding blanks, remove a representative aliquot from each grinding blank container from the same grinding dish. Extract as a regular sample with an assigned unique QC number from AlphaLIMS for each composite of the three dishes. The grinding blank composite should not contain any target analyte concentration > ½ the reporting limit. If the composite blank fails this criterion, refer back to the appropriate dish blanks and analyze each individually. Data should be flagged accordingly per individual grinding blanks. See section 14.4.

12.10 Subsampling

12.10.1 Obtain a subsample of the ground soil by spreading the entire sample evenly on to a clean surface (cookie sheet) so that the soil is only 1 to 2 cm thick across the surface.

**CAUTION:** This should be performed in fume hood to prevent the spread of dust and possible inhalation or residue loss.

12.10.2 Using a grid (at least 30 squares), randomly collect 30 subsamples to composite. Ensure that enough soil is collected to obtain a 10 gram aliquot for sample extraction. Reserve excess soil composites for possible re-extraction.

12.10.3 Remove the entire depth of each increment (about 0.3 g each). For matrix quality control remove a total of 30 g for the soil composite. For

at least one sample (where detects are anticipated) remove a total of 30 grams for triplicate analyses.

12.11 Sample Storage

12.11.1 Once the subsample is obtained, store the remaining ground soil in an air tight container. Store additional sample volumes in a cooler at 0°≤ 6° C.

## 13.0 SAMPLE PREPARATION FOR METALS ANALYSIS

**NOTE:** The following procedure describes the processing of solid samples when a separate container is received for the metals analysis.

13.1 Drying

13.1.1 Solid samples processed for metals must be dried and passed through a Number 10 sieve. Place a sheet of wax or parchment paper on the pan before adding the solid sample.

13.1.2 Spread the entire solid sample across the surface of the drying pan as evenly as possible with as much surface area exposed to the air to facilitate drying.

13.1.3 Weigh the solid and the drying pan. Record the weight in the log book and other information as required i.e. room temperature, date, and time.

13.1.4 Place the pan with solid sample in the drying rack to dry at room temperature (22° C ± 4° C).

13.1.5 Visually inspect the drying sample daily. The sample is considered "dry" if a constant weight is obtained after 2 consecutive weighings within ±5% and no less than 4 hours apart.

13.2 Sieving

13.2.1 Once the drying process is complete, the entire sample is passed through a No. 10 sieve.

13.2.2 To minimize dust, the sieving process should be performed in a ventilation hood or enclosure.

13.2.3 The solid material should be sieved and collected on another pan similar to the pan used to dry the solid. Ensure that the metallic surface is covered with the wax or parchment paper.

13.2.4 If grinding is not required for the sieved sample, proceed to Section 13.4.

13.3 Grinding

13.3.1 If grinding is required for the metals analysis, the sample should not be processed using a metallic grinding surface. Grinding should be performed using a nonmetallic surface such as a ceramic puck and bowl.

13.3.2 If ceramic puck and bowl are not available, the grinding surfaces should be tested using a blank solid material to evaluate any metals contamination introduced during the grinding process. The grinding surfaces should not contain significant amounts of the metals of interest or interferences for these metals. Alternatively, any metal contamination in the method blanks must meet project-specific data

quality objectives or the QC criteria in EDQW Guide, whichever is more stringent.

13.3.3 Large sample volumes will require multiple grinding cycles of sixty seconds to meet the particle reduction requirement for metals aliquots (1 gram at 0.01mm). The dish must be cooled between grinding cycles for at least two minutes. Additional time or means may be required to cool the dish before performing another grinding cycle. Generally, 3 grinding cycles are required to meet the 75 µm sieving criterion for explosives. Metals size reduction may not require multiple grinding cycles depending on the matrix components and particle size before grinding.

13.3.4 Combine each ground aliquot per sample. Carefully mix the aliquots to ensure homogeneity while minimizing dust.

13.3.5 The laboratory should demonstrate that the grinding procedure was successful in meeting the size reduction criteria by passing a representative portion of each completely ground sample (at least 10 grams) through the appropriate sieve for metals subsample mass (18 mesh).

13.3.6 Subsample for metals analysis as described in section 13.4.

13.3.7 To demonstrate acceptable laboratory precision (sub-sampling reproducibility) laboratory triplicates must be minimally processed on a per batch basis. The default acceptance criterion for the %RSD of laboratory triplicates is $\leq$ 15%. To meet this criterion, the fundamental error must be < 15% for subsamples processed for analysis.

13.4 Sample Split before Grinding

13.4.1 If a separate sample was not received for metals and explosives, and grinding was not required for the metals analysis, the sample should be split appropriately after the initial drying and sieving step. The standard operating procedures to split, grind, and subsample must be approved on a project-specific basis and be consistent with the guidance in ASTM D6323 and EPA600/R-03/027.

13.4.2 After drying the sample, gently mix the soil and spread as evenly as possible across the pan about 1 to 2 cm thick. Draw at least a 30 square grid in the soil using a spatula or tongue depressor.

13.4.3 From each square, remove 0.5 to 1 gram aliquots and combine in a wide mouth jar for the metals analysis. Label and status the metals analysis appropriately to enable the next step (digestion) to proceed.

13.4.4 To demonstrate acceptable laboratory precision, obtain three separate aliquots in the same manner as in section 13.4.3 above to perform the triplicate analysis required for each batch.

13.4.5 Grind the rest of the sample per section 12.7 of this SOP for explosives analysis.

## 14.0 QUALITY CONTROL REQUIREMENTS FOR PROCESSING AND EXTRACTION

14.1 A method blank must be processed, extracted, and analyzed under the same conditions of up to 20 client samples in a batch of the same matrix. This requirement applies to both soil and aqueous matrices.

14.2 A laboratory control sample (LCS) or standard reference material (SRM) containing all the reported analytes must be prepared and analyzed in exactly the same manner as field samples. The LCS or SRM is spiked prior to the drying step. The LCS must be included in each batch of up to 20 field samples of the same matrix. In-house laboratory control limits for the LCS must demonstrate the laboratory's ability to meet the project quality objectives.

14.3 A matrix spike (MS) and matrix spike duplicate (MSD) are used for matrix evaluation only. The MS and duplicate are included in each batch of up to 20 samples of the same matrix. The soil sample is spiked post grinding from the same ground sample that the parent subsample is taken. Percent recovery must meet LCS limits and relative percent difference (RPD) < 20%.

14.4 A soil grinding blank using a clean solid matrix (potting soil) must be prepared (ground and subsampled) and analyzed in the same manner as a field sample.

14.4.1 Grinding blanks must be performed between each field sample grinding.

14.4.2 Grinding blanks may be analyzed individually or as a composite.

14.4.3 If the composite grinding blank exceeds the acceptance criteria (no target analyte concentration greater than ½ the reporting limit), all samples associated with the grinding composite shall be qualified with a "B" qualifier.

14.4.4 If any individual grinding blank is found to exceed the acceptance criteria, then the sample following that blank shall be "B" qualified.

14.4.5 All blank results must be reported and the affected samples must be flagged accordingly.

14.5 For each solid batch, a soil sample triplicate will be performed on a sample expected to contain the highest levels of explosives within the quantitation range of the method. Three 10-gram subsamples from a client field sample must be used. This procedure cannot be performed on any type of blank sample. The RSD (percent relative standard deviation) for the results above the reporting limit must not be more than 20%.

## 15.0 ANALYST AND METHOD VERIFICATION REQUIREMENTS

15.1 Method Detection Limits

15.1.1 Method detection limits are determined and documented annually. Aqueous method detection limits and verifications are performed as stated in the GL-LB-E-001 for the Determination of Method Detection Limits.

15.1.2 Soil method detection limits are performed as described in the GL-LB-E-001 for MDLs, however the soil aliquots are spiked with the MDL

solution prior to extraction. The method detection limit verification samples are spiked prior to the drying and grinding steps in this method.

15.2 The puck and dish will "age" with number of grindings required to meet the 75 µm criterion. Upon receipt of a new puck and dish, the analyst should perform the following procedure before grinding client samples and while performing annual MDL studies.

15.2.1 Using the worst case soil material (soil, rocks, and other debris) grind the sample using the new puck and dish for at least two 60-second cycles.

15.2.2 After the second cycle, open the dish and observe the ground soil. If the sample looks like it requires additional grinding, replace the dish top and perform another 60-second grinding cycle. If the sample is not a fine talc-like consistency, the soil requires additional grinding.

15.2.3 The analyst should track the number of grinding cycles. Once the sample looks like a fine talc material, remove the sample from the dish and pass through a 75 µm sieve in an enclosure or hood. Care must be taken to minimize dust contamination in the processing area. If the ground material passes easily through the sieve, subsequent sample grinds should use the same number of tracked cycle grinds as a minimum before opening the dish for compositing. Samples containing cellulose based propellant residues require at least 5 grinding cycles regardless of the minimum grinds determined using the worst case scenario.

15.2.4 The puck and dish will wear with age and number of uses. Analysts may need to increase the number of grinds for samples if the minimum number of grinds does not meet the 75 µm criterion. Analysts should document additional grinds per sample if they are needed. Eventually, the puck and dish will require replacing.

## 16.0 DATA RECORDING

Data are recorded in the grinding blank and preprep logs. See App I for an example.

## 17.0 RECORDS MANAGEMENT

Extraction technicians and analysts must be properly trained to perform the contents of this SOP. Training is documented per GL-HR-E-003 for Maintaining Technical Training Records.

## 18.0 REFERENCES

18.1 SW-846 EPA Method 8330B Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography (HPLC), Rev. 2 October 2006.

18.2 EPA 600/R-03/027, Guidance for Obtaining Representative Laboratory Analytical Subsamples for Particulate Laboratory Samples, U.S. Environmental Protection Agency, 2003.

18.3 ASTM D6323-98(200-3) Standard Guide for Laboratory SubSampling of Media Related to Waste Management Activities.

18.4 Pierre Gy's Sampling Theory and Sampling Practice. Heterogeneity, Sampling, Correctness, and Statistical Process Control – Francis Pitard, CRC Press.

18.5 USACE Laboratory Requirements for Analysis of Explosives and Metals in Solid Matrices, 08/22/08 version 1.2.

## 19.0 WASTE MANAGEMENT

Laboratory waste is disposed in accordance with the Laboratory Waste Management Plan, GL-LB-G-001.

## 20.0 HISTORY

Revision 1: SOP updated to comply with internal audit findings.

Revision 2: Orphan Mine sample process added as Appendix II.

# APPENDIX I: GRINDING BLANK LOG BOOK

(For Illustrative Purposes Only)

Appendix IV FOR ILLUSTRATIVE PURPOSES ONLY

**Grinding Blank Log Book**

Batch ID: 123456
Analyst: Michael Penny
Date: 20-Aug-08
Method: 8330B
SOP: GL-OA-E-068

| Dish 1 Composite (3 GC req) | | | Dish 2 Composite (3 GC req) | | | Dish 3 Composite (5 GC req) | | |
|---|---|---|---|---|---|---|---|---|
| Sample ID | Time/Temp | Grind Cycles | Sample ID | Time/Temp | Grind Cycles | Sample ID | Time/Temp | Grind Cycles |
| 212333001 | 0800/21c | 3 | 212333002 | 0830/21c | 3 | 212333003 | 0930/20c | 5 |
| GBLK01A | 1000/21c | 3 | GBLK02A | 1030/20c | 3 | GBLK03A | 1100/21c | 5 |
| 212333004 | 1130/21c | 4 | 212333005 | 1230/20c | 3 | 212333006 | 1400/21c | 5 |
| GBLK01B | 1430/20c | 3 | GBLK02B | 1500/20c | 3 | GBLK03B | 1550/20c | 5 |
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# APPENDIX II: SAMPLE PROCESSING FOR ORPHAN MINE PROJECT

**Appendix II of GL-OA-E-071 finalized 10/25/11**
(SOP for The Pre-Extraction Processing
of Soil Samples Collected Using
Multi-Incremental Sampling (MIS)
Techniques)

## Sample Processing for Orphan Mine Project

### 1.0 Equipment List

1.1 #60 and #4 mesh sieve screen
1.2 Plastic Funnel
1.3 Laboratory Wrist Shaker
1.4 One gallon Zip-lock plastic bags
1.5 Sample drying pans
1.6 Parchment Paper
1.7 Puck Mill with bowls
1.8 Clean top soil
1.9 Large and small scoops
2.0 Tongue depressors

### 2.0 Overview:

This procedure is for the processing of multi-increment samples (MIS) collected from the Orphan Mine Site in a manner that provides a reasonable level of assurance that aliquots tested are chemically the same as the sample they are intended to represent. For each MIS sample received, the entire sample will be weighed, then sieved to isolate target particle size fractions, and then each separate size fraction weighed. Whenever the project Field Sampling Plan requires that a subsample for organic compounds or mercury analyses be collected from a sample, MIS will be employed to create these subsamples. Remaining sample material for each particle size fraction will be ground and homogenized, followed by another round of MIS to create subsamples for target analytes, radionuclide analyses, and various quality

control splits. Finally, the laboratory sections will follow standard operating procedures for sample preparation to obtain the extraction/digestion and analytical subsamples. MIS samples received for this project will come in two sizes --- approximately 2 kg ("small"), designated by the client as S and approximately 4 kg ("large"), designated by the client as T. The 4 kg samples will likely arrive in two separate containers, and these two containers must be processed by the lab as one sample.

All MIS samples received will be air dried. After weighing and drying, they will be separated by sieving into particle size fractions --- one size fraction will be retained and analyzed for the small (S) samples, and two size fractions will be retained and analyzed for the large (T) samples. For every MIS sample, the largest particle size range segregated by sieving, consists of particles retained on a #4 sieve (+#4). The material retained on the #4 sieve will not be analyzed and consequently it will be weighed and disposed. For the small (S) samples, the particle size range fraction to be analyzed are those particles passing the #60 sieve (-#60); therefore, for small (S) samples, the material retained on the #60 sieve will be weighed and disposed. For the large (T) samples, two particle size range fractions will be analyzed --- the particles passing the #60 sieve (- #60) and all particles retained on the #60 sieve but passing a #4 sieve (-#4/+#60); for large (T) samples, therefore, no additional material will be disposed after the material retained on the #4 sieve has been disposed.

