Final
Remedial Investigation Work Plan

Formerly Used Defense Site (FUDS)
Military Munitions Response Program

September 2016
Revision 00

STROTHER FIELD DISPOSAL AREA
Crowley County, Kansas
FUDS Property Number: B07KS0277
FUDS Project Number: B07KS027703

U.S. Army Corps of Engineers – Kansas City District

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ACRONYMS AND ABBREVIATIONS

%..... percent
°C..... degrees Celsius
°F ..... degrees Fahrenheit
95% UCL..... 95 percent Upper Confidence Level
AFB ..... Air Force Base
AFLU..... anticipated future land use
APP..... Accident Prevention Plan
AR ..... Administrative Record
ARAR ..... Applicable or Relevant and Appropriate Requirement
ASR..... Archives Search Report
ATF ..... Bureau of Alcohol, Tobacco, Firearms, and Explosives
AUF..... area use factor
Bay West..... Bay West LLC
BCF..... bioconcentration factor
BERA ..... baseline ecological risk assessment
bgs ..... below ground surface
BJC ..... Bechtel Jacobs Company LLC
BSAF..... biota sediment accumulation factor
BSI ..... blind seed item
BTAG ..... Biological Technical Assistance Group
bw ..... body weight
C&C ..... Command and Control
CERCLA ..... Comprehensive Environmental Response, Compensation and Liability Act
CFR..... Code of Federal Regulations
CIH..... Certified Industrial Hygienist
cm ..... centimeter
CoC..... chain of custody
COPC..... chemical of potential concern
COPEC ..... chemical of potential ecological concern
COR ..... Contracting Officer's Representative
CPSS ..... Certified Professional Soil Scientist
CQC ..... Contractor Quality Control
CRP ..... Community Relations Plan
CRS ..... Community Relations Specialist
CSM ..... conceptual site model
CSP..... Certified Safety Professional
DD ..... decision document
DDESB..... Department of Defense Explosives Safety Board
DERP ..... Defense Environmental Restoration Program
DFW..... definable features of work
DGM..... Digital Geophysical Mapping
DGPS ..... Differential Global Positioning System
DI..... deionized
DMM..... discarded military munitions
DMT ..... Data Management Tool
DoD ..... Department of Defense
DQCR..... Daily Quality Control Report
DQI..... Data Quality Indicator
DQO ..... Data Quality Objective
DTL ..... Design Center Technical Lead
DU ..... decision unit
dw..... dry weight
Eco-SSL ..... Ecological Soil Screening Level
EESOH-MIS .... Enterprise, Environmental, Safety and Occupational Health – Management Information System
ELAP ..... Environmental Laboratory Accreditation Program
EM..... Engineering Manual
EMM..... earth-moving machinery
EOD ..... explosive ordnance disposal
EPC..... exposure point concentration
EPP ..... Environmental Protection Plan
ERA..... Ecological Risk Assessment
ERAGS..... Ecological Risk Assessment Guidance for Superfund
ESP ..... Explosives Site Plan
ESTCP ..... Environmental Security Technology Certification Program
ESV ..... ecological screening value
EZ..... exclusion zone
FCA ..... function check area
FCR..... Field Change Request
FS..... Feasibility Study

ft ..... foot or feet
FUDS ..... Formerly Used Defense Site
g DMI/day..... gram of dry matter intake per day
g ..... gram(s)
g/g-day ..... grams water per grams body weight per day
GPS ..... Global Positioning System
GSV ..... Geophysical System Verification
HAZWOPER ... Hazardous waste operations and emergency response
HDPE ..... high density polyethylene
HEAST ..... Health Effects Assessment Summary Table
HHRA..... Human Health Risk Assessment
HI ..... Hazard Index
HPLC ..... high-performance liquid chromatography
HQ..... Hazard Quotient
HSM ..... Health and Safety Manager
IAW ..... in accordance with
IDW ..... investigation-derived waste
IEP ..... Important Ecological Place
ILCR ..... incremental lifetime cancer risk
IME..... Institute of Makers of Explosives
IR ..... Information Repository
IRIS ..... Integrated Risk Information System
ISM..... incremental sampling methodology
ISO..... Industry Standard Object
IVS ..... Instrument Verification Strip
KDWPT ..... Kansas Department of Wildlife, Parks and Tourism
kg ..... kilogram
KGS ..... Kansas Geological Survey
km ..... kilometer
KO..... Contracting Officer
KSHPO ..... Kansas State Historical Preservation Office
L/day ..... liters per day
LANL ..... Los Alamos National Laboratory
lb(s) ..... pound(s)
LLP..... Lessons Learned Program
LOAEL..... lowest observed adverse effects level
LQAP..... Laboratory Quality Assurance Plan
m ..... meter(s)
MC..... munitions constituents
MD..... munitions debris
MDAS..... material documented as safe
MEC ..... munitions and explosives of concern
mg/kg ..... milligrams per kilogram
mL ..... milliliter
MMRP ..... Military Munitions Response Program
MPC ..... Measurement Performance Criteria
MPPEH ..... material potentially presenting an explosive hazard
MRS ..... munitions response site
MRSPP ..... Munitions Response Site Prioritization Protocol
MS/MSD..... matrix spike/matrix spike duplicate
NAD83..... North American Datum 83
NCP..... National Oil and Hazardous Substances Pollution Contingency Plan
NFA ..... no further action
NFPA..... National Fire Protection Agency
NMRD ..... non-munitions related debris
NOAEL ..... no observed adverse effects level
NRL ..... Naval Research Laboratory
OESS ..... Ordnance and Explosives Safety Specialist
ORNL ..... Oak Ridge National Laboratory
OSHA ..... Occupational Safety and Health Administration
oz ..... ounce/ounces
PAL ..... project action level
PAO..... Public Affairs Officer
PDT ..... Project Delivery Team
PE ..... Professional Engineer
PEC..... probable effect concentration
PG ..... Professional Geologist
PGeo ..... Project Geophysicist
PGM ..... Program Manager

PM..... Project Manager
PMP ..... Project Management Plan
POC ..... point of contact
PP ..... Proposed Plan
PPE..... personal protective equipment
PPRTV ..... Provisional Peer Review Toxicity Value
PWS..... Performance Work Statement
QA..... quality assurance
QAPP ..... Quality Assurance Project Plan
QC..... quality control
QCS ..... quality control systems
RA ..... Risk Assessor
RACER ..... Remedial Action Cost Engineering and Requirements
RAGS..... Risk Assessment Guidance for Superfund
RBC ..... risk-based concentrations
RCA ..... Root Cause Analysis
RCWM ..... recovered chemical warfare materiel
RI ..... Remedial Investigation
RME ..... reasonable maximum exposure
RS ..... Regulatory Specialist
RSK..... Risk-Based Standard for Kansas
RSL ..... Regional Screening Level
RTK..... Real-Time Kinematic
SARA ..... Superfunds Amendments and Reauthorization Act
SEDD ..... Staged Electronic Data Deliverable
SI..... site inspection
SLERA ..... screening level ecological risk assessment
SMDP..... several scientific and management decision point
SOP..... Standard Operating Procedure
SSHP ..... Site Safety and Health Plan
SUXOS..... Senior UXO Supervisor
TAL..... TestAmerica Laboratories, Inc.
TBD ..... to be determined
Tetra Tech..... Tetra Tech, Inc.
TM ..... technical manual
TO ..... Task Order
TP..... technical paper
TPP ..... technical project planning
TRV ..... toxicity reference value
U.S. ..... United States
UFP–QAPP ..... Uniform Federal Policy for Quality Assurance Project Plan
USACE..... U.S. Army Corps of Engineers
USACHPPM.... U.S. Army Center for Health Promotion and Preventive Medicine
USDA ..... U.S. Department of Agriculture
USEPA..... U.S. Environmental Protection Agency
USFWS ..... U.S. Fish and Wildlife Service
UTM ..... Universal Transverse Mercator
UXO ..... unexploded ordnance
UXOQCS..... UXO Quality Control Specialist
UXOSO ..... UXO Safety Officer
VSP ..... Visual Sample Plan
VTA ..... vehicle towed array
Weston..... Weston Solutions, Inc.
WP ..... work plan

1.0 INTRODUCTION

1.1 Project Authorization

Bay West LLC (Bay West), with our principal subcontractors Weston Solutions, Inc. (Weston), and Tetra Tech, Inc. (Tetra Tech), referred to as the Bay West Team, will conduct a Remedial Investigation (RI) at the Strother Field Formerly Used Defense Sites (FUDS) located in Crowley County, Kansas (**Figure 1-1**). The RI is specific to the Disposal Area Munitions Responose Site (MRS) (**Figure 1-2** and **Figure 1-3**) at the FUDS and will be performed in accordance with (IAW) the Defense Environmental Restoration Program (DERP) for FUDS, Military Munitions Response Program (MMRP), and the Performance Work Statement (PWS) for the Task Order (TO) dated May 2015. The RI is for the United States Army Corps of Engineers (USACE) – Kansas City District under USACE – Omaha District Contract W9128F-10-D-0054, TO 0023.

The Bay West Team will perform all aspects of the project IAW the approved work plan (WP) in an environmentally acceptable manner conforming to the existing federal, state, and local regulations. The MMRP, implemented under the DERP FUDS, follows processes outlined in Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Per the NCP, on-site actions do not require Federal, State, or local permits but substantive requirements must be met.

This WP outlines the means and methods for the RI at the Strother Field FUDS. Activities that may present munitions and explosives of concern (MEC) hazards are required to comply with the Department of Defense (DoD), U.S. Army, and USACE requirements regarding personnel, equipment, and procedures. The following appendices are provided to support specific aspects of the work to be performed:

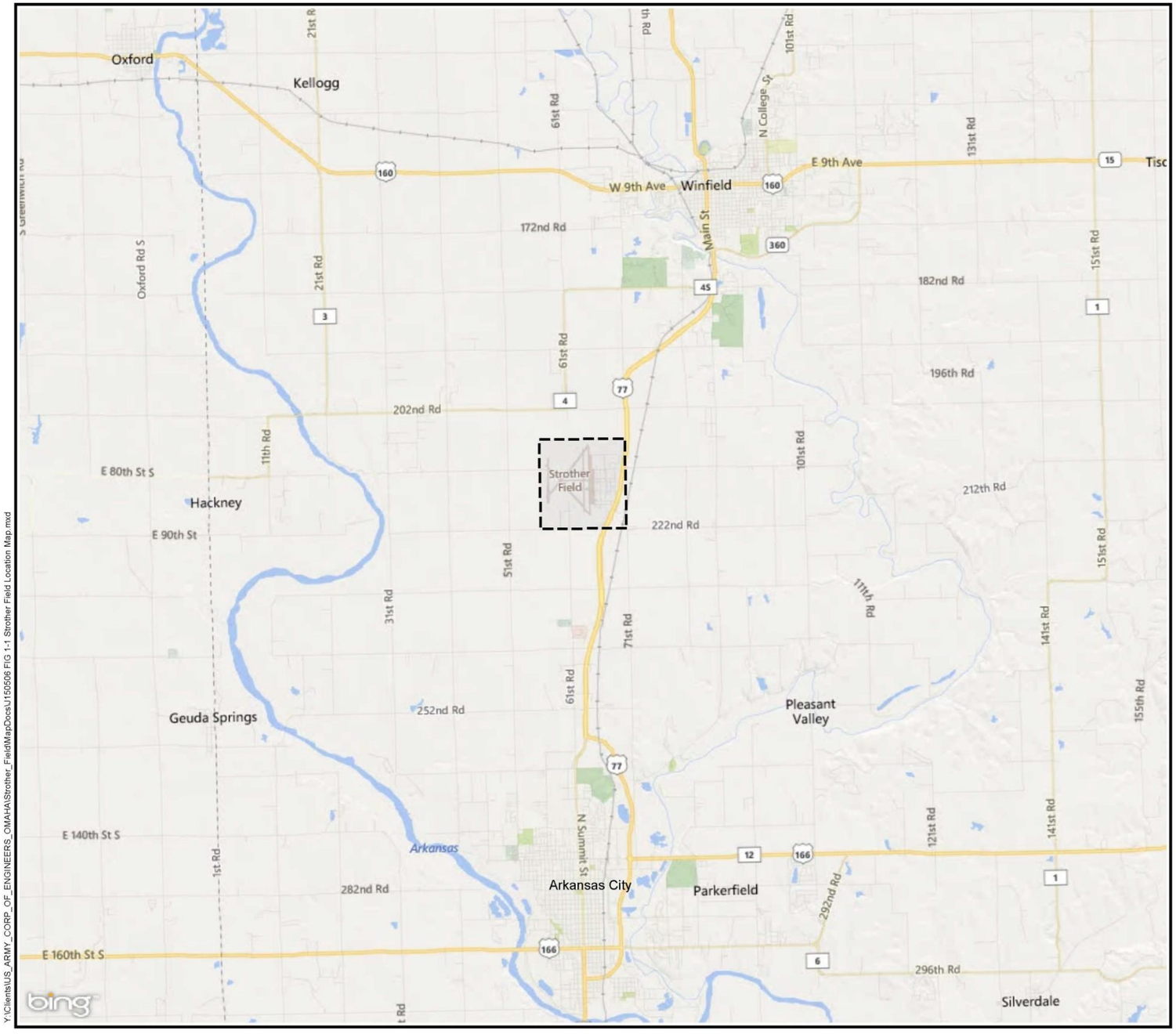
- Appendix A: Accident Prevention Plan/Site Safety and Health Plan (APP/SSHP)
- Appendix B: Quality Assurance Project Plan (QAPP)
- Appendix C: Field Forms (provided on enclosed disc)
- Appendix D: Standard Operating Procedures (SOPs)
- Appendix E: Contractor Personnel Qualification Letters (provided upon mobilization)
- Appendix F: Correspondence

Both a Community Relations Plan (available in the Administrative Record [AR] file and local Information Repositories [IRs]) and an Explosives Site Plan (ESP) have been finalized under separate cover to support RI activities at the Disposal Area MRS.

1.2 Purpose and Scope

The purpose of the RI is to determine the nature and extent of potential contaminants and to evaluate if unacceptable risks and hazards exist at the MRS through site characterization and risk assessment activities. Risk assessment includes evaluation of explosives hazards posed by MEC and human health or ecological risks posed by munitions constituents (MC) by conducting traditional risk assessment evaluations.

The RI provides a means to proceed from a position of limited information about a site to one of sufficient information such that assessment of potential risk and, if necessary, selection of a cost-effective and technically feasible method to reduce risk is achievable. The RI results allow stakeholders to select and evaluate munitions response alternatives that are protective given current or anticipated future land use (AFLU).

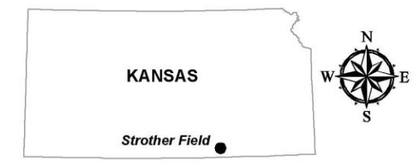


Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_OMAHA\Strother_Field\MapDocs\J150506 FIG 1-1 Strother Field Location Map.mxd

Figure 1-1

Strother Field Location Map

Strother Field FUDS
Cowley County, Kansas
FUDS Property No. B07KS0277

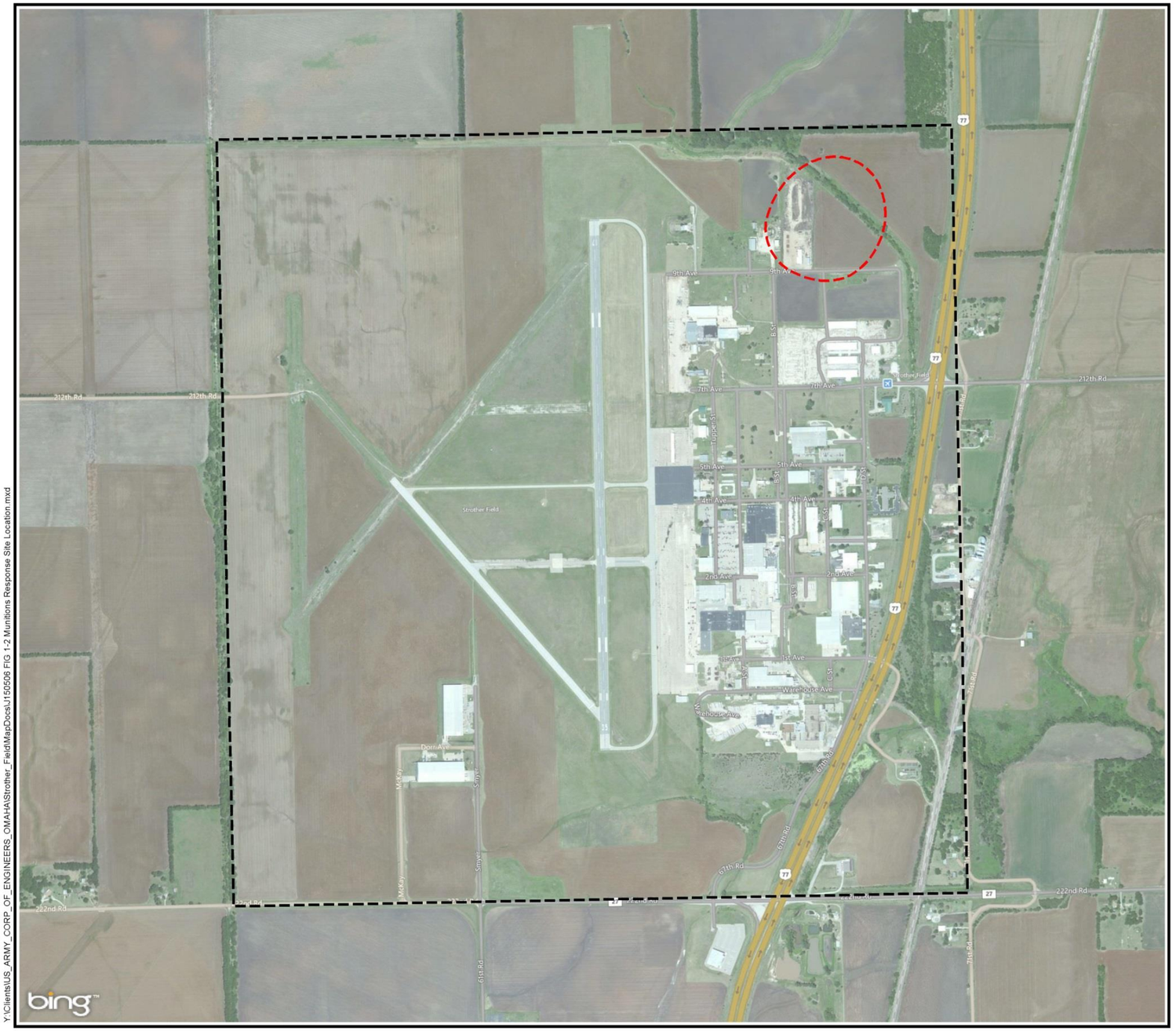


Coordinate System: NAD 1983 UTM Zone 14N
Basemap: National Geographic Society, i-cubed

0 10,000 20,000 Feet
0 3,000 6,000 Meters
1 inch = 8,506 feet

Strother Field FUDS - Installation Boundary

Drawn By: S.G. Date Drawn/Revised: 5/11/2016 Project No: J150506



Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_OMAHA\Strother_Field\MapDocs\J150506 FIG 1-2 Munitions Response Site Location.mxd

Figure 1-2

Strother Field Disposal Area MRS Location Map

Strother Field FUDS
Cowley County, Kansas
FUDS Property No. B07KS0277

Coordinate System: NAD 1983 UTM Zone 14N
Basemap: Bing Aerial Imagery WMS

0 1,000 2,000 Feet
0 300 600 Meters

1 inch = 1,000 feet

Disposal Area MRS Boundary
Strother Field FUDS - Installation Boundary

Drawn By: S.G. Date Drawn/Revised: 12/23/2015 Project No. J150506

Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_OMAHA\Strother_Field\MapDocs\J150506 FIG 1-3 Munitions Response Site.mxd

Figure 1-3

Munitions Response Site

Strother Field FUDS
Cowley County, Kansas
FUDS Property No. B07KS0277

Coordinate System: NAD 1983 UTM Zone 14N
Basemap: Bign Aerial Imagery WMS

0 150 300 Feet
0 50 100 Meters
1 inch = 150 feet

Disposal Area MRS Boundary

Drawn By: S.G. Date Drawn/Revised: 12/23/2015 Project No. J150506

Alternatives will be evaluated in a Feasibility Study (FS) prepared under this TO, following the RI. A Proposed Plan (PP) and Decision Document (DD) will also be prepared for the Strother Field FUDS under this TO.

1.3 Data Requirements

In general, data collected during the RI will include:

- Visual surveys to identify MEC on the surface, if present;
- Digital geophysical mapping (DGM) surveys to identify subsurface anomalies;
- Intrusive investigation of selected anomalies that represent potential MEC;
- Analog detector investigation with intrusive investigation (i.e., mag and dig) of areas that are inaccessible to DGM equipment; and
- Collection and analysis of environmental samples if a new potential source for MC is found.

Data collected during the RI field effort will be analyzed and serve as the input for explosives hazard and environmental risk assessment.

The detailed project problem definition and project objectives are described in **Section 3.5** below are part of the data quality objective (DQOs) for RI activities.

1.4 Changes to the Work Plan

The activities described in this WP are based on careful evaluation of the best information currently available. However, during execution of the work, unforeseen circumstances or events may arise that require modification to the procedures. Modification to procedures described herein will be coordinated with the stakeholders prior to implementation of changes.

Changes to the WP will be identified through the use of Field Change Requests (FCRs). FCRs will be routed through the USACE Kansas City District for coordination with regulatory agencies as needed. Approved changes will be transmitted to all plan holders by way of change pages.

2.0 SITE BACKGROUND AND EXISTING CONDITIONS

The following sections provide background information specific to the Strother Field FUDS and discuss information specific to the Disposal Area MRS considered in this WP.

2.1 Facility Description

The former Strother Field, FUDS property number B07KS0277, is located approximately 5 miles south of Winfield and 6 miles north of Arkansas City in Crowley County, Kansas. Strother Field was initially commissioned in 1942 and used primarily for basic Air Corps cadet training. Four auxiliary landing fields were associated with Strother Field (#1, #2, #3, and #5) and used primarily for emergency and touch-and-go landings.

In 1944, the installation became a fighter pilot training station. Training included expanded instrument training, and strafing and bombing practice, which was physically conducted not at Strother Field but at the auxiliary airfields. The property was declared surplus in January 1946 and conveyed to the cities of Winfield and Arkansas City in May 1948 (USACE, 2006a).

The cities of Winfield and Arkansas City own the majority of the property. Most of the FUDS property is occupied by the Strother Field Airport and Industrial Park, which are managed by the Strother Field Commission representing Arkansas City and Winfield. The Industrial Park covers the majority of the former base cantonment area. The remaining portions of the FUDS property are privately owned.

The Industrial Park has hosted a variety of industries, including a jet engine overhaul facility, a beer distributor, a driver's license office, and other manufacturers. There is no residential property use. Non-industrial portions of the property are used for agricultural production (USACE, 2006a).

2.2 Disposal Area Description

In general, Strother Field was used from 1942 to 1946; however, years of use for the Disposal Area are unknown. The Disposal Area MRS is primarily located within a former small arms training and skeet range identified during the Archives Search Report (ASR). There are no access restrictions at the Disposal Area and a majority of the Disposal Area MRS has been plowed without a reported incident for more than 50 years.

There is no historical information available for the Disposal Area MRS. One interviewee in the ASR indicated he had heard reports of burial sites at Strother Field, but specific locations were never identified. Aerial photographs evaluated during the ASR indicated only features related to the skeet range were observed in the area; there was no evidence of disturbance related to other activities. Thus, the existence of the Disposal Area was unknown prior to the site inspection (SI) fieldwork performed in 2009.

2.3 Regional Setting

2.3.1 Topography and Vegetation

Strother Field is located in the Flint Hills physiographic region of Kansas, an area of flat-topped hills, limestone outcrops, long, steep slopes, and valleys covered with natural prairie grasses formed by erosion of Permian-age limestones and shales. Streams in the Flint Hills cut deep, precipitous channels.

The Flint Hills are still largely native prairie grassland, one of the last great preserves of tallgrass prairie in the country. The tall grasses in this region are mostly big and little bluestem, switch grass, and Indian grass. Trees are rare, except along stream and river bottoms (Kansas Geological Survey [KGS], 1999).

The topographic slope is generally from the north to the southeast. The topography observed by the SI field team was generally flat throughout, with a steep drop to Posey Creek. Some slight depressions were observed in the plowed fields as evidenced by the pooled rainwater in several areas. However, the topography of the Disposal Area was described as flat (USACE, 2010a)

Vegetation on a large portion of the MRS is planted crops, predominantly winter wheat. Small areas of prairie grasses were observed adjacent to but outside the plowed field areas. Large-growth trees were observed in scattered areas throughout the industrial park, except along Posey Creek where a relatively dense band of trees and shrubs grow along the banks. Other vegetated areas within the industrial park consist of mowed grasses (USACE, 2010a).

2.3.2 Climate

Summers are warm, with the majority of the annual precipitation occurring during this season. Winters tend to be cold with an occasional mild spell and moderate snowfall amounts. At Winfield, Kansas, approximately 5 miles to the north, mean precipitation is 37.6 inches per year, based on data from 1971 to 2000. Mean monthly temperatures range from 30.6 degrees Fahrenheit (°F) in January to 80.5°F in July (USACE, 2010a).

2.3.3 Hydrology

Strother Field is underlain by the Flint Hills aquifer, which consists of the Permian limestones in the Chase and Council Grove Groups. The limestone aquifers in these rock units are sources of water for many springs and for public water supply throughout the Flint Hills region. Locally, well yields are estimated at up to 1,000 gallons per minute from the limestones in this aquifer.

Groundwater recharge takes place where aquifers outcrop to the east, and water moves down the regional bedrock dip toward the west. The bedrock aquifers are separated by thick, relatively impermeable shale units, leading to confined conditions. Typically, the water source for most domestic and stock wells in the Flint Hills aquifer includes about 30 to 50 feet (ft) of limestone.

The major source of groundwater for Strother Field is an alluvial aquifer comprised of sand and gravel. Groundwater is generally encountered at a depth of 18 to 23 ft below ground surface (bgs) and aquifer thickness varies in the area. Thickness of the sand and gravel deposits ranges from 7 to 28 ft beneath the FUDS. The general groundwater flow direction in the alluvial aquifer is northwest to southeast. Well completion records indicate depth to groundwater in wells at the FUDS ranges from 7 to 34 ft bgs and lithologic logs indicate the wells are installed in clay and sand (USACE, 2010a).

While the general topography of the site slopes from north to southeast, a swale (low area) intersects the FUDS south of the current Posey Creek channel. The swale appears to conform to what was the original channel of Posey Creek, which was re-routed by the Army in the 1940s. Surface runoff from aircraft-related industries at the FUDS either flows into this swale, to an open drainage ditch parallel to the railroad spur, or to storm sewer inlets (U.S. Environmental Protection Agency [USEPA], 1994a).

Posey Creek runs along the eastern FUDS border and drains into the Walnut River. In the past, the Strother Field Sewage Treatment Plant and an industrial cooling tower near the central portion of the industrial park supplied water to Posey Creek. Posey Creek becomes a natural perennial stream approximately 1.5 miles downstream of the FUDS, where it begins to intersect an alluvial aquifer that contributes base flow to the creek. The swale, drainage ditches, and the storm sewer all flow to Posey Creek at the southeastern corner of the FUDS (USEPA, 1994a).

The Disposal Area MRS is situated within the FUDS such that Posey Creek traverses through the northeast portion of the MRS. During the SI, the field team observed groundwater remediation wells and treatment systems in the northern portion of the FUDS were no longer in

use and were not supplying water to Posey Creek. As a result, sections of Posey Creek held stagnant water that likely flows only during high rainfall events (i.e., ephemeral stream). No surface water was present within the Disposal Area MRS during the SI fieldwork performed in October 2009 (USACE, 2010a).

2.3.4 Soil and Vegetation Types

Soil types are primarily loams including silt and silty clay loams. The most common soil types present in the Strother Field area are the Tabler silty clay loam and Bethany silt loam. The Tabler silty clay loam is a moderately well-drained soil that forms from alcareous clayey alluvium on slopes of 0 to 1 percent (%). The saturated hydraulic conductivity is very low to moderately low. The typical profile is clay loam from 0 to 8 inches and silty clay from 8 to 60 inches.

The Bethany silt loam is a well-drained soil that forms from clayey loess over old clayey alluvium on slopes of 1 to 3%. Saturated hydraulic conductivity is moderately low to moderately high. The typical profile is silt loam from 0 to 9 inches, silty clay loam from 9 to 16 inches, silty clay from 16 to 36 inches, and silty clay loam from 36 to 60 inches (U.S. Department of Agriculture [USDA], 2009).

Surface soil observed by the SI field team was soft clayey silt, dark brown to black, with low to medium plasticity. During the sampling effort, surface soils were very moist from recent rainfall. The Unified Soil Classification Code for the surface soil is ML, low plasticity silt (USACE, 2010a).

2.3.5 Sensitive Environments

Prior to the SI Fieldwork, the U.S. Fish and Wildlife Service (USFWS) and Kansas Department of Wildlife, Parks and Tourism (KDWPT) were contacted concerning Important Ecological Places (IEPs) and threatened or endangered species that might be present at Strother Field. Although Cowley County is home to 13 federal and state threatened and endangered species, neither agency indicated any areas of the Strother Field FUDS are managed for ecological purposes or qualified as IEPs or sensitive environments (USACE, 2010a). A similar assessment was performed for the RI, and similarly, no adverse effects from planned RI activites were identified (see **Section 12.1**).

The Kansas State Historical Preservation Office (KSHPO) reviewed its cultural resources files and indicated the former Strother Field is in an upland area of low archaeological potential. KSHPO also indicated that because the site is located in a formerly cultivated area, sampling activities were not likely to pose a threat to any intact cultural deposits and had little potential to impact standing structures that might be eligible for National Register listing. KSHPO concluded the proposed SI sampling activities would have no effect on historic properties (USACE, 2010a). A similar assessment was performed for the RI, and similarly, no adverse effects from planned RI activites were identified (see **Section 12.2**).

2.4 Previous Investigations

2.4.1 Inventory Project Report – 1994

USACE completed the Inventory Project Report in April 1994. The report determined the property was formerly used by DoD and therefore eligible under the Defense Environmental Restoration Program as a FUDS. One potential project was identified as an “Ordnance and Explosive Waste” project (USACE, 1994).

2.4.2 Archive Search Report – 2006

USACE completed an ASR in 2006. Ordnance facilities documented at Strother Field included a small arms storage building, an ammunition magazine, a skeet range, and a pistol range. No

records were found indicating the specific types of munitions used or stored at the property, or in which building they were stored. Former base personnel indicated only small arms munitions were used or stored at the FUDS during the basic flight training mission. When the installation became a fighter pilot training station, practice bombs and spotting charges may have been stored at the site. However, no documentation of other conventional munitions was found (USACE, 2006a).

2.4.3 Site Investigation – 2010

USACE completed an MMRP SI at the FUDS in 2010. During the October 2009 field effort for the SI, a visual reconnaissance was conducted to find evidence of former range activity (e.g., surface debris, stressed vegetation). The visual reconnaissance was supplemented with an all-metal detector to identify any metallic items present. The field team observed munitions debris (MD) and potential MEC associated with AN-M50 and AN-M54 incendiary bombs (12 items) and M15 white phosphorous smoke hand grenades (two items). The MD and potential MEC items were concentrated in an approximately 2-acre area.

Upon initial discovery, none of the items were believed to be MEC. After further research, the unexploded ordnance (UXO) technician determined one of the items was a portion of one AN-M50 incendiary bomb large enough to contain the first fire mixture, primer, and thermite, indicating the item could be MEC. The item was not confirmed as MEC but it was treated as such as a precaution.

The Explosive Ordnance Disposal (EOD) Unit from McConnell Air Force Base (AFB) in Wichita, Kansas, responded and confirmed the identification of the AN-M50 incendiary bomb, but they could not confirm the item was MEC. The EOD Unit transported the item to the eastern portion of the FUDS, where it was destroyed among rubble piles from former runways.

Historical documentation does not indicate use of the 4-pound (lb) incendiary bombs or any smoke hand grenades at the FUDS; therefore, it is presumed the area was used for munitions disposal rather than as a target range or training area given the mixed nature of the munitions and the proximity to the airfield cantonment area.

The SI recommended the Disposal Area be added to the MRS Inventory, with a size of approximately 28.3 acres as defined by the fragmentation distances of the munitions identified during the SI. The center of the Disposal Area is at Universal Transverse Mercator (UTM) coordinates [(Zone 14N, NAD 83), X=675077 (East), Y=4116343 (North)] (USACE, 2010a).

The remaining FUDS property encompassing the former skeet and pistol sub-ranges, referenced as the Range Complex No. 1 MRS during the SI, was recommended for no further action with respect to MEC and MC.

3.0 CONCEPTUAL SITE MODEL AND DATA QUALITY OBJECTIVES

The Conceptual Site Model (CSM) is developed to address potential MEC or MC contamination. The CSM is a description of the site and its environment based on existing knowledge. It describes potential contamination sources, possible receptors, and interactions that link them.

The CSM is intended to assist in planning, interpreting data, and communicating. As a planning tool, the CSM is used to integrate information from a variety of resources, to evaluate the information with respect to project objectives and data needs, and to evolve through an iterative process of further data collection or action.

3.1 Current and Future Land Use

The breakdown of the current land usage within the MRS is as follows:

- Cultivated Crop Area – 15.32 acres
- Industrial Facilities (includes open storage areas) – 8.80 acres
- Posey Creek (non-farmable banks and creek bed) – 3.30 acres
- Roadways (i.e., Ninth Avenue) – 0.94 acres

Future land use is expected to remain the same as the current land use. The expansion or contraction of the Industrial Facilities portion of the MRS is possible but the area contains a large amount of open storage area, some of which could support new facility construction without impacting the adjacent farmable property.

3.2 MEC

The MEC exposure analysis compiles all known information into an illustration of exposure pathways. The MEC CSM document divides the analysis into four components: source, activity, access, and receptor. Each component is briefly discussed in the following sections.

The MEC CSM is provided on **Figure 3-1** and is based on site-specific information obtained through the ASR and SI. The MEC CSM will be re-evaluated and revised as appropriate following analysis of the RI results.

3.2.1 Source

MEC exposure pathways for the Disposal Area MRS are shown on **Figure 3-1**. Exposure pathways take into account site access, MEC location, possible activities at the site, and the possible current and future site receptors.

No documentation was discovered to indicate the MRS was a target or impact area. The suspect MEC and MD items found to date are concentrated in a small area. Therefore, the CSM assumes the most probable source for MEC, if present, is a shallow burial pit or trench. More than one such trench is possible.

3.2.2 Activity

The hazard from MEC arises from direct contact due to human activity. This human activity is moving or somehow disturbing MEC, causing it to detonate. This could occur during cultivation of the area currently farmed, during future construction activities requiring excavation in the industrial areas, or due to potential exposure of MEC due to erosion or another event.

3.2.3 Access

The Strother Field FUDS property does not belong to the Government. Access to the Disposal Area is granted through the Strother Field Commission and by private landowners. The MRS is not restricted by any physical controls so public access is not impeded. A public roadway (Ninth

Avenue) transects the southern portion of the MRS and provides direct access to the Industrial Area facilities.

3.2.4 Receptors

Human receptors include current and future short-term and long-term workers who work at one of the industrial facilities or are involved in the farming operations (plowing, harvesting, etc.). Additionally, short-term workers may be involved in future construction or maintenance activities requiring excavation. There are no current residential facilities; future residential development is possible but not considered likely.

Potential ecological receptors include plants, mammals, and birds that may visit the site; the frequent presence of humans and ongoing equipment operations limits nesting activity across most of the MRS area. Vegetation removal is performed along Posey Creek on a five-year cycle, so long-term nesting or burrowing is not likely to occur.

3.3 MC

MC are explosive compounds and munitions-related metals derived from MEC. Because the suspected MEC item and MD identified during the SI were not determined to pose associated MC concerns based on the composition of the munitions found, there is limited potential for MC sources at the MRS. Based on this data, the MC CSM considers the potential receptors and exposure pathways present at the site (**Figure 3-2**). The MC CSM will also be re-evaluated based on the results of the RI.

3.3.1 Potential Sources

Potential sources for MC includes a MEC burial pit/trench, a new type of munitions item not previously found, or damaged/broken MEC with associated soil staining indicative of a potential MC release. Shallow burial pits/trenches may exist where farming activities have disturbed the top of a pit/trench and brought MEC or MD to the surface. Localized MC concentrations from burial pits or trenches may also exist in the subsurface. Additionally, farming operations may have resulted in redistribution of MC-affected soil away from pit/trench locations.

The MC most likely present are primarily munitions-related metals and possibly explosives, both of which tend to adsorb onto soil particles and typically have low migration potential. Migration of heavily impacted soil through erosion by water or wind is possible.

3.3.2 Human Receptors and Exposure Pathway Analysis

The most likely MC migration route is vertical migration to subsurface soil. However, the groundwater migration pathway for human MC exposure is considered incomplete because of low mobility of contaminants of concern in soil, and because there are no human receptors for groundwater in the MRS or immediate vicinity. There are no lakes present on the site; however, Posey Creek traverses through the northeast portion of the MRS. Posey Creek is considered an ephemeral stream that may flow within the MRS boundary during periods of heavy rainfall. Topography is typically flat and the potential for contamination of Posey Creek via runoff is low, however, the slopes down to Posey Creek within the MRS boundary are very steep and susceptible to erosion.

The following potential routes of exposure have been identified for human receptors in the vicinity of the Disposal Area MRS:

- Inadvertent and incidental ingestion of soil, surface water and sediment;
- Dermal contact with soil, surface water and sediment; and
- Inhalation of airborne suspended particulates associated with surface soils.

3.3.3 Ecological Receptors and Exposure Analysis

An ecological CSM that shows the source, migration routes, and potential receptors for each source media is presented in **Figure 3-3**. The CSM will be updated based on results of the RI sampling.

The KDWPT and the USFWS list 13 federal and state threatened and endangered species that have potential to be present within Cowley County. Neither KDWPT nor USFWS indicated any areas of the FUDS were managed for ecological purposes or qualified as IEPs or sensitive environments. Habitat that supports listed species is not present within the FUDS (KDWP, 2005).

3.4 Potential Chemical-Specific Screening Criteria

Based on the composition of known/suspected munitions, potential MC includes metals (antimony, copper, lead, and zinc) and explosives (USACE, 2010a). Soil, surface water, and sediment sampling for MC analysis will be conducted as described in **Section 6.0**. The screening criteria hierarchy detailed in **Section 6.0** and risk assessment process detailed in **Section 8.0** will be used to determine if MC pose a potential risk to human health and the environment and should be considered as chemicals of potential concern (COPCs) for further evaluation.

If contaminants are identified above screening levels, a risk assessment will be performed as described in **Section 8.0**. Sources of screening criteria are listed below. Numeric screening criteria are included in **Appendix B** (Attachment 3 of the QAPP).

3.5 Data Quality Objectives

The Data Quality Objective (DQO) process is detailed in the USEPA document Guidance on Systematic Planning Using the Data Quality Objectives Process - EPA QA/G-4, EPA/240/B-06/001, February, 2006 (USEPA, 2006a), which replaced the previous EPA QA/G-4 document EPA/600/R-96/055. The DQO process is used to establish performance or acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study. The process steps for establishing DQOs are outlined as follows, and summarized in the following paragraphs for the Disposal Area MRS RI:

1. State the Problem;
2. Identify the Goal of the Study;
3. Identify the Information Inputs;
4. Define the Boundaries of the Study;
5. Develop the Analytic Approach;
6. Specify Performance or Acceptance Criteria; and
7. Develop the Plan for Obtaining Data.

Step 1: State the Problem

The nature and extent of MEC, and potentially associated MC, at the Disposal Area MRS related to historical training conducted by DoD is unknown. An MMRP RI/FS, as recommended by the SI for MEC, will be performed to meet Army obligations under CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan to address potential residual hazards and risks to human health, welfare, and the environment. There is no historical information available for the Disposal Area MRS. One interviewee in the ASR indicated he had heard reports of burial sites at Strother Field, but specific locations were never identified. Aerial photographs evaluated during the ASR indicated only features related to the skeet range were

observed in the area; there was no evidence of disturbance related to other activities. Thus, the existence of the Disposal Area was unknown prior to the SI fieldwork performed in 2009. The SI field team observed MD and potential MEC associated with AN-M50 and AN-M54 incendiary bombs (12 items) and M15 white phosphorous smoke hand grenades (two items). The MD and potential MEC items were concentrated in an approximately 2-acre area. Historical documentation does not indicate use of the 4-lb incendiary bombs or any smoke hand grenades at the FUDS; therefore, it is presumed the area was used for munitions disposal rather than as a target range or training area given the mixed nature of the munitions and the proximity to the airfield cantonment area. The SI did not identify a potential risk from MC associated with the munitions discovered. Further MC investigation is not necessary unless a new source for MC is discovered (i.e., a burial pit, different types of MEC and/or if exposed filler or stained soil is identified next to or under compromised MEC). The nature and extent (lateral and vertical) of MEC is unknown. The hazard posed to current and future potential human and ecological receptors from the potentially complete exposure pathways identified for MEC and potentially MC is unknown and requires additional data collection for assessment.

Step 2: Identify the Goals of the Study

It will be determined whether a MEC hazard and associated MC risk to human or ecological receptors is present, and whether associated hazards/risks from the nature and extent of MEC or MC requires that future response actions be considered.

Step 3: Identify Information Inputs

Additional data collection will be performed based on historical information (ASR), current site conditions, and the results from previous studies (SI). These previous studies were used to develop the CSM and characterization planned for the RI. Visual survey data, geophysical survey data, and intrusive investigation results of selected anomalies will be collected during the RI to characterize MEC. Additional media sampling for MC will be performed if needed based on the results of MEC characterization.

Step 4: Define the Boundaries of the Study

The MRS boundary is approximately 28.3 acres, which was established following the SI based on the fragmentation distance associated with an AN-M50 (**Figure 1-2**). Planned MEC characterization will be performed within the boundary of the MRS and may extend beyond the boundary as needed to define the full extent of MEC. MC characterization will be performed if a MEC burial pit or different types of MEC than those already identified at the MRS are discovered, and if exposed filler or stained soil is identified next to or under compromised MEC. If performed, MC sampling may extend beyond the boundary of the MRS if on-site results indicate that risks extend beyond the current boundary and to assess background levels.

Step 5: Develop the Analytic Approach

The RI fieldwork includes a surface clearance in DGM areas to maximize safety of fieldwork, provide a dataset that will aid in characterization of the MRS, and to remove metallic clutter from DGM areas to the extent practical. Following the surface clearance, a subsurface investigation will be performed using DGM, analog geophysics in DGM-inaccessible areas, and intrusive investigation. Because the SI results did not indicate a potential for MC risks, additional characterization of MC is not warranted unless a MEC burial pit, different type of MEC and/or compromised MEC, with a potential to be a source for MC are encountered. Therefore, if no evidence of a MEC burial pit(s) and no new MEC types or compromised MEC are discovered, no analytical data will be collected. If on-site sampling of environmental media is performed for MC, a site-specific background dataset will also be collected. Background samples will be collected from areas where no military munitions activities have occurred that are located near

the MRS in similar conditions to those on the MRS, with respect to geology, soil, or land use properties that could affect the concentration of MC. The type and quantity of data required are presented in **Section 5.0**, **Section 6.0,** and **Section 7.0** of this WP.

Step 6: Specify Performance or Acceptance Criteria.

Physical Data

The physical data collected needs to be sufficient to complete reporting requirements. Geophysical survey and intrusive MEC data collected need to be sufficient to complete reporting requirements and IAW the SOPs (**Appendix D**) and the measurement performance criteria specified in **Section 7.0**. Field equipment will be calibrated as necessary to meet acceptance criteria specified in the SOPs and the manufacturer's operating manuals.

Chemical Data

If MC investigation is warranted, performance and acceptance criteria during sample collection and analytical data processing will rely on the DoD Quality Systems Manual acceptance criteria for analytical samples, and high quality objectives for precision, accuracy, representativeness, comparability and completeness detailed in **Appendix B** (see Section 3.0). Chemical data will be compared to project screening levels in **Appendix B** (see Attachment 2). Laboratory analytical data will be generated by a DoD Environmental Laboratory Accreditation Program (ELAP) laboratory using USEPA test methods. Laboratory certifications and SOPs are provided in **Appendix B** (see Attachment 2 and Attachment 5). The laboratory will provide acceptable electronic data deliverables (i.e., staged electronic data deliverables [SEDDs], which will be provided to USACE at the completion of the project and uploaded to the FUDS Chemistry Database with a copy of the Final WP and sample location data off-site.

Step 7: Develop the Detailed Plan for Obtaining Data

Section 5.0 identifies the technical approach including rationale for data collection and methods to be used at the MRS. The data obtained from the MEC investigation, and MC sampling if performed, will be used to perform a site-specific MEC hazard assessment and baseline human health risk assessment (HHRA) and ecological risk assessment (ERA). If unacceptable MEC hazards or MC risks are determined to exist at the conclusion of the investigation, then the MRS will be identified for further evaluation under the CERCLA process.

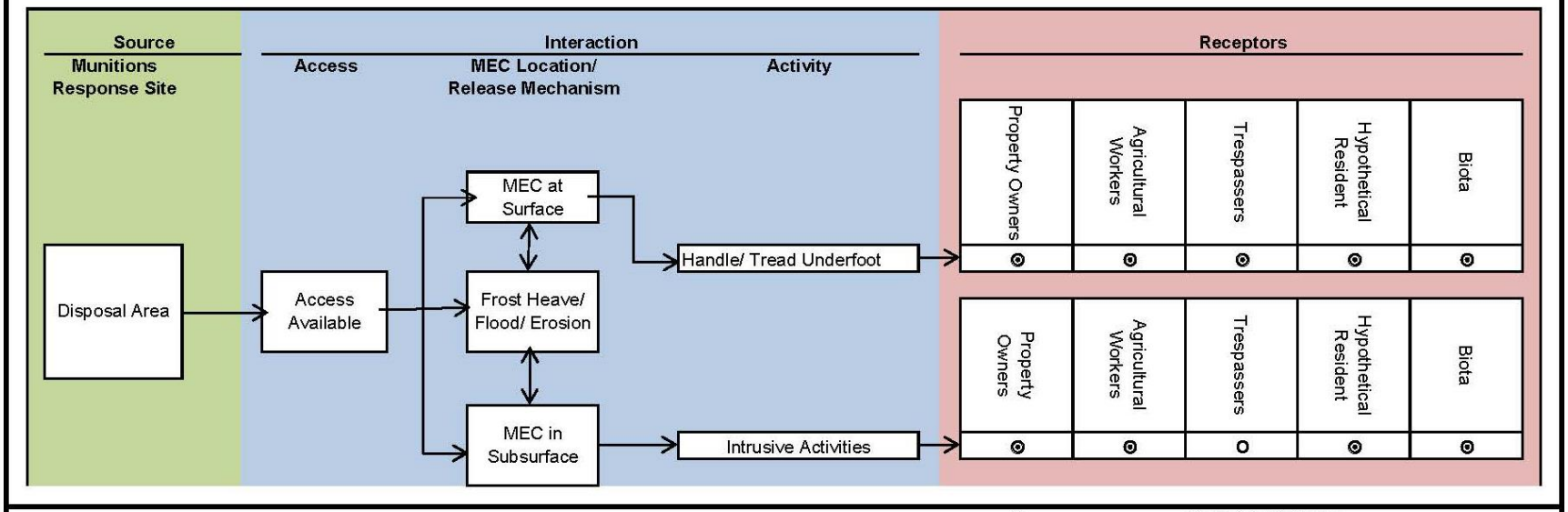


FIGURE 3-1
MEC Conceptual Site Model – Confirmed or Potential Exposure
Strother Field Disposal Area, Kansas

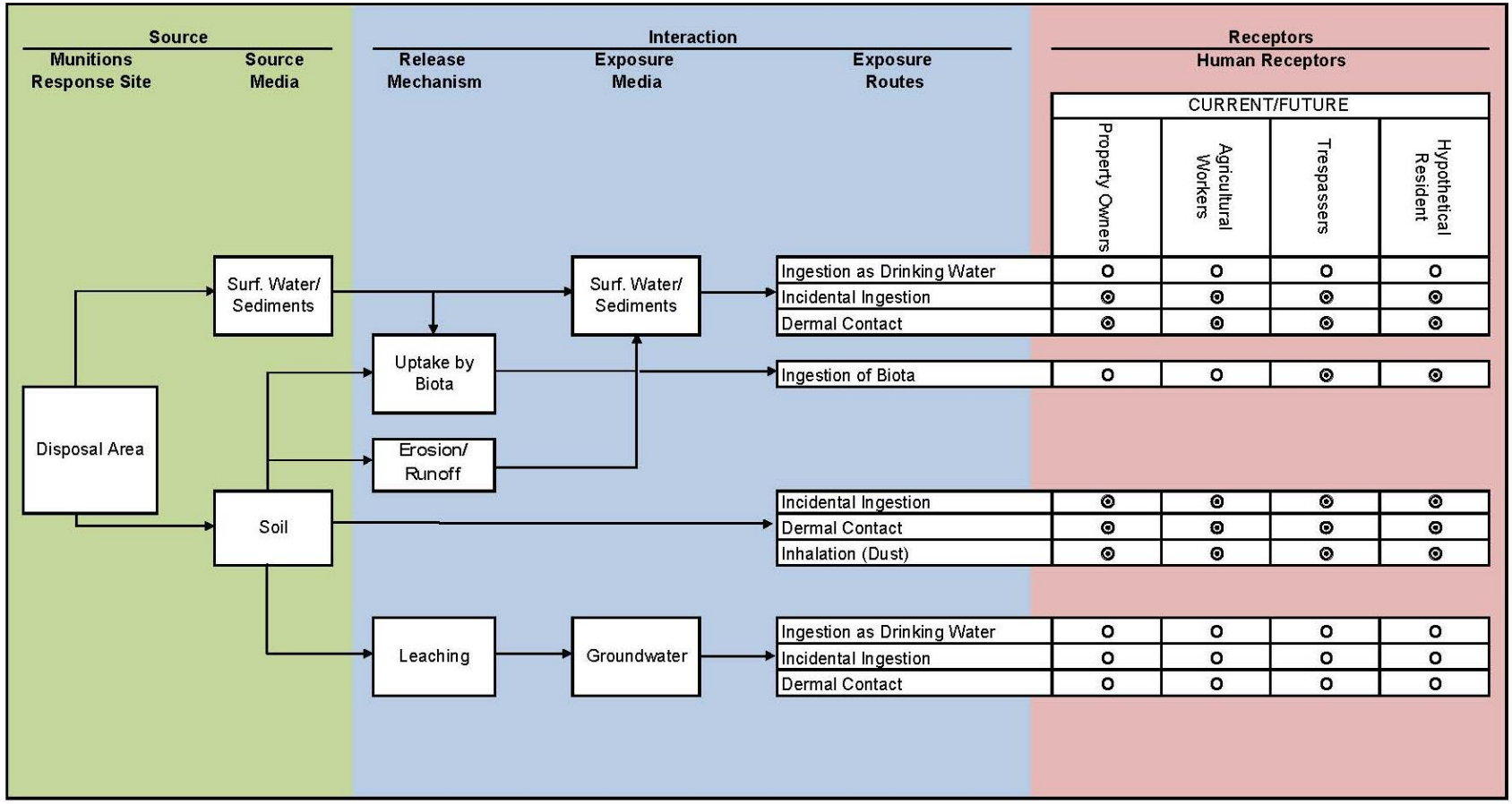


FIGURE 3-2
Human Health Conceptual Site Model Exposure Pathway for Munitions Constituents
Strother Field Disposal Area, Kansas

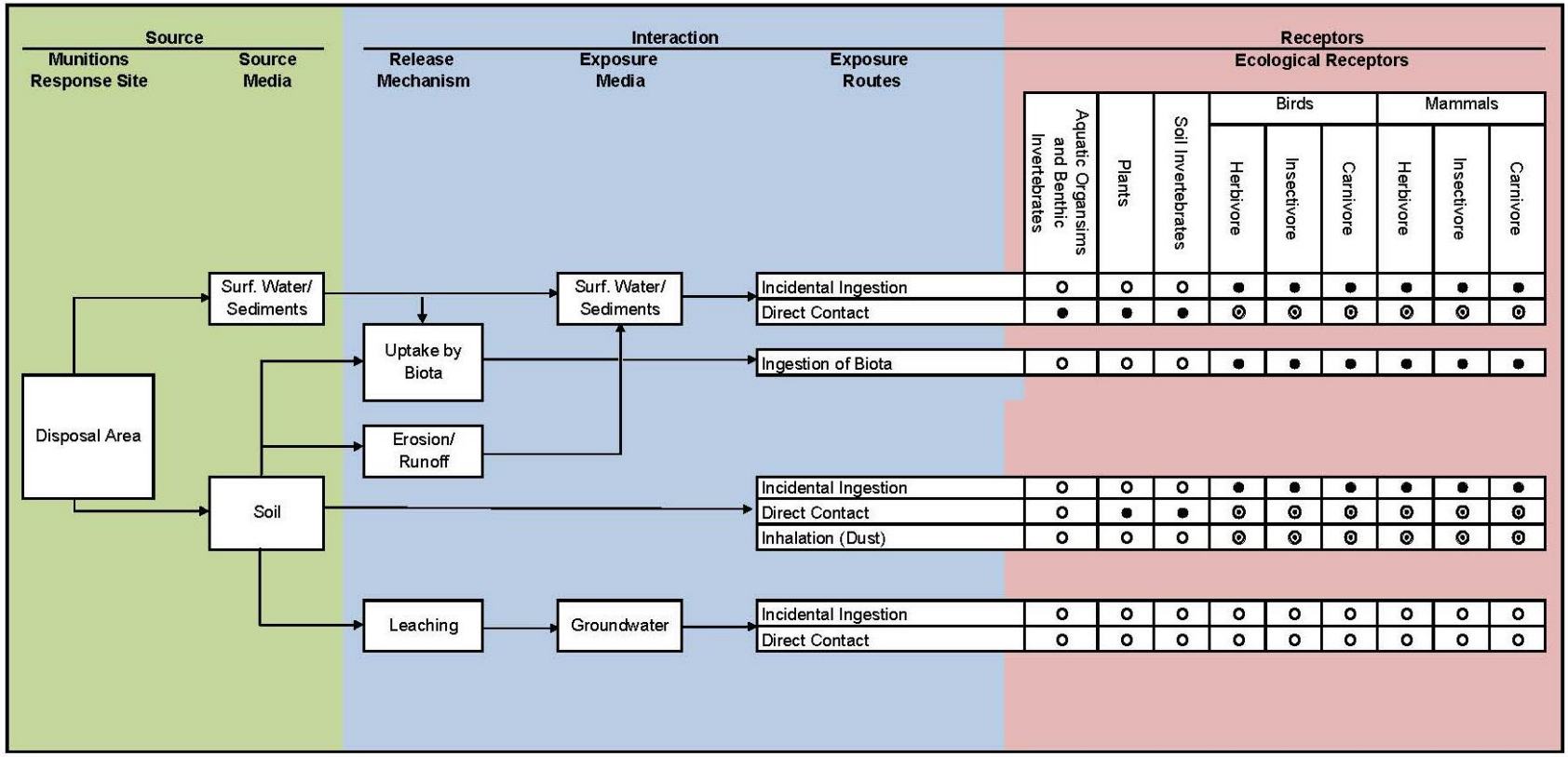


FIGURE 3-3
Ecological Conceptual Site Model Exposure Pathway for Munitions Constituents
Strother Field Disposal Area, Kansas

● Complete Pathway; quantified in ERA
⊙ Potentially Complete; cannot be quantified in ERA
○ Incomplete Pathway

4.0 TECHNICAL MANAGEMENT PLAN

4.1 Project Organization

The RI work at the Strother Field FUDS is a team effort led by the USACE – Kansas City District. The following organizations have major roles in this investigation. Contact information for key personnel is provided in **Table 4-1**.

4.1.1 USACE Personnel

Contracting Officer (KO): Authority and responsibility to contract for authorized supplies and services is vested in the agency head, who may establish contracting activities and delegate broad authority to manage the agency's contracting functions. Agency heads or designees issue warrants to KOs stating the limits of their authority.

Only the KO has the authority to legally bind the government and to enter into, administer, and terminate (if necessary) contracts for the Government. The KO may also modify the contract, if warranted, and is responsible for addressing dispute claims and bid protests if they arise. The KO is responsible for ensuring performance of all necessary actions for effective contracting, ensuring compliance with the terms of the contract, and safeguarding the interests of the United States in its contractual relationships.

USACE – Kansas City FUDS Program Manager (PGM): The FUDS PGM is responsible for final technical review and administrative compliance for project deliverables related to decision-making at the FUDS.

USACE – Kansas City Project Manager (USACE PM): The PM is responsible for providing facility maintenance of institutional and security controls. The PM reviews and comments on project-related documents including designs, WPs, investigation reports, CERCLA-required documents (e.g., FS, PP, DD) and status reports (document-specific) from draft forward. The PM serves as the lead interface with the regulators and coordinates operations on the facility side as it relates to the TO work under the USACE contract, and serves as the Bay West Team's point of contact (POC) for facility operations. The PM maintains the AR file.

USACE – Omaha Military Munitions Design Center Technical Lead (DTL)/Contracting Officer's Representative (COR): The COR is appointed by the KO and monitors the contractor's progress in fulfilling the technical requirements specified in the contract/TO. The DTL/COR is responsible for establishing project objectives and performing oversight of contractor activities including the review and conditional approval of contractor deliverables.

The DTL/COR supports the PM in discussions with the regulators, leads the exchange/transfer of technical data and information with the Project Delivery Team (PDT) throughout the project, and provides support to the PM for public-related activities performed under this TO. The DTL/COR reviews project documents and coordinates distribution of project documents to other USACE elements for review and approval.

The DTL/COR provides engineering and design support to the PM as needed and oversees the safety, occupational health, technical, and administrative aspects of the fieldwork. The DTL/COR approves payment milestones, approves invoices, and completes monitoring reports to confirm the contractor is meeting the contract terms and conditions and provides updates to the PM on a regular basis. Should the contractor fail to fulfill the contractual requirements, the DTL/COR will inform the KO of such failure.

Quality Assurance (QA) Risk Assessor: The Risk Assessment Lead is responsible for technical review of all project deliverables related to risk assessment and verifying the

procedures specified in the WPs and various guidance documents related to risk assessment are adhered to.

QA Chemist: The Chemistry Lead is responsible for technical review of all project deliverables related to chemistry and verifying the procedures specified in the WPs and various guidance documents related to chemistry are adhered to.

Ordnance and Explosives Safety Specialist (OESS): The OESS provides safety oversight of project-related activities, monitors operations in the exclusion zone, ensures proper certification of munitions-related debris, performs QA of MEC-related data obtained, and stops work in the event of unsafe conditions or if approved health and safety procedures are not being followed.

QA Geophysicist: The Geophysics Lead is responsible for technical review of all project deliverables related to geophysics, performing QA of geophysical data obtained, and verifying that the procedures specified in the work plans and various guidance documents related to geophysics were adhered to.

4.1.2 Contractor Organizations

Bay West is the Prime Contractor for this TO. Additional organizations supporting Bay West during this TO include:

- **Tetra Tech:** Tetra Tech will perform DGM including establishing the instrument verification strip (IVS) and preparing the IVS Report, providing personnel and equipment to collect DGM data, analyzing the data and preparing dig sheets to identify targeted anomalies and performance of anomaly reacquisition and resolution.
- **Weston:** Weston will develop the Community Relations Plan and coordinate closely with the USACE Public Affairs Officer throughout the project. Additionally, Weston staff will perform the risk assessment function and provide updated CSMs for the RI report. Weston will also provide UXO Technicians for the field team.
- **TestAmerica Laboratories (TAL)-Denver:** TAL-Denver will provide the analytical laboratory services to support the fieldwork.
- **Local Vendors and Subcontractors:** Bay West will obtain services of local or regional vendors and subcontractors for items and services such as equipment rental, trash disposal, backfill materials if needed to restore pits, etc.

4.1.3 Bay West Operations Personnel

The PGM has overall responsibility for the activities conducted for this TO. The PGM is responsible for supporting the PM with personnel and other resources and for providing performance oversight. Additional responsibilities include communications with the KO and COR; contract changes; guidance on difficult problems that may arise during the execution of the TO; communication of program status and problems encountered to the COR; and overall client satisfaction.

4.1.3.1 Project Manager

The PM has primary responsibility for the completion of activities on this TO. The PM has day-to-day control and responsibility for planning, scheduling, cost control, implementation of project tasks, technical reports, and TO management documents. The PM monitors project personnel during the TO performance and directs technical resources. The PM has overall responsibility for safety, quality, schedule, approval of project deliverables, and achieving the performance-based milestones. The PM reports to the PGM and the USACE PM.

4.1.3.2 RI Technical Lead

The RI Technical Lead's responsibilities include establishing technical standards for this TO, instructing project personnel in those standards, and monitoring technical task performance against the standards. The Technical Lead is responsible for technical decisions made during project planning, execution, and reporting of work. The Technical Lead helps the PM orient and guide the field teams to ensure project deliverables are technically sound, high quality, and consistent with RI guidance and Bay West's technical standards. The Technical Lead reports to the PM.

4.1.3.3 Project Chemist/Data Validation Manager

The Project Chemist/Data Validation Manager (PC) ensures the work is performed per the QAPP (**Appendix B**). The PC is responsible for sample tracking, data management, laboratory coordination, data interpretation, analytical electronic data deliverables, and reports. The PC supports the PM and reports to the RI Technical Lead.

4.1.3.4 Senior Project Geophysicist

The Project Geophysicist (PGeo) ensures the DGM effort meets the DQOs, the data are collected IAW the WP and are technically sound. The PGeo is responsible for reviewing quality control (QC) data and implement corrective actions if the data fail QC protocols. The PGeo supports the PM and reports to the RI Technical Lead.

4.1.3.5 Analytical Laboratory Project Manager

The Analytical Laboratory PM is responsible for technical quality of the laboratory, adherence to the laboratory quality assurance plan (LQAP), laboratory personnel management, cost control, and strict adherence to project schedules concerning the analysis for the parameters of interest. The Laboratory PM notifies the PC if sample receipt condition will impact data integrity, ensures the satisfactory analysis of all samples and the completeness of data documentation according to **Appendix B**. The Laboratory PM reports to the PC.

4.1.3.6 Risk Assessor

The Risk Assessor (RA) will develop a risk assessment to evaluate MEC explosive safety hazards and the potential human health/ecological risks posed by MC. Based on a limited list of site contaminants and a primarily industrial land use, a HHRA will be developed using risk-based concentrations (RBCs). The RA will also develop an ERA to assess potential adverse impacts on ecological receptors exposed to MC. Chemicals of potential ecological concern (COPEC) will be identified as those exceeding conservative ecological screening levels and natural background. The RA supports the PM and reports to the RI Technical Lead.

4.1.3.7 Community Relations Specialist

The Community Relations Specialist (CRS) will support all public participation activities by providing material and information to the stakeholders concerning the RI/FS, PP, and DD efforts. This may include drafting letters to appropriate stakeholders describing proposed activities, supporting public meetings to inform stakeholders of activities, and requesting information pertinent to prioritization or sequencing. The CRS supports the PM and reports to the RI Technical Lead.

4.1.3.8 Senior UXO Supervisor

The Senior UXO Supervisor (SUXOS) oversees the UXO operations conducted during the RI. The SUXOS is a technical resource for the PM and Technical Lead. The SUXOS is responsible for implementing the WP, coordinating personnel on-site tasking and schedules, supervising all

UXO activities, coordinating site activities, analyzing problems, implementing corrective actions, and establishing additional guidelines during the development of site- and task-specific policies and procedures. The SUXOS supports the PM and reports to the RI Technical Lead.

4.1.3.9 Regulatory Specialist

The Regulatory Specialist (RS) provides technical support during the WP preparation and acts as lead for developing and preparing the Applicable or Relevant and Appropriate Requirements (ARARs) for the FS Reports. The Regulatory Specialist is responsible for developing the ARARs IAW state and federal guidance documents.

4.1.4 Quality Control

The RI QC team consists of the Contractor Quality Control Systems (QCS) Manager and the UXO Safety Officer (UXOSO)/UXO Quality Control Specialist (UXOQCS). The functions of these roles are described below.

4.1.4.1 Contractor Quality Control Systems Manager

The Program Contractor Quality Control (CQC) Systems Manager has the overall responsibility to ensure that QA/QC procedures and objectives designated in **Section 11.0** are met for this TO. The CQC reports to the PGM.

4.1.4.2 UXO Quality Control Specialist

As there will be less than 15 personnel on-site during work, the UXOSO and UXOQCS positions are combined and are designated UXOSO/UXO QC Specialist (UXOSO/QCS). The UXOQCS is responsible for ensuring compliance with Contract and WP requirements, conducting QC inspections and testing, and documenting field QC and has full authorization to stop work and demand corrective action for non-compliance with the quality required by the contract plans. The UXOQCS reports to the CQC for quality-related issues.

4.1.5 Health and Safety

4.1.5.1 Health and Safety Manager

The Health and Safety Manager (HSM) has overall responsibility of assuring the field team's work is performed consistent with internal standards and the USACE contract requirements.

4.1.5.2 UXO Safety Officer

The UXOSO position is combined with the UXOQCS. The UXOSO is responsible for the implementation and oversight of the APP during the RI activities. The UXOSO has the authority to ensure compliance with the specified safety and health requirements, Federal, State, and Occupational Safety and Health Administration (OSHA) regulations and all aspects of the SSHP, including use of personal protective equipment (PPE), decontamination, site control, SOPs used to minimize hazards, safe use of engineering controls, the emergency response plan, spill containment program, and preparation of records by performing a daily safety and health inspection and documenting the results of said inspection in the daily log.

The UXOSO is responsible for implementation, oversight, and enforcement of the SSHP and overall management of the health and safety program for the RI. The UXOSO reports to the HSM for safety related issues and maintains on-site safety documents.

4.1.5.3 UXO Team Personnel

UXO Team personnel will be qualified IAW Department of Defense Explosives Safety Board (DDESB) Technical Paper (TP) 18 (DDESB, 2015). Surface clearance, analog investigations

and anomaly excavation teams will be composed of a UXO Technician III Team Leader and up to six UXO Technicians. The number of technicians may vary depending on the current task.

Table 4-1 Project Team Personnel and Contact Information

Name	Organization	Role	Phone	Email
Pat Overgaard	USACE – Omaha	KO	402-995-2062 (direct)	pat.m.overgaard@usace.army.mil
Sydney Elliot	USACE – Omaha	Contract Specialist	402-995-2088 (direct)	sydney.a.elliott@usace.army.mil
Dave Nelson	USACE – Kansas City	FUDS PGM	816-389-3572 (direct)	david.c.nelson@usace.army.mil
Kurt Baer	USACE – Kansas City	PM	816-389-3922 (direct)	kurt.h.baer@usace.army.mil
Brandon Sellers	USACE – Omaha	Military Munitions DTL/COR	402-995-2744 (direct)	brandon.m.sellers@usace.army.mil
Judith Strawhecker, Ph.D.	USACE – Omaha	MM Design Center Risk Assessor	402-995- 2747(direct)	judith.m.strawhecker@usace.army.mil
Jim Bond	USACE – Omaha	MM Design Center Chemist	402-995-2299 (direct)	james.r.bond@usace.army.mil
To be determined (TBD)	USACE – Omaha	MM Design Center OESS	TBD	TBD
Erin Wallin	USACE – Omaha	MM Design Center Geophysicist	402-995-2284 (direct)	erin.l.wallin@usace.army.mil
Martin Wangensteen, Professional Engineer (PE), Professional Geologist (PG)	Bay West	PGM	651-291-3475 (direct) 651-341-3265 (cell)	martyw@baywest.com
Doug Hickey, Certified Industrial Hygienist (CIH), Certified Safety Professional (CSP)	Bay West	HSM	763-479-3214 (direct)	dough@baywest.com
Brad Kulberg	Bay West	QCS Manager	651-291-3444 (direct) 651-775-7688 (cell)	bradk@baywest.com
Marie Swiech-Laflamme, PG	Bay West	PM	609-232-8026 (direct) 609-638-2919 (cell)	mlaflamme@baywest.com

Table 4-1 Project Team Personnel and Contact Information

Name	Organization	Role	Phone	Email
Rob Vinson, PE	Bay West	Sr. Engineer/Technical Lead	612-272-0971 (direct) 210-872-9220 (cell)	robv@baywest.com
Eric Malarek	Bay West	PC	443-641-0028 (direct) 443-415-1227 (cell)	emalarek@baywest.com
Elise Goggin	Tetra Tech	Senior PGeo	970-206-4310 (direct) 970-214-7108 (cell)	elise.goggin@tetratech.com
Patrick McEntee	TAL	Analytical Laboratory Project Manager	303-736-0107 (direct)	patrick.mcentee@testamericainc.com
Terry Bosco, Certified Professional Soil Scientist (CPSS)	Weston	Risk Assessor	224-864-7200 (direct)	terry.bosko@westonsolutions.com
Deb Volkmer	Weston	Community Relations Specialist	610-701-3913 (direct)	deborah.volkmer@westonsolutions.com
Dave Hannan	Bay West	SUXOS	850-797-4240 (cell)	dhannan@baywest.com
Jesse Norman	Bay West	UXOSO/QCS	317-468-5214 (cell)	jnorman@baywest.com
Gretchen Tabano, PE, Project Management Professional (PMP)	Bay West	Regulatory Specialist	443-532-3007 (direct) 443-255-6961 (cell)	gtabano@baywest.com

4.2 Project Communication and Reporting

Communications with non-DoD stakeholders and the general public will be IAW the approved Community Relations Plan (CRP). The primary contact for the public and the news media to communicate with USACE regarding activities at the Strother Field Disposal Area MRS is David Kolarik, USACE – Kansas City District Public Affairs Officer (PAO). Questions or information requests from regulatory agencies, the public or other non-USACE personnel will be referred to the USACE PAO.

4.2.1 Technical Project Planning Meetings

A technical project planning (TPP) meeting was held 4 November 2015 with USACE – Kansas City, USACE – Omaha, KDHE, Strother Field Commission, and contractors. The purpose of the meeting was to refine the RI approach at the Strother Field FUDS. The kickoff meeting results are incorporated into this WP.

A second TPP meeting will be held after distribution of the draft final WP and the subsequent stakeholder review. The objective of the second TPP is to review stakeholder comments, address any concerns and to finalize the WP requirement.

A third TPP will be held upon completion of the RI fieldwork and receipt of the MC analytical results. The RI field activities will be presented and the results discussed. The objective will be to obtain consensus on the path forward based on the initial RI data.

4.2.2 Weekly Progress Reporting

During field operations, weekly progress reports will be prepared detailing project performance and schedule variances for the reporting period, with projections on future tasks and schedule. These reports will also address issues that require direction/resolution. If necessary, updated project schedules will accompany each Progress Report. The progress report will be discussed during weekly teleconference meetings to be held between USACE, their contractor, and KDHE as needed. Minutes of the meetings will be distributed via email and copies maintained in the on-site project file.

4.2.3 Administration and Scheduling Meetings

Administration and scheduling meetings via teleconference will be held as needed at the discretion of the USACE PM. The purposes of the meetings are to:

- Review previously completed activities;
- Identify and resolve any QC or safety issues; and
- Discuss future field activities, or other logistical issues.

The meetings will be held as needed during project execution. Likely attendees include:

- USACE PM (or representative);
- USACE DTL/COR (or representative);
- PM;
- RI Technical Lead; and
- Other field team members (e.g., SUXOS, UXOSO/QCS) and/or appropriate subject matter experts as needed.

4.3 Project Deliverables/Milestones

4.3.1 RI Planning Documents

This deliverable includes the WP, APP/SSHP (**Appendix A**), the QAPP (**Appendix B**), copies of the forms and documents planned for field usage (**Appendix C**), and SOPs (**Appendix D**). Copies of Personnel Qualifications Letters will be provided prior to mobilization after the final staffing determinations are made. An ESP and CRP were submitted under separate covers.

4.3.2 Community Relations Plan

Community relations during the field activities will be led by the USACE – Kansas City PAO.

Fact sheets will be developed to provide a brief summary of MMRP activities conducted at the facility. A fact sheet will be developed prior to conducting the fieldwork and when the RI Report is issued to summarize planned activities and results from the RI. The fact sheets will be used for public relations events or to update the AR file.

4.3.3 RI Report

The MMRP RI Report will summarize field investigation data collection activities and sample results. The report will provide data analysis, assessment of the nature and extent of MEC and MC, identify associated hazards and risks that may remain, provide human health and ecological risk assessments, update the CSM and evaluate risk management alternatives if applicable. The report will include recommendations for any additional munitions response activities needed or any areas that can be considered for No Further Action (NFA). The RI Report will be prepared IAW with USACE FUDS guidance (EP 1110-1-18 [USACE, 2006b]).

The findings of the RI will be used to conduct a site-specific MEC assessment and will update the Munitions Response Site Prioritization Protocol (MRSPP). In addition, a SEDD format deliverable for analytical data that may be collected in accordance with Version 5.2 (or most recent) SEDD guidance will be generated at completion of the project, provided to USACE, and uploaded to the FUDS Chemistry Database with a copy of the Final WP and sample location data.

4.3.4 Update Administrative Record/Information Repository

The USACE PM will maintain the AR file at the USACE – Kansas City District office throughout the project in addition to updating the local IRs identified in the CRP as new documents are finalized.

4.4 Project Schedule

The schedule for the Disposal Area MRS RI anticipates fieldwork to be performed in August and September 2016 followed by submittal of the Draft Final RI Report to project stakeholders in March 2017.

4.5 Field Operations Management

4.5.1 Communications

On-site communications between field team members will be by cell phone and/or radio. Prior to the field efforts, coordination will be performed with the Strother Field Airport Manager to ensure communications can occur with the appropriate personnel and identified emergency contacts during the field activities without interfering with airfield communications. A backup radio will also be available at the work site.

4.5.2 MRS Access

USACE will coordinate access agreements with current property owners where work activities are planned. Prior to commencement of field activities, all field personnel will read and sign the APP and SSHP for the RI. In addition, the UXOSO will make sure all field personnel receive a MEC hazard awareness briefing, a site-specific safety briefing, and will conduct site-specific training requirements.

4.5.3 Mobilization

4.5.3.1 RI Project Equipment

The anticipated equipment planned for use during the RI falls under the five categories listed below:

- Excavation/Transportation Equipment;
- MEC Demolition Equipment and Supplies;
- Survey Instruments;
- Sampling Tools; and
- Consumable Supplies.

4.5.3.2 Support Facilities

Prior to the start of the field investigations, the SUXOS and UXOSO or UXOQCS will mobilize and set up a Command and Control (C&C) facility at the Strother Field FUDS. The SUXOS will manage the C&C, coordinate activities daily with the PM and USACE, and prepare daily operations journal entries, weekly summary, and monthly summary reports of activities conducted. Forms will be provided to USACE as they are completed.

4.5.3.3 Authorized Visitors

In accordance with EM 385-1-97 Paragraph I.2.G.02, no more than two authorized visitors will be permitted in the exclusion zone at any given time. Site visitors must receive a safety briefing prior to entering any portion of the MRS where field activities are performed. All visitors entering the respective exclusion zone must have the proper training and OSHA qualifications, be in the required PPE, and be escorted by a qualified UXO Technician at the discretion of the SUXOS based on the nature of the site visit.

In general, only essential personnel and authorized visitors may visit the exclusion zone (EZ) while MEC operations are being conducted. However, if required, all requests for approval as an authorized visitor for entry into the EZ during MEC operations must be submitted in writing through USACE for approval. The request shall:

- Describe the purpose of the visit and the tasks to be performed;
- Explain why the tasks must be performed during MEC operations;
- Specify whether the visit will be a single visit or one in a series of visits; and
- Disclose the frequency of the visits and the time required to perform the task.

4.5.3.4 Unauthorized Visitors

Any field team member discovering an unauthorized visitor in an investigation area will contact the SUXOS or UXOSO immediately and work will be stopped until the individual is no longer in the area. Unauthorized visitor events will be logged in the daily field log by the SUXOS.

4.5.4 Demobilization

The field team will demobilize from the Strother Field FUDS will approval from USACE following the RI fieldwork. All exclusion areas will be shut down and equipment will be cleaned and removed from the site.

5.0 RI FIELD OPERATIONS

The basic field processes required for site characterization include surface clearance, vegetation removal (Posey Creek only), digital geophysics for areas other than Posey Creek and analog geophysics on portions of the Posey Creek ditch with a slope less than 40%, data processing, target selection, anomaly reacquisition, and intrusive investigation of anomalies.

The Definable Features of Work (DFW) needed to complete the RI at the Strother Field FUDS include:

1. Mobilization, site preparation, and demobilization;
2. Vegetation removal;
3. Surface MEC removal;
4. Perform DGM surveys;
5. Perform analog/intrusive investigation;
6. MEC/material potentially presenting an explosive hazard (MPPEH) disposal by detonation;
7. Perform environmental sampling, if needed; and
8. MD/scrap metal inspection, certification and disposal.

5.1 Mobilization and Infrastructure Establishment

5.1.1 Certification and Training

A seven-person field crew will be deployed consisting of a SUXOS, a dual hatted UXOSO/UXOQCS, a UXO Tech III Team Leader, and four UXO Technicians. The SUXOS will determine if additional staff are needed based on field conditions. A geophysical team consisting of a geophysicist and two UXO Technicians will be on-site during the completion of the DGM DFW.

The UXOSO will review personnel files to verify work and safety qualifications are in place. Personnel qualification issues are resolved prior to fieldwork start. The UXOSO will verify all personnel have received 40-hour hazardous waste operations and emergency response (HAZWOPER) and 8-hour refresher training, all supervisors have received 8-hour supervisor safety training, and all field personnel have a current work physical.

Once personnel are on-site, the UXOSO will give an overview presentation of the WP and a safety briefing to address site-specific issues. Additionally, emergency procedures will be reviewed and tested. Personnel will read the SSHP and confirm they read and understood the provisions in the SSHP before performing any fieldwork.

The purpose of this training is for supervisors and site personnel to fully understand procedures and methods planned for investigation activities, individual duties and responsibilities, safety and environmental practices and procedures associated with the operations. Training topics include equipment field personnel will operate while on-site.

5.1.2 Support Facilities

The field team will set up a field office at Strother Field FUDS to direct and coordinate field activities. Temporary office and storage facilities, rental equipment and field services (e.g., trash disposal, Internet service, etc.) will be obtained from local or regional vendors.

The SUXOS will manage the field office; coordinate daily activities with the PM and USACE PM; and prepare daily operations reports, weekly summary, and monthly summary reports of

activities conducted at the site. Forms will be sent to the PM for review; in turn the PM will forward the reports to USACE.

5.1.3 Temporary Explosives Storage Magazine Installation

A temporary explosives storage facility will be established IAW the approved ESP and Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) specifications as outlined in **Section 9.3.1**. The facility will allow for secure storage of donor explosives and will be installed in advance of fieldwork. The SUXOS, UXOSO, and a local electrician will install the magazine(s) in a storage container connected to appropriate grounding rods.

The SUXOS will notify the ATF Field Office and State of Kansas Fire Marshal when the magazine(s) are available for inspection. Additional QC requirements for the temporary explosives storage magazine are provided in **Section 9.0**.

5.2 Surface Clearance

Surface clearance consists of removing MEC, MD, and non-munitions-related debris (NMRD) that is visually observable in the investigation area. The body of the M 50 fire bomb is nonferrous and may become separated from its ferrous components; electromagnetic detectors will be used in areas of vegetation where the ground surface is not visible (e.g., along Posey Creek) to assist in locating metallic objects on the surface. However, only limited vegetation removal using hand tools will be performed as needed to facilitate the visual clearance.

MPPEH will be identified by UXO Technicians and managed as described in **Section 5.6** and the SOP (**Appendix D**) for this task. Other debris consisting of trash and non-munitions-related items (e.g., concrete, wood, metal) certified as explosives-free will be left in-place. A detailed description of surface removal activities is provided in the SOP for this task (**Appendix D**).

5.3 Geophysical Investigation

A State of Kansas licensed professional land surveyor will be used to establish control points and benchmarks for data collection positioning references. The coordinate system for this project is the North American Datum 1983 (NAD83), UTM Zone 14N, Meters.

5.3.1 Establish IVS

A location for the IVS will be identified upon arrival at the MRS based on current site conditions. The PGeo will establish the IVS as described in **Section 7.0** and prepare the IVS Report. The DGM field team will validate their equipment against the IVS prior to data collection start and daily as described in **Section 7.0**.

5.3.2 DGM Survey

The DGM investigation will be performed over approximately 18.05 acres of farmable area. Details regarding equipment, operating procedures, DGM data processing, anomaly selection, and QC protocols are provided in **Section 7.0**.

5.3.3 Anomaly Selection

The target anomaly selection process is described in **Section 7.0**.

5.4 Intrusive Investigation

The DGM process produces a dig sheet of targeted anomalies and their location coordinates. The field team will intrusively investigate the targeted anomalies using industry standard procedures. Refer to the SOP for this task in **Appendix D** for additional details. All excavated items will initially be managed as MPPEH pending further classification as described in the SOP for this task provided in **Appendix D**.

Additional features of interest may include potential MD burial pits/mounds/trenches, etc., identified by DGM or analog metal detectors. The goal of the intrusive investigation is to determine the horizontal and vertical extent of the feature of interest, to characterize the contents and safely remove any MEC encountered for disposition.

Where appropriate, this may include trenching across a feature. Excavation of the features may be by hand or may include an armored excavator depending on site conditions and the items encountered. Specification for equipment armoring if necessary are identified in the ESP.

5.5 Analog Mag and Dig Survey

DGM will not be conducted on steep slopes or in standing water areas. Accordingly, UXO Technicians will investigate the Posey Creek area using handheld analog detectors. Due to safety concerns, no investigation will be performed on creek banks greater than 40 degrees. Approximately 2.45 acres of mag and dig transect coverage is planned along Posey Creek. Procedures for mag and dig operations are detailed in the SOP for analog operations (**Appendix D**) and further described in **Section 7.0**.

5.6 MPPEH, MDAS, NMRD, and IDW Management

All items recovered during intrusive investigation are initially treated as MPPEH. The MPPEH is evaluated by UXO Qualified Technicians and is further classified as MEC, material documented as safe (MDAS) or NMRD and managed as described in the SOP for this task (**Appendix D**).

Investigation-derived waste (IDW) management and disposal (see **Section 9.0**) will follow standard USACE procedures and comply with all Federal, state, and local laws and regulations. IDW from sampling activities will consist of general solid wastes including PPE, disposable trowels and miscellaneous trash (e.g., used paper towels, packaging). The volume of such waste is anticipated to be small and these materials will be disposed of as household waste.

In the event an open burn/open detonation or burial pit is identified, non-soil items will be evaluated and classified as MPPEH, MDAS, or NMRD as described in MPPEH SOP. Soil samples will be collected as detailed in **Section 6.0**. Excavated soils will be returned to the excavation area.

5.7 Analytical Sampling

The criteria for soil sampling, and sample collection, sample storage/custody and shipment procedures are provided in the Field Sampling Plan (**Section 6.0**) and the QAPP in **Appendix B**.

6.0 FIELD SAMPLING PLAN

The SI concluded there was no significant risk from MC based on a desktop evaluation of the munitions found and potential MC associated with them. Therefore, unless a MEC burial pit is found, MEC of a different type is found, and/or compromised MEC is discovered, no additional MC assessment is planned for the RI. Based on the composition of known/suspected munitions, potential MC includes metals (antimony, copper, lead and zinc) and explosives (USACE, 2010a). If MEC is discovered during the RI that has potential as a new MC source, the field team will collect and analyze soil samples to further characterize the MRS.

The field team will use two types of soil sample collection techniques: incremental sampling methodology (ISM) and discrete sampling. Additionally, if soil sampling is warranted based on the MEC investigation, then the field team will also collect surface water and sediment samples from Posey Creek providing surface water is present. This Field Sampling Plan constitutes Part I of the Sampling and Analysis Plan for the RI (Part II is provided as the QAPP in **Appendix B**).

6.1 Soil Sampling

6.1.1 Incremental Sampling

If a burial pit/trench is identified during the RI, the field team will collect surface soil samples using an ISM approach to identify if redistribution of MC-impacted soil away from pit/trench locations has occurred. In this case, the field team will include a lead sampler experienced in the use of ISM and a minimum of a UXO Technician II providing anomaly avoidance. A decision unit (DU) of 0.25- to 0.5-acre will be centered on the burial pit/trench for consistency with a conservative risk assumption for future residential exposure. Due to the annual farming activities that take place on the property reworking and homogenizing surface soil, the DU depth is considered to be 12 inches bgs. If incremental soil sample results are found to pose risk, the entire top 12 inches will be considered contaminated and addressed in the FS based on the DU depth and reworking of surface soil by agricultural activities over time.

Replicates (minimum of three) will be collected from each DU to assess relative standard deviation for sample results and such that an upper concentration limit can be calculated for each DU to assess potential exposure risk. In addition to analyzing samples for explosives and munitions related metals, pH will also be analyzed to support fate and transport evaluations if needed.

6.1.2 Discrete Sampling

If a burial pit/trench is identified during the RI, the field team will collect subsurface discrete soil samples from four locations within the burial area. Samples will be collected using a hand auger every 2 ft beginning at 24 inches bgs to a depth of 6 inches below the bottom of a MEC/MD burial pit/trench to identify if MC is present and mobilizing away from the burial area.

For new types of MEC found, or broken/damaged MEC found with associated soil staining, indicative of a potential MC release at the surface or subsurface that may pose as a source for MC, a discrete sample will be collected as close to the MEC item as is safely possible or from the base of the excavation area, as determined by the SUXOS. The use of discrete sampling for this purpose will assess a “worst-case scenario” for potential contamination. Similar to the ISM approach, discrete samples will be analyzed for explosives, munitions related metals and pH. The results will be used to assess risk due to subsurface or surface soil exposure and migration potential.

6.1.3 Background Sampling

If on-site soil sampling is performed, the field team will collect background soil samples using the same collection methods used on-site from outside of the MRS boundary where soil with similar characteristics is found and determined to be non-impacted by former military munitions use.

6.2 Surface Water and Sediment Sampling

The appropriate number, locations, and depths of samples collected will be determined based on the MEC investigation results and will be submitted to the project team (i.e., USACE, KDHE and USEPA) prior to collection. If collected, the co-located surface water sample will be taken before the sediment sample to avoid turbidity raised during collection of sediment.

6.3 Sampling Procedures

The following procedures will be followed to collect soil, surface water, and sediment samples during the RI. Additional SOP information for sampling is provided in **Appendix D**.

6.3.1 Soil/Sediment Sampling

The field team will collect discrete soil and/or sediment samples using a disposable trowel. Soil and/or sediment samples for laboratory analysis will be collected and any metallic debris will be removed from the sample, photographed, and noted in the sample log. The soil and/or sediment will be placed directly in a sample container.

ISM replicate samples will consist of a minimum of 30 soil increments collected at 1-to-2-inch depth using a systematic grid pattern (see **Figure 6-1**) to comprise a field sample volume of 1,000 grams. The sample collection depth of 1 inch to 2 inches bgs will reduce the probability of field errors occurring, and still is considered representative of the DU due to the farming activities resulting in homogeny within the top foot of soil. Increment collection will be completed using a systematic approach that begins in a random grid, the sampler will then move through the grids in a serpentine pattern to collect increments. A clean, disposable Terra Core® sampler will be used to ensure that the increments collected are uniform. The increments for each replicate sample will be consolidated into a one-gallon plastic bag for shipment to the laboratory.

Samples collected will consist of the following list of analytical suites:

- Select Metals by USEPA Method SW-846 3050B/6020A;
- Nitroaromatic/nitramine explosives by USEPA Method SW-846 8330B; and
- pH by Method SW-846 9045C.

The data will be reported and managed as specified in the QAPP (**Appendix B**). Data quality indicators will be reported in the RI report and evaluated against the criteria specified in the QAPP.

6.3.2 Analytical Surface Water Sampling

If Posey Creek has observable flow, the field team will collect surface water samples using a sterile sample container and pour directly into the appropriate containers for each analyte. Surface water samples will be collected prior to collecting any co-located sediment samples to avoid turbidity in the surface water sample caused by disturbing the sediment.

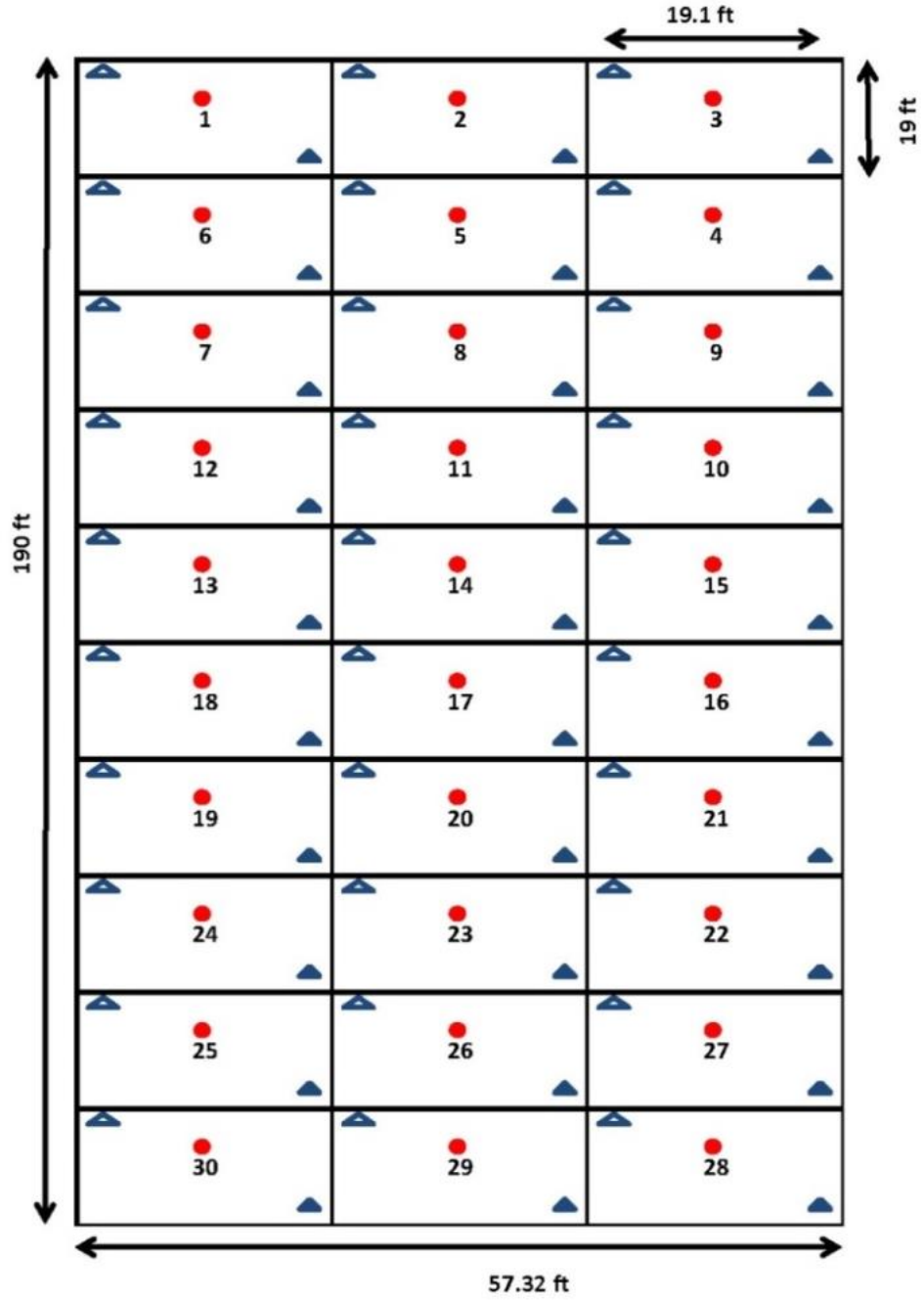
Surface water samples will be collected for laboratory analysis consisting of the following analyte list:

- Select Metals by USEPA Method SW-846 3020A/6020A;
- Nitroaromatic/nitramine explosives by USEPA Method SW-846 3535/8330B; and

- pH by Method SW-846 9040B.

The data will be reported and managed as specified in the QAPP (**Appendix B**). Data quality indicators will be reported in the RI report and evaluated against the criteria specified in the QAPP.

Figure 6-1 Incremental Sampling Design (Example Layout)



Notes:

Example sampling unit design for 0.25-acre (~10,890 ft^2) and 30 increments; design may be scaled based on the size of potential release areas identified during the RI

Sample collection to begin at increment 1 and continue consecutively in sequential order to increment 30 using a serpentine pattern throughout the Decision Unit.

Red dot (●) indicates location of systematic random increment collection point (~33.3 grams/increment)

Solid blue triangle (▲) indicates location of replicate (duplicate) increment collection point

Open blue triangle (△) indicates location of replicate (triplicate) increment collection point

ft = foot

6.3.3 Sample Identification

All sample identifiers will be unique using coding to specify the type, location and depth of collection for each sample. The sample identification scheme will contain at least four fields and resemble DA-ABC-123-1.

The first field of all sample identifiers will begin with:

- DA = disposal area

The second field will use the following codes based on the type of sample:

- DSS = discrete soil sample
- ISM = incremental soil sample
- DSD = discrete sediment sample
- SWG = surface water grab

The third field will include a three-digit number to be used sequentially for each sample type/location, and which will correlate to positioning data for the sample recorded in the field using a hand-held Trimble Global Positioning System (GPS) unit.

The fourth field will include a single-digit number related to the depth of collection as applicable:

- 1 = surface soil samples, surface water and sediment samples
- 2, 3, etc., = subsurface soil samples (to be used sequentially as samples get deeper at the same location

A fifth field will be used for duplicates and field replicates as follows:

- A = field duplicate or primary field replicate
- B = field replicate no. 2
- C = field replicate no. 3

6.3.4 Sample Location Surveying

The field team will mark sample collection locations with pin flags, stakes, and/or surveyor's flagging tape and record the location using handheld Trimble GPS units. Real-time GPS locations will be collected for surface water and sediment sample pairs if staking is not possible. Standard latitude/longitude coordinates will be used whenever possible. Raw data from the GPS units will be downloaded daily and transferred to the designated coordinator (once back at the field office) for data processing and mapping.

6.3.5 Sample Preservation, Packaging, Shipping

Sample volumes, containers and preservation requirements are provided in **Table 6-1** below. Sampling-related tasks and responsible parties including shipment information and disposal procedures are detailed in **Table 6-2**. The field technician is required to check, maintain, and document all samples in custody and the preservation process. The field technician will be responsible for packing each sample for shipment using a bubble wrap bag for glass containers, in a lined cooler with wet ice included (double-bagged to prevent leakage) for in-transit preservation. All coolers will be sealed with packaging and strapping tape, custody sealed and shipped with a copy of the Chain of Custody (CoC) taped to the inside cover.

Table 6-1 Sample Volumes, Containers, Preservation and Holding Times

Matrix	Analytical Group	Sample Volume[1]	Containers	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation, analysis)[2]	Data Package Turnaround
Soil	8330B HPLC	4 grams 20 grams	One 4 oz glass jar for discrete samples, 1-gallon plastic Ziploc for ISM samples[3]	Cool ≤ 6°C	14 – 40 days from extract	21 Days
Water	8330B HPLC	1,000 mL	One 2, 500 mL amber	Cool ≤ 6°C	7 days	21 Days
Water	6020A Metals	100 mL	One 250 mL, HDPE	HNO_3, pH < 2	180 days	21 Days
Soil/ Sediment	6020A Metals	20 grams	One 4 oz glass jar for discrete samples, 1-gallon plastic Ziploc for ISM samples[3]	Cool ≤ 6°C	180 days	21 Days
Soil/ Sediment	9045C General Chemistry	80 grams	One 4 oz, glass jar	Cool ≤ 6°C	28 days (same day as extracted)	21 days
Water	9040B General Chemistry	25 mL	One 100 mL HDPE	Cool ≤ 6°C	Immediately (48 hours of receipt)	21 days

[1] The minimum sample size is based on analysis allowing for sufficient sample for reanalysis. Additional volume is needed for the laboratory matrix spike/matrix spike duplicate (MS/MSD) sample analysis. For samples collected using ISM, field sample volume is 1,000 grams.
[2] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.
[3] When both explosives and metals are requested for analysis for samples collected using ISM, only one container of sample volume is required.
°C = degrees Celsius
HDPE = high density polyethylene
HPLC = high-performance liquid chromatography
kg = kilogram(s)
mL = milliliter(s)
oz = ounce(s)

Table 6-2 Collection, Shipping, Disposal and Responsible Parties

Task	Responsible Party/Timeframe
Sample Collection, Packaging, and Shipment	
Sample Collection	Environmental Field Technician
Field Analytical Sample Storage	Number of days from sample collection: Ship as soon as possible, the temperature of the samples will be maintained at ≤ 6ºC but not frozen, and the temperature will be recorded daily in the logbook.
Sample Packaging and Preservation	Environmental Field Technician
On-site Sample Cool Storage and Custody	Environmental Field Technician
Coordination of Shipment	Environmental Field Technician, in coordination with: Michelle Johnston TestAmerica Laboratories, Inc. 4955 Yarrow Street, Arvada, CO 80002 michelle.johnston@testamericainc.com 303-736-0110
Type of Shipment/Carrier	Overnight/Fed Ex
Sample Receipt and Analysis	
Sample Receipt	Sample Control – TAL
Sample Custody and Storage	Sample Control – TAL
Sample Preparation	TAL
Sample Determinative Analysis	TAL
Sample Disposal and Archiving	
Sample Disposal	Sample Control-TAL Number of days from analysis: Per laboratory SOP
Sample Extract/Digestate Storage	Sample Control-TAL Number of days from extraction/digestion: 30 days after analytical report.

Note: Samples will be handled in accordance with the applicable field and laboratory SOPs.

Recordkeeping is done on a daily basis in a logbook dedicated to analytical sample documentation (see **Section 6.3.8**). The field logbooks shall identify the day the samples were collected, the person responsible for sample custody and preservation, where they are stored on-site, and shall record when samples are shipped off-site and to whom.

6.3.6 Decontamination Requirements

It is anticipated that disposable materials and equipment that do not require decontamination on will be used for sampling activities. Accordingly, we anticipate minimal decontamination (if any) will be required. If unforeseen site conditions are present and it is not possible or practical to use disposable items, the field team will decontaminate sampling tools and equipment to prevent cross-contamination between analytical sampling locations.

The decontamination procedure, if required, will consist of the following steps:

- Place a small square of polyethylene sheeting on the ground and bracket/brace up the sides to contain any fluids;
- Prepare and label three plastic buckets (or wash tubs), one with a small quantity of Liquinox detergent and potable water, one with potable water, and one empty. Include nylon scrub brushes in the soap/water and water buckets. Stage the buckets on the plastic sheeting. Keep liquid quantities to the minimum needed to adequately decontaminate the equipment;
- Prepare and label two 1-liter poly spray bottles (or use 1-gallon poly garden sprayers); one with potable water and one with deionized (DI) water;
- Set one 5-gallon bucket on a pallet nearby and label it “IDW Liquids Only;” remove lid. Set up a heavy duty plastic lawn waste bag and label it “PPE and solid IDW Only”;
- Set up a clean area nearby but away from the decontaminate/washing area using separate poly sheeting. Stage aluminum foil and paper towels in this area;
- Take the equipment to be decontaminated and inspect for and remove any labels, tape, or adhesive glues (if decontaminating new equipment) or any residual soil or sediments (if used). Remove foreign material by scraping or using small wire brush or knife;
- Immerse the equipment into the soap/water bucket. Scrub all surfaces with a brush, taking care to examine the interior and exterior surfaces to ensure removal of particulate matter;
- Transfer equipment into the potable water bucket and immerse. Use a brush to remove remaining soap residue. Remove from the water and spray down all surfaces with potable water, catching the rinsate in the water bucket. Inspect equipment sampling surfaces for remaining particulate. Repeat soap/potable water wash and rinse steps if necessary;
- Transfer equipment into the empty bucket. Rinse equipment with the final DI water rinse, catching rinsate in the bucket. Perform final inspection of cleaned surfaces. Repeat steps as necessary to remove any remaining foreign material or residual soil/sediments;
- Transfer equipment to clean area and allow to air dry as much as possible, or use paper toweling to remove any remaining water. Equipment is ready to reuse if immediately needed. If equipment is to be stored for later use, wrap the dried sampling equipment with aluminum foil sheeting and seal in a labeled plastic trash bag if equipment is to be stored for longer term; and
- Repeat procedure for all sampling equipment. When complete, combine the contents of the buckets into the 5-gallon bucket(s) labeled “IDW Liquids Only.” Fold up the poly sheeting from the corners in (to contain any captured water) and drain water from the

poly into the IDW Liquids bucket. Fold the plastic into the smallest square possible and place into the bag labeled "PPE and solid IDW Only."

6.3.7 Field Quality Control Procedures

Trip blanks, field duplicates, field replicates, MSs, and MSDs will be collected and analyzed by the off-site laboratory to assess the quality of the data resulting from the field sampling and analytical programs.

- Duplicate samples are analyzed to check for sampling and analytical reproducibility. One field duplicate will be collected for every 10 or fewer investigative samples of a given matrix. Duplicate samples are preferred at locations anticipated to have higher concentrations.
- Field replicates (minimum of 3) are collected for each DU sampled using ISM to check representativeness and to be able to calculate an upper confidence limit (UCL) for risk assessment.
- MS/MSDs provide information about the effect of the sample matrix on the digestion and measurement methodology. Depending on site-specific circumstances, one MS/MSD will be collected for every 20 or fewer discrete samples of a given matrix. MS/MSD samples should be taken from locations anticipated to have low concentrations. Note that for samples collected using ISM, the laboratory performs a triplicate analysis for every 20 or fewer replicates submitted with volume obtained from the original sample(s).

6.3.8 Field Documentation

Samples will have CoC documentation. An example form is provided in **Appendix C** of the Work Plan.

Project field and QC documentation are summarized below in **Table 6-3**.

Table 6-3 Sample Collection, Field, Audit, and Laboratory Records

Sample Collection and Field Records			
Record	**Generation**	**Verification**	**Storage Location/Archival**
Field logbook or data collection sheets	Field Team	PM Technical Lead	Project Files (electronic – USACE contractor's servers)
CoC Forms	Field Team	PM Technical Lead	Project Files (electronic – USACE contractor's servers)
Air Bills	Field Team	PM Technical Lead	Project Files (electronic – USACE contractor's servers)
Contractor Daily Quality Control Report (DQCRs)	Field Team	PM Technical Lead	Project Files (electronic – USACE contractor's servers)
Deviations	Field Team	PM Technical Lead	Project Files (electronic – USACE contractor's servers)
Corrective Action Reports	Field Team	PM Technical Lead	Project Files (electronic – USACE contractor's servers)
Correspondence	Field Team	PM Technical Lead	Project Files (electronic – USACE contractor's servers)
Sample locations	Field Team	PM	Project Files (electronic –

		Technical Lead	USACE contractor's servers and FUDS Chemistry Database)

Table 6-3 Sample Collection, Field, Audit, and Laboratory Records (Continued)

Project Assessments			
Record	**Generation**	**Verification**	**Storage Location/Archival**
Field audit checklists	PM or Designee	PM Technical Lead	Project Files (electronic – USACE contractor's servers)
Data verification checklists	Project Chemist	PM Technical Lead	Project Files (electronic – USACE contractor's servers)
Data validation report	Project Chemist	PM Technical Lead	Project Files (electronic – USACE contractor's servers)
Data usability assessment report	PM or Designee	PM Technical Lead	Project Files (electronic – USACE contractor's servers)
Laboratory Records			
Record	**Generation**	**Verification**	**Storage Location/Archival**
SDG Report	Laboratory PM	Laboratory QA Manager	Project Files (electronic – USACE contractor's servers)
Laboratory Report	Laboratory PM	Laboratory QA Manager	Project Files (electronic – USACE contractor's servers)
SEDD Deliverable	Laboratory PM	Laboratory QA Manager	Project Files (electronic – USACE contractor's servers and FUDS Chemistry Database)

6.3.8.1 Field Log Books

All information pertinent to site conditions, MEC or MD information (such as munitions type, condition, number of items, and location), MC sample information for soils, sediments, and surface water (such as observations of staining, odors, vegetation, standing water, and location) instrument calibration or verification data, and any information a field team member feels is important to understanding a site, is recorded in field logbooks.

Field logbooks are bound and pages consecutively numbered. A diagonal line is drawn through any space at the bottom of each page and pages left partially blank will be lined out and initialed. The bottom of the page containing the last daily entry is signed by the author. No pages may be removed from a logbook. At a minimum, the following information will be included in the logbooks:

- Site name and location;
- Site conditions upon arrival and departure;
- Descriptions of all site activities, including site entry and exit times;
- Dates and times (24-hour clock) of all entries made in logbooks/field forms;

- Names, job functions, and organizational affiliations of personnel on-site;
- Weather conditions including estimated temperature;
- Identification or serial numbers of any instruments and equipment used;
- Any problems encountered; and
- A plan of each day's activities and a summary of each day's accomplishments.

In general, it is important that sufficient information is recorded during the sampling to permit reconstruction of the event without any reliance on the memory of field personnel.

The following guidelines are used for recording field data:

- Documentation is completed in permanent black ink;
- All entries are legible;
- Errors are corrected by crossing out with a single line, dating, and initialing (when appropriate, the reason for the change will also be included) and a diagonal line is drawn through the space at the bottom of each page; and
- All field documents must be signed.

7.0 GEOPHYSICAL INVESTIGATION PLAN

The Geophysical System Verification (GSV) process will be used at the Strother Field FUDS to demonstrate the DGM instrumentation (sensors and positioning), instrument operators, data acquisition methodologies, and the data processing and analysis procedures meet DQOs established for the RI. The procedures and processes described below closely follow (and often quote, in part or whole) those outlined in EM 200-1-15 (USACE, 2015).

7.1 Geophysical Equipment

The following geophysical and positional instruments, equipment, platforms, personnel, and data processing techniques are planned for use:

- EM61 MK2 geophysical sensors;
- High-resolution Differential GPS (DGPS) rigidly mounted on the EM61 MK2;
- Wide Area Augmentation System-Enabled GPS (for transect guidance);
- UXO technicians, craft labor, and geosciences field operators; and
- Digital data processing with automatic and manual anomaly selections.

The reacquisition process may include the following:

- EM61 MK2 geophysical sensors;
- Measuring tapes;
- Visual markers (Flags, tapes, ropes, etc.);
- High-resolution DGPS; and
- UXO technicians, geosciences field operators.

7.2 Geophysical System Verification Process

Prior to conducting the DGM surveys, the GSV process will be implemented, as described in the report titled Geophysical Systems Verification: A Physics-Based Alternative to Geophysical Prove-Outs for Munitions Response (Environmental Security Technology Certification Program [ESTCP], 2009). The GSV process consists of two main components:

- An IVS consists of industry standard objects (ISOs) buried in a representative, open area close to where the geophysical survey equipment is set up or operated. The objective of the IVS is to verify the geophysical detection system operates properly at the RI onset.

  The IVS is also used as an ongoing check during the RI field investigation (at the beginning and end of each data collection day). The ISO objects should be observed in the data with signals that are consistent with both historical measurements and physics-based model predictions.

  The IVS also serves to verify the geo-location system provides accurate sensor location data. The IVS typically contains a nearby noise strip with no buried targets. The noise strip characterizes and checks the dynamic noise level of the geophysical instrument and site background noise.

- Blind seed items (BSIs) are ISOs or inert ordnance targets buried in the production site at surveyed locations that are blind to the data collection and processing teams. Seeds provide ongoing quality monitoring of the geophysical data collection, target selection, and anomaly resolution process as it is performed in the production survey areas.

The IVS ensures geophysical equipment is operating properly and dynamic noise conditions are documented. The IVS will be used to determine target selection criteria in the production data by establishing an acceptable signal to noise ratio (e.g., 3 to 5 times background noise). An IVS Letter Report will document the construction and initial data collection results. This report will also finalize the thresholds for the daily metrics as well as define the target selection threshold to be used for production data. The IVS Letter Report will be provided to the USACE for review and approval within 48 hours of initial data collection.

7.2.1 IVS Technical Discussion

The DGM crew(s) will use the Geonics EM61 MK2 geophysical detector with the 1.0-meter (m) by 0.5-m coils, both in cart mode and in a 3-coil vehicle towed array (VTA). The Naval Research Laboratory (NRL, 2008; 2009) measured the EM61 MK2 response over standard munitions items and ISOs and compared these to physics-based models with excellent results. Thus, the EM61 MK2 is well-characterized over typical munitions and ISOs.

In addition, ESTCP provides access to the physics-based modeling software (EM61-MK2 Response) on its website (ESTCP, 2009) so sensor response curves are computed for IVS applications on actual projects.

The EM61 MK2 Response software is used in two modes:

- Computing the physics-based (model) response of standard munitions or ISOs at various offsets from the EM61 MK2 coils. This computation is done for the worst (lowest amplitude) target orientation (typically perpendicular or cross-track), and thus is the expected minimum signal expected for that target at that depth.
- Computing the minimum response curve for any actual munition or ISO, based on a few measurements of the EM61 MK2 over the target in the worst target orientation.

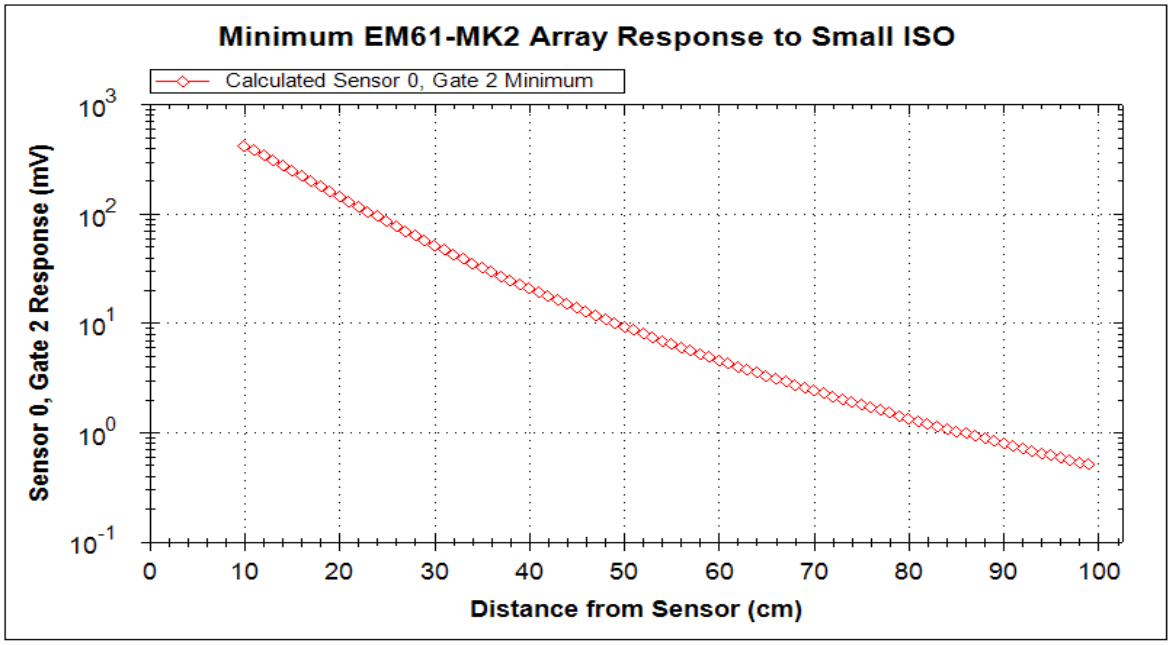
In this project, the IVS will use small ISOs; therefore, the first mode of the software will be selected. **Figure 7-1** shows the minimum response curve computed by the EM61-MK2 Response software for the small ISO offset by half the RI designed line spacing for Channel 2 (Gate 2) of the EM61 MK2 1.0- by 0.5-m coil.

This figure shows the minimum response computed for the small ISO; thus field measurements with the EM61 MK2 over this ISO should plot on or above this line. Although this figure shows Channel 2, the computations are made for all four channels of the EM61 MK2, and the threshold can be evaluated for any combination of channels. The plot shows response versus distance from the EM61 MK2 sensor (coil). The normal operating height of the EM61 MK2 is 40 centimeters (cm); this distance on the plot corresponds to a target on the surface.

As shown on **Figure 7-1**, small variations in distance (depth) from the sensor result in relatively large amplitude changes. The variations or errors (if unknown) are partially accounted for by placing approximate error bars on the measured values. **Figure 7-2** shows an example of field ISO measurements, showing error bars that correspond to a 2.5-cm (1 inch) uncertainty in the burial depth and 2x the measured amplitude noise.

The variation in target amplitude with lateral distance is much less, and can be characterized by measurements made on parallel transects and repeat measurements along transects in the IVS.

Figure 7-1 Computed Minimum Amplitude/Response for EM61 MK2, Channel 2, Small ISO



To reliably detect a target in the IVS (and production surveys), the signal from the target needs to be above the typical noise encountered in the survey area. In this setting, noise is defined as instrument measurement variations unrelated to a target response. The variations can be due to sensor electronics, sensor motion, geologic structure, noise in the atmosphere (natural and man-made), and interference from small metallic debris near the surface and/or metal carried by the operator (or on the operating system).

To characterize this noise, typically system measurements are made in a dynamic mode over a transect parallel to the IVS (noise strip). This noise strip is “cleared” or selected such that there are no buried or surface metallic objects in the strip that affect the noise measurements.

Additional transects between the IVS and noise strip can be used to help determine/confirm proper line spacing in the production work.

7.2.2 IVS Configuration

The specific location of the IVS will be determined in the field. Criteria for selection of the IVS test area are:

- Terrain, vegetation, and geology similar to the investigation areas;
- Proximity to the investigation areas to improve logistics; and
- Easy (road) access for field crews.

Table 7-1 provides detailed information on the ISOs to be used in the IVS. Each IVS seed item will be evaluated to the published NRL ISO response tables.

Table 7-1 ISOs Used in the IVS

Item	Nominal Pipe Size	Outside Diameter	Length	Part Number (1)	ASTM Specification
Small ISO	1 inch	1.315 inches (33mm)	4 inches (102mm)	44615K466	A53/A773

(1) *Part number from the McMaster-Carr catalog. Source: ESTCP 2009*

Figure 7-2 Calculated Minimum Response in Channel 2 of an EM61 MK2 for a 37mm Projectile (solid line), Showing IVS Measurements and Expected Error Bars (ESTCP 2009)

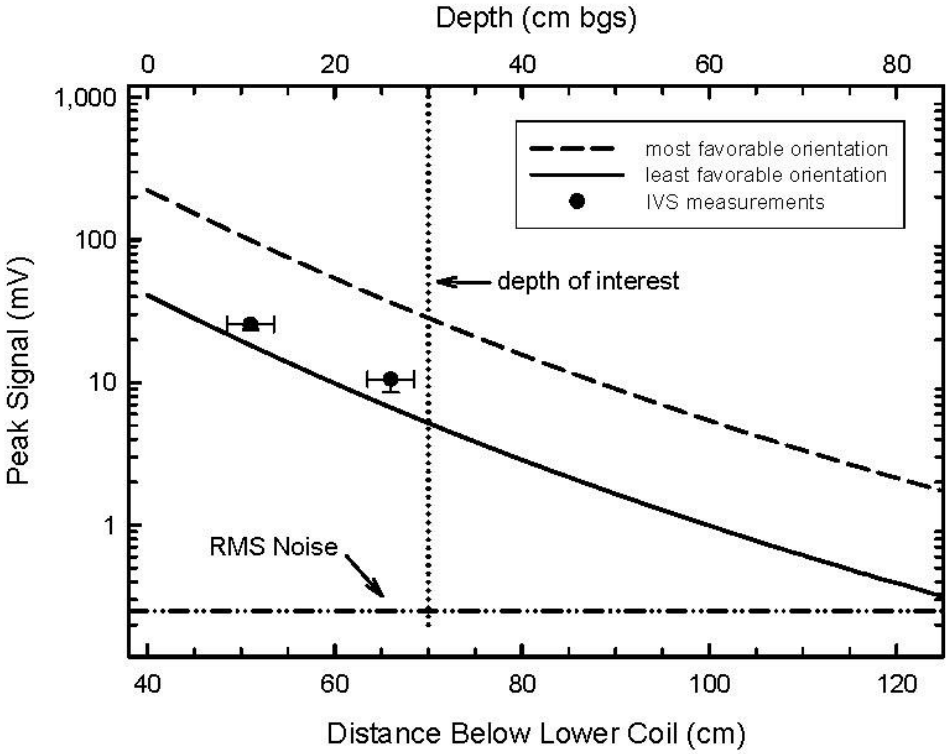
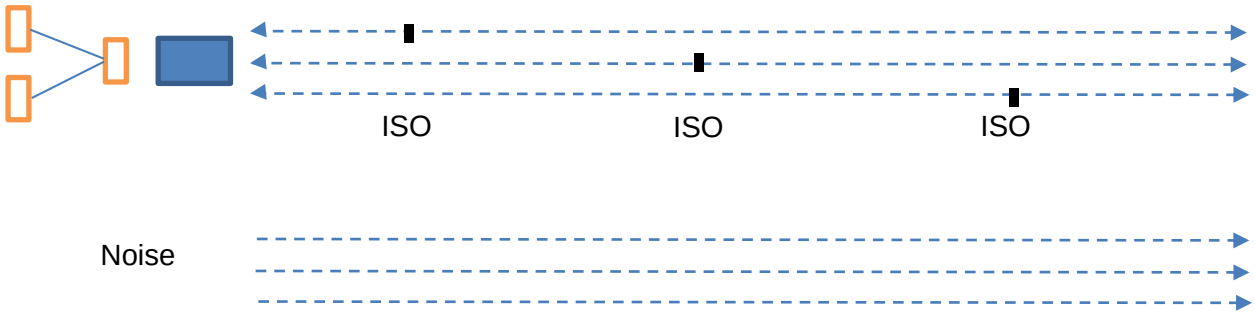


Table 7-2 lists the ISO specifications that will be used for the IVS installed. The IVS will consist of three separate lines spaced at approximately 30 inches (0.75 m) to allow each coil in the VTA to pass directly over an ISO. The man portable system will pass over just one lane (**Figure 7-3**).

Table 7-2 ISO Installation Specifications

Item	ID	Position (along line)	Depth to Center	Orientation
1	Small ISO	10 ft	4-2 inches	Horizontal across line/track
2	Small ISO	25 ft	4-2 inches	Horizontal across line/track
3	Small ISO	40 ft	4-2 inches	Horizontal across line/track

Figure 7-3 IVS Configuration



7.3 IVS Installation

The installation steps are as follows:

1. IVS locations that meet the criteria identified in **Section 3.1** are identified in the field.
2. Once the final IVS area is selected, UXO avoidance techniques are used to clear the prospective IVS area of any MEC, MD, or other metals on the surface. In the event there are significant quantities of metal objects, the IVS area is extended or relocated.
3. A background (confirmation) DGM survey is collected. The data are processed and analyzed to ensure there are no buried metal objects in the IVS area. All DGM surveys are conducted according to contractor SOPs. Contractor QC and USACE QA staff review the data and approve or reject the final IVS areas.
4. Test items (small ISOs) will be buried at locations indicated in **Figure 7-3**. The ISOs are located on straight lines established with a survey tape and marked at each end with a non-metallic survey stake. Depths are measured from the ground surface to the center of the ISO. Each IVS seed item is evaluated to the published NRL ISO response tables for the adjusted depth.
5. Prior to burial, each ISO is photographed in-place using a survey tape for orientation reference, and the ISO position (x, y, and depth to center) is measured with a survey grade Real Time Kinematic (RTK) GPS and the distance along line is measured. Variations between proposed and measured depth should not exceed ±1 inch. A survey grade RTK DGPS (5-cm accuracy) is used to document all ISO locations and measurement lines in the IVS area. Survey procedures are guided by the contractor SOPs.
6. A noise test strip is established parallel to and offset by at least 10 ft from the IVS line. The noise lines are established with colored string or paint and non-metallic survey markers on each end. The end points (survey markers) are measured with RTK DGPS.

A post-installation DGM survey is conducted after the IVS is installed to validate the installation. The post-installation DGM survey is conducted on the lines/transects following SOPs for DGM Data Acquisition. Non-metallic survey tapes or ropes are placed, or paint is used, on the IVS and noise strip transects (between survey hubs/markers) so the DGM crew can maintain accurate real-time positioning along transects.

Data is collected at the RI defined line spacing on either side of the IVS center line and 0.5 times the line spacing on one side of the center line with the man-portable system. This demonstrates the minimum expected response based on the defined line spacing. The VTA will collect data down and back.

The DGM data from the post installation survey are processed according to the Data Processing SOP. Processing primarily consists of adjustments for instrument latency/lag and compensation for instrument drift or bias.

The DGM data are analyzed to derive the following parameters/results:

- Expected latency/lag for the DGM instrument used during the survey;
- Range of values (millivolt) for the four channels of the EM61 MK2 over each ISO. Establish the baseline value expected for each channel for each ISO and compare to model results;
- Comparison of DGM anomaly locations versus known (surveyed) locations;
- Evaluation of the background noise at the site (noise strip);
- Evaluation of expected blind seed response; and
- Recommendation for target selection threshold.

The PGeo prepares an IVS installation report that discusses the installation, post-installation DGM surveys and DGM data analysis. The report contains (at a minimum) the following information/ discussions:

- Installation: IVS area map and coordinates, pre-installation DGM data and discussion, installation logistics narrative, photographs and coordinates of installed ISOs.
- Post-Installation DGM survey: DGM data for all repeats on all transects, example maps/profiles of data, logistics discussion (i.e., time required to run, terrain factors, etc.).
- DGM data analysis: discussion and quantified results for latency/lag, EM61 MK2 response over ISOs and comparison to model results, anomaly location versus known location of ISOs, background noise, and effect of transect position on ISO amplitude.
- Recommended metrics for applicable Performance Criteria such as static repeatability, blind seed response, etc.

The PM will deliver the IVS installation report to the USACE PM for approval. Any data collected prior to USACE approval is collected at the contractor's risk.

7.3.1 IVS Operation and Verification

DGM crews will use the IVS area as a daily test of their DGM systems. The IVS (and noise strip) is designed to test the EM61 MK2 and assumes production crews use this same DGM equipment in the same configuration used by the IVS installation crew. If the configuration changes during the RI, the IVS Report will be amended and resubmitted to USACE to approve the new configuration metrics.

This GSV plan is based on the application of the geophysical system components listed above. The system configuration used will depend on the specific site terrain. In all cases, the coil height will be maintained at the standard wheel based height, with the lower coil approximately 15 inches (±1 inch) above the walking surface. This distance will be measured and verified by field personnel prior to each data acquisition session.

If terrain or vegetation characteristics prevent the lower coil from being used at the intended height, the actual coil height used will be documented by the field crew. DGM and reacquire teams will be trained and certified based on the SOPs.

7.3.2 Daily IVS Testing Procedures

Each contractor DGM crew/system will run the IVS at the beginning and end of each production DGM day or if repairs are made to the equipment. The DGM crews will assemble, test, and

warm up the DGM system according to their SOPs prior to the initial testing in the IVS area, and at other times as required by their SOPs.

DGM crews will proceed directly from the IVS to the survey area without system disassembly, and begin production surveying. Likewise, at the end of the day, the DGM crews will proceed directly from the production survey area to the IVS.

The DGM crews will run the IVS in both directions and the noise strip in at least one direction. The DGM crews will also run the IVS and noise strip if any significant DGM system component is changed, repaired or modified during the survey day. Significant components are:

- Any part of the geophysical sensor/electronics (i.e., coils, electronics console, cables),
- Changes to DGPS antenna and/or antenna mount, and
- Changes to DGPS electronics.

These changes require re-run of the IVS, noise strip and the supplemental IVS transects, and re-evaluation of the DGM system.

7.3.3 Daily IVS Pass/Fail Criteria

The IVS data must pass the criteria established in the IVS Report for the daily production data to be acceptable. The daily IVS certification is in addition to (and does not substitute for) other DGM system tests specified in the contractor SOPs. The field team may choose to use the IVS more than twice daily to reduce the chance of unacceptable DGM data.

The PGeo will review the data in the case of a failure of the end of the day IVS. If it is determined the data can be retained, the supporting evidence or argument will be provided to the QA Geophysicist for review along with the DGM data.

7.3.4 Daily IVS Deliverables and Reporting

The PGeo is responsible for QC to evaluate the pass/fail criteria for the DGM crews/systems. If the IVS data for any DGM crew/system fails either of the test criteria during a production day, the PGeo will notify the USACE QA Geophysicist and the PM. The PGeo will perform a root cause analysis for the failure and recommend a corrective action.

The PGeo will provide the following deliverables to the QA Geophysicist:

- Raw and processed DGM data for each DGM crew/system for each IVS and noise strip test.
- Access Database with all selected IVS target amplitudes and positions with pass/fail indicated

7.4 Blind Seed Installation

The blind seed program is a critical component of the GSV. Blind seeds allow for continuous monitoring of the quality of the production DGM data, target selection and intrusive activities. In addition, the amplitudes of the seeds should be consistent with both historical measurements and IVS predictions.

This section discusses the general features of the blind seed program to be conducted by contractor QC. Blind seeds for this project will be the small ISOs (**Table 7-1**), as these small items are inexpensive, readily available, easily transportable, and do not pose any potential hazard if not recovered.

7.4.1 Blind Seed Locations

Blind seeds will be installed in the 100% coverage areas at the frequency of one seed per acre. The BSIs will be installed in horizontal orientations at a depth of 2 to 4 inches bgs to correlate with IVS ISO depths and provide a standardized comparison. The horizontally placed BSIs will be placed with either a general north-south or east-west orientation.

7.4.2 Seed Item Emplacement

The following general procedures are proposed for BSI emplacement:

- Scan a 3-ft area around each BSI location with a hand-held metal detector to ensure the area is free from other surface or subsurface anomalies before placing the BSI.
- Holes will be excavated with a shovel.
- Place the BSI in the respective hole and measure the depth to the center of mass using a rigid measuring tape. Obtain north-south or east-west azimuth of the item by compass.
- The survey team will survey the x, y, and z coordinates of the center of each seed item with the positioning system used for DGM data collection.

The seed item type, coordinates, depth, and orientation (azimuth and dip) will be stored in the RI database and secured so that only QC and QA personnel have access to the information.

7.4.3 BSI Detection Evaluation

The PGeo will evaluate the performance of the blind seed program using the Measurement Performance Criteria (MPCs) defined in the WP unless modified in the IVS Report.

7.5 Surface Clearance

Following completion of DGM preparatory activities, the UXO technicians will conduct a MEC surface clearance in support of the DGM efforts. The 100% DGM area will be gridded into nominal 200- by 200-ft grids; they need not be exact. Corners will be measured with sub-meter GPS or tapes and marked using wooden stakes or lathe. Surface clearance procedures are described in the Surface Clearance SOP provided in **Appendix D**.

Details regarding the reporting and disposition of MEC and MPPEH, MD, and NMRD are provided in **Section 5.5**. If an item is only partially visible on the ground surface, intrusive investigation procedures presented in **Section 5.4** will be used to remove the material.

7.6 Geophysical Mapping

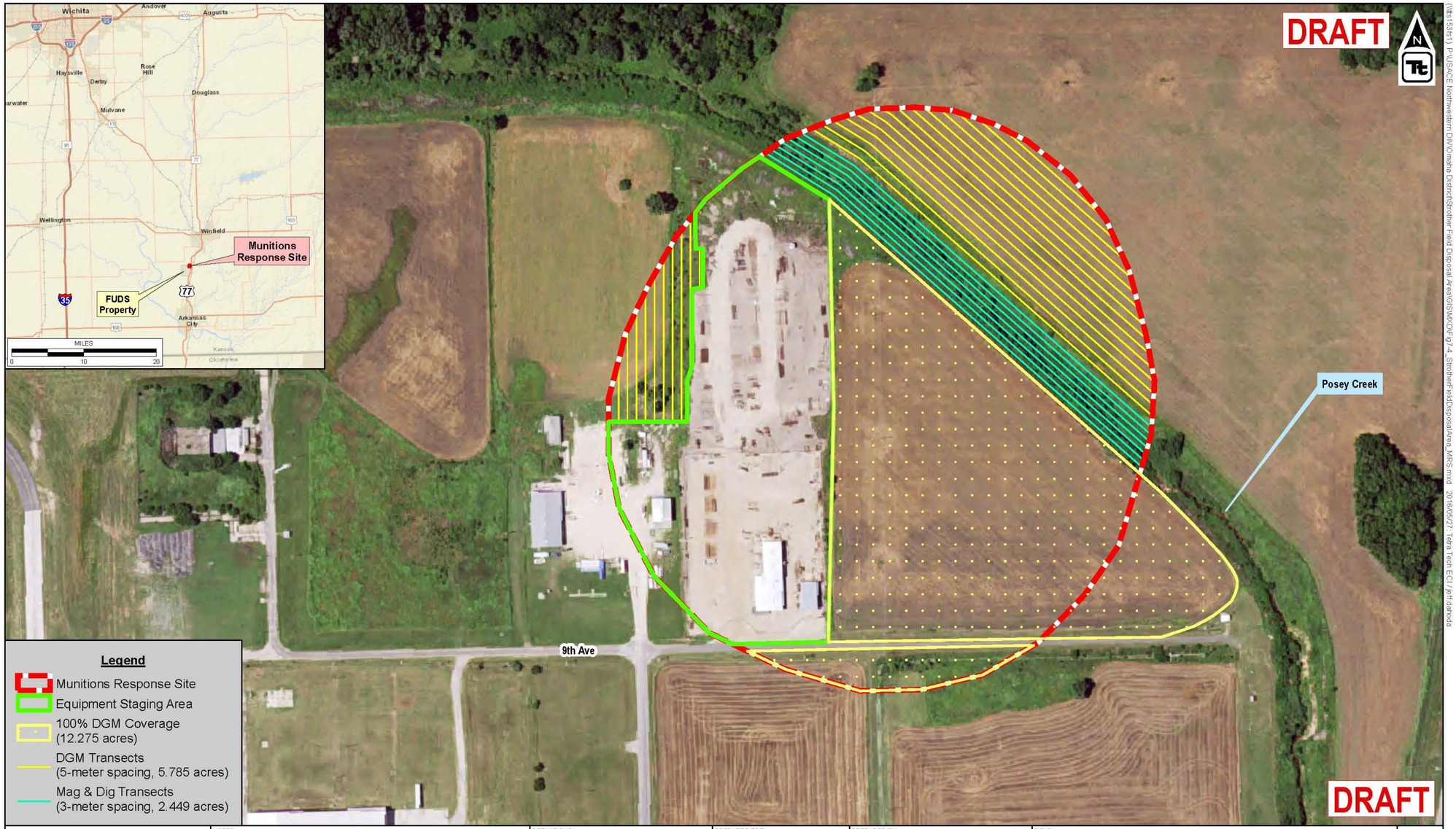
After the surface sweep is completed, DGM will be conducted with EM61-MK2 systems. Digital data will be positioned with Leica RTK DGPS. All data will be collected and processed IAW EM 200-1-15 (USACE, 2015) and SOPs provided in **Appendix D**.

7.6.1 DGM 100% Coverage Survey

A 100% coverage DGM survey will be performed over 12.27 acres as shown on **Figure 7-4**. The primary data collection platform for the 100% coverage area is a 3-coil VTA. The VTA has a swath width of 2.5 m with the coils spaced 0.75 m center-to-center. To obtain 100% coverage the VTA will collect data at a line spacing of 2.25 m. Coverage will be verified using Oasis Montaj QC tools to verify the MPC coverage found in **Table 7-3** are met.

Coordination will be performed with the local property owners to de-energize the overhead power lines for the time needed to collect the DGM data. If the field team is unable to have the overhead power distribution lines opened up and grounded for the data collection period a walk-

away line will be collected to determine the level of interference from the power lines in the EM61 data.



1 INCH = 200 FEET (SCALE AT 17" X 11")

SCALE IN FEET

0 200 400

WGS 1984 UTM ZONE 14N METERS

NOTES:
1) Imagery from the USDA National Agriculture Imagery Program (NAIP), 1-m resolution, 2015, via the ArcGIS Image Server.
2) Inset basemap from ESRI imagery web mapping service, provider of worldwide basemap, aerial, and satellite imagery. Go to esri.com for further information.

DEFINITIONS:
DGM = Digital Geophysical Mapping
MAG = Analog All-Metals Detector
MRS = Munitions Response Site

PREPARED FOR:
US Army Corps of Engineers
Omaha District

PREPARED BY:

TITLE:
REMEDIAL INVESTIGATION GEOPHYSICAL SURVEY PLAN
STROTHER FIELD FUDS (PROPERTY NO. B07KS0277)

A REVISION

PROJECT:	PROJECT NO.:	FIGURE:
DISPOSAL AREA MRS	106-46690002	Figure 7-4
LOCATION: COWLEY COUNTY, KANSAS	DATE: 05/27/2016	

This process consists of collecting DGM data starting under the power line and continuing until the noise from the utility is lower than the target selection threshold. This will allow us to delineate the acreage acceptable for DGM. Mag and dig procedures will be utilized to investigate 3 ft lanes to provide 100% coverage in areas not acceptable for DGM. Coverage and detection seeds will be placed at variable rates to validate analog coverage in these areas.

During the site walk conducted following the first TPP meeting, a portion of the MRS was observed to be not amenable to traditional investigation methods (i.e., DGM or analog surveying) due to the presence of oil drilling and farming equipment. Because of the large of amount of non-munitions related metal present that precludes traditional investigation, the project team will evaluate the need to investigate this area based on data collected during the RI leading into this portion of the MRS. If no evidence of munitions presence is found, no investigation will be performed. However, if evidence of munitions is found indicative of buried munitions in the equipment staging area, coordination will be conducted with the property manager to relocate equipment to the extent practical to support the use of analog detectors for subsurface investigation (see **Section 7.6.3** for mag and dig procedures).

7.6.2 DGM Transect Survey

DGM transect data will be collected over 5.78 acres as shown on **Figure 7-4**. Transect data will be collected with a single man-portable EM61-MK2 coil to increase mobility and allow for data collection closer to obstacles. The transects will be spaced 5 m apart to insure 100% traversal over pits with a diameter of at least 5 m. Along-line spacing will be less than or equal to 25 cm for at least 98% of the data, and 95% of the data will be collected at speeds demonstrated at the IVS. All obstacles that can be moved from a transect path will be cleared prior to data collection. For immovable obstacles, such as buildings, which interfere with the EM response, the DGM will be supplemented by mag and dig investigations to ensure maximum coverage is obtained. All anomalies detected on transects with amplitudes greater than the RI selection threshold will be intrusively investigated. If evidence of MEC is found during intrusive investigation, a mini-grid (5 m by 5 m) will be placed over the find to determine the extent of the potential MEC contamination. If the horizontal extent of the potential MEC contamination (e.g., elevated anomaly density or saturated response due to a pit) extends beyond the initial mini-grid footprint, additional 5-m by 5-m step-out grids will be surveyed until the horizontal extent has been bound.

7.6.3 Mag and Dig

A mag and dig survey will be performed over 2.45 acres as shown on **Figure 7-4**. While DGM is preferred to analog investigations, the dense vegetation and steep terrain in the vicinity of Posey Creek support the use of mag and dig procedures. UXO Technicians will use all-metals analog detectors, verified daily at the function check area (FCA), to sweep 3ft wide transects along the river bank IAW Analog Operations SOP provided in **Appendix D**. All detected anomalies will be intrusively investigated to determine the nature and extent of potential MEC contamination.

Slopes greater than 40 degrees will not be investigated due to safety concerns; however, the slopes will be characterized based on items found at the ditch bottom. This strategy makes the assumption if MEC were present on the steep slopes of the bank; it's extremely likely some, if not all of the contamination, would have migrated into the bottom of the creek bed over time.

Additional mag and dig investigation may be performed in the area demarcated as equipment staging area on **Figure 7-4** based on RI findings leading into this portion of the MRS. If munitions presence is likely due to munitions discovered in the 100% DGM coverage area or within the DGM transects abutting this area, then mag and dig will be performed around the

staged equipment; or, if necessary, the equipment will be relocated in coordination with the property manager to facilitate investigation.

7.7 Data Processing

DGM data will be processed and analyzed using Geonics software and the most up-to-date version of the industry standard Geosoft Oasis Montaj. Experienced geophysicists will process and analyze the data IAW the DGM Data Processing SOP DGM-002 to ensure it meets the MPC listed in **Table 7-3** and the EM 200-1-15 (USACE, 2015) requirements.

It is anticipated that discrete anomalies will be selected based on 3 to 5 times the RMS noise calculated during the initial IVS survey; however, the final target selection threshold will be documented in the IVS Report. An anomaly density map will also be produced.

All anomalies detected during the DGM transect survey with amplitudes greater than the RI selection threshold will be intrusively investigated.

Within the 100% DGM coverage area a potential burial pit/trench will be identified by areas of high amplitude saturated response, which will be demarcated for intrusive investigation via test pitting/trenching based on the spatial extent of the identified area(s). Outside of the potential burial locations, the number of discrete targets selected for intrusive investigation in the 100% coverage area will be determined using the Anomaly Verification Sampling Tool in Visual Sample Plan (VSP)[1] to provide 95% confidence that 95% of the anomalies do not contain MEC.

Unique Target IDs will be generated for each anomaly meeting the selection threshold and the reacquisition teams provided the coordinate locations. A minimum of 10% of all data processing and target selection will be reviewed by the QC Geophysicist prior to QA submittal.

7.8 Target Reacquisition and Intrusive Investigation

Following dig list development, targets selected for intrusive investigation will be reacquired using the RTK DGPS. Reacquisition of targets selected from the DGM data will be performed IAW the Reacquisition SOP found in **Appendix D**.

Following reacquisition, UXO Technicians will excavate each reacquired target IAW the Intrusive Investigation SOP provided in **Appendix D**. Dig results will be digitally recorded. MEC, MD, and unusual objects or conditions will be photographed.

The UXO Technician III Team Leader will assess the explosives safety status of any MPPEH encountered and ensure the item is properly identified to the SUXOS, who will determine the item's disposition. Demolition procedures detailed in SOP Positively identified or suspected MEC will be destroyed using protocols discussed under "MPPEH Management" in the next section.

The MSD based on the MGFD documented in the ESP, will be used to keep non-essential personnel clear of intrusive activities. We will communicate and coordinate work schedules and subsurface removal action locations with CENWO, and property owners as needed.

The PGeo or designee will review the results of intrusive investigations (i.e., completed dig sheets) and function tests daily to ensure the recovered items match the anomaly mV signature.

[1] VSP Version 7.4 help file states that the assumptions required to assure validity of the confidence statement are:
1. The number of anomalies have been detected in the lot by geophysical detectors.
2. The site owners and regulators have agreed on the level of confidence required that at least 95% of the detected anomalies are not TOI.
3. Simple random sampling is used to select the anomalies that will be evaluated.
4. The detected anomalies cannot be inappropriately classified as TOI. That is, no non-TOI objects will be inappropriately classified as TOI

Targets will be reinvestigated as necessary to verify the results. If greater than 8% of targets per lot receive a “No Contact” designation all “No Contact” targets in the defined lot will be reacquired and surveyed using an EM61-MK2 to determine if the signal is detectable. The surface/surrounding area will be visually inspected to identify possible reasons for the area to be targeted as an anomaly.

Anomaly Resolution of DGM targets: The final check of all DGM anomalies will be conducted with an EM61 by trained UXO personnel IAW the Anomaly Resolution SOP DGM-003 (**Appendix D**) before the flag is considered clear. All anomalies must meet one of the outcomes specified in the Anomaly Resolution MPC in **Table 7-3**.

Table 7-3 Measurement Performance Criteria

Task/Data Type	Data Quality Indicator (DQI)	QC sample or measurement performance activity	Frequency	Measurement Performance Criteria	Consequence of Failure
DGM/ Geophysical Sensor Data	Response	Minimum of 30 seconds background data recorded, followed by at least 30 seconds of data collected for a static test item	Start and end of day for each DGM team	Response (mean static spike minus mean static background) within +/- 10% of the expected response unless otherwise defined in the IVS Report.	Day's dataset fails unless seed item is mapped that day with repeatable anomaly characteristics (see dynamic detection repeatability). Perform root cause analysis (RCA) and recollect data if necessary.
	Completeness	Geosoft Oasis Montaj Sample Spacing Tool used to assess data	Per Grid	98% of data ≤ 9.4 inches (25 cm) along line.	Grid data fails. Perform RCA and perform corrective action if necessary.
	Completeness	Geosoft Oasis Montaj Footprint Coverage Tool used to assess data	Per Grid	>90% coverage at project design line spacing and 98% coverage at 1 m line spacing.	Grid data fails. Perform RCA and perform corrective action if necessary.
	Accuracy	Geosoft Oasis Montaj used to assess data collection speed	Per dataset (transects only)	95% within 4 miles per hour unless higher speed is demonstrated at the IVS.	Dataset fails. Perform RCA and perform corrective action if necessary.
	Accuracy	IVS test and noise strip	Start and end of day for each DGM team	Interpreted position of installed targets ISO offset ≤ 9.4 inches (25 cm). ISO target amplitude measure by DGM equipment is repeatable to +/- 25% of the expected response unless otherwise defined in the IVS Report	Days' data fails. Perform RCA and perform corrective action if necessary.

Table 7-3 Measurement Performance Criteria (Continued)

Task/Data Type	Data Quality Indicator (DQI)	QC sample or measurement performance activity	Frequency	Measurement Performance Criteria	Consequence of Failure
DGM/ Geophysical Sensor Data	Accuracy	Detection and DGM location and amplitude of QC blind seeds	Blind seeds to be installed at a rate of one seed per grid	All blind seeds must be detected and selected in the DGM data and target list. The DGM interpreted position of 90% of the blind seeds(s) must be ≤ 9.8 inches (25 cm) + half the line spacing. The DGM BSI peak response must be >75% of the minimum expected response unless otherwise defined in the IVS Report.	Grid data fails. Perform RCA and perform corrective action if necessary.
	Accuracy	Confirm project network and control points	Monthly for frequently used points, before use, for infrequently used points	Project network must be tied to HARN, CORS, OPUS, or other recognized network. Project control points that are used more than once must be repeatable to within 5 cm.	Reset points not located at original locations.
Analog Data Collection and Investigation	Accuracy	Confirm analog system is functional (personnel and equipment)	Min 1 daily	All items in FCA detected.	Perform RCA and perform additional training of personnel or replace faulty equipment.
	Accuracy	Check repeatability on transects	Second party repeat of 2% per lot	Repeat a segment of transect and show number of counts repeated within the greater of ±20% or ±8, or within range of adjacent segments.	Redo lot.
Target Reacquisition (survey location stakeout and measurement)	Accuracy	Check of positional error at a known monument	Start and end of day, when Robotic Total Station, or DGPS is used	Positional error of the RTK DGPS at a known monument will not exceed ±0.328 ft (10 cm).	Perform RCA and redo affected work.

Table 7-3 Measurement Performance Criteria (Continued)

Task/Data Type	Data Quality Indicator (DQI)	QC sample or measurement performance activity	Frequency	Measurement Performance Criteria	Consequence of Failure
Intrusive Investigation/ Anomaly Resolution	Accuracy	SUXOS, UXOQCS verification of MEC/material documented as an explosive hazard (MDEH) identification. Correct categorization of MPPEH	All MEC/MDEH	Type, condition, and fuze condition of UXO/discarded military munitions (DMM) correctly identified, consistent with the Army Technical Manual (TM). MPPEH correctly assigned as MEC, MDEH, or MDAS.	Perform RCA and perform corrective action if necessary.
	Accuracy	Minimum of 30 seconds background data recorded, followed by at least 30 seconds of data collected for a static test item	Start and end of day for each sensor used for anomaly resolution	Response (mean static spike minus mean static background) within 25% of the expected response unless otherwise defined in the IVS Report.	Day's dataset fails unless seed item is mapped that day with repeatable characteristics (see dynamic detection repeatability). Perform RCA and recollect data if necessary.
	Accuracy	Verification checking with original instrument of anomaly footprint after excavation. Specific mV response will be recorded for the channel(s) associated with DGM target selection	Targets selected from DGM data: 100% checked with EM61 Analog targets: 2nd party checks open holes to determine: 90% confidence < 5% unresolved anomalies	Each target location has been searched to the extent of the digital footprint of the anomaly (for DGM targets) and until no unexplained signal remains for analog targets and one of the following occurs: • The remnant response is less than the RI specific target selection threshold defined in the IVS report; • The excavation has been identified and QC verified as saturated with fragmentation and no metal larger than 2 inches in any dimension remains; • It is identified and QC verified as cultural or construction material that cannot reasonably be removed; or • The abandoned target hole is QC verified as insufficiently dewatered.	Re-work excavation until one of the criteria are achieved.

Table 7-3 Measurement Performance Criteria (Continued)

Task/Data Type	Data Quality Indicator (DQI)	QC sample or measurement performance activity	Frequency	Measurement Performance Criteria	Consequence of Failure
Intrusive Investigation/ Anomaly Resolution	Accuracy	QC audit of DGM target identification data	Per submittal	DGM target identification (e.g., depth, length, weight, and type) is congruous with the original DGM anomaly amplitude and size.	Reacquire and re-investigate target of concern.
	Completeness	QC audit of intrusive investigation procedures	Daily	Intrusive investigations are performed in strict compliance with SOPs.	Perform RCA and perform corrective action if necessary.
	Completeness	QC audit of intrusive investigation dig	Per submittal	Intrusive investigation dig sheets are filled out completely and accurately for each DGM target.	Perform RCA and perform corrective action if necessary.
Analog Clearance	Response	Operators and detectors verified in FCA	Start and end of day for each operator	All items detected.	Perform RCA and perform corrective action if necessary.
	Completeness	Coverage seeds, nails, or other small metallic objects will be placed in the analog survey areas located on or just below the surface Detection seeds, small and large ISOs, will be placed at depths from 90-100% of the expected depth of detection	Per operator, per acre of mag and dig: Coverage: 2-5 nails or similar seed item Detection: variable rate, 1-2 large/ deep and 1-3 small/shallow	All blind coverage seeds and blind detection seeds recovered.	Perform RCA and perform corrective action if necessary.
Disposal of MEC/MDEH	Accuracy	Demolition Supervisor verification of proper positioning of explosives for disposal	Per disposal	Donor explosives are placed correctly for the type of munition(s) being destroyed. Disposal team follows the guidance from USACE disposal manuals.	Re-position explosives.
	Completeness	SUXOS verification of complete destruction	Per disposal	All explosive materials (MEC, MDEH and donor explosives) placed in a disposal shot are consumed by the explosion and there are no kick-outs.	Perform RCA and corrective action if necessary.

Table 7-3 Measurement Performance Criteria (Continued)

Task/Data Type	Data Quality Indicator (DQI)	QC sample or measurement performance activity	Frequency	Measurement Performance Criteria	Consequence of Failure
MPPEH Management/ MDAS Documentation	Accuracy	SUXOS verification of correct materials category assignment for recovered materials	Per grid	Materials removed from excavations are correctly identified as MEC, MDEH, or MDAS. UXO/DMM are identified consistent the Army TM. MDAS and MDEH are identified by weight and type. MDEH is further categorized by the hazard (estimated type and weight of explosives residue or component).	Correct documentation.
	Completeness	QC audit of MEC/MDEH management	Per submittal	Each item of MEC/MDEH "determined safe to move" is properly logged into the storage magazine and the magazine card is filled out correctly and signed. Safe to move MEC/MDEH is stored in the storage magazine and accounted for on a magazine card. Final disposition is accounted by zeroing the magazine card and cross accounted using the demolition operations report.	Perform corrective action.
MPPEH Management/ MDAS Documentation	Completeness	MPPEH Management QC Audit	Per submittal	MPPEH that has been reclassified and certified as MDAS is segregated from other materials stored in a locked container to prevent cross contamination and is accounted for by weight. Final disposition is accounted for using a DD Form 1348-1 when the material is certified safe and transferred to a qualified recycler.	Perform corrective action.
Site Restoration Documentation	Completeness	QC audit of restoration activities	Per submittal	Intrusive investigation holes are backfilled and leveled to grade. Ruts from utility vehicles are smoothed and backfilled where needed.	Redo work.

8.0 RISK ASSESSMENT

Explosive hazards will be evaluated based on the type and location of MEC found in addition to current site conditions to determine a hazard level for the MRS that represents the baseline hazard posed to human receptors. Assessing MEC hazards will be addressing the following:

- The likelihood of encounter, which is a function of the amount of MEC potentially present and site accessibility/receptor activities.
- The severity of an incident, which is the likelihood of an encounter relative to the severity of an item functioning.
- The sensitively of potential interaction/encounter, which is the sensitivity of MEC items relative to the energy likely to be imparted on an item by a receptor's activity.

A risk assessment for MC will be conducted for the Disposal Area MRS if samples are collected based on the MEC characterization effort. The risk assessment will be prepared IAW the USEPA Risk Assessment Guidance for Superfund (RAGS) and USACE EM 200-1-4, Volumes I and II (USEPA, 1989; USEPA, 1997; USACE, 1999; USACE, 2010b). The risk assessment includes an HHRA for human receptors, and a screening level ecological risk assessment (SLERA) for ecological receptors.

8.1 Human Health Risk Assessment

A baseline HHRA will be conducted using the most conservative risk-based concentrations from the current USEPA Regional Screening Levels (RSLs). The HRA assumes baseline conditions (i.e., no remedy would be implemented for existing chemical contamination). A "sum of ratios" approach will be used to characterize risk, with risk estimates being calculated using screening levels for residents and non-residents (i.e., industrial workers).

The HHRA consists of four basic steps:

- Hazard identification;
- Exposure assessment;
- Toxicity assessment; and
- Risk characterization.

These HHRA steps are described in further detail in the following sections.

8.1.1 Hazard Identification

The hazard identification step consists of reviewing and evaluating available data and identifying MC in the environmental media at the site. Incremental sampling of soil and discrete sampling of soil, sediment and surface water will be performed during the field investigation. The sampling program is summarized as follows:

- Discrete samples will be collected from soil directly associated with any new or compromised MEC items discovered. If no MEC items are identified no samples will be collected.
- If MEC burial pits/trenches are discovered, discrete samples will be collected from subsurface soil at the bottom of the burial pit/trench.
- If MEC burial pits/trenches are discovered, ISM surface soil samples will be collected from a 0.25- to 0.5-acre DU centered on the pit/trench for consistency with residential exposure. Three field replicates will be collected from each DU to assess relative standard deviation for sample results.

- If soil sampling resulting from one or more of the conditions above is performed during the RI, background samples will be collected using the same methods used on-site in an area located outside of the MRS not impacted by past MMRP range activities or current industrial activities.
- If MEC or burial pits are found in Posey Creek, co-located discrete sediment and surface water samples will be collected from the creek if water is present and will be assessed separately. Discrete soil samples will be collected from the creek bed and/or banks if water is not present.

The analytical suite for discrete and ISM soil samples is munitions-related metals and explosives.

If MEC is discovered and soil sampling for MC is performed during the RI, sediment samples and surface water samples (if water is present in Posey Creek) will also be analyzed for the same chemicals analyzed in soil. Soil samples will be collected from the creek bed and/or banks if water is not present.

The ISM samples and the discrete samples will be summarized separately for evaluation in the HHRA. Detected analytes will be retained for further evaluation in the HHRA. All ISM replicate sample results will be retained if an analyte is detected in at least one replicate. Analytes not detected in soil, sediment, or surface water samples are eliminated from the respective data set. Achievable laboratory limits presented in **Appendix B** (see Attachment 3) are below the project action levels (PALs). The range of reporting limits will be presented in the screening level tables. If media interference results in laboratory reporting limits that exceed screening levels, these elevated reporting limits will be discussed in the uncertainty analysis.

The higher value of detected concentrations of a normal investigative sample and a field duplicate sample will be used for discrete samples. If only the field duplicate or the normal investigative sample have a detected result, the sample with the detected concentration will be used. If neither sample has a reported detected concentration, the reporting limits will be averaged. The use of the more conservative value will be discussed in the uncertainty analysis.

Risk due to subsurface or surface soil exposure will be evaluated for all receptors. Analytical results will be initially screened against EPA residential RSLs presented in **Appendix B** (see Attachment 3) to complete the hazard identification step. The uncertainty analysis will address the impact that screening out metals below background concentrations has on total site hazard.

USEPA RSLs have not been developed for sediments or surface water. USEPA soil RSLs (Appendix B, Attachment 3) will be used as a conservative proxy value for evaluating human exposure to sediment. Surface water concentrations will be screened against the National Recommended Ambient Water Quality Criteria for human health presented in **Appendix B** (see Attachment 3). For chemicals lacking water quality criteria, USEPA drinking water RSLs (Appendix B, Attachment 3) will be used to conservatively evaluate surface water. An analyte whose maximum concentration exceeds its media-specific screening level will be retained for further evaluation in the HHRA.

If discrete sampling is performed on-site, background soil samples will be collected at 10 locations in an area located outside of the MRS that has not been impacted by past MMRP activities or current industrial activities. Background sample collection and analyses will be completed following the USEPA Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (EPA 540-R-01-003 [USEPA, 2002]). At least ten discrete background samples will be collected to develop a discrete background data set. If ISM is used to collect soil samples on-site, a background DU will also be established off-site and sampled mimicking the procedure used on-site (i.e., minimum of three field replicates with a

minimum of 30 increments per replicate). Background samples will be obtained from the same soil type/horizon/stratum as those collected within the MRS. Analytes below background will be excluded from further evaluation in the HHRA. The uncertainty analysis will address the impact that screening out metals below background concentrations has on total site hazard.

8.1.2 Exposure Assessment

The exposure assessment estimates the nature and magnitude of potential human receptor MC exposure considering the current and reasonably anticipated future uses of the site. The actual or potential pathways through which human receptors could be exposed to MC in soil, sediment, and surface water at the Disposal Area MRS are identified including characterization of the site-related MCs and the potentially exposed populations.

Human exposures are evaluated based on a reasonable maximum exposure (RME), identified as the maximum exposure reasonably expected to occur at a site. The RME is a conservative exposure scenario within the range of possible exposures for each complete pathway. RME typically refers to all exposure factors, including exposure frequency, duration, averaging time, body weight, and ingestion rates, in addition to the medium concentration to which individuals are exposed. This step also involves estimating medium-specific exposure point concentrations (EPCs) based on measured MC concentrations at the human exposure points.

8.1.2.1 Potentially Exposed Human Receptors and Exposure Pathways

A complete pathway includes a chemical source and release mechanism, a transport or retention medium, an exposure point where human contact with the contaminated medium occurs, and a route of intake for the contaminant into the receptor at the exposure point. A CSM illustrates the potential exposure pathways associated with a site, including the source, migration routes, and potential receptors for each source media. A human health CSM for MC exposure at the Disposal Area MRS is presented in **Figure 3-2**.

The Disposal Area MRS is located within Range Complex #1, a former small arms training and skeet range at the FUDS (USACE, 2006a). The property is currently leased for farming or industrial use with no anticipated changes to this condition. There currently is no drinking water use of groundwater from the Disposal Area MRS.

The groundwater migration pathway for human MC exposure is considered incomplete because of low mobility of contaminants of concern in soil, and because there are no human receptors for groundwater in the MRS or immediate vicinity.

Potential human populations and related exposure pathways are identified based on current and expected future land uses. The potential human receptors anticipated at the Disposal Area MRS consist of property owners, agricultural workers, and trespassers. A hypothetical future resident is also evaluated to provide a baseline for understanding site risks under an unrestricted use scenario. These receptors may be incidentally exposed to MC in soil, sediment, and surface water within the MRS while working or visiting the site.

Potential exposure routes for soil and sediment that will be evaluated include incidental ingestion, dermal contact, and dust inhalation. While dust inhalation from sediments would be limited due to saturated conditions, the dust inhalation exposure route is considered for sediment because the soil RSL used in the risk characterization includes this exposure route. While a portion of the MRS is farmed for winter wheat, there is limited potential for gardening of home grown produce to occur and there is uncertainty associated with quantifying biota consumption, so this exposure route is not considered in the HHRA. Potential exposure routes for surface water that will be evaluated include incidental ingestion and dermal contact. Posey Creek is ephemeral, so fishing in the creek would not be a complete exposure route. These

exposure routes are consistent with those used to develop USEPA RSLs for residents and non-residents (i.e., industrial workers).

After exposure pathways have been identified, daily intakes or doses of the MCs are quantified using standard residential and non-residential/industrial exposure algorithms. Because an HHRA is proposed using screening levels that incorporate generic, conservative exposure parameters, site-specific scenarios and exposure factors are not planned.

The standard exposure parameters used to develop residential and non-residential screening levels will be used and discussed in the exposure assessment. Both residential and industrial worker (to represent property owners, agricultural workers, and trespassers) exposures will initially be assessed using soil and groundwater (proxy for surface water) screening levels as selected in the hazard identification.

8.1.2.2 Exposure Point Concentration

The EPC is the concentration of a chemical to which a receptor may be exposed. Discrete and ISM samples will be evaluated separately and compared to background data sets. The maximum detected concentration will be considered for use as the EPC for discrete datasets.

However, assuming long-term contact with the maximum concentration of a contaminant is not reasonable. Because the potential long-term human exposure is unlikely to occur at a single location, the 95th percentile upper confidence limit (95% UCL) of the MC concentrations will also be used as the EPCs for the area should discrete locations indicate potential risk.

USEPA's risk assessment guidance suggests a concentration average is regarded as a reasonable estimate of the concentration likely contacted over time. Because of the uncertainty associated with any estimate of the representative average EPC, the 95% UCL on the arithmetic mean is generally used as the RME concentration (USEPA, 1989).

ISM gives a confident estimate of the true mean concentration within a DU, and the 95% UCL of the replicate soil sample results will be calculated IAW the methodology described in the ISM guidance document (ITRC, 2012) and used as the soil EPC for each DU.