After sieving, subsamples for organic compounds, nitrate/nitrite, percent moisture, and mercury analyses will be removed via MIS. Remaining sample material will be spiked with KNO3, ground, homogenized, and then subsampled via MIS for metals (other than mercury), nitrate/nitrite, percent moisture, and radiochemistry tests. In addition, sample aliquots will be obtained from the post sieved and post grinding material to evaluate the efficiency of the procedures by the laboratory. The minimum masses for

subsamples and aliquots are listed in Table 1. The ground material from background samples that is not required for analyses and quality control purposes will be containerized, labeled, and archived.

To minimize the possibility for contamination or cross-contamination of samples, equipment such as puck mill bowls, sieving cones and butcher paper are cleaned and replaced frequently and never used for more than one sample prior to cleaning or disposing. The decontamination procedure for reusable equipment is described in Section 6.

Prior to implementation of this procedure, samples received will be assigned LIMs sample number according to GEL SOP GL-CS-M-001. The subsampling and aliquot preparation procedure herein supersedes all method-specific subsampling, aliquot selection, and/or sample processing procedures.

## 3.0 Sample Batching:

3.1 Sample batching is the process of grouping 20 or fewer field samples into a sample processing batch for the purpose of sample management. Each batch is assigned the appropriate standard reference materials (SRMs) and the grinding bowl for each field sample in the batch will be recorded. Batching is performed using information from the Chain-of-Custody (COC) form and does not involve sample handling.

3.2 Using information from the COC, create a batch by selecting up to 20 samples [either large (T) or small (S)] that will undergo the same sieve procedure, and assign a batch number to these samples. List these samples in the batch work list screen under the XM queue (in LIMS).

3.3 Assign any project requisite SRMs to the batch. SRMs submitted with sample batches will not undergo further processing by this procedure. Once field samples and quality control samples are batched, obtain the

sample container(s) from cold storage and transfer them to the processing trailer.

## 4.0 Client Sample Preparation:

4.1 Sample preparation includes the following steps: a) weighing, b) drying; c) weighing; d) sieving; e) homogenization, f) MIS to obtain subsamples for mercury and/or organic analyses; g) weighing; h) grinding; i) homogenization; j) MIS to obtain subsamples for target analyte list and radionuclide analyses.

Drying

4.2 Line a clean bun pan(s) with parchment paper. Select enough pans to accommodate the whole sample. Each pan will contain up to approximately 2 kg of soil. [Small (S) MIS samples will likely require one pan, large (T) MIS samples will require at least two pans.]

4.3 Label the short end of the pan(s) with the LIMS sample number and weigh the empty pan(s), including parchment paper. Enter the sample identifier and the pan weight(s) in the Soil Drying Log Book. Use multiple lines on the preprinted form if multiple pans are required.

4.4 In an enclosure, transfer the entire contents of all of the sample's container(s) to one or more bun pans. Spread the soil as evenly as possible with a tongue depressor or nitrile gloved hand. Replace gloves and tongue depressor between samples.

4.5 Break up clumps of soil with a gloved hand. All pans will be in a hood (enclosure) to perform this step.

4.6 Reweigh the bun pan(s) with soil. Document the pan and soil (P/S) weight on the Soil Drying Log Sheet. Calculate the soil wet weight by subtracting the pan weight from the P/S total weight. Enter this value in the soil (wet) column. Place the bun pan(s) in the drying rack. Ensure the vent fan on the rack is turned on. Dry at room temperature.

4.7 For each sample, if the sample, as received, appears to be relatively dry soil, reweigh the bun pan after a minimum of 8 hours drying. If the percent moisture loss is less than 2%, the sample is considered air-dry and ready to sieve. Calculate as follows:

- ((Initial Weight – 1st Weight)/Initial Weight)*100 = percent moisture loss

4.8 If the percent moisture loss equals or exceeds 2%, then all bun pans containing the sample's soil will be returned to the rack for another 8 hour drying period. This step will be repeated until the moisture loss in an 8 hour period is less than 2 percent.

4.9 Repeat procedures 4.2 through 4.6 for each sample in the batch. Concurrently proceed as below.

Weighing

4.10 Once it has been air-dried, the sample is ready to sieve. Record the combined weight of all air-dried sample material on the Soil Sieve Sheet before sieving.

Sieving

4.11 In an enclosure, assemble the sieve apparatus ensuring that the sieve screening fabric is taut across the cone and funnel connection. Place a tared, pre-labeled large plastic bag (open end up) over the funnel bottom and snap into place on the shaker. The sieving process may be performed by hand, or by a combination of hand and mechanical sieving. Between each sample processed, the #60 sieve screen fabric will be replaced, and the funnels and cones will either be decontaminated or replaced.

4.12 Each sample will be processed through both the #4 and #60 sieves, in that order. Depending on the sample fines, this may require up to 15 minutes of shaking either manually or on the shaker for every 200 to 250 g of soil.

4.13 For all samples both large (T) and small (S), pour approximately 200 – 250 grams through the #4 sieve. Turn on the shaker for 5 minutes. After shaking, gently crumble any aggregated particles that were retained on the screen using a gloved hand. Shake for 5 minutes more. Repeat this procedure until no more material passes the #4 sieve. Remove the material retained on the #4 sieve and place in a tared container. Repeat this process until all the sample has been processed through the #4 sieve. Combine the material retained on the #4 sieve after each iteration. Weigh and record the weight (on the Soil Sieve Sheet). Properly dispose of the retained (+#4) material. Notify the Project Manager if greater than 5% of the total material was retained on the #4 sieve.

4.14 For all samples large (T) and small (S), pour approximately 250 grams of the material with passed through the #4 mesh sieve onto the #60 sieve screen and turn on the shaker for 5 minutes. Using a gloved hand, rub and crush soil aggregates on top of the sieve for approximately one minute. Shake the material for another 5 minutes. Repeat the rubbing and crushing procedure.

4.15 If after 15 minutes of shaking and rubbing no more material is observed to pass the #60 sieve, pour the retained material from on top of the sieve into a tared container. Repeat steps 4.14 and 4.15.

4.16 All aliquots of the sample which were retained on the #60 sieve, and placed into the tared container are combined. This material is poured onto the #60 and shaken for one more 5 minute period to assure that all material which can pass through this sieve has done so. The material remaining after this final sieving through the #60, is reweighed, retained and stored separately from the rest of the sample. This portion of the sample will be processed as described in 4.25.

4.17 Weigh and document the weight of the total soil that passed through the sieve. Close the bag containing the - #60 (material that passed through the #60) size fraction tightly. Turn the sample in the bag end over end to mix thoroughly, for about one minute. NOTE: For samples larger than 5kg, mix thoroughly for 2 – 3 minutes.

4.18 Weigh and document the weight of the total soil that is retained on the #60 sieve (+# 60). If the material was obtained from a small (S) sample, discard the +#60 material. If this material was obtained from a large (T) sample, seal the +#60 in a plastic bag and turn end over end to mix the sample thoroughly for about one minute. NOTE: For samples larger than 5kg, mix thoroughly for 2 – 3 minutes.

4.19 From this point forward in the procedure, each large (T) sample is now represented by two containers, each with a different particle size fraction. Each small (S) sample is represented by a single container.

4.20 Notify the project manager for client instructions whenever:

- For both small (S) and large (T) samples, if there is less than 1000 grams of the -#60 particle size fraction subsample
- For large (T) samples, less than 2000 g of the -#4/+#60 size fraction subsample

Create Subsamples for Tests Performed Prior To Grinding using MIS 30-grid technique

4.21 For each sample (separately for each target particle size fraction in the sample) that will be analyzed for mercury, organics, TPH, moisture and Nitrate/Nitrite analyses, transfer the homogenized sieved sample to a pan lined with parchment paper. Gently spread the sample material throughout the entire surface of the paper. Care should be taken to keep the sample on the parchment paper and to control dust production. Using a tongue depressor, gently smooth the sample material to a uniform

depth across the surface (about 1 cm). Outline a 5 x 6 grid across the sample material of 30 squares.

4.22 Using a flat bottom, 5mL scoop, to collect representative material uniformly from the entire depth of soil, collect and transfer subsample aliquots from each square to pre-labeled containers for the organics, mercury + nitrate/nitrite, percent moisture~~,~~ and TPH tests requested. Select one sample per batch for the wet sieve test in section 4.23. The minimum split mass required for each analytical procedure will be collected. A scoop of approximately 5 ml volume, will be used with intention to represent the entire depth of soil at each random increment location. See the matrix weight requirement for each test.
NOTE: Five (5) containers of samples will be prepared from the 30-grid MIS technique. One container is prepared for each prep lab as follows: 1) Moisture, 2) Mercury plus Nitrate/Nitrite, 3) Volatile Organics, 4) Semivolatile Organics (PCBs, DRO and PAH), and 5) TPH to be sent to subcontract laboratory.

Sieve Wash Test #60 mesh

4.23 Select one sample from each group of 20 samples in a work order of the target particle size -#4 and +#60 mesh sieve material, for evaluation of sieving efficiency. Create a 50 gram subsample and place it in a prelabeled container. Record the sample number and sieve size on the Sample Sieve Wash Sheet.

4.23.1 Weigh a #60 sieve screen and record the weight on the Sample Sieve Wash Sheet.

4.23.2 Assemble the sieve apparatus.

4.23.3 Pour the 50 gram soil aliquot onto the sieve.

4.23.4 Over the sink, gently wash the material through the sieve for 1 minute.

4.23.5 Carefully towel-dry the outside of the sieve apparatus.

4.23.6 Place the sieve apparatus upright in the drying rack.

4.23.7 Once the sieve is dry, disassemble the sieve apparatus and reweigh the sieve and material retained on the sieve. Document the dry weight on the Sample Sieve Wash Sheet.

4.23.8 Calculate the percentage of material retained on the sieve after washing using the following equation:

((Dry Sieve wt. + dry material retained on the sieve) – (Sieve wt.)/(50))*100

4.23.9 Document the percentage of soil retained on the sieve. If the retained soil percentage is less than 95%, the sieving procedure is not sufficient to meet the requirements of the client. Additional measures should be taken (more time shaking and rubbing) to ensure that at least 95% of the sample that will pass through the #60 mesh screen, is adequately sieved.

4.23.10 Submit a copy of the Sample Sieve Wash Sheet to the project manager.

4.24 If not ready to proceed immediately to the steps below, return the rest of the sample to a clean container and label as dried and sieved only. Place the container in the “hold for grinding” area.

Spike with Potassium Nitrate and Grind Sample in Puck-Mill

4.25 Before grinding, SPIKE the entire soil size fraction. Add the appropriate weight of $KNO_3$ to the sieved material prior to grinding. Grind the entire subsample as follows:

4.25.1 Transfer approximately 500g – 700g of the material to a clean puck bowl. Large bowls are heavy. Use caution and the assistant to move the bowls from enclosures to the mill and back.

4.25.2 Grind to 75 µm (two – 1 minute each grinding cycles).

4.25.3 In an enclosure, remove the puck and place the ground material into a pre-labeled large plastic bag.

4.26 Repeat step 4.25 until the entire target size fraction has been ground. On the Sample Grinding/Grinding Blank Log Book Sheet, record the sample number in the column associated with the bowl number used.

Create Subsamples for Tests Performed After Grinding using MIS 30-grid technique

4.27 Close the bag containing the ground sample tightly and turn end over end to mix the sample thoroughly for about one minute. NOTE: For samples larger than 5kg, mix thoroughly for 2 – 3 minutes.
Obtain subsamples for metals (excluding Hg), Radiochemistry, percent moisture and nitrate/nitrite tests using the 30-grid MIS procedure described in steps 4.21 and 4.22. Perform steps 4.25 through 4.27 for all target particle size fractions.
NOTE: Three containers of samples will be prepared from the 30-grid MIS technique. One container is prepared for each prep lab as follows: 1) Radiochemistry, 2) Metals (non-mercury) plus Nitrate/Nitrite, and 3) Moisture.

Sieve Wash Test #200 mesh

4.28 All samples with BD-Return requested, will be used for evaluation of #200 sieving efficiency, at the end of the project. The samples for this test will be identified by the client upon submission. Create a 50 gram subsample and place it in a prelabeled container. Record the sample number and sieve size on the Sample Sieve Wash Sheet.

4.28.1 Weigh a #200 sieve screen and record the weight on the Sample Sieve Wash Sheet.

4.28.2 Follow the steps in 4.23.2 through 4.23.10, using the #200 sieve.

Creating Subsamples for Test Performed on Prepared Aliquots

4.29 To obtain aliquots for extraction and digestion procedures, the laboratory will follow the audited and approved standard operating procedures for each testing procedure, using the sample containers discussed in sections 4.22 and 4.27. A typical sub-sampling procedure as detailed in the laboratory prep SOPs requires the analyst to obtain a representative sample, and to assure that the remaining sample is also representative. An example is:

a) Mix the sample to achieve homogeneity.

b) Sample aliquots should not be taken from the top of an unmixed sample because large particles tend to rise in solid matrices and heavy materials tend to sink in liquid matrices.

c) Powdered samples may be homogenized by gently rocking the sample side to side. A representative aliquot may be taken from the center of the powder.

d) Other matrices must be stirred, turned or mixed before sampling.

e) The sample removed from the container must represent the sample remaining in the container.

4.30 Upon completion of the aliquot step for all requested tests, and for all samples in the batch, the batch status may be updated to “DONE” and the aliquots scanned to the appropriate storage area for the prep and analytical areas.

4.31 Any sample remaining from the portions aliquotted as described in sections 4.22 and 4.27 are returned to storage locations in the laboratory until the Project Manager coordinates disposal or return to the client.