The 95% UCLs are calculated using USEPA's ProUCL version 5.0.00 statistical program (2013). Sample results reported as below the quantitation limit (non-detects) are included in calculation of the 95% UCL. In the event the data set includes non-detect results, appropriate techniques for accommodating censored results provided in ProUCL, such as Kaplan-Meier estimation, will be used to estimate UCLs.

Background comparisons will also be performed using ProUCL and will follow the USEPA guidance "*Guidance for Comparing Background and Chemical Concentrations in Soil at CERCLIS Sites*," USEPA 540-R- 01-003 (2002).

8.1.3 Toxicity Assessment

IAW USEPA RAGS Part A (USEPA, 1989), the toxicity assessment weighs available evidence regarding the potential for particular contaminants to cause adverse effects in exposed individuals and provides, where possible, an estimate of the relationship between the extent of exposure to a contaminant and the increased likelihood or severity of adverse effects.

The toxicity assessment identifies these estimates of the potential cancer risks and non-cancer health effects of the MC. It also provides a description of the terms used to estimate toxic effects (i.e., cancer slope factors and non-cancer reference doses).

Toxicity data is built into the USEPA risk-based screening levels calculation. The toxicity data were obtained from the following sources in the order recommended in USEPA (2003) guidance:

- Tier 1 – Integrated Risk Information System (IRIS)
- Tier 2 – EPA's Provisional Peer Review Toxicity Values (PPRTVs) as presented in the RSL table (USEPA, 2016)
- Tier 3 – Other Toxicity Values, including the Agency for Toxic Substances and Disease Registry Minimal Risk Levels, toxicity values developed by state agencies (e.g., California EPA), and the Health Effects Assessment Summary Tables (HEAST) as presented in the Oak Ridge National Laboratory (ORNL) RSL table (USEPA, 2014b). HEAST is used as a last resort because it has not been updated since 1997.

The USEPA guidance provides additional information on the selection of toxicity values used in risk-based screening level development. A complete list of toxicity values used to develop the USEPA RSLs is provided in the RSL tables (USEPA, 2016). Toxicity values from the RSL tables will be included as an attachment to the HHRA.

8.1.4 Risk Characterization

In risk characterization, the results of the exposure and the toxicity assessments are integrated to provide a quantitative evaluation of the potential current and future cancer risks and non-cancer hazards to human health. The risk-based screening levels for comparisons with soil, sediment, and surface water EPCs are presented in **Appendix B** (see Attachment 3). A "sum of ratios" approach will be used to characterize risk, with risk estimates being calculated using published risk-based concentrations (i.e., RSLs) for residents and industrial workers. Risk estimates for these receptor groups are considered to be protective of property owners, agricultural workers, and trespassers, as the exposure of a resident and an industrial worker is anticipated to be greater.

Concentrations below human health risk-based screening levels are considered to pose no human health risk. Risk from lead will be assessed differently than risk from other COPCs. Risk will be assessed by direct comparison to the USEPA RSL of 400 milligrams per kilogram (mg/kg) for the residential scenario and 800 mg/kg for the commercial/industrial scenario. Concentrations above 400 mg/kg are considered to pose an unacceptable risk to residential receptors. Concentrations above 800 mg/kg are considered to pose an unacceptable risk to industrial worker (to represent property owners, agricultural workers, and trespassers). If concentrations exceed these screening levels, direct exposure with lead in soil will be evaluated by using blood lead modeling. The Integrated Exposure-Uptake Biokinetic Model for Lead in Children model will be used to evaluate the residential exposure scenario and the EPA Adult Lead Model will be used to evaluate the non-residential exposure scenarios.

Chemicals (except lead) whose maximum concentrations exceed screening levels will be evaluated further in the risk characterization. EPCs (except lead) will be screened against applicable risk-based screening levels for residential and non-residential land use to provide an estimate of non-cancer risk, termed the Hazard Quotient (HQ) and cancer risk, termed the incremental lifetime cancer risk (ILCR).

Noncancer HQs are calculated as the ratio of the EPC divided by the risk-based screening levels based on a target HQ of 1. The total Hazard Index (HI) will be calculated as the sum of individual chemical HQs.

If the HI is less than or equal to 1, the contaminant concentration is considered acceptable. If the HI exceeds 1, COPCs will be segregated by target endpoint and HQs will be summed for

COPCs with the same target endpoint to determine if the target endpoint HI is considered acceptable.

The ILCR is calculated as the EPC divided by the risk-based screening levels based on cancer effects multiplied by a factor of $1E^{-06}$. Total ILCR is calculated as the sum of individual chemical ILCRs.

For known or suspected carcinogens, USEPA establishes excess cancer risks lower than $1E^{-06}$ (also expressed as 1×10^{-6} or one in one million) are considered "de minimus" and are not addressed by the USEPA.

Excess cancer risks in the range of $1E^{-06}$ to $1E^{-04}$ may or may not be considered acceptable, depending on site-specific factors such as the potential for exposure, technical limitations to remediation, and data (USEPA, 1991). When reasonable maximum exposures for both current and future land use are less than $1E^{-04}$, action is generally not warranted (USEPA, 1991).

The non-cancer and cancer risk for each DU and each soil exceedance area will be assessed separately. For surface water and sediment, upstream and downstream locations (if applicable) will be evaluated separately and compared.

The risk characterization will also identify uncertainties associated with contaminant, toxicity, or exposure assumptions and will provide a qualitative evaluation of their potential to overestimate or underestimate the site risk.

8.2 Ecological Risk Assessment

An ERA will be conducted to determine whether munitions-related metals and explosives released to soil, sediment, and surface water from the Disposal Area create a potentially unacceptable risk to ecological receptors. If needed, the results of the ERA will also be used to establish acceptable remediation levels or alternative remedies that are protective of the ecological receptors based on current and future site usage.

USEPA ERA guidance (1997) defines the ERA as a "process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors." The approach proposed for this ERA is primarily based on the following guidance documents:

- *Guidelines for Ecological Risk Assessment* (USEPA, 1998);
- *Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997);
- *Framework for Ecological Risk Assessment* (USEPA, 1992);
- *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (USEPA, 2001);
- *Risk Assessment Handbook Volume II: Environmental Evaluation, EM 200-1-4, Volume II* (USACE, 2010b); and
- *A Guide to Screening Level Ecological Risk Assessment TSERAWG TG-090801* (Tri-Service Environmental Risk Assessment Working Group, 2008).

The primary guidance used to perform the ERA is USEPA's 1997 ERAGS interim final document. This guidance outlines an eight-step process incorporating several scientific and management decision points (SMDPs) intended to ensure the "risk assessment is proceeding in a direction that is acceptable to the risk assessor and the risk manager." These eight steps are discussed in the following subsections.

8.2.1 Screening Level Ecological Risk Assessment

The USEPA will begin with a SLERA, the first two steps of USEPA's (1997) eight-step ERA process:

- Step 1 – Screening level problem formulation and ecological effects evaluation; and
- Step 2 – Screening level exposure estimation and risk characterization.

In Step 1, the environmental setting will be characterized, COPECs will be selected, potential exposure pathways and receptors will be identified, assessment and measurement endpoints will be identified, and a screening level ecological effects evaluation will be performed. In Step 2 of the SLERA, exposure of ecological receptors to preliminary COPECs will be estimated, and risk will be characterized by comparing exposure concentrations with the ecotoxicity screening values presented in Step 1. This comparison is termed the HQ approach, and an HQ will be calculated for each constituent for each receptor group as follows:

$$HQ = EPC/ESV$$

Where:

HQ = hazard quotient

EPC = exposure point concentration

ESV = ecological screening value

The maximum reported concentration is typically used as the EPC in a SLERA to provide a conservative assumption of exposure.

The soil, sediment, and surface water data collected from the Disposal Area MRS will be evaluated in the SLERA. Detected analytes will be retained for further evaluation in the SLERA. Analytes not detected in soil, sediment, or surface water samples will be eliminated from their respective data set. Achievable laboratory limits presented in **Appendix B** (see Attachment 3) are below the PALs. The range of reporting limits will be presented in the screening level tables. If media interference results in laboratory reporting limits that exceed screening levels, these elevated reporting limits will be discussed in the uncertainty analysis.

The analysis of the data will be based on methodology presented in *Guidance for Data Usability in Risk Assessment, Part A* (USEPA, 1992) and the Tri-Service Environmental Risk Assessment Working Group's 2008 SLERA guidance. Detected concentrations from field duplicate samples are averaged. If only the field duplicate or the normal investigative sample have a detected result, the sample with the detected concentration is used. If neither sample has a reported detected concentration, the reporting limits are averaged.

For the SLERA, maximum detected concentrations (or maximum reporting limits if there are no detections) will be screened against USEPA recommended screening levels IAW the following hierarchy:

Soil:

- Site-specific background levels for naturally-occurring chemicals;
- USEPA Ecological Soil Screening Levels (Eco-SSLs; USEPA, 2005a, 2005b, 2005d, 2007b, 2007c);
- Los Alamos National Laboratory (LANL) EcoRisk Database Version 3.3, no effect level (LANL, 2015); and
- Other literature sources.

Sediment

- Consensus-based sediment quality, threshold effect concentration (MacDonald et al. 2000);
- National Status and Trends program sediment benchmarks (Long and Morgan, 1990);
- USEPA Region 4 Ecological Screening Values (ESVs) for sediment (USEPA, 2015); and
- Other literature sources.

Surface Water (Chronic values)

- Kansas Surface Water Quality Standards: Tables of Numeric Criteria (assume hardness of 100 milligrams per liter) (KDHE, 2012);
- USEPA Region 4 ESVs for freshwater (USEPA, 2015);
- USEPA Region III Biological Technical Assistance Group (BTAG) Screening Levels for freshwater (USEPA, 2006b); and
- Other literature sources.

Proposed ecological benchmarks are provided in **Appendix B** (see Attachment 3). The ecological benchmarks are based on receptors and exposure pathways taking into consideration land use, distribution of contaminants in the soil, sediment, and surface water, presence and types of receptors, and the presence of a complete migration pathway. The maximum soil concentrations will be compared to the lowest soil benchmark provided in **Appendix B** (see Attachment 3). The maximum detections in surface water will be compared to the chronic fish and aquatic life water quality criteria and the maximum sediment detections will be compared to the sediment threshold effect concentrations identified in **Appendix B** (see Attachment 3).

Benchmarks will also be based on no effect toxicity values to ensure risks are not underestimated and to provide a defensible conclusion that negligible ecological risk exists or that certain contaminants and exposure pathways can be eliminated from consideration (USEPA, 1997). Comparison to surface water criteria provides an evaluation of potential impacts to aquatic plants and fish. Aquatic life criteria for toxic chemicals are the highest concentration of specific pollutants in water that are not expected to pose a significant risk to the majority of species in a given environment (https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table). Comparison to sediment benchmarks provides an evaluation of potential risk to aquatic invertebrates. Comparison to sediment benchmarks provides an evaluation potential risk to aquatic invertebrates. Constituents that lack an ecological benchmark will be retained for evaluation in the uncertainty section.

Some chemicals are bioaccumulative and tend to increase in concentration within some species tissue when compared to the concentration in environmental media. Bioaccumulation is an important aspect of ecological risk assessment because it can result in increased exposure to various trophic levels when compared to COPCs that do not bioaccumulate. Bioaccumulative COPCs can be present at a concentration in environmental media that is protective for direct exposure, but that can pose risk to higher trophic levels through accumulation in the food chain.

Therefore, as part of the screening process, detected chemicals will be evaluated for potential bioaccumulation. Those that bioaccumulate will not be eliminated from further evaluation of risk to upper trophic level species even if the reported concentrations are less than the selected benchmark. Maximum soil concentrations will also be compared to receptor-group specific ESVs for plants and soil invertebrates, and to ESVs based on food-chain modeling for herbivorous, insectivorous, and carnivorous birds and mammals obtained from the above

hierarchy of sources. The SLERA will evaluate food chain impacts from sediment through use of soil ecological benchmarks based on food chain modeling. These benchmarks are considered protective of aquatic dependent mammals and birds as Piney Creek is ephemeral.

The KDWPT and the USFWS list 12 federal and state threatened and endangered species that have potential to be present within Cowley County (KDWP, 2005). Neither KDWPT nor USFWS indicated any areas of the FUDS were managed for ecological purposes or qualified as IEPs or sensitive environments. Habitat that supports listed species is not present within the FUDs.

An ecological CSM that shows the source, migration routes, and potential receptors for each source media is presented in **Figure 3-3**. The CSM will be updated based on results of the RI sampling.

8.2.2 Problem Formulation

At the completion of Step 2 is an SMDP, indicating whether additional action is warranted. At an HQ less than 1, harmful effects are not likely and at an HQ equal to 1, the contaminant alone is not likely to cause ecological risk (USEPA, 2011). If the media concentration exceeds the benchmark (i.e., HQ>1), the ratio indicates that the receptor group may be at risk to an adverse effect from the chemical through that exposure route, as the potential for harmful effects cannot be ruled out (USEPA, 2011). Because the benchmarks incorporate a number of extrapolation factors and are based on the most conservative findings, an exceedance of the benchmark does not necessarily indicate that an adverse effect will occur. This quantitative analysis is used to identify adverse risks for further assessment or conclude with a finding of negligible ecological risk.

The SLERA outcome develops the problem formulation, which is Step 3 of the ERA process. In the problem formulation a description of the complete exposure pathways and the MC identified in the SLERA are summarized. Recommendation for future action is provided.

Step 3 includes two component steps, Steps 3a and 3b. Step 3a includes refinement of the risk estimates from Steps 1 and 2, and Step 3b provides additional problem formulation for sites with greater ecological concerns (USEPA, 2001).

Step 3a, known as refining preliminary contaminants of ecological concern, is performed at the completion of Steps 1 and 2 (if needed) and is included in the SLERA document. This step provides a refinement of conservative screening level assumptions to consider how risk estimates would change if more realistic assumptions were used (USEPA, 2001). Step 3a includes the following:

- Comparison to low effect water quality criteria (e.g., acute criteria);
- Comparison to low effect concentrations for sediment (e.g., probable effect concentrations [PEC]);
- Comparison to site-specific background levels for anthropogenic chemicals;
- Comparison to ESVs (e.g., Eco-SSLs) for protection of plants and soil invertebrates;
- Comparison to ESVs (e.g., Eco-SSLs) for protection of herbivorous, insectivorous, and carnivorous birds and mammals; and
- Refinement of food chain modeling to evaluate risk to higher trophic level receptors using representative average exposure concentrations, area use factors, and low effect toxicity reference values.

For the SLERA, it is assumed that the home range of one or more animals is entirely within the contaminated area, and thus the animals are exposed 100% of the time. Exposure considerations, such as home range of the species in relation to the size of the impacted area is

considered in Step 3a, which is a transition from a SLERA to a baseline ecological risk assessment (BERA). If the size of the impacted area is considerably less than the home range of a local area receptor, an area use factor (AUF) would suffice to demonstrate that contaminants do not pose risk. For surface water and sediment, low effect criteria represent the lowest exposure level shown to produce adverse effects in a potential indicator species. Exposure to wildlife through food chain or trophic transfer and through direct contact exposure is also considered in Step 3a. Presentation of acute water quality criteria is an important component in characterizing risk to aquatic systems. Acute criteria are considered to be applicable because the surface water is ephemeral; long-term (chronic) exposure to ephemeral surface water would not occur.

During Step 3a (if needed), the ERA focuses on assessing risk to insectivorous small mammals (i.e., least shrew) and insectivorous avian receptors (i.e., snowy plover) through a desk-top approach to food chain exposure and risk to these receptors. The HQ method will be used to compare contaminant intake to no effect and low effect toxicity reference values (TRVs).

Literature-based values are used to estimate contaminant intake via food, soil, sediment, and water. Intake parameters including body weights, food ingestion rates, soil ingestion rates, water intake rates, and home range will be obtained from literature sources. Information on habitats present, migratory patterns, and extent of contamination are used to develop site-specific area use factors for the identified ecological receptors. Proposed intake factors for the Disposal Area FUDS are provided in **Table 8-1**. The dose-based HQs will be calculated for the shrew and plover using the following equation (Equation 4-2, USEPA, 2007a):

$$HQ_j = [FIR \times (Soil_j \times Ps + B_{ij})\} + [WIR \times Water_j] / TRV_j$$

Where:

FIR = food ingestion rate (kg food [dry weight]/kg body weight [bw, wet weight]/day)
$Soil_j$ = concentration of contaminant j in soil or sediment (mg/kg dry weight)
Ps = proportion of diet that is soil/sediment
B_{ij} = concentration of contaminant (j) in food type (i) mg/kg [dry weight]
WIR = kg water/kg bw
$Water_j$ = concentration of contaminants (j) in water (mg/L)
TRV_j = Toxicity reference value for contaminant (j) (mg [dry weight]/kg bw [wet weight]/d).

Tissue concentrations will be estimated from soil using soil bioconcentration factors (BCFs) and from sediment using biota sediment accumulation factors (BSAFs). BCFs and BSAFs are presented in the literature to model the uptake of chemicals in specific media to certain species.

BCFs are applied to soil concentrations to estimate concentrations in plants, soil invertebrates, and small mammals. BSAFs are applied to sediment concentrations to estimate concentrations in fish and benthic organisms. BSAFs and equations for such modeling will be obtained from literature sources (USEPA, 2005c; Bechtel Jacobs Company LLC [BJC], 1998; USEPA, 2014; LANL, 2015).

To provide a range of ecological hazards from contaminant exposure, TRVs based on no effect and low effect thresholds will be used in the HQ calculations. A four-way approach will be used to assess refined risk, ranging from more conservative to more realistic case, as follows:

HQ1 = 95% UCL concentration or dose /no-effect ESV or TRV
HQ2 = 95% UCL concentration or dose /low-effect ESV or TRV
HQ3 = Average concentration or dose /no-effect ESV or TRV
HQ4 = Average concentration or dose /low-effect ESV or TRV

Table 8-1
Intake Factors for the Indicator Species

Functional Group	Indicator Species	Body weight (BW) (g)		Food ingestion rate (g DW/g BW-day)		Water intake rate (g/g-day)		Home Range (acres)		Percent of diet as soil or sediment (unitless)	
Insectivorous small mammal	least shrew	4-6	Mammals of Kansas (http://kufs.ku.edu/media/kufs/libres/mammals_of_kansas/cryptotus-par.html)	0.209	EPA, 2007; short-tailed shrew	0.001	WI (L/day) = 0.099 Wt0.90 (kg); WEFH; maximum BW	0.3 hectares	Mammals of Kansas (http://kufs.ku.edu/media/kufs/libres/mammals_of_kansas/cryptotus-par.html)	3.0	EPA, 2007; short-tailed shrew
Insectivorous bird	snowy plover	34 - 58	Birds of North America Online: http://bna.birds.cornell.edu/bna/species/154 doi:10.2173/bna.154	0.28	Nagy, 2001; g DMI/day = 0.54*(g BW)^0.705; Maximum BW for intake divided by minimum BW	0.009	WI (L/day) = 0.059 Wt0.67 (kg); WEFH; maximum BW	3 km foraging area; earliest arrive March 17; latest depart October 13	Busby, 2002	16.4	EPA, 2007; value for woodcock

Busby, William H. 2002. Kansas Recovery Plan for the Snowy Plover. December 2002.

EPA, 2007. Attachment 4-1. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs) Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs. OSWER Direction 9285.7-55. April 2007.

Nagy, 2001. Food requirements of wild animals:predictive equations for free-living mammals, reptiles, and birds.Nutrition Abstracts and Reviews, Series B 71, 21R-31R.

WEFH = EPA. 1993. Wildlife Exposure Factors Handbook. EPA/600/R-93/187. December 1993.

BW = body weight
DW = dry weight
g = gram
g DMI/day = gram of dry matter intake per day
g/g-day = grams water per grams body weight per day
g DW/g BW-day) = gram of dry weight per gram body weight per day
kg = kilogram
km = kilometer
L/day = liter per day

TRVs will be obtained from the literature, primarily from the USEPA Eco-SSL documents (2005a; 2005b; 2007a; 2007b), from USEPA Region 9 BTAG (2002; 2009) and from the LANL EcoRisk database. Proposed BSAFs, BCFs, and TRVs are provided in **Table 8-2**.

If the HQ based on a no effect TRV is below 1 for a chemical, it generally is not retained for further evaluation. If the HQ is greater than 1, the chemical is present at a level at which a potential for adverse ecological effects may occur.

8.2.2.1 Risk Characterization and Uncertainty Analysis

Risk characterization integrates the exposure and ecological effects characterizations in a way that quantifies the nature and extent of potential ecological risk at the site. The primary goal of ecological risk characterization is to incorporate a weight-of-evidence approach, where multiple lines of target indicator species exposure (i.e., food chain modeling HQ method) are presented and evaluated and final conclusions drawn as to the overall potential impact.

Endpoints will be evaluated collectively as part of a weight-of-evidence approach. The greatest amount of weight is given to results of tissue analysis and uptake modeling to higher receptors.

For any environmental assessment process, many uncertainties are associated with estimating exposure and risks to ecological organisms. An uncertainty analysis will be performed to address the major assumptions that affect the degree of confidence in the estimate of risk.

Important sources of uncertainty and whether they result in an underestimate or overestimate of ecological risk at the site will be described. Highly uncertain parameters and assumptions that, if better understood, could alter the conclusions of the assessment are the most important to identify.

Uncertainty can be associated with (1) exposure parameters, bioaccumulation factors, and other information taken from the literature; (2) extrapolations used in developing a screening-level benchmark or TRV; (3) site data, or the lack thereof; and (4) elements of the CSM, such as chemical fate and transport and wildlife use of the site. These variables will be evaluated in the uncertainty analysis.

Table 8-2 Chemical-Specific Values

Chemical Name	Soil (Cs) to Earthworm (Ce) Uptake Factor[a,b]	Biota Sediment Accumulation Factor (dry weight basis)[b,c]	TRV[e] mg dw/kg bw/d		Alternative TRV[f] mg dw/kg bw/d	
			Avian	Mammal	Avian	Mammal
Antimony	Ce = Cs	1[d]	NA	0.059	NA	13.3
Copper	Ce= 0.515 * Cs	7.957	4.05	5.6	18.5	25
Lead	ln(Ce) = 0.807 * ln(Cs) - 0.218	0.946	1.63	4.7	10.9	40.7
Zinc	ln(Ce) = 0.328 * ln(Cs) + 4.449	8.465	66.1	75.4	172	411
Explosives						
1,3,5-Trinitrobenzene	0.063	0.063	0.422	13.4	4.22	134
1,3-Dinitrobenzene	0.568	0.568	NA	0.113	NA	0.264
2,4,6-Trinitrotoluene	0.0581	0.085	9.75	34.7	17.8	160
2,4-Dinitrotoluene	0.893	0.893	NA	2.68	NA	26.8
2,6-Dinitrotoluene	1.14	1.14	60	1.77	600	17.7
2-Amino-4,6-dinitrotoluene	4.33	2.49	9.59	95.9	NA	959
4-Amino-2,6-dinitrotoluene	3.78	6.25	NA	13.9	NA	139
HMX	0.313	0.017	NA	75	NA	200
3-Nitrotoluene	2.73	2.73	NA	10.7	NA	107
Nitrobenzene	1.34	1.34	NA	5.9	NA	59
Nitroglycerin	0.347	0.347	NA	96.4	NA	1020
2-Nitrotoluene	1.98	1.98	NA	8.91	NA	89.1
PETN	0.298	0.298	NA	70	NA	700
Picric acid	NA	NA	NA	2[g]	NA	10[g]
4-Nitrotoluene	2.33	2.33	NA	19.6	NA	196
RDX	2.63	0.192	2.36	8.94	4.49	28.3
Tetryl	0.079	0.079	NA	1.3	NA	6.2

Notes:

dw = dry weight

NA = not available.

NUT = essential nutrient

[a] USEPA, 2007a. Attachment 4-1. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs).

[b] Los Alamos National Laboratory (LANL), 2015. ECORISK Database Release 3.3. Environmental Programs, Engineering and Technology Division. October 2015.

Table 8-2 Chemical-Specific Values

Chemical Name	Soil (Cs) to Earthworm (Ce) Uptake Factor[a.b]	Biota Sediment Accumulation Factor (dry weight basis)[b,c]	TRV[e] mg dw/kg bw/d		Alternative TRV[f] mg dw/kg bw/d	
			Avian	Mammal	Avian	Mammal

http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php. Uptake factors on dry weight basis.

[c] 90th percentile, highest of depurated, non-depurated and all presented in BJC, 1998. BJC, 1998. Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation. August 1998. BJC/OR-112.

[d] Earthworm bioaccumulation factor (USEPA Eco-SSL document for antimony).

[e] TRV from USEPA Eco-SSL [metals] and LANL [explosives] documents, unless noted):

The mammalian wildlife TRV for antimony is equal to 0.059 mg antimony/kg bw/day, which is the highest bounded no observed adverse effects level (NOAEL) below the lowest bounded lowest observed adverse effects level (LOAEL) for effects on reproduction, growth or survival.

The avian wildlife TRV for copper is equal to 4.05 mg copper/kg bw/day, which is the highest NOAEL value lower than the lowest bound LOAEL value for effects on reproduction, growth or survival.

The mammalian wildlife TRV for copper is equal to 5.60 mg copper/kg bw/day, which is the highest NOAEL value lower than the lowest LOAEL value for reproduction and growth.

The avian wildlife TRV for lead is equal to 1.63 mg lead/kg bw/day, which is the highest bounded NOAEL below the lowest bounded LOAEL for effects on growth, reproduction, and survival.

The mammalian wildlife TRV for lead is equal to 4.70 mg lead/kg bw/day, which is the highest bounded NOAEL below the lowest bounded LOAEL for results in the growth, reproduction, and survival effect groups.

The avian wildlife TRV for zinc is equal to 66.1 mg zinc/kg bw/day, which is the geometric mean of NOAEL values for effects on reproduction and growth.

The mammalian wildlife TRV for zinc is equal to 75.4 mg zinc/kg bw/day, which is the geometric mean of NOAEL results within the reproduction and growth effect groups.

[f] Alternative TRV from USEPA Eco-SSL [metals] and LANL [explosives] documents, unless noted):

The geometric mean of the NOAEL values for growth and reproductive effects equals 13.3 mg antimony/kg bw/day but is higher than the lowest bounded LOAEL for reproduction, growth, or mortality effects.

The geometric mean of the NOAEL values is equal to 18.5 mg copper/kg bw/d and is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival effect groups.

The geometric mean of the NOAELs is equal to 25.0 mg copper/kg bw/d and is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival effect groups.

The geometric mean of the NOAELs is equal to 10.9 mg lead/kg bw/d but is higher than the lowest bounded LOAEL within the reproduction, growth, and survival effect groups.

The geometric mean of the NOAELs is equal to 40.7 mg lead/kg bw/d but is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival effect groups.

The high TRV for zinc based on growth, reproductive, multiple organs effects in mallard from study by Gasaway & Buss, 1972, as presented in USEPA Region 9 Biological Technical Assistance Group (BTAG) Recommended Toxicity Reference Values for Birds (Revision Date 02/24/09).

The high TRV for zinc based on development effects in rats from study by Schlicker & Cox, 1968 as presented in USEPA Region 9 BTAG Recommended Toxicity Reference Values for Mammals (Revision Date 11/21/2002).

[g] U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), 2005. Wildlife Toxicity Assessment for Picric Acid (2,4,6-Trinitrophenol). USACHPPM Document No: 37-EJ1138-01J.

9.0 INVESTIGATION-DERIVED WASTE PLAN

Waste management practices and procedures that will be followed for the types and quantities of waste expected to be generated during this RI are discussed in the following subsections. This waste management plan was prepared IAW the guidelines of Engineer Manual (EM) 200-1-15 (USACE, 2015) and USEPA's *Management of Investigation-Derived Wastes During Site Inspections* (USEPA, 1991).

9.1 Types and Quantities of Waste

Waste streams requiring disposal could potentially include soil, other solid waste (e.g., concrete), non-munitions related metallic debris, and MDAS; all are considered IDW.

9.1.1 Waste Soil

During anomaly/burial pit excavation, soil that is removed from the excavation site will be generated. Unless visual observation of contamination (odor, color, sheen) is observed, the soil will be placed back into the excavation site once the sampling/inspection is complete. No waste soil stream requiring disposal is anticipated. If visual observation of contamination is observed, the protocols described in the Hazardous Waste section will be followed (**Section 9.2.5**).

9.1.2 Other Solid Wastes

During the surface clearance and intrusive operations, teams may encounter solid wastes (e.g., concrete) that will require removal. In addition, the investigation activities will generate IDW (e.g., survey stakes, material packaging, disposable sampling equipment). Given the nature of the RI activities, estimating the quantity of solid waste is difficult.

9.1.3 Non-Munitions Related Metallic Debris

During the surface clearance and intrusive operations, teams may encounter metallic debris in the MRS that will require removal. Given the nature of the RI activities, estimating the quantity of non-munitions related metallic debris is difficult.

9.1.4 Material Documented as Safe

MPPEH inspection procedures include procedures for defining material as MDAS. These procedures are presented in the MPPEH Management SOP (**Appendix D**).

9.2 Waste Management Activities

The information below describes the procedures to be taken in the unlikely event that suspect hazardous wastes are encountered.

9.2.1 Characterization

Hazardous waste characterization is not anticipated for this project. The MPPEH Management SOP (**Appendix D**) describes the inspection process for characterizing MDAS.

9.2.2 Storage

Non-munitions related metallic debris and other solid wastes will be staged on-site in appropriate containers. Metal bins, wood bins, or polyethylene drums will be used to store other debris, as required.

9.2.3 Management

Temporary waste storage areas including staging areas for drums, roll-off bins, or dumpsters will be established as needed and in coordination with the respective property owners. Any temporary waste storage area established will be dismantled after IDW is transported off-site.

9.2.4 Disposal

Nonmetallic debris will be placed into the work area dumpster(s) for municipal disposal. If large quantities of nonmetallic debris are encountered, a temporary staging area may be established while more appropriate transportation (e.g., dump truck) can be arranged.

Metallic debris (both munitions and non-munitions-related) will be containerized into drums or roll-off bins (locking, when necessary) and transported by R.S. Davis Recycling (Clackamas, OR) for off-site disposal. Disposal of MDAS will include the proper chains of custody, documentation, and destruction requirements as outlined in the MPPEH Management SOP (**Appendix D**).

9.2.5 Hazardous Waste

If evidence of hazardous or toxic wastes such as drums, chemical odors, or stained soil is encountered, excavation will cease. The excavation will be left open and marked with warning tape or drift fence. USACE will be notified. Additional characterization, management, and disposal planning will be coordinated at that time. Hazardous waste operations will be conducted IAW 40 Code of Federal (CFR) Regulations parts 260 through 268.

9.2.6 Responsibility

The SUXOS or designee will coordinate disposal of IDW and will be responsible for ensuring the proper signatures are present, as needed.

9.3 Wastewater

Hazardous wastewater is not anticipated during the execution of this RI. Previous investigations at the MRS have indicated that potential for MC contamination is unlikely given the type of munitions previously discovered. Low quantities of wastewater may be generated during sampling (e.g., rinsate) and will be applied to the land in the vicinity of the sample collected.

9.4 Waste Minimization

Personnel are encouraged to minimize waste when appropriate. Metallic debris will be recycled. In addition, plastic drinking bottles may be collected and recycled.

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10.0 EXPLOSIVES MANAGEMENT PLAN

Explosives will be used to dispose of and/or vent MEC and MPPEH encountered during the field effort. This Explosives Management Plan describes procedures for the management of those explosives.

10.1 Acquisition

10.1.1 Description and Estimated Quantity of Explosives

Initially, donor explosives may include, but will not be limited to, detonating cord, shaped charges, detonators, shock tube, smokeless powder, squibs, and time fuse. Quantities of these items will vary by availability and project needs. Net explosive weight will not exceed 30 lbs of combined Hazard Division 1.1 and 1.3 explosives. In accordance with DoD guidelines, Hazard Division 1.4 explosives may be stored to the physical capacity of the magazine(s).

10.1.2 Acquisition Source

Commercial explosives will be obtained through, and delivered by, Buckley Powder Company of Prior, Oklahoma. Buckley Powder will also provide ATF Type 2 magazines. Government furnished explosives will not be used.

A State of Kansas explosives permit is already in-place and in accordance with State regulations, proof of annual/refresher training for explosives will be provided to the State. The explosive distributor will be provided a copy of USACE's contractor's ATF license and a certified statement of the intended use of the explosive material.

10.2 Initial Receipt

10.2.1 Receipt of Explosives from Vendor

The SUXOS will contact the explosives vendor to coordinate explosives delivery. The SUXOS and UXOSO or UXOQCS will inventory the received explosives, ensuring the correct quantities and lot numbers are delivered. Any discrepancies will be resolved before signing the receipt. They will then sign the vendor's delivery receipt and retain a copy. All receipts and packing lists must be retained in the project files.

After receipt of explosives, the UXOSO or UXOQCS will record the quantities and lot numbers issued on a magazine data card. A copy of the data card will be placed in the magazine, and a copy kept in the site office. Tamper-evident seals will be applied to the magazine after the inventory count is completed.

10.2.2 Reconciliation of Discrepancies in Delivery

If the quantity delivered does not match the quantity or lot numbers shipped, the SUXOS will notify the explosive vendor and the PM and investigate the discrepancy. If the discrepancy is resolved, the receipt will be signed and a memorandum documenting the discrepancy, investigation, and resolution will be prepared and filed with the project record. If the discrepancy cannot be resolved the shipment will be rejected and the discrepancy reported to ATF.

10.3 Storage

10.3.1 Explosives Storage Facilities Establishment

A temporary explosive storage facility will be established at the location approved in the ESP. Donor explosives will be stored in an ATF Type 2 portable magazine with attached detonator magazine (or two magazines sited as a complex).

The inhabited building distance is 200 ft and public transportation route distance is 120 ft (DoD 6055.09-M, Table V3.E3.T2; DoD, 2010).

Magazines will comply with ATF specifications as outlined in Title 27: Alcohol, Tobacco, and Firearms, Part 555, "Commerce in Explosives," Subpart K, Storage, and will be sited according to the DDESB-approved ESP.

The magazine(s) will be grounded for lightning protection. National Fire Protection Agency (NFPA) Code 780 allows an ATF Type 2 magazine to act as both the terminal and air conductor of a lightning protection system. While the NFPA code requires only a single ground, the Army requires two grounding rods at opposite corners of the magazine, at least 3 ft from the magazine per EM 1110-1-4009 (USACE, 2003). Rods must be at least 3/4 inch in diameter and 10 ft in length, not made of stainless steel, and the top should be driven a minimum of 1 ft bgs.

The rods must be bonded to the magazine with #2/0 copper cable. Resistance across the bonds must be 1 ohm or less. Services of a local electrical subcontractor will be used to install the grounding rods and conduct a three-point fall of potential test. The grounding system will be inspected and tested periodically. This includes a visual inspection every six months and an electrical test upon installation and annually.

Explosives will remain in their packaging until removed from the magazine for use. Only explosives will be stored in the magazines; tools, excess packing material, etc., will be stored separately. The field team will use non-spark-producing tools to open explosives packaging. If maintenance to an explosives storage magazine is necessary during the RI, the magazine will first be emptied of explosives.

10.3.2 Physical Security of Explosives Storage Facility

The magazine(s) will be placed inside a steel storage container (Conex). A tamper evident seal is used to detect unauthorized entry to the Conex. The seal number is recorded by the SUXOS and UXOSO or UXOQCS, and the integrity of the seal is verified before breaking it.

The magazine will be locked with padlocks that are compliant with ATF standards as outlined in ATF Pamphlet 5400.7 (ATF, 2012). Compliant locks will be used by the field team. The SUXOS and UXOSO or UXOQCS will inspect the magazine at least once every seven days for signs of unauthorized entry or tampering.

10.4 Transportation

10.4.1 Transportation from Storage Facility to Disposal Locations at the MRS

Explosives will be transported from the magazine to the MRS by vehicle on existing roads. Detonators and donor explosives are transported in the same vehicle. The detonators are transported in an Institute of Makers of Explosives (IME) Standard 22 detonator box physically separated from the donor charges. Explosives will be transported in containers as outlined in **Table 9-1**. Explosives containers will be secured to the bed of the vehicle and the load covered.

Placarding is not required for this project because the explosives used are Hazard Division 1.4 in quantities less than 1,001 lbs (49 CFR 172.504 [c]). Because no placarding is required, the vehicle operator does not require a commercial driver license or hazmat endorsement. A commercial driver license with a hazardous material endorsement is only required to operate a vehicle requiring placards (49 CFR 383.5).

10.4.2 Explosives Transportation Vehicles

The explosives transportation vehicle will be inspected prior to loading and after unloading the explosives; both inspections are documented on a DoD Form 626. The vehicle will be equipped

with a first aid kit and at least two 10-lb B:C fire extinguishers. The bed of the vehicle will be lined with wood. Explosives transportation vehicles may not have a fuel transfer tank onboard when transporting explosives.

Table 10-1 Donor Explosives Packaging for Transportation

Explosive Item	Hazard Division Compatibility Group	UN Number	49 CFR 173.62 Packing Method	Inner Package	Outer Package
Non-electric detonator assemblies	1.4 B	UN0361	131	Paper or plastic bag, fiberboard, metal, plastic or wood box	IME 22 Container, 50 or fewer detonator assemblies
Detonating cord up to 100 grains per foot (1)	1.4 D	UN0289	139	None if ends are sealed. Plastic bags, wood, metal, fiberboard or plastic containers, reel	Wood, metal, plastic or fiberboard container (2)
Shaped charge (3)	1.4 S	UN0440 UN0441	137	Plastic bags, fiberboard box, fiberboard, metal, plastic, tubes, dividing partitions of outer packaging	Wood, metal, plastic or fiberboard container
Shock tube	1.4 S	UN0349	101	Original packaging	Original packaging
Smokeless powder	1.4 C	UN0509	62	Original packaging	Wood, metal, plastic or fiberboard container

Notes:

(1) 100 grains per foot or smaller detonating cord may transported as HD 1.4D if gross weight is less than 99 lbs.

(2) Fiberboard containers include the box in which the items were delivered. If a different container is used it must meet 49 CFR 178.519 4G standards.

(3) Shaped charges must be transported cone down if in single layer or with cones facing if transported in pairs.

10.5 Receipt Procedures

Receipt procedures for initial delivery are described in **Section 10.2** of this WP.

10.5.1 Issues/Receipt of Explosives from Magazine

Explosives will be removed from storage for use by the demolition team leader or designee and witnessed by the UXOSO or UXOQCS. Each time explosives are used, the demolition team leader and the UXOSO/QCS will complete an explosives usage form. The completed form will be filed with the Daily Quality Control Report (DQCR).

After receipt of explosives the quantities and lot numbers issued will be recorded on a magazine data card. The quantities will be adjusted each time explosives are removed or added to the magazine. The data card will be placed in the magazine, and a copy kept in the site office.

10.5.2 Accountable Persons

The SUXOS and UXOSO or UXOQCS are responsible and accountable for project explosives. The SUXOS and any UXO-Qualified employee designated by the SUXOS may receive, transport, possess, and use explosives in the course of duty.

10.5.3 Reconciliation of Receipt Documents and Proposed Intervals

If a discrepancy is discovered as the result of a receipt or return of explosives, the UXOSO or UXOQCS and SUXOS will investigate. Interviews of site personnel will be conducted to reconstruct any events that may have contributed to a discrepancy. If the discrepancy can be resolved administratively, a report will be prepared for the PM and the USACE OESS. If the report is approved, the inventory will be adjusted. If a discrepancy cannot be resolved, it will be reported to the USACE and ATF as a theft.

Receipt documents will be reviewed at each issue or return of explosives to the magazine and during monthly inventories.

10.6 Inventory

10.6.1 Physical Inventory of Explosives

Magazines will be inventoried each time material is added or removed by physically counting the explosives or verifying the seals of previously counted material are not violated. If no explosives are used, the magazines will be inventoried monthly. Inventories are annotated on the magazine data card.

10.6.2 Reconciliation of Discrepancies

If a discrepancy is discovered as the result of an inventory, the UXOSO or UXOQCS and SUXOS will investigate. Interviews of site personnel will be conducted to reconstruct any events that may have contributed to a discrepancy. If the discrepancy can be resolved administratively, a report will be prepared for the PM and the USACE OESS. If the report is approved, the inventory will be adjusted. If a discrepancy cannot be resolved, it will be reported to the USACE and ATF as a theft.

10.7 Magazines Inspection

10.7.1 Inspection Criteria

The UXOSO or UXOQCS will inspect the magazine, locks, and tamper evident seals every seven days for signs of tampering or unauthorized entry. An inventory is not required during the course of this inspection, however it is not prohibited.

10.7.2 Installation procedures

This explosives management plan and the approved ESP comply with applicable explosive storage regulations and directives.

10.8 Procedures Upon Discovery of Lost, Stolen, or Unauthorized Use of Explosives

If at any time theft, loss or unauthorized use of explosives is suspected, the SUXOS will make a report to the ATF by calling (800) 800-3855. This will be followed within 24 hours by submitting ATF Form 5400.5 to the ATF field office located in Wichita, Kansas, care of Resident Agent in Charge, 301 North Main Street, Suite 225, Wichita, Kansas, 67202, (316) 269-6229. A theft report will also be sent to USACE COR.

10.9 Return of Unused Explosives to Storage

Unused explosives will be returned to storage and documented on the explosive usage form and magazine data card.

10.10 Disposition of Unexpended Explosives

Any explosives remaining after completion of the RI field investigation will be detonated within the MRS.

11.0 QUALITY CONTROL PLAN

11.1 Introduction

This QC Plan provides the procedures and methods to be used for the RI at the Strother Field FUDS. This plan addresses organization and responsibilities, equipment testing and calibration, QC inspections and audits, and reporting procedures. Detailed QC information related to analytical tasks is provided in **Appendix B**.

QC implies a system for verifying and maintaining quality throughout all phases of a project. Thus, every person involved is an essential element of QC. During fieldwork, this means that the person performing an intrusive investigation must verify his/her own work before testing by the UXOQCS.

11.2 QC Inspections and Reports

QC inspections and reporting will be performed based on the three-phase inspection process for contactors to ensure quality.

11.2.1 Three-Phase Inspections

The three-phase inspection process identifies expectations and provides all team members the opportunity to have input to task improvement. A preparatory and initial inspection will be performed by the UXOQCS prior to and at the onset of each DFW, respectively. Follow-on inspections will be conducted throughout the duration of the DFW and after completion to ensure activities are performed safely and IAW with the WP.

Inspections will be conducted for each DFW below:

1. Mobilization, site preparation and demobilization;
2. Vegetation removal;
3. Surface MEC removal;
4. Perform DGM surveys;
5. Perform analog and/or intrusive investigation;
6. MEC disposal by detonation;
7. Perform environmental sampling, if needed; and
8. MDAS Management, certification and disposal.

11.2.1.1 Preparatory Phase Inspection

The preparatory phase inspection identifies work requirements, expectations, safety criteria, and adequacy of equipment, materials, and personnel. This inspection is conducted prior to beginning any fieldwork. This inspection consists of a WP review, a review of local conditions (particularly any changed site conditions), a formal safety briefing, equipment inventories, site training, and an on-site proficiency demonstration.

All field personnel will demonstrate their ability to meet project objectives on each field task. This will be repeated, as necessary, when personnel are replaced or equipment is replaced or repaired. The UXOQCS will observe the activities to ensure WP SOPs are being followed. An example of the inspection document is provided in **Appendix C**.

11.2.1.2 Initial Phase Inspection

The initial phase inspection tests the first work completed to identify any problem areas and allow for process improvement. This inspection consists of a briefing/debriefing and process testing. An example of the inspection document is provided in **Appendix C**.

11.2.1.3 Follow-on Phase Inspection

The follow-on phase inspections control quality through process observation, testing, and feedback from client and work teams. This is a continuous process and is documented in field logs, inspection forms, and the DQCR.

11.2.2 Field System Audits

On a daily basis during fieldwork , documentation such as DQCRs, field logbooks, sample collection field sheets, and chain-of-custody forms will be reviewed by the field team, and real-time monitoring of work performed will be performed by the UXOQCS and SUXOS, and/or field team leaders. Deficiencies that are identified will be recorded, and tracked throughout implementation of corrective actions until the issue is resolved. Technical memorandums and/or reports will be developed for PDT members as needed after each major phase of work/performance monitoring event.

11.3 Quality Management Structure

The Quality Management Team member names and duties are provided in **Section 4.0** of this WP, and in **Appendix B** for MC-related activities. Names and qualifications of additional site personnel will be provided prior to mobilization.

11.4 Lessons Learned Program

As required by ER 1110-1-12 (USACE, 2006), a Lessons Learned Program (LLP) will be developed to provide for the exchange of information regarding problems that may occur during the RI at the Strother Field FUDS.

11.4.1 Lessons Learned Objective

The objective of the LLP is to capture and share experiences or recognized potential problems or better business practices to accomplish the following:

- Prevent the recurrence of design/execution deficiency;
- Clarify interpretation of regulations or standards;
- Reduce the potential for mistakes in high risk/probability areas of concern;
- Pass on information specific to an installation or project;
- Promote a good work practice that should be ingrained for repeat application; and
- Promote efficient and cost-effective business practice.

11.5 Government Quality Assurance

Completed work that has passed UXOQCS inspection will be submitted to the government for QA inspection, as applicable. The USACE Omaha Military Munitions Design Center will perform the QA IAW USACE directives and regulations.

12.0 ENVIRONMENTAL PROTECTION PLAN

This Environmental Protection Plan (EPP) ensures full consideration is given and measures are taken to prevent adverse impacts to any cultural or archeological resources and to prevent impacts to natural resources. The intent of this EPP is to prevent, abate, and control any activity associated with this project that could contribute pollution or degradation to the environment. This EPP is subject to change based on the review and implementation of additional tasks.

12.1 Natural Resources Protection

The natural resources within the Strother Field FUDS during this RI are not expected to be significantly disturbed during surface clearance, DGM surveys, digging anomalies, or sample collection. Similar to the SI, letters have been sent to the USFWS and KDWPT concerning IEPs and threatened or endangered species that might be present at Strother Field with a description of planned RI activities. Copies of the letters sent and responses, indication no anticipated adverse effects from planned RI activities, are provided in **Appendix F**.

Precautions will be taken to minimize disturbance of the limited amount of natural vegetation within the area. After investigation by the USACE PM or designated representative, field crews will be instructed on the procedures to follow.

12.1.1 Land Resources

In general, minimal disturbance to land resources is anticipated. Site access will include the use of a truck with an explosives day box. DGM surveys are done using a small sled pull,ed by an all-terrain type vehicle, which causes much less disturbance than the farming equipment routinely used on the land.

Subsurface investigation work in the MRS will be conducted by hand unless the DGM survey indicates potential burial pits or trenches. In this event, small earth-moving machinery (EMM), e.g., a small excavator, may be used in a limited area. Excavations will be backfilled to the maximum extent possible using the soil excavated from the hole. Clean backfill will be imported as needed to restore the ground to match adjacent surfaces.

12.1.2 Water Resources

There are no lakes or persistent ponds present on the site; however, during periods of heavy rainfall, pooling and standing water can develop within site boundaries. Posey Creek cuts through the MRS but is an artificial perennial stream that depends on the Strother Field Sewage Treatment Plant and an industrial cooling tower near the central portion of the industrial park supply water to Posey Creek. No disturbance to water resources is anticipated.

12.1.3 Fish and Wildlife Resources

None of the activities proposed for the RI will have an adverse impact on fish and wildlife resources in the area. The feeding, harassing, or disturbing of any wildlife is strictly prohibited.

Efforts will be made to keep the work areas as clean as possible so as not to attract wildlife to the area. A dumpster will be obtained from a local waste management company and weekly pickup and disposal services will be scheduled.

12.1.4 Vegetation

The SI report notes that very limited areas of native prairie vegetation exist at the perimeter of the MRS. Every precaution will be taken to preserve and protect local vegetation during the DGM survey and sampling activities.

The RI schedule is based on performing the field operations after the harvest and before the replanting season. Accordingly, no vegetation removal in the farmable area is planned for the geophysical and intrusive investigation.

12.2 Cultural and Archaeological Resources

There are no known cultural or archaeological resources within the footprint of the investigation area. During the SI, the KSHPO reviewed its cultural resources files and indicated the former Strother Field is in an upland area of low archaeological potential. The KSHPO also indicated because the site is located in a formerly cultivated area sampling activities were not likely to pose a threat to any intact cultural deposits and had little potential to impact standing structures that might be eligible for National Register listing. The KSHPO concluded the proposed SI sampling activities would have no effect on historic properties (USACE, 2010a). This assessment was verified for RI. Both the letter sent to the KSHPO and the response, indicating no adverse effects are anticipated, are provided in **Appendix F**.

However, if during the RI any potential historical or archaeological resources are identified in the area personnel will stop work and the PM will notify USACE if a suspected cultural or archaeological resource is identified within an investigation area.

12.3 Dust Control

Work activities at the sites primarily include foot traffic and hand digging, reducing the potential for dust. However, EMM may be used to assist in digging. If EMM is used, dust levels will be evaluated and water suppression used if necessary. Given the soil type and moisture content at the site, this is not likely required. Passenger vehicles used for transportation to the site and movement of supplies and equipment will remain on gravel roads. Dust levels will be minimal.

12.4 Noise

The nearest residents to the work area are approximately 1 mile north of the site. Industrial Facilities fall within the MRS with additional industrial facilities and a regional airfield within ½ mile of the site. However, the typical noise level expected at the work site is minimal and not noticeable beyond the immediate area.

12.5 Pollution

Work activities at the Strother Field FUDS include surface clearance, geophysical investigation, intrusive investigation, and environmental sampling, none of which cause pollution impacting the environment, wildlife, nearby inhabitants, or workers in the MRS area.

If any waste is generated during the course of fieldwork it will be properly disposed of IAW **Section 9.0** of this WP and will have no impact to the site. Site investigations will be completed on foot, minimizing the chances of adverse effects on the environment. If at any point during the field activities contamination of soil or water takes place, proper measures will be taken to contain, remove, and report the incident.

12.6 Restoring Damage

For the duration of the RI field investigation, care will be taken to prevent damaging the environment, equipment used during the course of fieldwork, and any property located on the premises. Any damage caused will be restored by the contractor.

At the end of each day, all debris, materials, supplies, and equipment brought to or generated at the site will be collected, containerized and otherwise removed from the site. The field team will maintain a clean working site throughout the RI field investigation, thus the expected post-project cleanup is minimal.

13.0 PROPERTY MANAGEMENT PLAN

This plan is not applicable because no government-furnished equipment is used.

14.0 INTERIM HOLDING FACILITY SITING PLAN FOR RCWM PROJECTS

This plan is not applicable because this is not a Recovered Chemical Warfare Materiel (RCWM) project.

15.0 PHYSICAL SECURITY PLAN FOR RCWM PROJECT SITES

This plan is not applicable because this is not an RCWM project.

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Appendix A

Accident Prevention Plan/Site Safety and Health Plan (APP/SSHP)

FINAL

ACCIDENT PREVENTION PLAN

Formerly Used Defense Site (FUDS)
Military Munitions Response Program
Remedial Investigation

STROTHER FIELD DISPOSAL AREA
Cowley County, Kansas

FUDS Property Number: B07KS0277
FUDS Project Number: B07KS027703

CONTRACT W9128F-10-D-0054, TASK ORDER 0023

September 2016
Revision 00

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Acronyms and Abbreviations

°F ..... degrees Fahrenheit
ACGIH ..... American Conference of Governmental Industrial Hygienists
AHA ..... activity hazard analysis
ANSI ..... American National Standards Institute
APP ..... Accident Prevention Plan
ASTM ..... American Society for Testing and Materials
Bay West ..... Bay West LLC
BBP ..... bloodborne pathogen
bpm ..... beats per minute
CDC ..... Centers for Disease Control and Prevention
CFR ..... Code of Federal Regulations
COR ..... contracting officer's representative
CPR ..... cardiopulmonary resuscitation
CSHM ..... Corporate Safety and Health Manager
CSP ..... Certified Safety Professional
CWM ..... chemical warfare materiel
DDESB ..... Department of Defense Explosives Safety Board
DFARS ..... Defense Acquisition Regulations System
DGM ..... digital geophysical mapping
DOT ..... Department of Transportation
DQCR ..... Daily Quality Control Report
EM ..... Engineer Manual
EMS ..... Emergency Medical Service
EOD ..... Explosive Ordnance Disposal
ERP ..... Emergency Response Plan
ESP ..... Explosives Site Plan
ESQD ..... explosive safety quantity distance
EZ ..... exclusion zone
FS ..... feasibility study
FUDS ..... formerly used defense site
HAV ..... Hepatitis A virus
HBV ..... Hepatitis B virus
HCV ..... Hepatitis C virus
HI ..... heat index
HIV ..... Human Immunodeficiency Virus
HTRW ..... hazardous, toxic, or radioactive waste
IAW ..... in accordance with
ISEA ..... Industrial Safety Equipment Association
KDHE ..... Kansas Department of Health and Environment
MC ..... munitions constituent
MD ..... munitions debris
MEC ..... munitions and explosives of concern
mph ..... miles per hour
MRS ..... munitions response site
NWS ..... National Weather Service
OESS ..... Ordnance and Explosives Safety Specialist
OSHA ..... Occupational Safety and Health Administration
OSIC ..... On-Scene Incident Commander
PEL ..... permissible exposure limit
PM ..... Project Manager
POC ..... point of contact
PPE ..... personal protective equipment
QC ..... quality control
QCS ..... Quality Control Specialist
RAC ..... risk assessment code
RFP ..... request for proposal
RI ..... remedial investigation
RPM ..... Restoration Project Manager
SDS ..... Safety Data Sheets
SI ..... Site Inspection
SOO ..... Statement of Objectives
SOP ..... standard operating procedure
SOW ..... Statement of Work
SSHP ..... Site Safety and Health Plan
SUXOS ..... Senior Unexploded Ordnance Supervisor
SZ ..... support zone
TBD ..... to be determined
Tetra Tech ..... Tetra Tech Inc.
TLV ..... threshold limit value
TO ..... Task Order
TP ..... Technical Paper
USACE ..... U.S. Army Corps of Engineers
UXO ..... unexploded ordnance
UXOQCS ..... Unexploded Ordnance Quality Control Specialist
UXOSO ..... Unexploded Ordnance Safety Officer
Weston ..... Weston Solutions Inc.
WBGT ..... wet bulb globe temperature
WP ..... white phosphorus

1.0 SIGNATURE SHEET

The following Bay West LLC (Bay West), project personnel have reviewed and have agreed to implement and comply with the requirements of the Accident Prevention Plan (APP), for the duration of site activities.

Prepared by: _____ _____

Wayne Martrildonno
UXO Technical Manager
Bay West LLC
509-481-9081

Date

Approved by: _____ _____

Jamison Harrell-Latham, CSP
Corporate Safety and Health Manager
Bay West LLC
651-291-3480

Date

Reviewed by: _____ _____

Doug Hickey, CIH, CSP
Corporate Industrial Hygienist
Bay West LLC
612-719-9922

Date

2.0 BACKGROUND INFORMATION

2.1 Contractor

Bay West LLC

2.2 Contract Number

W9128F-10-D-0054, Task Order 0023

2.3 Project Name

Formerly Used Defense Site (FUDS)
Military Munitions Response Program Remedial Investigation/Feasibility Study (RI/FS)
Strother Field Disposal Area
Cowley County, Kansas,
FUDS Property Number: B07KS0277
FUDS Project Number: B07KS027703 (**Figures B-1** and **B-2**)

2.4 Project Description

Bay West LLC (Bay West), with our principal subcontractors Weston Solutions, Inc. (Weston), and Tetra Tech, Inc. (Tetra Tech), referred to as the Bay West Team, will conduct a Remedial Investigation (RI), at the Disposal Area Munitions Response Site (MRS), former Strother Field.

2.5 Definable Features of Work

Bay West will conduct the following definable features of work:

1. Mobilization, site preparation, and demobilization;
2. Vegetation removal;
3. Surface MEC removal;
4. Perform DGM surveys;
5. Perform analog and/or intrusive investigation;
6. MEC disposal by detonation;
7. Perform environmental sampling, if needed; and
8. MDAS management, certification, and disposal.

2.6 Contractor Accident Experience

Bay West's safety performance measurements for 2016 include a Total Recordable Incident Rate of 0, Days Away Restricted Time of 0, Lost Workday Incident Rate of 0.0, and an Experience Modification Rate of 0.65.

2.7 Forms

Safety-related forms are in **Appendix D** of the Work Plan, which consolidates all project forms.

2.8 Site Safety and Health Plan

In accordance with Engineer Manual (EM) 385-1-97 section I.1.A.01.01, the APP must be supplemented with a Site Safety and Health Plan (SSHP) to address MEC-related hazards. EM 385-1-97 requires the SSHP elements listed below: the SSHP duplicates some elements in EM 385-1-1, Appendix A. Information is not to be repeated, and duplicate elements are to be addressed in the SSHP.

Figure A-1 Strother Field FUDS Location

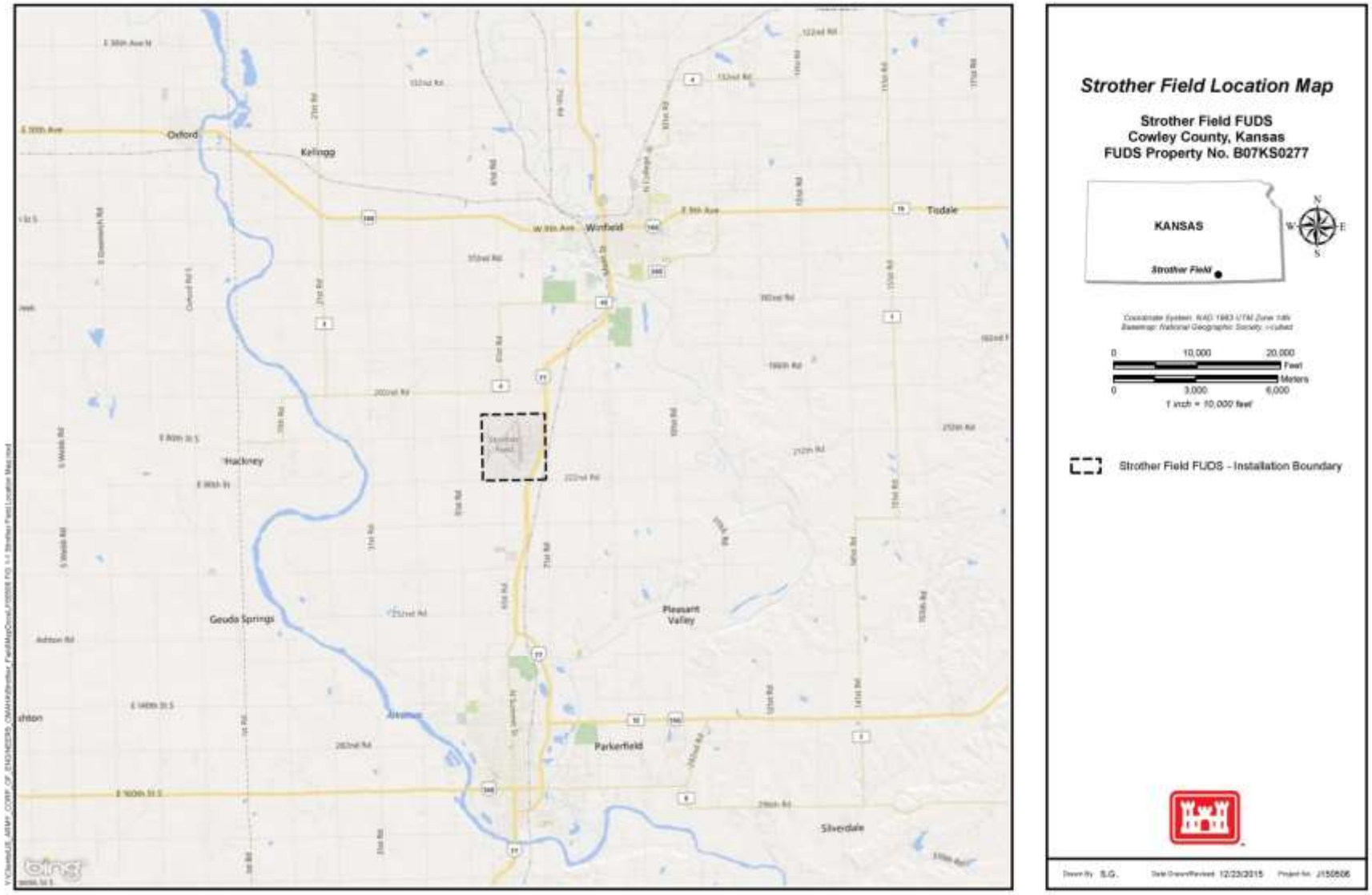
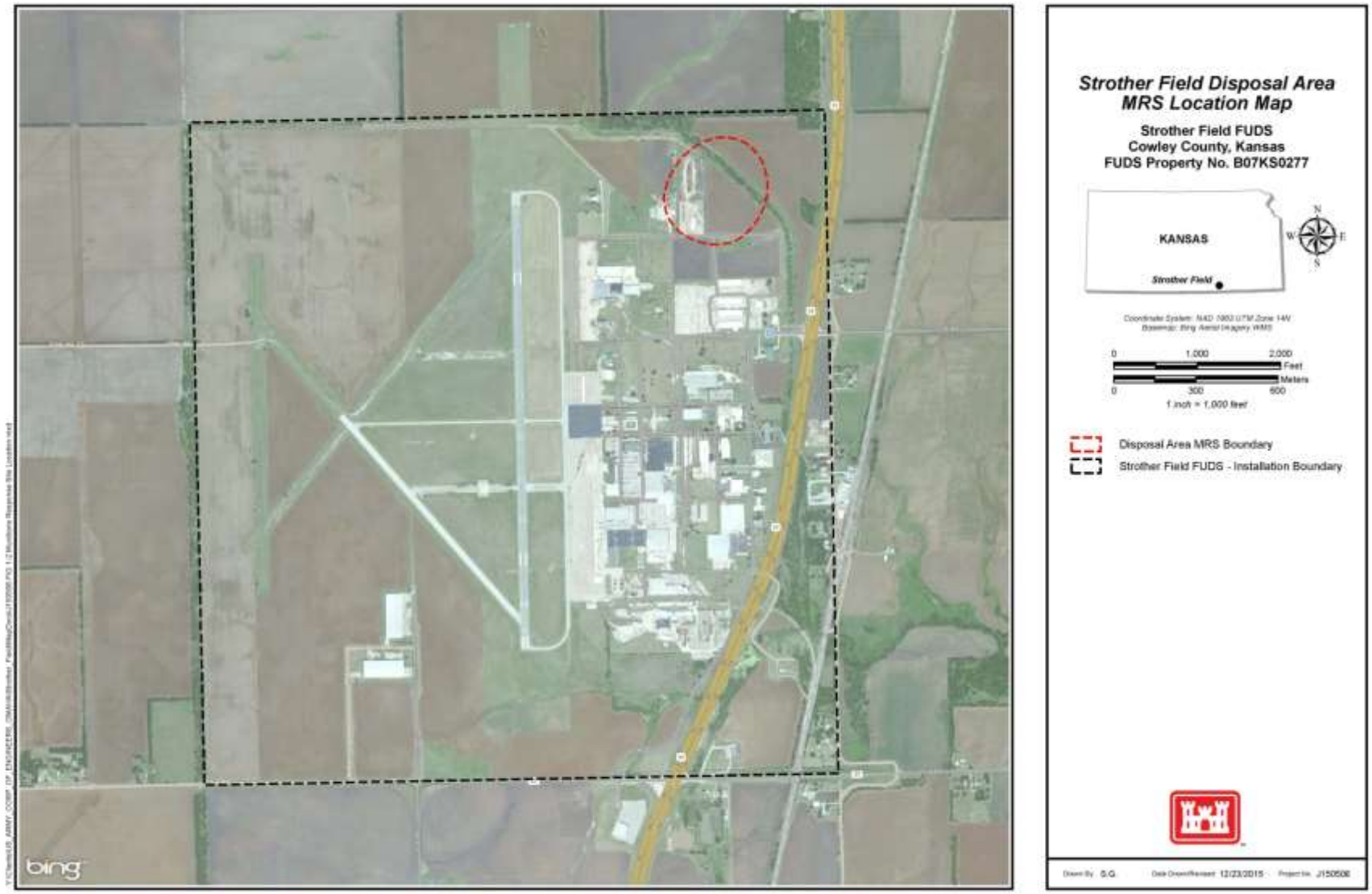


Figure A-2 Site Location



3.0 STATEMENT OF SAFETY AND HEALTH POLICY

3.1 Official Policy

Bay West's primary goal is to minimize the human suffering by employees resulting from occupational injuries through application of these safety policies and procedures. Injuries have a serious physical and emotional impact on employees and have a negative effect on family members and co-workers.

In addition, Bay West recognizes the deterrent and eroding effect injuries have on potential profit. Insurance costs, combined with the indirect costs of injuries, are a matter of serious concern and Bay West's intends to reduce them by eliminating injuries. As it affects Bay West, elimination of on-the-job injuries is an important management responsibility. We assume and treat this responsibility in the same manner as our business philosophies relating to services rendered.

Bay West requires that employees and subcontractors concerned devote their serious attention toward making safety an integral part of day-to-day business operations. Always remember that no job is so important, and no service is so urgent, that we cannot take time to perform it safely.

Bay West employees and subcontractors must conduct operations in accordance with (IAW) applicable federal, state, and local regulations and procedures, Occupational Safety and Health Administration (OSHA) requirements, client requirements, and this APP.

Safety comes down to self-preservation for the sake oneself, one's family and one's Team. We want everyone to go home each day and be healthy for work the next. Individual safety behavior also affects your teammates. Incidents, especially detonations, can kill or wound multiple people.

4.0 RESPONSIBILITIES AND THE LINES OF AUTHORITIES

Bay West is responsible for implementing this APP. Personnel are responsible for following this APP along with safety and health procedures during the performance of their work. Bay West will dismiss personnel or contractors from the site if any person violates safety procedures. Bay West and subcontractor employees are subject to progressive discipline and termination for continued safety violations.

4.1 Identification and Accountability of Personnel

4.1.1 Corporate Level

4.1.1.1 Project Manager

The Project Manager (PM) is responsible for overall direction, coordination, and successful completion of field operations. PM health and safety responsibilities include the following:

- Preparing and organizing project activities;
- Reviewing and approving the APP;
- Coordinating project activities with the Strother Field Restoration Project Manager (RPM), U.S. Army Corps of Engineers (USACE) PM, and other USACE personnel;
- Providing operational/health and safety equipment for project assignments and providing resources and support to the Unexploded Ordnance (UXO) Safety Officer (UXOSO) for effective completion of duties;
- Emphasizing the importance of safety for effective project management and holding supervision/site personnel and subcontractor management accountable for safe job performance; and
- Overseeing correction of identified unsafe work conditions/work practices.

4.1.1.2 Corporate Safety and Health Manager

The Corporate Safety and Health Manager (CSHM) has the authority and responsibility for implementing the APP. The CSHM is a certified safety professional (CSP). The CSHM's responsibilities are as follows:

- Reviewing and approving the APP before submittal to the USACE;
- Completing revisions or addenda to the APP, as needed;
- Providing for implementation, oversight, and enforcement of the APP;
- Confirming that personnel and subcontractors are qualified according to medical surveillance and training requirements;
- Being available for emergencies;
- Coordinating any APP modifications with the PM, UXOSO, and Contracting Officer;
- Supporting, upgrading, or downgrading the level of personal protection;
- Evaluating data and recommending changes to engineering controls, work practices, and personal protective equipment (PPE);
- Reviewing incident or near miss reports and inspection results;
- Determining and implementing disciplinary actions for safety violations;
- Serving as a member of the Bay West quality control (QC) staff;

- Stopping any operation that threatens the health or safety of the team or surrounding population;
- Providing additional health and safety technical assistance to the PM and UXOSO;
- Communicating with the PM to evaluate/resolve health and safety issues;
- Providing oversight and support to the UXOSO;
- Investigating significant incidents and implementing corrective actions; and
- Overseeing exposure monitoring programs.

4.1.2 Field Level

See the SSHP for responsibilities and duties of field level personnel.

4.2 Lines of Authority

Table A-1 contains the project personnel and their involvement on the project. See the **SSHP** for contact information for these and other personnel. Resumes of Bay West safety personnel are included in **Attachment 2**.

Table A-1 Lines of Authority

Name	Position	Telephone Number
Baer, Kurt	USACE PM	816-389-3922
Sellers, Brandon	Contracting Officer's Representative (COR)/Military Munitions Design Technical Lead	402-995-2744
TBD	USACE Ordnance and Explosives Safety Specialist (OESS; Omaha)	TBD
Harrell-Latham, Jamison	CSHM	651-291-3480
Norman, Jesse	UXOSO and UXOQCS	317-468-5214
Swiech-Laflamme, Marie	PM	609-232-8026
Hannan, Dave	Senior UXO Supervisor (SUXOS)	850-797-4240

4.3 Competent Person

Refer to the SSHP Section 3.2.

4.4 Pre-Task Safety and Health Analysis

Pre-task safety and health analysis begins at the request for proposal (RFP) phase by utilizing available documentation, prior project information, and site visits. The process continues through development of the APP and activity hazard analyses (AHAs) (see **Appendix A** of **Attachment 1** to this APP) for each definable feature of work (**Section 2.5**). The PM and UXOSO are responsible for ensuring that a survey is conducted for each work area during mobilization to identify the sources and types of hazards and to confirm that the APP and AHAs address these hazards.

Bay West has experience performing similar site work. We will review information available from work on similar projects as well as additional public documents and data relevant to the work. Bay West conducts external reviews after receiving notice to proceed.

During the site visit, the PM and UXO technician determined the level of PPE required for the work areas and activities. During field work, they will evaluate potential physical hazards associated with the work areas activities (e.g., walking/working surfaces, electrical installations/lines, noise exposure) and select PPE to mitigate identified hazards.

4.5 Management Accountability for Safety

The PM and SUXOS are accountable for the health and safety of their employees and of subcontractors and for the continual communication of hazards and hazard controls to the workforce. The UXOSO and CSHM assess the health and safety performance of employees. All levels of management conduct employee reviews to ensure compliance with the APP and corporate safety policies.

4.6 Stop Work Authority

The PM, CSHM, and **all site workers** have authority to stop activities if a dangerous situation exists. Project team members will review the emergency. USACE also has the responsibility to stop work if there is a serious threat to the health or safety of workers or other personnel or to the environment.

Work must stop if there are unanticipated chemical, biological warfare agents, or radiological materials.

If work stops due to a safety issue, Bay West must document the situation and submit a memorandum to the PM, CSHM, and USACE PM.

4.7 Employee Hazard Reporting

A hazard report form is in **Appendix D** for employees to report hazards to project and/or corporate management.

4.8 Subcontractors and Suppliers

4.8.1 Identification of Subcontractors and Suppliers

Subcontractor personnel associated with this project must follow the guidelines and provisions in this APP. The SUXOS and UXOSO or UXOQCS will monitor the field performance of subcontractors.

The anticipated contractors include the following:

- Tetra Tech, for DGM; and
- Weston, for risk assessment and community relations.

Prior to project initiation, Bay West will negotiate and prepare a subcontract agreement to detail the subcontractor's Statement of Work (SOW) and necessary terms and conditions, including safety requirements. Once executed, Bay West will perform daily subcontractor QC reviews documented on the Daily Quality Control Report (DQCR; **Appendix D**).

4.8.2 Safety Responsibilities of Subcontractors and Suppliers

Subcontractors who work in or enter controlled areas of the site are subject to the APP. Subcontractor health and safety responsibilities include the following:

- Providing necessary health and safety documentation to the UXOSO as indicated below (as applicable):
    - First aid/cardiopulmonary resuscitation (CPR) training;
    - HAZWOPER training; and
    - Other health and safety training as appropriate (e.g., excavation competent person);
- Following this APP in the same manner as Bay West personnel;

- Providing a hazardous substances inventory list and copies of applicable safety data sheets (SDSs);
- Reviewing, understanding, and complying with the APP and safety instructions from the CSHM, UXOSO, PM, or other competent authority;
- Promptly reporting injuries or illnesses to their supervisor and the UXOSO; and
- Reporting any unsafe work conditions, unsafe work practices, and violations of the APP to their supervisor and the UXOSO.

Bay West may use any deviations from the APP as the basis to terminate a subcontractor agreement.

4.8.3 Subcontractor Safety Plans

This APP applies to Bay West subcontractor employees. Subcontractor employees must sign the Training Acknowledgement Form (**Appendix D**) indicating that they have read and understand the APP and that they agree to follow the requirements in these documents.

Bay West will obtain and verify the subcontractor personnel training records prior to beginning work.

5.0 TRAINING AND MEDICAL SURVEILLANCE

5.1 Safety Indoctrination

The UXOSO must train field workers in this APP and they must acknowledge that they understand this APP prior to performing work. Document this training on the initial Training Acknowledgement Form.

5.2 Mandatory Training and Certification

Refer to the SSHP Section 4.0.

5.3 Safety Meetings

5.3.1 Daily Safety Brief

The UXOSO conducts a daily safety briefing that covers the day's planned operations, reviews the previous day's safety considerations, and reviews new safety issues.

The UXOSO will conduct weekly training. The training shall address new MEC encountered, safety and health procedures, work practices, changes in the APP or AHA, work tasks, or schedule. The UXOSO will conduct site-specific training sessions for new personnel, visitors, and suppliers using information supplied in this APP.

Document safety meetings and training on the Safety and Health Meeting Report Form (**Appendix D**). Personnel who attend this briefing must sign the form. The UXOSO maintains copies of documentation.

5.3.2 Tailgate Safety Brief

The leader of each field team shall conduct a tailgate safety brief at the work site to discuss local conditions and hazards at the beginning of each shift or when beginning work at a new site. Topics in the briefing may include:

- Tasks to be performed and work method and general description of job scope;
- Ordnance;
- PPE;
- Weather conditions;
- Heat/cold stress management;
- Standard operating procedures (SOPs), engineering controls, and work practices;
- Site control measures;
- Personal hygiene;
- Emergency equipment and first aid;
- Emergency response and contingency procedures; and
- Logs, reports, and recordkeeping.

5.4 Medical Surveillance

Refer to the SSHP Section 6.0.

6.0 SAFETY AND HEALTH INSPECTIONS

The UXOSO is responsible for safety inspections. Use safety inspection checklist forms or memos to record, track, and follow-up to correct safety deficiencies. Maintain a record of the safety inspections in the project file. Post identified deficiencies on the safety and health bulletin board, and note when the deficiencies are rectified.

6.1 Internal Inspections

The Bay West UXOSO may make additional random inspections as warranted. The areas to inspect include, but are not limited to, those listed on **Table A-2**.

Table A-2 Internal Inspections

Inspection	Frequency	Responsible Person
Motor vehicles	Daily	Operator
	Weekly	UXOSO (spot check)
Heavy equipment	Daily	Operator
Fire extinguisher	Daily	Vehicle/equipment operators, SUXOS
	Monthly	UXOSO/QCS
Trenching/Excavation	Daily	Competent Person
First aid kits	Weekly	UXOSO/QCS
PPE	Daily	All workers
	Daily	UXOSO
Observance of safety precautions and safe work practices	Daily	All workers, UXOSO

6.1.1 Vehicle Inspections

Vehicle inspections are detailed inspections performed by vehicle maintenance technicians Bay West conducts the vehicle inspections to comply with Department of Transportation (DOT) regulations. Bay West ensures inspections are current before dispatching vehicles. Vehicle inspection records reside on the Bay West server and are available by request.

6.1.2 Vehicle Checks

Operators perform vehicle checks. Check the vehicle prior to use each day to ensure it is in safe operating condition. There is no checkout form required. Correct minor deficiencies such as fluid levels. Report safety discrepancies to the UXOSO and SUXOS using the safety inspection form. Don't operate an unsafe vehicle. Items to check include:

- Lights
- Horn
- Wipers
- Fluids
- Tires
- Safety gear, and
- Glass (windows, mirrors).

6.1.3 Heavy Equipment

This includes earth moving machinery and stationary equipment. Inspect it daily and document on the form provided.

6.1.4 Logbook

Refer to the SSHP Section 15.5.

6.2 External Inspections

Although no external inspection is expected, regulatory agencies do conduct inspections. Refer the regulatory agency inspector to the SUXOS and UXOSO. The inspector must present credentials to verify that they are representing a recognized regulatory agency (e.g., OSHA or DOT). Personnel who cannot demonstrate their affiliation with a recognized regulatory agency are not allowed access to the project site or office.

Prior to taking the inspector on-site or into the office, contact the PM, and CSHM.

7.0 NONCOMPLIANCE AND INCENTIVE PROGRAMS

7.1 Noncompliance

Noncompliance violations include, but are not limited to, the following:

- Unsafe vehicle operation;
- Failure to wear PPE;
- Coming to work under the influence of alcohol, narcotics, intoxicants, hallucinogens, or other mind-altering substances; or
- Not following verbal or written safety procedures (e.g., this APP), guidelines, or rules

7.2 Disciplinary Actions

Although noncompliance is not expected, safety and health program violations can and will result in disciplinary action up to and including dismissal/removal from the project

7.3 Incentive Program

Bay West develops and integrates project-specific financial and other incentive plans with safety and health goals.

8.0 INCIDENT REPORTING

8.1 Exposure Data

Bay West will report hours worked in the DQCR and through the Contractor Manpower Reporting System.

8.2 Incident Investigations, Reports, and Logs

Refer to the SSHP Section 15.

8.3 Major Incident Notifications

Refer to the SSHP Section 15.4.

9.0 PLANS, PROGRAMS, AND PROCEDURES

IAW USACE EM 385-1-1 Appendix A, the APP may include certain plans, programs, and procedures. Bay West has selected the plans necessary to conduct this work. We intentionally omitted other plans listed in the appendix because they do not apply to this project.

9.1 Fatigue Management Plan

The Fatigue Management Plan, as supplemented below, is presented in the SOPs in **Appendix E**.

USACE has different duty restrictions for drivers and equipment operators then DOT. As such, the following supplements the Fatigue Management Plan:

9.1.1 Equipment Operators

Operators of equipment, such as hoisting equipment and drag lines, mobile construction equipment, electrical power systems, hydropower plants, industrial manufacturing systems, hydraulically operated equipment, powered vessels, and boats, may not exceed 12 hours of duty time in any 24-hour period, including time working another occupation. A minimum of eight consecutive hours of rest between sets in a 24-hour period is required.

9.1.2 Motor Vehicle Operators

Operators of motor vehicles, while on duty, shall not operate vehicles for continuous period of more than 10 hours in any 24-hour period; moreover, no employee, while on duty, may operate a motor vehicle after being in a duty status for more than 12-hours during any 24-hour period. Operators must have a minimum of eight consecutive hours of rest in each 24-hour period.

9.2 Emergency Response Plan

Refer to the SSHP Section 14.0.

9.2.1 First Aid Plan

Refer to the SSHP Section 13.2.

9.3 Bloodborne Pathogen Exposure Control Plan

Refer to the SSHP Section 13.4.

9.4 Personal Protective Equipment

Refer to the SSHP Section 5.0 for a discussion of PPE.

9.5 Site Control Measures

Refer to the SSHP Section 10.0 for a discussion of site control measures.

9.6 Alcohol and Drug Abuse Plan

Bay West supports the Drug-Free Workplace Act of 1988. As such, Bay West has implemented a Drug and Alcohol Use and Testing Program. This program is IAW Defense Acquisition Regulations System (DFARS) subpart 252.223-7004. Bay West will impose disciplinary actions for violation of the Drug-Free Workplace policy. Bay West employees, as a condition of employment, have documented understanding and receipt of this policy.

While on duty, employees will not use or be under the influence of alcohol, narcotics, intoxicants, hallucinogens, or other mind-altering substances. Bay West will remove employees found to be under the influence of or consuming such substances from the job site. Subcontractors will enforce Bay West's drug-free workplace requirements.

Any employee under a physician's treatment and taking prescribed narcotics or any medication, including over the counter, that may prevent a person from being ready, willing, and able to safely perform his/her duties will provide a medical clearance statement to their supervisor from the attending physician.

Bay West's program emphasizes supervisor training, a provision for self-referral to treatment, and maximum respect for individual confidentiality, as well as a provision for identifying and dealing with illegal drug users, including testing. Bay West's program also provides for education, counseling, rehabilitation, and coordination with available community resources.

9.7 Site Sanitation Plan

The following sanitation provisions will be established and maintained for the duration of this project:

- Drinking water: provide an adequate supply of cool water in water coolers or individual bottles. Keep water in the site office, break areas and with all work vehicles. Personnel should wash their face and hands prior to drinking;
- Non-Potable Water: Label non-potable water containers as such;
- Personal Hygiene: provide sanitary hand wipes or soap and water for washing;
- Toilet Facilities: Provide chemical toilet/outhouses. Ensure there is toilet paper, toilet paper holder, locking door, and adequate ventilation; and
- Waste Disposal: Provide a trash receptacle such as a dumpster for the disposal of hand drying materials, any disposable PPE, and other generated site debris.

9.8 Health Hazard Control Program

Based on review of the historical information, radioactive material and chemical warfare materiel (CWM) is not anticipated at this site. However, if you encounter suspected radioactive material or CWM during conventional MEC investigation and removal, cease work immediately, move upwind at least 100 yards, and notify the UXOSO and/or SUXOS. The UXOSO must notify the PM and USACE PM.

9.8.1 Biological Hazards

9.8.1.1 General Wildlife

Wildlife may attack if disturbed or threatened. If wildlife approaches the work area, especially if an animal appears to be disoriented, aggressive, or exhibits other strange behavior, avoid the animal. Workers should avoid wildlife and to report any encounters. It may be necessary to call law enforcement for assistance.

Biological hazards may include insects, arachnids (e.g., spiders, ticks), snakes, mammals, and plants. Employee awareness and the safe work practices outlined in the following paragraphs should reduce the risk associated with these hazards to acceptable levels.

Personnel injured by any biological hazard must report the injury to the SUXOS or UXOSO for monitoring and medical attention, if necessary.

9.8.1.2 Biting and Stinging Insects and Arachnids

Biting and stinging insects/arachnids (e.g., bees, wasps, ticks, mites and spiders) may be encountered. Use insect repellents, if deemed necessary.

Bees, Hornets and Wasps

Insect stings (e.g., bees, hornets, velvet ants, and wasps) may cause health effects from mild discomfort to life threatening. Exercise caution whenever site and weather conditions increase the risk of encountering insects. Some of the factors that increase risk of contact are:

- These insects frequently nest in remote wooded, grassy areas;
- The nests can be in abandoned equipment, trees, rocks, and bushes or in the ground, and are usually difficult to see;
- Wasps often nest in pipes, tubing and similar places.
- Wasps are attracted to moisture and may climb into beverage containers. Keep openings covered and perform a wasp check before drinking;
- Expect insect encounters during warm weather;
- If a site worker accidentally disturbs a nest, the insects may administer multiple stings, causing extreme pain and swelling which can leave the worker incapacitated and needing medical attention; and
- Some people are hypersensitive to insect toxins, and when stung, experience a violent and immediate allergic reaction resulting in a life-threatening condition known as anaphylactic shock. Anaphylactic shock manifests itself very rapidly and causes extreme swelling of the body, eyes, face, mouth, and respiratory passages.

The hypersensitivity needed to cause anaphylactic shock can accumulate over time and exposure; therefore, even if someone has not previously had an allergic reaction, there is no guarantee that they will not have an allergic reaction the next time.

Ticks

Ticks are small, ranging from the size of a comma up to about one quarter inch (**Figure A-3**). They are sometimes difficult to see. When embedded in the skin, they may look like a freckle. The tick season extends from spring through summer.

Lyme disease and Rocky Mountain spotted fever have occurred in Kansas. The first symptoms of either disease are flu like chills, fever, headache, dizziness, fatigue, stiff neck, and bone pain. With medical treatment, most individuals recover fully in a short period. If not treated, symptoms that are more serious can occur. If you believe a tick has bitten you, or if any of the signs and symptoms noted above appears, get medical attention.

Mites (Chiggers)

Chiggers are small mites that are usually a yellowish to bright red color (**Figure A-4**). Chiggers may live year-round, but are especially active during spring and summer. The larval chigger is the active stage that bites animals and humans, attaching themselves tightly. After secreting digestive enzymes that break down the skin cells, the mite feeds on the liquefied cells. The rash and intense itching associated with chiggers is an allergic reaction to the mite's saliva. Preventive measures used against mosquitoes are effective against chiggers. Treatments to ease itching include ointments such as calamine lotion, hydrocortisone, and benzocaine.

Black Widow Spider

The black widow spider is not aggressive unless agitated when guarding her egg sack. They live in a variety of natural and domestic habitats such as under rocks, wooden boards and in dense plant growth. The female spider is glossy black and marked with a characteristic red hourglass on the underside of the abdomen. The female has a body length of about ½" with a total length of about 1½" (**Figure A-5**).

Black widow spider venom affects the nervous system. The venom causes pain in the lymph nodes. Other symptoms of a severe bite include nausea, elevated blood pressure, sweating, tremors and increased white blood cell counts. The wound may appear as a bluish red spot, surrounded by a whitish area. Victims of a black widow bite may exhibit the following signs or symptoms:

- Sensation of pinprick or minor burning at the time of the bite; and
- Appearance of small punctures (but sometimes none are visible).

After 15 to 60 minutes, there is intense pain at the site of the bite, which spreads quickly, followed by profuse sweating, rigid abdominal muscles, muscle spasms, breathing difficulty, slurred speech, poor coordination, dilated pupils, and generalized swelling of face and extremities.

Brown Recluse Spider

The brown recluse is brownish to tan in color, rather flat, 5/8 to 2 inches long with a dark brown "violin" shape on the underside, (**Figure A-6**). It may inhabit trees, or dark locations. Victims of a brown recluse bite may exhibit the following signs or symptoms:

- Blistering at the site of the bite, followed by a local burning at the site 30 to 60 minutes after the bite;
- Formation of a large, red, swollen, pustule with a bull's-eye appearance;
- Systemic affects may include a generalized rash, joint pain, chills, fever, nausea, and vomiting; and pain may become severe after 8 hours, with the onset of tissue necrosis;
- Formation of a large, red, swollen, pustule with a bull's-eye appearance; and
- Systemic affects may include a generalized rash, joint pain, chills, fever, nausea, and vomiting; and pain may become severe after 8 hours, with the onset of tissue necrosis.

Treatment for Spider Bites: There is no effective first aid treatment for any of these bites. Except for very young, very old, or weak victims, spider bites are usually not life threatening; however, get medical treatment to reduce the damage caused by the toxins.

If possible, retrieve the spider and take it with the patient to medical treatment.

Safe Work Practices for Insects/Arachnids

Follow these safe work practices:

- If hypersensitive to bee, wasp or hornet stings, inform the UXOSO of this and any associated antidotes;
- Wear gloves;
- Watch for stinging insects and their nests, and advise the SUXOS or UXOSO that a stinging insect nest or a swarm of bees is located or suspected in the area;
- Flag nests and notify teammates; and
- Keep required emergency medication on or near yourself, and inform teammates of the location and administration.

Snakes

Depending on the time of year, snakes may be present. Be aware of your surroundings and take particular care when traversing areas such as near rocks, logs, crevices and in holes or pipes. There may be rattlesnakes (**Figure A-7**) and copperheads (**Figure A-8**) in Cowley

County. Snakes usually avoid humans; if there is a snake in the work area don't try to remove it or kill it, just allow it to leave.

Figure A-3 Deer Tick

Figure A-4 Chigger

Figure A-5 Black Widow Spider

Figure A-6 Brown Recluse Spider

Figure A-7 Rattlesnake

Figure A-8 Copperhead

9.8.1.3 Mammals

Local mammals include rodents, bats, coyote, wolves, deer, black bears, and bobcats. Most will shy away from humans. If a mammal enters the work area, walk away calmly and shelter in a vehicle or building. If the animal appears to be wounded or behaving in a threating manner, call law enforcement for help. Return to work after the animal leaves the area.

9.8.1.4 Plants Causing Skin Reactions

Poison ivy exists in Kansas (**Figure A-9**). It grows close to the ground and vines around trees. As the Boy Scouts say, “leaves of three, leave them be.” Contact with the leaves, stems, or roots may produce redness, blisters, swelling, and intense burning and itching due to transfer of oils or sap. The victim also may develop an infection should the surface of the skin be broken.

Figure A-9 Poison Ivy

The compound that causes the allergic reaction is urushiol. It is easy to transfer it from contaminated surfaces to the skin and other non-contaminated surfaces. A careless person can actually bring urushiol home and contaminate his home and family members. Contact may be incidental while conducting normal duties or intentional such as when removing vegetation.

Preventive measures for incidental contact are:

- Avoid contact with poison plants;
- Remove gloves prior to touching face, neck, or other exposed areas of the body;
- Avoid transferring oils and sap;
- **Wash hands, face or other exposed areas at the beginning of each break period and at the end of each workday**; and
- Keep the skin covered as much as possible (i.e., long pants and long sleeved shirts) in areas with poison ivy will limit exposure.

Conducting vegetation removal with mechanical equipment such as brush trimmers will cause spraying urushiol and scattering of flying plant material at high rates of speed in all directions. If you cannot avoid cutting poisonous plants, take some serious safety precautions:

- Use a barrier cream such as TechNu ® or other fine brand on your skin;
- Wear coveralls, preferably disposable such as Tyvek;
- Keep skin and hair covered, this includes wearing a face cover such as a neckerchief;
- Wear boot covers;
- Remove potentially contaminated outer clothing before taking a break, entering a vehicle or building and leaving the site;
- Put disposable clothing in plastic bags and dispose of it in the trash;
- Launder other clothing, including underclothing, before wearing again;
- Thoroughly wash footwear; and
- Cleanse your body as soon as possible.

Tips for Urushiol-Contaminated Gear

- Remember that any container such as your laundry bag can pick up the urushiol, so don't put your washed clothes back in a used laundry bag;
- Detergent and water works well;
- TechNu® cleanser (or similar) works well on skin;
- Launder or dry clean textile protective gear such as chaps;
- Many people use alcohol or bleach in spray bottles to break down urushiol. This has limited effectiveness and soap or detergent and water works best;
- Any tool used for cutting the plant is heavily contaminated; clean hard gear such as tools and hard hats by washing with soap and water;
- It's better to discard and replace contaminated gloves; and
- If you send anything out for commercial cleaning, advise them of the possibility of urushiol.

Treatment

Report any case of poison ivy to the UXOSO. See a doctor for any rashes or reactions in or around your eyes. Serious cases require medical treatment. Treat minor cases with over-the-

counter medications. Scratching your rash will not cause it to spread, but it can lead to infections.

9.8.1.5 Plants Causing Skin and Tissue Injury

Contact with sharp leaves, nettles, and thorns may injure. Punctures, cuts, and even minor scrapes may cause non-infectious skin lesions, and the introduction of fungi or bacteria through the skin or eye. The warm moist environment inside protective clothing is ideal for the propagation of infection. Preventive measures are:

- Avoid contact with hazardous plants;
- Remove gloves prior to touching face, neck, or other exposed areas of the body;
- Wash hands, face or other exposed areas at the beginning of each break period and at the end of each workday; and
- Keep your skin covered as much as possible (i.e., gloves, long pants and long sleeved shirts) in areas where these plants are known to exist to limit exposure.

9.9 Hazard Communication Program

The majority of hazardous materials used will be in limited quantities in end-consumer containers such as batteries, spray paint, printer ink, window cleaner and sanitary hand wipes. No SDSs are required for these items IAW 29 CFR 1910.1200(b)(6)(ix). SDS should be onsite for chemicals such as gasoline, diesel, paints, herbicides, and insecticides. Bay West does not anticipate exposure to site chemicals above OSHA permissible exposure limits (PELs) or American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs). If we require any hazardous materials, follow these guidelines:

- Store materials in secure and sealed containers;
- Maintain the Hazardous Substance Inventory List and copies of SDSs. Note that no SDS's are currently required. The UXOSO will provide copies of applicable SDSs to emergency service personnel as needed or requested.
- Subcontractors shall submit copies of SDSs for hazardous substances they use to the UXOSO who will in turn inform them of the location of the project SDS files. The UXOSO will provide copies of applicable SDSs to subcontractor personnel as needed or requested.
- Inform site personnel of the hazardous substances that they will be working with through hazard communication training during APP review and at safety meetings.
- Label containers with product identity and hazard ratings. Hazardous substances transferred from an original container to another container require labeling when filling.

9.10 Heat/Cold Stress Management

Refer to the SSHP Section 8.0 for heat and cold stress management.

9.11 Traffic Safety Plan

Follow these general driving and traffic rules:

- The maximum speed limit is 25 miles per hour (mph) for unposted roads. All personnel must observe speed limits;
- Seatbelts are required for drivers and passengers. The driver is responsible for passengers wearing seatbelts;
- Operators must have a driving license;

- Driving under the influence of alcohol or other drugs is not allowed, and is a; violation of company policy; and the law;
- Drivers must yield to pedestrians;
- When driving to and from work, be mindful of crepuscular creatures;
- Parking is allowed in designated areas only;
- Traffic accidents will be reported immediately to the PM and CSHM;
- While driving, there is no cell phone use without a hands-free device. Even with a hands-free device, consider if it's really necessary to talk on the phone; and
- Before driving, walk around the vehicle to identify obstructions invisible from the driver's seat.

When working around heavy equipment:

- Yield the right of way to heavy equipment. The operator's vision is restricted and the machines are less maneuverable than road vehicles;
- Ground personnel must wear high visibility vests;
- Establish routes for heavy equipment and use them;
- Establish eye contact and ensure the operator knows what you plan to do before driving or walking near the heavy equipment; and
- Equipment operators must remain alert to the activities around them.

9.12 Fire Prevention Plan

Potential causes of fires include tobacco smoking and internal combustion engines. Observing the following precautions prevents fires:

- Smoke only in designated smoking areas;
- Discard extinguished cigarette butts into acceptable receptacle;
- Ensure internal combustion equipment has proper exhaust systems with spark arresting devices;
- Do not park vehicles where vegetation may contact the exhaust system;
- No smoking at sites with unmaintained vegetation (prairie grasses);
- Do not refuel small portable engines (i.e., generators, pressure washers) while hot;
- Perform all fueling in well ventilated areas free from open flames;
- Store flammable liquids at least 50 feet from potential ignition sources and in a well-ventilated area; and
- Refuel equipment at least 50 feet from potential ignition sources.

Keep at least one 10-B:C fire extinguisher on each vehicle. Use shovels and other hand tools to fight small fires to prevent them from becoming wild land fires. Personnel must not endanger themselves when fighting fires and must notify the fire department even after extinguishing the fire so firefighters can determine if a residual ignition hazard exists.

9.13 Wild Land Fire Management Plan

Personnel safety is paramount in the event of a wild land fire. Bay West personnel will report wild land fires by calling **911**. In the event of a wild land fire, Bay West personnel will evacuate the work site. When safe to do so, remove any materials such as flammable liquids that have the potential to accelerate the fire from the site.

9.14 Physical Hazard Control Plan

9.14.1 General Site Rules and Prohibitions

To ensure a safe operation, project personnel will comply with the following general rules and prohibitions.

- Display federal/state/local required postings;
- Entry into and exit from a site is permitted only through designated access points, except during an emergency, or as authorized by the UXOSO;
- Practice good personal hygiene – wash exposed areas prior to eating, drinking, smoking/using tobacco products, using the restroom, any other activity involving hand-to-mouth contact, or exiting the work site. The UXOSO will establish the designated break/rest and smoke areas;
- Matches, lighters, or spark-producing materials are not permitted within 25 feet of flammable materials except for the purpose of performing a flame test IAW EM 385-1-97, on a suspected explosive;
- Proper site housekeeping (including removal of trash and orderly stacking and removal of materials to reduce slipping, tripping, and fire hazards) is a daily; and
- No guns or alcohol.

9.14.2 Digging permit

A digging permit is required prior to beginning intrusive activities, including site set up. Call the agency listed in **Table A-3**. A utility clearance inspection form is provided to assist with dig permitting.

Table A-3 Digging Permit Telephone Numbers

Company	Description	Number
Kansas One Call	Call before you dig; utility clearance	811

9.14.3 Overhead Utilities

There are overhead utilities in the MRS. Maintain the distances presented in **Table A-4** between utility lines and heavy equipment to prevent contact and arcing. Consult the local electrical utility to ascertain line voltage.

Table A-4 Minimum Clearance from Energized Overhead Electric Lines

Voltage (nominal, kV, alternating current)	**Minimum Clearance Distance**
Up to 50	10 ft (3 m)
51 – 200	15 ft (4.6 m)
201 – 350	20 ft (6 m)
351 – 500	25 ft (7.6 m)
501 – 750	35 ft (10.7 m)
751 – 1000	45 ft (13.7 m)
Over 1,000	(As established by the utility owner/operator

9.14.4 Other Permits

No other work permits are required.

9.14.5 Dust Control

Dust control measures minimize/reduce surface and air movement of dust from disturbed soil surfaces. The UXO Team will use water spray/wetting as a dust control measure, if necessary.

9.14.6 Personnel Decontamination

Refer to the SSHP Section 11.0.

9.14.7 Equipment Decontamination

Refer to the SSHP Section 12.0.

9.15 Contingency Plan for Severe Weather

Refer to the SSHP Section 14.2.

9.16 Excavation and Trenching Plan

Refer to the SSHP Section 9.3.3.

9.17 Explosives Safety Site Plan

Refer to the SSHP Section 9.3.4.

10.0 RISK MANAGEMENT PROCESS

Refer to the SSHP Section 2.0.

Attachment 1

Site Safety and Health Plan

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This SSHP addresses work on:

Formerly Used Defense Site (FUDS)
Military Munitions Response Program Remedial Investigation/Feasibility Study
Strother Field Disposal Area
Cowley County, Kansas
FUDS Property Number: B07KS0277
FUDS Project Number: B07KS027703

In accordance with (IAW) Engineer Manual (EM) 385-1-97 section I.1.A.01.01, the Accident Prevention Plan (APP) must be supplemented with an SSHP to address hazards related to munitions and explosives of concern (MEC). EM 385-1-97 requires the SSHP elements listed below: the SSHP duplicates some elements in EM 385-1-1, Appendix A. Information is not to be repeated, and duplicate elements are to be addressed in the SSHP.

1.0 SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

The former Strother Field, FUDS property number B07KS0277, is located approximately 5 miles south of Winfield and 6 miles north of Arkansas City in Crowley County, Kansas. Strother Field was a pilot training base with a small arms storage building, an ammunition magazine, a skeet range, and a pistol range. There was no bombing/gunnery range at Strother Field. Previous investigations found no documentation of the types of ordnance used or stored.

There is no historical information available for the Disposal Area munitions response site (MRS). The Site Inspection (SI) field team observed munitions debris (MD) and potential MEC associated with AN-M50 and AN-M54 incendiary bombs (12 items) and M15 white phosphorous (WP) smoke hand grenades (two items). The MD and potential MEC items were concentrated in an approximately 2-acre area.

The SI concluded there was not a significant risk from MC.

2.0 HAZARD/RISK ANALYSIS (ACTIVITY HAZARD ANALYSIS FOR EACH TASK/OPERATION TO BE PERFORMED ON-SITE)

Activity hazard analyses (AHAs) provide project-specific hazards and controls for each definable feature of work. AHAs are task specific; therefore, the field teams create the AHAs at the preparatory phase meeting. However, in accordance with U.S. Army Corps of Engineers (USACE) direction, we have provided draft AHAs in **Appendix A, Attachment 1, Appendix 1**. The AHAs define the work sequence, anticipated hazards, conditions, equipment, materials, personnel, and control measures for eliminating or reducing each hazard to an acceptable level of risk. Once this process has occurred, an overall Risk Assessment Code (RAC) is assigned to the activity based on the highest RAC for an individual step. Bay West will not begin work prior to USACE acceptance of AHAs. If the initial RAC increases due to an update, we will resubmit the AHA to USACE. If the RAC does not increase, resubmittal is not required.

3.0 STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

This section outlines the organization, qualifications, and responsibilities of field level personnel.

3.1 Field Level Personnel

3.1.1 Senior UXO Supervisor

The Senior Unexploded Ordnance Supervisor (SUXOS) supervises and oversees normal and emergency work. He or she is responsible for the following:

- Supervising activities;
- Implementing the field APP and SSHP;
- Coordinating with the Unexploded Ordnance Safety Officer (UXOSO) on safety-related matters;
- Coordinating with the USACE Ordnance and Explosives Safety Specialist (OESS);
- Stopping any operation that threatens the health or safety of the team or surrounding population;
- Maintaining logs and records in the field; and
- Implementing changes to APP or SSHP as directed by the Corporate Safety and Health Manager (CSHM) and/or UXOSO.

3.1.2 UXO Safety Officer

The UXOSO fulfills the duties of the Site Safety and Health Officer. The UXOSO acts as safety oversight for normal and emergency work, and performs emergency notification as the On-Scene Incident Commander. The UXOSO is responsible for the following:

- Implementing the APP and SSHP;
- Identifying needed changes to the APP or SSHP;
- Coordinating with the OESS;
- Determining evacuation routes;
- Presenting daily safety meetings;
- Presenting training for workers and visitors;
- Maintaining safety logs and records in the field;
- Implementing changes to the APP or SSHP as directed by the CSHM;
- Enforcing and administrating general health and safety programs;
- Contacting the Project Manager (PM) or CHSM immediately for any work-related injuries;
- Enforcing the level of personal protective equipment (PPE) required;
- Investigating work-related accidents and illnesses, and implementing corrective action plans;
- Establishing monitoring parameters based on expected contaminants;
- Establishing employee exposure monitoring notification programs;
- Stopping any operation that threatens the health or safety of the team or surrounding population; and
- Upgrading levels of protection based on observations or monitoring results.

When there are 15 or fewer people working at the site, the UXOSO and Unexploded Ordnance (UXO) Quality Control Specialist positions may be combined as the UXO Safety Officer/Quality Control Specialist (UXOSO/QCS).

3.1.3 Work Team

The work crew has the following responsibilities:

- Reporting any unsafe or potentially hazardous conditions to the SUXOS, UXOSO, or CSHM;
- Reporting incidents, accidents, and near misses, no matter how minor they may seem, to the UXOSO;
- Stopping any operation that threatens the health or safety of the team or surrounding population;
- Maintaining knowledge of the information, instructions, and Emergency Response Plan (ERP) contained in the APP; and
- Complying with the requirements and procedures set forth in the APP and any addenda.

3.2 Competent Person

Occupational Safety and Health Administration (OSHA) Regulation 29 Code of Federal Regulations (CFR) 1926.32 defines a Competent Person. Specific OSHA and USACE regulations identify the need for competent persons.

The UXOSO is a Competent Person as defined in OSHA 29 CFR 1926.32. The UXOSO will have performed work on sites of similar hazard, risk, and complexity to the task assignment. He or she will have five years of experience implementing safety and occupational health procedures and experience conducting exposure monitoring. He or she will have the knowledge, experience, and training necessary to perform the duties of Competent Person.

4.0 TRAINING

Bay West will maintain personnel qualifications of site workers at the site office. Bay West maintains certifications and overall qualifications in a corporate database. Project field personnel will have the following qualifications, training, and/or certifications:

- 40-hour HAZWOPER training IAW 29 CFR 1910.120(e);
- 8-hour annual HAZWOPER refresher training IAW 29 CFR 1910.120(e);
- Trained IAW Department of Defense Explosives Safety Board (DDESB) Technical Paper (TP) 18, Minimum Qualifications for UXO Technicians and Personnel, with Explosive Ordnance Disposal/MEC experience in Table 4.1;
- First Aid and cardiopulmonary resuscitation (CPR) training (minimum of two personnel);
- 30-hour OSHA construction safety for the UXOSO/Quality Control Specialist (QCS) IAW USACE EM 385-1-1;
- 10-hour or 30-hour construction safety for the SUXOS;
- 8-hour OSHA Site Supervisor training for supervisory personnel (SUXOS, UXOSO, UXOQCS and UXOTIII) IAW 29 CFR 1910.120(e); and
- Heavy equipment operators will be skilled and knowledgeable at the level of a qualified person.

5.0 PERSONNEL PROTECTIVE EQUIPMENT

Use PPE IAW OSHA 29 CFR 1910 Subpart I. Bay West selected PPE after consideration of hazards. During field work, monitor PPE for changes in condition or the presence of

unanticipated hazards. If necessary, the UXOSO will adjust PPE levels in coordination with the CSHM.

The UXOSO will train employees on PPE before beginning work. Workers must demonstrate understanding of the training and the ability to use PPE. Document PPE training on the Training Acknowledgement Form (**Appendix D**).

5.1 PPE Hazard Assessment

We conducted hazard assessments during the site walk and document review. During the initial PPE decision-making process, the APP preparer reviewed available information and established the level of protection for each task. The UXOSO must conduct additional hazard assessments periodically and when field activities or conditions change.

5.2 PPE Hazard Assessment Criteria

PPE minimizes personnel exposure to hazards. Decision-making criteria for identifying hazard assessments include the following:

- Historical information and work location;
- Type of exposure potential suspected or known to be present (e.g., chemical hazards, physical agents, physical hazards, biological hazards);
- Duration of activities;
- Type of task to be performed; and
- USACE, OSHA, and Bay West requirements.

The UXOSO will enforce PPE use. The UXOSO may increase the level of protection due to changing requirements, but may not decrease the level of protection without approval of the CSHM. Document changes in the level of protection. The requirements outlined below consider the potential hazards, potential for contact, and chemical resistance of protective clothing, IAW current information.

5.3 Proper PPE Use

Minimum requirements are as follows:

- The need for PPE;
- The proper use and proper donning/removing of PPE; and
- PPE limitations.

The UXOSO is to conduct PPE training and ensure PPE fits properly. Administer remedial PPE training to employees who demonstrate a lack of knowledge or skill after initial training.

Workers must report any problem or difficulties with PPE to the UXOSO, including any signs or symptoms of heat stress (e.g., rapid pulse, nausea, fatigue), any problems/difficulties such as chest pain, discomfort, interference with vision or communication, restriction of movement, unusual residues on PPE, or skin irritation.

5.4 Maintenance and Inspection of PPE

The UXOSO is responsible for maintaining, storing, and issuing PPE. Employees are responsible for the PPE issued to them. Maintain and store PPE IAW the manufacturers' recommendations.

5.4.1 General PPE Requirements

Clothing—Workers must wear coveralls or long pants and shirts with sleeves. There is no loose clothing, dangling jewelry, loose, long hair, or rings permitted around heavy equipment, drill rigs, or rotating machinery.

Foot Protection—Wear work boots with ankle support and safety toes meeting the American Society for Testing and Materials standards F2412 and F2413 in the field. Personnel may use rubber safety shoes or rubber boots over safety shoes if they see fit. Open shoes, sandals, and sneakers are forbidden in the field, but personnel may wear them in an office environment.

Head Protection—Wear head protection (hard hats) when working around overhead hazards.

Hearing Protection—Disposable earplugs or earmuffs are available to employees potentially exposed to excessive or chronic noise levels.

Eye/Face Protection—IAW Bay West policy, wear safety glasses with side protection during field work. Eye and face protection, including prescription glasses, must meet Industrial Safety Equipment Association/American National Standards Institute (ISEA/ANSI) standard Z87.1.

High Visibility—Wear a high visibility clothing routinely; vest meeting ISEA/ANSI 107 Class 2 requirements when exposed to traffic or heavy equipment.

5.4.2 Levels of Protection

Level D is required for project personnel and visitors. The UXOSO may increase the level of protection due to changing requirements, but may not decrease the level of protection without approval of the CSHM. Should personnel encounter an unusual odor, discolored soil, or an unknown item that may be hazardous, toxic, or radioactive waste, they will notify their supervisor and evacuate the site upwind of the suspected item or source.

5.4.2.1 Level D Protection

Level D PPE includes the following:

- Cotton coveralls or long pants and a shirt with sleeves;
- Hard hat as required by the AHA;
- Safety glasses;
- Safety toe work boots with ankle support;
- Work gloves for material handling;
- High visibility clothing (Class 2 vests or higher when working near roadways with traffic or heavy equipment);
- Snake leggings (as necessary); and
- Hearing protection, earplugs, and/or earmuffs as required by the AHA.

5.4.2.2 Greater Levels of Protection

Bay West does not anticipate hazards that would require Level C PPE or greater.

5.4.3 Respiratory Protection

No respiratory protection is required for this field effort.

6.0 MEDICAL SURVEILLANCE

6.1 Medical Examination

All personnel performing work that may result in exposure to contaminant-related health and safety hazards participate in a medical surveillance program. They will have successfully completed a preplacement occupational physical examination and will complete an occupational physical examination annually thereafter. This examination meets 29 CFR 1910.120(f) requirements for hazardous waste site operations.

The medical surveillance includes a judgment by the medical examiner of the ability of the employee to use either positive or negative pressure respiratory equipment IAW 29 CFR 1910.134. Any employee with a medical condition that could be aggravated by exposure to chemical substances or by the use of respiratory equipment will not work on projects requiring respiratory protection.

The employee is informed of any medical conditions that result in work restriction or that would prevent them from working at hazardous waste sites. Bay West provides a copy of the medical examination report to the employee.

6.2 Medical Restriction

If an occupational injury or illness occurs that restricts an employee's ability to function at full capacity, Bay West maintains a policy of providing these employees with restricted duty assignments whenever possible to allow them to continue to be productive.

6.3 Medical Records

Bay West maintains medical and personal exposure monitoring records according to the requirements of 29 CFR 1910.120(f), and these records shall be kept for a minimum of 30 years. We maintain employee confidentiality. Medical records and personal exposure monitoring records are available via written request to CHSM.

7.0 EXPOSURE MONITORING/AIR MONITORING

No exposure monitoring for chemical contaminants is necessary.

Based on the nonaggressive excavation methods, soil types, and high moisture content, excavation will not result in concentrations above the exposure limit for dust and other particles. The UXO team will visibly monitor the air for suspended dust and will take dust control measures as outlined in APP.

8.0 HEAT AND COLD STRESS MANAGEMENT

The UXOSO is responsible for ensuring temperature stress controls are adequate for the conditions and tasks. Employees, and specifically the UXOSO, are empowered and expected to stop or modify work and take precautions to prevent temperature-related illnesses.

Monitor the environment for heat and cold stress as outlined below. Monitoring is no substitute for common sense. If temperature extremes affect workers, take measures such as adjusting work schedules, increasing fluid intake, or drinking cool/warm liquids.

8.1 Heat Stress

Heat stress is one of the most common (and potentially serious) illnesses that affects workers. When workers are engaged in operations involving hot environments, a number of physiological responses can occur that may seriously affect the health and safety of the workers. We can

eliminate or control these effects through a comprehensive heat stress prevention and monitoring program.

Individuals vary in their susceptibility and degree of response to stress induced by increased body heat. Heat stress can result in health effects ranging from transient heat fatigue to serious illness to death. Interacting factors including environmental conditions, clothing, workload, and the individual characteristics of the worker may lead to heat stress.

Factors that may predispose a worker to heat stress include the following:

- Lack of physical fitness;
- PPE (level D PPE causes a minimal increase in the potential for heat stress);
- Lack of acclimatization to hot environments;
- Degree of hydration;
- Level of physical fitness;
- Current health (e.g., having an infection, chronic disease, diarrhea);
- Alcohol or drug use;
- Age and gender; and
- Prior history of heat stress.

8.1.1 Temperature Monitoring

- Measure the ambient air temperature during the day;
- If the temperatures reach or exceed 75 degrees Fahrenheit (°F), implement temperature stress controls; and
- Document temperature monitoring results and temperature stress controls in field logbooks.

8.1.2 Early Symptoms of Heat-Related Problems

- Decline in task performance
- Lack of coordination
- Decline in alertness
- Unsteady walk
- Excessive fatigue
- Muscle cramps
- Dizziness

8.1.3 Preventive Measures

Proper training and preventive measures help avert serious illness and loss of work productivity. Preventing heat stress is particularly important because once someone suffers from heat exhaustion, that person may become predisposed to additional heat injuries. These preventive measures represent the minimal steps to be taken and include the following procedures:

Workers are allowed time to acclimatize to work conditions, temperature, protective equipment, and workload. Acclimatization is the adaptive process of working in hot environments, resulting in a decrease of the physiological strain and allowing the worker’s body to adjust to the level and type of work.

This process involves a gradual increase in the individual's workload over the required period, the length of which depends upon the nature of the work performed, ambient temperatures, and the individual's susceptibility to heat stress.

A medical clearance as outlined in **Section 6.0** above does not necessarily mean that workers are fit for duty in all environments. Workers should achieve and maintain an optimum level of physical fitness to tolerate and respond to hot environments and heavy workloads. In comparison to an unfit person, a fit person will have less physiological strain, a lower heart rate and body temperature, and a more efficient sweating mechanism.

The UXOSO or other authorized person will observe each worker prior to the start of daily operations and periodically throughout the day to determine the individual's susceptibility to heat-induced stress. Evidence of extreme dehydration, illness, the effects of prescription medication, or residual impacts of off-duty alcohol use may require the UXOSO to restrict the worker's activities until the worker is fit for duty. The UXOSO will perform monitoring of personnel identified as being at high risk for heat stress more frequently

Train workers to recognize and treat heat-related illnesses. This training will include the signs, symptoms, and treatment of heat stress disorders as outlined in this section.

The normal thirst mechanism is not sensitive enough to ensure people consume enough water to replace lost sweat. To maintain workers' body fluids at normal levels, workers should drink a minimum of approximately 16 ounces of liquids prior to start of work in the morning, after lunch and prior to leaving the site at the conclusion of the day's activities. Bay West will provide disposable 4- to 12-ounce cups and liquids. Avoid liquids containing caffeine. Workers must also consume adequate meals. Workers may drink water and sports drinks from canteens or other similar closeable containers within the MRS when working in level D PPE.

When ambient conditions and workload requirements dictate, as determined by the UXOSO, workers are required to drink a minimum of 16 ounces of liquids during each rest cycle. A shelter or shaded area may be provided where workers are protected from direct sunlight during rest periods.

8.2 Heat Index

The National Weather Service (NWS) has devised a heat index (HI) (sometimes referred to as the "apparent temperature") as an accurate measure of how hot it really feels when relative humidity is added to the actual air temperature. **Figure A1-1** provides a general guideline for assessing the potential severity of heat stress. Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous as the wind adds heat to the body.

8.3 Physiological Monitoring

Because the incidence of heat stress depends on a variety of factors, monitor workers. Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work. Adjust the length of the work cycle to the frequency of the required physiological monitoring.

Monitoring of personnel wearing PPE should begin when the ambient temperature is 75°F or above. **Table A1-1** presents the frequency for monitoring. Monitoring frequency should increase as the ambient temperature increases or as slow recovery rates are observed.

A person with a current first aid certification who is trained to recognize heat stress symptoms must perform heat stress monitoring.

When monitoring the worker physically, measure the following:

- **Heart rate**
  - Use a heart rate monitor or count the pulse during a 30-second period as early as possible in the rest period;
  - If the heart rate exceeds 110 beats per minute (bpm) at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same; and
  - If the heart rate still exceeds 110 bpm at the next rest period, shorten the following work cycle by one-third.
- **Oral temperature**
  - Use a clinical thermometer (oral, temporal, etc.) to measure the body temperature at the end of the work period (before drinking);
  - If body temperature exceeds 99.6°F, shorten the next work cycle by one-third without changing the rest period;
  - If body temperature still exceeds 99.6°F at the beginning of the next rest period, shorten the following cycle by one-third; and
  - Do not permit a worker to wear a semi-impermeable or impermeable garment when oral temperature exceeds 100.6°F.

Figure A1-1 Heat Index Chart

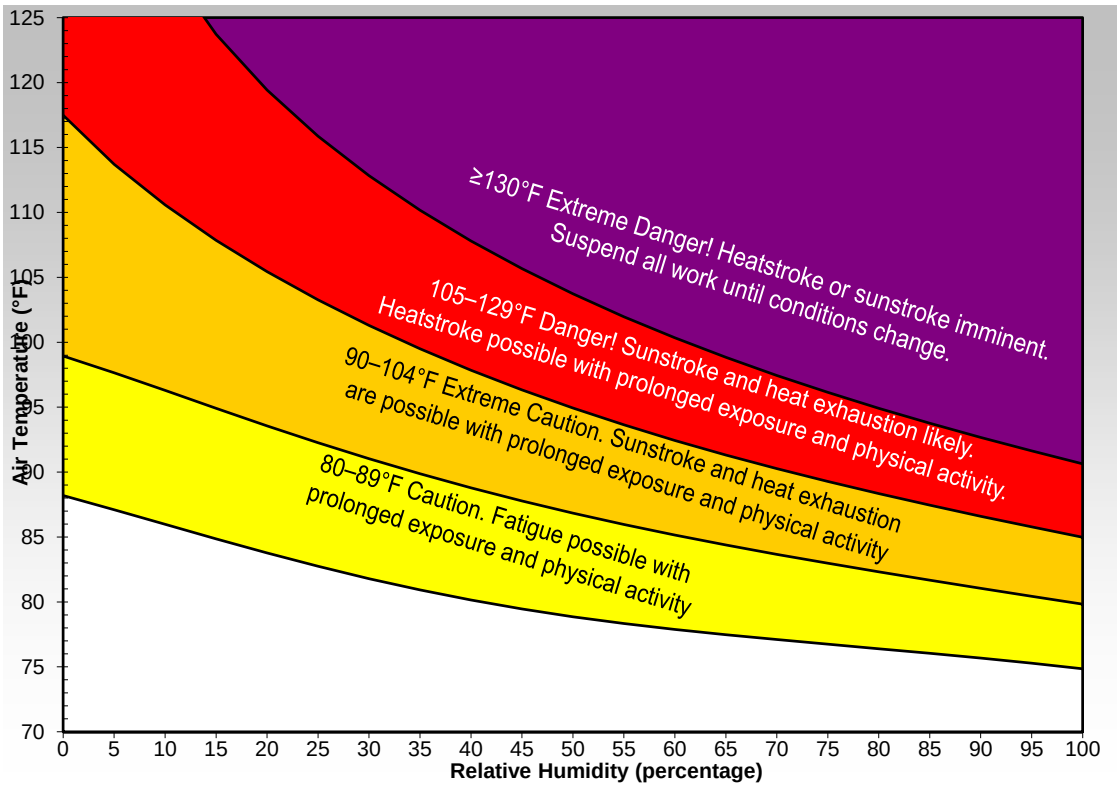


Table A1-1 Physiological Monitoring for Fit and Acclimatized Workers

Adjusted Temperature	Normal Work Ensemble	Impermeable Ensemble
90°F or above	After each 45 minutes of work	After each 15 minutes of work
87.5°F to 90°F	After each 60 minutes of work	After each 30 minutes of work
82.5°F to 87.5°F	After each 90 minutes of work	After each 60 minutes of work
75°F to 82.5°F	After each 120 minutes of work	After each 90 minutes of work

Notes:

- *For work levels of 250 kilocalories/hour*
- *Calculate the adjusted air temperature by using this equation: adjusted air temperature (°F) = air temperature (°F) + (13 x percent sunshine). Measure air temperature with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.) or use a wet bulb globe thermometer.*
- *A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.*

8.4 Cold Stress

Freezing temperatures are possible in winter. If work on this project is conducted in the winter months, thermal injury due to cold exposure can become a problem for field personnel. Work will cease under unusually hazardous conditions (e.g., wind-chill less than 0°F, or wind-chill less than 10°F with precipitation).

Systemic cold exposure is called hypothermia. Localized cold exposure is called frostbite. Discuss recognition of the symptoms of cold-related illness during the initial health and safety briefing. Refer to the most recent revision of the ACGIH TLV for Chemical Substances and Physical Agents for additional information on cold-stress prevention, monitoring, and work-warming regimens.

Recommended Work/Rest Schedule Guidelines:

Table A1-2 Four-Hour Shift Schedule

Air Temp	No Wind	5 mph Wind	10 mph Wind	15 mph Wind	20+ mph Wind
-5°F to -9°F	Normal with 1 break	Normal with 1 break	75 minutes with 2 breaks	55 minutes with 3 breaks	40 minutes with 4 breaks
-10°F to -14°F	Normal with 1 break	75 minutes with 2 breaks	55 minutes with 3 breaks	40 minutes with 4 breaks	30 minutes with 5 breaks
-15°F to -19°F	75 minutes with 2 breaks	55 minutes with 3 breaks	40 minutes with 4 breaks	30 minutes with 5 breaks	Cease Work
-20°F to -24°F	55 minutes with 3 breaks	40 minutes with 4 breaks	30 minutes with 5 breaks	Cease Work	Cease Work
-25°F to -29°F	40 minutes with 4 breaks	30 minutes with 5 breaks	Cease Work	Cease Work	Cease Work
-30°F to -34°F	30 minutes with 5 breaks	Cease Work	Cease Work	Cease Work	Cease Work

Cold Weather Work Guidelines Reminder:

- Work under constant protective observation (buddy system…no lone worker)
- Wear proper attire (pack type safety toed boots, layered clothing, full-body coverage, and face masks
- Change wet clothing immediately in a heated area

- Avoid touching bare metal surfaces with temps are less than 20°F
- Protective PPE may become brittle and more susceptible to cracking and tearing…watch out!

Drink hot liquids such as hot cocoa, decaffeinated coffee or tea. Limit alcohol consumption (off job hours of course).

9.0 STANDARD OPERATING SAFETY PROCEDURES, ENGINEERING CONTROLS, AND WORK PRACTICES

9.1 SOPs

SOPs are presented in **Appendix E** of the Work Plan.

9.2 Engineering Controls

Engineering controls may be necessary for demolition shots. See the Explosives Site Plan (ESP).

9.3 Work Practices

9.3.1 MEC Safety Plan

UXO personnel are cognizant of MEC safety procedures. The following general safety precautions are provided for guidance:

- Non-UXO-qualified personnel must be escorted by a UXO-qualified personnel in any MEC area;
- DO NOT touch or move any ordnance item(s) regardless of the markings or apparent condition unless the functioning or hazards are known;
- DO NOT visit an ordnance site if an electrical storm is occurring or approaching. If a storm approaches, leave the site immediately and seek shelter;
- DO NOT use flash photography, radios, or cellular phones in the immediate vicinity of suspect ordnance items unless the functioning and hazards are known; and
- DO NOT rely on color code for positive identification of ordnance item(s) or their contents.

Specific actions to be taken upon locating ordnance include the following:

- Keep the exposure of personnel to a minimum;
- Approach ordnance items from the side; avoid approaching the front or rear areas;
- Always assume ordnance items contain a live charge until it is ascertained otherwise;
- DO NOT be misled by markings on the ordnance item stating practice or inert. Practice items may have explosive charges used to mark/spot the point of impact, or the item could be incorrectly marked;
- Follow the safety precautions in EM 385-1-97 and data sheets for the type of MEC encountered;
- Clearly mark the location of any ordnance items found so it can be easily located and avoided until disposed of;
- Notify the SUXOS upon locating any MEC or suspect MEC;
- The SUXOS and UXOSO must evaluate MEC before movement and ensure that the risk of movement is acceptable.

- Do not approach a smoking WP munition. Burning WP may detonate the burster.
- Due to incomplete combustion, WP or residue may reignite spontaneously if the crust is broken and exposed to air.
- Cover a smoking (leaking) WP munition in water, mud, wet sand or earth, or foam as quickly and gently as possible.
- Drinking water is always available and one can use it if necessary.
- Blow a WP munition in place if possible.
- Sand bag, water, and earth tamp engineering controls are not permitted for WP munitions because they may prevent complete burning of the filler.
- If necessary to transport within the MRS, immerse WP munitions in water, mud, or wet sand.

9.3.2 Hazardous Energy Control Plan

This project may involve a mechanical screening plant. The potential exists for a person to be working within the hopper or in close proximity to moving parts, belts, rollers, etc., while performing maintenance, clearing jams, or inspecting suspect MEC items. Activation of the plant may expose workers to hazardous energy.

The following rules apply to the operation of the screening plant:

- Account for personnel before starting the plant.
- Ensure personnel are clear of moving parts and are not within any areas where ejected material may strike them.
- Turn the screen plant off before any person enters the machine or any danger zones or comes in close proximity to moving parts.
- If the control panel has a suitable lockout hasp, install a BLUE lockout padlock before any worker may be exposed to hazardous energy. The worker will carry the key, and there are no duplicate keys allowed.
- If a key operates the machine, before any person enters or climbs on the screen plant, they will remove the key and carry it on to the machine while performing the task. The last person working on the screen plant will retain the key. He or she will ensure other personnel are clear before leaving the plant. Only one key is allowed in the work area. The extra key will remain locked inside the site office.
- If there is no hasp on the control panel, place a weatherproof tag entitled DANGER Tagged Out DO NOT REMOVE or similar language and the name of the person entering the screen plant over the control panel. Attach the tag with a non-reusable fastener, such as a zip-tie. Each person must have a separate tag. Do not start the screen plant until every person has exited the sifter and retrieved his or her own tag.

The SUXOS is responsible for implementing the hazardous energy control plan. The UXOSO will verify that workers are following procedures and document an inspection of the procedures at least weekly.

Brief this plan at the preparatory inspection. Evaluate the first use of these procedures as part of the initial inspection. Document training as part of the initial safety briefing.

9.3.3 Excavation and Trenching Plan

An excavation is any manmade cavity or depression. Depending on its depth, width, and the presence of a hazardous atmosphere, an excavation may also be a confined space. Excavations include trenching. A trench is a narrow excavation in which the depth is greater

than the width, and width is 15 feet or less. Trenches excavated deeper than 4 feet are considered a confined space. The activities currently scheduled for the project may include excavation.

Perform excavations IAW 29 CFR 1926 Subpart P. Prior to starting any excavation, investigate the possibility of the presence of underground pipelines, electric wires, conduits, or vessels containing material under pressure. This includes reviewing DGM maps and contacting 811. The UXOSO/QCS will coordinate with the Strother Field point of contact (POC) and local utility locators to locate and shut off existing utilities. Remove or support surface encumbrances that will create a hazard to workers.

As an OSHA Competent Person, the UXOSO must inspect the excavations, adjacent areas, and protective systems on the following schedule:

- Daily and prior to work in or around the excavation;
- After every rain storm or other hazard-increasing occurrence; and
- As needed throughout the work as conditions change.

If a hazardous condition exists, remove endangered workers from the excavation and stop work until you can mitigate the hazard. A Daily Excavation/Trench Inspection Report Form is provided.

Implement the following safety controls during excavation:

- If the excavation endangers the stability of adjacent structures, then use support systems such as shoring, provide bracing, or underpinning.
- Place excavated soil a minimum of 2 feet from the edge of the excavation and not closer than half the maximum depth of the excavation.
- Due to the limited work area, workers must wear high-visibility “traffic” vests when heavy equipment/motor vehicles are in use.
- When mobile equipment is operated near an excavation or required to approach the edge of an excavation, use a warning system (e.g., barricades, hand signals, mechanical signals, stop logs).
- Workers are not permitted underneath loads handled by lifting or excavating equipment.
- Prior to exiting the site, the UXOSO will ensure that temporary orange fencing, caution tape, or similar barrier is set up around any open excavations to prevent unauthorized personnel from falling into an excavation during nonworking hours. The barriers will remain in place until the excavation has been backfilled and any time the excavation is unsupervised.

9.3.4 Explosives Safety Site Plan

Bay West developed an ESP to describe explosives safety concepts and precautions for this project. The ESP approval process is separate from the APP approval process and includes USACE, Army Safety, and the DDESB. We will have copies of the approved ESP available at the site.

10.0 SITE CONTROL MEASURES

10.1 Work Zones

The project will use a modified zone system to protect essential and nonessential personnel. The exclusion zone (EZ) and support zone (SZ) are prior to the start of each task. A contamination reduction zone is not necessary.

10.2 Exclusion Zone

EZs protect personnel from the hazards of blast and fragmentation as outlined in the ESP. Personnel are not allowed in the EZ without the training outlined in **Section 4.0**, a buddy, and PPE.

10.3 Support Zone

The SZ consists of a staging area outside the team separation distance (see the ESP). It shall contain the team vehicles, a first aid/medical monitoring station, and other elements necessary to support activities. Base the SZ location upon favorable wind direction, topography, and accessibility.

10.4 Site Access and Security

The SUXOS is responsible for site control and access. The site is on private property and access is not normally restricted. Nonessential personnel must not enter exclusion zones during MEC operations as outlined in the ESP. Site workers must monitor the exclusion zone and stop work upon an encroachment. Politely explain the danger to the person and ask them to leave. If the person refuses to leave, notify the SUXOS. Don't ever be confrontational or belligerent because this may affect your personal safety. The SUXOS may call law enforcement for assistance.

Place warning signs at the limits of the magazine Explosive Safety Quantity Distance arcs shown in the ESP.

10.5 On-Site Communications

In an emergency, it is important to convey messages quickly and accurately. Workers must communicate information even through noise and confusion. External communications are through cellular phones located in the EZ or SZ.

Develop separate internal emergency signals at safety meetings. Verbal communication is the primary form of communication. The anticipated distance between the workers is no more than 225 feet. Use a vehicle horn or air horn for emergency alerting.

11.0 PERSONAL HYGIENE AND DECONTAMINATION

Personal decontamination is routine sanitation and hygiene, including prevention of hand-to-mouth contact within the MRS and normal cleansing and washing prior to eating and smoking.

Personnel should shower after work and change into clean clothes.

11.1.1 Decontamination during a Medical Emergency

The probability of contamination is low, and emergency decontamination of workers is not anticipated.

12.0 EQUIPMENT DECONTAMINATION

- Clean all equipment and tools prior to site entry to remove grease, oil, dirt, or any other materials.
- Clean equipment used during the project before demobilizing.
- Decontamination of equipment used in MC sampling is discussed in the field sampling plan.

13.0 EMERGENCY EQUIPMENT AND FIRST AID

13.1 Equipment

Keep a complete ANSI/ISEA Z308.1 first-aid kit, Type III, 16 unit or larger in a waterproof container, containing at a minimum: pocket mouthpiece for CPR, absorbent compresses, adhesive bandages, adhesive tape, antiseptic swabs, burn gel, sterile pads, and a triangular bandage in the site office **and** in each work vehicle. The UXOSO or another designated individual will check items for sterility and inventory the first aid kits weekly and replace expended or outdated items. Replace any items used as soon as possible.

Have the following fire extinguishers available (minimum ratings and quantities):

- Site office, one 2A 10B:C
- Work vehicles, one 10 B:C per vehicle
- Vehicle with fuel transfer tank, one 20 B:C
- Magazine, one 20 B:C
- Explosives transportation vehicle, two 10 B:C
- Heavy equipment, one 10 B:C

Provide fire extinguisher training to workers at the initial safety brief and give occasional refreshers during daily safety briefs.

Inspect fire extinguishers monthly to ensure they are fully charged and operable. Record results on a tag attached to the extinguisher or in a database (electronic or hard copy).

13.2 First Aid

13.2.1 WP

WP is an incendiary or smoke agent used in munitions. It appears as a white to yellow transparent, waxy crystalline solid and turns dark on exposure to light. It ignites spontaneously in moist air and reacts with oxidizers, including sulfur, strong caustics, and halogens. Particles may stick to or embed in skin and continue to burn. One can absorb white phosphorous into the body by inhalation, ingestion, or skin contact and suffer from systemic poisoning. Avoid contacting white phosphorous or inhaling the smoke or fumes. The National Institute for Occupational Safety and Health recommended exposure limits and OSHA permissible exposure limits are 0.1 mg/m3. **It is vital to get the victim medical attention for any type of exposure.** Even if the exposure or injury seems minor, let a medical professional decide what care the victim needs.

Symptoms of exposure include the following:

- Eye exposure
  - Severe irritation and sensation of foreign body in the eye

  - Excessive blinking and tear production
  - Increased sensitivity to light
- Ingestion
  - Feeling of warmth or burning in the throat and abdomen accompanied by intense thirst, nausea, vomiting, diarrhea, and severe abdominal pain
  - Garlic odor to breath, vomitus, and feces
- Inhalation
  - Eye and upper respiratory tract irritation
  - Accumulation of fluid in lungs (pulmonary edema)
  - Whole-body systemic effects
- Skin
  - Severe painful burns
  - Whole-body systemic effects.

If WP contacts or embeds in the skin:

- Quickly smother the flame with water;
- Cover the area with wet material or mud to prevent air from reaching the WP;
- Keep the material covering the phosphorus wet and occluded from air;
- Call 911 or transport the person to the hospital;
- Do not attempt to remove the white phosphorus particles from the person's skin; and
- Do not use grease or oil on the white phosphorus burn since they may cause the body to absorb the poisonous particles.

13.2.2 Heat Stress Illness/Injury First Aid

13.2.2.1 Heat Rash

Heat rash is caused by continuous exposure to heat and humid air and is aggravated by wet, chafing clothing. This condition decreases a worker's ability to tolerate hot environments.

- **Symptoms:** Mild red rash, especially in areas of the body that sweat heavily.
- **Treatment:** Use powder such as cornstarch or baby powder to help absorb moisture and decrease chafing. Maintain good personal hygiene standards and change into dry clothes as needed.

13.2.2.2 Heat Cramps

Heat cramps result from a profuse rate of perspiration not balanced by adequate fluid and electrolyte intake. Heat-related cramps indicate excessive water and electrolyte loss, which can further develop into heat exhaustion or heat stroke.

- **Symptoms:** Acute, painful spasms of voluntary muscles such as the back, abdomen, and extremities.
- **Treatment:** Remove the individual to a cool area and loosen restrictive clothing. Stretch and massage affected muscles to increase blood flow to the area. Have the patient drink one to two cups of liquids immediately, and every 20 minutes thereafter. Consult with physician if condition does not improve. Bay West will provide an electrolyte solution.

13.2.2.3 Heat Exhaustion

Heat exhaustion occurs due to large fluid and electrolyte loss from profuse sweating. It is a state of very definite weakness or exhaustion caused by increased stress on various organs to meet increased demands to cool the body. This leads to inadequate blood supply and cardiac insufficiency.

Heat exhaustion is less dangerous than heat stroke, but requires treatment. If allowed to go untreated, it can quickly develop into heat stroke.

- **Symptoms:** Pale or flushed, clammy, moist skin; profuse perspiration; and extreme weakness. Body temperature is normal or slightly elevated, the pulse is weak and rapid, and breathing is shallow. The individual may have a headache or be dizzy or nauseated.
- **Treatment:** Remove the individual to a cool, air-conditioned place, loosen clothing, elevate feet, and allow individual to rest. Consult a physician, especially in severe cases. Have the patient drink one to two cups of liquids immediately, and every 20 minutes thereafter. If the signs and symptoms of heat exhaustion do not subside, or become more severe, get medical attention.

13.2.2.4 Heat Stroke

Heat stroke is an acute and dangerous reaction to heat stress caused by failure of the heat-regulating mechanisms of the body. Heat stroke occurs when the body's system of temperature regulation fails and the body temperature rises to critical levels. When this occurs, the body core temperature rises very rapidly to a point (>105.8°F) where brain damage and death may result if the person is not cooled quickly.

- **Symptoms:** The individual's skin is hot and may or may not be red, dry, and/or spotted; nausea; dizziness; confusion; extremely high body temperature; rapid respiratory and pulse rate; delirium; convulsions; unconsciousness; or coma.
- **Treatment:** Cool the individual. If the body temperature is not reduced quickly, permanent brain damage or death may result. Move the individual to an air-conditioned or shady area; lie him or her down and elevate the head. Cool the individual by either sponging or immersing the individual in very cool water to reduce the core temperature to a safe level (<102°F). If conscious, give the individual cool liquids to drink. Do not give the individual caffeinated or alcoholic beverages.
- Observe the individual and obtain immediate medical help. Heat stroke is a medical emergency.
- **Early recognition and treatment of heat stroke are the only means of preventing brain damage or death.**

13.2.3 Snakebite First Aid

In the event of a snakebite emergency, take the following actions (**Table A1-2**). ***DO NOT*** apply ice, cut the bite wound, or apply a tourniquet to a snakebite.

Table A1-3 First Aid Procedure for a Snakebite

Step	Task
1.	Try to keep the victim calm.
2.	Contact Emergency Medical Service (EMS).
3.	Wash the bite wound.
4.	If the snakebite is on the victim's arm or leg, • Keep the bitten area below the level of the victim's heart. • Splint the appendage to keep it immobile.

Table A1-3 First Aid Procedure for a Snakebite

Step	Task
5.	If necessary, carry the victim to emergency transportation or have the victim walk slowly.
6.	Identify the type of snake if possible to do so without endangering oneself, and report it to EMS.

13.2.4 Insect and Spider Bites/Stings First Aid

Signs of spider bites are similar to other sudden illnesses. The signs include the following:

- Nausea or vomiting;
- Difficulty breathing; and/or
- Sweating or salivating more than usual.

A spider bite may also be suspected when there is also severe pain in the bite area, a mark indicating a possible bite, or swelling of an area. In the event of a spider bite emergency, follow the procedures listed in **Table A1-3**.

Table A1-4 First Aid Procedures for a Spider Bite

Step	Task
1.	Wash the wound/swollen area with soap and water.
2.	Cover the wound area to keep it clean.
3.	Apply an ice pack to the wound/swollen area to reduce any pain and swelling.
4.	Contact EMS.

If a worker is bitten/stung by an insect, follow the procedures listed in **Table A1-4**.

Table A1-5 First Aid Procedures for an Insect Bite/Sting

Step	Task
1.	Remove the stinger if possible. Scrape the stinger away from the skin with a fingernail, or use tweezers. If tweezers are used, be sure to grasp the stinger and not the venom sac.
2.	Wash the bite/sting area with soap and water.
3.	Cover the bite/sting area to keep it clean.
4.	Apply an ice pack to the bite/sting area to reduce any pain and swelling.
5.	Watch the victim for signals of an allergic reaction.

EMS should be contacted in the event of an insect bite/sting in the following situations:

- If the individual does not know what bit/stung him or her;
- If the individual has a history of allergic reactions to insect bites/stings;
- If the individual is bitten/stung on the face or neck; or
- If the individual begins to have difficulty breathing.

If a worker finds a tick attached to his or her skin, follow the procedures listed in **Table A1-5**.

Table A1-6 First Aid Procedures for Tick Removal

Step	Task
1.	To minimize the chance you will get a tick-borne illness, remove the tick quickly. Using a tick key or blunt tweezers, grasp the tick firmly and close to the skin and then pull up. Avoid squeezing the tick's body.
2.	Wash the bite area with soap and water.
3.	Cover the bite area to keep it clean.

Table A1-6 First Aid Procedures for Tick Removal

Step	Task
4.	Report to UXOSO if there is redness or swelling at the site of the tick bite, and seek medical attention.
5.	Recover and retain the tick to present to medical personnel if you suspect a tick-borne illness such as Lyme disease or Rocky Mountain Spotted Fever.

13.2.4.1 Site Security and Control

The UXOSO is responsible for site security and includes the control of entry or exit of personnel and equipment to the site in an emergency. The UXOSO coordinates the arrival of any emergency response personnel. Workers who are not involved in the emergency response should stand down and remain clear of the emergency area unless instructed otherwise. Nonessential persons may not enter the site during an emergency incident.

13.3 Emergency Communications

Communications during emergencies will include the following procedure:

- Contact **911** first; then contact the contact UXOSO and/or UXOQCS, SUXOS, PM, CSHM, and USACE POC;
- On-site communications with personnel using handheld portable radios or telephones, air horns, and verbal messages; and
- Off-site communications using the telephone; **Appendix A, Attachment 1, Appendix 2** provides a list of emergency telephone numbers.

If necessary, use a horn (air horn, vehicle horn, etc.) to alert workers of an emergency. Use the following signals (**Table A1-6**):

Table A1-7 Air Horn Signals

Signal	Meaning
One long blast for at least 10 seconds	Evacuate the site and assemble at the safe evacuation location identified by the UXOSO at the morning safety briefing.
Five short blasts	There is an emergency that requires first aid or assistance.

13.4 Bloodborne Pathogen Exposure Control Plan

The potential exposure to bloodborne pathogens (BBPs) or other potentially infectious materials on this project is low. The potential exposure may be during a first aid/CPR event, such as applying pressure, bandages, or gauze to someone that is bleeding, or providing mouth-to-mouth resuscitation. Vaccinations (e.g., Hepatitis B) are not required for site work. BBP hazards include the transmission of human immunodeficiency virus (HIV), Hepatitis B virus (HBV), Hepatitis C virus (HCV), Hepatitis A virus (HAV), or other communicable diseases.

13.4.1 Procedures for Performing First-Aid Involving Blood and Body Fluids

Hazard Controls

- Eliminate the hazards by cleaning up and disinfecting the potentially contaminated area;
- Use a barrier (i.e., mouth barrier) when providing CPR;
- Use general precautions (i.e., assume everything is contaminated until you know otherwise);

- Encourage and walk the injured individual through self-care (e.g., applying pressure to their wound);
- Wear the following PPE:
  - Protective gloves (e.g., medical type, nitrile, latex, vinyl);
  - Long sleeves;
  - Safety glasses; and
  - Barrier mouth guard for CPR (as needed).

Decontamination

Place potentially contaminated material in leak-proof bags for handling, storage, transport, and disposal. Cleanse and decontaminate equipment and surfaces with diluted bleach. Place single-use PPE in a blood-borne pathogen bag (Biohazard Red or Orange color) and dispose of as instructed by local medical personnel. Cleanse and disinfect the remaining PPE using a diluted bleach solution. Thoroughly wash hands and any contact point with soap and water or a hand sanitizer.

13.4.2 Procedures Following an Exposure Incident

If a possible exposure to blood or body fluids occurs, inform the source individual of the incident, and on consent, receive immediate medical evaluation per the current recommendations of the Centers for Disease Control and Prevention for HIV, HBV, HCV, and HAV. Notify the PM and CSHM of any potential BBP exposure.

13.4.3 Training Requirements

Training on OSHA 29 CFR 1910.1030 BBP standard and this BBP Exposure Control Plan is required upon initial project placement as part of the safety indoctrination.

14.0 EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

14.1 Emergency Response

14.1.1 General

This section provides information regarding the action(s) to be taken in the event an emergency develops. In the event of an emergency, all personnel are authorized to stop work. All workers are authorized to call 911 in an emergency and then notify the UXOSO. The UXOSO will implement the ERP whenever there is an emergency. Workers may contact the UXOSO if they need more information on their responsibilities under this ERP.

14.1.2 Pre-emergency Planning

Decisive action is required if an emergency occurs. Personnel must make decisions and be ready to respond to an emergency. For this reason, pre-emergency planning is an essential part of each project's ERP. Pre-emergency planning for the project includes the following tasks:

- Development and approval of this ERP section;
- Coordination of the ERP with emergency response personnel;
- Training workers in emergency procedures;
- Maintaining emergency response equipment;
- Conducting an emergency response practice drill before activities begin; and
- Modification of the ERP, if necessary.

14.1.3 Response Priorities and Procedures

The following outline provides guidance in prioritizing emergency response action and provides general response procedures to be followed. Personnel will only provide minimal or first-line response to emergencies. In the event of an emergency, **911** is the primary POC, and the UXOSO will coordinate the appropriate response.

First Priority: Prevent further injury or illness by:

- Protecting response personnel;
- Isolating the scene to authorized personnel only;
- Notifying emergency response personnel; and
- If possible, rescuing any injured parties.

Second Priority: Provide first aid to persons with life-threatening injuries or illnesses.

Third Priority: Alleviate the immediate hazards by:

- Extinguishing incipient stage fire;
- Reducing chemical releases; or
- Containing any spill.

14.1.4 Evacuation Routes and Procedures

In a severe emergency (e.g., a large fire, explosion, large chemical release) evacuation may be necessary. The UXOSO is responsible for informing workers of the evacuation routes for each worksite during the morning safety briefing. The evacuation route and assembly area will correlate to the wind direction, topography, and the nature of the incident.

Move upwind at least 100 yards from any fires and/or releases, and continually monitor wind direction for changes. If moving upwind is not possible without encountering the incident, move cross wind or downwind a distance necessary to be out of the path of vapor releases, smoke, odors, or spills. If an evacuation is necessary, follow **Table A1-7**.

Table A1-8 Site Evacuation Procedures

Step	Task
1.	Notify workers of an emergency evacuation via portable hand-held radios, an air horn signal, or verbal command. Personnel will stop work and shut down equipment using emergency procedures.
2.	Evacuate the work area as safely as possible, and assemble at a specified location at least 100 yards upwind of the incident or as instructed during the morning safety briefing.
3.	The UXOSO is responsible for initiating a roll call.
4.	The UXOSO will contact EMS as workers are roll called.
5.	The UXOSO will ensure EMS has adequate site access.
6.	The UXOSO will ensure shutdown of combustion equipment.
7.	Personnel assembled at the designated safe evacuation area will wait for further instructions from emergency response personnel.

14.1.5 Community Notification

The major hazards posed to employees and visitors on the project site are from physical hazards from activities. Each AHA in **Appendix A**, **Attachment 1, Appendix 1** identifies site hazards. Establishing and implementing site control measures mitigates hazards to protect employees and the public.

If activities require road closure, thereby restricting access to an area by employees or visitors, or if an emergency requires the evacuation of nearby employees and visitors, the UXOSO/QCS will coordinate these events with the installation POC. After starting community notification procedures, the UXOSO and/or UXOQCS or SUXOS will notify the PM, who will contact the USACE.

14.1.6 Test

The UXOSO/QCS will conduct at least one emergency response drill during the field effort to test emergency response capabilities. Document drills on the Daily Quality Control Report (DQCR) and in the UXOSO log book.

14.1.7 Spill Plan

14.1.7.1 Spill Prevention

It is preferable to refill vehicles and equipment at service stations. However, refueling in the field may be necessary.

When refueling equipment from portable tanks or fuel cans, use plastic drop cloths to catch spilled product. This will prevent contamination of the environment and the need for a spill cleanup.

14.1.7.2 Spill Response

In the event of a spill of hazardous material, the UXOSO shall assume control and direct efforts for controlling and remediating the incident and reporting the incident to the PM. However, direct first efforts toward controlling the spill and preventing further spillage.

The most likely hazardous material release event to occur is the release of fuel or hydraulic fluid during filling. There are no other significant quantities of hazardous materials planned.

If the spill is due to a broken fuel line or hydraulic line, shut down equipment and attempt to catch spilling material with a bucket or other container. Do not attempt to block leakages with hands or other parts of the body as injection may occur.

Level D PPE is adequate for controlling and remediating spills and discharges based upon the anticipated types and quantities of materials.

If the spill or discharge is reportable and/or human health or the environment is threatened, the UXOSO will notify the USACE POC.

Use berms, sorbent pads, and socks to contain the spill and recover spilled material from the ground. Place used sorbents and any contaminated soil in sealed drums and contact a local waste processor for disposal.

14.1.7.3 Spill Reporting

Report all spills that impact soil, surface water, and groundwater to Kansas Department of Health and Environment (KDHE; see contact list for telephone number).

Report any amount of petroleum or other chemical spilled in surface water to the National Response Center (see contact list for telephone number).

14.1.8 Firefighting Plan

14.1.8.1 Small/Incipient Fire

A small fire is a fire that one can extinguish with a fire extinguisher. An incipient fire is a fire that is small because it has just started. In the event of a small or incipient fire:

- Evacuate nearby personnel from the area to an upwind location or, if an upwind location is not feasible, to an area not affected by smoke or hazardous decomposition products;
- Attempt to extinguish the fire using portable fire extinguisher or by smothering;
- Contact EMS for any injuries or exposures to hazardous decomposition products; and
- After the fire has been extinguished or emergency response personnel have been contacted through **911**, notify the PM, CSHM, and the USACE POC.

14.1.8.2 Large Fire/Explosion

An explosion, large fire, or an inextinguishable small fire is beyond first-line personnel capabilities and needs professional emergency response personnel. In this event, take the following actions:

- Evacuate personnel from the site to an upwind location or, if an upwind location is not feasible, to an area not affected by smoke or hazardous decomposition products;
- Perform a roll call;
- Contact **911** for fire response and for any injuries or exposures to hazardous decomposition products; and
- After emergency response personnel have been contacted through **911**, notify the PM, CSHM, and the USACE POC.

14.1.9 Posting of Emergency Telephone Numbers

Emergency telephone numbers are in **Appendix A**, **Attachment 1, Appendix 2**. Keep a copy in the site office and in each work vehicle.

14.1.10 Medical Support

In a true emergency, apply first aid and call **911**. Be prepared to brief the operator on details such as location of the emergency and the nature and extent of injuries. Preservation of life and limb is the priority. Some discretion is required as to whether to call EMS, transport, or seek urgent, versus emergency, care; when in doubt, **call 911**.

Any person, employee, or visitor with known allergies or a medical condition should advise the UXOSO in confidence to ensure proper medical care.

14.1.10.1 On-Site Medical Support

There must be a minimum of two employees certified in CPR and first aid per site and first aid kits in each project vehicle and at the site office.

14.1.10.2 Off-Site Medical Support

Emergency

EMS will coordinate emergency medical treatment other than first aid. **Appendix A, Attachment 1, Appendix 2** lists emergency telephone numbers. Certified workers will administer first aid. If it is safe to transport a victim, the closest hospital is:

William Newton Hospital
1300 E. 5th Ave.
Winfield, KS 67156
Phone: 620-221-2300

A map and driving directions to the hospital are located in **Appendix A**, **Attachment 1, Appendix 3**.

Non-Emergency

There are no urgent care clinics in the project area. Take a person with a nonemergency injury or illness that may require treatment beyond first aid to any available medical provider in Winfield or Arkansas City.

Bay West employees should utilize WorkCare Incident Intervention (888-449-7787) to report an onsite injury or illness that may require clinical consultation call. WorkCare Incident Intervention is only for non-emergency incidents and provides access to experienced occupational health nurses and physicians who speak directly with an employee who presents a work-related injury or illness. WorkCare recommends calling within one hour of incident for optimal results. Call WorkCare anytime, 24-hours a day, seven days a week.

14.2 Contingency Plan for Severe Weather

Weather conditions are a part of the daily safety briefing. During severe weather, project personnel will seek shelter in an appropriate location (i.e., building or vehicle). Weather-related hazards include the potential for heat stress, electrical storms, ice/snow storms, tornadoes, high winds and dust storms, limited visibility, and treacherous weather-related working conditions.

Suspend outside work during electrical storms. In the event of other adverse weather conditions, the UXOSO will determine if it is safe to continue work.

14.2.1 Adverse Weather Condition Monitoring

In the event of adverse weather conditions, the UXOSO will determine if work can continue without sacrificing the health and safety of workers. The UXOSO will monitor threatening weather conditions via radio, television, Internet, or calls to the NWS. Some of the conditions considered by the UXOSO include the following:

- Potential for heat stress;
- Limited visibility;

- Electrical storms/thunderstorms;
- Conditions, such as flooding, that would impede an emergency response or evacuation;
- Tornado warning or sighting; and
- Treacherous weather-related working conditions (e.g., heavy rainfall, high winds, icy conditions causing slipping hazards).

14.2.2 Thunderstorm and Lightning Activity

The safest shelter location during a thunderstorm and lightning activity is a large, enclosed building. If lightning strikes this type of building, it will typically travel through the wiring or plumbing into the ground. Once inside a safe building, stay away from the plumbing and electronic equipment.

The second safest shelter location is in an enclosed vehicle with the doors and windows closed. Do not touch any metal surfaces, and do not use any electronic devices, including cell phones.

Seek shelter when dark, threatening clouds are developing overhead or you observed lightning or hear thunder. Remain protected for 30 minutes after the last lightning strike or thunder clap. No place is absolutely safe from severe weather; however, some places are safer than others:

- Large, enclosed structures tend to be much safer than smaller or open structures;
- The risk for lightning injury depends on whether the structure incorporates lightning protection, the construction materials used, and the size of the structure;
- In general, fully enclosed metal vehicles such as cars, trucks, buses, vans, etc. with the windows rolled up provide good shelter from many weather conditions;
- Avoid being in or near high places and open fields, isolated trees, rain or picnic shelters, communications towers, flagpoles, light poles, bleachers (metal or wood), metal fences, or water (lakes, streams, rivers, etc.); and
- When inside a building, avoid the use of the telephone, washing your hands, or any contact with conductive surfaces exposed to the outside such as metal doors, window frames, electrical wiring, telephone wiring, cable TV wiring, plumbing, etc., if lightning is a factor.

14.2.3 Tornadoes

Tornadoes may occur with severe thunderstorms. They may be stationary or travel at speeds up to 70 mph, generally from southwest to northeast. A tornado watch means the weather conditions are favorable for the development of a tornado. A tornado warning means a tornado has been sighted or indicated on radar. If you are in the warned area, seek shelter.

When severe thunderstorms are in the area, workers will watch the sky, and the UXOSO will monitor the weather advisories. Environmental “clues” that may indicate an approaching tornado include the following:

- A dark and often greenish sky;
- Large hail; and/or
- A loud roar similar to a freight train.

The general rule for tornadoes is “go low and get low:”

If you are in a trailer, in a vehicle, or outside, try to get to a sturdy building for shelter. For this MRS, the main terminal building (constructed of reinforced concrete) for the Strother Field Airport will serve as a muster point and shelter for the field crew during a tornado. All field crew

members will be briefed on the location of the terminal, which is approximately 4 minutes (0.9-mile) away by vehicle.

Go to the lowest level of a sturdy building. The best shelter from a tornado is a basement. If a basement is not available, go to an inside room without windows.

- Take shelter in the lowest level;
- Stay away from windows;
- Crouch in a low position; and
- Protect your head and body from flying debris with a blanket or jacket.

Trailers and vehicles are unsafe during tornadoes; seek shelter elsewhere. If you cannot get to a sturdy building, then lie flat in a low area (e.g., ditch, depression) and use your hands to cover the back of your head and neck.

15.0 LOGS, REPORTS, AND RECORDKEEPING

15.1 Training Acknowledgement Form

Document initial APP/SSHP and PPE training on a Training Acknowledgement Form

15.2 Safety Log

The UXOSO will maintain a log of activities. This may be part of the DQCR. Maintain the following information in the log:

- Date/location;
- Tailgate safety briefing topic;
- Training performed;
- Visitor arrival/departure and nature of visit;
- Weather conditions;
- Task assignments;
- Operational issues or problems encountered;
- Heat/cold stress monitoring;
- Instructions by the client/customer;
- Significant events relating to safety;
- Stop-work events;
- Accidents;
- Emergencies;
- Inspections and safety audits performed; and
- Signature at end of each day.

15.3 Reports

This section provides the requirements for implementing the incident reporting provisions of the USACE Safety and Health Requirements Manual (EM 385-1-1).

Investigate accidents, including “near incidents” or “near misses.” The lead incident investigator for the project is the UXOSO. The UXOSO will log each incident, recording the dates and times the event occurred, when the event was reported, when the response began, and when the

investigation was completed, as well as documenting the investigation procedures and outcome.

Notify the PM and the CSHM as soon as practical by phone or email. An Incident Investigation Report must be submitted to the CSHM no later than 48 hours post-incident of any accidents and follow up with USACE's Accident Investigation and Reporting Form. The PM will notify the USACE POC of the incident.

Person(s) who become ill or injured during work activities will inform their direct supervisor, regardless of the severity of the illness or injury. In the event the medical emergency is severe enough, the UXOSO will order a cessation of work and notify off-site emergency personnel.

In the event that a cessation of work is ordered, personnel should:

- Assist the UXOSO, UXOQCS and/or SUXOS, if required, in assisting the victim and/or administering first aid;
- Leave the work area and remain in the worker rest area (site office) until further notice; and
- Assist emergency response personnel when requested.

Workers receiving medical treatment by a physician will obtain a release from the physician on the date of treatment stating one of the following: (1) the employee is not fit for duty; (2) the employee is fit for restricted duty; or (3) the employee is fit for duty. Attach a copy of the release to the accident report (ENG Form 3394) and submitted to USACE.

In addition to USACE reporting requirements, Bay West will report and record injuries, accidents, and illnesses IAW OSHA requirements and Bay West policies. Incident Investigation Forms are provided. Employees must to submit a post-accident drug and alcohol screen if there is a death, treatment beyond first aid, ticket/citation, or vehicle towed.

15.4 Major Incident Notifications

Should an incident occur resulting in a fatality, permanent or partial disability, $200,000 or more in property damage, a person being hospitalized from a single occurrence, or possible adverse publicity to USACE, immediately notify the USACE PM in person, by telephone, or by email. Submit an ENG Form 3394 to USACE within five working days. If a subcontractor employee is affected, contact the subcontractor's respective safety and health contact. The CSHM will notify OSHA when appropriate.

15.5 Recordkeeping

Maintain copies of all reports with the DQCR. The logbook is part of the project record.

Appendix 1

Activity Hazard Analyses

Activity/Work Task:	**1. Mobilization, Site Preparation, and Demobilization**	Overall Risk Assessment Code (RAC) (Use Highest Code)	**M**
Project Location	Strother Field, Cowley County, Kansas		
Contract Number	W9128F-10-D-0054 Task Order No. 0023		
Date Prepared	12/16/2015		
Prepared by (Name/Title):	Wayne Martrildonno, UXO Technical Manager		
Reviewed by (Name/Title):	Jamison Harrell-Latham, CSP, Corp H&S Mgr		
Notes: (Field Notes, Review Comments, etc.)			

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "Hazard" with identified safety "Controls" and determine RAC (see above)

"**Probability**" is the likelihood to cause an incident, near miss, or accident, and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"**Severity**" is the outcome/degree if an incident, near miss, or accident did occur and identified as Catastrophic, Critical, Marginal, and Negligible.