## 5.0 Grinding Blanks and Grinding Efficiency

5.1 One set of Grinding Blanks will be created prior to sample processing. An aliquot of Ottowa sand will be ground in each puck mill using the same process as the ground samples. Each puck mill will be used to produce three separate grinding samples using Ottawa sand for a total of nine (9) Ottawa sand grinding blanks. These samples will be analyzed for metals (non-mercury) and the results of the ground blanks will be provided to the client in Certificate of Analysis only.

5.2 A second set of Grinding blank samples will be created at the end of the project to measure grinding efficiency. The client will identify three samples from each of two sample size aliquots and submit them for sequential grinding in the puck mills. Aliquots for metals analysis will be created after each of the grinding iterations, and from each of the three puck mill bowls used to generate the samples. A total of 54 grinding efficiency samples will be created and each will be analyzed for metals (non mercury). The results will be provided to the client in Certificate of Analysis only.

## 6.0 Equipment Decontamination Procedure:

6.1 Decontaminate puck mill bowls, pucks, lids, plastic cones, and pots with a mild detergent and water. Gently scrub bowls to avoid additional scratching. Rinse with water thoroughly.

6.2 Air dry if possible, however towel drying is acceptable. Ensure all materials are completely dry before using.

Table 1

Minimum Weights needed for Testing (grams)

| Test | Test | Test plus QC | SRM |
|---|---|---|---|
| **Pre-grind aliquots** | | | |
| ~~Mercury + NO3/NO2~~ | ~~25~~ | ~~75~~ | ~~N/A~~ |

| | | | |
|---|---|---|---|
| Volatile Organics | 15 | 25 | N/A |
| Semivolatile Organics (3 tests) | 210 | 375 | 10 |
| PAHs by 8270 | 70 | 125 | N/A |
| DRO | 70 | 125 | N/A |
| PCBs | 70 | 125 | 10 |
| TPH (sub lab) | 50 | 100 | N/A |
| Moisture | 10 | 20 | N/A |
| **Ground Aliquots (minimum of 500g, split half with client as** | | | |
| Radiochemistry | 200 | 200 | 5* |
| Metals (non-Hg) + NO3/NO2 | 25 | 50 | N/A |
| Moisture | 10 | 20 | N/A |

*Do not grind SRM.

Metals SRM generated in Metals Prep lab

BD return samples—take aliquot of post grind (~200g) for return to client

# APPENDIX F

# PROJECT ACTION LIMIT BACKUP TABLES

**Soil**

The surface and subsurface soil human health risk assessment (HHRA) PALs were selected to be the lowest of the following:

- USEPA Regions 3, 6, and 9 Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites – Residential Soil Values (R-RSLs) (USEPA, May 2012).
- USEPA Regions 3, 6, and 9 Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites – Risk-Based Migration-to-Groundwater Soil Screening Values (RBSSLs) (USEPA, May 2012).

For delineation purposes, if a background concentration for a particular metal analyte is greater than the PAL for that analyte, the background concentration will replace the PAL prior to decision-making.

The surface soil ecological risk assessment (ERA) PALs were selected from the following sources of criteria, presented in hierarchical order:

- USEPA Ecological Soil Screening Level (Eco SSL) (USEPA, 2008).
- USEPA Region 4 Ecological Screening Value (R4 ESV) (USEPA, 2001).

**Sediment**

The sediment HHRA PALs were selected to be the lowest of the following:

- USEPA R-RSLs, as described previously.

For delineation purposes, if a background concentration for a particular metal analyte is greater than the PAL for that analyte, the background concentration will replace the PAL prior to decision-making.

The sediment ERA PALs were selected from the following sources of criteria, presented in hierarchical order:

- USEPA Region 4 Ecological Sediment Screening Level (R4 SDSL) (USEPA, 2001).
- USEPA Region 3 Biological Technical Assistance Group Sediment Screening Benchmarks (R3 BTAG SED) (USEPA, 2006).

**Surface Water**

The surface water HHRA PALs were selected to be the lowest of the following:

- Federal Maximum Contaminant Levels (MCLs) per the Safe Drinking Water Act (USEPA, January 2011).
- USEPA Regions 3, 6, and 9 RSLs for Chemical Contaminants at Superfund Sites – Tapwater Values (T-RSLs) (USEPA, May 2012).

The surface water ERA PALs were selected from the following sources of criteria, presented in hierarchical order:

- USEPA Region 4 Ecological Freshwater Surface Water Screening Level (R4 Eco) (USEPA, 2001).
- USEPA Region 3 Biological Technical Assistance Group Freshwater Surface Water Screening Benchmarks (R3 BTAG) (USEPA, 2006).
- National Oceanographic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRTs), freshwater chronic surface water benchmarks (Buchman, 2008).

**Groundwater**

The groundwater HHRA PALs were selected to be the lowest of the following:

- Federal MCLs, as described previously.
- USEPA T-RSLs, as described previously.

## Parris Island MC UXO Sites 2-8 Human Health Screening Criteria - Surface and Subsurface Soil Samples

| Analyte | CAS Number | EPA Regional Screening Level, Residential Soil [1] (mg/kg) | Adjusted EPA Regional Screening Level, Residential Soil [2] (mg/kg) | EPA Regional Screening Level, Migration to Groundwater [1] (mg/kg) | Adjusted EPA Regional Screening Level, Migration to Groundwater [2] (mg/kg) | Lowest Human Health Criterion | Lowest Human Health Criterion Reference | MCAS Beaufort Basewide Background [3] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Average Concentration (mg/kg) | Representative Concentration (mg/kg) | 2X Average Concentration (mg/kg) |
| **Metals** | | | | | | | | | | |
| Aluminum | 7429-90-5 | 77000 N | 7700 N | 23000 | 23000 | 7700 | R-RSL | 4,231 | 4,778 | 8,462 |
| Antimony | 7440-36-0 | 31 N | 3.1 N | 0.27 | 0.27 | 0.27 | RBSSL | NA | NA | NA |
| Arsenic | 7440-38-2 | 0.39 C | 0.39 C | 0.0013 | 0.0013 | 0.0013 | RBSSL | 1.05 | 1.16 | 2.10 |
| Barium | 7440-39-3 | 15000 N | 1500 N | 82 | 82 | 82 | RBSSL | 11.4 | 12.9 | 22.8 |
| Beryllium | 7440-41-7 | 160 N | 16 N | 3.2 | 3.2 | 3.2 | RBSSL | 0.227 | 0.288 | 0.454 |
| Cadmium | 7440-43-9 | 70 N | 7.0 N | 0.38 | 0.38 | 0.38 | RBSSL | 0.356 | 0.320 | 0.712 |
| Calcium | 7440-70-2 | NA | NA | NA | NA | NA | None | NA | NA | NA |
| Chromium | 7440-47-3 | 0.29 C[4] | 0.29 C[4] | 0.00059 [4] | 0.00059 [4] | 0.00059 | RBSSL | 4.62 | 5.17 | 9.24 |
| Cobalt | 7440-48-4 | 23 N | 2.3 N | 0.21 | 0.21 | 0.21 | RBSSL | 0.867 | 1.20 | 1.734 |
| Copper | 7440-50-8 | 3100 N | 310 N | 22 | 22 | 22 | RBSSL | 2.28 | 2.50 | 4.56 |
| Iron | 7439-89-6 | 55000 N | 5500 N | 270 | 270 | 270 | RBSSL | 2,443 | 2,875 | 4,886 |
| Lead | 7439-92-1 | 400 L | 400 L | 14 L | 14 L | 14 | RBSSL | 4.89 | 6.92 | 10 |
| Magnesium | 7439-95-4 | NA | NA | NA | NA | NA | None | NA | NA | NA |
| Manganese | 7439-96-5 | 1800 N | 180 N | 21 | 21 | 21 | RBSSL | 15.8 | 19.2 | 31.6 |
| Mercury | 7439-97-6 | 23 N[5] | 2.3 N[5] | 0.033 [8] | 0.033 [8] | 0.033 | RBSSL | 0.204 | 0.248 | 0.408 |
| Nickel | 7440-02-0 | 1500 N | 150 N | 20 | 20 | 20 | RBSSL | 1.24 | 1.65 | 2.48 |
| Potassium | 7440-09-7 | NA | NA | NA | NA | NA | None | NA | NA | NA |
| Selenium | 7782-49-2 | 390 N | 39 N | 0.26 | 0.26 | 0.26 | RBSSL | 0.457 | 0.595 | 0.914 |
| Silver | 7440-22-4 | 390 N | 39 N | 0.60 | 0.60 | 0.60 | RBSSL | 0.643 | 0.99 | 1.29 |
| Sodium | 7440-23-5 | NA | NA | NA | NA | NA | None | NA | NA | NA |
| Thallium | 7440-28-0 | 0.78 | 0.078 | 0.011 | 0.011 | 0.011 | RBSSL | 0.482 | 0.682 | 0.964 |
| Vanadium | 7440-62-2 | 390 N[6] | 39 N[6] | 78 [6] | 78 [6] | 39 | R-RSL | 5.88 | 8.22 | 11.8 |
| Zinc | 7440-66-6 | 23000 N | 2300 N | 290 | 290 | 290 | RBSSL | 5.61 | 4.27 | 11.2 |
| **Explosives** | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 99-35-4 | 2200 N | 220 N | 1.7 | 1.7 | 1.7 | RBSSL | NA | NA | NA |
| 1,3-Dinitrobenzene | 99-65-0 | 6.1 N | 0.61 N | 0.0014 | 0.0014 | 0.0014 | RBSSL | NA | NA | NA |
| 2,4,6-Trinitrotoluene (TNT) | 118-96-7 | 36 N[7] | 3.6 N[7] | 0.013 | 0.013 | 0.013 | RBSSL | NA | NA | NA |
| 2,4-Dinitrotoluene | 121-14-2 | 1.6 C | 1.6 C | 0.00028 | 0.00028 | 0.00028 | RBSSL | NA | NA | NA |
| 2,6-Dinitrotoluene | 606-20-2 | 61 N | 6.1 N | 0.020 | 0.020 | 0.020 | RBSSL | NA | NA | NA |
| HMX | 2691-41-0 | 380 N | 38 N | 0.99 | 0.99 | 0.99 | RBSSL | NA | NA | NA |
| 3-Nitrotoluene | 99-08-1 | 6.1 N | 0.61 N | 0.0012 | 0.0012 | 0.0012 | RBSSL | NA | NA | NA |
| 2-Nitrotoluene | 88-72-2 | 2.9 C | 2.9 C | 0.00025 | 0.00025 | 0.00025 | RBSSL | NA | NA | NA |
| 4-Nitrotoluene | 99-99-0 | 30 C | 30 C | 0.0034 | 0.0034 | 0.0034 | RBSSL | NA | NA | NA |
| 4-Amino-2,6-Dinitrotoluene | 19406-51-0 | 150 N | 15 N | 0.023 | 0.023 | 0.023 | RBSSL | NA | NA | NA |
| 2-Amino-4,6-Dinitrotoluene | 35572-78-2 | 150 N | 15 N | 0.023 | 0.023 | 0.023 | RBSSL | NA | NA | NA |
| Tetryl | 479-45-8 | 240 N | 24 N | 0.59 | 0.59 | 0.59 | RBSSL | NA | NA | NA |
| Nitrobenzene | 98-95-3 | 4.8 C | 4.8 C | 0.000079 | 0.000079 | 0.000079 | RBSSL | NA | NA | NA |
| RDX | 121-82-4 | 5.6 C | 5.6 C | 0.00023 | 0.00023 | 0.00023 | RBSSL | NA | NA | NA |

Notes:

## Parris Island MC UXO Sites 2-8 Human Health Screening Criteria - Surface and Subsurface Soil Samples

| Analyte | CAS Number | EPA Regional Screening Level, Residential Soil [1] (mg/kg) | Adjusted EPA Regional Screening Level, Residential Soil [2] (mg/kg) | EPA Regional Screening Level, Migration to Groundwater [1] (mg/kg) | Adjusted EPA Regional Screening Level, Migration to Groundwater [2] (mg/kg) | Lowest Human Health Criterion | Lowest Human Health Criterion Reference | MCAS Beaufort Basewide Background [3] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Average Concentration (mg/kg) | Representative Concentration (mg/kg) | 2X Average Concentration (mg/kg) |

1 - The residential direct contact (R-RSL) and risk-based migration to groundwater soil screening levels (RBSSL) from the USEPA Regions 3, 6, and 9 Regional Screening Levels for Chemical Contaminants at Superfund Sites (USEPA, May 2012) available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm. The risk-based screening levels are based on a target hazard quotient of 1 for noncarcinogens (denoted with a "N" flag), or an incremental lifetime cancer risk (ILCR) of 1E-6 for carcinogens (denoted with a "C" flag), or lead-specific criteria (denoted with a "L" flag).

2 - The USEPA R-RSL (USEPA, May 2012) residential soil screening level for noncarcinogens adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The residential soil screening level for carcinogens (not adjusted) is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6. The USEPA RBSSL (USEPA, May 2012) is based on a dilution attenuation factor (DAF) of 1.

3 - MCAS Beaufort Basewide Background Average Concentrations and Representative Concentrations obtained directly from Table 5-1 of the MCAS Basewide Background Study (Tetra Tech, November 2006). Per USEPA Region 4 guidance, an adjusted site-specific background concentration based on two times the average basewide background concentration is also presented.

Yellow highlighted cells indicate target analytes whose site-specific background concentration (adjusted) is higher than the risk-based Lowest Human Health Criterion; therefore, if a result exceeds the risk-based criterion (not including essential nutrient metals that do not have a risk-based criterion and not including metals that were not detected in the Background Study), then the background value will be used to replace the risk-based value during the risk evaluation.

4 - Value is for hexavalent chromium.

5 - Value is for mercuric chloride (and other mercury salts).

6 - Value is for vanadium and compounds.