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Controls	RAC
Mobilization / Site Preparation 1. Establish storage area for equipment; secure materials in storage. 2. Accept deliveries of equipment and site supplies. 3. Stage sanitary facilities, equipment, and supplies. 4. Evaluate site access and control; additional measures may be required. 5. Surveying. **Demobilization** 1. Remove equipment. 2. Load unused material for removal off-site.	Heavy equipment or vehicle accidents/collisions	1. Wear high visibility safety vests when working around heavy equipment/motor vehicles. 2. Vehicle/equipment operators should always look in the direction of travel; 3. Look before backing up. 4. Prevent foot traffic from crossing routes of heavy equipment. 5. Speed limit is 25 mph unless otherwise noted. 6. Use a spotter for maneuvering heavy equipment to reduce blind spots. 7. Ensure the operator acknowledges your presence before walking near equipment in operation by making eye contact. 8. Minimize distractions.	**L**
	Injury from improper use of hand or power tools	1. Only trained personnel will use hand and power tools. 2. Power tools and equipment will be equipped with a shutoff switch. 3. All rotating parts will be properly guarded. 4. Guard against contact burns from hot equipment.	**L**
	Electrical shock from energized equipment	Use GFCI plugs, heavy duty extension cords, 3-prong grounded equipment and double insulated power tools.	**L**
	Muscle strain from improper lifting techniques	1.Follow proper lifting techniques; 2. No manual lifting of heavy (50 lbs) loads.	**L**
	Excessive noise exposure (e.g. > 85 dB)	Wear hearing protection.	**L**
	Hands/feet caught in pinch points	1. Be aware of and keep hands and feet out of potential pinch points; 2. Wear heavy work (leather) gloves, as needed.	**L**

Job Steps	Hazards	Controls	RAC
	Slips, trips, or falls	Practice good housekeeping procedures by keeping walking and working surfaces free from slip and trip hazards.	**L**
	Improper storage of flammable and combustible materials causes a fire hazard	1. Separate flammable/combustible materials from other materials. 2. Post “No Smoking or Open Flames” signs. 3. Portable Fire extinguishers must be nearby and readily available. 4. Proper hazardous material labeling is required on containers.	**L**
	Inclement weather	In the event of a threat of severe weather conditions, stabilize the work area and evacuate the site. Proceed to assigned assembly point(s).	**L**
	Wild animals/insects	1. Avoid wild animals and their dens/nests. 2. Inspect the work area to determine what animal/insects may reside. 3. Do not become distracted by flying/biting insects. 4. Use snake chaps if snake potential is high. 5. Use insect resistant clothing such as a head net. 6. Use insect repellant, as needed.	**L**
	Unintentional contact with MEC	1. Observe the ground surface to avoid MEC. 2. Mark any encountered MEC and avoid until MEC removal procedures can be completed. 3. Non-UXO personnel must be escorted in MEC areas. 4. Use metal detector for anomaly avoidance during intrusive work such as staking.	**M**
	Heat and cold stress	1. Review signs, symptoms and prevention techniques. 2. Dress for the weather, in layers of removable clothing. 3. Perform heat stress monitoring. 4. Drink the appropriate fluids on a frequent basis. 5. Enforce buddy system monitoring.	**L**
	Unauthorized personnel	1. Maintain positive site control; 2. Immediately cease operations if unauthorized entry is made.	**L**

Equipment to be Used	Training Requirements / Competent or Qualified Personnel name(s)	Inspection Requirements

• Motor vehicles
• Communications equipment
• Metal detector
• MEC flagging material
• First aid kit
• Fire extinguisher
• Level D PPE
• Long- or short-sleeved shirt and pants (T-shirts at discretion of UXOSO)
  ○ Safety-toe boots
  ○ Safety glasses
  ○ Hearing protection (as necessary)
  ○ Hard hat (as necessary)
  ○ High visibility safety vest (Class II or greater as necessary)
  ○ Work gloves
  ○ If using chain saws and cutting tools, include hard hat, face shield (with safety glasses), hearing protection, and leg chaps.
• Hand tools
• Digital camera
• GPS
	Training to be performed by the UXOSO unless otherwise specified:
	• OSHA 1910.120 HAZWOPER program
	• Techniques for MEC/UXO avoidance.
	• MEC identification and safety precautions for UXO and non-UXO qualified personnel IAW the WP/SSHP.
	• Hand tool safety
	• Equipment familiarity as required.
	• Knowledge of the Emergency Response and Notifications procedures IAW the APP.
	• First aid and CPR training as required by the APP.
	• Safe work practices and precautions associated with task being performed IAW the WP.
	• Specific response training IAW the APP.
	• Personnel will meet requirements IAW the applicable regulations for the training and use of PPE.
	• Evacuation and emergency procedures IAW the APP.
	• OSHA qualifications and training as required IAW the APP.
		Inspections to be performed by the UXOSO unless otherwise specified:
		• Daily serviceability check of equipment.
		• Daily communications checks.
		• Daily checks of first aid kits and weekly inventory of kits.
		• Daily check for serviceability, fit, and comfort of PPE.
		• Type and quantity check of flagging material.

Activity/Work Task:	**2. Vegetation Removal**
Project Location	Strother Field, Cowley County, Kansas
Contract Number	W9128F-10-D-0054 Task Order No. 0023
Date Prepared	12/16/2015
Prepared by (Name/Title):	Wayne Martrildonno, UXO Technical Manager
Reviewed by (Name/Title):	Jamison Harrell-Latham, CSP, Corp H&S Mgr
Notes: (Field Notes, Review Comments, etc.)	

Overall Risk Assessment Code (RAC) (Use Highest Code): **M**

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "Hazard" with identified safety "Controls" and determine RAC (see above)

"**Probability**" is the likelihood to cause an incident, near miss, or accident, and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"**Severity**" is the outcome/degree if an incident, near miss, or accident did occur and identified as Catastrophic, Critical, Marginal, and Negligible.

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Controls	RAC
Vegetation Removal 1. Visually survey work area 2. Ensure areas requiring vegetation removal are well delineated and marked 3. UXO escort 4. Brush cutting	Heavy equipment or vehicle accidents/collisions	1. Do not attempt to exceed the slope capabilities of the vegetation removal equipment. 2. Wear high visibility safety vests when working around vegetation removal machine/motor vehicles. 3. Look in the direction of travel; look before backing up. 4. Prevent foot traffic from crossing routes of heavy equipment. 5. Use a spotter for maneuvering in tight spaces to reduce blind spots. 6. Make eye contact with the operator before walking near equipment in operation. 7. Minimize distractions.	**M**
	Unintentional contact with MEC	1. Observe the ground surface and/or use metal detector to avoid MEC. 2. Mark any encountered MEC and avoid until MEC removal procedures can be completed. 3. Vegetation removal equipment and non-UXO personnel must be escorted in MEC areas.	**M**
	Muscle strain from improper lifting techniques	1. Follow proper lifting techniques; 2. No manual lifting of heavy (50 lbs) loads.	**L**
	Slips, trips, or falls	Practice good housekeeping procedures by keeping walking and working surfaces free from slip and trip hazards.	**L**
	Wild animals	1. Avoid wild animals and their dens/nests. 2. Be alert for snakes. Don't handle snakes. Wear snake chaps if hazard is high.	**L**

Job Steps	Hazards	Controls	RAC
	Insects	1. Check vegetation for insect nests or hives. 2. Do not become distracted by flying/biting insects. 3. Use insect resistant clothing such as a head net. 4. Use insect repellant.	**L**
	Inclement weather	In the event of a threat of severe weather conditions, stabilize the work area and evacuate the site. Proceed to assigned assembly point(s).	**L**
	Flying debris/falling timber	1. Stand clear of the debris zone of the mechanized vegetation removal equipment. 2. Always wear hardhats and safety glasses. 3. Attempt to have trees fall in a safe direction. 4. Do not stand in the path of falling timber.	**M**
	Heat and cold stress	1. Review signs, symptoms and prevention techniques. 2. Dress for the weather, in layers of removable clothing. 3. Drink the appropriate fluids on a frequent basis and eat nutritious meals. 4. Enforce buddy system monitoring.	**L**
	Chain saws/motorized brush cutters	Always wear hardhats, face shields, hearing protection, safety toed boots and chaps.	**M**

Equipment to be Used	Training Requirements / Competent or Qualified Personnel name(s)	Inspection Requirements

• Motor vehicles
• Heavy equipment
• Communications equipment
• Analog metal detectors
• Chainsaw
• Motorized brush cutter (weed whacker)
• MEC flagging material
• First aid kit
• Fire extinguisher
• Level D PPE
  ○ Long- or short-sleeved shirt and pants (T-shirts at discretion of UXOSO)
  ○ Safety-toe boots
  ○ Safety glasses
  ○ Hearing protection (as necessary)
  ○ Hard hat (as necessary)
  ○ High visibility safety vest (Class II or greater as necessary)
  ○ Work gloves
  ○ Face shield
  ○ Protective chaps
• Hand tools
• Digital camera
• GPS
	Training to be performed by the UXOSO unless otherwise specified:
	• OSHA 1910.120 HAZWOPER Program
	• Techniques for MEC/UXO avoidance.
	• MEC identification and safety precautions for UXO and non-UXO qualified personnel IAW the WP/SSHP.
	• Hand tool safety
	• Equipment familiarity as required.
	• Knowledge of the Emergency Response and Notifications procedures IAW the APP.
	• First aid and CPR training as required by the APP.
	• Safe work practices and precautions associated with task being performed IAW the WP.
	• Specific response training IAW the APP.
	• Personnel will meet requirements IAW the applicable regulations for the training and use of PPE.
	• Evacuation and emergency procedures IAW the APP.
	• OSHA qualifications and training as required IAW the APP.
		Inspections to be performed by the UXOSO unless otherwise specified:
		• Daily serviceability check of equipment.
		• Daily communications checks.
		• Daily checks of first aid kits and weekly inventory of kits.
		• Daily check for serviceability, fit, and comfort of PPE.
		• Type and quantity check of flagging material.

Activity/Work Task:	**3. Surface MEC Removal**
Project Location	Strother Field, Cowley County, Kansas
Contract Number	W9128F-10-D-0054 Task Order No. 0023
Date Prepared	12/16/2015
Prepared by (Name/Title):	Wayne Martrildonno, UXO Technical Manager
Reviewed by (Name/Title):	Jamison Harrell-Latham, CSP, Corp H&S Mgr
Notes: (Field Notes, Review Comments, etc.)	

Overall Risk Assessment Code (RAC) (Use Highest Code): **M**

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "Hazard" with identified safety "Controls" and determine RAC (see above)

"**Probability**" is the likelihood to cause an incident, near miss, or accident, and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"**Severity**" is the outcome/degree if an incident, near miss, or accident did occur and identified as Catastrophic, Critical, Marginal, and Negligible.

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Controls	RAC
Surface MEC Removal 1. Stake out MRS boundaries and grids 2. SUXOS visually surveys work area 3. Visual and detector-aided sweep for MEC 4. Use metal detector to identify metallic items to mineral soil layer along the planned DGM transects 5. QC actions	Heavy equipment or vehicle accidents/collisions	1. Wear high visibility safety vests when working around heavy equipment/motor vehicles. 2. Vehicle/equipment operators should always look in the direction of travel; look before backing up. 3. Prevent foot traffic from crossing routes of heavy equipment. 4. Speed limit is 25 mph unless otherwise noted. 5. Use a spotter for maneuvering heavy equipment to reduce blind spots. 6. Ensure the operator acknowledges your presence by making eye contact before walking near equipment in operation. 7. Minimize distractions.	**L**
	Unintentional contact with MEC (during survey and stake out)	1. Observe the ground surface and/or use metal detector to avoid MEC. 2. Mark any encountered MEC and avoid until MEC removal procedures can be completed. Non-UXO personnel must be escorted in MEC areas. 3. Use metal detector for anomaly avoidance during intrusive work such as staking or soil sample collection.	**M**
	Muscle strain from improper lifting techniques	1. Follow proper lifting techniques; 2. No manual lifting of heavy (50 lbs) loads.	**L**
	Slips, trips, or falls	1. Practice good housekeeping procedures by keeping walking and working surfaces free from slip and trip hazards. 2. Safety toe boots not required during UXO sweeps but required when handling heavy loads.	**L**

Job Steps	Hazards	Controls	RAC
	Wild animals	1. Avoid wild animals and their dens/nests. 2. Be alert for snakes. Do not handle snakes.	**L**
	Insects	1. Inspect work area for highs or nests. 2. Do not become distracted by flying/biting insects. 3. Use insect resistant clothing such as a head net. Use insect repellant, as needed.	**L**
	Inclement weather	In the event of a threat of severe weather conditions, stabilize the work area and evacuate the site. Proceed to assigned assembly point(s).	**L**
	Potential MEC	1. Observe all MEC safety precautions, such as movement, heat, shock, and friction. 2. Establish and observe team separation distances (ESP). 3. Mark and report any MEC encountered to team leader. Team leader, notify SUXOS. 4. Only UXO-qualified personnel or T1 supervised by UXO-qualified personnel will handle MEC items. 5. Limit site entry to essential personnel during MEC operations.	**M**
	Heat and cold stress	1. Review signs, symptoms and prevention techniques. 2. Dress for the weather, in layers of removable clothing. 3. Drink the appropriate fluids on a frequent basis. 4. Enforce buddy system monitoring.	**L**
	Unauthorized personnel	1. Establish exclusion zone as outlined in the ESP. 2. Maintain positive site control; 3. Immediately cease operations if unauthorized entry is made.	**L**

Equipment to be Used	Training Requirements / Competent or Qualified Personnel name(s)	Inspection Requirements

• Motor vehicles
• Heavy equipment
• Communications equipment
• Analog metal detectors
• MEC flagging material
• First aid kit
• Fire extinguisher
• Level D PPE
• Long- or short-sleeved shirt and pants (T-shirts at discretion of UXOSO)
  ○ Safety-toe boots
  ○ Safety glasses
  ○ Hearing protection (as necessary)
  ○ Hard hat (as necessary)
  ○ High visibility safety vest (Class II or greater as necessary)
  ○ Work gloves
• Hand tools
• Digital camera
• GPS
	Training to be performed by the UXOSO unless otherwise specified:
	• OSHA 1910.120 HAZWOPER Program
	• Techniques for MEC/UXO avoidance.
	• MEC identification and safety precautions for UXO and non-UXO qualified personnel IAW the WP/SSHP.
	• Hand tool safety
	• Equipment familiarity as required.
	• Knowledge of the Emergency Response and Notifications procedures IAW the APP.
	• First aid and CPR training as required by the APP.
	• Safe work practices and precautions associated with task being performed IAW the WP.
	• Specific response training IAW the APP.
	• Personnel will meet requirements IAW the applicable regulations for the training and use of PPE.
	• Evacuation and emergency procedures IAW the APP.
	• OSHA qualifications and training as required IAW the APP.
		Inspections to be performed by the UXOSO unless otherwise specified:
		• Daily serviceability check of equipment.
		• Daily communications checks.
		• Daily checks of first aid kits and weekly inventory of kits.
		• Daily check for serviceability, fit, and comfort of PPE.
		• Type and quantity check of flagging material.

Activity/Work Task:	**4. DGM Surveys**	Overall Risk Assessment Code (RAC) (Use Highest Code)	**M**
Project Location	Strother Field, Cowley County, Kansas		
Contract Number	W9128F-10-D-0054 Task Order No. 0023		
Date Prepared	12/16/2015		
Prepared by (Name/Title):	Wayne Martrildonno, UXO Technical Manager		
Reviewed by (Name/Title):	Jamison Harrell-Latham, CSP, Corp H&S Mgr		
Notes: (Field Notes, Review Comments, etc.)			

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "Hazard" with identified safety "Controls" and determine RAC (see above)

"**Probability**" is the likelihood to cause an incident, near miss, or accident, and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"**Severity**" is the outcome/degree if an incident, near miss, or accident did occur and identified as Catastrophic, Critical, Marginal, and Negligible.

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Controls	RAC
1. Install instrument verification strip (IVS) 2. Assemble DGM equipment 3. Collect DGM data	Contact underground utilities	1. Utility clearance must be confirmed before excavation of IVS begins. 2. Obtain utility clearance and dig permits.	**M**
	Vehicle accidents/collisions	1. Wear high visibility traffic safety vests when working around motor vehicles. 2. Vehicle and equipment operators should always look in the direction of travel; 3. Look before backing up. The speed limit is 25 mph – unless otherwise noted.	**L**
	Heat and cold stress	1. Review signs, symptoms and prevention techniques. 2. Dress for the weather, in layers of removable clothing. 3. Drink the appropriate fluids on a frequent basis. 4. Enforce buddy system monitoring. 5. Perform physiological monitoring as outlined in the APP.	**L**
	Wild animals/insects	1. Avoid wild animals and their dens/nests. 2. Do not become distracted by flying/biting insects. 3. Use insect-resistant clothing such as a head net. Use insect repellant.	**L**
	Unintentional contact with MEC	1. Established IVS/ITS in an area clear of anomalies or perform a subsurface MEC clearance. 2. Ensure surface MEC removal has been completed prior to DGM. 3. Stop DGM if any suspected MEC is encountered and notify SUXOS. 4. Mark any encountered MEC and avoid until MEC removal procedures can be completed. 5. DGM personnel must remain observant for potential MEC and request assistance from UXO personnel when necessary.	**M**
	Slips, trips, or falls; fall into excavation	Practice good housekeeping procedures. Keep walking/working surfaces free from slip/ trip hazards.	**L**
	Inclement weather	1. In the event a threat of severe weather conditions, personnel will perform tasks necessary to stabilize the work area and evacuate the site. 2. Personnel will proceed to assigned assembly point(s).	**L**
	Unauthorized personnel	Cease operations if there is an unauthorized entry.	**L**

Equipment to be Used	Training Requirements / Competent or Qualified Personnel name(s)	Inspection Requirements

• Motor vehicles
• Fire extinguishers
• Eye wash bottles
• First aid kit
• Level D PPE
  ○ Long- or short-sleeved shirt and pants (T-shirts at discretion of UXOSO
  ○ Safety toe boots
  ○ Safety glasses
  ○ Hearing protection (as necessary)
  ○ High visibility safety vest (class II or greater)
  ○ Work gloves
• Hand tools
• Digital camera
• GPS
• G858
• Analog metal detector/magnetometer
	Training to be performed by the UXOSO unless otherwise specified:
	• OSHA 1910.120 HAZWOPER Program
	• MEC safety awareness
	• Heavy equipment operation
	• Excavation safety
	• Hearing conservation program
	• Equipment familiarity as required.
	• Knowledge of the Emergency Response and Notifications procedures IAW the APP.
	• First aid and CPR training as required by the APP.
	• Safe work practices and precautions associated with task being performed IAW the WP.
	• Specific response training IAW the APP
	• Personnel will meet requirements IAW the applicable regulations for the training and use of PPE (including respiratory protection).
	• Evacuation and emergency procedures IAW the APP.
	• OSHA qualifications and training as required IAW the APP.
		Inspections to be performed by the UXOSO unless otherwise specified:
		• Inspect open excavation regularly IAW OSHA 29 CFR 1926 Subpart P.
		• Ensure barriers are set up around open excavations to prevent unauthorized personnel from falling into an excavation during non-working hours.
		• Daily inspection of heavy equipment daily for function of safety features and general assembly.
		• Calibrate monitoring equipment.
		• Daily preventive maintenance.
		• Daily serviceability check of equipment.
		• Daily communications checks.
		• Daily checks of first aid kits and weekly inventory of kits.
		• Daily check for serviceability, fit, and comfort of PPE.

Activity/Work Task:	**5. Analog and/or Intrusive Investigation**
Project Location	Strother Field, Cowley County, Kansas
Contract Number	W9128F-10-D-0054 Task Order No. 0023
Date Prepared	12/16/2015
Prepared by (Name/Title):	Wayne Martrildonno, UXO Technical Manager
Reviewed by (Name/Title):	Jamison Harrell-Latham, CSP, Corp H&S Mgr

Notes: (Field Notes, Review Comments, etc.)
Note: If using earth moving machinery for any purpose, refer to the Excavation AHA.

Overall Risk Assessment Code (RAC) (Use Highest Code): **M**

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "Hazard" with identified safety "Controls" and determine RAC (see above)

"**Probability**" is the likelihood to cause an incident, near miss, or accident, and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"**Severity**" is the outcome/degree if an incident, near miss, or accident did occur and identified as Catastrophic, Critical, Marginal, and Negligible.

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Controls	RAC
1. Mark survey lanes (analog) 2. Trim vegetation if necessary (see vegetation removal AHA). 3. Conduct analog investigation (mag and dig). 4. Locate anomalies with GPS (DGM selected anomalies) or analog survey (mag and dig) 5. Excavate individual anomalies 6. Use earth moving machinery to remove earth overburden from anomaly (optional) 7. Mechanized MEC procedures (optional) 8. Inspect recovered material 9. Backfill excavation 10. Site restoration IAW project specifications	Contact with underground/overhead utilities	1. Utility clearance must be confirmed before excavation begins. 2. Obtain utility clearance and dig permits. 3. Refer to APP for clearance distances from overhead power lines.	**M**
	Contact with contaminated material	Wear the appropriate PPE for the task being performed.	**L**
	Unintentional contact with MEC	1. A UXO TII or higher must be on the Reacquisition Team. 2. Monitor the ground with a metal detector before inserting a vinyl pin flag to avoid anomalies and unintentional detonations.	**M**
	Potential MEC/MPPEH	1. Establish exclusion zone. Observe all MEC safety precautions, such as movement, heat, shock, and friction. 2. Mark and report any MEC encountered. Only UXO-qualified personnel and UXOTI under the supervision of UXO-qualified personnel will perform intrusive investigations. 3. SUXOS and UXOSO must approve movement of MEC. 4. Monitor digging with analog instrument to avoid unintentional contact with MEC. 5. Halt excavation with earth moving machinery within 12 inches of an anomaly and continue excavating manually.	**M**
	Mechanized MEC procedures	1. Refer to ESP for distances and shielding. 2. Ensure that the correct shielding is installed and of that operator is protected from detonations from all potential directions. 3. Ensure the effective digging range of the excavator exceeds the K18 overpressure distance. 4. All personnel must remain outside the K18 overpressure distance and operator must use double hearing protection offering 9 dB or greater protection if within the K24. 5. All unshielded personnel must be removed to the MSD.	**M**
	Impact/injury from	1. Wear high visibility traffic safety vests when working around heavy equipment/motor	**L**

Job Steps	Hazards	Controls	RAC
	heavy equipment or moving loads	vehicles. 2. Ensure the operator acknowledges your presence before walking near equipment in operation.	
	Heavy equipment or vehicle accidents/ collisions	1. Wear hard hat and high visibility safety vests when working around heavy equipment. 2. Do not enter the excavator arc to monitor anomaly until the operator has grounded the excavator bucket and de activated the controls. 3. Vehicle/equipment operators should look in the direction of travel; 4. Look before backing up. 5. Prevent foot traffic from crossing routes of heavy equipment. 6. Speed limit is 25 mph unless otherwise noted. 7. Use a spotter for maneuvering heavy equipment to reduce blind spots. 8. Ensure the operator acknowledges your presence before walking near equipment in operation. 9. Minimize distractions.	**L**
	Excessive noise exposure	Wear hearing protection when operating heavy equipment. .	**L**
	Slips, trips, or falls; fall into excavation	1. Practice good housekeeping procedures. 2. Keep walking/working surfaces free from slip/ trip hazards. 3. If excavation is left open, use barriers or marking to preclude personnel falling into the excavation. 4. Don't trip over lane lines.	**L**
	Engulfment	1. An OSHA-competent person (UXOSO)must inspect the excavation daily before worker entry. 2. Ensure sides are sloped or shored accordingly.	**M**
	Inclement weather	In the event a threat of severe weather conditions, personnel will perform tasks necessary to stabilize the work area and evacuate the site. Personnel will proceed to assigned assembly point(s).	**L**
	Muscle strain from improper lifting techniques	1.Follow proper lifting techniques; 2. No manual lifting of heavy (50 lbs) loads.	**L**
	Heat and cold stress	1. Review signs, symptoms and prevention techniques. 2. Dress for the weather in layers of removable clothing. 3. Use rain gear when it's raining. 4. Drink the appropriate fluids on a frequent basis and practice proper nutrition. 5. Enforce buddy system monitoring.	**L**
	Wild animals/insects	1. Avoid wild animals and their dens/nests. 2. Do not become distracted by flying/biting insects. 3. Be alert for snakes and do not handle them. 4. Use insect-resistant clothing such as a head net.	**L**

Job Steps	Hazards	Controls	RAC
		5. Use insect repellant.	
	Unauthorized personnel	Cease operations if unauthorized entry.	**L**

Equipment to be Used	Training Requirements / Competent or Qualified Personnel name(s)	Inspection Requirements

• Motor vehicles
• Fire extinguishers
• Eye wash bottles
• First aid kit
• Level D PPE
  ○ Long- or short-sleeved shirt and pants (T-shirts at discretion of UXOSO
  ○ Safety-toe boots
  ○ Safety glasses
  ○ Hearing protection (as necessary)
  ○ Hard hat (as necessary)
  ○ High visibility safety vest (Class II or greater)
  ○ Work gloves
• Hand tools
• Heavy equipment (With shielding as outlined in ESP if using mechanized MEC procedures)
• Excavation barriers (e.g., temporary orange fencing)
• Digital camera
• GPS
• Lines for marking search lanes
• Analog metal detector/magnetometer
	Training to be performed by the UXOSO unless otherwise specified:
	• OSHA 1910.120 HAZWOPER Program
	• MEC Safety Awareness
	• Heavy equipment operation
	• Excavation safety
	• Hearing conservation program
	• Equipment familiarity as required.
	• Knowledge of the Emergency Response and Notifications procedures IAW the APP.
	• First aid and CPR training as required by the APP.
	• Safe work practices and precautions associated with task being performed IAW the WP.
	• Specific response training IAW the APP
	• Personnel will meet requirements IAW the applicable regulations for the training and use of PPE (including respiratory protection).
	• Evacuation and emergency procedures IAW the APP.
	• OSHA qualifications and training as required IAW the APP.
		Inspections to be performed by the UXOSO unless otherwise specified:
		• Inspect open excavation regularly IAW OSHA 29 CFR 1926 Subpart P.
		• Ensure barriers are set up around open excavations to prevent unauthorized personnel from falling into an excavation during non-working hours.
		• Daily inspection of heavy equipment daily for function of safety features and general assembly.
		• Calibrate monitoring equipment.
		• Daily preventive maintenance.
		• Daily serviceability check of equipment.
		• Daily communications checks.
		• Daily checks of first aid kits and weekly inventory of kits.
		• Daily check for serviceability, fit, and comfort of PPE.

Activity/Work Task:	**6. MEC/MPPEH Disposal By Detonation**
Project Location	Strother Field, Cowley County, Kansas
Contract Number	W9128F-10-D-0054 Task Order No. 0023
Date Prepared	12/16/2015
Prepared by (Name/Title):	Wayne Martrildonno, UXO Technical Manager
Reviewed by (Name/Title):	Jamison Harrell-Latham, CSP, Corp H&S Mgr
Notes: (Field Notes, Review Comments, etc.)	

Overall Risk Assessment Code (RAC) (Use Highest Code): **M**

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "Hazard" with identified safety "Controls" and determine RAC (see above)

"**Probability**" is the likelihood to cause an incident, near miss, or accident, and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"**Severity**" is the outcome/degree if an incident, near miss, or accident did occur and identified as Catastrophic, Critical, Marginal, and Negligible.

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Controls	RAC
1. Issue of donor charges 2. Transporting explosives 3. Preparation of explosive charges 4. Firing the demolition shot 5. Clearing misfires 6. Post blast cleanup	Vehicle accidents/collisions	1. Wear high visibility traffic safety vests when working around heavy equipment/motor vehicles. 2. Vehicle and equipment operators should always look in the direction of travel; 3. Look before backing up. 4. Chock wheels and set parking brake when loading vehicle. 5. Follow prescribed explosive transport route. 6. The speed limit is 25 mph – unless otherwise noted.	**L**
	Cargo fire/vehicle fire/unintentional detonation during transportation	1. Inspect explosives transport vehicle using DD Form 626. 2. Complete explosives transportation paperwork accurately. 3. Use a familiar route. 4. Package the explosives properly. 5. Transport detonators in an IME 22 detonator box.	**M**
	Muscle strain from improper lifting techniques	1.Follow proper lifting techniques; 2. No manual lifting of heavy (50 lbs) loads.	**L**
	Excessive noise exposure	Wear hearing protection.	**L**
	Unauthorized personnel	Maintain positive site control; cease operations if unauthorized entry is made.	**L**
	Slips, trips, or falls	Practice good housekeeping procedures. Keep walking/working surfaces free from slip/trip hazards.	**L**
	Wild animals/insects	1. Avoid wild animals and their dens/nests. 2. Do not become distracted by flying/biting insects. 3. Use insect-resistant clothing such as a head net. Use insect repellant.	**L**

Job Steps	Hazards	Controls	RAC
	Heat and cold stress	1. Review signs, symptoms and prevention techniques. 2. Dress for the weather, in layers of removable clothing. 3. Drink the appropriate fluids on a frequent basis. 4. Enforce buddy system monitoring.	**L**
	Unplanned detonations	1. Separate detonators from main charges until priming the shot. 2. Observe all MEC safety precautions. 3. Only UXO-qualified personnel or UXO Technician supervised by UXO-qualified personnel will handle demolition materials. 4. Do not bury blasting caps. 5. Use detonating cord to allow for priming without disturbance of placed donor charges. 6. **In case of misfire:** Wait 30 minutes before approaching the demolition charge. Cut the detonating cord to separate the blasting caps from the main charge prior to electrically disconnecting the blasting caps.	**M**
	Blast/ fragmentation injury	1. Post barriers and barricades prior to commencing operations. 2. Ensure all notifications as outlined in the work plan have been made. 3. Use engineering controls in accordance with the ESP if necessary. 4. Ensure all personnel are clear of the demolition site and in a safe are prior to firing the shot. 5. Visually check the MFD-H and MFD-V to ensure it is clear prior to firing the shot. 6. Give warning signal prior to firing shot. 7. Ensure no fires involving MEC are burning. Approach the demolition site cautiously to avoid kicked-out MEC.	**M**

Equipment to be Used	Training Requirements / Competent or Qualified Personnel name(s)	Inspection Requirements

• Communications equipment.
• Fire extinguishers
• First aid kit
• Eye wash bottles
• Explosive demolition/blasting equipment
• EZ barriers/caution tape
• Explosives packaging material
• Motor vehicles
• Level D PPE
  ○ Long- or short-sleeved shirt and pants (T-shirts at discretion of UXOSO)
  ○ Safety-toe boots
  ○ Safety glasses
  ○ Hearing protection (as necessary)
  ○ Hard hat (as necessary)
  ○ High visibility safety vest (Class II or greater)
  ○ Work gloves
• Hand tools
• Camera
• GPS
	Training to be performed by the UXOSO unless otherwise specified:
	• OSHA 1910.120 HAZWOPER Program
	• Explosive Demolition Techniques for MEC Disposal.
	• Hand tool safety
	• Hearing conservation program
	• Equipment familiarity as required.
	• Knowledge of the Emergency Response and Notifications procedures IAW the APP.
	• First aid and CPR training as required by the APP.
	• Safe work practices and precautions associated with task being performed IAW the WP.
	• Specific response training IAW the APP.
	• Personnel will meet requirements IAW the applicable regulations for the training and use of PPE (including respiratory protection).
	• OSHA qualifications and training as required IAW the APP.
		Inspections to be performed by the UXOSO unless otherwise specified:
		• Type and quantity check of flagging material.
		• Daily checks of fire extinguishers.
		• Daily serviceability check of equipment.
		• Inspect hand tools for excessive wear and loose parts.
		• Daily communications checks.
		• Daily checks and weekly inventory of first aid kits.
		• Daily check for serviceability, fit, and comfort of PPE.
		• Inspect any engineering controls used prior to firing a shot.
		• Inspect area for to ensure it is clear prior to firing shot.

Activity/Work Task:	**7. Environmental Sampling**
Project Location	Strother Field, Cowley County, Kansas
Contract Number	W9128F-10-D-0054 Task Order No. 0023
Date Prepared	12/16/2015
Prepared by (Name/Title):	Wayne Martrildonno, UXO Technical Manager
Reviewed by (Name/Title):	Jamison Harrell-Latham, CSP, Corp H&S Mgr
Notes: (Field Notes, Review Comments, etc.)	

Overall Risk Assessment Code (RAC) (Use Highest Code): **M**

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "Hazard" with identified safety "Controls" and determine RAC (see above)

"**Probability**" is the likelihood to cause an incident, near miss, or accident, and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"**Severity**" is the outcome/degree if an incident, near miss, or accident did occur and identified as Catastrophic, Critical, Marginal, and Negligible.

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Controls	RAC
Soil sampling 1. Flag soil sample locations(s) 2. Sampling personnel fill appropriate sample bottles with soil from the IAW the work plan.	Contact with contaminated material	1. Wear the appropriate PPE for the task being performed. 2. Use good personal hygiene: wash hands and face prior to eating, drinking, or tobacco use. 3. Decontaminate equipment (Alconox). 4. Handle samples carefully to avoid spills. 5. Use dedicated and/or disposable equipment, if possible.	**L**
	Injury from improper use of hand tools	Only trained personnel will use hand tools.	**L**
	Muscle strain due to improper lifting or hand auger/core sampler use	1. Avoid twisting while using the hand auger/shovel. 2. Rotate the task among workers to share the sample collection duties. 3. Follow proper lifting techniques; no manual lifting of heavy (50 pounds) loads. 4. Do not over pack coolers greater than 50 pounds. 5. Use two person lifts for heavy objects over 50 pounds.	**L**
	Slips, trips, or falls	Practice good housekeeping procedures. Keep walking/working surfaces free from slip/ trip hazards.	**L**
	Excavation collapse (pit bottom and sidewall samples)	1. No work will be performed inside an excavation while heavy equipment is operating. 2. Implement excavation safety procedures. 3. Keep unnecessary personnel away from excavation work area. 4. Set up barriers (e.g., temporary orange fencing) around open excavation. 5. Ensure egress, sloping, shoring and protective systems as necessary. 6. Excavation inspection by competent person (UXOSO) daily.	**M**
	Inclement weather	In the event of a threat of other weather conditions, stabilize the work area and evacuate the site. proceed to assigned assembly point(s).	**L**

Job Steps	Hazards	Controls	RAC
	Cut or skin puncture	1. Review proper cutting procedures; 2. Always cut away from your body; use a proper cutting tool; 3. Use sharp tools.	**L**
	Heavy equipment or vehicle accidents/ collisions	1. Wear high visibility safety vests when working around heavy equipment/motor vehicles. 2. Vehicle/equipment operators should always look in the direction of travel; 3. Always look before backing up. 4. Prevent foot traffic from crossing routes of heavy equipment. 5. Speed limit is 25 mph unless otherwise noted. 6. Use a spotter for maneuvering heavy equipment to reduce blind spots. 7. Ensure the operator acknowledges your presence by making eye contact before walking near equipment in operation. 8. Minimize distractions.	**L**
	Unintentional contact with MEC	1. Observe the ground surface and/or use metal detector to avoid MEC. 2. Mark any encountered MEC and avoid until MEC removal procedures can be completed. 3. Non-UXO personnel must be escorted in MEC areas. 4. Use metal detector for anomaly avoidance during intrusive work such as soil sample collection.	**M**

Equipment to be Used	Training Requirements / Competent or Qualified Personnel name(s)	Inspection Requirements

• Motor vehicles
• Communications equipment
• First aid kit
• Fire extinguishers
• Eye wash bottles
• Level D Modified PPE
  ○ Long- or short-sleeved shirt and pants (T-shirts at discretion of UXOSO)
  ○ Safety-toe boots
  ○ Safety glasses
  ○ Hearing protection (as necessary)
  ○ Hard hat (as necessary)
  ○ High visibility vest (as necessary)
  ○ Work gloves
  ○ Nitrile sample gloves
• Hand tools
• Sampling equipment
• Stainless steel hand auger
• Stainless steel buckets
• Disposable trowels
• Stainless steel trowels
• Stainless steel spoons
• Stainless steel mixing bowls
• Sample glassware
• Digital Camera
• GPS
	Training to be performed by the UXOSO unless otherwise specified:
	• OSHA 1910.120 HAZWOPER Program
	• DOT Hazardous Materials Transportation Training
	• Heavy equipment operation
	• Excavation safety
	• MEC safety awareness
	• Hand tool safety
	• Hearing conservation program
	• Equipment familiarity as required.
	• Knowledge of the Emergency Response and Notifications procedures IAW the APP.
	• First aid and CPR training as required by the APP.
	• Safe work practices and precautions associated with task being performed IAW the WP.
	• Specific response training IAW the APP.
	• Personnel will meet requirements IAW the applicable regulations for the training and use of PPE (including respiratory protection).
	• OSHA qualifications and training as required IAW the APP.
		Inspections to be performed by the UXOSO unless otherwise specified:
		• Inspect open excavation regularly IAW OSHA 29 CFR 1926 Subpart P.
		• Ensure barrier is set up around open excavations to prevent unauthorized personnel from falling into an excavation during non-working hours.
		• Inspect heavy equipment daily for function of safety features and general assembly.
		• Calibrate monitoring equipment.
		• Daily serviceability check of equipment.
		• Inspect hand tools for excessive wear and loose parts.
		• Daily communications checks.
		• Daily checks of first aid kits and weekly inventory of kits.
		• Daily check for serviceability, fit, and comfort of PPE.

Activity/Work Task:	**8. Munitions Debris/Scrap Metal Inspection, Certification and Disposal**	Overall Risk Assessment Code (RAC) (Use Highest Code)	**M**
Project Location	Strother Field, Cowley County, Kansas		
Contract Number	W9128F-10-D-0054 Task Order No. 0023		
Date Prepared	12/16/2015		
Prepared by (Name/Title):	Wayne Martrildonno, UXO Technical Manager		
Reviewed by (Name/Title):	Jamison Harrell-Latham, CSP, Corp H&S Mgr		
Notes: (Field Notes, Review Comments, etc.)			

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "Hazard" with identified safety "Controls" and determine RAC (see above)

"**Probability**" is the likelihood to cause an incident, near miss, or accident, and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"**Severity**" is the outcome/degree if an incident, near miss, or accident did occur and identified as Catastrophic, Critical, Marginal, and Negligible.

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Controls	RAC
1. Inspection of material and containers. 2. Mobilize earth moving machinery (if required). 3. Consolidation, packaging, and loading containers. 4. Certification of MDAS 5. Complete documentation, identify and record MEC. 6. MDAS and scrap metal disposal	Heavy equipment or vehicle accidents/collisions	1. Wear high visibility safety vests when working around heavy equipment/motor vehicles. 2. Vehicle/equipment operators should always look in the direction of travel; 3. Always look before backing up. 4. Prevent foot traffic from crossing routes of heavy equipment. 5. Speed limit is 25 mph unless otherwise noted. 6. Use a spotter for maneuvering heavy equipment to reduce blind spots. 7. Ensure the operator acknowledge your presence by making eye contact before walking near equipment in operation. 8. Minimize distractions and use defensive driving techniques.	**L**
	Injury from improper use of hand/power tools	1. Only trained personnel will use hand/power tools. 2. Power tools and equipment will be equipped with a shutoff switch. 3. All rotating parts will be properly guarded.	**L**
	Muscle strain from improper lifting techniques	1. Follow proper lifting techniques; 2. No manual lifting of heavy loads over 50 pounds.	**L**

Job Steps	Hazards	Controls	RAC
	Potential MEC/UXO	1. Perform MPPEH inspections within then MRS. 2. Observe all MEC safety precautions, such as movement, heat, shock, and friction. 3. Establish and observe team separation distances. 4. Only UXO-qualified personnel will inspect scrap material. UXO TIII must perform independent inspection of 5. Inspections must take place within the MRS. 6. Test unknown substances with colorimetric test set or flame test. 7. Perform flame test at least 25 feet downwind of other potential MEC.	**M**
	Slips, trips, or falls	Practice good housekeeping procedures. Keep walking/working surfaces free from slip/trip hazards.	**L**
	Impact/injury from heavy equipment or moving loads	1. Wear high visibility traffic safety vests when working around heavy equipment/motor vehicles. 2. Ensure the operator acknowledges your presence by making eye contact before walking near equipment in operation.	**L**
	Unauthorized personnel	1. Cease operations if unauthorized entry is made. 2. Post barriers and barricades prior to commencing operations.	**L**

Equipment to be Used	Training Requirements / Competent or Qualified Personnel name(s)	Inspection Requirements

• Heavy equipment
• 55-gallon drums/scrap containers
• Motor vehicles
• First aid kit
• Fire extinguisher
• Eye wash bottles
• Level D PPE
  ○ Long- or short-sleeved shirt and pants (T-shirts at discretion of UXOSO)
  ○ Safety-toe boots
  ○ Safety glasses
  ○ Hearing protection (as necessary)
  ○ Hard hat (as necessary)
  ○ High visibility safety vest (Class II or greater)
  ○ Work gloves
• Hand tools
• Colorimetric explosives test kit
• Digital camera
• GPS
	Training to be performed by the UXOSO unless otherwise specified:
	• OSHA 1910.120 HAZWOPER Program
	• DOT Hazardous Materials Transportation Training
	• MEC safety awareness
	• Hand tool safety
	• Equipment familiarity as required.
	• Heavy equipment operation
	• Knowledge of the Emergency Response and Notifications procedures IAW the APP.
	• First aid and CPR training as required by the APP.
	• Safe work practices and precautions associated with task being performed IAW the WP.
	• Specific response training IAW the APP.
	• Personnel will meet requirements IAW the applicable regulations for the training and use of PPE (including respiratory protection).
	• OSHA qualifications and training as required IAW the APP.
		Inspections to be performed by the UXOSO unless otherwise specified:
		• Daily serviceability check of equipment.
		• Inspect hand tools for excessive wear and loose parts.
		• Daily communications checks.
		• Daily checks of first aid kits and weekly inventory of kits.
		• Daily check for serviceability, fit, and comfort of PPE.

Activity/Work Task:	**9. Excavation**
Project Location	Strother Field, Cowley County, Kansas
Contract Number	W9128F-10-D-0054 Task Order No. 0023
Date Prepared	12/16/2015
Prepared by (Name/Title):	Wayne Martrildonno, UXO Technical Manager
Reviewed by (Name/Title):	Jamison Harrell-Latham, CSP, Corp H&S Mgr

Notes: (Field Notes, Review Comments, etc.)

Provided as a supplement to AHA #5 if excavation via mechanized means is required, and not addressed as a specific definable feature of work in the work plan.

Overall Risk Assessment Code (RAC) (Use Highest Code): **M**

Risk Assessment Code (RAC) Matrix

Severity	**Probability**				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "Hazard" with identified safety "Controls" and determine RAC (see above)

"Probability" is the likelihood to cause an incident, near miss, or accident, and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as Catastrophic, Critical, Marginal, and Negligible.

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	**Hazards**	**Controls**	**RAC**
1. Identify limits of excavation. 2. Mobilize heavy equipment. 3. Excavate soil. 4. Stockpile removed soil. 5. Place or distribute backfill in excavation.	Contact with overhead or underground utilities.	1. Utility clearance must be confirmed before excavation begins. 2. Obtain utility clearance and dig permits. Refer to APP for overhead and underground utility clearance requirements. 3. Stay alert for utilities while excavating even though utility clearance has been obtained.	**M**
	Overhead hazard	1. Wear hard hat when overhead hazard exists. 2. No work will be performed inside the excavation or operating arc while heavy equipment is operating.	**L**
	Excavation Collapse	1. UXOSO is designated competent person for excavation. 2. Implement excavation safety procedures. 3. Keep unnecessary personnel away from excavation work area. 4. Ensure egress, sloping, shoring and protective systems. 5. Excavation inspection by competent person daily before and during each work shift. Stockpile excavated soil well away (minimum of 2 feet) from excavation to prevent loading of excavation face or sloughing of stockpile into excavation.	**M**
	Water Incursion	Employees shall not work in excavations in which water is accumulating unless the water hazard is controlled.	**M**
	Impact/injury from heavy equipment or moving loads	1. Wear high visibility traffic safety vests when working around heavy equipment/motor vehicles. 2. Ensure the operator acknowledges your presence by making eye contact before walking near equipment in operation.	**L**

Job Steps	Hazards	Controls	RAC
	Vehicle accidents/collisions	1. Wear high visibility traffic safety vests when working around heavy equipment/motor vehicles. 2. Vehicle and equipment operators should always look in the direction of travel; 3. Look before backing up. 4. The speed limit is 25 mph – unless otherwise noted.	**L**
	Struck by falling load	1. Arrange traffic flow to prevent foot traffic from crossing the routes of heavy equipment and moving loads. 2. Don't stand, walk, or work beneath loads being handled by heavy equipment in operation.	**L**
	Heat and cold stress	1. Review signs, symptoms and prevention techniques. 2. Dress for the weather, in layers of removable clothing. 3. Drink the appropriate fluids on a frequent basis and eat nutritious meals. 4. Perform physiological monitoring as outlined in the APP. 5. Enforce buddy system monitoring.	**L**
	Excessive noise exposure	Provide hearing protection.	**L**
	Slips, trips, or falls; fall into excavation	1. Practice good housekeeping procedures. 2. Keep walking/working surfaces free from slip/ trip hazards. 3. Backfill excavation as soon as possible. 4. If excavation will be left unattended, provide a minimum of Class III perimeter protection around open excavation. Class III perimeter protection consists of warning barricades or flagging placed not closer than 6 inches nor further than 6 feet from the edge of the excavation.	**L**
	Potential MEC/MPPEH	1. Establish exclusion zone. 2. Observe all MEC safety precautions, such as movement, heat, shock, and friction. 3. Mark and report any MEC encountered. 4. UXO-qualified personnel will monitor activities. 5. SUXOS and UXOSO must approve movement of MEC. 6. Monitor digging with analog instrument to avoid unintentional contact with MEC. 7. Halt excavation with earth moving machinery within 12 inches of an anomaly and continue excavating manually.	**M**

Job Steps	Hazards	Controls	RAC
	Mechanized MEC procedures	1. Ensure that the correct shielding is installed and of that operator and essential personnel are protected from detonations and all potential directions. 2. Ensure the effective digging range of the excavator exceeds the K18 overpressure distance. 3. Operator and essential personnel must use double hearing protection (ear plugs and ear muffs) with 9 dB or greater protection and remain outside the K18. 4. All unshielded personnel must be removed to the MSD. Shielding, overpressure distances and MSD's are outlined in the ESP.	**M**
	Biological hazards (biting or stinging insects, poisonous snakes, wildlife, animals).	1. If insects are a problem, use insect repellant with <30% DEET. 2. Avoid all wildlife including mammals and reptiles. 3. Do not approach animal dens or nests. 4. Use barrier creams/ointments as necessary.	**L**
	Unauthorized Personnel.	1. Maintain positive site control; 2. Cease operations if unauthorized entry is made.	**L**

Equipment to be Used	Training Requirements / Competent or Qualified Personnel name(s)	Inspection Requirements

• Heavy Earth Moving Equipment
• Motor Vehicles
• Fire Extinguishers
• Eye Wash Bottles
• First Aid Kit
• Level D PPE (Modified Level D when working with contaminated soil)
  ○ Long- or Short-Sleeved Shirt and Pants (T-shirts at discretion of UXOSO
  ○ Safety-toe Boots
  ○ Safety Glasses
  ○ Hearing Protection (as necessary)
  ○ Hard Hat (as necessary)
  ○ High visibility safety vest (Class II or greater)
  ○ Work gloves
• Hand tools
• Excavation barriers (e.g., temporary orange fencing)
• Digital Camera
• GPS
• Analog Metal Detector/Magnetometer
	Training to be performed by the UXOSO unless otherwise specified:
	• OSHA 1910.120 HAZWOPER Program
	• MEC Safety Awareness
	• Heavy equipment operation
	• OSHA 30-hour Construction Safety for UXOSO
	• Excavation safety
	• Hearing Conservation Program
	• Equipment familiarity as required.
	• Knowledge of the Emergency Response and Notifications procedures IAW the APP
	• First Aid and CPR training as required by the APP
	• Safe work practices and precautions associated with task being performed IAW the WP
	• Specific response training IAW the APP
	• Personnel will meet requirements IAW the applicable regulations for the training and use of PPE (including respiratory protection)
	• Evacuation and emergency procedures IAW the APP
	• OSHA qualifications and training as required IAW the APP
		Inspections to be performed by the UXOSO unless otherwise specified:
		• Inspect open excavation regularly IAW OSHA 29 CFR 1926 Subpart P.
		• Ensure barriers are set up around open excavations to prevent unauthorized personnel from falling into an excavation during non-working hours.
		• Daily inspection of heavy equipment for function of safety features and general assembly.
		• Daily preventive maintenance.
		• Daily serviceability check of equipment.
		• Daily communications checks.
		• Daily checks of first aid kits and weekly inventory of kits.
		• Daily check for serviceability, fit, and comfort of PPE.

Appendix 2

Points of Contact

Points of Contact

Agency Contact List

Agency	Number
Contact first for any emergency	911
Medical Emergencies	911
Fire Emergencies	911
Police Emergency	911
Cowley County Sheriff (nonemergency)	620-221-5444/4555
Federal OSHA Hotline	800-321-6742
Kansas One Call (call before digging)	811
KDHE Bureau of Environmental Remediation	785-296-0603
KDHE Spill Reporting	785-291-3333
National Response Center (spill reporting)	800-424-8802
OSHA	316-269-6644
Poison Control Center	800-222-1222

Personnel Contact List*

Name	Function	Telephone Number	Mobile Phone Number	Email Address
Baer, Kurt	USACE PM	816-389-3922	N/A	kurt.h.baer@usace.army.mil
Hannan, Dave	SUXOS	651-291-3437	850-797-4240	dhannan@baywest.com
Harrell-Latham, Jamison	CSHM	651-291-3480	651-503-1744	jharrell-latham@baywest.com
Sellers, Brandon	Contracting Officer's Representative (COR)/Military Munitions Design Technical Lead	402-995-2744	402-253-5406	brandon.m.sellers@usace.army.mil
Martrildonno, Wayne	UXO Technical Manager	509-481-9081	651-248-9551	waynem@baywest.com
Norman, Jesse	UXOSO and UXOQCS	651-291-3433	317-468-5214	jnorman@baywest.com
Swiech-Laflamme, Marie	PM	609-232-8026	609-638-2919	mlaflamme@baywest.com
TBD	USACE Ordnance and Explosives Safety Specialist (OESS)			

Appendix 3

Map to Medical Facility

bing Maps

A **near 7730 9th Ave, Winfield, KS 67156**
(Directions to approximate location.)

B **William Newton Hospital, KS**

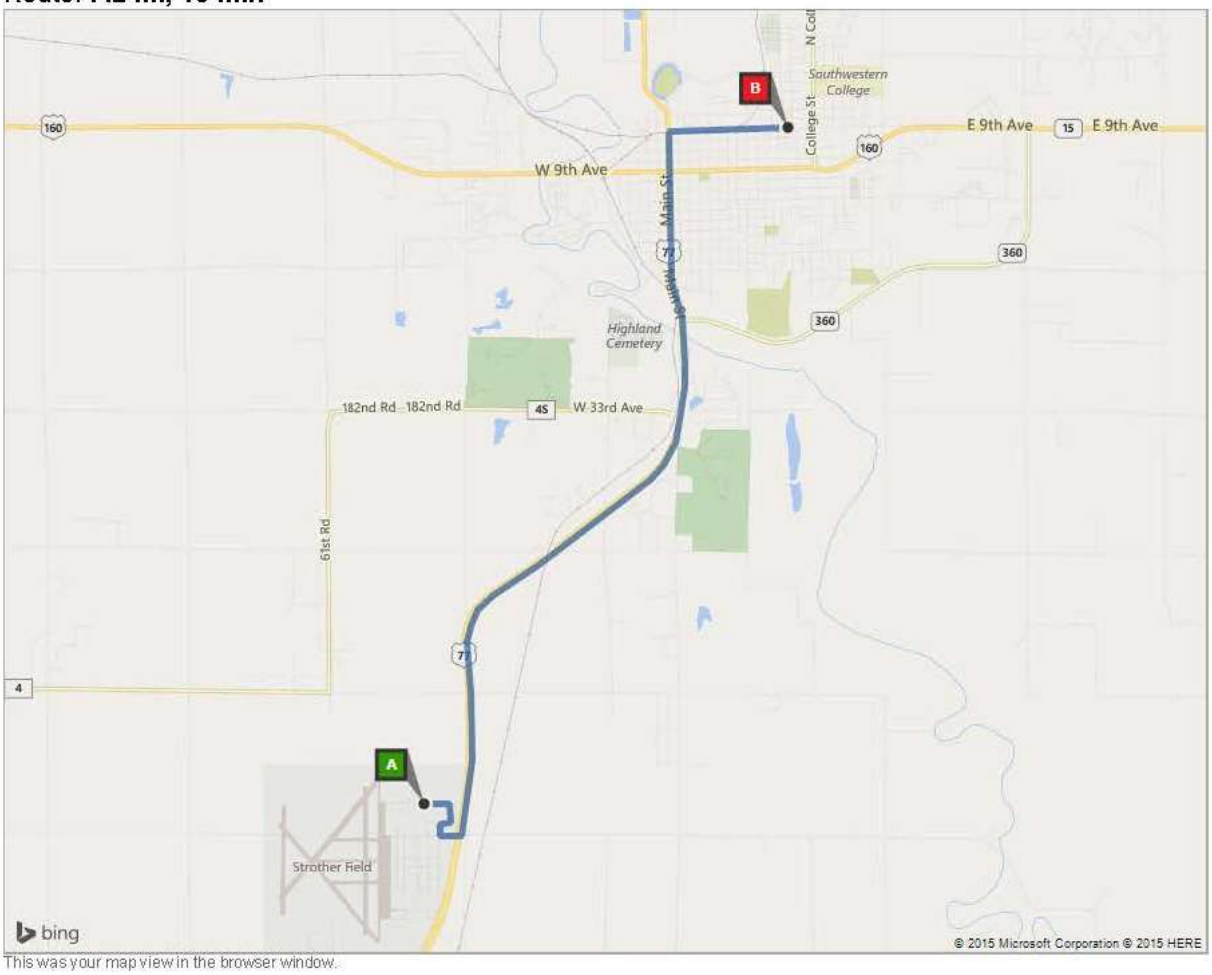
Route: **7.2 mi, 15 min**

My Notes

On the go? Use **m.bing.com** to find maps, directions, businesses, and more

A	**near 7730 9th Ave, Winfield, KS 67156**	**A–B: 7.2 mi** 15 min
	1. Depart **9th Ave**	0.2 mi
	2. Bear **right** onto **road**	0.2 mi
	3. Turn **left**, and then immediately turn **left** onto **7th Ave**	0.2 mi
	4. Turn **left** onto **US-77 N** *Pass Dillons Fuel Center in 4.4 mi*	5.7 mi
	5. Turn **right** onto **E 5th Ave**	0.9 mi
	6. Turn **left** onto **road**	62 ft
B	7. Arrive at **William Newton Hospital, KS** *The last intersection is E 5th Ave*	

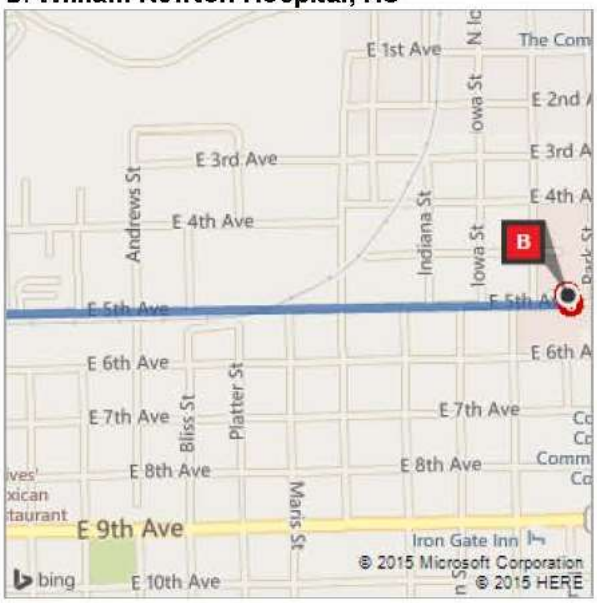
Route: **7.2 mi, 15 min**



This was your map view in the browser window.

A: **near 7730 9th Ave, Winfield, KS 67156**

B: **William Newton Hospital, KS**



Appendix 4

Safety Data Sheets

This attachment is reserved for safety data sheets if any become necessary.

Attachment 2

Personnel Resumes and Certificates

David A. Hannan

Graduated Basic EOD/UXO School: Sep 85
40 Hour HAZWOPER: Aug 95
30 Hour Construction Safety: Apr 10
USACE Construction Quality Management: Jan 16
8 Hour Refresher: Mar 16
8 Hour Supervisor: Aug 10
CPR: Mar 15
First Aid: Mar 15

Military EOD Experience

Sep 85 - Sep 87	EOD Technician, 7008 EOD Flight, RAF Lakenheath, UK
Sep 87 - Sep 91	EOD Supervisor, 56 CSG, MacDill AFB, FL

Total Military EOD Experience: 6 Years, 1 Month

Civilian UXO Experience

May 94 - Aug 95	UXO Tech II, Environmental Chemical Corporation, Mission Trails Regional Park, San Diego CA, MEC removal
Aug 95 - Jul 98	UXO Tech III, CMS Environmental Inc., Fort Ord, CA, MEC removal
Jul 98 - Nov 03	UXO Tech III, USAE, Fort Ord, CA, MEC removal
Nov 03 - Nov 05	SUXOS, USAE, Fort Ord, CA, MEC removal
Dec 05 – Dec 05	UXO Tech III, USAE, Camp Lejeune, NC, UXO escort/avoidance
Jan 06 - Feb 06	UXO Tech III, USAE, Pohakuloa Training Area, HI, MEC removal
Feb 06 - Apr 09	SUXOS, USAE, Camp Sibert, Site 8, AL, MEC/CWM removal
Apr 09 - Apr 10	UXO Tech III, AECOM., Eglin AFB, FL, CSE Phase II
Apr 10 - May 10	UXOSO, Parsons Infrastructure and Technologies, Tooele Army Depot (TEAD), UT, MEC removal
May 10 - Jan 11	UXO Tech III, Bay West LLC, Eglin AFB, FL, CSE Phase II
Jan 11 - May 11	SUXOS, Bay West LLC, Arnold AFB, TN, MEC removal
May 11 - Jun 11	SUXOS, Parsons Infrastructure and Tech., George AFB, CA, MEC removal

Jun 11 - Dec 11	UXO Tech III, Zapata, Eglin AFB, FL, UXO avoidance/MEC removal
Dec 11 - Apr 12	SUXOS, Zapata, Eglin AFB, FL, UXO avoidance/MEC removal
Apr 12 - Jun 12	UXO Tech III, Zapata, Fort Indiantown Gap, PA, MEC removal
Jul 12 - Aug 12	UXOSO/QCS, Bay West LLC, Minot AFB, ND, MEC removal
Aug 12 - Oct 12	SUXOS, Bay West LLC, Minot AFB, ND, RI
Nov 12 - Feb 14	UXO Tech III, Bay West LLC, Eglin AFB, FL, CSE Phase II
Feb 14 - Jul 14	SUXOS, Bay West LLC, Eglin AFB, FL, CSE Phase II
Jul 14 – Feb 15	UXOSO, Bay West LLC, Cornhusker Army Ammunition Plant, NE, MEC Removal
Mar 15 – Apr 15	UXOSO/QCS, Bay West LLC, Eglin AFB, FL, CSE PH II
May 15 – Jul 15	SUXOS, Bay West LLC, Eareckson AS, AK, RI
Aug 15 – Aug 15	SUXOS, Bay West LLC, Campion AS, AK, TCRA
Nov 15 – Apr 16	SUXOS, Bay West LLC, Edwards AFB, CA, RI and CSE PH II
Apr 16 – Sep 16	SUXOS, Bay West LLC, Eglin AFB, FL CSE PH II

Total Civilian UXO Experience: 22 Years 3 Months

Naval School
Explosive Ordnance Disposal

EXPLOSIVE ORDNANCE DISPOSAL
U.S. NAVAL SCHOOL
PER SCIENTIAM SERVITIA

This certifies that

Airman First Class
David A. Hannan, USAF

having successfully completed
the prescribed course of study for

EXPLOSIVE ORDNANCE DISPOSAL SPECIALIST - G5ABN46430
PDS-CID

is awarded this
Certificate

this 6th day of September A.D. 1985

J. Sedlak Jr.
J. SEDLAK, JR., CDR, USN
COMMANDING OFFICER

Certificate of Training

This certifies that

David Hannan

has successfully completed the training program requirements for

40 Hour OSHA Training for Hazardous Waste Operations - 29 CFR 1910.120 (e)(g)

Tampa, Florida

Awarded on this 18 day of August 19 95

CMS, Inc.

AC 303

Certificate of Completion

Presented to:

DAVID HANNAN

On 4/14/2010, DAVID HANNAN successfully completed the OSHA 30 Hour Outreach Training for the Construction Industry.

Taylor Alan Silva

OSHA Authorized Trainer

UNIVERSITY OF SOUTH FLORIDA

OSHA TRAINING INSTITUTE EDUCATION CENTER

American Safety Council .com

Bay West

Customer-Focused Environmental & Industrial Solutions

Certificate of Training

Is hereby granted to

David Hannan

To certify that they satisfactorily completed

Department of Transportation Hazardous Materials Training

This training has been performed in accordance with the requirements of 49 CFR 172.704.

Granted April 21, 2015

Jeff Gordon

Project Manager – Bay West LLC

Training Location: Minnesota Department of Transportation – Web Based E-Learning Course

Bay West LLC 5 Empire Drive, Saint Paul, Minnesota 55103-1867

American Red Cross

Dave Hannan

has successfully completed requirements for

Adult First Aid/CPR/AED: valid 2 Years

Date Completed: 03/03/2015

conducted by: American Red Cross

Instructor: Alonzo B Hunter

ID: 0WINIA

Scan code or visit:
redcross.org/confirm

Certificate of Training

This certifies that

Dave Hannan

has successfully completed the training program requirements for

Supervisors Training for Hazardous Waste Operations - 29 CFR 1910.120 (e)

Awarded at Oldsmar, Florida

on this 23rd Day of August, 2010

Certificate No: T-355

Robert D. Crownover, Corporate Safety and Health Manager

USA Environmental, Inc., 720 Brooker Creek Blvd. Suite 204, Oldsmar, FL. 34677 (813) 343-6336

CLICKSAFETY®

certifies that

DAVID HANNAN

has successfully completed ClickSafety's web-based training course:

D3 DOT Drug and Alcohol Training for Supervisors

This course was developed and presented by ClickSafety.com, Inc.

CLICKSAFETY
www.ClickSafety.com

I confirm that I personally took the course listed above.

15156120	9/16/2015	2 HOURS	
SERIAL NUMBER	COMPLETION DATE	COURSE DURATION	STUDENT SIGNATURE

15156120

CLICKSAFETY®

certifies that

DAVID HANNAN

has successfully completed

Hazwoper Refresher 2016

and has earned 0.8 IACET CEUs and 8 Contact Hours.

I confirm that I personally took the course listed above.

STUDENT SIGNATURE

AUTHORIZED IACET PROVIDER

16566529	3/9/2016	8.25 HOURS
SERIAL NUMBER	COMPLETION DATE	COURSE DURATION

16566529

U.S. ARMY CORPS OF ENGINEERS

USACE LEARNING CENTER
HUNTSVILLE, ALABAMA

NAVFAC

CERTIFICATE

DAVE HANNAN

SE9-04-16-00107

has completed the Corps of Engineers and Naval Facility Engineering Command Training Course

CONSTRUCTION QUALITY MANAGEMENT FOR CONTRACTORS - #784

NORTH CHARLESTON, SC	4 JANUARY 2016	NAVFAC SE	Robert "Whit" Heffington P.E. NAVFAC SE
Location	Training Date(s)	Instructional District/ NAVFAC	CQM-C Manager
John E Parker III, PMP	PARKERJEUSA@TDS.NET	843-834-0173	
Facilitator/Instructor	Email	Telephone	Facilitator/Instructor Signature

Jeffrey D. Dziedzic
Chief, USACE Learning Center

THIS CERTIFICATE EXPIRES FIVE YEARS FROM DATE OF ISSUE
CQM-C Recertification online course: https://www.myuln.net

WorkCare
MAKING HEALTH COUNT

WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: **Annual Exam**
EXAM CLASSIFICATION: **Periodic Examination**

EMPLOYEE:	**Hannan, David**	**COMPANY:**	**Bay West, Inc.**
ID:		**POSITION:**	**UXO Supervisor**
DATE OF EXAM:	**03/09/2016**	**LOCATION:**	**Bay West - Saint Paul, MN**
EXPIRATION DATE:	**03/09/2017**	**SITE:**	

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

	Yes	No	Undecided
Has the employee any detected medical conditions that would increase his/her risk of material health impairment from occupational exposure in accordance with 29 CFR §1910.120 (Hazwoper)?	☐	X	☐
Has the employee any limitations in accordance with 29 CFR §1910.134 (Respirator)?	☐	X	☐

STATUS

X **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

☐ **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

☐ **NOT QUALIFIED**

☐ **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Peter P. Greaney, M.D. Date: 03/13/16

Signature: Peter P Greaney MD

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

Jesse J. Norman

Graduated Basic EOD/UXO School: Mar 05
40 Hour HAZWOPER: Aug 09
30 Hour Construction Safety: Jul 14
USACE Construction Quality Management: Apr 15
8 Hour Refresher: Oct 15
8 Hour Supervisor: Jul 13
CPR: Apr 15
First Aid: Apr 15

Military EOD Experience

Apr 05 – Jun 05	EOD Technician, 718th Ordnance Company (EOD) Camp Red Cloud, Korea
Jun 05 – Apr 06	EOD Technician, 718th Ordnance Company (EOD) Yongsan Garrison, Korea
Apr 06 – Jun 07	EOD Technician, 731st Ordnance Company (EOD) Wright-Patterson AFB, OH
Jun 07 – Mar 08	EOD Technician, 731st Ordnance Company (EOD), Ft. Stewart, GA,
Mar 08 – Apr 09	EOD Technician, 731st Ordnance Company (EOD) Camp Liberty, Iraq
Apr 09 – Jul 09	EOD Technician, 731st Ordnance Company (EOD) Ft. Stewart, GA

Total Military EOD Experience: 4 Years, 4 Months

Civilian UXO Experience

Jul 09 – Jul 10	UXO Tech II, Matrix Environmental Services, Anniston, AL. Removal Action (RA)
Aug 10 – Aug 10	UXO Tech II, Shaw Environmental Group E&I, Camp Lejeune, NC. Remedial Investigation (RI).
Sep 10 – Dec 10	UXO Tech II, Shaw Environmental Group E&I, Fort Belvoir, VA, Remedial Investigation (RI).
Dec 10 – May 11	UXO Tech II, Shaw Environmental Group E&I, Camp Lejeune, NC. Remedial Investigation (RI).
May 11 – May 11	UXO Tech II, Shaw Environmental Group E&I, NAS Pax River, MD. Construction Support.
Jun 11 – Oct 11	UXO Tech II, Shaw Environmental Group E&I, New Boston AFB, NH. Remedial Investigation (RI)

Nov 11 – Dec 11	UXO Tech II, Shaw Environmental Group E&I, Yuma Proving Ground, AR. Remedial Investigation (RI).
Jan 12 – Sep 12	UXO Tech II, Shaw Environmental Group E&I, Quantico, VA. Remedial Investigation (RI).
Sep 12 – Sep 12	UXO Tech III, Shaw Environmental Group E&I, Yuma Proving Ground, AR. Removal Action (RA).
Oct 12 – Nov 12	UXO Tech II, Ordnance & Explosive Remediation, Deseret Chemical Depot, UT. Non-Time Critical Removal Action (NTCRA).
Nov 12 – Dec 12	UXO Tech II, USA Environmental, Camp Ripley, MN. Removal Action (RA).
Dec 12 – Dec 12	UXO Tech II, USA Environmental, Camp Lejeune, NC. Remedial Investigation (RI).
Jan 13 – Mar 13	UXO Tech II, USA Environmental, Elk River, MN. Removal Action (RA).
Apr 13 – Sep 13	UXO Tech III, USA Environmental, Adak, AK. Removal Action (RA.)
Oct 13 – Oct 13	UXO Tech III, USA Environmental, Ft. Polk, LA. Remedial Investigation (RI).
Nov 13 – Nov 13	UXO Tech II, USA Environmental, Raritan, NJ. Remedial Investigation (RI).
Nov 13 – Dec 13	UXO Tech III, USA Environmental, Ft. Polk, LA. Remedial Investigation (RI).
Jan 14 – Mar 14	UXO Tech III, USA Environmental, Ft. Polk, LA. Remedial Investigation (RI).
Jun 14 – Jun 14	UXO Tech III, Ahtna Environmental, Galena, AK. Comprehensive Site Evaluation (CSE) Phase II.
Aug 14 – Oct 14	UXO Tech III, Bay West LLC, Campion AS, AK, RI
May 15 – July 15	UXOSO/QCS, Bay West LLC, Eareckson AS, AK, RI
Aug 15 – Aug 15	UXOSO/QCS, Bay West LLC, Campion AS, AK, RA
Nov 15 – Mar 16	UXOSO/QCS, Bay West LLC, Edwards AFB, CA, CSE PH II and RI
Apr 16 – Sep 16	UXOSO/QCS, Bay West LLC, Eglin AFB, FL CSE PH II

Total Civilian UXO Experience: 6 Years, 4 Months

Naval School

Explosive Ordnance Disposal

This is to certify that

PFC Jesse J. Norman

completed the

Army Basic EOD Course-Surface

(CIN A-431-0113)

Class 0421CA

In witness thereof, this certificate has been signed and given under my hand at

Naval School Explosive Ordnance Disposal, Eglin AFB, Florida

This 18th day of March in the Year of Our Lord, Two Thousand Five

Commanding Officer

NAVSCOLEOD 1500/26

US ARMY ORDNANCE

CERTIFICATE OF TRAINING

PRIVATE JESSE J. NORMAN

HAS SUCCESSFULLY COMPLETED 360 HOURS OF
EXPLOSIVE ORDNANCE DISPOSAL SPECIALIST (PH1)
4E-91E/645-55D10/20, CLASS 514-04
12 APRIL 2004 – 21 JUNE 2004

GIVEN AT
REDSTONE ARSENAL, ALABAMA

21 June 2004

JOYCE P. NAPIER
Colonel, Ordnance Corps
Commander

OMEMS Form 727, 1 Oct 02

THE NATIONAL ENVIRONMENTAL TRAINERS

Jesse Norman

has satisfactorily passed an exam and completed a 40-hour training course entitled

Hazardous Waste Operations and Emergency Response

meeting the requirements identified in Title 29 CFR 1910.120 (OSHA HAZWOPER Regulations). This course has been awarded 5.0 Industrial Hygiene CM Points by the American Board of Industrial Hygiene-Approval Number 13334. This course is also eligible for 3.33 Continuance of Certification (COC) points from the Board of Certified Safety Professionals

NATIONAL ENVIRONMENTAL TRAINERS, Inc.

Course Number 1003, Awarded 40 PDH's
Florida Board of Professional Engineers
CEU Provider Number 0004284

Signature of Instructor

August 09, 2009

www.nationalenvironmentaltrainers.com

Clay A. Bednarz, MS, RPIH

AdvanceOnline Solutions Online Institute

Certificate of Completion

Jesse Norman

has met the online course completion requirements for

OSHA 30-Hour Construction Safety

This student has completed the formal instruction for the 30-Hour Construction Outreach Program. Topics covered in this program were Introduction to OSHA, Managing Safety and Health, Struck and Caught Hazards, Personal Protective Equipment, Hearing Conservation, Respiratory Protection, Lead and Crystalline Silica, Asbestos, Hazard Communication, Electrical Safety, Hand and Power Tools, Fall Protection, Ladder Safety, Excavations, Scaffolds, Crane Safety, Heavy Equipment, Forklift Safety, Materials Handling, Permit-Required Confined Spaces, Fire Safety, Welding and Cutting, Concrete and Masonry, Steel Erection, and Ergonomics.

Certificate ID: 6745_976334
Instructor: Rick Gleason
Continuing Education Units: 3.0

Date: 7/22/2014 12:15:00 PM
Time Online: 30:29:27

AdvanceOnline Solutions Inc. has been approved as an Authorized Provider by the International Association for Continuing Education and Training (IACET), 1760 Old Meadow Road, Suite 500, McLean, VA 22102; (703) 506-3275.

AUTHORIZED IACET PROVIDER

AdvanceOnline Solutions, Inc.
2400 Augusta Drive, Suite 465
Houston, Texas 77057
www.advanceonline.com
Phone: (713) 621-1100

AdvanceOnline SOLUTIONS

U.S. ARMY CORPS OF ENGINEERS

USACE LEARNING CENTER
HUNTSVILLE, ALABAMA

NAVFAC

CERTIFICATE

JESSE NORMAN

SE9-04-15-00289

has completed the Corps of Engineers and Naval Facility Engineering Command Training Course

CONSTRUCTION QUALITY MANAGEMENT FOR CONTRACTORS - #784

NORTH CHARLESTON, SC	6 APRIL 2015	NAVFAC SE	Robert "Whit" Heffington P.E. NAVFAC SE
Location	Training Date(s)	Instructional District/ NAVFAC	CQM-C Manager
John E Parker III, PMP	PARKERJEUSA@TDS.NET	843-834-0173	
Facilitator/Instructor	Email	Telephone	Facilitator/Instructor Signature

Chief, USACE Learning Center

THIS CERTIFICATE EXPIRES FIVE YEARS FROM DATE OF ISSUE
CQM-C Recertification online course: https://www.myuln.net

Bay West

Customer-Focused Environmental & Industrial Solutions

Certificate of Training

Is hereby granted to

Jesse Norman

To certify that they satisfactorily completed

Department of Transportation Hazardous Materials Training

This training has been performed in accordance with the requirements of 49 CFR 172.704.

Granted April 19, 2015

Jeff Gordon

Project Manager – Bay West LLC

Training Location: Minnesota Department of Transportation – Web Based E-Learning Course

Bay West LLC 5 Empire Drive, Saint Paul, Minnesota 55103-1867

American Red Cross

Certificate of Completion

Jesse Norman

has successfully completed requirements for

Adult First Aid/CPR/AED - valid 2 Years

conducted by
American Red Cross

Date Completed: 04/23/2015
Instructors: Michael E Reid, Lydia M Lambert-Wolfe

Certificate ID: 0WRCII

To verify, scan code or visit:
redcross.org/confirm

Certificate of Completion

This certifies that

Jesse Norman

has successfully completed the requirements for
29 CFR 1910.120(e)
8-Hour Hazardous Waste Operations & Emergency
Response Supervisor Training

Awarded on this 5th day of July, 2013

Certificate No: T-2279

James Walden, UXO Safety & Health Manager

USA Environmental, Inc., 720 Brooker Creek Blvd. Suite 204, Oldsmar, FL. 34677 (813) 343-6336

Student Affiliation:
Bay West
4795

Compliance Solutions

"Today's Training...Tomorrow's Solution"

3980 Quebec St., 2nd Floor, Denver CO 80207-1633 800-711-2706

Certificate of Completio

This is to certify that

Jesse Norman

has been tested and successfully meets the training req

8-Hour HAZWOPER Refresher
as per 29 CFR 1910.120(e)

Presented
Tuesday, October 06, 2015

Compliance Solutions Occupational Trainers, Inc.

Neval Gupta
Vice President

Jeffrey E. Kline
President/CEO

Certificate Number: *754895552*

4795

Compliance SolutionsOccupational Trainers, Inc.
Certificate of Completion

Student Name: Jesse Norman
Company: Bay West
I Certify the above named student has been tested and trained for:
8-Hour HAZWOPER Refresher
as per 29 CFR 1910.120(e)
Date of Issue: 10/6/2015
By: **President**

WorkCare
MAKING HEALTH COUNT

WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: **Annual Exam**
EXAM CLASSIFICATION: **Periodic Examination**

EMPLOYEE:	**Norman, Jesse**	**COMPANY:**	**Bay West, Inc.**
ID:		**POSITION:**	**QC/Safety/UXO**
DATE OF EXAM:	**04/20/2016**	**LOCATION:**	**Bay West - Saint Paul, MN**
EXPIRATION DATE:	**04/20/2017**	**SITE:**	

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

	Yes	No	Undecided
Has the employee any detected medical conditions that would increase his/her risk of material health impairment from occupational exposure in accordance with 29 CFR §1910.120 (Hazwoper)?	☐	☒	☐
Has the employee any limitations in accordance with 29 CFR §1910.134 (Respirator)?	☐	☒	☐

STATUS

☒ **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

☐ **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

☐ **NOT QUALIFIED**

☐ **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Peter P. Greaney, M.D. Date: 04/25/16

Signature: Peter P Greaney MD

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

Kevin Nicholas

Graduated Basic EOD/UXO School: Jun 05
40 Hour HAZWOPER: Dec 08
30 Hour OSHA Const. Safety: Jan 16
8 Hour Refresher: May 16
8 Hour Supervisor: Aug 13

Military EOD Experience

Jun 05 – Jun 08	EOD Technician, 787th ORD CO (EOD) FT Lewis, WA

Total Military EOD Experience: 3 Years, 1 Month

Civilian UXO Experience

Oct 08 – Dec 08	UXO Tech II, EOD Technology, Inc. Camp Kasey, S. Korea, MEC Removal
Jan 09 – May 09	UXO Tech ll, UXB International, Inc. GTMO, Cuba, MEC Removal
Aug 09 – Dec 09	UXO Tech ll, PIKA International, Inc., Ft Leonard Wood, MO, MEC Removal
Jan 10 – Nov 10	UXO Tech ll, Shaw Environmental, Camp Pendleton, CA, MEC Removal
Jan 11 – May 11	UXO Tech ll, Bay West, Inc., Arnold AFB, TN, MEC Removal
July 11 – Dec 11	UXO Tech ll, Weston Solutions, Inc., Missoula, MT, RI
Dec 11 – Oct 12	UXO Tech ll, Weston Solutions, Inc., Luke AFB, AZ, MEC Removal
Nov 12 - May 14	UXO Tech II, Weston Solutions, Inc., Eglin AFB FL, CSE Phase II and Supplemental Investigation
May 14 – Sep 14	UXO Tech III, Weston Solutions, Inc., Eglin AFB FL, CSE Phase II and Supplemental Investigation
Sep 14 – Oct 14	UXO Tech III, Bay West LLC, Campion AS, AK, RI
Jan 15 – Mar 15	UXO Tech III, EW Wells Group, Arnold AFB, TN, RI
May 15 – Jul 15	UXO Tech III, Weston Solutions, Eareckson AS, AK, TCRA
Jul 15 – Sep 15	UXO Tech III, Weston Solutions, Campion AS, AK, TCRA
Dec 15 – Jan 16	UXO Tech III, Bay West LLC, JB – MDL, NJ, RI
Jan 16 – Feb 16	UXO Tech III, Bay West LLC, Camp Pendleton, VA, CSE PH II
Feb 16 – Mar 16	UXO Tech III, Bay West LLC, Edwards AFB, CA, CSE PH II and RI

Apr 16 – Aug 16 UXO Tech III, Weston Solutions Inc., Eglin AFB, FL, CSE PH II

Sep 16 – Sep 16 UXO Tech III, Weston Solutions Inc., Eglin AFB, FL, CSE PH II

Total Civilian UXO Experience: 7 Years, 3 Months

Naval School

Explosive Ordnance Disposal

This is to certify that

PV2 Kevin D. Nicholas

completed the

Army Basic EOD Course-Surface

(CIN A-431-0113)

Class 05070A

In witness thereof, this certificate has been signed and given under my hand at Naval School Explosive Ordnance Disposal, Eglin AFB, Florida

This 1st day of June in the Year of Our Lord, Two Thousand Five

Commanding Officer

NAVSCOLEOD 1600/06

SAFETY UNLIMITED, INC.

OSHA Compliant Safety Training & Consulting

690A East Los Angeles Ave.Suite. 180 Agoura Hills , CA 91301
888 309-7233 * 805 306-8027 * 805 526-0377
www.SafetyUnlimited.com

Certifies that

Kevin Nicholas

has successfully completed

OSHA 40 Hour HAZWOPER Training

In Accordance With Federal OSHA Regulation 29 CFR 1910.120

Julius P. Griggs

Julius P. Griggs
Instructor #892

12/18/2008

081218117736
Certificate Number

TO VERIFY THE VALIDITY OF THIS CERTIFICATE, go to www.SafetyUnlimited.com/certificate.htm

AdvanceOnline Solutions Online Institute

Certificate of Completion

Kevin Nicholas

has met the online course completion requirements for

OSHA 30-Hour Construction Safety

This student has completed the formal instruction for the 30-Hour Construction Outreach Program. Topics covered in this program were Introduction to OSHA, Managing Safety and Health, Struck-by and Caught-In or Between Hazards, Personal Protective Equipment, Hearing Conservation, Respiratory Protection, Lead and Crystalline Silica, Asbestos, GHS Hazard Communication, Electrical Safety, Hand and Power Tools, Fall Protection, Ladder Safety, Excavations, Scaffolds, Crane Safety, Heavy Equipment, Forklift Safety, Materials Handling, Permit-Required Confined Spaces, Fire Safety, Welding and Cutting, Concrete and Masonry, Steel Erection, and Ergonomics.

Course ID A0310
Certificate ID 6745_1174262
Instructor Rick Gleason
Continuing Education Units 3.0
AdvanceOnline Solutions, Inc. is authorized by IACET to offer 3.0 CEUs for this program.

AdvanceOnline Solutions, Inc. is accredited by the International Association for Continuing Education and Training (IACET) and is authorized to issue the IACET CEU.

ACCREDITED IACET PROVIDER

Date 1/17/2016 10:02:00 AM
Time Online 30:11:51
AdvanceOnline Solutions, Inc.
2400 Augusta Drive, Suite 465
Houston, Texas 77057
www.advanceonline.com
Phone: (713) 621-1100

AdvanceOnline SOLUTIONS

Certificate of Completion

This certifies that

Kevin Nicholas

Has Successfully completed

8 Hour HAZWOPER Refresher Training

Refresher certification does NOT necessarily indicate initial 24 or 40 Hour HAZWOPER certification

In Accordance w/Federal OSHA Regulation 29 CFR 1910.120(e) & (p)

And all State OSHA and EPA Regulations As Well

This course (Version 2) is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) issued by Safety Unlimited, Inc. (Accreditation # 044).

Julius P. Griggs	**160515584905**	**5/15/2016**
Julius P. Griggs Training Director	Certificate Number	Issue Date

SAFETY UNLIMITED, Inc.
OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley, CA 93063
888 309-SAFE (7233) or 805 306-8027 866-369-7097 (fax)
www.safetyunlimited.com

Proof of initial certification and subsequent refresher training is NOT required to take refresher training

Want to be sure this certificate is valid? Visit safetyunlimited.com/verification

Certificate of Completion

This certifies that

Kevin Nicholas

Has Successfully completed

8 Hour HAZWOPER Supervisor Training

This certificate does not in itself indicate initial 24 or 40 Hour HAZWOPER Training

In Accordance With Federal OSHA Regulation 29 CFR 1910.120(e)(4)

And all State OSHA/EPA Regulations as well

This course is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) issued by Safety Unlimited, Inc. (Accreditation # 044)

Julius P. Griggs	**130802484905**	**8/2/2013**
Julius P. Griggs Instructor #892	Certificate Number	Issue Date

SAFETY UNLIMITED, Inc.
OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley, CA 93063
888 309-SAFE (7233) or 805 306-8027 866-369-7097 (fax)
www.safetyunlimited.com

Annual Refresher Training NOT Required

Want to be sure this certificate is valid? Visit safetyunlimited.com/verification

WorkCare
MAKING HEALTH COUNT

WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: **Baseline Exam**
EXAM CLASSIFICATION: **Baseline Examination**

EMPLOYEE:	**Nicholas, Kevin**	**COMPANY:**	**Bay West, Inc.**
ID:		**POSITION:**	**Tech III**
DATE OF EXAM:	**04/05/2016**	**LOCATION:**	**Bay West - Saint Paul, MN**
EXPIRATION DATE:	**04/05/2017**	**SITE:**	

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

	Yes	No	Undecided
Has the employee any detected medical conditions that would increase his/her risk of material health impairment from occupational exposure in accordance with 29 CFR §1910.120 (Hazwoper)?	☐	X	☐
Has the employee any contraindication for work in accordance with 29 CFR §1910.95(g)1926.52 (Hearing Conservation)?	☐	X	☐
Has the employee any limitations in accordance with 29 CFR §1910.134 (Respirator)?	☐	X	☐

STATUS

☒ **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

☐ **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

☐ **NOT QUALIFIED**

☐ **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Peter P. Greaney, M.D. Date: 07/27/16

Signature: Peter P Greaney MD

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

Duncan (Trey) H. Harvin II

Graduated Basic EOD/UXO School: Sep 05
40 Hour HAZWOPER: Oct 05
30 Hour Construction Safety: Mar 12
8 Hour Refresher: Jan 16
8 Hour Supervisor: Mar 14

Military EOD Experience

Total Military EOD Experience: 0 Years, 0 Months

Civilian UXO Experience

Oct 05 – Jul 09	UXO Tech I, Bristol Environmental & Engineering Services, Camp Lejeune, NC, Live Range/Sub Surface Clearance
Aug 09 – Nov 10	UXO Tech I, Bay West, Inc., Eglin AFB, FL, CSE PH II
Nov 10 – Nov 10	UXO Tech ll, Bay West, Inc., Four Lakes, WA, CSE Phase I
Nov 10 – Nov 10	UXO Tech II, Bay West, Inc., Sepulveda, CA, CSE Phase I
Nov 10 – Dec 10	UXO Tech II, Bay West, Inc., Fort Riley, KS, RI
Jan 11 – May 11	UXO Tech II, Bay West, Inc. Arnold AFB, TN, RI
May 11 – Aug 11	UXO Tech II, Zapata Eng. Eglin AFB, FL, CSE PH II
Aug 11 – Dec 11	UXO Tech II, Bay West, Inc. Jefferson Range, IN, Const. Support
Jan 12 - Sep 12	UXO Tech II, Bay West, Inc. Arnold AFB, TN, RI
Sep 12 – Sep 12	UXO Tech II, EA Engineering, Ft. Knox, KY, ORAP Phase II
Sep 12 – Oct 12	UXO Tech II, EA Engineering, ANG Alpena, MI, RI
Oct 12 – Dec 12	UXO Tech II, Bay West, Inc. Volk Field, WI, RI
Jan 13 – May 14	UXO Tech II, Bay West LLC, Eglin AFB, FL, CSE Phase II and Supplemental Investigation
May 14 – Sep 14	UXO Tech III, Bay West LLC, Eglin AFB, FL, CSE Phase II and Supplemental Investigation
Sep 14 – Oct 14	UXO Tech III, Bay West LLC, Campion AS, AK, RI
Oct 14 – Feb 15	UXO Tech III, Bay West LLC, Cornhusker Army Ammunition Plant, NE, MEC Removal

Mar 15 – Apr 15	UXO Tech III, Bay West LLC. Eglin AFB, FL, CSE Phase I/II and Supplemental Investigation
May 15 – Jul 15	UXO Tech III, Bay West LLC, Eareckson AS, AK, RI
Aug 15 – Aug 15	UXO Tech III, Bay West LLC, Campion AS, AK, TCRA
Oct 15 – Oct 15	UXO Tech III, Bay West LLC, Salton Sea Test Base, CA, SI
Oct 15 – Nov 15	UXO Tech III, Bay West LLC, Ft. Riley, KS, RI
Nov 15 – Mar 16	UXO Tech III, Bay West LLC, Edwards AFB, CA, RI and CSE PH II
Apr 16 – Sep 16	UXO Tech III, Bay West LLC, Eglin AFB, FL CSE PH II

Total Civilian UXO Experience: 10 Years, 11 Months

The Texas A&M University System

Texas Engineering Extension Service

Public Safety & Security

Duncan Harvin II

has successfully completed

Unexploded Ordnance Technician Level I

September 30, 2005
200 Hours
A DOD Certified Course

Robert L. Smith
Director, Texas Engineering Extension Service

Thomas A. Swann
Division Director, Public Safety & Security

06/13/2009 16:00 19103465624 STAPLED

SHE Solutions, LLC

581 W. Locust Dr., Chandler, AZ 85248

CENTER FOR ENVIRONMENTAL TRAINING

Certificate of Completion # 501026

This is to certify that

Duncan H. Harvin II

has diligently and with merit completed training in

"40-Hour Health and Safety Training Course for Workers at Hazardous Waste Operations, 29 CFR 1910.120"

October 26, 2005

40 Hour Training Date of Completion

Ken Mushet, CSP

Ken Mushet, CSP

Certificate of Completion

This certifies that

Duncan Harvin II

Has Successfully completed

8 Hour HAZWOPER Supervisor Training

This certificate does not in itself indicate initial 24 or 40 Hour HAZWOPER Training

In Accordance With Federal OSHA Regulation 29 CFR 1910.120(e)(4)

And all State OSHA/EPA Regulations as well

This course is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) issued by Safety Unlimited, Inc. (Accreditation # 044)

Julius P. Griggs	**140315456143**	**3/15/2014**
Julius P. Griggs Instructor #892	Certificate Number	Issue Date

SAFETY UNLIMITED, Inc.
OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley, CA 93063
888 309-SAFE (7233) or 805 306-8027 866-869-7097 (fax)
www.safetyunlimited.com

Annual Refresher Training NOT Required
Want to be sure this certificate is valid? Visit safetyunlimited.com/verification

CLICKSAFETY®

certifies that

DUNCAN HARVIN II

has successfully completed ClickSafety's web-based training course:

Hazwoper Refresher 2016

This course was developed and presented by ClickSafety.com, Inc.

CLICKSAFETY
www.ClickSafety.com

I confirm that I personally took the course listed above.

16146124	1/1/2016	14.25 HOURS	
SERIAL NUMBER	COMPLETION DATE	COURSE DURATION	STUDENT SIGNATURE

16146124

Scanned by CamScanner

WorkCare
MAKING HEALTH COUNT

WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: **Annual Exam**
EXAM CLASSIFICATION: **Periodic Examination**

EMPLOYEE:	**Harvin, Duncan II**	**COMPANY:**	**Bay West, Inc.**
ID:		**POSITION:**	**UXO Tech**
DATE OF EXAM:	**04/15/2016**	**LOCATION:**	**Bay West - Saint Paul, MN**
EXPIRATION DATE:	**04/15/2017**	**SITE:**	

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

	Yes	No	Undecided
Has the employee any detected medical conditions that would increase his/her risk of material health impairment from occupational exposure in accordance with 29 CFR §1910.120 (Hazwoper)?	☐	☒	☐
Has the employee any limitations in accordance with 29 CFR §1910.134 (Respirator)?	☐	☒	☐

STATUS

☒ **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

☐ **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

☐ **NOT QUALIFIED**

☐ **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Peter P. Greaney, M.D. Date: 04/20/16

Signature: Peter P Greaney MD

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

Tom Holland

Graduated UXO School: Jun 08
40 Hour HAZWOPER: Jun 08
8 Hour Refresher: May 16

Civilian UXO Experience

Jun 08 – Aug 08	UXO Tech I Zapata Engineering, Pine Castle Jeep Range, Orlando, FL, team member reacquiring selected targets, investigating and excavating marked anomalies.
Sept 08 – Jul 09	UXO Tech I, Zapata Engineering, Fort Belvoir, VA, dig team member clearing of UXO, sift team member and heavy equipment operator.
Jul 09 – Aug 09	UXO Tech I, Zapata Engineering, Southwest Proving Grounds, Hope, AK team member requiring DGM targets in the former proving grounds, removing and disposing of UXO.
Nov 09 – July 10	UXO Tech I, Zapata Engineering, Schofield Barracks, Oahu, HI, team member clearing grids of UXO/CWM.
Sep 10 – Nov 10	UXO Tech I, Zapata Engineering, Schofield barracks, Oahu, HI, dig team member clearing surface and sub-surface of UXO/CWM.
Jan 11 – Aug 11	UXO Tech I, Zapata Engineering, Schofield Barracks, Oahu, HI, team member clearing UXO/CWM from surface and sub-surface, clearance and disposal.
Apr 12 – Oct 12	UXO Tech II, Weston Solutions, Tobyhanna, PA, team member clearing UXO anomalies surface and sub-surface, demo team member and heavy equipment operator.
Sep 12 – Nov 12	UXO Tech II, Zapata Engineering, Schofield Barracks, Oahu, HI, team member clearing grids of UXO and demo team member.
Nov 12 – Dec 12	UXO Tech II, Zapata Engineering, Fort Benning, GA, team member clearing old target range surface and sub-surface using Schonstedts.
Apr 13 – Nov 13	UXO Tech II, Weston Solutions, Tobyhanna, PA, dig team member clearing surface and sub-surface of UXO anomalies, heavy equipment operator and demo team member.
Jan 14 – Mar 14	UXO Tech II, Weston Solutions, Makua Valley, HI, dig team member clearing surface and sub-surface of UXO using Whites all metal detectors.
May 14 – Sep 14	UXO Tech, II Weston Solutions, Tobyhanna, PA, dig team member removing UXO from surface and sub-surface, demo team member and heavy equipment operator.

Oct 14 – Oct 14	UXO Tech II, Weston Solutions, Camp Dawson, WV, dig team member requiring DGM targets and working transect lines.
May 15 – Aug 15	UXO Tech ll, Weston Solutions, Long Beach Island, NJ, team member on dredge removing and inspecting heads during dredging operations.
Aug 15 – Aug 15	UXO Tech II, Weston Solutions, Lakehurst Naval Base, NJ, dig team member reacquiring DGM targets investigating and removing UXO from 50 x 50 grids and transects.
Sep 15 – Nov 15	UXO Tech II, Weston Solutions, Hope, AR, Southwest Proving Grounds, reacquiring targets selected from metal mapping data, using Schonstedt and CEIA all metal detectors also used Leica rover for pinning locations of anomalies.
Nov 15 – Nov 15	UXO Tech II, Weston Solutions, Lakehurst, NJ, completed fieldwork in grids of UXO removal on DGM targets.
Nov 15 – Dec 15	UXO Tech II, Weston Solutions, Long Beach Island, NJ, team member on dredge inspecting and removing UXO from dredge heads during dredging operations.
Feb 16 – Mar 16	UXO Tech II, Weston Solutions, Hurlburt Field, Eglin AFB, FL, UXO escort for sampling of water and soil, and for sample well locations.
Apr 16 – Apr 16	UXO Tech II, Weston Solutions, Nansemond, VA, team member clearing grids and transects of UXO on DGM required targets.
Apr 16 – Aug 16	UXO Tech II, Weston Solutions, Long Beach Island, NJ, team member removing UXO and inspecting heads during dredging operations.
Aug 16 – Sep 16	UXO Tech II, Weston Solutions, Aberdeen Proving Grounds, MD, team member clearing grids on the proving grounds using Schonstedt and Whites all metal detectors of UXO anomalies.

Total Civilian UXO Experience: 6 Years, 5 Months

CERTIFICATE OF COMPLETION

This certificate awarded to

Tom Holland

for satisfactory participation in

OSHA 8 Hour Hazwoper Refresher

29 CFR Part 1910.120 - 8 Contact Hour(s)

Certificate 72653 awarded on May 8, 2016.

Eduwhere

Your compliance connection.

Joni White

Eduwhere

Eduwhere · PO Box 4704 · Chapel Hill, NC 27515 · www.eduwhere.com · (919) 246-4847

WESTON SOLUTIONS®

Restoring Resource Efficiency

This Certifies That

TOMMY HOLLAND

Has Completed the

First Aid/ CPR/AED Initial

completed on 08/22/2016 in Belcamp, MD

INSTRUCTOR

Lawrence J. Werts III

1331_17389_08222016 *Weston Solutions, Inc • 1400 Weston Way • West Chester, PA • 19380*

06P-0910-2

TEXAS ENGINEERING EXTENSION SERVICE

The Texas A&M University System

TEEX

TRAIN ▪ SERVE ▪ RESPOND

Tom Holland

has successfully completed

Unexploded Ordnance Technician Level I

Bryan, TX

200 Hours

May 19 - June 20, 2008

Gary F. Sera, Director
Texas Engineering Extension Service

Thomas N. Shehan, Division Director
Public Safety and Security

200 0006

State Board for Educator Certification #500132

WorkCare™ Making Health Count

WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: Annual Exam
EXAM CLASSIFICATION: Periodic Examination
PLACE OF EXAMINATION: 3803 - ST. LUKE'S HOSPITAL OCC HEALTH

EMPLOYEE:	Holland, Tom	**COMPANY:**	Weston Solutions, Inc
ID:	020563	**POSITION:**	UXO Tech II
DATE OF EXAM:	04/10/2014	**LOCATION:**	Weston-West Chester (Federal)
EXPIRATION DATE:	04/10/2016	**SITE:**	

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

	Yes	No	Undecided
Has the employee any detected medical conditions that would increase his/her risk of material health impairment from occupational exposure in accordance with 29 CFR §1910.120?	☐	☒	☐
Does the employee have any limitations in the use of respirators in accordance with 29 CFR §1910.134?	☐	☒	☐

STATUS

☒ **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

☐ **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

☐ **NOT QUALIFIED**

☐ **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Irene L. Grace, M.D. Date: 04/16/14

Signature: Irene L. Grace, MD

THE NATIONAL ENVIRONMENTAL TRAINERS

certify that

Tom Holland

has satisfactorily passed an exam and completed a 40 hour training course entitled
Hazardous Waste Operations and Emergency Response
meeting the requirements identified in Title 29 CFR 1910.120 (OSHA HAZWOPER Regulations).
This course has been awarded 5.0 Industrial Hygiene CM Points by the American Board of Industrial Hygiene-Approval Number 13334. This course is eligible for 3.33 Continuance of Certification (COC) points from the Board of Certified Safety Professionals.

NATIONAL ENVIRONMENTAL TRAINERS, Inc.

June 16, 2008

Course Number 1003, Awarded 40 PDH's
Florida Board of Professional Engineers CEU Provider Number 0004284

www.nationalenvironmentaltrainers.com

Signature of Instructor

Clay A. Bednarz, MS, RPIH

Aaron A. Martinez

Graduated Basic EOD/UXO School: Aug 11
40-Hour HAZWOPER: Aug 11
30-Hour Construction Safety: Aug 12
8-Hour Refresher: May 16

Military EOD Experience

.

Total Military EOD Experience: 0 Years, 0 Months

Civilian UXO Experience

Aug 11 – Nov 11	UXO Tech I, Aerotek, Waikane Valley, HI, RA
Nov 11 – Dec 11	UXO Tech I, URS, Beale AFB Yuba City, CA, SI
Jan 12 – Aug 12	UXO Tech 1, Bay West, Inc., Arnold AFB Manchester, TN, RI
Aug 12 – Oct 12	UXO Tech I, Chimera Enterprises, Davis-Monthan AFB, AZ, SI
Oct 12 – Jan 13	UXO Tech I, Chimera Enterprises, Former Lowry Bombing and Gunnery Range Jeep/Demolition Range, CO, RA
Jan 13 – May 13	UXO Tech I, EA Engineering, Arnold AFB, TN, RI
May 13 – Oct 13	UXO Tech I, Bay West, Inc., F.E. Warren AFB,WY, RA
Nov 13 – Dec 13	UXO Tech I, Bristol Environmental, Ft. Huachuca, AZ, SI
Jan 14 – Apr 14	UXO Tech I, Bristol Environmental, Camp Lejune Jacksonville, NC, SI
May 14 – Feb 15	UXO Tech I, Bay West LLC, Cornhusker Army Ammunition Plant, NE, MEC Removal
Mar 15 – Apr 15	UXO Tech I, Bay West LLC, Eglin AFB, FL, CSE PH II
May 15 – Jul 15	UXO Tech I, Bay West LLC, Eareckson AS, AK, RI
Aug 15 – Sep 15	UXO Tech II, EA Engineering, Ft. Meade, MD, RA
Sep 15 – Oct 15	UXO Tech II, EA Engineering, Los Alamos National Laboratory, NM, RA
Nov 15 – Apr 16	UXO Tech II, Bay West LLC, Edwards AFB, CA, CSE PH II and RI
Apr 16 – Sep 16	UXO Tech II, Bay West LLC, Eglin AFB, FL CSE PH II

Total Civilian UXO Experience: 5 Years, 2 Months

UXO GLOBAL

AARON A. MARTINEZ

having completed the necessary 200 hours of study and having satisfied all requirements in accordance with Department of Defense Explosives Safety Board Technical Paper 18 is hereby declared a certified

UXO TECHNICIAN LEVEL 1

and is awarded this certificate with all the honors and privileges pertaining thereto.

In testimony whereof the signatures of the Instructor, Lead Instructor, and Director of Training have been affixed this day, August 5, 2011

"Incendia In Aula"

Instructor, Phillip R. Clark

Lead Instructor, John Galinaitis

Director of Training, D. Kevin Cooper

Certificate of Completion

This certifies that

Aaron Martinez

Has Successfully completed

OSHA 40 Hour HAZWOPER Training

Annual Refresher Training Required

In Accordance With Federal OSHA Regulation 29 CFR 1910.120

And all State OSHA and EPA Regulations As Well

Julius P. Griggs	110728147821	7/28/2011
Julius P. Griggs Instructor #892	Certificate Number	Issue Date

SAFETY UNLIMITED, Inc.
OSHA Compliant Safety Training Since 1993

690A East Los Angeles Ave Suite 180 Simi Valley, CA 93065
888-309-7233 * 805-306-8027 * 866-869-7097 (F)
www.safetyunlimited.com

Want to be sure this certificate is valid? Visit safetyunlimited.com/verification

Certificate of Completion

This certifies that

Aaron Martinez

Has Successfully completed

8 Hour HAZWOPER Refresher Training

Refresher certification does NOT necessarily indicate initial 24 or 40 Hour HAZWOPER certification

In Accordance w/Federal OSHA Regulation 29 CFR 1910.120(e) & (p)

And all State OSHA and EPA Regulations As Well

This course (Version 2) is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) issued by Safety Unlimited, Inc. (Accreditation # 044).

Julius P. Griggs	**160503547821**	**5/3/2016**
Julius P. Griggs Training Director	Certificate Number	Issue Date

SAFETY UNLIMITED, Inc.
OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley, CA 93063
888 309-SAFE (7233) or 805 306-8027 866-369-7097 (fax)
www.safetyunlimited.com

Proof of initial certification and subsequent refresher training is NOT required to take refresher training

Want to be sure this certificate is valid? Visit safetyunlimited.com/verification

Certificate of Acheivement

Presented to

Aaron Martinez

In recognition for completing Earth Moving Machinery

Excavator Safety and Operations Training

On the Link Belt and Caterpillar Excavators, F.E.L's and Dumps up 30ton

Bay West

Customer-Focused Environmental & Industrial Solutions

Instructor

Ben Suissa

WorkCare™
MAKING HEALTH COUNT

WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: **Annual Exam**
EXAM CLASSIFICATION: **Periodic Examination**

EMPLOYEE:	**Martinez, Aaron**	**COMPANY:**	**Bay West, Inc.**
ID:		**POSITION:**	**UXO Tech I**
DATE OF EXAM:	**02/15/2016**	**LOCATION:**	**Bay West - Saint Paul, MN**
EXPIRATION DATE:	**02/15/2017**	**SITE:**	

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

	Yes	No	Undecided
Has the employee any detected medical conditions that would increase his/her risk of material health impairment from occupational exposure in accordance with 29 CFR §1910.120 (Hazwoper)?	☐	☒	☐
Has the employee any limitations in accordance with 29 CFR §1910.134 (Respirator)?	☐	☒	☐

STATUS

☒ **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

☐ **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

☐ **NOT QUALIFIED**

☐ **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Peter P. Greaney, MD / Scott Hardy, MD Date: 02/18/16

Signature: _____

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

Dennis J. Littfin

Graduated Basic EOD/UXO School: Nov 07
40 Hour HAZWOPER: Feb 88
8 Hour Refresher: Nov 15
8 Hour Supervisor: Mar 94
CPR: Nov 14
First Aid: Nov 14

Military EOD Experience

Total Military EOD Experience: 0 Years, 0 Months

Civilian UXO Experience

Apr 09 – Jan 11	UXO Tech I, Bay West, Inc., Eglin AFB, Florida, CSE Phase II & SI
Jan 11 - Apr 11	UXO Tech I, Bay West, Inc., Fort Riley, KS, RI
May 11 – May 11	UXO Tech I, Bay West, Inc., (Pittsburgh Various), CSE Phase I/II
Jul 11 – Aug 11	UXO Tech I, Bay West, Inc., Arnold AFB, TN, RI
Aug 11 – Nov 11	UXO Tech I, Bay West, Inc., Former Mather AFB, CA, MMR Actions
Jan 12 – Apr 12	UXO Tech I, Bay West, Inc., Arnold AFB, TN, RI
May 12 – Jul 12	UXO Tech I, Bay West, Inc., Eareckson AS, AK, NTCRA/RI
Jul 12 – Aug 12	UXO Tech I, Bay West, Inc., Minot AFB, ND, RA & RI
Nov 12 – Jul 14	UXO Tech I, Bay West LLC, Eglin AFB, FL, CSE Phase II
Jul 14 – Feb 15	UXO Tech II, Bay West LLC, Cornhusker Army Ammunition Plant, NE, MEC Removal
Mar 15 – Apr 15	UXO Tech II, Bay West LLC, Eglin AFB, FL, CSE PH II
May 15 – Jul 15	UXO Tech II, Bay West LLC, Eareckson AS, AK, RI
Aug 15 – Aug 15	UXO Tech II, Bay West LLC, Campion AS, AK, TCRA
Sep 15 – Sep 15	UXO Tech II, Bay West LLC, Camp Withycombe, OR, TCRA
Oct 15 – Nov 15	UXO Tech II, Bay West LLC, Ft. Riley, KS, RI
Nov 15 – Mar 16	UXO Tech II, Bay West LLC, Edwards AFB, CA, RI and CSE PH II
Apr 16 – Sep 16	UXO Tech II, Bay West LLC, Eglin AFB, FL CSE PH II
Sep 16 – Sep 16	UXO Tech II, Bay West LLC, USAFA, CO RA

Total Civilian UXO Experience: 7 Years, 2 Months

TEXAS ENGINEERING EXTENSION SERVICE

The Texas A&M University System

TRAIN ▪ SERVE ▪ RESPOND

Dennis J. Littfin

has successfully completed

Unexploded Ordnance Technician Level I

Bryan, TX

200 Hours

October 15 - November 16, 2007

Gary F. Sera, Interim Director
Texas Engineering Extension Service

Thomas N. Shehan, Division Director
Public Safety and Security

THIS CERTIFIES THAT

DENNIS LITTFIN

has completed the continuing education course entitled

Safety and Health Training for Hazardous Waste Site Personnel
February 8-12, 1988, Earle Brown Center, University of Minn.

Fulfills OSHA regulatory requirements (29 CFR 1910.120) as mandated under the "Superfund Amendments and Reauthorization Act of 1986" (SARA).

given by the

Midwest Center for Occupational Health & Safety

Program in Continuing Education — Occupational Health

CEU'S : 4.0

Meets requirements of the American Board of Industrial Hygiene for:
-2.0 Maintenance of Certification Points.

A NIOSH Sponsored Educational Resource Center

Course Director

CERTIFICATE
of TRAINING

This certifies that

DENNIS LITTFIN

Has successfully completed the training program requirement for

CONFINED SPACE/LOCK OUT-TAG OUT

29 CFR 1910.146/29 CFR 1910.147/29 CFR 1910.132

Topics Covered: Definition of a Confined Space, entry, duties of attendant/supervisor/entrant/rescue, dangers, recognition, atmospheric monitoring, permits, Lock Out Tag Out.
Hands On and Written Examination.

EX Environmental, Inc.
648 Commerce Drive PO Box 222
Hudson, WI 54016
www.exenvironmental.com

November 122, 2013
DATE

TED BEYER, INSTRUCTOR

Certificate of Completion

8 Hour HAZWOPER Refresher Training

29 CFR 1910.120/29 CFR 1926.65

This is to certify completion of 8 Hour Hazardous Waste Operations and Emergency Response Refresher Training
November 13, 2015

Dennis Littfin

Topics Covered:
HAZWOPER Standard, History, Acts, Scope and Application. Chemistry & Toxicology, DOTERG, NIOSH Pocket Guide, Hazard Communication, Identification, Evaluation and Control, Personal Protective Equipment, Donning, Doffing, Decontamination, Respiratory Protection, Confined Space Entry & Rescue, Lockout/Tagout, Air Monitoring, Incident Command, Written Examination & Testing,

Ex Safety LLC
PO Box 468 Hudson, WI 54016
tbeyer@pressenter.com 715-220-5188 www.exsafetyguru.com
Ted Beyer, Instructor

T Beyer

A.R.K. Management Associates
14636 Hampshire Place
Burnsville, Minnesota 55306
612-435-8890

Dennis Littfin
Bay West
St Paul, MN

March 17, 1998

Dear Mr Littfin;

In accordance with the Department of Labor, Occupational Safety and Health Administration, OSHA standards, Subpart P Excavations 1926.650, I certify that you have attended a "Competent Person" training program. The scope of the training program is as listed below:

1. Understanding of definitions applicable to subpart P
2. Understanding of the general requirements section-1926.651,
3. Understanding of requirements for protective systems section-1926.652
   A. Protection of employees in excavations
   B. Design of sloping and benching systems
   C. Design of support systems, shield systems and other protective systems.
   D. Materials and equipment
   E. Installation and removal of support systems.

4. A understanding of soil classification
   A. Definitions of soils
   B. Understanding types of soils
   C. Actual working with soils, using acceptable methods for visual and manual testing to determine soil classifications.
   D. Understanding visual checks for a safe excavation

5. A understanding of the maximum allowable slopes and how to apply allowable slopes to types of soils. Working with the various slope tables as they apply to different types of soils.

With the knowledge given to you, in soils analysis and the requirements of subpart P, and constant alertness to the elements around your project, you should be able identify any existing or predictable hazards in your excavation work. You should have with you at all times on the project, your work book, to refer to in case of any questions.

Arnold R Kraft CSP
ARK Management Associates

WorkCare™
MAKING HEALTH COUNT

WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: **Annual Exam**
EXAM CLASSIFICATION: **DOT Exam**

EMPLOYEE: **Littfin, Dennis**
ID:
DATE OF EXAM: **10/23/2015**
EXPIRATION DATE: **10/23/2017**

COMPANY: **Bay West, Inc.**
POSITION: **Geologist**
LOCATION: **Bay West - Saint Paul, MN**
SITE:

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

STATUS

[X] **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

[ ] **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

[ ] **NOT QUALIFIED**

[ ] **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Peter P. Greaney, M.D. _____ Date: 10/29/15

Signature: Peter P Greaney MD

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

WorkCare™
MAKING HEALTH COUNT

WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: **Annual Exam**
EXAM CLASSIFICATION: **Periodic Examination**

EMPLOYEE:	**Littfin, Dennis**	**COMPANY:**	**Bay West, Inc.**
ID:		**POSITION:**	**Geologist**
DATE OF EXAM:	**10/23/2015**	**LOCATION:**	**Bay West - Saint Paul, MN**
EXPIRATION DATE:	**10/23/2016**	**SITE:**	

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

	Yes	No	Undecided
Has the employee any detected medical conditions that would increase his/her risk of material health impairment from occupational exposure in accordance with 29 CFR §1910.120 (Hazwoper)?	☐	☒	☐
Has the employee any limitations in accordance with 29 CFR §1910.134 (Respirator)?	☐	☒	☐

STATUS

☒ **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

☐ **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

☐ **NOT QUALIFIED**

☐ **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Peter P. Greaney, M.D. _____ Date: 10/29/15

Signature: Peter P Greaney MD

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

Certificate of Completion

This is to certify completion 1st Aid, CPR, BBP, AED
Training on
November 13, 2015

Dennis Littfin

Testing Administered
Course Outline: 1st Aid, CPR, BBP, AED, Universal Precautions, Dieease signs and symptoms, exposure, prevention and control. Personal Protective Equipment, Demonstration of Donning Doffing, Decontamination.

Ex Safety LLC
P O Box 468, Hudson, WI 54016
715.220.5188
Theodor J. Beyer, Instructor

T Beyer

© Gartner Studios

Haydn King

Graduated UXO School: Mar 2011
40 Hour HAZWOPER: Mar 2011
8 Hour Refresher: Feb 16
CPR: Mar 15
First Aid: Mar 15

Military EOD Experience

Total Military EOD Experience: 0 Years, 0 Months

Civilian UXO Experience

Jun 11 – Aug 11	UXO Tech I, Tetra Tech, Delta Range, Delta, CO, RI and RA
Sep 11 – Sep 11	UXO Tech I, Tetra Tech, Lowry Range, Denver, CO, AA
Oct 11 – Nov 11	UXO Tech I, Bay West, Mather Air Force Base, CA, MR and SI
Nov 11 – Dec 11	UXO Tech I, Bay West, Fort Leavenworth, KS, IRA
Dec 11 – Jun 12	UXO Tech I, Bay West, Luke Air Force Base, Sentinel, AZ, RA
Jun 12 – Jul 12	UXO Tech I, SERES, Deseret Chemical Depot, Tooele, UT, SI and RA
Aug 12 – Sep 12	UXO Tech I, Weston Solutions Inc. Yuma Proving Grounds, AZ, SI and RA
Nov 12 – Sep 14	UXO Tech I, Bay West, Eglin AFB, FL, CSE Phase II and Supplemental Investigation
Sep 14 – Oct 14	UXO Tech I, Bay West, Campion AS, AK, RI
Mar 15 – Apr 15	UXO Tech I, Bay West LLC, Eglin AFB, FL, CSE PH II
May 15 – Jul 15	UXO Tech I, Bay West LLC, Eareckson AS, AK, RI
Aug 15 – Aug 15	UXO Tech I, Bay West LLC, Campion AS, AK, TCRA
Oct 15 – Oct 15	UXO Tech II, Bay West LLC, Salton Sea Test Base, CA, SI
Oct 15 – Nov 15	UXO Tech II, Bay West LLC, Ft. Riley, KS, RI
Nov 15 – Mar 16	UXO Tech II, Bay West LLC, Edwards AFB, CA, CSE PH II & RI
Apr 16 – Sep 16	UXO Tech II, Bay West LLC, Eglin AFB, FL CSE PH II

Total Civilian UXO Experience: 4 Years, 10 Months

UXO GLOBAL

HAYDN C. KING

having completed the necessary 200 hours of study and having satisfied all requirements in accordance with Department of Defense Explosives Safety Board Technical Paper 18 is hereby declared a certified

UXO TECHNICIAN LEVEL 1

and is awarded this certificate with all the honors and privileges pertaining thereto.

In testimony whereof the signatures of the Instructor, Lead Instructor, and Director of Training have been affixed this day. March 18, 2011

"Incendia In Aula"

Instructor, Phillip R. Clark	Lead Instructor, John Galinaitis	Director of Training, D. Kevin Cooper

BOULDER SEAL 2005 COLORADO

UXO GLOBAL

HAYDN C. KING

having completed the necessary 40 hours of study and having satisfied all requirements in accordance with 29 CFR 1910.120(q) & (e) is hereby declared a certified

HAZARDOUS WASTE OPERATOR

and is awarded this certificate with all the honors and privileges pertaining thereto. In testimony whereof the signatures of the Lead Instructor and Director of Training have been affixed this day, March 18, 2011.

"Subsisto Tutus"

Director of Training, D. Kevin Cooper

Lead Instructor, John Galinaitis

CLICKSAFETY®

certifies that

HAYDN KING

has successfully completed

Hazwoper Refresher 2016

and has earned 0.8 IACET CEUs and 8 Contact Hours.

I confirm that I personally took the course listed above.

STUDENT SIGNATURE

AUTHORIZED IACET PROVIDER

16566224	2/13/2016	8.25 HOURS
SERIAL NUMBER	COMPLETION DATE	COURSE DURATION

16566224

American Red Cross

Haydn King

has successfully completed requirements for

Adult and Pediatric First Aid/CPR/AED: valid 2 Years

Date Completed: 03/03/2015

conducted by: American Red Cross

Instructor: Alonzo B Hunter

ID: 0WINAX

Scan code or visit:

redcross.org/confirm

WorkCare
MAKING HEALTH COUNT

WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: **Annual Exam**
EXAM CLASSIFICATION: **Periodic Examination**

EMPLOYEE:	**King, Haydn**	**COMPANY:**	**Bay West, Inc.**
ID:		**POSITION:**	**UXO Tech**
DATE OF EXAM:	**02/25/2016**	**LOCATION:**	**Bay West - Saint Paul, MN**
EXPIRATION DATE:	**02/25/2017**	**SITE:**	

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

	Yes	No	Undecided
Has the employee any detected medical conditions that would increase his/her risk of material health impairment from occupational exposure in accordance with 29 CFR §1910.120 (Hazwoper)?	☐	☒	☐
Has the employee any limitations in accordance with 29 CFR §1910.134 (Respirator)?	☐	☒	☐

STATUS

☒ **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

☐ **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

☐ **NOT QUALIFIED**

☐ **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Peter P. Greaney, M.D. Date: 03/01/16

Signature: Peter P Greaney MD

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

Ryan W. Shetrom

Graduated Basic EOD/UXO School: Nov 08
40 Hour HAZWOPER: Nov 08
8 Hour Refresher: Jan 16

Military EOD Experience

Total Military EOD Experience: 0 Years, 0 Months

Civilian UXO Experience

Dec 08 – Feb 10	UXO Tech I, Aerotek, Ft. McClellan, AL, MEC Remediation
Mar 10 – Apr 10	UXO Tech I, Bay West, Hurlburt Field, FL, CSE PH II
Apr 10 – Jun 10	UXO Tech I, OER Inc., Ft. Ritchey, MD, Base Realignment and Closure Site
Jun 10 – Nov 10	UXO Tech I, Bay West, Eglin AFB, FL, CSE Phase II
Dec 10 – Dec 10	UXO Tech I, OER Inc., Bridgeport, CT, Electro demo Operation
Jan 11 – Apr 11	UXO Tech I, Bay West, Arnold AFB, TN, RI
Apr 11 - Dec 11	UXO Tech I, Weston Solutions Inc., Tobyhanna ARMY Depot, RA
Jan 12 – Jun 12	UXO Tech II, Bay West, Luke AFB, AZ, RA
Jun 12 – Aug 12	UXO Tech II, AMEC Inc., Ft. McClellan, AL, RA
Nov 12 – Jul 14	UXO Tech II, Bay West, Eglin AFB, CSE Phase II/MEC removal
Aug 14 – Feb 15	UXO Tech II, Bay West LLC, Cornhusker Army Ammunition Plant, NE, MEC Removal
Mar 15 – Apr 15	UXO Tech II, Bay West LLC, Eglin AFB, FL, CSE PH II
May 15 – Sep 15	UXO Tech II, Bay West LLC, Camp Withycombe, OR, TCRA
Nov 15 – Mar 16	UXO Tech II, Bay West LLC, Edwards AFB, CA, CSE PH II and RI
Apr 16 – Sep 16	UXO Tech II, Bay West LLC, Egin AFB, FL, CSE PH II

Total Civilian UXO Experience: 7 Years, 7 Months

TEXAS ENGINEERING EXTENSION SERVICE

The Texas A&M University System

TRAIN ▪ SERVE ▪ RESPOND

Ryan W. Shetrom

has successfully completed

Unexploded Ordnance Technician Level I

Bryan, TX

200 Hours

October 13 - November 14, 2008

Gary F. Sefa, Director
Texas Engineering Extension Service

Thomas N. Shehan, Division Director
Public Safety and Security

0 0008

State Board for Educator Certification #500132

TEXAS ENGINEERING EXTENSION SERVICE

The Texas A&M University System

TRAIN • SERVE • RESPOND

Ryan W. Shetrom

has successfully completed

Hazwoper for Clean-Up Operations Training

conducted in cooperation with

Emergency Services Training Institute

Taught In Accordance With 29 CFR 1910.12(e)(3)

November 17 - 21, 2008
40 Hours

Gary F. Sera, Director
Texas Engineering Extension Service

Les Bunte, Division Director
Emergency Services Training Institute

Instructor
Emergency Services Training Institute
State Board for Educator Certification #500132

15 0010

CLICKSAFETY®

certifies that

RYAN SHETROM

has successfully completed ClickSafety's web-based training course:

Hazwoper Refresher 2016

This course was developed and presented by ClickSafety.com, Inc.

I confirm that I personally took the course listed above.

16145919	1/1/2016	14.25 HOURS	
SERIAL NUMBER	COMPLETION DATE	COURSE DURATION	STUDENT SIGNATURE

16145919

WorkCare™
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WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: **Annual Exam**
EXAM CLASSIFICATION: **DOT Exam**

EMPLOYEE:	**Shetrom, Ryan**	**COMPANY:**	**Bay West, Inc.**
ID:		**POSITION:**	**UXO Tech II**
DATE OF EXAM:	**01/26/2016**	**LOCATION:**	**Bay West - Saint Paul, MN**
EXPIRATION DATE:	**01/26/2018**	**SITE:**	

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

STATUS

[X] **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

[ ] **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

[ ] **NOT QUALIFIED**

[ ] **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Peter P. Greaney, M.D. Date: 02/01/16

Signature: Peter P Greaney MD

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

WorkCare
MAKING HEALTH COUNT

WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: **Annual Exam**
EXAM CLASSIFICATION: **Periodic Examination**

EMPLOYEE:	**Shetrom, Ryan**	**COMPANY:**	**Bay West, Inc.**
ID:		**POSITION:**	**UXO Tech II**
DATE OF EXAM:	**01/26/2016**	**LOCATION:**	**Bay West - Saint Paul, MN**
EXPIRATION DATE:	**01/26/2017**	**SITE:**	

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

	Yes	No	Undecided
Has the employee any detected medical conditions that would increase his/her risk of material health impairment from occupational exposure in accordance with 29 CFR §1910.120 (Hazwoper)?	☐	X	☐
Has the employee any limitations in accordance with 29 CFR §1910.134 (Respirator)?	☐	X	☐

STATUS

X **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

☐ **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

☐ **NOT QUALIFIED**

☐ **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Peter P. Greaney, M.D. Date: 02/01/16

Signature: Peter P Greaney MD

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

Joshua A. Bair

Graduated Basic EOD/UXO School: May 13
40 Hour HAZWOPER: Apr 13
8 Hour Refresher: May 16

Military EOD Experience

Total Military UXO Experience: 0 years, 0 months

Civilian UXO Experience

June 13 – July 13	UXO Tech I, Pika International Inc., Ft. Carson, CO, RA
July 13 – Feb 14	UXO Tech I, Pika International Inc., Ft. Stewart, GA, RA
June 14 – Aug 14	UXO Tech I, Weston Solutions Inc., Volk Field, WI, RI
Oct 14 – May 15	UXO Tech I, EOTI, Ft. Chaffee, AR, RA
June 14 – Aug 14	UXO Tech I, Weston Solutions Inc., Volk Field, WI, RI
July 13 – Feb 14	UXO Tech I, Pika International Inc., Ft. Stewart, GA, RA
June 13 – July 13	UXO Tech I, Pika International Inc., Ft. Carson, CO, RA

Civilian UXO Experience: 2 years, 5 months

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a service of

THE UNIVERSITY of TENNESSEE

Awards to

Joshua Bair

Certificate of Completion for the

40-Hour Site Worker Course

Date of Completion: 4/5/2013

Certificate Number: IP04021340H10

administered by The University of Tennessee

Center for Industrial Services

and The Mid-West Consortium

for Hazardous Waste Worker Training

Refresher training documentation or an updated statement of employee competency must be on file with the employer by one year from completion date. 4.0 CEUs or 40 PDHs

Walter Idol, Instructor

Employer Certification

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THE UNIVERSITY of TENNESSEE

Awards to

Joshua Bair

Certificate of Completion for the

Backhoe Operator Safety Course

administered by The University of Tennessee
Center for Industrial Services

Date of Completion: 4/8/2013
Certificate Number: IP040813BHS01

6 Contact Hours

Walter Idol, Instructor
The University of Tennessee Center for Industrial Services
...an agency of The University of Tennessee's
Institute for Public Services

UT | CIS

Center for Industrial Services

A NIST MEP Affiliate

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THE UNIVERSITY of TENNESSEE

Awards to

Joshua Bair

Certificate of Completion for the

Fork Lift Operator Safety Course

administered by The University of Tennessee
Center for Industrial Services

Date of Completion: 4/9/2013
Certificate Number: IP040913FLS01

6 Contact Hours

Walter Idol, Instructor
The University of Tennessee Center for Industrial Services
...an agency of The University of Tennessee's
Institute for Public Services

The University of Tennessee

Knoxville, Tennessee

Conferences and Non-Credit Programs

certifies that

Joshua Adam Bair

has satisfactorily completed the requirements prescribed for the

Unexploded Ordnance Technician Level 1

conducted by The University of Tennessee
in cooperation with Relyant.

RELYANT
A PROMISE DELIVERED

Daniel Smith, President & CEO
RELYANT

May 17, 2013
Date

THE UNIVERSITY of TENNESSEE
Professional Development Programs

Robert Gibbs, Executive Director
Conferences & Non-Credit Programs

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Release to Duty

Clinic Instructions:
Please complete the following form and give to employee before they leave the facility.

Date: 4-4-16

Employee Name: Joshua Bair

Clinic Name: USH

Company Name: Western Solutions Inc

Company Location: West Chester, PA

Complete only if applicable:

To work with hazardous materials in accordance with 29 CFR 1910.120 ☑ Yes ☐ No

To use respiratory protective equipment in accordance with 29 CFR 1910.134 ☑ Yes ☐ No

Based on the limited information WorkCare has requested me to review, I find no necessity for immediate restrictions and I release this employee for duty. It is understood and agreed upon by the employer or potential employer of this examinee that subsequent comprehensive review of all laboratory and other test data by WorkCare, may detect health conditions not apparent to me. It is further agreed that such health conditions may necessitate the need for workplace restrictions. Examination has been performed in compliance with 1910.120 and 1910.134.

Signed: Robert J. Csorba, D.O. M.D./D.O.

Date: 4-4-2016

300 S. Harbor Blvd., Ste. 600 • Anaheim, CA 92805 • (800) 455-6155 • Fax: (714) 456-2154
1320 Harbor Bay Parkway, #115 • Alameda, CA 94502 • (510) 748-6900 • Fax: (510) 748-6915
info@workcare.com • www.workcare.com

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United States Department of Labor

Occupational Safety and Health Administration
Southeastern OSHA Training Institute Education Center
North Carolina State University and the University of Tennessee

This is to certify that on

APRIL 9, 2013

Joshua Bair

Has diligently and with merit completed training in

OTI #7300:
OSHA's Permit-Required Confined Space Standard

Southeastern OSHA Training Institute Education Center

Director, OSHA Training Institute

Program Manager, Southeastern OTI Education Center

JKO

JOINT KNOWLEDGE ONLINE

Joshua Bair

has successfully completed

JS-US007 Level I Antiterrorism Awareness Training

05/20/2015

J.D. Camacho, GS-15
Chief, Joint Knowledge Online Division
Deputy Director Joint Training, JS J7

Appendix B

Quality Assurance Project Plan (QAPP)

SAMPLING AND ANALYSIS PLAN

PART II

Quality Assurance Project Plan

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Attachment 5: Laboratory Standard Operating Procedures

ACRONYMS AND ABBREVIATIONS

°C ..... degrees Celsius
% ..... percent
ARAR ..... Applicable or Relevant & Appropriate Requirement
ASTM ..... American Society for Testing and Materials
Bay West ..... Bay West LLC
BER ..... Bureau of Environmental Remediation
CCV ..... Continuing Calibration Verification
CERCLA ..... Comprehensive Environmental Response, Compensation, and Liability Act
COC ..... Chain-of-Custody
CPSS ..... Certified Professional Soil Scientist
CQCO ..... Chemical Quality Control Officer
DCQCR ..... Daily Chemical Quality Control Report
DERP ..... Defense Environmental Restoration Program
DL ..... Detection Limit
DQO ..... Data Quality Objective
DMM ..... Discarded Military Munitions
DoD ..... Department of Defense
EDD ..... Electronic Data Deliverable
EM ..... Engineer Manual
FQCC ..... Field Quality Control Coordinator
FUDS ..... Formerly Used Defense Sites
HDPE ..... high-density polyethylene
HPLC ..... high performance liquid chromatography
IAW ..... in accordance with
ICAL ..... Initial Calibration
ID ..... Identification
IDL ..... Instrument Detection Limit
ISM ..... Incremental Sampling Methodology
KDHE ..... Kansas Department of Health and Environment
LCS ..... Laboratory Control Sample
LCSD ..... Laboratory Control Sample Duplicate
LIMS ..... Laboratory Information Management Systems
LOD ..... limit of detection
LOQ ..... limit of quantitation
MC ..... munitions constituents
MD ..... munitions debris
DL ..... Detection Limit
MEC ..... munitions and explosives of concern
mL ..... milliliter
MMRP ..... Military Munitions and Response Program
MQL ..... Method Quantification Limit
MRS ..... Munitions Response Site
MS ..... Matrix Spike
MSD ..... Matrix Spike Duplicate
NFG ..... National Functional Guideline
NIST ..... National Institute of Standards and Technology
NR ..... not required
oz ..... ounce(s)
PG ..... Professional Geologist
PE ..... Performance Evaluation
PE ..... Professional Engineer
PRG ..... Preliminary Remediation Goal
QA ..... Quality Assurance
QAPP ..... Quality Assurance Project Plan
QAM ..... Quality Assurance Manual
QC ..... Quality Control
QSM ..... Quality Systems Manual
REC ..... recovery
RI/FS ..... Remedial Investigation/Feasibility Study
RF ..... Response Factor
RPD ..... Relative Percent Difference
RSD ..... Relative Standard Deviation
RSK ..... Risk-Based Standards for Kansas
SARM ..... Standard Analytical Reference Materials
SEDD ..... Staged Electronic Data Deliverable
SI ..... Site Inspection
SOP ..... Standard Operating Procedure
TestAmerica . TestAmerica, Inc. of Denver, Colorado
TO ..... Task Order
USACE ..... United States Army Corps of Engineers
USDOE ..... U.S. Department of Education
USEPA ..... U.S. Environmental Protection Agency
UXO ..... unexploded ordnance

1.0 PROJECT DESCRIPTION

Bay West LLC (Bay West) prepared this Quality Assurance Project Plan (QAPP) in accordance with (IAW) the content and format presented in Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; United States Environmental Protection Agency [USEPA], 1998a), and EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5 (USEPA, 1998b). This QAPP defines the general procedures that will be observed in any sample collection and analysis as part of a Military Munitions and Response Program (MMRP) Remedial Investigation/Feasibility Study (RI/FS) at a 28.3-acre munitions response site (MRS) known as the Disposal Area located at the former Strother Field in Crowley County, Kansas (see Figures 1-1, 1-2 and 1-3 in the Work Plan). This work is being performed IAW the Defense Environmental Restoration Program (DERP), Formerly Used Defense Site (FUDS) and MMRP. The United States Army Corps of Engineers (USACE) – Kansas City is performing the RI under USACE – Omaha District Contract W9128F-10-D-0054, Task Order (TO) 0023 (May 2015). The specific details for sampling procedures are outlined in the Work Plan (see Section 6, Field Sampling Plan, which constitutes Part I of the Sampling and Analysis Plan for the RI). This QAPP, Part II of the Sampling and Analysis Plan for the RI, contains necessary technical detail and directions such that laboratory personnel understand all project sample analysis, quality control (QC), and data reporting requirements. This will include detailed descriptions of analytical methods for various analyses, method required detection limits (DLs), and method required QC requirements, data validation, and reporting requirements.

In the Site Inspection (SI) Report (USACE, 2010), further characterization and the addition of the Disposal Area to the MRS inventory was recommended based on munitions debris (MD) items identified during a visual reconnaissance. The number, type, and mixed nature of MD items identified suggest a munitions disposal area, in lieu of either a target range or training area. In addition, none of the MD items identified were confirmed as munitions and explosives of concern (MEC); one item, a portion of an AN-M50 incendiary bomb, was treated as MEC for precautionary measures. The SI did not identify a potential risk from munitions constituents (MC) based on the specific type of MD and potential MEC item discovered. The RI to be completed under TO0023 Performance Work Statement (dated May 2015) will determine the nature and extent of potential MEC and will determine the need for sample collection and subsequent risk evaluation based on results obtained.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Bay West will use TestAmerica, Inc., of Denver, Colorado (TestAmerica), to provide the off-site analytical services required for this project. TestAmerica has developed a Quality Assurance Manual (QAM) to ensure that the clients receive high-quality analytical and environmental services that are timely, reliable, and meet the intended purpose in a cost-effective manner. TestAmerica's QAM Table of Contents is included in **Attachment 1**. Department of Defense (DoD) Environmental Laboratory Accreditation Program and state-certifications for the analyses needed to support the RI are provided in **Attachment 2**.

Bay West has designed its quality assurance (QA)/QC program to ensure that appropriate QA/QC procedures will be implemented during all stages of the project. The key QA/QC personnel and other key project staff are summarized in the following table. Refer to the project Work Plan (see Section 4) for additional personnel not directly involved in the sampling and analysis associated with the MC component of the project.

Table B-1 Project Personnel

Personnel	Project Title	QA/QC Responsibility	Affiliation	Phone/Email
Marty Wangensteen, PE, PG	Program Manager	Management of Environmental Remediation Services Program	Bay West	(651) 291-3475 martyw@baywest.com
Brad Kulberg	QA/QC Manager	Developing, refining, and implementing the Bay West Quality Management Plan and the Chemical QA/QC Plan.	Bay West	(651) 291-3444 bradk@baywest.com
Marie Swiech-Laflamme, PG	Project Manager	Project Management. Responsible for planning and oversight of project.	Bay West	(609) 638-2919 mlaflamme@baywest.com
Eric Malarek	Chemical Quality Control Officer/ Project Chemist	Ensuring that all chemistry-related objectives are attained.	Bay West	(443) 641-0028 emalarek@baywest.com
Terry Bosco, CPSS	Risk Assessment Lead	Completion of human health and ecological risk assessment.	Weston	(224) 864-7200 terry.bosko@westonsolutions.com
Pam Blanton	Field Quality Control Coordinator/MC Sampling Lead	Responsible for overseeing the implementation of chemical QA/QC procedures and sample collection	Bay West	(719) 244-9641 / Cell: (651) 325-5609 pblanton@baywest.com
Michelle Johnston	Laboratory Project Manger	Responsible for overseeing the laboratory performance on this project.	TestAmerica	(303) 736-0110 michelle.johnston@testamericainc.com

PE – Professional Engineer
PG – Professional Geologist
CPSS – Certified Professional Soil Scientist

The Field Quality Control Coordinator (FQCC) will oversee the implementation of QA/QC procedures on a daily basis and will coordinate with the Chemical Quality Control Officer (CQCO) to identify and resolve any issues potentially affecting the quality of chemical data and to ensure the data quality objectives of this project are met. In the event that the FQCC or CQCO cannot resolve an issue, the CQCO will report to the Project Manager. Additional information on roles and responsibilities is presented in Section 4.0 of the Work Plan.

2.1 Chemical Quality Control Officer

Responsibilities of the CQCO and support staff will include, but not be limited to, the following:

- Ensuring compliance with specified data quality objectives (DQOs);
- Maintaining QA management of laboratory chemical data;
- Providing guidance and direction to the FQCC;
- Initiating, reviewing, and following up on corrective actions, as necessary; and
- Consulting with the Program Manager as necessary on appropriate QC measures and corrective actions.

2.2 Field Quality Control Coordinator

The FQCC's responsibilities will include, but not be limited to, the following:

- Consulting with the CQCO as necessary on appropriate QC measures and corrective actions;
- Serving as sample custodian;
- Initiating and following up on corrective actions; and
- Daily Chemical Quality Control Reports (DCQCRs).

3.0 QUALITY ASSURANCE OBJECTIVES

The QA objectives for this project are based on a common understanding of the intended use of the data, available laboratory procedures, and available resources.

3.1 Data Quality Objectives

See Section 3.5 of the Work Plan for the DQOs developed to support the Disposal Area MRS RI.

3.2 QA Objectives for Chemical Data Measurement

Precision: Precision is a measurement of mutual agreement (or variability) among individual measurements of the same property, usually under prescribed similar conditions. The following equation will be used to evaluate the precision:

$$RPD = \frac{S - D}{(S+D)/2} \times 100$$

RPD = Relative Percent Difference
S = first sample value
D = second sample value

Possible QC samples indicative of precision are listed in the following table:

Table B-2 QC Sample Types for Precision

QC Sample Type	Components of Variability Captured (applicable to field and fixed laboratory processes)
Laboratory QC sample duplicates (MS/MSD, LCS/LCSD)	Instrument response, sub-sampling and sample prep, spiking technique, plus laboratory homogenization
Laboratory sample replicate analysis	Instrument response, sub-sampling and sample prep, plus laboratory homogenization
Field replicate	Instrument response, sub-sampling and sample prep, laboratory homogenization, plus sample handling and field homogenization, matrix representativeness
Co-located samples or (field duplicate samples)	Instrument response, sub-sampling and sample prep, laboratory homogenization, plus sample handling, plus field sample acquisition and small scale spatial variability (site)

LCS – Laboratory Control Sample *LCSD – Laboratory Control Sample Duplicate*
MS – Matrix Spike *MSD – Matrix Spike Duplicate*

Precision is usually expressed in terms of the relative standard deviation or RPD, but can be expressed in terms of the variance, range, or other statistical parameters. For this project, precision will be measured as laboratory sample duplicate analysis and field sample replicate analysis.

Accuracy: Accuracy is a measure of the bias in a system or the degree of agreement of a measurement, X (or an average of measurements of the same parameter) with an accepted reference or true value, T. Accuracy is typically expressed as a percentage of the ratio of measurement and accepted value (X/T x 100). Accuracy will be measured using procedures prescribed in the analytical methods.

Possible QC samples indicative of accuracy are listed in the table below:

Table B-3 QC Sample Types for Accuracy

Sample Type	Accuracy/Bias Indicator for
MS	Instrument contamination, calibration, and effectiveness of sample prep
Reference Material Analysis or performance evaluation sample	Instrument contamination, calibration, and effectiveness of sample prep. Most representative of performance when the performance evaluation sample is of similar matrix
LCS	Instrument contamination, calibration, and effectiveness of sample prep on clean lab matrix
Surrogate standards	The role of surrogates is to mimic the behavior of target analytes and as such provides indications of instrument contamination, calibration, sample prep, matrix effects
Calibration blank	Instrument contamination, calibration
Preparation blank (method blank)	Instrument contamination, calibration, and laboratory contamination
Field blank (equipment/trip)	Instrument contamination, calibration, and laboratory/field/transport/storage contamination

Where applicable, recovery of matrix spike/matrix spike duplicate (MS/MSD), laboratory control sample/laboratory control sample duplicate (LCS/LCSD), surrogates, and laboratory method blanks will be used to measure accuracy and bias for this project.

Sensitivity: Sensitivity indicators of primary interest to environmental projects are those related to detection and quantification capabilities otherwise known as Detection Limits (DLs), the limit of detection (LOD) and limit of quantitation (LOQ). Sensitivity issues can play a critical role in achieving the DQOs.

DLs, LODs, and LOQs for the target analytes are compared to the minimum screening levels that will be used during the RI risk assessment in **Attachment 3**. The selected project screening levels are detailed with rationale for selection in Section 8 of the Work Plan. LOQs and/or LODs were below the project screening levels in almost all cases, indicating that the selected methods are sufficiently sensitive to meet the project goals. Exceptions where one or more project screening levels are lower than the LOQ/LOD are shown in **Attachment 3**.

The selected analytical methods are commonly-used standard methods that represent current available technology, and are acceptable to both the KDHE and the USACE.

Several analytical identifiers have been created to describe approximate sensitivity performance at a specified concentration level (i.e., DL, LOD, and LOQ). The table below defines these commonly used sensitivity indicators.

Table B-4 Commonly Used Sensitivity Indicators

Sensitivity Indicators	Numerical Definition	Definition	Common Use
DL	A laboratory shall establish a detection limit (DL) using accepted, published methodologies from recognized entities such as USEPA, USDOE, American Society for Testing and	Lowest level at which instrument can distinguish from zero	Provides basis for establishing the LOD and LOQ

Table B-4 Commonly Used Sensitivity Indicators

Sensitivity Indicators	Numerical Definition	Definition	Common Use
	Materials (ASTM), or NIOSH for each suite of analyte-matrix-method, including surrogates. The DL may be established based on historical data.		
LOD	The laboratory establishes the LOD by spiking a quality system matrix at a concentration of at least 2 times but no greater than four times the DL.	Minimum conc. of analyte that can be reported with 99% confidence that analyte concentration is greater than zero	Determines lowest quantifiable conc. for a given method
LOQ	The laboratory established the LOQ at or above the concentration of the lowest initial calibration standard and within the calibration range.	Lowest concentration of analyte that can be reliably measured within method specified limits of precision and accuracy	Lab basis for reporting data without flags

Completeness: Completeness is the amount of valid data, including QC sample data, obtained from a measurement system compared to the amount that was expected to be obtained under correct normal operations. It is usually expressed as a percentage. Completeness for usable data is defined as the percentage of the usable data out of the total amount of data generated. The goal for laboratory completeness is 90% and the goal for overall analytical completeness is 90%.

The following table summarizes the data quality indicators used for this project and their respective acceptance criteria, which are also presented in detail in **Attachment 4**. Poor analyte performers and sporadic marginal failures are acceptable, per the DoD Quality Systems Manual (QSM; DoD, 2013). The measurement quality objectives are as follows:

Table B-5 Measurement Quality Objectives

QC Sample	Select MC Metals 6020A		Nitroaromatic/nitramine explosives 8330B	
	Frequency	Acceptance Criteria	Frequency	Acceptance Criteria
Method Blank	1 per lab QC Batch	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	1 per lab QC Batch	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater
LCS	1 per lab QC Batch	QSM Appendix C Limits or in-house laboratory limits*	1 per lab QC Batch	QSM Appendix C Limits or in-house laboratory limits*
MS/MSD	1 MS/MSD pair per 20 field samples	QSM Appendix C Limits or in-house laboratory limits*	1 MS/MSD pair per 20 field samples	QSM Appendix C Limits or in-house laboratory limits*
Surrogates	NR	NR	Every sample	78-119% Soils 83-119% Waters
Lab Sample Dup.	1 per lab QC Batch (preferably MSD, can be LCSD or	<20% RPD	1 per lab QC Batch (preferably MSD, can be LCSD or sample	<20% RPD

Table B-5 Measurement Quality Objectives

QC Sample	Select MC Metals 6020A		Nitroaromatic/nitramine explosives 8330B	
	Frequency	Acceptance Criteria	Frequency	Acceptance Criteria
	sample duplicate)		duplicate)	
Blind Field Dup.	10% of field samples collected	<50% RPD	10% of field samples collected	<50% RPD
Field Replicate**	At least three replicates will be collected for each decision unit.	RSD ≤ 20% (explosives) or 30% (metals) when detects for all replicates are greater than LOQ.	At least three replicates will be collected for each decision unit.	RSD ≤ 20% (explosives) or 30% (metals) when explosive detects for all replicates are greater than LOQ.
Lab Replicate**	At the sub-sampling step, at least three replicates are analyzed for every 20 primary samples run by the laboratory.	The RSD for results above the LOQ must be ≤ 20%.	At the sub-sampling step, at least three replicates are analyzed for every 20 primary samples run by the laboratory.	The RSD for results above the LOQ must be ≤ 20%.

NR – Not Required
REC – recovery
** Analyte-specific recovery limits (established in Appendix C of the DoD QSM – in-house limits are used if no limits exist in the QSM) are presented in **Attachment 4**.*
***Applicable only to samples collected using incremental sampling methodology (ISM)*

Representativeness: Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. The characteristics of representativeness are usually not quantifiable. Subjective factors to be taken into account are as follows:

- Degree of homogeneity of a site;
- Degree of homogeneity of a sample taken from one point in a site;
- Available information on which a sampling plan is based.

Field duplicates and replicates are also used to assess representativeness. For field duplicates (discrete samples), two samples collected at the same location and at the same time are considered to be equally representative of this condition, at a given point in space and time. To maximize representativeness of results, sampling techniques, sample size, and sample location will be carefully chosen so they provide laboratory samples representative of the site and the specific area. For this project, it is expected that the chosen sampling design will reflect a high degree of representativeness. Samples exhibiting obvious non-homogeneity should not be used as replicates. Within the laboratory, precautions are taken to extract from the sample container an aliquot representative of the whole sample. If MEC or evidence of a burial trench is identified during the RI, ISM will be utilized for surface soil sampling. Field replicates (minimum of three) will be obtained in order to assess the RSD for sample results and in order to be able to calculate an upper concentration limit for evaluation for potential exposure risk.

Comparability: Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is ensured through the use of established and approved sample collection techniques and analytical methods, consistency in the basis of analysis, consistency in reporting units, and analysis of standard reference materials.

The use of standard methods to collect and analyze samples, along with instruments calibrated against Standard Analytical Reference Materials (SARM) which are National Institute of Standards and Technology (NIST)-traceable standards, will also ensure comparability.

Comparability also depends on the other data quality characteristics. Only when data are judged to be representative of the environmental conditions, and when precision and accuracy are known, can data sets be compared with the highest degree of confidence.

3.3 Laboratory QA/QC Samples

Analytical QC is comprised of the QC procedures, checks, samples, and their respective acceptance limits that will be used during the project to monitor the quality of various aspects of the sampling events. Laboratory QC samples (e.g., method blanks and LCS) shall be included in the preparation batch with the field samples. An analytical batch is a number of samples (not to exceed 20 environmental samples plus the associated laboratory QC samples) that are similar in composition (matrix) and that are extracted at the same time and with the same lot of reagents. MSs and MSDs count as environmental samples. The identity of each analytical batch shall be clearly reported with the analyses so that a reviewer can identify the QC samples and the associated environmental samples. The QC procedures employed at TestAmerica are detailed in the laboratory's QAM. The reliability and credibility of the laboratory results will be corroborated by the inclusion of scheduled QA analyses. The type of QC and the scheduled QA analysis include the following:

Laboratory Control Sample

The LCS is analyte-free solid matrix (sand) spiked with all analytes listed in the QC acceptance criteria in the laboratory method Standard Operating Procedure (SOP). If not otherwise specified, each analyte in the LCS shall be spiked at a level less than or equal to the midpoint of the calibration curve for each analyte. (The midpoint is defined as the median point in the curve, not the middle of the range). The LCS shall be carried through the complete sample preparation and analysis procedure.

The LCS is used to evaluate each analytical batch and to determine if the method is in control. The LCS cannot be used as the continuing calibration verification.

One LCS shall be included in every analytical batch. If more than one LCS is analyzed in an analytical batch, results from all LCSs analyzed shall be reported. A QC failure of an analyte in any of the LCSs shall require appropriate corrective action including qualification of the failed analyte in all of the samples as required.

Matrix Spike/Matrix Spike Duplicate

A MS and MSD is an aliquot of an actual sample spiked with known concentrations of all analytes listed in the method and/or project-specific QC acceptance limits. The spiking occurs prior to sample preparation and analysis. If not otherwise specified, each analyte in the MS and MSD shall be spiked at a level less than or equal to the midpoint of the calibration curve for each analyte. The MS/MSD sample will be site-specific and designated on the chain-of-custody (COC) by Bay West field personnel. If an analytical batch is run without an MSD, then an LCSD or a sample duplicate will be run to assess precision. The MS/MSD results and any data qualifiers must be associated or related to samples that are collected from the same site. Therefore, if an MS/MSD causes qualification of the data, the laboratory may qualify all associated samples within the analytical batch. If appropriate, during data validation Bay West may further qualify any additional samples from the same batch or collected from the same site that were not included in the analytical batch, based on professional judgment.

The MS/MSD is used to document the accuracy/bias of a method due to the sample matrix associated with the project. MS/MSDs will be analyzed at a rate of 5% (one spike per 20 samples and one spike duplicate per 20 samples). The performance of the MS and MSD is evaluated against the method and project-specific QC acceptance limits and appropriate analytes (in all related samples) shall be qualified according to the data qualification criteria. The MS recoveries from samples that contain significant native background levels of the target analytes will be evaluated using the professional judgment of the Bay West CQCO for acceptance. Significant native background level is defined as an amount equal to or above that concentration which the laboratory spiked into the sample.

MS recoveries and RPDs will be computed and reported for all laboratory spike pairs along with any analyte- or matrix-specific control limits.

Surrogates

Surrogates are organic compounds that are similar to the target analyte(s) in chemical composition and behavior in the analytical process but that are not normally found in environmental samples. For the scope of work outlined herein, use of surrogates is limited to analysis of explosives by Method 8330B.

Method Blank

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank shall be carried through the complete sample preparation and analytical procedure. The method blank is included in every analytical batch and is used to document contamination resulting from the analytical process.

The presence of analytes in a method blank at concentrations greater than one-half the LOQ indicates a need for corrective action per the DoD QSM. Corrective action shall be performed to eliminate the source of contamination prior to proceeding with analysis. After the source of contamination has been eliminated, all samples containing the analyte(s) found in the method blank >LOQ shall be re-prepared and reanalyzed. No analytical data shall be corrected for the presence of analytes in blanks. When an analyte is detected in the method blank and in the associated samples and corrective actions are not performed or are ineffective, the appropriate qualification flag shall be applied to the sample results.

Field Duplicates

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned a unique identification number in the field by Bay West field staff.

Field duplicate sample RPD results shall be calculated and used to evaluate overall field and laboratory precision.

Evaluative Procedures

Evaluative procedures will be used to assess the overall measurement error and data usability. They also will serve to reconcile the data with the project DQOs. The evaluative procedures for the above analytical QC are detailed in **Section 3.2** of this QAPP. The evaluative measurements to be employed include Precision, Accuracy, Sensitivity, Completeness, Representativeness, and Comparability.

4.0 SAMPLING LOCATIONS AND PROCEDURES

Sampling location rational and procedures are defined in Sections 6.0 and 8.0 of the Work Plan. In general, analytical samples will only be obtained if MEC is discovered during the RI. If MEC with a potential for MC is identified, the number and locations of analytical samples will be reviewed by the project team prior to collection. Field SOPs for sampling methods are provided in **Appendix D** of the Work Plan.

5.0 SAMPLE CUSTODY AND HOLDING TIME

The sample custody procedures are detailed in a field SOP provided in **Appendix D** of the Work Plan and addressed in Section 6 of the Work Plan (see Table 6-1).

Holding times for the individual analytes are summarized below:

Table B-6 Holding Times

Matrix	Analytical Group	Analytical/Preparation Method SOP Reference[1]	Maximum Holding Time[2] (preparation/analysis)
Water	8330 HPLC	DV-LC-0002 / DV-OP-0017	7 days
Soil[3]	8330 HPLC	DV-LC-0002 / DV-OP-0018	14 – 40 days from extract
Water	6020 Metals	DV-MT-0022 / DV-IP-0014	180 days
Soil	6020 Metals	DV-MT-0022 / DV-IP-0015	180 days
Soil	9045 General Chemistry	DV-WC-0001	28 days (same day as extracted)
Water	9040 General Chemistry	DV-WC-0031	**Immediately** (48 hours of receipt)

*[1] Refer to the Analytical SOP in **Attachment 5**.*
[2] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.
[3] Samples identified as sediment will be processed as routine soil procedures.

6.0 ANALYTICAL PROCEDURES

The analytical procedures for preservation and sample volume requirements are summarized below:

Matrix	Analytical Group	Analytical / Preparation Method SOP Reference[1]	Containers (number, size, and type)	Sample volume[2] (units)	Preservation Requirements (chemical, temperature, light protected)
Water	8330 HPLC	DV-LC-0002/ DV-OP-0017	2, 500 mL, amber	1,000 mL	Cool ≤ 6°C
Soil[3]	8330 HPLC	DV-LC-0002/ DV-OP-0018	1, 4 oz glass jar for discrete samples; or, 1, gallon-sized plastic zip-top bag for samples collected using ISM[4]	4 grams 20 grams	Cool ≤ 6°C
Water	6020 Metals	DV-MT-0022 or DV-MT-0021/ DV-IP-0014	1, 250 mL, HDPE	100 mL	HNO_3, pH < 2;
Soil[3]	6020 Metals	DV-MT-0022 or DV-MT-0021/ DV-IP-0015	1, 4 oz, glass jar for discrete samples; or, 1, gallon-sized plastic zip-top bag for samples collected using ISM[4]	4 grams 20 grams	Cool ≤ 6°C
Soil	9045 General Chemistry	DV-WC-0001	1, 4 oz, glass jar	80 grams	Cool ≤ 6°C
Water	9040 General Chemistry	DV-WC-0031	1, 100 mL HDPE	25 mL	Cool ≤ 6°C

Notes:
°C – degrees Celsius
HDPE – High-density polyethylene
HPLC – High performance liquid chromatography
mL – milliliter(s)
oz – ounce(s)
*[1]Refer to the Analytical SOPs in **Attachment 5.***
[2]The minimum sample size is based on analysis allowing for sufficient sample for reanalysis. Additional volume is needed for the laboratory Matrix Spike/Matrix Spike Duplicate sample analysis.
[3]Samples identified as sediment will be processed as routine soil procedures, including container and volume.
[4]ISM soil for Method 8330B requires drying and subsequent ring and puck grinding. If metals under Method 6020 are requested note that the 20-gram subsampling aliquot is to be removed by Test America prior to grinding.

6.1 Preventative Maintenance

The primary purpose of the maintenance program is to prevent instrument and equipment failure and to minimize down time. A properly implemented maintenance program increases the reliability of a measurement system.

On-site Equipment: There is no on-site equipment associated with the sampling for MC – refer to the work plan for details regarding unexploded ordnance/discarded military munitions (UXO/DMM) activities.

Laboratory Facilities: The TestAmerica laboratory facility will be adequately maintained with a safe and clean environment. The maintenance activities include appropriate engineering controls such as proper ventilation, lighting, dust control, hoods, air flow, and protection from extreme temperatures, waste disposal and a source of stable power.

Preventative maintenance procedures to minimize laboratory equipment downtime are detailed in each analytical method SOP (see **Attachment 5**).

6.2 Calibration Procedures and Frequency

Laboratory Equipment: Calibration procedures for TestAmerica are included in their QAM and method-specific analytical SOPs. Each type of instrumentation is calibrated prior to sample analysis according to method criteria. Method-specific criteria for the instrument calibrations must be met before samples may be processed. The specific criteria for calibration are written in each method SOP.

Corrective action must be taken to remedy any out-of-control situations prior to analysis of any samples. Deviations from stated criteria are not acceptable. Hard copy records of all instrument calibrations are maintained in the individual laboratories and must be made available to Bay West upon request. These records are reviewed by the laboratory department managers and/or supervisors and are frequently included in audits performed by the laboratory QA department.

Analytical instruments at the laboratories shall be calibrated using traceable standards in accordance with specified analytical methods and manufacturers' procedures. Calibration procedures, at a minimum, include the equipment to be calibrated, the reference standards used for calibration, the calibration techniques and the sequential actions, acceptable performance tolerances, frequency of calibration, and calibration documentation format. Records of standard preparation and instrument calibration shall be maintained. The analysis logbook, maintained for each analytical instrument, shall include at a minimum 1) the date and time of calibration; 2) the initials of the person performing the calibration; 3) the calibrator reference number; and 4) the concentration. Project laboratory calibration procedures, frequency, and associated corrective actions are further detailed in the method-specific SOPs and TestAmerica's QAM.

6.3 Laboratory Internal QC Checks

Specific laboratory internal QC checks and frequencies are included in TestAmerica's QAM and the specific analytical SOPs.

6.4 Performance and System Audits

Performance and system audits are a component of internal laboratory QA policy and procedures as well as external certification processes. Performance and system audits continue to be performed on an ongoing basis; however, project-specific audits will not be performed.

6.5 Nonconformance and Corrective Actions

A nonconformance is an unplanned deviation from an established protocol or plan. The deviation may be the result of the actions of TestAmerica, Bay West or the result of events beyond the control of any of these parties. Nonconformances include the following situations:

- Holding item violations due to laboratory error, shipping delays, or other factors;
- Calibrations errors;

- Deviations from SOPs;
- QC sample results outside established limits;
- Elevated LOQs; and
- Errors in reports.

Corrective actions range from flagging of data to re-preparation and re-analysis of the affected samples. Actions taken depend on the severity of the nonconformance and the effect on data quality. The laboratory will notify Bay West of any nonconformance which impacts data quality so that Bay West may be involved in the corrective action process.

7.0 DATA REDUCTION, DATA QUALITY INDICATORS CALCULATION AND REPORTING

Data review procedures, defined as a set of computerized and manual checks applied at appropriate levels of the measurement process, are defined for all measurement systems in the QAM. Data review will begin with the reduction or processing of data and will continue through verification of the data and the reporting of analytical results.

Calculations will be checked in the field (if applicable) and at the laboratory from the raw data to the final value prior to reporting results for each group of samples. Data reduction will be performed by the analyst who obtained the data or by another analyst. Data verification will start with the analyst who will perform a 100% review of the data to ensure the work was done correctly the first time.

The complete chemistry data package will be provided to Bay West within 20 business days of sample receipt.

7.1 Data Reduction and Verification

Data reduction and verification may be performed by more than one analyst depending upon the analytical method employed. The preparation and analytical data may be reviewed independently by different analysts. In these instances, each item may not be applicable to the subset of the data verified or an item may be applicable in both instances. It is the responsibility of the analyst to ensure that the verification of data in his or her area is complete. The data reduction and initial verification process must ensure that:

- Sample preparation information is correct and complete including documentation of standard identification, sample amounts, etc.;
- Analysis information is correct and complete, including proper identification of analysis output;
- Analytical results are correct and complete, including calculation or verification or instrument calibration, QC results, and qualitative and quantitative sample results with appropriate qualifiers;
- The appropriate SOPs have been followed and are identified in the project records;
- Proper documentation procedures have been followed;
- All non-conformances have been documented;
- Special sample preparation and analytical requirements have been met; and
- The data generated have been reported with the appropriate number of significant figures as defined by the analytical methods in the laboratory information management systems (LIMSs) or otherwise specified by the client.

In general, data will be processed by an analyst in one of the following ways:

- Manual computation of results directly on the data sheet or on calculation pages attached to the data sheets;
- Input of raw data for computer processing; and
- Direct acquisition and processing of raw data by a computer.