7 - One tenth the noncarcinogenic value is less than the carcinogenic value; therefore, the noncarcinogenic value is presented.

8 - No value is available for mercuric chloride (and other mercury salts); therefore, the value for mercury (elemental) is presented.

## Parris Island MC UXO Sites 2-8 Human Health Screening Criteria - Groundwater Samples

| Analyte | CAS Number | EPA Regional Screening Level, Tap Water[1] (ug/L) | Adjusted EPA Regional Screening Level, Tap Water[2] (ug/L) | EPA Regional Screening Level, Vapor[1] (ug/L) | Adjusted EPA Regional Screening Level, Vapor[2] (ug/L) | EPA Maximum Contaminant Level (ug/L)[3] | Other (ug/L) | Minimum Criteria (ug/L) | Minimum Criterion Reference |
|---|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | | |
| Aluminum | 7429-90-5 | 16000 N | 1600 N | NA | NA | NA | | 1600 | T-RSL |
| Antimony | 7440-36-0 | 6.0 N | 0.60 N | NA | NA | 6 | | 0.6 | T-RSL |
| Arsenic | 7440-38-2 | 0.045 C | 0.045 C | NA | NA | 10 | | 0.045 | T-RSL |
| Barium | 7440-39-3 | 2900 N | 290 N | NA | NA | 2000 | | 290 | T-RSL |
| Beryllium | 7440-41-7 | 16 N | 1.6 N | NA | NA | 4 | | 1.6 | T-RSL |
| Cadmium | 7440-43-9 | 6.9 N | 0.69 N | NA | NA | 5 | | 0.69 | T-RSL |
| Calcium | 7440-70-2 | NA | NA | NA | NA | NA | | NA | None |
| Chromium | 7440-47-3 | 0.031 C[4] | 0.031 C[4] | NA | NA | 100 | | 0.031 | T-RSL |
| Cobalt | 7440-48-4 | 4.7 N | 0.47 N | NA | NA | NA | | 0.47 | T-RSL |
| Copper | 7440-50-8 | 620 N | 62 N | NA | NA | 1300 | | 62 | T-RSL |
| Iron | 7439-89-6 | 11000 N | 1100 N | NA | NA | NA | | 1100 | T-RSL |
| Lead | 7439-92-1 | 15 L | 15 L | NA | NA | 15 | | 15 | T-RSL |
| Magnesium | 7439-95-4 | NA | NA | NA | NA | NA | | NA | None |
| Manganese | 7439-96-5 | 320 N | 32 N | NA | NA | NA | | 32 | T-RSL |
| Mercury | 7439-97-6 | 4.3 N[5] | 0.43 N[5] | NA | NA | 2 | | 0.43 | T-RSL |
| Nickel | 7440-02-0 | 300 N | 30 N | NA | NA | NA | | 30 | T-RSL |
| Potassium | 7440-09-7 | NA | NA | NA | NA | NA | | NA | None |
| Selenium | 7782-49-2 | 78 N | 7.8 N | NA | NA | 50 | | 7.8 | T-RSL |
| Silver | 7440-22-4 | 71 N | 7.1 N | NA | NA | NA | | 7.1 | T-RSL |
| Sodium | 7440-23-5 | NA | NA | NA | NA | NA | | NA | None |
| Thallium | 7440-28-0 | 0.16 N | 0.016 N | NA | NA | 2 | | 0.016 | T-RSL |
| Vanadium | 7440-62-2 | 78 N[6] | 7.8 N[6] | NA | NA | NA | | 7.8 | T-RSL |
| Zinc | 7440-66-6 | 4700 N | 470 N | NA | NA | NA | | 470 | T-RSL |
| **Explosives and Perchlorate** | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 99-35-4 | 460 N | 46 N | NA | NA | NA | | 46 | T-RSL |
| 1,3-Dinitrobenzene | 99-65-0 | 1.5 N | 0.15 N | NA | NA | NA | | 0.15 | T-RSL |
| TNT | 118-96-7 | 7.6 N[7] | 0.76 N[7] | NA | NA | NA | | 0.76 | T-RSL |
| 2,4-Dinitrotoluene | 121-14-2 | 0.20 C | 0.20 C | NA | NA | NA | | 0.20 | T-RSL |
| 2,6-Dinitrotoluene | 606-20-2 | 15 N | 1.5 N | NA | NA | NA | | 1.5 | T-RSL |
| HMX | 2691-41-0 | 780 N | 78 N | NA | NA | NA | | 78 | T-RSL |
| 3-Nitrotoluene | 99-08-1 | 1.3 N | 0.13 N | NA | NA | NA | | 0.13 | T-RSL |
| 2-Nitrotoluene | 88-72-2 | 0.27 C | 0.27 C | NA | NA | NA | | 0.27 | T-RSL |
| 4-Nitrotoluene | 99-99-0 | 3.7 C | 3.7 C | NA | NA | NA | | 3.7 | T-RSL |
| 4-Amino-2,6-Dinitrotoluene | 19406-51-0 | 30 N | 3.0 N | NA | NA | NA | | 3.0 | T-RSL |
| 2-Amino-4,6-Dinitrotoluene | 35572-78-2 | 30 N | 3.0 N | NA | NA | NA | | 3.0 | T-RSL |
| Tetryl | 479-45-8 | 63 N | 6.3 N | NA | NA | NA | | 6.3 | T-RSL |
| Nitrobenzene | 98-95-3 | 0.12 C | 0.12 C | 62 C | 62 C | NA | | 0.12 | T-RSL |
| RDX | 121-82-4 | 0.61 C | 0.61 C | NA | NA | NA | | 0.61 | T-RSL |

## Parris Island MC UXO Sites 2-8 Human Health Screening Criteria - Groundwater Samples

| Analyte | CAS Number | EPA Regional Screening Level, Tap Water[(1)] (ug/L) | Adjusted EPA Regional Screening Level, Tap Water[(2)] (ug/L) | EPA Regional Screening Level, Vapor[(1)] (ug/L) | Adjusted EPA Regional Screening Level, Vapor[(2)] (ug/L) | EPA Maximum Contaminant Level (ug/L)[(3)] | Other (ug/L) | Minimum Criteria (ug/L) | Minimum Criterion Reference |
|---|---|---|---|---|---|---|---|---|---|
| Perchlorate | 14797-73-0 | 11 N | 1.1 N | NA | NA | NA | | 1.1 | T-RSL |

Notes:

1 - The tapwater screening levels from the USEPA Regions 3, 6, and 9 Regional Screening Levels (T-RSLs) for Chemical Contaminants at Superfund Sites (USEPA, May 2012) available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm. The vapor screening levels (VAPOR) were calculated using USEPA Vapor Intrusion Screening Level Calculator (USEPA, March 2012). The risk-based screening levels are based on a target hazard quotient of 1 for noncarcinogens (denoted with a "N" flag), or an incremental lifetime cancer risk (ILCR) of 1E-6 for carcinogens (denoted with a "C" flag), or lead-specific criteria (denoted with a "L" flag).

2 - The USEPA T-RSL (USEPA, May 2012) and VAPOR (calculated using USEPA Vapor Intrusion Screening Level Calculator [USEPA, March 2012]) adjusted values from the risk-based screening level for noncarcinogens adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The risk-based screening level for carcinogens is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6.

3 - USEPA Maximum Contaminant Levels (MCLs) from the 2011 Edition of the Drinking Water Standards and Health Advisories (USEPA, January 2011).

4 - Value is for hexavalent chromium.

5 - Value is for mercuric chloride (and other mercury salts).

6 - Value is for vanadium and compounds.

7 - One tenth the noncarcinogenic value is less than the carcinogenic value; therefore, the noncarcinogenic value is presented.

## Parris Island MC UXO Sites 2-8 Human Health Screening Criteria - Sediment Samples

| Analyte | CAS Number | EPA Regional Screening Level, Residential Soil [1] (mg/kg) | Adjusted EPA Regional Screening Level, Residential Soil [2] (mg/kg) | Lowest Human Health Criterion | Lowest Human Health Criterion Reference | MCAS Beaufort Basewide Background [3] | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Average Concentration (mg/kg) | Representative Concentration (mg/kg) | 2X Average Concentration (mg/kg) |
| **Metals** | | | | | | | | |
| Aluminum | 7429-90-5 | 77000 N | 7700 N | 7700 | R-RSL | 3,563 | 5,803 | 7,126 |
| Antimony | 7440-36-0 | 31 N | 3.1 N | 3.1 | R-RSL | NA | NA | NA |
| Arsenic | 7440-38-2 | 0.39 C | 0.39 C | 0.39 | R-RSL | 2.99 | 3.98 | 5.98 |
| Barium | 7440-39-3 | 15000 N | 1500 N | 1500 | R-RSL | 7.91 | 10.9 | 15.8 |
| Beryllium | 7440-41-7 | 160 N | 16 N | 16 | R-RSL | 0.641 | 0.416 | 1.28 |
| Cadmium | 7440-43-9 | 70 N | 7.0 N | 7.0 | R-RSL | NA | NA | NA |
| Calcium | 7440-70-2 | NA | NA | NA | None | NA | NA | NA |
| Chromium | 7440-47-3 | 0.29 C[4] | 0.29 C[4] | 0.29 | R-RSL | 6.48 | 9.25 | 13.0 |
| Cobalt | 7440-48-4 | 23 N | 2.3 N | 2.3 | R-RSL | 2.28 | 4.86 | 4.56 |
| Copper | 7440-50-8 | 3100 N | 310 N | 310 | R-RSL | 6.69 | 12.1 | 13.4 |
| Iron | 7439-89-6 | 55000 N | 5500 N | 5500 | R-RSL | 4,447 | 6,560 | 8,894 |
| Lead | 7439-92-1 | 400 L | 400 L | 400 | R-RSL | 6.00 | 7.99 | 12.0 |
| Magnesium | 7439-95-4 | NA | NA | NA | None | NA | NA | NA |
| Manganese | 7439-96-5 | 1800 N | 180 N | 180 | R-RSL | 22.8 | 43.1 | 45.6 |
| Mercury | 7439-97-6 | 23 N[5] | 2.3 N[5] | 2.3 | R-RSL | 0.140 | 0.190 | 0.280 |
| Nickel | 7440-02-0 | 1500 N | 150 N | 150 | R-RSL | 1.71 | 2.43 | 3.42 |
| Potassium | 7440-09-7 | NA | NA | NA | None | NA | NA | NA |
| Selenium | 7782-49-2 | 390 N | 39 N | 39 | R-RSL | 1.03 | 1.54 | 2.06 |
| Silver | 7440-22-4 | 390 N | 39 N | 39 | R-RSL | NA | NA | NA |
| Sodium | 7440-23-5 | NA | NA | NA | None | NA | NA | NA |
| Thallium | 7440-28-0 | 0.78 | 0.078 | 0.078 | R-RSL | NA | NA | NA |
| Vanadium | 7440-62-2 | 390 N[6] | 39 N[6] | 39 | R-RSL | 9.99 | 14.3 | 20.0 |
| Zinc | 7440-66-6 | 23000 N | 2300 N | 2300 | R-RSL | 20.4 | 38.4 | 40.8 |
| **Explosives** | | | | | | | | |
| 1,3,5-Trinitrobenzene | 99-35-4 | 2,200 N | 220 N | 220 | R-RSL | NA | NA | NA |
| 1,3-Dinitrobenzene | 99-65-0 | 6.1 N | 0.61 N | 0.61 | R-RSL | NA | NA | NA |
| TNT | 118-96-7 | 36 N[7] | 3.6 N[7] | 3.6 | R-RSL | NA | NA | NA |
| 2,4-Dinitrotoluene | 121-14-2 | 1.6 C | 1.6 C | 1.6 | R-RSL | NA | NA | NA |
| 2,6-Dinitrotoluene | 606-20-2 | 61 N | 6.1 N | 6.1 | R-RSL | NA | NA | NA |
| HMX | 2691-41-0 | 380 N | 38 N | 38 | R-RSL | NA | NA | NA |
| 3-Nitrotoluene | 99-08-1 | 6.1 N | 0.61 N | 0.61 | R-RSL | NA | NA | NA |
| 2-Nitrotoluene | 88-72-2 | 2.9 C | 2.9 C | 2.9 | R-RSL | NA | NA | NA |
| 4-Nitrotoluene | 99-99-0 | 30 C | 30 C | 30 | R-RSL | NA | NA | NA |

## Parris Island MC UXO Sites 2-8 Human Health Screening Criteria - Sediment Samples

| Analyte | CAS Number | EPA Regional Screening Level, Residential Soil [1] (mg/kg) | Adjusted EPA Regional Screening Level, Residential Soil [2] (mg/kg) | Lowest Human Health Criterion | Lowest Human Health Criterion Reference | MCAS Beaufort Basewide Background [3] | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Average Concentration (mg/kg) | Representative Concentration (mg/kg) | 2X Average Concentration (mg/kg) |
| 4-Amino-2,6-Dinitrotoluene | 19406-51-0 | 150 N | 15 N | 15 | R-RSL | NA | NA | NA |
| 2-Amino-4,6-Dinitrotoluene | 35572-78-2 | 150 N | 15 N | 15 | R-RSL | NA | NA | NA |
| Tetryl | 479-45-8 | 240 N | 24 N | 24 | R-RSL | NA | NA | NA |
| Nitrobenzene | 98-95-3 | 4.8 C | 4.8 C | 4.8 | R-RSL | NA | NA | NA |
| RDX | 121-82-4 | 5.6 C | 5.6 C | 5.6 | R-RSL | NA | NA | NA |

Notes:

1 - The residential direct contact (R-RSL) and risk-based migration to groundwater soil screening levels (RBSSL) from the USEPA Regions 3, 6, and 9 Regional Screening Levels for Chemical Contaminants at Superfund Sites (USEPA, May 2012) available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm. The risk-based screening levels are based on a target hazard quotient of 1 for noncarcinogens (denoted with a "N" flag), or an incremental lifetime cancer risk (ILCR) of 1E-6 for carcinogens (denoted with a "C" flag), or lead-specific criteria (denoted with a "L" flag).

2 - The USEPA R-RSL (USEPA, May 2012) residential soil screening level for noncarcinogens adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The residential soil screening level for carcinogens (not adjusted) is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6.

3 - MCAS Beaufort Basewide Background Average Concentrations and Representative Concentrations obtained directly from Table 5-2 of the MCAS Basewide Background Study (Tetra Tech, November 2006). Per USEPA Region 4 guidance, an adjusted site-specific background concentration based on two times the average basewide background concentration is also presented.

Yellow highlighted cells indicate target analytes whose site-specific background concentration (adjusted) is higher than the risk-based Lowest Human Health Criterion; therefore, if a result exceeds the risk-based criterion (not including essential nutrient metals that do not have a risk-based criterion and not including metals that were not detected in the Background Study), then the background value will be used to replace the risk-based value during the risk evaluation.

4 - Value is for hexavalent chromium.

5 - Value is for mercuric chloride (and other mercury salts).

6 - Value is for vanadium and compounds.

7 - One tenth the noncarcinogenic value is less than the carcinogenic value; therefore, the noncarcinogenic value is presented.

## Parris Island MC UXO Sites 2-8 Human Health Screening Criteria - Surface Water Samples

| Analyte | CAS Number | EPA Regional Screening Level, Tap Water[1] (ug/L) | Adjusted EPA Regional Screening Level, Tap Water[2] (ug/L) | EPA Maximum Contaminant Level (ug/L)[3] | Minimum Criteria (ug/L) | Minimum Criterion Reference |
|---|---|---|---|---|---|---|
| **Metals** | | | | | | |
| Aluminum | 7429-90-5 | 16000 N | 1600 N | NA | 1600 | T-RSL |
| Antimony | 7440-36-0 | 6.0 N | 0.60 N | 6 | 0.60 | T-RSL |
| Arsenic | 7440-38-2 | 0.045 C | 0.045 C | 10 | 0.045 | T-RSL |
| Barium | 7440-39-3 | 2900 N | 290 N | 2000 | 290 | T-RSL |
| Beryllium | 7440-41-7 | 16 N | 1.6 N | 4 | 1.6 | T-RSL |
| Cadmium | 7440-43-9 | 6.9 N | 0.69 N | 5 | 0.69 | T-RSL |
| Calcium | 7440-70-2 | NA | NA | NA | NA | None |
| Chromium | 7440-47-3 | 0.031 C[4] | 0.031 C[4] | 100 | 0.031 | T-RSL |
| Cobalt | 7440-48-4 | 5 N | 0.47 N | NA | 0.47 | T-RSL |
| Copper | 7440-50-8 | 620 N | 62 N | 1300 | 62 | T-RSL |
| Iron | 7439-89-6 | 11000 N | 1100 N | NA | 1100 | T-RSL |
| Lead | 7439-92-1 | 15 L | 15 L | 15 | 15 | T-RSL |
| Magnesium | 7439-95-4 | NA | NA | NA | NA | None |
| Manganese | 7439-96-5 | 320 N | 32 N | NA | 32 | T-RSL |
| Mercury | 7439-97-6 | 4.3 N[5] | 0.43 N[5] | 2 | 0.43 | T-RSL |
| Nickel | 7440-02-0 | 300 N | 30 N | NA | 30 | T-RSL |
| Potassium | 7440-09-7 | NA | NA | NA | NA | None |
| Selenium | 7782-49-2 | 78 N | 7.8 N | 50 | 7.8 | T-RSL |
| Silver | 7440-22-4 | 71 N | 7.1 N | NA | 7.1 | T-RSL |
| Sodium | 7440-23-5 | NA | NA | NA | NA | None |
| Thallium | 7440-28-0 | 0.16 N | 0.016 N | 2 | 0.016 | T-RSL |
| Vanadium | 7440-62-2 | 78 N[6] | 7.8 N[6] | NA | 7.8 | T-RSL |
| Zinc | 7440-66-6 | 4700 N | 470 N | NA | 470 | T-RSL |
| **Explosives** | | | | | | |
| 1,3,5-Trinitrobenzene | 99-35-4 | 460 N | 46 N | NA | 46 | T-RSL |
| 1,3-Dinitrobenzene | 99-65-0 | 1.5 N | 0.15 N | NA | 0.15 | T-RSL |
| TNT | 118-96-7 | 7.6 N[7] | 0.76 N[7] | NA | 0.76 | T-RSL |
| 2,4-Dinitrotoluene | 121-14-2 | 0.20 C | 0.20 C | NA | 0.20 | T-RSL |
| 2,6-Dinitrotoluene | 606-20-2 | 15 N | 1.5 N | NA | 1.5 | T-RSL |
| HMX | 2691-41-0 | 780 N | 78 N | NA | 78 | T-RSL |
| 3-Nitrotoluene | 99-08-1 | 1.3 N | 0.13 N | NA | 0.13 | T-RSL |

## Parris Island MC UXO Sites 2-8 Human Health Screening Criteria - Surface Water Samples

| Analyte | CAS Number | EPA Regional Screening Level, Tap Water[1] (ug/L) | Adjusted EPA Regional Screening Level, Tap Water[2] (ug/L) | EPA Maximum Contaminant Level (ug/L)[3] | Minimum Criteria (ug/L) | Minimum Criterion Reference |
|---|---|---|---|---|---|---|
| 2-Nitrotoluene | 88-72-2 | 0.27 C | 0.27 C | NA | 0.27 | T-RSL |
| 4-Nitrotoluene | 99-99-0 | 3.7 C | 3.7 C | NA | 3.7 | T-RSL |
| 4-Amino-2,6-Dinitrotoluene | 19406-51-0 | 30 N | 3.0 N | NA | 3.0 | T-RSL |
| 2-Amino-4,6-Dinitrotoluene | 35572-78-2 | 30 N | 3.0 N | NA | 3.0 | T-RSL |
| Tetryl | 479-45-8 | 63 N | 6.3 N | NA | 6.3 | T-RSL |
| Nitrobenzene | 98-95-3 | 0.12 C | 0.12 C | NA | 0.12 | T-RSL |
| RDX | 121-82-4 | 0.61 C | 0.61 C | NA | 0.61 | T-RSL |

Notes:

1 - The surface water screening levels from the USEPA Regions 3, 6, and 9 Tapwater Regional Screening Levels (T-RSLs) for Chemical Contaminants at Superfund Sites (USEPA, May 2012) available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm. The risk-based screening levels are based on a target hazard quotient of 1 for noncarcinogens (denoted with a "N" flag), or an incremental lifetime cancer risk (ILCR) of 1E-6 for carcinogens (denoted with a "C" flag), or lead-specific criteria (denoted with a "L" flag).

2 - The USEPA T-RSL (USEPA, May 2012) adjusted values from the risk-based screening level for noncarcinogens adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The risk-based screening level for carcinogens is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6.

3 - USEPA Maximum Contaminant Levels (MCLs) from the 2011 Edition of the Drinking Water Standards and Health Advisories (USEPA, January 2011).

4 - Value is for hexavalent chromium.

5 - Value is for mercuric chloride (and other mercury salts).

6 - Value is for vanadium and compounds.

7 - One tenth the noncarcinogenic value is less than the carcinogenic value; therefore, the noncarcinogenic value is presented.

**Parris Island MC UXO Sites 2-8 Ecological Screening Criteria - Surface Soil Samples**

| Analyte | CAS Number | Ecological Soil Screening Level [1] (mg/kg) | Source of Ecological Soil Screening Level | EPA Eco SSLs | | | | Minimum EPA Eco SSL (mg/kg) | EPA R4 ESV (mg/kg) | NOAA SQUIRT (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Plants | Soil Invertebrates | Birds | Mammals | | | |
| **Metals** | | | | | | | | | | |
| Aluminum | 7429-90-5 | 50 | R4 ESV | NC[2] | NC[2] | NC[2] | NC[2] | pH>5.5 | **50** | NC |
| Antimony | 7440-36-0 | 0.27 | Eco SSL | NC | 78 | NC | 0.27 | **0.27** | 3.5 | 0.142 |
| Arsenic | 7440-38-2 | 18 | Eco SSL | 18 | NC | 43 | 46 | **18** | 10 | 5.7 |
| Barium | 7440-39-3 | 330 | Eco SSL | NC | 330 | NC | 2000 | **330** | 165 | 1.04 |
| Beryllium | 7440-41-7 | 21 | Eco SSL | NC | 40 | NC | 21 | **21** | 1.1 | 1.06 |
| Cadmium | 7440-43-9 | 0.36 | Eco SSL | 32 | 140 | 0.77 | 0.36 | **0.36** | 1.6 | 0.00222 |
| Calcium | 7440-70-2 | NC | None | NC | NC | NC | NC | **NC** | **NC** | **NC** |
| Chromium | 7440-47-3 | 26 | Eco SSL | NC | NC | 26 | 34 | **26** | 0.4 | 0.4 |
| Cobalt | 7440-48-4 | 13 | Eco SSL | 13 | NC | 120 | 230 | **13** | 20 | 0.14 |
| Copper | 7440-50-8 | 28 | Eco SSL | 70 | 80 | 28 | 49 | **28** | 40 | 5.4 |
| Iron | 7439-89-6 | 200 | R4 ESV | NC[3] | NC | NC | NC | 5<pH<8 | **200** | NC |
| Lead | 7439-92-1 | 11 | Eco SSL | 120 | 1700 | 11 | 56 | **11** | 50 | 0.0537 |
| Magnesium | 7439-95-4 | NC | None | NC | NC | NC | NC | **NC** | **NC** | **NC** |
| Manganese | 7439-96-5 | 220 | Eco SSL | 220 | 450 | 4300 | 4000 | **220** | 100 | **220** |
| Mercury | 7439-97-6 | 0.1 | R4 ESV | NC | NC | NC | NC | NA | **0.1** | **0.1** |
| Nickel | 7440-02-0 | 38 | Eco SSL | 38 | 280 | 210 | 130 | **38** | 30 | 13.6 |
| Potassium | 7440-09-7 | NC | None | NC | NC | NC | NC | **NC** | **NC** | **NC** |
| Selenium | 7782-49-2 | 0.52 | Eco SSL | 0.52 | 4.1 | 1.2 | 0.63 | **0.52** | 0.81 | **0.52** |
| Silver | 7440-22-4 | 4.2 | Eco SSL | 560 | NC | 4.2 | 14 | **4.2** | 2 | 2 |
| Sodium | 7440-23-5 | NC | None | NC | NC | NC | NC | **NC** | **NC** | **NC** |
| Thallium | 7440-28-0 | 1 | R4 ESV | NC | NC | NC | NC | NC | **1** | 0.0569 |
| Vanadium | 7440-62-2 | 7.8 | Eco SSL | NC | NC | 7.8 | 280 | **7.8** | 2 | 1.59 |
| Zinc | 7440-66-6 | 46 | Eco SSL | 160 | 120 | 46 | 79 | **46** | 50 | 6.62 |
| **Explosives** | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 99-35-4 | 0.376 | NOAA | NC | NC | NC | NC | NC | NC | **0.376** |
| 1,3-Dinitrobenzene | 99-65-0 | NC | None | NC | NC | NC | NC | **NC** | **NC** | **NC** |
| TNT | 118-96-7 | 6 | Sunahara | NC | NC | NC | NC | NC | NC | NC |
| 2,4-Dinitrotoluene | 121-14-2 | 1.28 | NOAA | NC | NC | NC | NC | NC | NC | **1.28** |
| 2,6-Dinitrotoluene | 606-20-2 | 600 | Sunahara | NC | NC | NC | NC | NC | NC | NC |
| HMX | 2691-41-0 | NC | None | NC | NC | NC | NC | **NC** | **NC** | **NC** |
| 3-Nitrotoluene | 99-08-1 | NC | None | NC | NC | NC | NC | **NC** | **NC** | **NC** |
| 2-Nitrotoluene | 88-72-2 | NC | None | NC | NC | NC | NC | **NC** | **NC** | **NC** |
| 4-Nitrotoluene | 99-99-0 | NC | None | NC | NC | NC | NC | **NC** | **NC** | **NC** |
| 4-Amino-2,6-Dinitrotoluene | 19406-51-0 | NC | None | NC | NC | NC | NC | **NC** | **NC** | **NC** |
| 2-Amino-4,6-Dinitrotoluene | 35572-78-2 | 80 | LANL, 2009 | NC | NC | NC | NC | NC | NC | NC |
| Tetryl | 479-45-8 | 25 | LANL, 2009 | NC | NC | NC | NC | NC | NC | NC |
| Nitrobenzene | 98-95-3 | 40 | R4 ESV | NC | NC | NC | NC | NC | **40** | NC |
| RDX | 121-82-4 | 98 | Sunahara | NC | NC | NC | NC | NC | NC | NC |

1- The following hierarchy was used for selecting the Ecological Soil Screening Level, in order of preference:
USEPA Ecological Soil Screening Levels (Eco SSL) (EPA, 2003, 2005, 2006, 2007). The lower of the plant, invertebrate, or wildlife Eco SSL is selected as the screening level.
USEPA Region 4 Ecological Screening Values (R4 ESV) (USEPA, 2001).
Ecotoxicogical tolerance values (Sunahara, 2009).
Los Alamos National Laboratory (LANL) Ecological Screening Values (LANL, 2009).
Lowest of National Oceanographic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQUIRT) surface soil benchmarks (Buchman, 2008).
2- Aluminum is considered an ecological COPC only when the soil pH is less than 5.5
3 - Iron is not expected to be toxic to plants with a soil pH between 5 and 8.
Shaded cells are values that were selected as the overall ecological soil screening level.
NC - No criteria