If data are manually processed by an analyst, all steps in the computation shall be provided including equations used and the source of input parameters such as response factors (RFs), dilution factors, and calibration constants. If calculations are not performed directly on the data sheet, they may be attached to the data sheets.

For data that are input by an analyst and processed using a computer, a copy of the input shall be kept and uniquely identified with the project number and other information as needed. The samples analyzed must be clearly identified.

If data are directly acquired from instrumentation and processed, the analyst must verify that the following are correct:

- Project sample numbers;
- Calibration constants and RFs;
- Units; and
- Numerical values used for detection and quantitation limits.

Analysis-specific calculations for methods are provided in SOPs. In cases where computers perform the calculations, software must be validated or verified before it is used to process data.

The data reduction is documented, signed, and dated by the analyst completing the process. Initial verification of the data reduction by the same analyst is documented on a data review checklist, signed, and dated by the analyst.

7.2 Data Verification

Following the completion of the initial verification by the analyst performing the data reduction, a systematic second-level verification of the data is performed by an experienced peer, supervisor, or designee. The second-level reviewer examines the data signed by the analyst. This review includes an evaluation of all items required in the raw data package. Any exceptions noted by the analyst must be reviewed. Included in this review is an assessment of the acceptability of the data with respect to the following:

- Adherence of the procedure used to the requested analytical method SOP;
- Correct interpretation of data;
- Correctness of numerical input when computer programs are used (checked randomly);
- Correct identification and quantification of constituents with appropriate qualifiers;
- Numerical correctness of calculations and formulas (checked randomly);
- Acceptability of QC data;
- Documentation that instruments were operating according to methods specifications (calibrations, performance checks, etc.);
- Documentation of dilution factors, standard concentrations, etc. and;
- Sample holding time assessment.

A case narrative to accompany the final report will be finalized by the laboratory Project Manager. This narrative will include relevant comments collected during the earlier reviews.

7.3 Calculation of Data Quality Indicators

Procedures for calculation of data quality indicators are described in TestAmerica's QAM and the laboratory SOPs, and summarized in **Section 3.2** of this QAPP.

7.4 Data Reporting

The following items are included in the data reporting methodology:

Data Reports

TestAmerica is capable of developing a variety of data deliverable reports. In general, data reports contain:

- **Cover Letter/Case Narrative:** Information on sample types, tests performed, any problems encountered, and other general comments are provided;
- **Analytical Data:** Data are reported by sample or by test with the appropriate significant figures and detection/quantitation limits, and have been adjusted for dilution, if appropriate. Pertinent information including dates sampled, received, prepared, extracted, and analyzed are provided; and
- **Methodology:** Reference for analytical methodology used is cited.

The following specific information will be included in the data package:

- Laboratory name and location (city and state);
- Project name and unique identification (ID) number;
- Sample condition upon receipt in the laboratory;
- Holding times;
- Instrument initial and continuing calibration;
- Method blanks;
- Surrogate spike recoveries;
- Matrix spikes and laboratory control samples;
- Laboratory sample duplicates;
- Field sample ID number as written on COC;
- Sample description, laboratory sample ID number, and matrix;
- Sample preservation or condition at receipt;
- Date sample collected, received, extracted/prepared, and analyzed;
- Analysis time when holding time limit is less than 48 hours;
- Method (and SOP) numbers for all preparation, cleanup, and analysis procedures employed;
- Preparation, analysis, and other batch numbers;
- Analyte or parameter;
- Method detection and quantitation limits adjusted for sample-specific factors;
- Method detection and quantitation limits;
- Analytical results with correct number of significant figures;
- Any data qualifiers assigned;
- Concentration units;
- Dilution factors (report both diluted and undiluted runs);
- Percent moisture or percent solids (report solids on dry weight basis);
- Chromatograms, as needed;
- Sample final extract volume and aliquot analyzed; and
- Sample management records (COC and other records generated to document sample custody, transfer, analysis, and disposal).

Verbal Results

If Bay West requests analytical results to be communicated verbally or by facsimile prior to final review, they will be clearly identified as “Preliminary” results. Bay West understands that the data may not have undergone the complete levels of verification and review required and that the data may change.

Reporting Analytical Results

Sample results are reported according to analytical method SOP. The laboratory will normally report results within the calibration; however, any reported results outside of the calibration range will be flagged and documented in the final report.

The laboratory will generate an Electronic Data Deliverable (EDD) as a Stage 2a Staged Electronic Data Deliverable (SEDD), per Version 5.2 (or most current) which will be submitted to USACE at the conclusion of the project.

8.0 DATA ASSESSMENTS AND REVIEW

All chemical data generated will have their quality assessed prior to use. TestAmerica will perform 100% data verification as described in **Section 7.2** of the QAPP prior to release of data. Data verification will ensure the data package is complete, correct, consistent and compliant with the Sampling and Analysis Plan requirements.

Upon receipt of the interim data package including sample and QC sample results, the Bay West CQCO will conduct a data review as described in **Section 8.1**. Data review will assess the summary QC data provided by the laboratory to ascertain the corresponding project sample data quality. If the data verification and review indicate that the chemical data quality meets the project quality objectives, the data will be used as appropriate to support the project.

Data validation, as described in **Section 8.2**, will be completed within thirty days of completing work at the site. A data usability assessment, as described in **Section 8.3**, will be included with the RI Report.

8.1 Data Verification

Data verification determines and documents possible effects on the data that result from various QC failures. The following elements of data review will aid the CQCO in assessing whether the data are of acceptable quality:

- COC forms, analysis requested, sample description/ID;
- Sample handling procedures, holding times, preservation;
- Verify the following for completeness of lab data packages:
  - Lab Case Narrative
  - Sample condition upon receipt
  - Holding times
  - Sample results
  - Blanks
  - MS/MSDs
  - LCSs
  - Surrogate for SW 846 8330B
  - Serial Dilution and Post Digestion Spike for SW 846 6020A
  - Calibration summary and raw data
  - Analytical raw data;
- Identification of QC samples that may include:
  - Laboratory sample duplicates;
  - Blind field duplicates; and
  - Method blanks, trip blanks and equipment blanks;
- LCS/LCSD;
- MS/MSD;
- Surrogate recoveries; and
- Examination of QC sample data against Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity objectives

8.2 Data Validation

Bay West will perform USEPA Tier III data validation on 10% of the analytical data, and USEPA Tier II validation on the remaining 90% of the analytical data IAW the DoD QSM v5.0, laboratory SOPs and the National Functional Guidelines (NFGs). The data validation strategy will be consistent with the DQOs.

Because explosives are not specifically addressed in the NFGs, the organic and inorganic NFGs will be used in a general way, along with the method requirements and the TestAmerica SOPs to serve as guidelines for data validation. This approach is summarized in the following table:

Table B-7 Data Validation of Explosives Using Method 8330b

Review Data	Summary of Criteria/Requirements	Reviewer Qualification Guidelines
I. Preservation and Holding Times	Cool samples to 4 ± 2 ºC, extract within 14 days of collection for soils, 7 days for water, 40 days from extraction to analysis	If criteria not met, flag UJ/J* or if grossly exceeded, flag R*.
II. Initial Calibration	%RSD of calibration factors ≤20%, or if r ≥ 0.995, linear regression used.	If criteria not met, ICAL should be repeated – potentially qualify R* or UJ/J* if corrective action not performed.
III. Calibration Verification	Mid-level standard within + 15% of predicted response. CCV after ever 10 injections.	If criteria not met and reanalysis not conducted, may flag data J/UJ* or R*.
IV. Blanks	Method Blank < ½ LOQ	If concentration in blank within 5X of samples, flag U*, consider undetected at elevated LOQ.
V. Accuracy and Precision	LCS and MS/MSD within statistically-determined limits and RPDs specified in **Attachment 4**	Results outside criteria may result in UJ/J* qualification, or R* in cases of very low recovery.
VI. Surrogates	All samples including QC samples spiked with surrogates. Recoveries within statistically determined limits specified in **Attachment 4.**	Results outside criteria may result in UJ/J* qualification, or R* in cases of very low recovery.
VII. Duplicates	See RPD for MS/MSD (30%) – Sample duplicates also ≤30% for soils. Field duplicates 50% for soils, 25% for waters.	Results outside criteria may result in UJ/J* qualification, depending on other measures of precision.
VIII. Overall Assessment of data	Review of overall data package; evaluate QC measures in relationship to one another. Confirm tentative identifications with second column or GC/MS	Review to use professional judgment.

Notes:
** - See Data Qualifier Definitions Table, below*
CCV – continuing calibration verification
r – Correlation Coefficient
ICAL - Initial Calibration

Data Validation, according to USEPA's definition, is "an evaluation of the technical usability of the verified data with respect to the planned objectives or intention of the project. In addition, data validation can provide a level of overall confidence in the reporting of the data based on the methods used."

The data validation process will consist of:

- Assembling planning documents, laboratory data to be validated and data review documentation;

- Review verified data, and reported sample results collectively for the data set as a whole, including laboratory applied data qualifiers against the requirements the laboratory was expected to meet;
- Summarize data and QC deficiencies and evaluate the impact on the overall data quality. Additionally, given information obtained during the course of the project, an assessment of certain performance criteria may be made;
- Assigning validation qualifiers as appropriate to individual data values giving an indication of potential bias or uncertainty discovered during the validation process. Data qualification will be performed with consideration given to the importance and level of deviation from performance standards; and
- Preparation of analytical data validation report.

All data qualifiers assigned as a result of the data validation process will be consistent with the guidelines and will also reflect the project-specific DQOs. Typical data validation qualifiers can be found in the table below. NFGs will be used for the evaluative measurements with non-specified criteria during the data validation process.

Table B-8 Data Qualifier Definitions for Data Validators

Data Qualifier	Definition
U	The analyte was analyzed for but was not detected above the reported sample quantitation limit.
J	The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high (inorganics only).
J-	The result is an estimated quantity, but the result may be biased low (inorganics only).
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification (organics only).
NJ	The analysis indicates the presence of an analyte that has been “tentatively identified” and the associated numerical value represents its approximate concentration (organics only).
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

8.3 Data Usability

The Data Usability Assessment will be performed by the Bay West Team. The Bay West PM will be responsible for information in the Usability Assessment. The Bay West PM will also be responsible for assigning task work to the individual task members who will support the Data Usability Assessment. The Data Usability Assessment will be conducted on verified/validated data. After the Data Usability Assessment has been performed, data deemed appropriate for decision-making purposes will be used to delineate the extent of contamination and assess risk to receptors. The results of the Data Usability Assessment will be presented in the RI Report. The following items will be assessed and conclusions drawn based on their results.

Step 1: Review the project’s objectives and sampling design

Review the key outputs defined during systematic planning (DQOs and Measurement Performance Criteria) to make sure they are still applicable. Review the sampling design for consistency with stated objectives. This provides the context for interpreting the data in subsequent steps.

Step 2: Review the data verification and data validation outputs

Review available QA reports, including the data verification and data validation reports. Perform basic calculations and summarize the data (using graphs, maps, tables, etc.). Look for patterns, trends, and anomalies (i.e., unexpected results). Review deviations from planned activities (e.g., number and locations of samples, holding time exceedances, damaged samples, and SOP deviations) and determine their impacts on the data usability. Evaluate implications of unacceptable QC sample results.

Step 3: Verify the assumptions of the selected statistical method

Verify whether underlying assumptions for selected statistical methods (if documented in the QAPP) are valid. Common assumptions include the distributional form of the data, independence of the data, dispersion characteristics, homogeneity, etc. Depending on the robustness of the statistical method, minor deviations from assumptions usually are not critical to statistical analysis and data interpretation. If serious deviations from assumptions are discovered, then another statistical method may need to be selected.

Step 4: Implement the statistical method

Implement the specified statistical procedures for analyzing the data and review underlying assumptions. For decision projects that involve hypothesis testing (e.g., "concentrations of lead in soil are below the project action level") consider the consequences for selecting the incorrect alternative; for estimation projects (e.g., establishing a boundary for surface soil contamination), consider the tolerance for uncertainty in measurements.

Step 5: Document data usability and draw conclusions

Determine if the data can be used as intended, considering implications of deviations and corrective actions. Discuss data quality indicators. Assess the performance of the sampling design and Identify limitations on data use. Update the conceptual site model and document conclusions. Prepare the data usability summary report, which can be in the form of text and/or a table.

8.3.1 Data Usability Assessment Parameters

Precision – Results of field duplicates will be presented separately in tabular format for each sample pair. For each field duplicate pair, the results will be assessed as stated in **Table C-5**. When replicates are collected for incremental samples, RSDs will be calculated. MS/MSD RPDs are calculated by the laboratory and those with RPDs outside the criteria established in **Table C-5** will be listed in tabular form in the data verification report. A discussion will follow summarizing the results of the laboratory precision. Any conclusions about the precision of the analyses will be drawn and any limitations on the use of the data will be described.

Accuracy/Bias Contamination – Results for all laboratory method blanks will be evaluated and analytes detected in these blanks will be listed in tabular form in the data verification report. Laboratory data will be qualified based on the criteria listed in Table 1, Appendix B of the QSM (DoD, 2013). A discussion will follow summarizing the results of the laboratory accuracy/bias. Any conclusions about the accuracy/bias of the analyses based on contamination will be drawn and any limitations on the use of the data will be described.

Overall Accuracy/Bias – Results for all laboratory control sample, surrogate and MS/MSD recoveries that are outside evaluation criteria will be presented in tabular format in the data verification reports. The results will be checked versus those listed in **Attachment 4** from Appendix B of the QSM. A discussion will follow summarizing the overall accuracy/bias. Any conclusions about the accuracy/bias of the analyses based on contamination will be drawn and any limitations on the use of the data will be described.

Sensitivity – Results for the sensitivity check standard will be provided by the laboratory for all analyses. The results for each analyte will be checked against the performance criteria presented **Table C-5** and cross checked against the quantitation limits presented on **Attachment 4**. Results for analytes that exceed criteria will be identified on the tables. A discussion will follow summarizing the results of the laboratory sensitivity. Any conclusions about the sensitivity of the analyses will be drawn and any limitations on the use of the data will be described.

Representativeness – A measure of representativeness will be provided by assessing if the proper analytical procedures, appropriate methods, laboratory SOPs, holding times, and field duplicate/replicate procedures were followed. Any conclusions about the representativeness of the analyses will be drawn and any limitations on the use of the data will be described.

Comparability – The results will be compared to previous sampling results taken from the MRSs. A measure of comparability will be provided by assessing if the appropriate field SOPs were followed.

Completeness – A completeness check will be performed on all data generated by the laboratory. Completeness criteria are presented in **Section 3.2.** Completeness will be calculated as the number of data points for each analyte that is deemed useable (not rejected) divided by the total number of data points for each analyte. A discussion will follow summarizing the results of the calculation of data completeness. Any conclusions about the completeness of the data will be drawn and any limitations on the use of the data will be described.

Graphics – Figures will be constructed showing the contamination levels at each sampling location.

Reconciliation – Each of the measurement performance criteria listed in **Section 3.2** will be examined to determine if the objective was met. Each analysis will be evaluated separately in terms of the major impacts observed from the data verification/validation, DQIs and measurement performance criteria assessments. Based on the results of these assessments, the quality of the data will be determined. Usability of the data will be based on the quality assessment. After establishing the usability of the data, it will be determined if the DQO was met and if project action limits were met. The final report will include a summary of all points that comprised the reconciliation of each objective. Any conclusions or limitations on the usability of any of the data will be described.

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Attachment 1

Laboratory Quality Assurance Manual Table of Contents

Quality Assurance Manual Cover Page

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Quality Assurance Manual
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REFERENCED CORPORATE SOPs AND POLICIES

SOP / Policy Reference	Title
CA-I-P-002	Electronic Reporting and Signature Policy
CA-L-P-002	Contract Compliance Policy
CA-L-S-002	Subcontracting Procedures
CA-Q-M-002	Corporate Quality Management Plan
CA-Q-S-001	Solvent and Acid Lot Testing and Approval
CA-Q-S-002	Acceptable Manual Integration Practices
CA-Q-S-006	Detection Limits
CA-T-P-001	Qualified Products List
CW-E-M-001	Corporate Environmental Health and Safety Manual
CW-F-P-002	Company-Wide Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CW-F-S-007	Capital Expenditure, Controlled Purchase Requests and Fixed Asset Capitalization
CW-L-P-004	Ethics Policy
CW-L-S-002	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CW-Q-S-003	Internal Auditing
CW-Q-S-004	Management Systems Review

REFERENCED LABORATORY SOPs

SOP Reference	Title
CA-Q-S-001 DV-1	Procedure for Testing Anhydrous Sodium Sulfate and Solvents from CYCLE-TAINERS®
DV-HS-0004	Hazardous Waste Manifesting
DV-HS-0005	Excess Sample Material Management
DV-QA-0001	Thermometer Calibration Procedure
DV-QA-0003	Sample Management and Chain of Custody
DV-QA-0005	Document Archiving Procedure
DV-QA-0008	Calibration and Verification of Mechanical Pipettes
DV-QA-0010	Document Control
DV-QA-0012	Monitoring Refrigerator Temperature and Power Failure Contingency Plan
DV-QA-0014	Balance Calibration Check
DV-QA-0015	Verification and Storage of Calibration Standards
DV-QA-0019	Quarantine Soils Procedure
DV-QA-001P	Preparation and Management of Standard Operating Procedures and Other Controlled Documents
DV-QA-0020	Data Review
DV-QA-0022	Data Package Assembly
DV-QA-0023	Subsampling
DV-QA-0024	Training
DV-QA-0026	DI Water Monitoring
DV-QA-0036	Sub-out Work Sample Management and Chain of Custody
DV-QA-003P	Quality Control Program
DV-QA-004P	Rounding and Significant Figures
DV-QA-005P	Determination of Method Detection Limits
DV-QA-011P	Acceptable Manual Integration Practices
DV-QA-013P	Customer Complaints
DV-QA-017P	Electronic Reporting
DV-QA-019P	Result and Report Revisions
DV-QA-025P	Electronic Data Backup
DV-QA-028P	Management of Change

SECTION 3. INTRODUCTION, SCOPE AND APPLICABILITY

3.1 Introduction and Compliance References

TestAmerica Denver's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with The NELAC Institute (TNI) Standard, dated 2009, Volume 1 Modules 2 and 4, ISO/IEC Guide 17025:2005(E) and DoD ELAP. In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plan (CQMP) and the various accreditation and certification programs listed in Appendix 3. The CQMP provides a summary of TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all TestAmerica facilities shall conduct their operations.

The QAM has been prepared to be consistent with the requirements of the following documents:

- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water,* EPA, Revised July 1991.
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water,* Supplement III, EPA, August 1995.
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* EPA, March 1979.
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *U.S. Department of Defense (DoD), Quality Systems Manual for Environmental Laboratories, Version 4.2, October 2010.*
- *U.S. Department of Defense (DoD)/Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.0, July 2013.*
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)*
- APHA, *Standard Methods for* the Examination of Water and Wastewater, 18th Edition, 19th, 20th, 21st, and on-line Editions.
- *U.S. Department of Energy* Order 414.1B, *Quality Assurance*, Approved April 29, 2004.
- *U.S. Department of Energy* Order 414.1C, *Quality Assurance*, June 17, 2005.
- *U.S. Department of Energy*, *Quality Systems for Analytical Services*, Revision 2.9, May 2013.

- U.S. Department of Defense, *Air Force Center for Environmental Excellence Quality Assurance Project Plan (QAPP),* Version 4.0.02, May 2006.
- Nuclear Regulatory Commission (NRC) Quality Assurance Requirements.
- Toxic Substances Control Act (TSCA).

3.2 Terms and Definitions

A Quality Assurance Program is a company-wide system designed to ensure that data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 2 for the Glossary/Acronyms.

3.3 Scope / Fields of Testing

The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among drinking water, effluent water, groundwater, hazardous waste, sludge and soils. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical and biological parameters. The Program also contains guidelines on maintaining documentation of analytical processes, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all analytical requests are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found in the LIMS. The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet these requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director and the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and the QA Manager must determine if it is in the lab's best interest to follow the less stringent requirements.

3.4 Management of the Manual

3.4.1 Review Process

The template on which this manual is based is reviewed annually by Corporate Quality Management Personnel to assure that it remains in compliance with Section 3.1. This manual itself is reviewed annually by senior laboratory management to assure that it reflects current

practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be reviewed by the senior laboratory management staff. The laboratory updates and approves such changes according to its Document Control procedures (refer to SOP No. SOP DV-QA-0010).

SECTION 4. MANAGEMENT REQUIREMENTS

4.1 Overview

TestAmerica Denver is a local operating unit of TestAmerica Laboratories, Inc. The organizational structure, responsibilities and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., Chief Executive Officer (CEO), Executive Vice President (VP) Operations, Corporate Quality, etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate and TestAmerica Denver is presented in Figure 4-1.

4.2 Roles and Responsibilities

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance Program.

4.2.1 Additional Requirements for Laboratories

The responsibility for quality resides with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for upholding the standards therein. Each person carries out his/her daily tasks in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. This manual is specific to the operations of TestAmerica's Denver laboratory.

4.2.2 Chief Executive Officer (CEO)

The CEO is a member of the Board of Directors and is ultimately responsible for the quality and performance of all TestAmerica facilities. CEO establishes the overall quality standard and data integrity program for the Analytical Business, providing the necessary leadership and resources to assure that the standard and integrity program are met.

4.2.3 Executive Vice President of Operations (VPO)

The Executive VPO reports directly to the CEO of TestAmerica. The VPO oversees the operations of all TestAmerica laboratories and the EMLab P&K business unit. The VP's of Operations report directly to the Exec. VP of Operations.

4.2.4 Vice President of Operations

Each VP of Operations reports directly to the Executive VP of Operations and is a part of the Executive Committee. Each VP of Operations is responsible for the overall administrative and operational management of their respective laboratories. The VP's responsibilities include allocation of personnel and resources, long-term planning, goal setting, and achieving the financial, business, and quality objectives of TestAmerica. The VP's ensure timely compliance with Corporate Management directives, policies, and management systems reviews. The VP's are also responsible for restricting any laboratory from performing analyses that cannot be consistently and successfully performed to meet the standards set forth in this manual.

4.2.5 Vice President of Client Services

The VP of Client Services leads the Client Service Organization (CSO) and is responsible for client satisfaction, driving operational excellence and improving client responsiveness. The VP provides direction to the Client Service Directors, Programs Managers and Project Managers.

4.2.6 Executive Director of Quality and EHS

The Executive Director of Quality and Environmental Health & Safety (EHS) reports directly to the VP of Quality, Technical & Operations Support. With the aid of the Executive Committee, Laboratory Directors, Quality Directors and QA Managers, the Exec. Director of Quality & EHS has the responsibility for the establishment, general overview and Corporate maintenance of the Quality Assurance Program within TestAmerica. Additional responsibilities include:

- Review of QA/QC aspects of Corporate SOPs & Policies, national projects and expansions or changes in services.
- Work with various organizations outside of TestAmerica to further the development of quality standards and represent TestAmerica at various trade meetings.
- Preparation of a monthly report that includes quality metrics across the analytical laboratories and a summary of any quality related initiatives and issues.

4.2.7 Quality Assessment Director

The Quality Assessment Director reports to the Exec. Director of Quality & EHS. The Quality Assessment Director has QA oversight of laboratories; responsible for the internal audit system, schedule and procedure; monitors laboratory internal audit findings; identifies common laboratory weaknesses; and monitors corrective action closures. Together with the Quality Compliance Director, the Quality Systems Director, and the Exec. Director of Quality & EHS, the Quality Assessment Director has the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within TestAmerica.

4.2.8 Quality Compliance Director

The Quality Compliance Director reports to the Exec. Director of Quality & EHS. The Quality Compliance Director has QA oversight of laboratories; monitors and communicates DoD / DoE requirements; develops corporate tools for ensuring and improving compliance; develops corporate assessment tools; identifies common laboratory weaknesses; and monitors corrective

action closures. Together with the Quality Assessment Director, Quality Systems Director and the Exec. Director of Quality & EHS, the Quality Compliance Director has the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within TestAmerica.

4.2.9 Quality Systems Director

The Quality Systems Director reports to the Exec. Director of Quality & EHS. The Quality Systems Director has QA oversight of laboratories; develops quality policies, procedures and management tools; monitors and communicates regulatory and certification requirements; identifies common laboratory weaknesses; and monitors corrective action closures. Together with the Quality Assessment Director, Quality Compliance Director and the Exec. Director of Quality & EHS, the Quality Systems Director has the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within TestAmerica.

4.2.10 Quality Information Manager

The Quality Information Manager is responsible for managing all company official documents (e.g., Policies, Procedures, Work Instructions), the company's accreditation database, intranet websites, external laboratory subcontracting, regulatory limits for clients on the company's TotalAccess website; internal and external client support for various company groups (e.g., Client Services, EH&S, Legal, IT, Sales) for both quality and operational functions. The Quality Information Manager reports to the Exec. Director of Quality & EHS; and works alongside the Quality Assessment, Quality Compliance and Quality System Directors and EHS Managers to support both the Analytical Quality Assurance and EHS Programs within TestAmerica.

4.2.11 Technical Services Director

The Technical Services Director is responsible for establishing, implementing and communicating TestAmerica's Analytical Business's Technical Policies, SOPs, and Manuals. Other responsibilities include conducting technical assessments as required, acting as a technical resource in national contracts review, coordinating new technologies, establishing best practices, advising staff on technology advances, innovations, and applications.

4.2.12 Ethics and Compliance Officers (ECOs)

TestAmerica has designated two senior members of the Corporate staff to fulfill the role of Ethics and Compliance Officer (ECO) – Corporate Counsel and Vice President of Human Resources and the Exec. Director of Quality and EHS Each ECO acts as a back-up to the other ECO and both are involved when data investigations occur. Each ECO has a direct line of communication to the entire senior Corporate and lab management staff.

The ECOs ensure that the organization distributes the data integrity and ethical practices policies to all employees and ensures annual trainings and orientation of new hires to the ethics program and its policies. The ECO is responsible for establishing a mechanism to foster employee reporting of incidents of illegal, unethical, or improper practices in a safe and confidential environment.

The ECOs monitor and audit procedures to determine compliance with policies and to make recommendations for policy enhancements to the CEO~~s~~, VPOs, Laboratory Director or other

appropriate individuals within the laboratory. The ECO will assist the laboratory QA Manager in the coordination of internal auditing of ethical policy related activities and processes within the laboratory, in conjunction with the laboratories regular internal auditing function.

The ECOs will also participate in investigations of alleged violations of policies and work with the appropriate internal departments to investigate misconduct, remedy the situation, and prevent recurrence of any such activity.

4.2.13 Chief Information Officer (CIO)

The CIO is responsible for establishing, implementing and communicating TestAmerica's Information Technology (IT) Policies, SOPs and Manuals. Other responsibilities include coordinating new technologies, development of electronic communication tools such as TestAmerica's intranet and internet sites, ensuring data security and documentation of software, ensuring compliance with the NELAC standard, and assistance in establishing, updating, and maintaining Laboratory Information Management Systems (LIMS) at the various TestAmerica facilities.

4.2.14 Environmental Health and Safety Managers (Corporate)

The EHS Managers report directly to the Exec. Director of Quality and EHS. The EHS Managers are responsible for the development and implementation of the TestAmerica Environmental, Health and Safety program. Responsibilities include:

- Consolidation and tracking all safety and health-related information and reports for the company, and managing compliance activities for TestAmerica locations.
- Coordination/preparation of the corporate Environmental, Health and Safety Manual Template that is used by each laboratory to prepare its own laboratory-specific Safety Manual/ CHP.
- Preparation of information and training materials for laboratory EHS Coordinators.
- Assistance in the internal and external coordination of employee exposure and medical monitoring programs to insure compliance with applicable safety and health regulations.
- Serving as Department of Transportation (DOT) focal point and providing technical assistance to location management.
- Serving as Hazardous Waste Management main contact and providing technical assistance to location management.

4.2.15 Laboratory Director

TestAmerica Denver's Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource and service performance of the whole laboratory and reports to their respective VP of Operations. The Laboratory Director provides the resources necessary to implement and maintain an effective and comprehensive Quality Assurance and Data Integrity Program. The role of the Lead Technical Manager at TestAmerica Denver as required by NELAP is fulfilled by the Laboratory Director.

Specific responsibilities include, but are not limited to:

- Providing one or more technical managers for the appropriate fields of testing. If the Technical Manager is absent for a period of time exceeding 15 consecutive calendar days, the Laboratory Director must designate another full time staff member meeting the qualifications of the Technical Manager to temporarily perform this function. If the absence exceeds 65 consecutive calendar days, the primary accrediting authority must be notified in writing.

- Ensuring that all analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented.

- Ensuring that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work.

- Ensuring TestAmerica's human resource policies are adhered to and maintained.

- Ensuring that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory.

- Ensuring that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director.

- Reviewing and approving all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to.

- Pursuing and maintaining appropriate laboratory certification and contract approvals.

- Supporting ISO 17025 requirements.

- Supporting DoD ELAP requirements.

- Ensuring client specific reporting and quality control requirements are met.

- Directing the management team, consisting of the QA Manager, the Operations Manager, the EH&S Coordinator and the Office Manager as direct reports.

4.2.16 Quality Assurance (QA) Manager or Designee

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system.

The QA Manager reports directly to the Laboratory Director and to their Corporate Quality Director. This person is able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence. Corporate QA may be used as a resource in dealing with regulatory requirements, certifications and other quality assurance related items. This person has documented training and/or experience in QA/QC procedures and the laboratory's Quality System. The QA Manager directs the activities of the QA officers to accomplish specific responsibilities, which include, but are not limited to:

- Serving as the focal point for QA/QC in the laboratory.
- Having functions independent from laboratory operations for which he/she has quality assurance oversight.
- Maintaining and updating the QAM.
- Monitoring and evaluating laboratory certifications; scheduling proficiency testing samples.
- Monitoring and communicating regulatory changes that may affect the laboratory to management.
- Training and advising the laboratory staff on quality assurance/quality control procedures that are pertinent to their daily activities.
- Having documented training and/or experience in QA/QC procedures and the laboratory's Quality System.
- Having a general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed).
- Arranging for or conducting internal audits on quality systems and the technical operation.
- Maintaining records of all ethics-related training, including the type and proof of attendance.
- Maintaining, improving, and evaluating the corrective action database and the corrective and preventive action systems.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs shall be investigated following procedures outlined in Section 12 and if deemed necessary may be temporarily suspended during the investigation.
- Objectively monitoring standards of performance in quality control and quality assurance without outside (e.g., managerial) influence.
- Coordinating document control of SOPs, MDLs, control limits, and miscellaneous forms and information.
- Reviewing a percentage of all final data reports for internal consistency. Reviewing Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness of any corrective action statements, 5% of calculations, format, holding time, sensibility and completeness of the project file contents.
- Reviewing external audit reports and data validation requests.
- Following-up with audits to ensure client QAPP requirements are met.
- Establishing reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.

- Developing suggestions and recommendations to improve quality systems.
- Researching current state and federal requirements and guidelines.
- Directing the QA team to enable communication and to distribute duties and responsibilities.
- Ensuring communication with laboratory staff and monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs are temporarily suspended following the procedures outlined in Section 12.
- Evaluating the thoroughness and effectiveness of training.
- Assuring compliance with ISO 17025.
- Assuring compliance with DoD ELAP.

4.2.17 Quality Assurance Specialist

The Quality Assurance Specialist performs several roles. The QA Specialist reports to the facility QA Manager. The QA Specialist is responsible for QA documentation and involvement in the following activities:

- Assisting the QA Manager in performing the annual internal laboratory audits, compiling the evaluation, and coordinating the development of an action plan to address any deficiency identified.
- Facilitating external audits, coordinating with the QA Manager and Laboratory Staff to address any deficiencies noted at the time of the audit and subsequently presented in the final audit report.
- Assisting the QA Manager in the preparation of new SOPs and in the maintenance of existing SOPs, coordinating annual reviews and updates.
- Managing the performance testing (PT) studies, coordinates follow up studies for failed analytes and works with QA Manager and Laboratory Staff to complete needed corrective action reports.
- Reviewing and maintaining personnel training records.
- Documenting control maintenance.
- Assisting the Quality Manager and Project Management Group in the review of program plans for consistency with organizational and contractual requirements. Summarize and convey to appropriate personnel anomalies or inconsistencies observed in the review process.
- Managing certifications and accreditations.

- Monitoring for compliance with the following QA Metrics: Temperature Monitoring of refrigeration units; thermometer calibrations; balance calibrations; eppendorf/pipette calibrations; and proper standard/reagent storage.
- Periodically checking the proper use and review of instrument logs.
- Initiating the Mint-miner data file review process for organic instrumentation.
- Initiating the annual Instrument review.
- Assisting in the technical review of data packages which require QA review.
- Assisting the QA Manager in meeting the responsibilities of the QA Department as described in laboratory policies and SOPs.

4.2.18 Quality Assurance Assistant

The Quality Assurance Assistant performs several roles. The QA Assistant reports to the facility QA Manager. The QA Assistant is responsible for QA documentation and involvement in the following activities:

- Assisting the QA Manager in performing the annual internal laboratory audits, compiling the evaluation, and coordinating the development of an action plan to address any deficiency identified.
- Serving as a project manager for proficiency testing samples and other QC samples. Processes and reports QC samples as routine samples to appropriate agencies.
- Assisting the QA Manager in maintaining the laboratory's reference data to keep it current and accurate.
- Preparing certification applications for states as directed by QA Manager.
- Reviewing and maintaining personnel training records.
- Performing document control maintenance.
- Assisting departments in generating MDL spreadsheets and calculations, reviewing MDL studies submitted to QA.
- Assisting in control limit generation.
- Ensuring maintenance of records archives.
- Maintaining historical indices for all technical records including SOPs, QC records, laboratory data, etc.
- Assisting the QA Manager in meeting the responsibilities of the QA Department as described in laboratory policies and SOPs.

4.2.19 Operations Manager (referred to in this document as Technical Manager)

The Operations Manager (Technical Manager) reports directly to the Laboratory Director. He/she is accountable for all analyses and analysts under their experienced supervision and for compliance with the ISO 17025 Standard. The scope of responsibility ranges from the new-hire process and existing technology through the ongoing training and development programs for existing analysts and new instrumentation. Specific responsibilities include, but are not limited to:

- Exercising day-to-day supervision of laboratory operations for the appropriate field of accreditation and reporting of results. Coordinating, writing, and reviewing preparation of all test methods, i.e., SOPs, with regard to quality, integrity, regulatory and optimum and efficient production techniques, and subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples. He/she insures that the SOPs are properly managed and adhered to at the bench. He/she develops standard costing of SOPs to include supplies, labor, overhead, and capacity (design versus demonstrated versus first-run yield) utilization.

- Reviewing and approving, with input from the QA Manager, proposals from marketing, in accordance with an established procedure for the review of requests and contracts. This procedure addresses the adequate definition of methods to be used for analysis and any limitations, the laboratory's capability and resources, the client's expectations. Differences are resolved before the contract is signed and work begins. A system documenting any significant changes is maintained, as well as pertinent discussions with the client regarding their requirements or the results of the analyses during the performance of the contract. All work subcontracted by the laboratory must be approved by the client. Any deviations from the contract must be disclosed to the client. Once the work has begun, any amendments to the contract must be discussed with the client and so documented.

- Monitoring the validity of the analyses performed and data generated in the laboratory. This activity begins with reviewing and supporting all new business contracts, insuring data quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process (training, development, and accountability at the bench), and providing technical and troubleshooting expertise on routine and unusual or complex problems.

- Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.

- Enhancing efficiency and improving quality through technical advances and improved LIMS utilization. Capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.

- Coordinating sample management from "cradle to grave," insuring that no time is lost in locating samples.

- Evaluating the level of internal/external non-conformances for all departments.

- Continuously evaluating turnaround time and addressing any problems that may hinder meeting the required and committed turnaround time from the various departments.
- Developing and improving the training of all analysts in cooperation with the Laboratory Director and QA Manager and in compliance with regulatory requirements.
- Working with the Department Managers/Supervisors to ensure that scheduled instrument maintenance is completed.
- Ensuring efficient utilization of supplies
- Constantly monitoring and modifying the processing of samples through the departments.
- Fully supporting the quality system.
- Ensuring Department Managers/Supervisors schedule all QA/QC-related requirements for compliance, e.g., MDLs, control chart review, etc.
- Directing department personnel to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.
- Coordinating audit responses with the QA Manager.
- Assuring compliance with ISO 17025.
- Assuring compliance with DoD ELAP.

4.2.20 Radiation Safety Officer

The Radiation Safety Officer (RSO) is responsible for implementing TestAmerica Denver's radiation safety program. The RSO reports directly to the Laboratory Director. The RSO's duties consist of:

- Managing the personnel radiation dosimetry program
- Maintaining the Radioactive Materials License and radionuclide inventory
- Monitoring laboratory operations for compliance with the Radiation Safety Manual
- Training, documenting, and evaluating the TestAmerica Denver personnel for handling radioactive material
- Creating, releasing, and decontaminating Radiological Control Areas (RCAs)
- Monitoring and tracking radioactive materials
- Conducting the radioactive material waste disposal program in accordance with State and Federal regulations
- Maintaining all records related to the radiation safety program

4.2.21 Employee Health and Safety Coordinator

The Employee Health and Safety Coordinator (EH&S Coordinator) is responsible for administering the EH&S program that provides a safe, healthy working environment for all employees and the environment. The EH&S Coordinator reports directly to the Laboratory Director and the corporate Environmental Health and Safety Director. He/She monitors all areas for unsafe conditions, acts, and potential hazards. Specific responsibilities include, but are not limited to:

- Staying current with the hazardous waste regulations
- Continuing training on hazardous waste issues
- Reviewing and updating annually the Hazardous Waste Contingency Plan in the Environmental Health and Safety Manual
- Auditing the staff with regard to compliance with the Hazardous Waste Contingency Plan
- Contacting the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste
- Conducting ongoing, necessary safety training and conducting new employee safety orientation
- Assisting in development and maintenance of the Chemical Hygiene/Safety Manual
- Administering dispersal of all Safety Data Sheet (SDS) information
- Performing regular chemical hygiene and housekeeping instruction
- Giving instruction on proper labeling and practice
- Serving as chairman of the laboratory safety committee
- Providing and training personnel on protective equipment
- Overseeing the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash fountains, etc. and ensure prompt repairs as needed
- Supervising and scheduling fire drills and emergency evacuation drills
- Determining initial and subsequent exposure monitoring, if necessary, to determine potential employee exposure to chemicals used in the laboratory
- Conducting exposure monitoring assessments, as needed
- Determining when a complaint of possible over-exposure is “reasonable” and should be referred for medical consultation
- Assisting in the internal and external coordination of the medical consultation/monitoring

program conducted by TestAmerica's medical consultants

- Conducting weekly inspections of satellite accumulation areas and all hazardous waste storage areas
- Coordinating the proper storage, packing and disposal of laboratory wastes according to Department of Transportation (DOT) and Resource Conservation and Recovery Act (RCRA) regulations
- Maintaining waste disposal records
- Coordinating spill response activities including documentation for waste storage areas

4.2.22 Waste Disposal Technician

The Waste Disposal Technician is responsible for proper disposal of spent chemicals, process waste, and unused laboratory samples used in the laboratory according to corporate, federal, state, and local guidelines. The Waste Disposal Technician reports to the Hazardous Waste Specialist and EH&S Coordinator. The duties consist of:

- Packaging hazardous waste for transport per DOT, RCRA and TSCA guidelines
- Identifying waste streams and maintaining satellite accumulation areas
- Packaging expired chemicals for shipment or disposal
- Tracking volume of waste generated for reporting to corporate and EPA
- Preparing and tracking implementation of the Waste Minimization Plan
- Emptying satellite containers into bulk containers and returns to the laboratory for reuse

4.2.23 Department Manager/Supervisor

Department Managers/Supervisors report to the Operations Manager. At TestAmerica Denver these individuals may have the title of Department Manager I or II or Supervisor I or II. The title and level designation are based on the level of experience. He/she is accountable for all analyses and analysts under their experienced supervision and act as the Technical Managers in their assigned area in compliance with TNI requirements and for compliance with the ISO 17025 Standard. The scope of responsibility ranges from the new-hire process and existing technology through the ongoing training and development programs for existing analysts and new instrumentation. Specific responsibilities include, but are not limited to:

- Exercising day-to-day supervision of laboratory operations for the appropriate field of accreditation and reporting of results.
- Ensuring that analysts in their department adhere to applicable SOPs and the QA Manual. They perform frequent SOP and QA Manual review to determine if analysts are in compliance and if new, modified, and optimized measures are feasible and should be added to these documents.

- Coordinating, writing, and reviewing documentation of all test methods, i.e., SOPs, with regard to quality, integrity, regulatory requirements and optimum and efficient production techniques, and subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples.

- Reviewing and approving, with input from the QA Manager, Quality Assurance Project Plans (QAPPs). This procedure addresses the adequate definition of methods to be used for analysis and any limitations, the laboratory's capability and resources and the client's expectations. Differences are resolved before the contract is signed and work begins. A system documenting any significant changes is maintained, as well as pertinent discussions with the client regarding their requirements or the results of the analyses during the performance of the contract. Any deviations from the contract must be disclosed to the client. Once the work has begun, any amendments to the contract must be discussed with the client and so documented.

- Monitoring the validity of the analyses performed and data generated in the laboratory. This activity begins with reviewing and supporting all new business contracts, insuring data quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process (training, development, and accountability at the bench), and providing technical and troubleshooting expertise on routine and unusual or complex problems.

- Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.

- Enhancing efficiency and improving quality through technical advances, improved LIMS utilization, capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.

- Coordinating sample management from "cradle to grave," insuring that no time is lost in locating samples.

- Scheduling all QA/QC-related requirements for compliance, e.g., MDLs, etc.

- Directing department personnel to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.

- Coordinating audit responses with the QA Manager.

- Complying with ISO 17025, The NELAC Institute (TNI) Standard, DOD ELAP and the various QC programs implemented at the Denver laboratory.

- Participating in the selection, training (familiarization with SOP, QC, Safety and computer systems), developing performance objectives and standards of performance, appraising (measurement of objectives), scheduling, counseling, disciplining, and motivating analysts and documenting these activities in accordance with systems developed by the QA and Personnel Departments.

- Evaluating staffing sufficiency and overtime needs.

- Encouraging the development of analysts to become cross-trained in various methods and/or operate multiple instruments efficiently while performing maintenance and documentation, self-supervise, and function as a department team.

- Providing guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the Operations Manager, and/or QA Manager. Each is responsible for 100% of the data review and documentation, non-conformance and corrective actions, the timely and accurate completion of performance evaluation samples and MDLs, for his/her department.

- Ensuring all logbooks are maintained, current, reviewed, and properly labeled or archived.

- Reporting all non-conformance conditions to the QA Manager, Operations Manager, and/or Laboratory Director.

- Ensuring that preventive maintenance is performed on instrumentation as detailed in the QA Manual or SOPs. He/She has responsibility for developing and implementing a system for preventive maintenance, troubleshooting, and repairing or arranging for repair of instruments.

- Maintaining adequate and valid inventory of reagents, standards, spare parts, and other relevant resources required to perform daily analysis.

- Achieving optimum turnaround time on analyses and compliance with holding times.

- Conducting efficiency and cost control evaluations on an ongoing basis to determine optimization of labor, supplies, overtime, first-run yield, capacity (designed vs. demonstrated), second- and third-generation production techniques/instruments, and long-term needs for budgetary planning.

- Developing and implementing calibration programs.

- Providing written responses to external and internal audit issues.

4.2.24 Laboratory Analysts

Laboratory analysts are responsible for conducting analysis and performing all tasks assigned to them by the group leader or supervisor. The Analyst position at TestAmerica Denver is divided into levels. These levels range from Analyst I to Analyst V. The level designation is based on experience, expertise, and responsibilities. The responsibilities of the analysts are listed below:

- Performing analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.

- Documenting standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on worklists, benchsheets, lab notebooks and/or the Non-Conformance Memo module in the LIMS.

- Reporting all non-conformance situations, instrument problems, matrix problems and QC

failures, which might affect the reliability of the data, to their supervisor, the Technical Manager, and/or the QA Manager or member of QA staff.

- Performing 100% review of the data generated prior to entering and submitting for secondary level review.

- Suggesting method improvements to their supervisor, the Technical Manager, and the QA Manager. These improvements, if approved, will be incorporated. Providing ideas for the optimum performance of their assigned area, for example, through the proper cleaning and maintenance of the assigned instruments and equipment, are encouraged.

- Working cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

4.2.25 Laboratory Technician

Laboratory Technicians are responsible for the preparation of samples and performing all tasks assigned to them by the group leader or supervisor. The Laboratory Technician position at TestAmerica Denver is divided into three levels. These levels are Laboratory Technician I, Laboratory Technician II, and Laboratory Technician III. The level designation is based on experience, expertise, and responsibilities. The responsibilities of the Laboratory Technician are listed below:

- Retrieving samples from Sample Control for analysis

- Performing sample preparation by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.

- Documenting standard and sample preparation, sample matrix effects, and any observed non-conformance on worklists, benchsheets, lab notebooks and/or the Non-Conformance Database.

- Reporting all non-conformance situations, sample preparation problems, matrix problems and QC failures, which might affect the reliability of the data, to their supervisor, the Technical Manager, and/or the QA Manager or member of QA staff.

- Working cohesively as a team member in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

4.2.26 Laboratory Assistant

The Laboratory Assistant position is an entry-level position to learn basic laboratory technician skills. The Laboratory Assistant reports to their group leader or supervisor. The Laboratory Assistant's duties include the following:

- Assisting the Laboratory Technicians in preparation of samples for analysis

- Preparing routine forms and reports

- Collecting and preparing materials and supplies for the laboratory
- Assisting technicians in conducting routine analysis.

4.2.27 Sample Receiving Supervisor

The Sample Receiving Supervisor reports to the Operations Manager. The responsibilities are outlined below:

- Managing department resources in cooperation.
- Serving as liaison between the Sample Receiving, the Customer Service Organization (CSO) and operations.
- Directing the logging of incoming samples into the LIMS
- Ensuring the verification of data entry from login
- Providing daily assessments of sample receipts
- Monitoring the preparation and shipment of bottle kits to clients
- Overseeing the receipt, log in, and storage of samples
- Scheduling couriers for sample pickup from customer sites

4.2.28 Sample Control Technician

The Sample Control Technician reports to the Sample Receiving Supervisor. The Sample Control Technician position at TestAmerica Denver is divided into levels. These levels range from Sample Control Technician I to Sample Control Technician IV. The level designation is based on experience and responsibilities of the Technician. The Sample Control Technician responsibilities include the following:

- Receiving and unloading samples or consignments in accordance with DOT regulations
- Verifying samples against the Chain of Custody (COC)
- Logging samples into the LIMS to assign a lot number for tracking purposes and distribute the paperwork to the Project Managers and Department Managers/Supervisors
- Labeling samples with lot number assigned and deliver the samples to the appropriate labs for analysis daily
- Monitoring freezer and cooler temperatures daily to confirm that the readings are within SOP guidelines
- Shipping all subcontracted samples to designated lab in accordance with DOT regulations as needed

4.2.29 Shipping/Maintenance Technician

The Shipping/Maintenance Technician reports to the Sample Receiving Supervisor. The Shipping/Maintenance Technician duties include the following:

- Maintaining the inventory control system
- Receiving and distributing incoming supplies
- Preparing and shipping bottle sampling kits to clients or on-site crews
- Maintaining bottle and cooler inventory
- Packing in-house samples for shipment to other laboratories

4.2.30 Courier

The Courier reports to the Sample Receiving Supervisor. The Courier's duties include the following:

- Picking up and delivering samples and reports to clients and the laboratory
- Receiving and signing the chain of custody for samples
- Preparing and shipping bottle sampling kits to clients or on-site crews
- Performing preventative maintenance on company vehicles

4.2.31 Manager of Client Relations Managers

The Manager of Client Relations Managers mentors a regional team of Client Relations Managers (CRMs), coordinating workload and ensuring that bids and proposals are provided on schedule. The Manager of Client Relations Managers reports to the Client Services Director. The responsibilities of this position include:

- Managing the CRM team to ensure that bids are provided to clients in a timely manner
- Providing oversight to CRMs regarding pricing decisions
- Providing guidance to the CRMs for compilation of large bids and proposals such as strategy and content
- Providing guidance for professional development of the CRMs

4.2.32 Client Relations Manager

The Client Relations Manager (CRM) is accountable for new client setup, account maintenance, document review, quotes and proposals, and project kick-off. The CRM role fosters and develops client relationships in support of the CSO mission. The duties of this position include:

- Verifying that that lab certification meets project requirements for new quotes

- Verifying that lab compound lists and limits meet project requirements for new quotes
- Confirming that EDD format is available for new quotes
- Engaging workshare labs, service centers and non-TA locations as needed for new quotes
- Providing supporting documentation to the client as needed
- Setting up new clients initiating project QAPP review with operations, QA and subcontract labs as needed
- Initiating technical support from operations as needed
- Providing quotes
- Communicating with clients to ensure client requirements are being met and complaints are communicated to the appropriate personnel within TestAmerica for resolution

4.2.33 Manager of Project Management

The Manager of Project Management reports to the Regional Client Services Director and serves as the interface between the laboratory's technical departments and the laboratory's clients. The staff consists of the Project Management team. With the overall goal of total client satisfaction, the duties of this position are outlined below:

- Managing technical training and growth of the Project Management team
- Serving as technical liaison for the Project Management team
- Providing human resource management of the Project Management team
- Overseeing response to client inquiries concerning sample status
- Assisting clients regarding the resolution of problems concerning COC
- Ensuring that client specifications are met by communicating project and quality assurance requirements to the laboratory
- Notifying the supervisors of incoming projects and sample delivery schedules
- Being accountable to clients for communicating sample progress in daily status meeting with agreed-upon due dates
- Discussing with clients any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff
- Monitoring the status of all data package projects in-house to ensure timely and accurate delivery of reports
- Informing clients of data package-related problems and resolve service issues

4.2.34 Project Manager

The Project Managers report to the Manager of Project Management (MPM) and serve as liaisons between the laboratory's technical departments and the laboratory's clients. At TestAmerica Denver there are two levels of Project Managers (I or II). The level designation is based on experience, expertise, and responsibilities. The Project Manager's responsibilities include:

- Ensuring client specifications are met by communicating project and quality assurance requirements to the laboratory
- Notifying laboratory personnel of incoming projects and sample delivery schedules
- Monitoring the status of all projects in-house to ensure timely delivery of reports
- Informing clients of project-related problems, resolving service issues and coordinating technical issues with the laboratory staff
- Assisting clients regarding the resolution of problems concerning COC
- Coordinating client requests for sample containers and ensuring clients receive the proper sampling supplies
- Scheduling sample pick-ups from client offices or project sites and notifying the laboratory staff of incoming samples
- Coordinating subcontract work
- Responding to client inquiries concerning sample status
- Assisting clients with resolution of problems concerning Chains-of-Custody

4.2.35 Manager of Project Management Assistants

The Manager of Project Management Assistants (PMAs) reports to the Manager of Project Management. The Manager of PMAs responsibilities include:

- Supporting Project Management staff to meet the mission of the Client Service Organization
- Supervising the Project Management Assistants
- Managing technical training and growth of the Project Management Assistants team

4.2.36 Project Management Assistant

The Project Management Assistant reports to the Manager of Project Management Assistants and designated Project Managers. The Project Management Assistant assists the Project Manager in servicing the client's needs and communicating those needs to the laboratory. The Project Management Assistant's responsibilities include:

- Collating data reports, expanded deliverables, and electronic data deliverables (EDD's) for

delivery to clients.

- Writing case narratives accompanying data packages to communicate anomalies to clients
- Proof reading and filing data reports received from the laboratory
- Assisting Project Managers in changing compound lists, TAT, and setting up tables in Word or Excel
- Monitoring report due dates for timely delivery
- Invoicing completed data packages
- Generating credit or debit invoices to ensure proper payment
- Copying and paginating reports

4.3 Deputies

The following table defines who assumes the responsibilities of key personnel in their absence. See WI-DV-0071 for the current list of personnel in these roles.

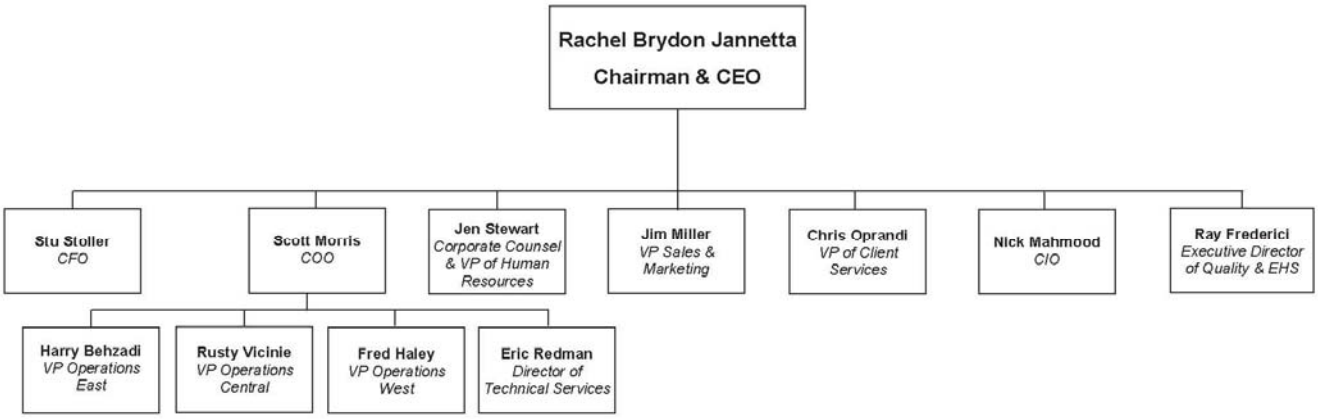
Key Personnel	Deputy
Laboratory Director	Administrative Duties: Office Manager Technical and Operations Duties: Operations Manager
Quality Manager	Quality Assurance Specialist
Operations Manager	Department Manager/Supervisor
EHS Coordinator	Backup EHS Coordinator
Radiation Safety Officer	Backup Radiation Safety Officer
CSO Manager of Project Management	CSO Manager of Project Management Assistants

Figure 4-1. Corporate and Laboratory Organization Charts

The current version of this organization chart is available on Oasis.

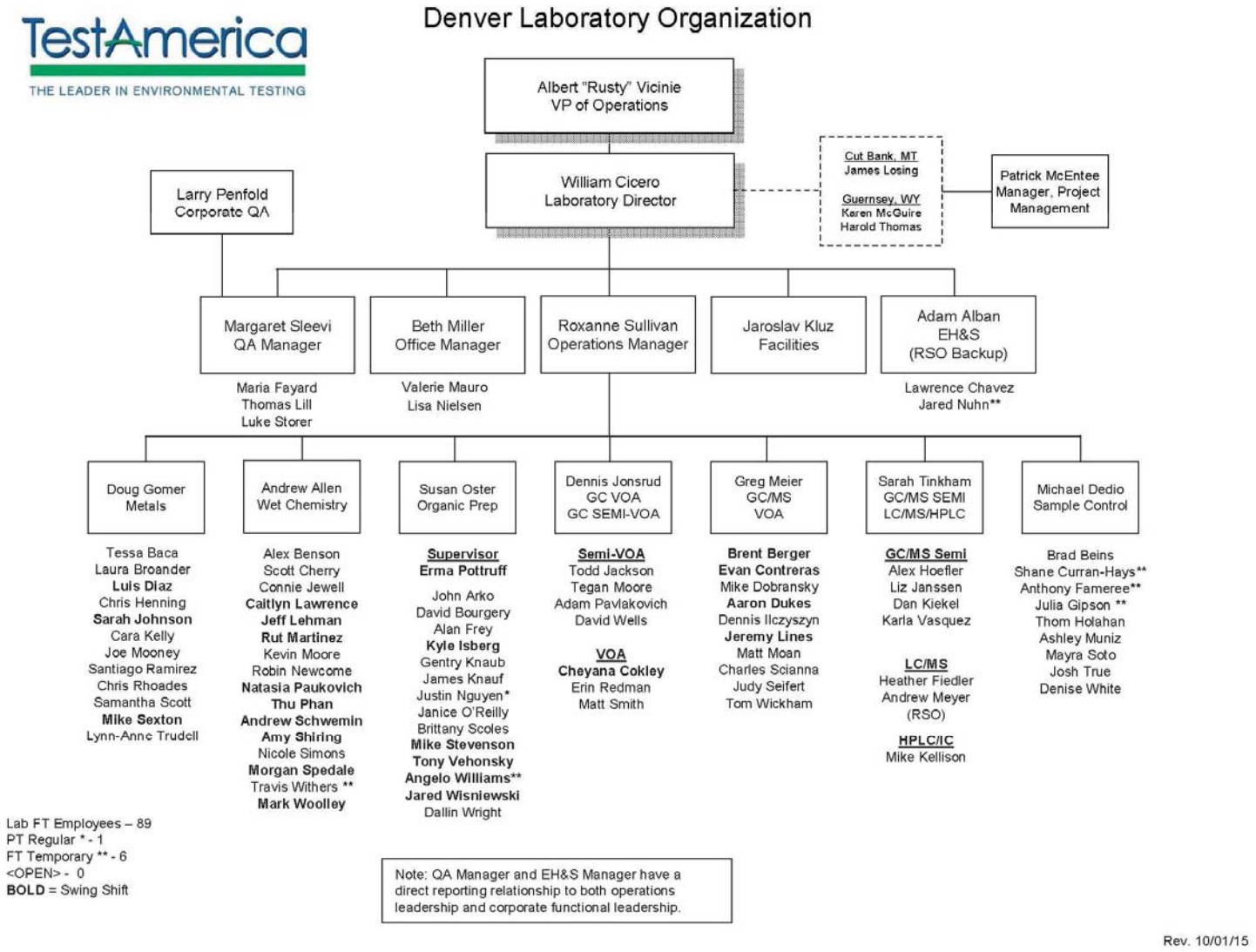
TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Executive Team



17 August 2015

Figure 4-1. Corporate and Laboratory Organization Charts (cont.)



The current version of this organization chart is available on the public drive:
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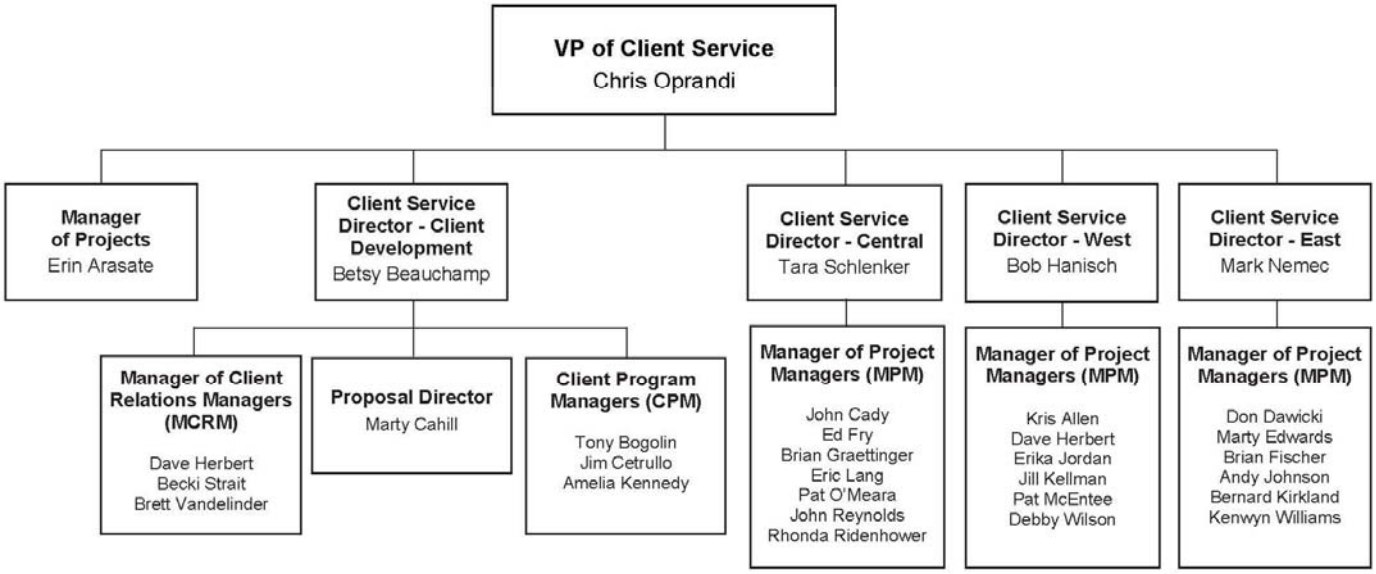
Figure 4-1. Corporate and Laboratory Organization Charts (cont.)

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Service Organization



- **Manager of Projects –** Oversee and lead major project initiatives as well as drive training and development of staff.
- **Client Service Director (CSD) - Client Development –** Responsible for oversight of the Client Relations Managers, Proposal Managers and Client Program Managers.
- **Client Service Director (CSD) - East, Central and West –** Responsible for all daily client service in a region. Includes oversight of Project Managers and Project Manager Assistants. Regions are aligned closely to Operational VPO regions.
- **Client Relations Manager (CRM) –** Support key business development actions including quote and proposal development and information transfer between clients, sales, project management and operations.
- **Proposal Director –** Responsible for coordinating and preparing large, complex response for proposals.
- **Client Program Managers (CPM) –** Key contact for National Account Clients with focus on enhancing communications and driving ease of use both externally and internally.
- **Manager of Project Managers (MPM)** - Responsible for oversight of the Project Managers and Project Manager Assistants.

Effective April 20, 2015

The current version of this organization chart is available on the public drive:
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SECTION 5. QUALITY SYSTEM

5.1 Quality Policy Statement

It is TestAmerica's Policy to:

- Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.
- Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.
- Continually improve systems and provide support to quality improvement efforts in laboratory, administrative and managerial activities. TestAmerica recognizes that the implementation of a quality assurance program requires management's commitment and support as well as the involvement of the entire staff.
- Provide clients with the highest level of professionalism and the best service practices in the industry.
- Comply with the ISO/IEC 17025:2005(E) International Standard, the 2009 TNI Standard and to continually improve the effectiveness of the management system.

Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 Ethics and Data Integrity

TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of TestAmerica's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy No. CW-L-P-004) and Employee Ethics Statements.
- Ethics and Compliance Officers (ECOs).
- A Training Program.
- Self-governance through disciplinary action for violations.
- A Confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct. (Corporate SOP No. CW-L-S-002).
- Procedures and guidance for recalling data if necessary (Corporate SOP No. CW-L-S-002).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15).

These elements assure that the laboratory is able to:

- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs).

- Present services in a confidential, honest and forthright manner.
- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of this industry.
- Operate the facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of this industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 Quality System Documentation

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab-specific quality assurance manual.
- Corporate SOPs and Policies – Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.
- Work Instructions – A subset of procedural steps, tasks or forms associated with an operation of a management system (e.g., checklists, preformatted bench sheets, forms).
- Laboratory SOPs – General and Technical
- Laboratory Policy Memoranda – Quality or Administrative policies issued by the QA Manager and/or Laboratory Director to address requirements not otherwise detailed in SOPs or Work Instructions.

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory Policy Memoranda
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), memos, forms, flow charts, checklists, etc.)

Note: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's QAM shall take precedence over the CQMP in those cases.

5.4 QA/QC Objectives for the Measurement of Data

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control is generally understood to be limited to the analyses of samples and to be synonymous with the term *"analytical quality control"*. QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. Additionally, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS).

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be

documented by the relative percent difference between separately procured, but otherwise identical samples or sample aliquots.

The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision and reporting limits with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability will be defined in a QAPP, project scope or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), interelement corrections (separation), use of matrix modifiers (separation), specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific wavelengths (identification), specific mass spectra (identification), specific electrodes (separation and identification), etc.

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Method Detection Limit) or quantified (Reporting Limit).

5.5 Criteria for Quality Indicators

The laboratory maintains a *Quality Control Limit Summary* in the LIMS referred to as a *"Method Limit Group"* that summarizes the precision and accuracy acceptability limits for each performed analysis. This summary includes an effective date, is updated each time new limits are generated and are managed by the laboratory's QA department. Unless otherwise noted, limits

within these tables are laboratory generated. Some acceptability limits are derived from US EPA methods when they are required or other programs such as DoD QSM. Where US EPA method limits are not required or program limits are not available, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits are contained in SOP DV-QA-003P, Quality Assurance Program.

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846). The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The analysts are instructed to use the current limits in the Laboratory Information Management System (LIMS). Limits are entered into the Method Limit Groups according to the effective date. Historical limits can be obtained using the "Historical" feature in the LIMS. If a method defines the QC limits, the method limits are used.

If a method requires the generation of historical limits, the laboratory develops such limits from recent data in the QC database of the LIMS following the guidelines described in Section 24. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project. These are stored in the project in the LIMS and are used only for samples assigned to that project.

As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.6.1 QC Charts

As the QC limits are calculated in the Control Chart Module in the LIMS, QC charts are generated showing warning and control limits for the purpose of evaluating trends. Refer to SOP DV-QA-003P for a description of the control chart process and evaluation of trends. The Department Managers/Supervisors evaluate these to determine if adjustments need to be made or for corrective actions to methods and submits requests for limits updates to the QA Manager. The QA manager assesses the limits to determine if they will be updated or requests corrective action to the method procedure. All findings are documented and kept on file.

5.7 Quality System Metrics

In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

SECTION 6. DOCUMENT CONTROL

6.1 Overview

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled:

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Corporate Policies and Procedures distributed outside the intranet

Corporate Quality posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP No. CW-Q-S-001, Corporate Document Control and Archiving. The laboratory's internal document control procedure is defined in SOP DV-QA-0010, *Document Control*.

The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. Instrument manuals (hard or electronic copies) are also maintained by the laboratory.

The laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports. Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports.

6.2 Document Approval and Issue

The pertinent elements of a document control system for each document include a unique document title and number, pagination, the total number of pages of the item or an 'end of document' page, the effective date, revision number and the laboratory's name. The QA personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department. In order to develop a new document, a department manager/supervisor submits an electronic draft to the QA Department for suggestions and approval before use. Upon approval, QA personnel add the identifying version information to the document and retain that document as the official document on file. That document is then provided to all applicable operational units (may include electronic access). Controlled documents are identified as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed at a minimum every year and revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 Procedures for Document Control Policy

For changes to the QA Manual, refer to SOP DV-QA-001P, *Preparation and Management of Standard Operating Procedures (SOPs) and Other Controlled Documents.* Uncontrolled copies must not be used within the laboratory. Previous revisions and back-up data are stored by the QA department. Electronic copies are stored on the Public server in the QA folder (R:\QA\Read\SOPS\ESOPS\ALL) for the current revision. The SOP identified above also defines the process for changes to SOPs.

Forms, worksheets, work instructions and information are organized by department and document type in the QA office. Electronic versions are kept on a hard drive in the QA department; hard copies are kept in QA files. The procedure for the care of these documents is in SOP DV-QA-001P and SOP DV-QA-0010.

6.4 Obsolete Documents

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. In general, obsolete documents are collected from employees according to distribution lists and are marked obsolete on the cover or destroyed. At least one copy of the obsolete document is archived according to SOP DV-QA-0005, *Document Archiving Procedure*.

SECTION 7. SERVICE TO THE CLIENT

7.1 Overview

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to its clients.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (Percent Recovery and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel and information resources to meet the contract, and if the personnel have the expertise needed to perform the

testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica facility or to an outside firm, this will be documented and discussed with the client prior to contract approval. (Refer to Section 8 for Subcontracting Procedures.)

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or TestAmerica, are documented in writing.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

7.2 Review Sequence and Key Personnel

Appropriate personnel will review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the Project Manager (PM) is considered adequate. The PM confirms that the laboratory has any required certifications, that it can meet the client's data quality and reporting requirements and that the lab has the capacity to meet the client's turn around needs. It is recommended that, where there is a sales person assigned to the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

For new, complex or large projects, the proposed contract is given to the Client Relationship Manager or Proposal Team, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in TestAmerica's Corporate SOP No. CA-L-P-002**,** Contract Compliance Policy.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (not necessarily in the order below)

- Contract Administrator
- VP of Operations
- Laboratory Client Relations Manager
- Laboratory Project Manager

- Laboratory and/or Corporate Technical Managers / Directors
- Laboratory and/or Corporate Information Technology Managers/Directors
- Account Executives
- Laboratory and/or Corporate Quality
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors
- The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility.

The Sales Director, Contract Administrator, Account Executive or Proposal Coordinator then submits the final proposal to the client. In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements.

The Contracts Department maintains copies of all signed contracts. TestAmerica Denver's Customer Service Organization maintains copies of all signed contracts for reference locally on the network.

7.3 Documentation

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes.

The contract will be distributed to and maintained by the appropriate sales/marketing personnel and the Account Executive. A copy of the contract and formal quote will be filed with the laboratory PM.

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps a phone log of conversations with the client.

7.3.1 Project-Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, the laboratory assigns a PM to each client. It is the PM's responsibility to ensure that project-specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA department involvement may be needed to assist in the evaluation of custom QC requirements.

PM's are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the

supervisory staff during production meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing. Unique or large programs generally have a Quality Assurance Summary prepared by the PM. This summary is posted on the public Outlook folders for anyone in the lab to access. The Quality Assurance Summary documents all requirements that are non-standard that cannot effectively be done in TALS method comments.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes (e.g., use of a non-standard method or modification of a method) and approvals must be documented prior to implementation. Documentation pertains to any document, e.g., letter, e-mail, variance, contract addendum, which has been signed by both parties.

Such changes are also communicated to the laboratory during production meetings and updated in the Quality Assurance Summary, when applicable. Changes are also updated in the project notes and are introduced to the managers at these meetings or via email. The laboratory staff is introduced to the modified requirements via the PM or the individual laboratory Technical Manager. After the modification is implemented into the laboratory process, documentation of the modification is made in the case narrative of the data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 Special Services

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 15 and 25).

Note: ISO/IEC 17025 states that a laboratory "shall afford clients or their representatives cooperation to clarify the client's request". This topic is discussed in Section 7.

The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

- Providing reasonable access for clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.
- Assisting client-specified third party data validators as specified in the client's contract.
- Providing supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

7.5 Client Communication

Project managers are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project management will maintain ongoing client communication

throughout the entire client project.

The Technical Manager, department managers / supervisors and/or QA Manager are available to discuss any technical questions or concerns that the client may have.

7.6 Reporting

The laboratory works with its clients to produce any special communication reports required by the contract.

7.7 Client Surveys

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service. TestAmerica's Sales and Marketing teams periodically develops lab and client specific surveys to assess client satisfaction.

SECTION 8. SUBCONTRACTING OF TESTS

8.1 Overview

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the TestAmerica laboratories. The phrase "work sharing" refers to internal transfers of samples between the TestAmerica laboratories. The term outsourcing refers to the act of subcontracting tests.

When contracting with clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, it must be assured that the subcontractors or work sharing laboratories understand the requirements and will meet the same commitments the laboratory has made to the client. Refer to TestAmerica's Corporate SOP's on Subcontracting Procedures (CA-L-S-002).

When outsourcing analytical services, the laboratory will assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in TNI/ISO 17025 and/or the client's Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client's analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-TNI accredited work where required.

Project Managers (PMs), Client Relations Managers (CRM), or Account Executives (AE) for the Export Lab (TestAmerica laboratory that transfers samples to another laboratory) are responsible for obtaining client approval prior to subcontracting any samples. The laboratory will advise the client of a subcontract arrangement in writing and when possible approval from the client shall be retained in the project folder. Standard TestAmerica Terms and Conditions include the flexibility to subcontract samples within the TestAmerica laboratories. Therefore, additional advance notification to clients for intra-laboratory subcontracting is not necessary unless specifically required by a client contract.

Note: In addition to the client, some regulating agencies (e.g., USDA) or contracts (e.g., certain USACE projects) may require notification prior to placing such work**.**

8.2 Qualifying and Monitoring Subcontractors

Whenever a PM [or Account Executive (AE) or Client Relations Manager (CRM), etc.] becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory;
- Firms specified by the client for the task (Documentation that a subcontractor was designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder);
- Firms listed as pre-qualified and currently under a subcontract with TestAmerica. A listing of all approved subcontracting laboratories is available on the TestAmerica intranet site. Supporting documentation is maintained by corporate offices and by the TestAmerica laboratory originally requesting approval of the subcontract lab. Verify necessary accreditation, where applicable, (e.g., on the subcontractors TNI, A2LA accreditation or State Certification).
- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses;
- TNI or A2LA accredited laboratories.
- In addition, the firm must hold the appropriate certification to perform the work required.

All TestAmerica laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approved sending samples to that laboratory. The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs.

When the potential sub-contract laboratory has not been previously approved, Account Executives or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director. The Laboratory Director requests that the PM begins the process of approving the subcontract laboratory as outlined in Corporate SOP No. CA-L-S-002, Subcontracting Procedures.

8.2.1 Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to the Corporate Quality Information Manager (QIM) for review. Once all documents are reviewed for completeness, the Corporate QIM will forward the documents to the Purchasing Manager for formal signature and contracting with the laboratory. The approved vendor will be added to the approved subcontractor list on the intranet site and the finance group is concurrently notified for inclusion of the vendor in JD Edwards.

8.2.2 The client will assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are known to meet minimal standards. TestAmerica does not certify laboratories. The subcontractor is on the laboratory's approved list and can only be recommended to the extent that TestAmerica would use them.

8.2.3 The status and performance of qualified subcontractors will be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified will be brought to the attention of TestAmerica's Corporate Finance or Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation and corrective action will be maintained in the subcontractor's file on the intranet site. Complaints are posted using the Vendor Performance Report.
- Information shall be updated on the intranet when new information is received from the subcontracted laboratories.
- Subcontractors in good standing will be retained on the intranet listing. The QA Manager will notify all TestAmerica laboratories, Corporate Quality and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all Laboratory Directors, QA Managers and Sales Personnel.

8.3 Oversight and Reporting

The PM or CRM must request that the selected subcontractor be presented with a subcontract, if one is not already executed between the laboratory and the subcontractor. The subcontract must include terms which flow down the requirements of the laboratory's clients, either in the subcontract itself or through the mechanism of work orders relating to individual projects. A standard subcontract and the Lab Subcontractor Vendor Package (posted on the intranet) can be used to accomplish this, and Corporate Counsel can tailor the document or assist with negotiations, if needed. The PM (or EDS, AEs or CRM, etc.) responsible for the project must advise and obtain client consent to the subcontract as appropriate, and provide the scope of work to ensure that the proper requirements are made a part of the subcontract and are made known to the subcontractor.

Prior to sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it is current and scope-inclusive. The information is documented on a Subcontracted Sample Form (Figure 8-1) and the form is retained in the project folder. For TestAmerica laboratories, certifications can be viewed on the company's TotalAccess Database.

The Sample Control department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

All subcontracted samples must be accompanied by a TestAmerica Chain of Custody (COC). A copy of the original COC sent by the client must also be included with all samples subcontracted within TestAmerica. Client COCs are only forwarded to external subcontractors when samples are shipped directly from the project site to the subcontractor lab. Under routine circumstances, client COCs are not provided to external subcontractors.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

Non-TNI accredited work must be identified in the subcontractor's report as appropriate. If TNI accreditation is not required, the report does not need to include this information.

Reports submitted from subcontractor laboratories are not altered and are included in their

original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data are incorporated into the laboratories EDD (i.e., imported), the report must explicitly indicate which lab produced the data for which methods and samples.

Note: The results submitted by a TestAmerica work sharing laboratory may be transferred electronically and the results reported by the TestAmerica work sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4 Contingency Planning

The Laboratory Director may waive the full qualification of a subcontractor process temporarily to meet emergency needs; however, this decision and justification must be documented in the project files, and the 'Purchase Order Terms And Conditions For Subcontracted Laboratory Services' must be sent with the samples and Chain-of-Custody. In the event this provision is utilized, the laboratory (e.g., PM) will be required to verify and document the applicable accreditations of the subcontractor. All other quality and accreditation requirements will still be applicable, but the subcontractor need not have signed a subcontract with TestAmerica at this time. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

Figure 8-1.

Example - Subcontracted Sample Form

Date/Time: _____

Subcontracted Laboratory Information:

- Subcontractor's Name: _____
- Subcontractor Point of Contact: _____
- Subcontractor's Address: _____
- Subcontractor's Phone: _____
- Analyte/Method: _____
- Certified for State of Origin: _____
- TNI Certified: Yes_____No_____
- USDA Permit (__Domestic __ Foreign) Yes_____No_____
- A2LA (or ISO 17025) Certified: Yes_____No_____
- CLP-like Required: Yes_____No_____
  (Full doc required)
- Requested Sample Due Date: _____
  (Must be put on COC)
- Client POC Approval on-file to Subcontract Samples to Sub Laboratory: Yes_____No_____

Project Manager: _____

Laboratory Sample # Range: _____
(Only of Subcontracted Samples)

Laboratory Project Number (Billing Control #): _____

All subcontracted samples are to be sent via bonded carrier and Priority Overnight. Please attach tracking number below and maintain these records in the project files.

PM Signature_____**Date**_____

SECTION 9. PURCHASING SERVICES AND SUPPLIES

9.1 Overview

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with TestAmerica's Capital Expenditure, Controlled Purchase Requests and Fixed Asset Capitalization, SOP No. CW-F-S-007.

Contracts will be signed in accordance with TestAmerica's Company-Wide Authorization Matrix Policy, Policy No. CW-F-P-002. Request for Proposals (RFP's) will be issued where more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts Policy (Policy No. CW-F-P-004). RFP's allow TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the TestAmerica facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 Glassware

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

9.3 Reagents, Standards and Supplies

Purchasing guidelines for equipment and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with TestAmerica's Corporate SOP on Solvent and Acid Lot Testing and Approval, SOP No. CA-Q-S-001 and CA-Q-S-001 DV-1, *Procedure for Testing Acetonitrile and Solvents from CYCLE-TAINERS®.*

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination. This information is contained in the method SOP. The analyst completes the Material Request Sheet when requesting reagents, standards, or supplies. The analyst may check the item out of the on-site consignment system that contains items approved for laboratory use.

The analyst must provide the master item number (from the master item list that has been

approved by the Technical Manager), item description, package size, catalogue page number, and the quantity needed. If an item being ordered is not the exact item requested, approval must be obtained from the Technical Manager prior to placing the order. The purchasing manager or designee places the order.

9.3.2 Receiving

It is the responsibility of the purchasing manager or designee to receive the shipment. It is the responsibility of the analyst who ordered the materials to document the date materials were received. Once the ordered reagents or materials are received, the analyst compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. Safety Data Sheets (SDSs) are available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.3.3 Specifications

Methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, analytical reagent grade will be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five year expiration date on inorganic dry chemicals and solvents unless noted otherwise by the manufacturer or by the reference source method. Chemicals/solvents should not be used past the manufacturer's or SOPs expiration date unless 'verified' as described below.

An expiration date **cannot** be extended if the dry chemical/solvent is discolored or appears otherwise physically degraded. The dry chemical/solvent must be discarded.