**Parris Island MC UXO Sites 2-8 Ecological Screening Criteria - Sediment Samples**

| Analyte | CAS Number | Ecological Sediment Screening Level [1] (mg/kg) | Source of Ecological Sediment Screening Level | EPA R4 Eco SDSL (mg/kg) | EPA R3 BTAG SED (mg/kg) | NOAA SQuiRT AET (mg/kg) |
|---|---|---|---|---|---|---|
| **Metals** | | | | | | |
| Aluminum | 7429-90-5 | 18000 | NOAA AET | NA | NA | **18000** |
| Antimony | 7440-36-0 | 2 | R4 Eco SDSL | **2** | 2 | 9.3 |
| Arsenic | 7440-38-2 | 7.24 | R4 Eco SDSL | **7.24** | 9.8 | 35 |
| Barium | 7440-39-3 | 48 | NOAA AET | NA | NA | **48** |
| Beryllium | 7440-41-7 | NC | None | NA | NA | NA |
| Cadmium | 7440-43-9 | 0.676 | R4 Eco SDSL | **0.676** | 0.99 | 3 |
| Calcium | 7440-70-2 | NC | None | NA | NA | NA |
| Chromium | 7440-47-3 | 52.3 | R4 Eco SDSL | **52.3** | 43.4 | 62 |
| Cobalt | 7440-48-4 | 50 | R3 BTAG SED | NA | **50** | 10 |
| Copper | 7440-50-8 | 18.7 | R4 Eco SDSL | **18.7** | 31.6 | 390 |
| Iron | 7439-89-6 | 20000 | R3 BTAG SED | NA | **20000** | 22000 |
| Lead | 7439-92-1 | 30.2 | R4 Eco SDSL | **30.2** | 35.8 | 400 |
| Magnesium | 7439-95-4 | NC | None | NA | NA | NA |
| Manganese | 7439-96-5 | 460 | R3 BTAG SED | NA | **460** | 260 |
| Mercury | 7439-97-6 | 0.13 | R4 Eco SDSL | **0.13** | 0.18 | 0.41 |
| Nickel | 7440-02-0 | 15.9 | R4 Eco SDSL | **15.9** | 22.7 | 110 |
| Potassium | 7440-09-7 | NC | None | NA | NA | NA |
| Selenium | 7782-49-2 | 2 | R3 BTAG SED | NA | **2** | 1.0 |
| Silver | 7440-22-4 | 0.733 | R4 Eco SDSL | **0.733** | 1 | 3.1 |
| Sodium | 7440-23-5 | NC | None | NA | NA | NA |
| Thallium | 7440-28-0 | NC | None | NA | NA | NA |
| Vanadium | 7440-62-2 | 57 | NOAA AET | NA | NA | **57** |
| Zinc | 7440-66-6 | 124 | R4 Eco SDSL | **124** | 121 | 410 |
| **Explosives** | | | | | | |
| 1,3,5-Trinitrobenzene | 99-35-4 | 8 | NOEC | NA | NA | NA |
| 1,3-Dinitrobenzene | 99-65-0 | NC | None | NA | NA | NA |
| TNT | 118-96-7 | 0.092 | R3 BTAG SED | NA | **0.092** | NA |
| 2,4-Dinitrotoluene | 121-14-2 | 0.0416 | R3 BTAG SED | NA | **0.0416** | NA |
| 2,6-Dinitrotoluene | 606-20-2 | 0.0416 | R3 BTAG SED | NA | **0.0416** | NA |
| HMX | 2691-41-0 | 126 | NOEC | NA | NA | NA |
| 3-Nitrotoluene | 99-08-1 | 4.06 | R3 BTAG SED | NA | **4.06** | NA |
| 2-Nitrotoluene | 88-72-2 | 4.06 | R3 BTAG SED | NA | **4.06** | NA |
| 4-Nitrotoluene | 99-99-0 | 4.06 | R3 BTAG SED | NA | **4.06** | NA |
| 4-Amino-2,6-Dinitrotoluene | 19406-51-0 | 150 | R3 BTAG SED | NA | **150** | NA |
| 2-Amino-4,6-Dinitrotoluene | 35572-78-2 | 150 | R3 BTAG SED | NA | **150** | NA |
| Tetryl | 479-45-8 | 240 | R3 BTAG SED | NA | **240** | NA |
| Nitrobenzene | 98-95-3 | 0.021 | NOAA AET | NA | NA | **0.021** |
| RDX | 121-82-4 | 0.013 | R3 BTAG SED | NA | **0.013** | NA |
| NG | 55-63-0 | NC | None | NA | NA | NA |

1- The following hierarchy was used for selecting the Ecological Sediment Screening level in order of preference:
USEPA Region 4 Ecological Sediment Screening Levels (R4 Eco SDSL) (USEPA, 2001).
USEPA Region 3 BTAG Ecological Sediment Screening Levels (R3 BTAG SED) (USEPA, 2005).
Lowest of National Oceanographic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQUIRT) Alternate Effects Table (AET) sediment benchmarks (Buchman, 2008).

Shaded cells are values that were selected as the overall ecological sediment screening level.
NC - No criteria

**Parris Island MC UXO Sites 2-8 Ecological Screening Criteria - Surface Water Samples**

| Analyte | CAS Number | Ecological Surface Water Screening Level [1] (ug/L) | Source of Ecological Surface Water Screening Level | NRWQC FW (ug/L) | NRWQC SW (ug/L) | EPA R4 Eco CSV FW (ug/L) | EPA R4 Eco CSV SW (ug/L) | EPA R3 BTAG FW (ug/L) | EPA R3 BTAG SW (ug/L) | NOAA FW (ug/L) | NOAA SW (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | | | | |
| Aluminum | 7429-90-5 | 87 | NRWQC FW | **87** | NA | **87** | NA | **87** | NA | **87** | NA |
| Antimony | 7440-36-0 | 160 | R4 Eco FW | NA | NA | **160** | NA | 30 | 500 | 30 | 500 |
| Arsenic | 7440-38-2 | 36 | NRWQC SW | 150 | **36** | 190 | **36** | 5 | 12.5 | 150 | **36** |
| Barium | 7440-39-3 | 4 | R3 BTAG FW | NA | NA | NA | NA | **4** | NA | 3.9 | 200 |
| Beryllium | 7440-41-7 | 0.53 | R4 Eco FW | NA | NA | **0.53** | NA | 0.66 | NA | 0.66 | 100 |
| Cadmium | 7440-43-9 | 0.25 | NRWQC FW | **0.25** | 8.8 | 0.66 | 9.3 | **0.25** | 0.12 | **0.25** | 8.8 |
| Calcium | 7440-70-2 | 116000 | R3 BTAG FW | NA | NA | NA | NA | **116000** | NA | NA | NA |
| Chromium | 7440-47-3 | **74**[2] | NRWQC FW | **74**[2] | NA | 117[2] | 103[2] | 85 | 57.5 | **74**[2] | 27.4[2] |
| Cobalt | 7440-48-4 | 23 | R3 BTAG FW | NA | NA | NA | NA | **23** | NA | 3 | 1 |
| Copper | 7440-50-8 | 3.1 | NRWQC SW | NA | **3.1** | 6.54 | 2.9 | 9 | **3.1** | 9 | **3.1** |
| Iron | 7439-89-6 | 1000 | NRWQC FW | **1000** | NA | **1000** | NA | 300 | NA | **1000** | 50 |
| Lead | 7439-92-1 | 2.5 | NRWQC FW | **2.5** | 8.1 | 1.32 | 8.5 | **2.5** | 8.1 | **2.5** | 8.1 |
| Magnesium | 7439-95-4 | 82000 | R3 BTAG FW | NA | NA | NA | NA | **82000** | NA | NA | NA |
| Manganese | 7439-96-5 | 120 | R3 BTAG FW | NA | NA | NA | NA | **120** | NA | 80 | 100 |
| Mercury | 7439-97-6 | 0.77 | NRWQC FW | **0.77** | 0.94 | 0.012 | 0.025 | 0.026 | 0.016 | **0.77** | 0.94 |
| Nickel | 7440-02-0 | 8.2 | NRWQC SW | 52 | **8.2** | 87.71 | 8.3 | 52 | **8.2** | 52 | **8.2** |
| Potassium | 7440-09-7 | 53000 | R3 BTAG FW | NA | NA | NA | NA | **53000** | NA | NA | NA |
| Selenium | 7782-49-2 | 5 | NRWQC FW | **5** | 71 | **5** | 71 | 1 | 71 | **5** | 71 |
| Silver | 7440-22-4 | 0.012 | R4 Eco FW | NA | NA | **0.012** | 0.23 | 3.2 | 0.23 | 0.36 | NA |
| Sodium | 7440-23-5 | 680000 | R3 BTAG FW | NA | NA | NA | NA | **680000** | NA | NA | NA |
| Thallium | 7440-28-0 | 4 | R4 Eco FW | NA | NA | **4** | 21.3 | 0.8 | 21.3 | 0.03 | 17 |
| Vanadium | 7440-62-2 | 20 | R3 BTAG FW | NA | NA | NA | NA | **20** | NA | 19 | 50 |
| Zinc | 7440-66-6 | 81 | NRWQC SW | 120 | **81** | 58.91 | 86 | 120 | **81** | 120 | **81** |
| **Explosives** | | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 99-35-4 | 11.1 | Sunahara | NA | NA | NA | NA | NA | NA | NA | NA |
| 1,3-Dinitrobenzene | 99-65-0 | 17 | Sunahara | NA | NA | NA | NA | NA | NA | NA | NA |
| TNT | 118-96-7 | 100 | R3 BTAG FW | NA | NA | NA | NA | **100** | **100** | NA | NA |
| 2,4-Dinitrotoluene | 121-14-2 | 310 | R4 Eco FW | NA | NA | **310** | NA | 44 | NA | 65 | 370 |
| 2,6-Dinitrotoluene | 606-20-2 | 81 | R3 BTAG FW | NA | NA | NA | NA | **81** | NA | NA | NA |
| HMX | 2691-41-0 | 150 | R3 BTAG FW | NA | NA | NA | NA | **150** | NA | NA | NA |
| 3-Nitrotoluene | 99-08-1 | 750 | R3 BTAG FW | NA | NA | NA | NA | **750** | NA | NA | NA |
| 2-Nitrotoluene | 88-72-2 | 750 | R3 BTAG FW | NA | NA | NA | NA | **750** | NA | NA | NA |
| 4-Nitrotoluene | 99-99-0 | 1900 | R3 BTAG FW | NA | NA | NA | NA | **1900** | NA | NA | NA |
| 4-Amino-2,6-Dinitrotoluene | 19406-51-0 | 1480 | R3 BTAG FW | NA | NA | NA | NA | **1480** | NA | NA | NA |
| 2-Amino-4,6-Dinitrotoluene | 35572-78-2 | 1480 | R3 BTAG FW | NA | NA | NA | NA | **1480** | NA | NA | NA |
| Tetryl | 479-45-8 | NC | None | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrobenzene | 98-95-3 | 66.8 | R4 Eco SW | NA | NA | 270 | **66.8** | NA | **66.8** | 220 | 668 |
| RDX | 121-82-4 | 360 | R3 BTAG FW | NA | NA | NA | NA | **360** | NA | NA | NA |
| NG | 55-63-0 | 138 | R3 BTAG FW | NA | NA | NA | NA | **138** | NA | NA | NA |

1- The following hierarchy was used for selecting the Ecological Surface Water Screening Level, in order of preference (using the lower of the freshwater and saltwater values):
National Recommended Water Quality Criteria (NRWQC), chronic values (USEPA, 2009).
USEPA Region 4 Ecological (R4 Eco) Chronic Screening Value (CSV) Surface Water Screening Levels (USEPA, 2001).
USEPA Region 3 BTAG (R3 BTAG) Ecological Surface Water Screening Values (USEPA, 2005).
Sunahara - Water quality criteria for protection of aquatic life, chronic values (Sunahara, et al, 2009).
Lowest of National Oceanographic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQUIRT) surface water benchmarks, chronic values (Buchman, 2008).
2 - Value is for trivalent chromium.
Shaded cells are values that were selected as the overall ecological surface water screening level.

FW - Freshwater
SW - Saltwater
NC - No criteria

# Comprehensive Long-term Environmental Action Navy

CONTRACT NUMBER N62467-94-D-0888

Rev. 1
11/06

# RCRA Facility Investigation Report
## for
# Solid Waste Management Unit 3
# Borrow Pit Landfill

# Appendix Z
# Basewide Background Report

## Marine Corps Air Station
## Beaufort, South Carolina

## Contract Task Order 0329

## November 2006


NAVFAC
Naval Facilities Engineering Command
Southeast
2155 Eagle Drive
North Charleston, South Carolina 29406

TETRA TECH NUS, Inc.

**TABLE 5-1**

**REPRESENTATIVE CONCENTRATIONS - SSA, SSB, AND SCS SOIL CATEGORIES**
**BASEWIDE BACKGROUND STUDY**
**MCAS BEAUFORT, SOUTH CAROLINA**


| CHEMICAL | RAW STATISTICS | | | | | | | | | | | DATA DISTRIBUTION | RECOMMENDED UCL ADJUSTED EPA'S ProUCL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FREQUENCY OF DETECTION | | MINIMUM DETECTION | MAXIMUM DETECTION | SAMPLE WITH MAXIMUM DETECTION | MEAN OF ALL SAMPLES | MEAN OF POSITIVE DETECTIONS | STANDARD DEVIATION | COEEFICIENT OF VARIATION | SKEWNESS | OUTLIER | | | |
| | NUMBER | PERCENT | | | | | | | | | | | | |
| **Volatile Organics (ug/kg)** | | | | | | | | | | | | | | |
| **CARBON DISULFIDE** | **26/60** | **43%** | **2 J** | **230 J** | **SCS-04_2-3** | **20.0** | **41.7** | **39.1** | **1.96** | **3.29** | **NA(1)** | **Non-parametric** | **51.5** | **97.5% Chebyshev(Mean, Std) UCL** |
| **DICHLORODIFLUOROMETHANE** | **2/60** | **3%** | **1 J** | **2.8 J** | **SSA-04_0-1-AVG** | **3.59** | **1.90** | **0.756** | **0.211** | **-0.210** | **NA(1)** | **Non-parametric** | **2.8** | **Maximum Detection** |
| **METHYL ACETATE** | **2/60** | **3%** | **1.9 J** | **3 J** | **SCS-01_0-1** | **3.60** | **2.45** | **0.696** | **0.194** | **0.306** | **NA(1)** | **Non-parametric** | **3** | **Maximum Detection** |
| **TRICHLOROFLUOROMETHANE** | **5/60** | **8%** | **2 J** | **7** | **BEA-BG-SS-SSB-10-01** | **3.77** | **4.40** | **0.808** | **0.214** | **1.06** | **NA(1)** | **Gamma** | **4.81** | **99.5% Chebyshev(Mean, Std) UCL** |
| **Semivolatile Organics (ug/kg)** | | | | | | | | | | | | | | |
| **ANTHRACENE** | **2/60** | **3%** | **77 J** | **590 J** | **SCS-01_0-1** | **194** | **334** | **54.7** | **0.282** | **6.46** | **NA(1)** | **Non-parametric** | **206** | **Student-t** |
| **BENZALDEHYDE** | **1/3** | **33%** | **580 J** | **580 J** | **BEA-BG-SS-SSB-04-01-AVG** | **325** | **580** | **NA(2)** | **NA(2)** | **NA(2)** | **NA(2)** | **NA(2)** | **580** | **Maximum Detection** |
| **BENZO(A)ANTHRACENE** | **3/60** | **5%** | **150 J** | **2200** | **SCS-01_0-1** | **227** | **950** | **262** | **1.15** | **7.47** | **NA(1)** | **Non-parametric** | **284** | **Student-t** |
| **BENZO(A)PYRENE** | **4/60** | **7%** | **58 J** | **1400 J** | **SCS-01_0-1** | **213** | **540** | **164** | **0.769** | **6.82** | **NA(1)** | **Non-parametric** | **248** | **Student-t** |
| **BENZO(B)FLUORANTHENE** | **4/60** | **7%** | **89 J** | **1900 J** | **SCS-01_0-1** | **222** | **680** | **226** | **1.02** | **7.27** | **NA(1)** | **Non-parametric** | **271** | **Student-t** |
| **BENZO(G,H,I)PERYLENE** | **2/60** | **3%** | **220 J** | **1100 J** | **SCS-01_0-1** | **205** | **660** | **118** | **0.576** | **7.66** | **NA(1)** | **Non-parametric** | **230** | **Student-t** |
| **BENZO(K)FLUORANTHENE** | **4/60** | **7%** | **66 J** | **1500 J** | **SCS-01_0-1** | **214** | **564** | **175** | **0.817** | **7.01** | **NA(1)** | **Non-parametric** | **252** | **Student-t** |
| **CARBAZOLE** | **1/60** | **2%** | **450 J** | **450 J** | **SCS-01_0-1** | **193** | **450** | **34.9** | **0.180** | **6.94** | **NA(1)** | **Non-parametric** | **201** | **Student-t** |
| **CHRYSENE** | **3/60** | **5%** | **180 J** | **2500** | **SCS-01_0-1** | **234** | **1080** | **302** | **1.29** | **7.46** | **NA(1)** | **Non-parametric** | **299** | **Student-t** |
| **DIBENZO(A,H)ANTHRACENE** | **1/60** | **2%** | **550 J** | **550 J** | **SCS-01_0-1** | **195** | **550** | **47.5** | **0.243** | **7.30** | **NA(1)** | **Non-parametric** | **205** | **Student-t** |
| **FLUORANTHENE** | **4/60** | **7%** | **84 J** | **5800** | **SCS-01_0-1** | **294** | **1766** | **729** | **2.48** | **7.55** | **NA(1)** | **Non-parametric** | **705** | **95% Chebyshev(Mean, Std) UCL** |
| **INDENO(1,2,3-CD)PYRENE** | **2/60** | **3%** | **210 J** | **980 J** | **SCS-01_0-1** | **203** | **595** | **102** | **0.506** | **7.64** | **NA(1)** | **Non-parametric** | **225** | **Student-t** |
| **PHENANTHRENE** | **3/60** | **5%** | **92 J** | **3200** | **SCS-01_0-1** | **241** | **1227** | **390** | **1.62** | **7.67** | **NA(1)** | **Non-parametric** | **325** | **Student-t** |
| **PYRENE** | **3/60** | **5%** | **280 J** | **3500** | **SCS-01_0-1** | **261** | **1627** | **441** | **1.69** | **7.04** | **NA(1)** | **Non-parametric** | **356** | **Student-t** |
| **TOTAL PAHs** | **4/60** | **7%** | **142** | **25220** | **SCS-01_0-1** | **510** | **7643** | | | | **NA(1)** | **Non-parametric** | **628** | **Student-t** |
| **Pesticides PCBs (ug/kg)** | | | | | | | | | | | | | | |
| **4,4'-DDD** | **1/60** | **2%** | **1.8 J** | **1.8 J** | **BEA-BG-SB-SSB-01-03** | **2.16** | **1.80** | **2.08** | **0.965** | **7.72** | **NA(1)** | **Non-parametric** | **1.8** | **Maximum Detection** |
| **4,4'-DDE** | **4/60** | **7%** | **2.4 J** | **8.9** | **BEA-BG-SB-SSB-01-03** | **2.43** | **5.92** | **2.37** | **0.974** | **5.51** | **NA(1)** | **Non-parametric** | **2.94** | **Student-t** |
| **4,4'-DDT** | **5/60** | **8%** | **1.8 J** | **5.2** | **BEA-BG-SS-SSB-01-01** | **2.30** | **3.56** | **2.15** | **0.935** | **6.92** | **NA(1)** | **Non-parametric** | **2.76** | **Student-t** |
| **ALPHA-CHLORDANE** | **20/60** | **33%** | **0.862 J** | **280 J** | **BEA-BG-SB-SSB-06-03** | **6.46** | **17.5** | **36.0** | **5.57** | **7.71** | **NA(1)** | **Non-parametric** | **26.7** | **95% Chebyshev(Mean, Std) UCL** |
| **ENDOSULFAN SULFATE** | **3/60** | **5%** | **2.42 J** | **7.715 J** | **SSA-03_0-1-AVG** | **2.31** | **4.87** | **2.22** | **0.960** | **6.47** | **NA(1)** | **Non-parametric** | **2.79** | **Student-t** |
| **ENDRIN** | **1/60** | **2%** | **3.64 J** | **3.64 J** | **SSA-03_0-1-AVG** | **2.19** | **3.64** | **2.09** | **0.955** | **7.59** | **NA(1)** | **Non-parametric** | **2.64** | **Student-t** |
| **ENDRIN ALDEHYDE** | **1/60** | **2%** | **4.18 J** | **4.18 J** | **SSA-03_0-1-AVG** | **2.20** | **4.18** | **2.10** | **0.954** | **7.51** | **NA(1)** | **Non-parametric** | **2.65** | **Student-t** |
| **GAMMA-CHLORDANE** | **1/60** | **2%** | **200** | **200** | **BEA-BG-SB-SSB-06-03** | **4.27** | **200** | **25.7** | **6.02** | **7.75** | **NA(1)** | **Non-parametric** | **18.7** | **95% Chebyshev(Mean, Std) UCL** |
| **HEPTACHLOR** | **1/60** | **2%** | **1.03 J** | **1.03 J** | **SSA-02_0-1-AVG** | **1.09** | **1.03** | **1.04** | **0.954** | **7.71** | **NA(1)** | **Non-parametric** | **1.03** | **Maximum Detection** |
| **METHOXYCHLOR** | **2/60** | **3%** | **2.11 J** | **32.8 J** | **SCS-01_0-1** | **11.2** | **17.5** | **10.8** | **0.972** | **6.88** | **NA(1)** | **Non-parametric** | **13.5** | **Student-t** |
| **TOTAL DDT** | **6/60** | **10%** | **2.93** | **12.5** | **BEA-BG-SB-SSB-01-03** | **0.721** | **7.21** | | | | **NA(1)** | **Non-parametric** | **2.24** | **Student-t** |
| **Herbicides (ug/kg)** | | | | | | | | | | | | | | |
| **2,4-D** | **1/60** | **2%** | **14.5 J** | **14.5 J** | **SSA-01_0-1-AVG** | **12.7** | **14.5** | **4.62** | **0.363** | **0.725** | **NA(1)** | **Non-parametric** | **13.7** | **Student-t or Modified-t UCL** |
| **DALAPON** | **1/60** | **2%** | **25 J** | **25 J** | **BEA-BG-SS-SSB-06-01** | **37.8** | **25.0** | **41.7** | **1.10** | **0.826** | **NA(1)** | **Non-parametric** | **25.0** | **Maximum Detection** |
| **Inorganics (mg/kg)** | | | | | | | | | | | | | | |
| ALUMINUM | 60/60 | 100% | 746 | 12100 | SCS-01_2-3 | 4231 | 4231 | 2338 | 0.553 | 1.37 | NA(1) | Gamma | 4778 | Approximate Gamma 95% UCL |
| ARSENIC | 46/60 | 77% | 0.25 | 3.3 | SCS-01_2-3 | 1.05 | 1.09 | 0.524 | 0.501 | 1.80 | NA(1) | Gamma | 1.16 | Approximate Gamma 95% UCL |
| BARIUM | 60/60 | 100% | 1.8 | 32.5 J | SCS-03_2-3 | 11.4 | 11.4 | 6.93 | 0.610 | 1.06 | NA(1) | Normal | 12.9 | Student-t |
| BERYLLIUM | 39/60 | 65% | 0.055 | 0.288 J | SCS-03_0-1 | 0.227 | 0.130 | 0.192 | 0.844 | 0.867 | NA(1) | Non-parametric | 0.288 | Maximum Detection |
| **CADMIUM** | **5/60** | **8%** | **0.0665 J** | **0.32** | **BEA-BG-SS-SSB-02-01** | **0.356** | **0.156** | **0.245** | **0.687** | **-0.629** | **NA(1)** | **Non-parametric** | **0.320** | **Maximum Detection** |
| CALCIUM | 37/60 | 62% | 39.9 J | 43300 | BEA-BG-SS-SSB-02-01 | 1521 | 2441 | 6170 | 4.06 | 6.00 | NA(1) | Lognormal | 1880 | H-UCL |
| CHROMIUM | 60/60 | 100% | 1.532 J | 14.3 | SCS-02_2-3 | 4.62 | 4.62 | 2.70 | 0.583 | 1.92 | NA(1) | Lognormal | 5.17 | H-UCL |
| COBALT | 53/60 | 88% | 0.129 J | 1.2 | BEA-BG-SS-SSB-02-01 | 0.867 | 0.363 | 1.56 | 1.80 | 2.64 | NA(1) | Non-parametric | 1.20 | Maximum Detection |
| COPPER | 60/60 | 100% | 0.32 J | 4.85 J | SCS-09_0-1 | 2.28 | 2.28 | 1.01 | 0.443 | 0.255 | NA(1) | Normal | 2.50 | Student-t |
| IRON | 60/60 | 100% | 125.15 | 11200 | SCS-01_2-3 | 2433 | 2433 | 1985 | 0.816 | 2.25 | NA(1) | Gamma | 2875 | Approximate Gamma 95% UCL |
| LEAD | 60/60 | 100% | 0.978 | 20.4 | BEA-BG-SS-SSB-01-01 | 4.89 | 4.89 | 3.60 | 0.737 | 2.47 | NA(1) | Non-parametric | 6.92 | 95% Chebyshev(Mean, Std) UCL |
| MAGNESIUM | 60/60 | 100% | 32.13 J | 1040 | BEA-BG-SB-SSB-07-03 | 174 | 174 | 184 | 1.06 | 3.55 | NA(1) | Non-parametric | 278 | 95% Chebyshev(Mean, Std) UCL |
| MANGANESE | 60/60 | 100% | 2.01 J | 80.1 | SCS-03_0-1 | 15.8 | 15.8 | 17.0 | 1.07 | 2.45 | NA(1) | Gamma | 19.2 | Approximate Gamma 95% UCL |
| MERCURY | 36/60 | 60% | 0.025 | 0.77 | SCS-09_0-1 | 0.128 | 0.204 | 0.149 | 1.16 | 1.91 | NA(1) | Non-parametric | 0.248 | 97.5% Chebyshev(Mean, Std) UCL |
| NICKEL | 57/60 | 95% | 0.314 J | 3.6 | BEA-BG-SS-SSB-02-01 | 1.40 | 1.24 | 1.02 | 0.726 | 1.71 | NA(1) | Lognormal | 1.65 | H-UCL |
| POTASSIUM | 58/60 | 97% | 19.5 J | 570 | BEA-BG-SB-SSB-07-03 | 91.4 | 93.8 | 89.9 | 0.984 | 3.48 | NA(1) | Lognormal | 105 | H-UCL |
| **SELENIUM** | **20/60** | **33%** | **0.15** | **1.4** | **SCS-01_2-3** | **0.465** | **0.457** | **0.231** | **0.497** | **0.971** | **NA(1)** | **Non-parametric** | **0.595** | **95% Chebyshev(Mean, Std) UCL** |
| **SILVER** | **3/60** | **5%** | **0.14** | **0.986 J** | **SSA-02_0-1-AVG** | **0.702** | **0.643** | **0.502** | **0.714** | **-0.611** | **NA(1)** | **Non-parametric** | **0.99** | **Maximum Detection** |
| **SODIUM** | **17/60** | **28%** | **40 J** | **549** | **BEA-BG-SB-SSB-01-03** | **285** | **95.3** | **255** | **0.893** | **0.049** | **NA(1)** | **Non-parametric** | **491** | **97.5% Chebyshev(Mean, Std) UCL** |
| **THALLIUM** | **3/60** | **5%** | **0.379 J** | **0.682 J** | **SCS-04_0-1** | **0.442** | **0.482** | **0.418** | **0.947** | **0.697** | **NA(1)** | **Non-parametric** | **0.682** | **Maximum Detection** |
| VANADIUM | 60/60 | 100% | 1.33 J | 23.2 | SCS-01_2-3 | 5.88 | 5.88 | 4.16 | 0.709 | 2.66 | NA(1) | Non-parametric | 8.22 | 95% Chebyshev(Mean, Std) UCL |
| **ZINC** | **26/60** | **43%** | **1.6** | **18** | **BEA-BG-SS-SSB-02-01** | **3.43** | **5.61** | **3.72** | **1.09** | **2.19** | **NA(1)** | **Lognormal** | **4.27** | **H-UCL** |

**TABLE 5-1**

**REPRESENTATIVE CONCENTRATIONS - SSA, SSB, AND SCS SOIL CATEGORIES**
**BASEWIDE BACKGROUND STUDY**
**MCAS BEAUFORT, SOUTH CAROLINA**


| CHEMICAL | RAW STATISTICS | | | | | | | | | | DATA DISTRIBUTION | RECOMMENDED UCL ADJUSTED EPA'S ProUCL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FREQUENCY OF DETECTION | | MINIMUM DETECTION | MAXIMUM DETECTION | SAMPLE WITH MAXIMUM DETECTION | MEAN OF ALL SAMPLES | MEAN OF POSITIVE DETECTIONS | STANDARD DEVIATION | COEEFICIENT OF VARIATION | SKEWNESS | OUTLIER | | | |
| | NUMBER | PERCENT | | | | | | | | | | | | |
| **Miscellaneous Parameters** | | | | | | | | | | | | | | |
| CATION EXCHANGE CAPACITY (MEQ/100) | 60/60 | 100% | 0.46 J | 47.7 | SCS-07_0-1 | 12.7 | 12.7 | 12.6 | 0.991 | 1.39 | NA(1) | Gamma | 16.0 | Approximate Gamma 95% UCL |
| PERCENT SOLIDS (%) | 60/60 | 100% | 76 | 99 | SSA-01_2-3 | 88.2 | 88.2 | 4.27 | 0.048 | -0.603 | NA(1) | Non-parametric | 89.1 | Student-t or Modified-t UCL |
| PH (S.U.) | 60/60 | 100% | 3.63 | 8.1 | BEA-BG-SB-SSB-07-03, BEA-BG-SS-SSB-02-01 | 5.34 | 5.34 | 1.22 | 0.229 | 0.736 | NA(1) | Normal | 5.61 | Student-t |
| TOTAL ORGANIC CARBON (mg/kg) | 54/60 | 90% | 21 J | 30500 | BEA-BG-SS-SSB-04-01-AVG | 3909 | 4338 | 5485 | 1.40 | 2.51 | NA(1) | Gamma | 5509 | Adjusted Gamma 95% UCL |

**NOTES:**
Bolded shaded values indicate that frequency of detection is less than 50 percent.
For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.
Consistent with recent EPA and Navy background guidance, background range interpretation, as necessary, will be compared to site specific data instead of any statistically derived single backgorund number.

1 The Discordance Test could not be performed because there are more than 50 samples.
2 There are insufficient number of samples to perform statistics. Representative concentration will be the maximum detection.

Associated Samples

| | | |
|---|---|---|
| SSA-01_0-1-AVG | BEA-BG-SB-SSB-01-03 | SCS-01_0-1 |
| SSA-02_0-1-AVG | BEA-BG-SB-SSB-02-03 | SCS-02_0-1 |
| SSA-03_0-1-AVG | BEA-BG-SB-SSB-03-03 | SCS-03_0-1 |
| SSA-04_0-1-AVG | BEA-BG-SB-SSB-04-03 | SCS-04_0-1 |
| SSA-05_0-1 | BEA-BG-SB-SSB-05-03 | SCS-05_0-1 |
| SSA-06_0-1 | BEA-BG-SB-SSB-06-03 | SCS-06_0-1 |
| SSA-07_0-1 | BEA-BG-SB-SSB-07-03 | SCS-07_0-1 |
| SSA-08_0-1 | BEA-BG-SB-SSB-08-03 | SCS-08_0-1 |
| SSA-09_0-1 | BEA-BG-SB-SSB-09-03 | SCS-09_0-1 |
| SSA-10_0-1 | BEA-BG-SB-SSB-10-03 | SCS-10_0-1 |
| SSA-01_2-3 | BEA-BG-SS-SSB-01-01 | SCS-01_2-3 |
| SSA-02_2-3 | BEA-BG-SS-SSB-02-01 | SCS-02_2-3 |
| SSA-03_2-3 | BEA-BG-SS-SSB-03-01-AVG | SCS-03_2-3 |
| SSA-04_2-3 | BEA-BG-SS-SSB-04-01-AVG | SCS-04_2-3 |
| SSA-05_2-3 | BEA-BG-SS-SSB-05-01 | SCS-05_2-3 |
| SSA-06_2-3 | BEA-BG-SS-SSB-06-01 | SCS-06_2-3 |
| SSA-07_2-3 | BEA-BG-SS-SSB-07-01 | SCS-07_2-3 |
| SSA-08_2-3 | BEA-BG-SS-SSB-08-01 | SCS-08_2-3 |
| SSA-09_2-3 | BEA-BG-SS-SSB-09-01 | SCS-09_2-3 |
| SSA-10_2-3 | BEA-BG-SS-SSB-10-01 | SCS-10_2-3 |

**TABLE 5-2**

**REPRESENTATIVE CONCENTRATIONS - CSA SOIL CATEGORY**
**BASEWIDE BACKGROUND STUDY**
**MCAS BEAUFORT, SOUTH CAROLINA**

| CHEMICAL | RAW STATISTICS | | | | | | | | | | | | DATA DISTRIBUTION | RECOMMENDED UCL ADJUSTED EPA'S ProUCL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FREQUENCY OF DETECTION | | MINIMUM DETECTION | MAXIMUM DETECTION | SAMPLE WITH MAXIMUM DETECTION | MEAN OF ALL SAMPLES | MEAN OF POSITIVE DETECTIONS | MEDIAN | STANDARD DEVIATION | COEEFICIENT OF VARIATION | SKEWNESS | OUTLIER | | | |
| | NUMBER | PERCENT | | | | | | | | | | | | | |
| **Volatile Organics (ug/kg)** | | | | | | | | | | | | | | | |
| CARBON DISULFIDE | 10/10 | 100% | 2.7 J | 1400 J | CSA-06, CSA-07 | 687 | 687 | 740 | 535 | 0.779 | 0.118 | - - | Normal | 998 | Student-t |
| **METHYL ACETATE** | **1/10** | **10%** | **3.3 J** | **3.3 J** | **CSA-01-AVG** | **6.07** | **3.30** | **5.50** | **2.57** | **0.423** | **0.173** | **ND(1)** | **Normal** | **3.3(2)** | **Maximum Detection** |
| **Pesticides PCBs (ug/kg)** | | | | | | | | | | | | | | | |
| **ENDRIN KETONE** | **3/10** | **30%** | **12.9 J** | **76.5 J** | **CSA-10** | **12.7** | **34.9** | **3.66** | **22.9** | **1.81** | **2.94** | **Yes** | **Non-parametric** | **57.9** | **97.5% Chebyshev(Mean, Std) UCL** |
| **METHOXYCHLOR** | **2/10** | **20%** | **22.4 J** | **362 J** | **CSA-10** | **50.9** | **192** | **16.8** | **109** | **2.15** | **3.16** | **Yes** | **Non-parametric** | **362(2)** | **Maximum Detection** |
| **Inorganics (mg/kg)** | | | | | | | | | | | | | | | |
| ALUMINUM | 10/10 | 100% | 938 J | 7090 | CSA-07 | 3563 | 3563 | 2985 | 2507 | 0.704 | 0.400 | - - | Gamma | 5803 | Approximate Gamma 95% UCL |
| ARSENIC | 6/10 | 60% | 0.99 J | 5.66 | CSA-07 | 2.99 | 3.75 | 2.29 | 1.72 | 0.575 | 0.580 | - - | Normal | 3.98 | Student-t |
| BARIUM | 10/10 | 100% | 2.23 J | 18.6 J | CSA-04 | 7.91 | 7.91 | 7.11 | 5.17 | 0.654 | 0.948 | - - | Normal | 10.9 | Student-t |
| **BERYLLIUM** | **4/10** | **40%** | **0.165 J** | **0.416 J** | **CSA-07** | **0.641** | **0.337** | **0.678** | **0.314** | **0.489** | **0.283** | **ND(1)** | **Normal** | **0.416(2)** | **Maximum Detection** |
| CALCIUM | 10/10 | 100% | 387 J | 1960 J | CSA-05 | 1092 | 1092 | 1145 | 518 | 0.474 | 0.165 | - - | Normal | 1392 | Student-t |
| CHROMIUM | 10/10 | 100% | 1.52 J | 13.7 | CSA-08 | 6.48 | 6.48 | 5.22 | 4.77 | 0.736 | 0.526 | - - | Normal | 9.25 | Student-t |
| COBALT | 8/10 | 80% | 0.261 J | 2.33 J | CSA-07 | 2.28 | 1.03 | 1.26 | 2.76 | 1.21 | 1.57 | ND(1) | Gamma | 4.86 | Approximate Gamma 95% UCL |
| COPPER | 10/10 | 100% | 1.66 J | 23 | CSA-03 | 6.69 | 6.69 | 4.52 | 6.75 | 1.01 | 1.84 | Yes | Gamma | 12.1 | Approximate Gamma 95% UCL |
| IRON | 10/10 | 100% | 493.5 | 10200 | CSA-07 | 4447 | 4447 | 2795 | 3644 | 0.819 | 0.557 | - - | Normal | 6560 | Student-t |
| LEAD | 10/10 | 100% | 1.49 | 12.7 | CSA-06 | 6.00 | 6.00 | 5.08 | 3.44 | 0.572 | 0.779 | - - | Normal | 7.99 | Student-t |
| MAGNESIUM | 10/10 | 100% | 348 J | 3400 | CSA-06 | 1790 | 1790 | 1645 | 1093 | 0.611 | 0.257 | - - | Normal | 2423 | Student-t |
| MANGANESE | 10/10 | 100% | 4.44 J | 67.9 | CSA-08 | 22.8 | 22.8 | 11.8 | 22.4 | 0.981 | 1.17 | - - | Gamma | 43.1 | Approximate Gamma 95% UCL |
| MERCURY | 10/10 | 100% | 0.027 J | 0.29 | CSA-04 | 0.140 | 0.140 | 0.151 | 0.085 | 0.608 | 0.140 | - - | Normal | 0.190 | Student-t |
| NICKEL | 10/10 | 100% | 0.5005 J | 3.97 J | CSA-07 | 1.71 | 1.71 | 1.21 | 1.24 | 0.728 | 0.927 | - - | Normal | 2.43 | Student-t |
| POTASSIUM | 10/10 | 100% | 134 J | 2060 J | CSA-08 | 945 | 945 | 539 | 760 | 0.804 | 0.474 | - - | Gamma | 1671 | Approximate Gamma 95% UCL |
| **SELENIUM** | **3/10** | **30%** | **1.12 J** | **1.67 J** | **CSA-08** | **1.03** | **1.47** | **0.953** | **0.371** | **0.360** | **0.869** | **- -** | **Normal** | **1.54** | **95% Chebyshev(Mean,Std)** |
| SODIUM | 10/10 | 100% | 135 J | 14900 J | CSA-06 | 6551 | 6551 | 4863 | 4583 | 0.700 | 0.540 | - - | Normal | 9208 | Student-t |
| VANADIUM | 10/10 | 100% | 2.53 J | 22.7 | CSA-07 | 9.99 | 9.99 | 8.13 | 7.41 | 0.742 | 0.594 | - - | Normal | 14.3 | Student-t |
| ZINC | 10/10 | 100% | 3.825 J | 55.2 | CSA-07 | 20.4 | 20.4 | 16.0 | 19.3 | 0.947 | 1.11 | - - | Gamma | 38.4 | Approximate Gamma 95% UCL |
| **Miscellaneous Parameters** | | | | | | | | | | | | | | | |
| CATION EXCHANGE CAPACITY (MEQ/100) | 10/10 | 100% | 27.5 J | 76.4 | CSA-05 | 47.0 | 47.0 | 44.8 | 14.9 | 0.316 | 0.688 | - - | Normal | 55.6 | Student-t |
| PERCENT SOLIDS (%) | 10/10 | 100% | 42 | 72 | CSA-04, CSA-10 | 56.2 | 56.2 | 55.0 | 11.6 | 0.207 | 0.337 | - - | Normal | 62.9 | Student-t |
| PH (S.U.) | 10/10 | 100% | 5.995 | 7.66 | CSA-06 | 6.66 | 6.66 | 6.60 | 0.529 | 0.079 | 0.493 | - - | Normal | 6.97 | Student-t |
| TOTAL ORGANIC CARBON (mg/kg) | 10/10 | 100% | 8900 | 64000 | CSA-05 | 26840 | 26840 | 21500 | 20126 | 0.750 | 1.35 | - - | Gamma | 41816 | Approximate Gamma 95% UCL |

**NOTES:**
Bolded shaded values indicate that frequency of detection is less than 50 percent.
For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.
The Discordance Outlier test assumes normality after the maximum concentration is removed. The Discordance Test does not test for multiple outliers.

1 The highest concentration is a nondetected value. The Discordance Test could not be performed
2 The recommended UCL exceeds the maximum concentration. The maximum concentration is selected as the representative concentration.

Associated Samples
CSA-01-AVG
CSA-02
CSA-03
CSA-04
CSA-05
CSA-06
CSA-07
CSA-08
CSA-09
CSA-10