- Expiration dates can be extended if the dry chemical/solvent is found to be satisfactory based on acceptable performance of quality control samples (Continuing Calibration Verification (CCV), Blanks, Laboratory Control Sample (LCS), etc.).

If the dry chemical/solvent is used for the preparation of standards, the expiration dates can be extended 6 months if the dry chemical/solvent is compared to an unexpired independent source in performing the method and the performance of the dry chemical/solvent is found to be satisfactory. The comparison must show that the dry chemical/solvent meets CCV limits. The comparison studies are attached to the new entry for the standard in the TALS reagent module as described in SOP DV-QA-0015, *Verification of Chemical Standards and Reagents.*

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

Compressed gases in use are checked for pressure and secure positioning daily. To prevent a tank from going to dryness, or introducing potential impurities, the pressure should be closely

watched as it decreases to approximately 15% of the original reading, at which point it should be replaced. For example, a standard sized laboratory gas cylinder containing 3,000 psig of gas should be replaced when it drops to approximately 500 psig. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of standards or reagents must have a specific conductivity of less than 1- µmho/cm (or specific resistivity of greater than 1.0 megohm-cm) at 25°C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Facility Manager and QA Manager (or designee) must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction. See SOP DV-QA-0026, *DI Water Monitoring*.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified "clean" by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased bottleware used for sampling must be certified clean and the certificates must be maintained. If uncertified sampling bottleware is purchased, all lots must be verified clean prior to use. This verification must be maintained.

Records of manufacturer's certification and traceability statements are maintained in electronic files. These records include date of receipt, lot number (when applicable), and expiration date (when applicable). Incorporation of the item into the record indicates that the analyst has compared the new certificate with the previous one for the same purpose and that no difference is noted, unless approved and so documented by the QA Manager or designee. For all standards recorded in the Reagent Module in the LIMS, the certificate of analysis must be attached to the record for the source material. See SOP DV-QA-0015, *Verification of Chemical Standards and Reagents.*

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health and Safety Manual (Corp. Doc. No. CW-E-M-001) and method SOPs or manufacturer instructions.

9.4 Purchase of Equipment / Instruments / Software

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or supervisor makes a supply request to the Technical Manager and/or the Laboratory Director. If they agree with the request, the procedures outlined in TestAmerica's Corporate Policy No. CA-T-P-001, *Qualified Products List*, are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The appropriate written requests are completed and purchasing places the order.

Upon receipt of a new or used piece of equipment, an identification name is assigned and added to the equipment list. IT must also be notified so that they can synchronize the

instrument for back-ups. The equipment's capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated, followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 19). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department or QA Department. Software certificates supplied by the vendors are filed with the LIMS Administrator or Data Center Manager, as appropriate. The manufacturer's operation manual is retained at the bench or available through the laboratory's computer network.

9.5 Services

Service to analytical instruments (except analytical balances) is performed on an as needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is determined by analysts and/or Department Managers/Supervisors. The service providers that perform the services are approved by the Technical Manager and/or Laboratory Director.

9.6 Suppliers

TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Procurement and Contracts Policy (Policy No. CW-F-P-004). The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The JD Edwards purchasing system includes all suppliers/vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report.

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

As deemed appropriate, the Vendor Performance Reports will be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors.

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the JD Edwards purchasing system.

9.6.1 New Vendor Procedure

TestAmerica employees who wish to request the addition of a new vendor must complete a J.D. Edwards Vendor Add Request Form.

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with TestAmerica employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department and/or the Director of Technical Services are consulted with vendor and product selection that have an impact on quality.

SECTION 10. COMPLAINTS

10.1 Overview

The laboratory considers an effective client complaint handling process to be of significant business and strategic value. Listening to and documenting client concerns captures 'client knowledge' that enables the laboratory's operations to continually improve processes and client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of the laboratory's business services (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is documented following SOP DV-QA-013P, *Customer Complaints*.

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to SOP DV-QA-013P.

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints should be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Complaint Investigation and Service Recovery

- Process Improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.3 Internal Complaints

Internal complaints include, but are not limited to: errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and shall follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing and IT may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 12.

10.4 Management Review

The number and nature of client complaints is reported by the QA Manager to the laboratory and Quality Director in the QA monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Review (Section 16).

SECTION 11. CONTROL OF NON-CONFORMING WORK

11.1 Overview

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the corrective action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. When an analyst encounters such a situation, the problem is presented to the supervisor for resolution. The supervisor may elect to discuss it with the Technical Manager or have a representative contact the client to decide on a logical course of action. Once an approach is agreed upon, the analyst documents it using the laboratories corrective action system described in Section 12. This information can then be supplied to the client in the form of a footnote or a case narrative with the report. Refer to SOP DV-QA-0031, *Nonconformance and Corrective Action System* for the procedure to handle such situations.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 19. The client may request that the compound be reported based only on the calibration. Such

a request would need to be approved by the Technical Manager or Department Supervisor and QA Manager, documented and included in the project folder. Deviations **must** also be noted on the final report with a statement that the compound is not reported in compliance with TNI (or the analytical method) requirements and the reason. The laboratory must also disclose if an analyte is not listed on the appropriate accreditation or certification documents for a given state when that status is available. Data being reported to a non-TNI state would need to note the change made to how the method is normally run.

11.2 Responsibilities and Authorities

TestAmerica's Corporate SOP entitled *Internal Investigation of Potential Data Discrepancies and Determination for Data Recall* (SOP No. CW-L-S-002), outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

Under certain circumstances, the Laboratory Director, the Technical Manager, or a member of the QA team may authorize departures from documented procedures or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc. In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's corrective action procedures using a Nonconformance Memo (NCM). This information may also be documented in the batch record, logbooks and/or data review checklists as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to facility Senior Management within 24-hours. The Senior Management staff is comprised of the Laboratory Director, the QA Manager, and the Technical Manager. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an Ethics and Compliance Officer (ECO), Executive Director of Quality and EHS and the laboratory's Quality Director within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

The Laboratory Director, QA Manager, ECOs, Corporate Quality, Executive VP of Operations, VP of Operations and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

11.3 Evaluation of Significance and Actions Taken

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

TestAmerica's Corporate Data Investigation and Recall Procedure (SOP No. CW-L-S-002) distinguishes between situations when it would be appropriate for laboratory management to

make the decision on the need for client notification (written or verbal) and data recall (report revision) and when the decision must be made with the assistance of the ECO's and Corporate Management. Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/corrective action reporting in lieu of the data recall determination form contained in TestAmerica's Corporate SOP No. CW-L-S-002.

11.4 Prevention of Nonconforming Work

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's corrective action system. Periodically as defined by the laboratory's preventive action schedule. The QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's corrective action process may be followed.

11.5 Method Suspension / Restriction (Stop Work Procedures)

In some cases, it may be necessary to suspend/restrict the use of a method or target compound which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 5.

Prior to suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the Laboratory Director.

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases, that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line.

The QA Manager will initiate a corrective action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed upon steps should be faxed or e-mailed by the laboratory to the appropriate VP of Operations and member of Corporate QA. This fax/e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the internet. It is the responsibility of the Laboratory Director to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction (e.g., Project Management, Log-in, etc.). Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (Laboratory Director, Technical Manager, QA Manager) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management, and the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions

after all corrective action is complete. This approval is given by final signature on the completed corrective action report.

Communications to all external parties (e.g., clients) who need to be notified will be made as quickly as possible. Reports will be revised and reissued as part of the corrective action as identified by the investigation and corrective action plan. The procedures to be used for investigation and notification are described in SOP CW-L-S-002, *Internal Investigation of Potential Data Discrepancies and Determination for Data Recall* and SOP DV-QA-019P*, Results and Report Revisions*

SECTION 12. CORRECTIVE ACTION

12.1 Overview

A major component of TestAmerica's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the corrective action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Corrective actions are documented using Non-Conformance Memos (NCM) and Corrective Action Reports (CAR) (refer to Figure 12-1).

12.2 General

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc.

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility(s) for investigating.
- Resolve non-conformance events and assign responsibility for any required corrective action.
- Identify systematic problems before they become serious.
- Identify and track client complaints and provide resolution.

12.2.1 Non-Conformance Memo (NCM) is used to document the following types of corrective actions:

- Deviations from an established procedure or SOP
- QC outside of limits (non-matrix related)
- Isolated reporting / calculation errors
- Client complaints
- Discrepancies in materials / goods received vs. manufacturer packing slips.

12.2.2 Corrective Action Report (CAR) is used to document the following types of corrective actions:

- Questionable trends that are found in the review of NCMs.
- Issues found while reviewing NCMs that warrant further investigation.
- Internal and external audit findings.
- Failed or unacceptable PT results.
- Corrective actions that cross multiple departments in the laboratory.
- Systematic reporting / calculation errors
- Client complaints
- Data recall investigations
- Identified poor process or method performance trends
- Excessive revised reports
- Health and Safety violations identified in audits

This will provide background documentation to enable root cause analysis and preventive action.

12.3 Closed Loop Corrective Action Process

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. An NCM or CAR must be initiated, someone is assigned to investigate the issue and the event is investigated for cause. Table 12-1 provides some general guidelines on determining responsibility for assessment.
- The cause analysis step is the key to the process as a long term corrective action cannot be determined until the cause is determined.
- If the cause is not readily obvious, the Technical Manager, Laboratory Director, or QA Manager (or QA designee) is consulted.

12.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.
- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.
- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The NCM or CAR is used for this documentation.

12.3.3 Root Cause Analysis

Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness.

Systematically analyze and document the Root Causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the Root Cause data from these incidents to identify Root Causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

Identify the one event associated with the problem and ask why this event occurred. Brainstorm the root causes of failures; for example, by asking why events occurred or conditions existed; and then why the cause occurred five consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and continue to plague the laboratory or operation.

12.3.4 Monitoring of the Corrective Actions

- The Technical Manager and QA Manager are responsible to ensure that the corrective action taken was effective.
- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Technical Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- Each CAR is entered into a database for tracking purposes and at least monthly a summary of all corrective actions is printed out for review to aid in ensuring that the corrective actions have taken effect.
- The QA Manager reviews NCMs and CARs for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA Manager and shall be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements.

- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

(Also refer to Section 15.1.4, Special Audits.)

12.4 Technical Corrective Actions

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and quality control have occurred (refer to Section 11). The documentation of these procedures is through the use of an NCM or CAR.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs. The laboratory may also maintain Work Instructions on these items that are available upon request.

Table 12-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in Method SOPs, Work Instructions, QAM Sections 19 and 20. All corrective actions are reviewed monthly, at a minimum, by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by an NCM and appropriate corrective action (e.g., reanalysis) is taken and documented.

12.5 Basic Corrections

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g., no white-out)], and the correct value entered alongside. All such corrections shall be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original “uncorrected” file must be maintained intact and a second “corrected” file is created.

This same process applies to adding additional information to a record. All additions made later than the initial documentation must also be initialed (or signed) and dated.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

Figure 12-1.
Example - Corrective Action Report

TestAmerica Corrective Action Plan

TAL Audit # *Program:* *Requirements Document:*

Purpose: Not entered *Company Auditing:*

Date Audited: *Lead Auditor:*

Date Report Received: *Response Due Date:*

TAL Issue Number *Status:* *Title:*

Reference Citation: *Lab Process:* *Lab Section:*

Client Issue #: *Type of Issue:* *Method #:*

Finding Description:

Cause Analysis:

Corrective Action Plan:

Lab Responsible Party:

Planned Completion Date:

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Table 12-1. Example – General Corrective Action Procedures

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Initial Instrument Blank *(Analyst, Data Reviewer)*	- Instrument response < ½ RL.	- Prepare another blank. - If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc.
Initial Calibration Standards *(Analyst, Data Reviewer)*	- Correlation coefficient > 0.99 or method requirement. - % Recovery within acceptance range. - See details in Method SOP.	- Reanalyze standards. - If still unacceptable, remake standards and recalibrate instrument.
Independent Calibration Verification (Second Source) *(Analyst, Data Reviewer)*	- % Recovery within control limits as defined in Method SOPs.	- Remake and reanalyze standard. - If still unacceptable, then remake calibration standards or use new primary standards and recalibrate instrument.
Continuing Calibration Standards *(Analyst, Data Reviewer)*	% Recovery within control limits as defined in Method SOPs.	- Reanalyze standard. - If still unacceptable, then recalibrate and rerun affected samples.
Matrix Spike / Matrix Spike Duplicate (MS/MSD) *(Analyst, Data Reviewer)*	- % Recovery within limits documented in the LIMS.	- If the acceptance criteria for duplicates or matrix spikes are not met because of matrix interferences, the acceptance of the analytical batch is determined by the validity of the LCS. - If the LCS is within acceptable limits the batch is acceptable. - The results of the duplicates, matrix spikes and the LCS are reported with the data set. - For matrix spike or duplicate results outside criteria the data for that sample shall be reported with qualifiers. **NOTE:** The laboratory must eliminate lab error as the cause of the deviation.
Laboratory Control Sample (LCS) *(Analyst, Data Reviewer)*	- % Recovery within limits documented in the LIMS.	- Batch must be re-prepared and re-analyzed. This includes any allowable marginal exceedance. When not using marginal exceedances, the following exceptions apply: 1) when the acceptance criteria for the positive control are exceeded high (i.e., high bias) and there are associated samples that are non-detects, then those non-detects may be reported with data qualifying codes; 2) when the acceptance criteria for the positive control are exceeded low (i.e., low bias), those sample results may be

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
		reported if they exceed a maximum regulatory limit/decision level with data qualifying codes. **Note:** If there is insufficient sample or the holding time cannot be met, contact client and report with flags.
Surrogates *(Analyst, Data Reviewer)*	- % Recovery within limits of method or within three standard deviations of the historical mean as documented in the LIMS.	- Individual sample must be repeated. Place comment in LIMS. - Surrogate results outside criteria shall be reported with qualifiers.
Method Blank (MB) *(Analyst, Data Reviewer)*	< ½ Reporting Limit	- Reanalyze blank. - If still positive, determine source of contamination. If necessary, reprocess (i.e., digest or extract) entire sample batch. Report blank results. - Qualify the result(s) if the concentration of a targeted analyte in the MB is at or above one-half the reporting limit AND is > 1/10 of the amount measured in the sample. See SOP DV-QA-003P.
Proficiency Testing (PT) Samples *(Department Manager(s) /Supervisor(s), QA Manager)*	- Criteria supplied by PT Supplier.	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.
Internal / External Audits *(QA Manager, Department Manager(s) /Supervisor(s)/ Technical Manager/, Laboratory Director)*	- Defined in Quality System documentation such as SOPs, QAM, etc.	- Non-conformances must be investigated through CAR system and necessary corrections must be made.
Reporting / Calculation Errors (Depends on issue – possible individuals include: *Analysts, Data Reviewers, Project Managers, Technical Manager, Department Manager(s) /Supervisor(s),QA Manager, Corporate QA, Corporate Management)*	- SOP CW-L-S-002, Internal Investigation of Potential Data Discrepancies and Determination for Data Recall.	- Corrective action is determined by type of error. Follow the procedures in SOP CW-L-S-002 and SOP DV-QA-019P.
Client Complaints *(Project Managers, Lab*	-[Issue specific]	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Director/Manager, Sales and Marketing)		address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., database needs to be updated). See SOP DV-QA-013P.
QA Monthly Report (*QA Manager, Lab Director/Technical Manager)*	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated.
Health and Safety Violation (*EHS Coordinator, Lab Director/Technical Manager, Department Manager(s) /Supervisor(s))*	- Environmental Health and Safety (EHS) Manual.	- Non-conformance is investigated and corrected through EHS procedures.

Note:
1. Except as noted below for certain compounds, the method blank should be below one-half the reporting limit. Concentrations up to five times the reporting limit will be allowed for the ubiquitous laboratory and reagent contaminants: methylene chloride, acetone, 2-butanone, phthalates, sodium, zinc, and iron, **provided** they appear in similar levels in the reagent blank and samples. This allowance presumes that the reporting limit is significantly below any regulatory limit to which the data are to be compared and that blank subtraction will not occur.

SECTION 13. PREVENTIVE ACTION / IMPROVEMENT

13.1 Overview

The laboratory's preventive action programs improve or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive and continuous process of improvement activities that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, the laboratory continually strives to improve customer service and client satisfaction through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered during management system reviews, review of the monthly QA Metrics Report, evaluation of internal or external audits, results and evaluation of proficiency testing (PT) performance, review of control charts and QC results, data analysis and review processing operations, client complaints, staff observation, etc.

The monthly Management Systems Metrics Report shows performance indicators in all areas of the laboratory and quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, ethics training, etc. The metrics report is reviewed monthly by laboratory management, Corporate QA and TestAmerica's Executive Committee. These metrics are used to evaluate the management and quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

Items identified as continuous improvement opportunities to the management system may be issued as goals from the annual management systems review, recommendations from internal audits, white papers, Lesson Learned, Technical Services audit report, Technical Best Practices, or as Corporate or management initiatives.

The laboratory's corrective action process is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action and non-conformances provides a valuable mechanism for identifying preventive action opportunities.

13.1.1 The following elements are part of a preventive action/process improvement system:

- Identification of an opportunity for preventive action or process improvement.
- Identification of process for the preventive action or improvement..
- Definition of the measurements to assess the effectiveness of the process once undertaken.
- Execution of the preventive action or improvement.
- Evaluation of the plan using the defined measurements.
- Verification of the effectiveness of the preventive action or improvement.

- Documentation of any permanent changes to the Quality System as a result of the Preventive Action or Process Improvement to close out the process. Documentation of Preventive Action/Process improvement is incorporated into the monthly QA reports, corrective action process and management review.

13.1.2 Any Preventive Actions/Process Improvement undertaken or attempted shall be taken into account during the annual Management Systems Review (Section 16). A highly detailed report is not required; however, a summary of successes and failures within the preventive action program is sufficient to provide management with a measurement for evaluation.

13.2 Management of Change

The Management of Change process is designed to manage significant events and changes that occur within the laboratory. Through these procedures, the potential risks inherent with a new event or change are identified and evaluated. The risks are minimized or eliminated through pre-planning and the development of preventive measures. The types of changes covered under this system include: Facility Changes, Major Accreditation Changes, Addition or Deletion to Laboratory's Capabilities or Instrumentation, Key Personnel Changes, Laboratory Information Management System (LIMS) changes. This process is discussed in further detail in SOP DV-QA-028P, *Management of Change*.

SECTION 14. CONTROL OF RECORDS

The laboratory maintains a records management system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued.

14.1 Overview

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. Quality records are maintained by the QA department in a database or electronic files that list the contents of archived data, which is backed up as part of the regular laboratory backup. Records are of two types; either electronic or hard copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by the Department Manager/Supervisor or their designee.

Table 14-1. Record Index[1]

	Record Types [1]:	Retention Time:
Technical Records	- Raw Data - Logbooks[2] - Standards - Certificates - Analytical Records - MDLs/IDLs/DOCs - Lab Reports	5 Years from analytical report issue*
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals	5 Years from document retirement date*
QA Records	- Internal and External Audits/Responses - Certifications - Corrective/Preventive Actions - Management Reviews - Method and Software Validation / Verification Data - Data Investigation	5 Years from archival* **Data Investigation:** 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)
Project Records	- Sample Receipt and COC Documentation - Contracts and Amendments - Correspondence - QAPP - SAP - Telephone Logbooks - Lab Reports	5 Years from analytical report issue*
Administrative Records	Finance and Accounting	10 years
	EH&S Manual, Permits	7 years
	Disposal Records	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature and Initials, Administrative Training Records (e.g., Ethics)	Refer to HR Manual
	Administrative Policies Technical Training Records	7 years

[1] Record Types encompass hardcopy and electronic records.
[2] Examples of Logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).
* Exceptions listed in Table 14-2.

14.1.1 All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or the Iron Mountain data storage facility that provides a suitable environment to prevent damage or deterioration and to prevent loss. All records shall

be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees and shall be documented with an access log. Records archived off-site are stored in a secure location where a record is maintained of any entry into the storage facility. Whether on-site or off-site storage is used, logs are maintained in each storage box to note removal and return of records. Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention shall be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 14-2 have lengthier retention requirements and are subject to the requirements in Section 14.1.3.

14.1.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Table 14-2. Example: Special Record Retention Requirements

Program	[1]Retention Requirement
Drinking Water – All States	5 years (project records) 10 years - Radiochemistry (project records)
Drinking Water Lead and Copper Rule	12 years (project records)
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
Alaska	10 years
Louisiana – All	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
Navy Facilities Engineering Service Center (NFESC)	10 years
NY Potable Water NYCRR Part 55-2	10 years
Ohio VAP	10 years and State contacted prior to disposal
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

[1]Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data are maintained as hard copy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 19.14.1 for more information. In addition, refer to SOP DV-QA-025P, *Electronic Data Backup*.

14.1.4 The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data. (Records stored off site should be accessible within 2 days of a request for such records). The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory's copy of the COC is maintained electronically with the project records. (Only the state of California requires the original COC be maintained.) The chain of custody would indicate the name of the sampler. If any sampling notes are provided with a work order, they are kept with the project record in the LIMS. All other documents are scanned and attached to the project record in the LIMS.
- All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.
- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set per SOP DV-QA-0005, *Document Archiving Procedure).* Instrument data are stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; a copy of each day's run log or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or electronic bench sheets are used to record and file data. Standard and reagent information is entered into the LIMS for each method as required.
- Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.
- The reason for a signature or initials on a document is clearly indicated in the records such as "sampled by," "prepared by," "reviewed by", or "analyzed by".
- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.
- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data are lost. The data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard copy that was scanned.
- Also refer to Section 19.14.1 'Computer and Electronic Data Related Requirements'.

14.2 Technical and Analytical Records

14.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement. The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records shall include the identity of laboratory personnel responsible for the sampling, performance of each analysis and reviewing results.

14.2.2 Observations, data and calculations are recorded real-time and are identifiable to the specific task.

14.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

- laboratory sample ID code**;**
- date of analysis; time of analysis is also required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook, on a benchsheet or in the batch information in the LIMS.
- instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available.
- analysis type**;**
- all manual calculations and manual integrations**;**
- analyst's or operator's initials/signature**;**
- sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents**;**
- test results**;**
- standard and reagent origin, receipt, preparation, and use**;**
- calibration criteria, frequency and acceptance criteria**;**
- data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions**;**
- quality control protocols and assessment**;**
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- method performance criteria including expected quality control requirements. These are indicated both in the LIMS and on specific analytical report formats**.**

14.2.4 All logbooks used during receipt, preparation, storage, analysis, and reporting of samples or monitoring of support equipment shall undergo a documented supervisory or peer review on a bi-monthly basis.

14.3 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- all original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records);
- a written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value;
- copies of final reports;
- archived SOPs;
- correspondence relating to laboratory activities for a specific project;
- all corrective action reports, audits and audit responses;
- proficiency test results and raw data; and
- results of data review, verification, and crosschecking procedures

14.3.1 Sample Handling Records

Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include but are not limited to records pertaining to:

- sample preservation including appropriateness of sample container and compliance with holding time requirement;
- sample identification, receipt, acceptance or rejection and login;
- sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.4 Administrative Records

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 14-1.

14.5 Records Management, Storage and Disposal

All records (including those pertaining to test equipment), certificates and reports are safely stored, held secure and in confidence to the client. Certification related records are available upon request.

All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access.

The laboratory has a record management system (a.k.a., document control) for control of instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. Logbooks are issued on a per instrument basis, and are numbered sequentially. All data are recorded sequentially within a series of sequential logbooks or directly in the LIMS or on batch-specific bench sheets. Scanned copies of bench sheets are filed sequentially on the laboratory network or attached specifically to the batch in the LIMS. Standards are maintained in the LIMS – no logbooks are used to record that data. Records are considered archived when noted as such in the records management system (a.k.a., document control).

14.5.1 Transfer of Ownership

In the event that the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

14.5.2 Records Disposal

Records are removed from the archive and destroyed after 5 years unless otherwise specified by a client or regulatory requirement. On a project specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration. (Refer to Tables 14-1 and 14-2).

Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required.

SECTION 15. AUDITS

15.1 Internal Audits

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting

quality and to report the assessments to laboratory management and, when requested, to corporate management.

Audits are conducted and documented as described in the TestAmerica Corporate SOP on performing Internal Auditing, SOP No. CW-Q-S-003. The types and frequency of routine internal audits are described in Table 15-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems Audits	QA Department, QA approved designee, or Corporate QA	All areas of the laboratory annually
QA Technical Audits	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CW-Q-S-003)	50% of methods annually
SOP Method Compliance	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CW-Q-S-003)	SOP Compliance Review Frequency: • **100% of SOPs annually (DoD Labs)**
Special	QA Department or Designee	Surveillance or spot checks performed as needed, e.g., to confirm corrective actions from other audits.
Performance Testing	Analysts with QA oversight	Two successful per year for each TNI-field of testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, TestAmerica's Data Integrity and Ethics Policies, TNI quality systems, client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to data review, quality controls, preventive action and corrective action. The completeness of earlier corrective actions is assessed for effectiveness and sustainability. The audit is divided into sections for each operating or support area of the lab, and the audit is comprehensive for a given area. The audits may be performed on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

15.1.2 QA Technical Audits

QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes,

and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, electronic audit miner programs (e.g., Chrom AuditMiner) are used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the Technical Manager or qualified designee at least annually. It is also recommended that the work of each newly hired analyst is assessed within 3 months of working independently, (e.g., completion of method IDOC).

15.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

15.1.5 Performance Testing

The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: (e.g., Nonpotable Water (WP), Soil, and Underground Storage Tank (UST)).

It is TestAmerica's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Written responses to unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

15.2 External Audits

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time allotted by the client or agency performing the audit. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in the 2009 TNI standards.

15.3 Audit Findings

Audit findings are documented using the corrective action process and database. The laboratory's corrective action responses for both types of audits may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must be set and agreed to by operations management and the QA Manager.

Developing and implementing corrective actions to findings is the responsibility of the Department Manager/Supervisor where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. When requested, a copy of the audit report and the laboratory's corrective action plan will be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory shall take timely corrective action, and shall notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24-hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

SECTION 16. MANAGEMENT REVIEWS

16.1 Quality Assurance Report

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, Technical Manager, their Quality Director as well as the VP of Operations. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director, VP of Operations or Corporate QA may request that additional information be added to the report.

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Senior Management Team and VPs of Operations.

16.2 Annual Management Review

The senior lab management team (Laboratory Director, Technical Manager, and QA Manager) conducts a review annually of its quality systems and LIMS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining goals, objectives and action items that feed into the laboratory planning system. Corporate Operations and Corporate QA personnel are included in this meeting at the discretion of the Laboratory Director. The LIMS review consists of examining any audits, complaints or concerns that have been raised through the year that are related to the LIMS. The laboratory will summarize any critical findings that cannot be solved by the lab and report them to Corporate IT.

This management systems review (Corporate SOP No. CW-Q-S-004 and Work Instruction No. CW-Q-WI-003) uses information generated during the preceding year to assess the “big picture” by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective, therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

- Matters arising from the previous annual review.
- Prior Monthly QA Reports issues.
- Laboratory QA Metrics.
- Review of report reissue requests.
- Review of client feedback and complaints.
- Issues arising from any prior management or staff meetings.
- Minutes from prior senior lab management meetings. Issues that may be raised from these meetings include:
    - Adequacy of staff, equipment and facility resources.
    - Adequacy of policies and procedures.
    - Future plans for resources and testing capability and capacity.
- Compliance to the Ethics Policy and Data Integrity Plan. Including any evidence/incidents of inappropriate actions or vulnerabilities related to data integrity.

A report is generated by the QA Manager and management. The report is distributed to the appropriate VP of Operations and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants.
- A reference to the existing data quality related documents and topics that were reviewed.

- Quality system or operational changes or improvements that will be made as a result of the review [e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)].

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

16.3 Potential Integrity Related Managerial Reviews

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. TestAmerica's Corporate Data Investigation/Recall SOP shall be followed (SOP No. CW-L-S-002). All investigations that result in finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

TestAmerica's CEO, Executive VP of Operations, VP of Client Services, VPs of Operations and Quality Directors receive a monthly report from the Executive Director of Quality and EHS summarizing any current data integrity or data recall investigations. The VPs of Operations are also made aware of progress on these issues for their specific labs.

SECTION 17. PERSONNEL

17.1 Overview

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the organization chart in Figure 4-1.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training shall be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

17.2 Education and Experience Requirements for Technical Personnel

The laboratory makes every effort to hire analytical staffs that possess a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the TestAmerica intranet site's Human Resources web-page (Also see Section 4 for position descriptions/responsibilities).

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc., are also considered).

As a general rule for analytical staff:

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO, Redox, etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
GFAA, CVAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC	A college degree in an applied science or 2 years of college and at least 1 year of college chemistry	or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, Herbicides, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	or 5 years of prior analytical experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	and 2 years relevant experience or 5 years of prior analytical experience

Specialty	Education	Experience
Department Managers/Supervisors – **General**	Bachelor's Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	and 2 years experience in environmental analysis of representative analytes for which they will oversee
Department Managers/Supervisors – **Wet Chem** only (no advanced instrumentation)	Associates degree in an applied science or engineering or 2 years of college with 16 semester hours in chemistry	and 2 years relevant experience

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Department Manager/Supervisor, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

17.3 Training

The laboratory is committed to furthering the professional and technical development of employees at all levels.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training:

Required Training	Time Frame	Employee Type
Environmental Health and Safety	Prior to lab work	All
Ethics – New Hires	1 week of hire	All
Ethics – Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All
Radiation Safety	30 days of hire	All
Ethics – Comprehensive Refresher	Annually	All
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance	Technical

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to "Demonstration of Capability" in Section 19.

The training of technical staff is kept up to date by:

- Documentation in each employee's training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics are maintained in their training file.
- Documentation of proficiency (refer to Section 19).
- Evidence of annual ethics training and an Ethics Agreement signed by each staff member (renewed each year).
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- Documentation and attestation forms on employment status and records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics violations), maintained by Human Resources in the employee's secured personnel file.

Evidence of successful training could include such items as:

- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.
- Analysts knowledge to refer to QA Manual for quality issues.
- Analysts following SOPs, i.e., practice matches SOPs.
- Analysts regularly communicate to supervisors and QA if SOPs need revision, rather than waiting for auditors to find problems.

Further details of the laboratory's training program are described in SOPs DV-QA-0024, *Training* and DV-QA-0037, *New Employee and On-going Training.*

17.4 Data Integrity and Ethics Training Program

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica. It is a formal part of the initial employee orientation within 1 week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and an annual refresher for all employees. Senior management at each facility performs the ethics training for their staff.

In order to ensure that all personnel understand the importance TestAmerica places on maintaining high ethical standards at all times; TestAmerica has established a Corporate Ethics Policy (Policy No. CW-L-P-004) and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on government contracts, and for that reason, TestAmerica has a Zero Tolerance approach to such violations.

Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.
- Ethics Policy
- How and when to report ethical/data integrity issues. Confidential reporting.
- Record keeping.
- Discussion regarding data integrity procedures.
- Specific examples of breaches of ethical behavior (e.g., peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion)
- Internal monitoring, investigations and data recalls.
- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution.
- Importance of proper written narration / data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient.

Additionally, a data integrity hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

SECTION 18. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1 Overview

The laboratory is a 54,000 ft^2 secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc., OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity controlled), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, sample preparation, organic sample analysis, inorganic sample analysis, and administrative functions.

18.2 Environment

Laboratory accommodation, test areas, energy sources, and lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage, temperature, and vibration levels in the laboratory.

When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and LIMS are regulated to protect against raw data loss.

18.3 Work Areas

There is effective separation between neighboring areas when the activities therein are incompatible with each other such as:

- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.

Access to and use of all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory. Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory.
- Sample receipt areas.
- Sample storage areas.
- Chemical and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

18.4 Floor Plan

A floor plan can be found in Appendix 1.

18.5 Building Security

Building keys and alarm codes are distributed to employees as necessary.

Visitors to the laboratory sign in and out in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed. Visitors (with the exception of company employees) are escorted by laboratory personnel at all times. Contractors may work in the building without an escort at all times as long as his/her location is noted in the visitor's logbook.

SECTION 19. TEST METHODS AND METHOD VALIDATION

19.1 Overview

The laboratory uses methods that are appropriate to meet clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.2 Standard Operating Procedures (SOPS)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for writing an SOP are incorporated by reference to TestAmerica's Corporate SOP entitled 'Writing a Standard Operating Procedure', No. CW-Q-S-002 or the laboratory's SOP DV-QA-001P.
- SOPs are reviewed at a minimum of every year, and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

19.3 Laboratory Methods Manual

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains an SOP Index for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

19.4 Selection of Methods

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists), the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.4.1 Sources of Methods

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Reference methods include:

- *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Analysis and Sampling Procedures; 40CFR Part 136 as amended by Method Update Rule; May 18, 2012*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.*

- *Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.*
- *Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992. Supplement III EPA/600/R-95/131 - August 1995 (EPA 500 Series) (EPA 500 Series methods)*
- *Technical Notes on Drinking Water Methods, EPA-600/R94-173, October 1994*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th/ on-line edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.*
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *Annual Book of ASTM Standards, American Society for Testing and Materials (ASTM), Philadelphia, PA.*
- *National Status and Trends Program, National Oceanographic and Atmospheric Administration, Volume I-IV, 1985-1994.*
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)*
- *Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261*

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory shall inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it will be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

A demonstration of capability (DOC), SOP DV-QA-0024 is performed whenever there is a change in instrument type (e.g., new instrumentation), matrix, method or personnel (e.g., analyst hasn't performed the test within the last twelve months).

Note: The laboratory shall have a DOC for all analytes included in the methods that the laboratory performs, and proficiency DOCs for each analyst shall include all analytes that the laboratory routinely performs. Addition of non-routine analytes does not require new DOCs for all analysts if those analysts are already qualified for routine analytes tested using identical chemistry and instrument conditions.

The initial demonstration of capability must be thoroughly documented and approved by the Department Manager/Supervisor and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures.

The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default reporting limit (RL) is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL).
- The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted: *Reporting Limit based on the low standard of the calibration curve.*

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

19.4.3.1 Refer to SOP DV-QA-0024, *Training*.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

A certification statement (refer to Figure 19-1) shall be used to document the completion of each initial demonstration of capability. A copy of the certification is archived in the analyst's training folder.

19.5 Laboratory Developed Methods and Non-Standard Methods

Any new method developed by the laboratory must be fully defined in an SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-

standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method.

19.6 Validation of Methods

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 Method Validation and Verification Activities for All New Methods

While method validation can take various courses, the following activities can be required as part of method validation. Method validation records are designated QC records and are archived accordingly.

19.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

19.6.1.2 Determination of Method Sensitivity

Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed.

19.6.1.3 Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)

An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The QL is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias. For most instrumental measurement systems, there is a region where semi-quantitative data are generated around the LOD (both above and below the estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data are to be reported in this region, it must be done with a qualification that denotes the semi-quantitative nature of the result.

19.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is made.

19.6.1.5 Determination of Range

Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or QL cannot be lower than the lowest non-zero calibration level, and may be constrained by required levels of bias and precision.

19.6.1.6 Determination of Accuracy and Precision

Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

19.6.1.7 Documentation of Method

The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, describing the specific differences in the new method in a revision of the existing SOP is acceptable in place of a separate SOP.

19.6.1.8 Continued Demonstration of Method Performance

Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS, method blanks or PT samples.

19.7 Method Detection Limits (MDL) / Limits of Detection (LOD)

Method detection limits (MDL) are initially determined in accordance with 40 CFR Part 136, Appendix B or alternatively by other technically acceptable practices that have been accepted by regulators. MDL is also sometimes referred to as Limit of Detection (LOD). The MDL theoretically represents the concentration level for each analyte within a method at which the Analyst is 99% confident that the true value is not zero. The MDL is determined for each analyte initially during the method validation process and updated as required in the analytical methods, whenever there is a significant change in the procedure or equipment, or based on project specific requirements. Generally, the analyst prepares at least seven replicates of solution spiked at one to five times the estimated method detection limit (most often at the lowest standard in the calibration curve) into the applicable matrix with all the analytes of interest. Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples. Where possible, the seven replicates should be analyzed over 2-4 days to provide a more realistic MDL. To allow for some flexibility, this low level sample may be analyzed every batch or every week or some other frequency rather than doing the study all at once. In addition, a larger number of data points may be used if the appropriate t-value multiplier is used.

Refer to the Corporate SOP No. CA-Q-S-006 or the laboratory's SOP No. DV-QA-005P, *Determination of Method Detection Limits* for details on the laboratory's MDL process.

19.8 Instrument Detection Limits (IDL)

The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most often used in metals analyses but may be useful in demonstration of instrument performance in other areas.

IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using seven replicate spike analyses, like the MDL but without sample preparation, or by the analysis of ten instrument blanks and calculating three times the absolute value of the standard deviation.

If the IDL is greater than the MDL, it may be used as the reported MDL.

19.9 Verification of Detection and Reporting Limits

Once the MDL is determined, it must be verified on each instrument used for the given method. TestAmerica defines the DoD QSM Detection Limit (DL) as being equal to the MDL. TestAmerica also defines the DoD QSM Limit of Detection (LOD) as being equal to the lowest concentration standard that successfully verifies the MDL, also referred to as the MDLV standard. MDL and MDLV standards are extracted/digested and analyzed through the entire analytical process. The MDL and MDLV determinations do not apply to methods that are not readily spiked (e.g., pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDLV standard is not successful, then the laboratory will redevelop their MDL or perform and pass two consecutive MDLVs at a higher concentration and set the LOD at the higher concentration. Initial and quarterly verification is required for all methods listed in the laboratory's DoD ELAP Scope of Accreditation. For methods that are not listed in this Scope of Accreditation, annual verification is performed. If an analyte is not on the laboratory's DoD ELAP accreditation, the MDL must be verified annually. Refer to the laboratory SOP DV-QA-005P, *Determination of Method Detection Limits* for further details.

The laboratory quantitation limit is equivalent to the DoD Limit of Quantitation (LOQ), which is at a concentration equal to or greater than the lowest non-zero calibration standard. The DoD QSM requires the laboratory to perform an initial characterization of the bias and precision at the LOQ and quarterly LOQ verifications thereafter. If the quarterly verification results are not consistent with three-standard deviation confidence limits established initially, then the bias and precision will be reevaluated and clients contacted for any on-going projects. For DoD projects, TestAmerica makes a distinction between the Reporting Limit (RL) and the LOQ. The RL is a level at or above the LOQ that is used for specific project reporting purposes, as agreed to between the laboratory and the client. The RL cannot be lower than the LOQ concentration, but may be higher. If an analyte is not on the laboratory's DoD ELAP accreditation the LOQ must be verified at least annually unless an annual MDL verification is performed.

19.10 Retention Time Windows

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis each analyte will have a specific time of elution from the column to the detector. This is known as the analyte's retention time. The variance in the expected time of elution is defined as the retention time

window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept with the files associated with an instrument for later quantitation of the analytes. Complete details are available in the laboratory SOPs.

19.11 Evaluation of Selectivity

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical, atomic absorption or fluorescence profiles, co-precipitation evaluations and specific electrode response factors.

19.12 Estimation of Uncertainty of Measurement

19.12.1 Uncertainty is "a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand" (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result's validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an "expanded uncertainty": the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor k=2.

19.12.2 Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

19.12.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.12.4 To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent uncertainties at approximately the 99% confidence level with a coverage factor of k = 3. As an example, for a reported result of 1.0 mg/L with an LCS recovery range of 50 to 150%, the estimated uncertainty in the result would be 1.0 $\pm$ 0.5 mg/L.

19.12.5 In the case where a well-recognized test method specifies limits to the values of major sources of uncertainty of measurement (e.g., 524.2, 525, etc.) and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

19.13 Sample Reanalysis Guidelines

Because there is a certain level of uncertainty with any analytical measurement, a sample re-preparation (where appropriate) and subsequent analysis (hereafter referred to as 'reanalysis') may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats.

Note: Client specific Contractual Terms and Conditions for reanalysis protocols may supersede the following items.

- Homogenous samples: If a reanalysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within $\pm$ 1 reporting limit for samples $\leq$ 5x the reporting limit, the original analysis will be reported. At the client's request, both results may be reported on the same report but not on two separate reports.
- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and reanalyze the sample a third time for confirmation if sufficient sample is available.
- Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.
- Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Department Manager/Supervisor, Technical Manager or Laboratory Director if unsure.

19.14 Control of Data

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.14.1 Computer and Electronic Data Related Requirements

The three basic objectives of the laboratory's computer security procedures and policies are shown below. The laboratory is currently running the TestAmerica Laboratory Information Management System (TALS) which is a custom in-house developed LIMS system that has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes Sequel Server which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

19.14.1.1 **Maintain the Database Integrity:** Assurance that data are reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure. More detail can be found in SOP DV-QA-0020, Data Review and policies

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use. Cells containing calculations must be lock-protected and controlled. More detail is provided in SOP DV-QA-0010, *Document Control.*
- Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails and controlled access.

19.14.1.2 **Ensure Information Availability:** Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented. More detail is provided in SOP DV-QA-025P, *Electronic Data Backup.*

19.14.1.3 **Maintain Confidentiality:** Ensure data confidentiality through physical access controls such as password protection or website access approval when electronically transmitting data. See Policies CW-I-P-007, *Computer Systems Password Policy* and CW-I-P-004, *Internet Use Policy*.

19.14.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data are reduced by the analyst and then verified by the Data Reviewer prior to updating the data in LIMS. This review is documented on the data review checklist. These checklists are saved electronically.

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP No. CA-Q-S-002, *Acceptable Manual Integration Practices* and SOP DV-QA-011P, *Acceptable Manual Integration Practices.*

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.14.2.1 All raw data must be retained in the worklist folder, computer file (if appropriate), and/or runlog. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). It must be easily identifiable who performed which tasks if multiple people were involved.

19.14.2.2 In general, concentration results are reported in milligrams per liter (mg/L) or micrograms per liter (µg/L) for liquids and milligrams per kilogram (mg/kg) or

micrograms per kilogram (µg/kg) for solids. For values greater than 10,000 mg/L, results can be reported in percent, i.e., 10,000 mg/L = 1**%.** Units are defined in each laboratory SOP.

19.14.2.3 In reporting, the analyst or the instrument output records the raw data result using values of known certainty plus one uncertain digit. If final calculations are performed external to LIMS, the results should be entered in LIMS with at least three significant figures. In general, results are reported to two significant figures on the final report. Refer to SOP DV-QA-004P, *Rounding and Significant Figures* for details regarding the number of significant figures to report for each step in the process.

19.14.2.4 For those methods that do not have an instrument printout or an instrumental output compatible with the LIMS System, the raw results and dilution factors are entered directly into LIMS by the analyst, and the software calculates the final result for the analytical report. LIMS has a defined significant figure criterion for each analyte.

19.14.2.5 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the LIMS, the raw results and dilution factors are transferred into LIMS electronically after reviewing the quantitation report, and removing unrequested or poor spectrally-matched compounds. The analyst verifies that the data were uploaded correctly. All electronic data files are transferred to the server and eventually to a tape file.

19.14.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out 'real time', i.e., observations and measurements are recorded as they are made, and have enough information on them to trace the events of the applicable analysis/task. (e.g., calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.)

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all paper logbooks used in the laboratory.
- Unused portions of pages must be "Z"'d out, signed and dated.
- Worksheets and electronic forms are created with the approval of the QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

19.14.4 Review / Verification Procedures

Review procedures are outlined in several SOPs (e.g., DV-QA-0003, *Sample Management and Chain of Custody,* DV-QA-0020, *Data Review*, and DV-QA-0022, *Data Package Assembly),* to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data are reported. The laboratory also has an SOP discussing Manual Integrations to ensure the authenticity of the data (DV-QA-011P, *Acceptable Manual Integration Practices*). The general review concepts are discussed below, more specific information can be found in the SOPs.

19.14.4.1 Log-In Review - The data review process starts at the sample receipt stage. Sample control personnel review chain-of-custody forms and project instructions from the project

management group. This is the basis of the sample information and analytical instructions entered into the LIMS. The log-in instructions are reviewed by the personnel entering the information, and a second level review is conducted by the project management staff.

19.14.4.2 First Level Data Review - The next level of data review occurs with the analysts. As data are generated, analysts review their work to ensure that the results meet project and SOP requirements. First level reviews include inspection of all raw data (e.g., instrument output for continuous analyzers, chromatograms, spectra, and manual integrations), evaluation of calibration/calibration verification data in the day's analytical run, evaluation of QC data, and reliability of sample results. The analyst transfers data into LIMS, data qualifiers are verified or added as needed. All first level reviews are documented.

19.14.4.3 Second Level Data Review – All analytical data are subject to review by a second qualified analyst or supervisor. Second level reviews include inspection of all raw data (e.g., instrument output, chromatograms, and spectra) including 100% of data associated with any changes made by the primary analyst, such as manual integrations or reassignment of peaks to different analytes, or elimination of false negative analytes. The second review also includes evaluation of initial calibration/calibration verification data in the day's analytical run, evaluation of QC data, reliability of sample results, qualifiers and NCM narratives. Manual calculations are checked in second level review. All second level reviews are documented.

Issues that deem further review include the following:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data do not match with reported results
- Unusual reporting limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors
- Results outside of calibration range

19.14.4.4 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, Project Manager, Quality Assurance Manager, Technical Manager, Department Manager/Supervisor, or Quality Director for further investigation. Corrective action is initiated whenever necessary.

19.14.4.5 The results are then entered or directly transferred into the computer database and a hard copy (or .pdf) is printed for the client.

19.14.4.6 As a final review prior to the release of the report, the Project Manager reviews the results for appropriateness and completeness. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The process includes, but is not limited to, verifying that chemical

relationships are evaluated, COC is followed, cover letters/ narratives are present, flags are appropriate, and project specific requirements are met.

19.14.4.7 Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable quality control requirements. The Project Manager then signs the final report. When complete, the report is sent out to the client.

19.14.4.8 A visual summary of the flow of samples and information through the laboratory, as well as data review and validation, is presented in Figure 19-2.

19.14.5 <u>Manual Integrations</u>

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP (CA-Q-S-002) as the guideline for the internal SOP DV-QA-011P, *Acceptable Manual Integration Practices*.

19.14.5.1 The analyst must adjust the baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integration is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.14.5.2 Analysts shall not increase or decrease peak areas for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principles and policy and is grounds for immediate termination.

19.14.5.3 Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

19.14.5.4 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale "after" chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale "before" chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 19-1. Example - Demonstration of Capability Documentation

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

IDOC	☐
DOC	☐

Analyst Name	
Date	
SOP Number	
Method	
Analysis	
Matrix	

We the undersigned, CERTIFY that:

1. The analyst identified above, using the cited test method with the specifications in the cited SOP, which is in use at this facility for the analysis of samples under the TestAmerica Quality Assurance Manual, has met the Initial or Ongoing Demonstration of Capability.
2. The test method was performed by the analyst identified on this certification following the TestAmerica SOP and source method.
3. A copy of the laboratory-specific SOP and source method is available for all personnel on-site. These documents have been reviewed by the analyst as part of this Demonstration of Capability.
4. The data associated with the initial/ongoing demonstration of capability are true, accurate, complete and self-explanatory (*). These data are attached to this certification statement.
5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized inspectors.

Comments/Observations:

Analyst's Name (Print) Signature & Date

Supervisor (Print) Signature & Date

Margaret S. Sleevi

QA Manager's Name Signature & Date

* *True: Consistent with supporting data.*
Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.
Complete: Includes the results of all supporting performance testing.
Self-explanatory: Data properly labeled and stored so that the results are traceable and require no additional explanation.

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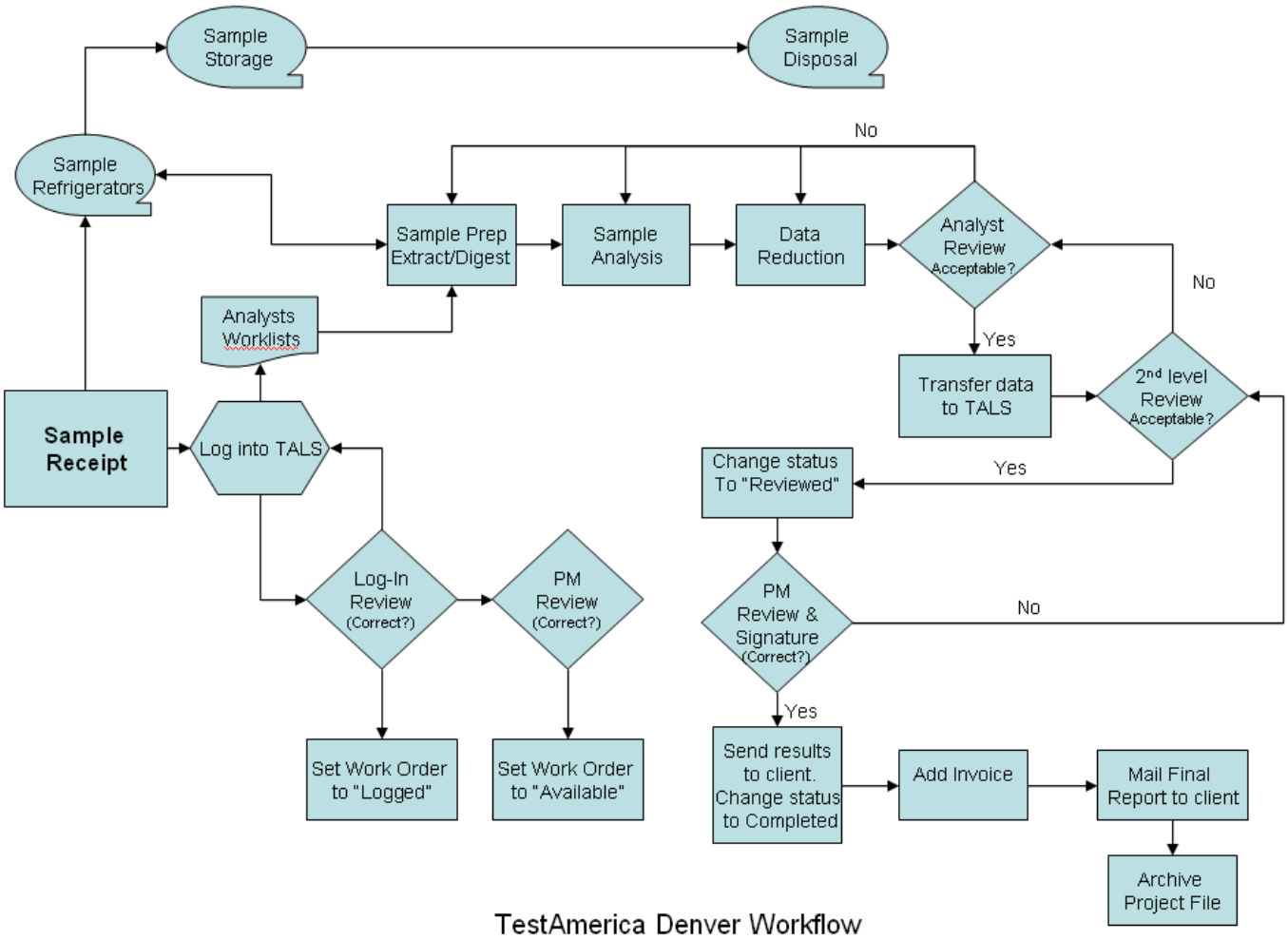
Rev 4 – 4/16/2014

Figure 19-2. Example: Work Flow



SECTION 20. EQUIPMENT and CALIBRATIONS

20.1 Overview

Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. The laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in laboratory SOPs. A list of laboratory instrumentation and support equipment is presented in Table 20-1.

Equipment is only operated by authorized and trained personnel. Manufacturer's instructions for equipment use are readily accessible to all appropriate laboratory personnel.

20.2 Preventive Maintenance

The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

Routine preventive maintenance procedures and frequency, such as cleaning and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Department Manager/Supervisor to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures may be / are also outlined in analytical SOPs or instrument manuals. (Note: for some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.
- Each entry in the instrument log includes the analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control, e.g., CCV run on *'date'* was acceptable, or instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.

- When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This taped in page must be signed across the page entered, the tape and the logbook so that it is clear that a page is missing if only half a signature is found in the logbook. Alternatively the maintenance event can be documented in the log and the location where the service receipts are stored referenced in this entry.

If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it shall be taken out of operation and tagged as out-of-service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory shall examine the effect of this defect on previous analyses.

In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Back up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the back-up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

At a minimum, if an instrument is sent out for service or transferred to another facility, it must be recalibrated and the laboratory MDL verified (using an MDLV) prior to return to lab operations.

20.3 Support Equipment

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, field sampling devices, temperature measuring devices, thermal/pressure sample preparation devices and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance.

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked prior to initial serviceable use with at least two certified ASTM type 1 weights spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). ASTM type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains “calibration only” ASTM type 1 weights).

All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file. Refer to SOP DV-QA-0014, *Balance Calibration Check.*

20.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one µmhos/cm.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult pH and Conductivity, and Turbidity SOPs for further information.

20.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer at temperatures bracketing the range of use. IR thermometers, digital probes and thermocouples are calibrated quarterly. IR Thermometers should be calibrated over the full range of use, including ambient, iced (4°C) and frozen (0°C to -5°C), per the Drinking Water Manual.

The mercury NIST thermometer is recalibrated every five years and the digital NIST thermometer is recalibrated annually (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The NIST thermometer(s) have increments of 1 degree, and have ranges applicable to method and certification requirements. The NIST traceable thermometer is used for no other purpose than to calibrate other thermometers.

Internal calibration records are documented in electronic spreadsheets. Certificates documenting calibration by outside vendors is maintained in files in the QA office. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in method-specific logbooks or batch records. More information on this subject can be found in SOP DV-QA-0001, *Thermometer Calibration Procedure.*

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored 7 days a week.

Ovens, waterbaths and incubators are monitored on days of use.

All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

Sample storage refrigerator temperatures are kept between > 0ºC and ≤ 6 ºC.

Specific temperature settings/ranges for other refrigerators, ovens waterbaths, and incubators can be found in method specific SOPs.

All of this information is documented in Daily Temperature Logs, logtag (datalogger) downloads and method-specific logbooks. See SOP DV-QA-0012, *Monitoring Refrigerator Temperature and Power Failure Contingency Plan* or method specific SOPs.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices (except Class A Glassware and Glass microliter syringes) are given unique identification numbers and the delivery volumes are verified gravimetrically, daily (if used).

For those dispensers that are not used for analytical measurements, a label is / can be applied to the device stating that it is not calibrated. Any device not regularly verified cannot be used for any quantitative measurements.

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. The laboratory keeps on file an "Accuracy and Precision Statement of Conformance" from Hamilton attesting established accuracy.

Refer to SOP DV-QA-0008, *Calibration and Verification of Mechanical Pipettes.*

20.4 Instrument Calibrations

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day.

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, type of calibration (Avg RF, curve, or other calculations that may be used to reduce instrument responses to concentration).

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

If the initial calibration results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 12).

Note: Instruments are calibrated initially and as needed after that and at least annually.

20.4.1 Calibration Standards

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP. If a reference method does not specify the number of calibration standards, a minimum of 3 calibration points (exception being ICP and ICP/MS methods) will be used.

Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample).

The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to at least the same number of significant figures used to report the data) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exception to these rules is ICP methods or other methods where the referenced method does not specify two or more standards.

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). For unique situations, such as Disodium Iminodiacetate (IDA) analysis where no other source or lot is available, a standard made by a different analyst at a different time or a different preparation would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.4.1.1 Calibration Verification

The calibration relationship established during the initial calibration must be verified initially and at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and in the 2009 TNI Standard. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. Initial calibration verification is with a standard source secondary (second source standard) to the calibration standards, but continuing calibration verifications may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to here is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, i.e., RPD, per 2009 TNI Std. EL-V1M4 Sec. 1.7.2.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Note: If an internal standard calibration is being used (e.g., GC or GCMS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

Generally, the initial calibrations must be verified at the beginning of each 12-hour analytical shift during which samples are analyzed. (Some methods may specify more or less frequent verifications). The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample, QC, or standard that can be injected within 12-hours of the beginning of the shift.

A continuing instrument calibration verification (CCV) must be repeated at the beginning and, for methods that have quantitation by external calibration models, at the end of each analytical batch. Some methods have more frequent CCV requirements see specific SOPs. Most Inorganic methods require the CCV to be analyzed after ever ten samples or injections, including matrix or batch QC samples.

If the results of a CCV are outside the established acceptance criteria and analysis of a second consecutive (and immediate) CCV fails to produce results within acceptance criteria, corrective action shall be performed. Once corrective actions have been completed and documented, the laboratory shall demonstrate acceptable instrument / method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with an unacceptable calibration verification may be fully useable under the following special conditions and reported based upon discussion and approval of the client:

a). when the acceptance criteria for the CCV are exceeded high (i.e., high bias) and the associated samples within the batch are non-detects, then those non-detects may be reported with a footnote or case narrative explaining the high bias. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted; or

b). when the acceptance criteria for the CCV are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted.

Samples reported by the two conditions identified above will be appropriately flagged.

20.4.1.2 <u>Verification of Linear and Non-Linear Calibrations</u>

Calibration verification for calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. (These calculations are available in the laboratory method SOPs. Verification standards are evaluated based on the Percent Difference from the average CF or RF of the initial calibration or based on Percent Drift or Percent Recovery if a linear or quadratic curve is used.

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

- When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.
- When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted. Alternatively, a reporting limit standard may be analyzed to demonstrate that the laboratory can still support non-detects at their reporting limit.

20.5 Tentatively Identified Compounds (TICs) – GC/MS Analysis

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Data system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the laboratory does not routinely analyze for this compound and may not have verified MDLs, the compound is reported as a “targeted TIC” as it is reported compared to a known standard and can be quantitatively (if verification is in control) and qualitatively measured. The result should be qualified if this is the case.

For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification.

20.6 GC/MS Tuning

Prior to any GCMS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

Prior to tuning/auto-tuning the mass spec, the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally don't need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

Table 20-1. Instrumentation List

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year in Service	Method Performed[1]
ICP	Thermo Fischer (025)	ICP 6500	S/N 20090307	2006	6010, 200.7
ICP	Thermo Fischer (026)	ICP 6500	S/N 20063207	2006	6010, 200.7
				2001	8310
HPLC/ICP/MS	Agilent Technologies (Q) Agilent ICP-MS (024)	UV Multiple wavelength detector 1365B Quarternary Pump G1311A 7500 Series	S/N DE11101025 S/N DE11114412 S/N JP51201530	2006	Speciation
ICP/MS	Agilent ICP-MS (077)	7700 Series	S/N JP09320047	2009	6020, 200.8
ICP/MS	Agilent ICP-MS (078)	7700 Series	S/N JP12422099	2014	6020, 200.8
Mercury Analyzer	Cetac CVAA (033)	M-7500	S/N 08092QTA	2010	7470, 7471, 245.1
Mercury Analyzer	Cetac CVAA (034)	M-7500	S/N 0021105QTA	2011	7470, 7471, 245.1
Graphite Furnace	Perkin Elmer GFAA (MT_035)	AAnalyst 600	S/N 601S2030105	2013	939M
Ion Chromatograph	Dionex (IC6)	ICS 2000	S/N 03100162/03100118	2003	300.0, 9056
Ion Chromatograph	Dionex (IC7)	ICS 2000	S/N 03100161/03100122	2003	300.0, 9056
Ion Chromatograph	Dionex (IC8)	ICS 2000 RFIC	S/N 08020954/08020762	2008	300.0, 9056
Ion Chromatograph	Dionex (IC9)	ICS 3000	S/N 08020888	2008	Hydrazine, MMH, UDMH
Ion Chromatograph	Metrohm (IC10)	881 Compact IC	S/N 1881000124128	2012	300.0, 9056
Ion Chromatograph	Dionex (IC11)	ICS 1100	S/N 09100167	2013	300.0, 9056
TOC	LECO (LEC)	C632 (Solid)	S/N 3097	2007	9060
TOC	Shimadzu (SHI3)	TOC-VCPN	S/N H51404335027	2005	9060, 5310B
TOC	Shimadzu (SHI2)	TOC-VCSH	S/N 414445340	2008	9060, 5310B
TOX	Thermo Euroglass (Thermo 2)	ECS 1200	S/N 2004.119/ 2008.28	2008	9020
TOX	Thermo Scientific (Thermo 3)	ECS 1200	S/N 993728/ 2008.28	2004	9020
UV/VIS	Alpkem (Alp2)	A002393	S/N 908893427/ 906850834	1997	353.2
UV/VIS	Alpkem (Alp1)	A002393	S/N 917893398/ 912850458	1997	420.4, 9066, all CN methods

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year in Service	Method Performed[1]
UV/VIS	Alpkem (ALP3)	Flow Solution 3000	S/N 632-1010-49/60092	2010	350.1
UV/VIS	Konelab	Model 20	S/N P0518697	2003	365.1
UV/VIS	Astoria Pacific Analyzer	Astoria 2	S/N 200052	2005	351.2
Autotitrator (pH, Alkalinity, Conductance)	Man-Tech (AT2)	PC – Titrate / PC-1000	S/N MS-0D0-240	2000	9040, 9045, SM2320B
Autotitrator (pH, Alkalinity, Conductance)	Man-Tech (AT3)	PC – Titrate / PC-1000	S/N MS-0A9-546	2011	9040, 9045, SM2320B
pH Meter	ThermoScientific	Orion 5 Star	S/N B27854	2012	9040, 9045, SM4500-H B
Conductivity Meter	Orion	Orion Star A112	S/N J05436	2013	SM2510B, 9050
Dissolved Oxygen Meter	YSI	5100	S/N 02G0238	2008	SM5210B
Turbidimeter	HF Scientific (TB2)	Micro 100	S/N 104008	2001	180.1
Flashpoint	Herzog Pensky Martens	Model MP-329	S/N 43291648	2003	1010
Spectrophotometer	HACH	DR/2010	S/N 990200012321	2007	410.4, 7196, SM3500 Fe D, SM3500 Cr B, SM4500S-2 D, 420.1
Spectrophotometer	Genesys	Genesys 20	SN: 3SGP171002	2011	410.4, 7196, SM3500 Fe D, SM3500 Cr B, SM4500S-2 D, 420.1
TCLP - pH Meter	Thermo Orion	SA720	S/N TVT71A	2005	1311, 1312
GC/MS Semivolatiles	Hewlett-Packard (D)	6890 – GC 5973 – MSD	S/N US00007319 S/N US70820565	1996	8270, 625
GC/MS Semivolatiles	Agilent Technologies (F)	6890 – GC 5973N – MSD	S/N US00036181 S/N US02480180	1996	8270 SIM
GC/MS Semivolatiles	Agilent Technologies (K)	6890N – GC 5973 – MSD	S/N CN10332028 S/N US33266011	2003	8270, 625, LVI
GC/MS Semivolatiles	Agilent Technologies (GCMS6)	7890A – GC 5975C inert XL w/ triple Axis Detector	S/N CN10933128 S/N US92033627	2010	8270, 625
GC/MS Semivolatiles	Agilent Technologies (G4)	6890N – GC 5973 Inert – MSD	S/N CN10438087 S/N US43120937	2004	8270 Best Practice, D7065-11
GC/MS Semivolatiles	Agilent Technologies (X4)	6890N – GC 5973 inert – MSD	S/N CN10438076 S/N US43120927	2004	8270 SIM, LVI

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year in Service	Method Performed[1]
GC/MS Semivolatiles	Hewlett-Packard (Y)	6890 – GC 5973 – MSD	S/N US00007291 S/N US70820572	1996	8270, 625
GC/MS Semivolatiles	Hewlett-Packard (B2)	6890 – GC 5973 – MSD	S/N US00010475 S/N US7820578	2013	8270, 625
GC/MS Semivolatiles	Agilent Technologies (GCMS5)	6890N – GC 5975 – MSD	S/N CN10605078 S/N US60532282	2006	8270 SIM
GC/MS Volatiles	Agilent Technologies (C) O·I Analytical	6890N – GC 5973 – MSD 4552 - Purge and Trap 4660 Concentrator	S/N US00007315 S/N US70820571 S/N 14049 S/N A344466379E	2002	8260
GC/MS Volatiles	Agilent Technologies (E) O·I Analytical	6890 – GC 5973 – MSD 4552 - Purge and Trap 4660 – Concentrator	S/N-US00029543 S/N –US93122910 S/N - 13442 S/N – G116466985P	2011	8260 8260 SIM
GC/MS Volatiles	Hewlett-Packard (H) O·I Analytical	5890II – GC 5972 – MSD 4552 – Purge and Trap 4660 – Concentrator	S/N 3336A60700 S/N 3524A03013 S/N 14383 S/N A3444663771	1994	8260, 624
GC/MS Volatiles	Hewlett Packard (P) O·I Analytical	6890 - GC 5973 – MSD 4552 – Purge and Trap 4660 - Concentrator	S/N US00007321 S/N US70820566 S/N 14377 S/N C509466078P	1997	8620 MLE SOIL
GC/MS Volatiles	Hewlett-Packard (G) Varian OI Analytical	5890 Series II - GC 5972 – MSD Archon Purge and Trap O•I 4560 - Concentrator	S/N 3336A56276 S/N 3435A01850 S/N 12751 S/N 1913460964	1996	8260 (SOIL & WATER)
GC/MS Volatiles	Hewlett-Packard (J) Hewlett Packard Varian O•I Analytical	5890 II Series - GC 5972 - MSD Archon Purge and Trap 4560 - Concentrator	3336A60701 3524A03016 3524A03016 D308367	1994	8260 (SOIL)
GC/MS Volatiles	Agilent Technologies (R1) O•I Analytical	6890N - GC 5973 Inert – MSD 4552 – Purge and Trap 4660 – Concentrator	CN10524033 US52420237 14043 A344466372B	1994	8260
GC/MS Volatiles	Hewlett-Packard (Z) O·I Analytical	5890II – GC 5972 – MSD Archon Purge and Trap O•I 4660 – Concentrator	S/N 3336A60013 S/N 352AA02693 S/N C429411174 S/N G109466777	1996	8260, 624

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year in Service	Method Performed[1]
GC/MS Volatiles	Agilent Technologies (GCMS1) O·I Analytical	6890N – GC 5973 – MSD 4552 – Purge and Trap 4660 – Concentrator	S/N CN10420009 S/N US35120257 S/N 14593 S/N C509466077P	2004	8260
GC/MS Volatiles	Agilent Technologies (G2) Varian	6890N – GC 5973 – MSD Archon Purge and Trap O•I 4660 – Concentrator	S/N CN10421078 S/N GS36120303 S/N MS0902W012 S/N 19374669269	2004	8260 (SOIL & WATER) 8260 SIM (SOIL)
GC/MS Volatiles	Hewlett-Packard (Q) Varian OI Analytical	6890 – GC 5973 – MSD Archon Purge and Trap O•I 4560 – Concentrator	S/N US0000021949 S/N US72810801 S/N 12750 S/N H216466454P	2001	8260 AK SOIL
GC/MS Volatiles	Hewlett-Packard (I) Tekmar Dohrmann	5890 – GC 7000 – Headspace Autosampler 7000 - Autosampler Tray	S/N 2643A11361 S/N US03038002 S/N US03045009	2003	Volatile Screening
GC/MS Volatiles	Hewlett-Packard (T) Tekmar Dohrmann	5890 Series II – GC 7000HT Headspace 7000HT Autosampler	S/N 2750A14928 S/N US01198005 S/N US01281004	2001	Volatile Screening
GC/MS Volatiles	Hewlett-Packard (GCMS8) O·I Analytical	HP6890 HP5973 4552 –Autosampler 4560 –Purge and Trap	S/N US0006567 S/N US63810338 S/N 11958-696A S/N M934460860	2013	8260 FREONS
GC/MS Volatiles	Agilent Technologies (GCMS9) O·I Analytical	6890N 5975B 4552 Eclipse 4660	S/N US10229109 S/N US60522608 S/N 14052 S/N C509466077E	2015	8260B Water
GC Semivolatiles	Hewlett-Packard (A)	5890 Dual FID	S/N 2750A16891	1987	8015 Alcohols
GC Semivolatiles	Hewlett-Packard (C)	6890 Dual ECD	S/N US00029514	1999	608, 8081
GC Semivolatiles	Hewlett-Packard (D)	6890 Dual NPD	S/N DE00020818	1997	614, 8141
GC Semivolatiles	Agilent Technologies (D2)	6890N Dual NPD	S/N US10521035	2004	614, 8141
GC Semivolatiles	Hewlett-Packard (E)	5890II Dual ECD	S/N 3121A35858	1992	8011
GC Semivolatiles	Hewlett-Packard (M)	6890 Dual ECD	S/N US00024143	1999	8151
GC Semivolatiles	Agilent Technologies (P1)	6890N Dual ECD	S/N US10418019	2004	608, 8081
GC Semivolatiles	Agilent Technologies (P2)	6890N Dual ECD	S/N US10418024	2004	608, 8081
GC Semivolatiles	Agilent Technologies (P3)	6890N Dual ECD	S/N US10418023	2004	608, 8082
GC Semivolatiles	Hewlett-Packard (R)	5890II Dual ECD	S/N 3336A55030	1994	608, 8082
GC Semivolatiles	Hewlett-Packard (U)	5890II Single FID	S/N US00063217	1999	8015 DRO
GC Semivolatiles	Agilent (U2)	7890A Dual FID	S/N CN10942072	2009	8015 DRO
GC Semivolatiles	Hewlett-Packard (W)	5890II Dual ECD	S/N 3126A36250	1990	608, 8082
GC Semivolatiles	Hewlett-Packard (Z2)	5890II Dual FID	S/N 3336A51924	1990	Glycols

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year in Service	Method Performed[1]
GC Volatiles	Hewlett-Packard (J) Tekmar Dohrmann	6890 Dual FID HS Autosampler 7000 HS Autosampler 7000 HT	S/N US00026194 S/N US02296006 S/N US02296004	1997	RSK-175
GC Volatiles	Hewlett-Packard (L) Tekmar Dohrmann	5890A FID LSC 2000 Concentrator ALS 2016 Purge and Trap ALS 2032 Purge and Trap	S/N 2336A00164 S/N 89283001 S/N 90121028 S/N 94300004	1988	8015 GRO
GC Volatiles	Agilent Technologies (S-1) O I Analytical	6890 Dual PID/ Dual ELCD 4552 – Purge and Trap 4660 – Concentrator	S/N US10341120 S/N 14046 S/N 343466333P	2003	8021
GC Volatiles	Hewlett-Packard (Y) Tekmar Dohrmann	5890A PID/FIDLSC 3000 Concentrator ALS 2016 Purge and Trap ALS 2032 Purge and Trap	S/N 2843A19484 S/N 93132006 S/N 88145006 S/N 91112002	1988	Screening
GC Volatiles	Agilent (Q) OI Corporation	7890A Dual PID Dual FID 4660 Concentrator 4552 Autosampler	S/N CN12161119 S/N H216466450P S/N US12090001	2012	8015 GRO, AK101
HPLC	Hewlett-Packard (G)	Multiple wavelength UV Detector G1365A Fluorescence detector G1321A Quarternary Pump G1311A	S/N DE91600240 S/N DE92001251 S/N DE91606289	1999	8310
HPLC	Agilent Technologies (G2)	UV Diode Array Detector G1315B Fluorescence detector G1321A Binary Pump G1321A	S/N DE11112694 S/N DE40506039 S/N US83105106	2011	8330
HPLC	Agilent Technologies (X3)	UV Diode Array Detector G1315B Fluorescence detector G1321A Quarternary Pump G1311A	S/N DE23917239 S/N DE33205520 S/N DE33224364	2004	8330
HPLC	Agilent Technologies (X4)	UV Multiple wavelength detector 1365B Quarternary Pump G1311A	S/N DE22601691 S/N DE14918799	2010	8330

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year in Service	Method Performed[1]
HPLC/MS/MS	Waters (LCMS2) Waters Dionex	Quattro Ultima MS/MS HPLC 2790 Ion Chromatography (IC) System ICS-2000	S/N VB304 S/N D00SM9378M S/N 07070021	2001	8321, 6860
HPLC/MS/MS	Waters (LCMS3)	Quattro Premier XE MS/MS Sample Manager Acquity Binary Solvent Manager Acquity	S/N VAB661 S/N M04UPS473M S/N M04UPB504M	2005	8321
HPLC/MS/MS	Waters (LCMS4)	Quattro Micromass MS/MS HPLC Inlet Acquity Waters Ion Sabre Control Unit	S/N QAA632 S/N K035M4028M S/N 29005	2006	8321 Explosives
HPLC/MS/MS	Agilent Technologies (LCMS5) Agilent	G6460A MS/MS Binary Pump G1312B Binary Pump G1379B	S/N US95270371 S/N DE63061753 S/N JP94112712	2010	PFCs

[1]Laboratory performs one or more versions of SW-846 methods. Only the parent method number is listed without the version letter.

TestAmerica Denver Support Equipment

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Refrigerator	Lab Line Industries, Inc	Frigid Cab	--	GC North Aliquoting
Refrigerator	Beverage Air	--	4007882	GC-VOA
Refrigerator	VWR Scientific	--	902331	GC-VOA
Refrigerator	Beverage Air	Refrigerator	4007879	GC-VOA
Refrigerator	Frigidaire	FKCH17FHWE	WB41560080	GC-VOA
Refrigerator	Frigidaire	FKC17F7QTA	WB42948212	GC-VOA
Refrigerator	Summit	SCRR490	7.61101E+11	GC-VOA
Refrigerator	Frigidaire	FKCH17FHWE	WB41560082	GC North Aliquoting
Refrigerator	Frigidaire	FKCH17F7HWD	WB33778319	GC North Aliquoting
Refrigerator	Frigidaire	FKCH17F7HWD	WB33778320	LCMS
Refrigerator	Frigidaire	FKC17F7QTA	WB42948283	LCMS North Aliquoting

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Refrigerator	Sanyo	SR1287X	880508138	Log-in
Refrigerator	Atosa	MBF8005	MBF8005150505C40	Log-in
Refrigerator	Beverage Air	ER48-IAS	6126470	MS-VOA
Refrigerator	Trautsen	G20010	T39912A03	MS-VOA
Refrigerator	Fisher Scientific	Isotemp Plus (13-986-126)	512N0035	MS-VOA
Refrigerator	Beverage Air	Refrigerator	8548726	MS-VOA
Refrigerator	Hoshizaki	RH2AAC	M60350G	MS-VOA
Refrigerator	Hoshizaki	RH2AAC	M60349G	MS-VOA
Refrigerator	Intertek	MBF8005	MBF8005150127C4007	MS-VOA
Refrigerator	Trautsen	G20010	T39703A03	North OP
Refrigerator	Fisher Scientific	3556FS	0119097301100515	North OP
Refrigerator	Fisher Scientific	Isotemp - 3556FS	0119097401100515	North OP
Refrigerator	Fisher Scientific	Isotemp (13-986-245G)	407N0077	North OP
Refrigerator	Lab Line Industries, Inc	VWR Frigid Cab	--	North OP
Refrigerator	Glenco	XL Series E (ALA-48-TE)	EE-319830-C	North OP
Refrigerator	Frigidaire	FKCH17FHWE	WB41560092	Wet Chemistry
Refrigerator	Frigidaire	FKCH17FHWE	WB41560078	Wet Chemistry
Refrigerator/Freezer	Fisher Scientific	--	--	Explosives Prep
Refrigerator/Freezer	VWR	--	--	Explosives Prep
Refrigerator/Freezer	Frigidaire	Crown Series (F44C18SHW0R4C18571)	BA01927318	GC North Aliquoting
Refrigerator/Freezer	Lab Line Industries, Inc	Frigid Cab	--	GC North Aliquoting
Refrigerator/Freezer	Lab Line Industries, Inc	Frigid Cab (EEL14ZCTWR0)	--E03532259	GC North Aliquoting
Refrigerator/Freezer	GE	GTH17DBDDRWW	AA813320	GC North Aliquoting
Refrigerator/Freezer	Hotpoint	HTS18GBSBRWW	HS748902	GC North Aliquoting
Refrigerator/Freezer	Lab Line Industries, Inc	VWR Frigid Cab	S63228358	GC North Aliquoting

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Refrigerator/Freezer	Precision	R12813	14AW-5	GC-VOA
Refrigerator/Freezer	Sears	25367800792	BA81102895	GC-VOA
Refrigerator/Freezer	Hotpoint	HTS18GBSARWW	HR731980	GC-VOA
Refrigerator/Freezer	Lab Line Industries, Inc	VWR Frigid Cab	88-002--	GC-VOA
Refrigerator /Freezer	Vulcan	CRA2	3202290	MS Aliquotting
Refrigerator/Freezer	Fisher Scientific	--	--	MS South Aliquoting
Refrigerator/Freezer	Fisher Scientific	--	--	MS South Aliquoting
Refrigerator/Freezer	Fisher Scientific	13-986-111A	016875390110908	MS-VOA
Refrigerator/Freezer	Fisher Scientific	97-925-1	0119104401100518	MS-VOA
Refrigerator/Freezer	Fisher Scientific	97-925-1	0119196001100611	MS-VOA
Refrigerator/Freezer	Fisher Scientific	TDX15SNBRWH	GH812576	MS-VOA
Refrigerator/Freezer	Lab Line Industries, Inc	VWR Frigid Cab	S82927189	MS-VOA
Refrigerator/Freezer	Fisher Scientific	97-925-1	0119104401100518	North OP
Refrigerator/Freezer	Curtin Matheson Scientific	P73953-33WW	CK3737-5084-8	North OP
Refrigerator/Freezer	GE	TBF22306	RN507856	GC North Aliquoting
Refrigerator/Freezer	Fisher Scientific	TDX15SNSBRWH	MH732121	North OP
Refrigerator/Freezer	GE	TBF22306	RN507856	Wet Chemistry
Refrigerator/Freezer	Frigidaire	FKCH17FHWE	WB41560092	Wet Chemistry
Balance	Denver Instruments	TP 1502	24750526	Explosives Prep
Balance	Denver Instruments	TP 1502	24750525	GC SVOA Hood #32
Balance	Denver Instruments	TP 3102	24750837	Hg Prep Room

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Balance	Denver Instruments	TP 214	24650979	Metals
Balance	Denver Instruments	TP 3102	24750836	Metals Prep
Balance	Denver Instruments	TP 323	24850252	MS VOA Hood #36
Balance	Mettler	PE3600	D56416	MS VOA Hood #37
Balance	Mettler	AE 260	H52017	MS VOA Standards Prep Room
Balance	Denver Instruments	TP 214	24450835	North Prep
Balance	Denver Instruments	TP 6101	24750402	North Prep
Balance	Denver Instruments	TP 6101	24350888	North Prep
Balance	Scout Pro	SP4001	B442138757	North Prep
Balance	Scout Pro	SP4001	B318295195	North Prep
Balance	Mettler	AE 240	I23294	Stnds and Aliquotting Hood #58
Balance	Denver Instruments	TP 3102	24950431	TCLP
Balance	Denver Instruments	PI-20.3	24850570	Wet Chem (Storage)
Balance	Mettler	AE 160	C33519	Wet Chem (Storage)
Balance	Mettler	PM4000	M28318	Wet Chem (Storage)
Balance	Denver Instruments	P-602	P602036023	Wet Chemistry
Balance	Denver Instruments	TP 3102	24950432	Wet Chemistry
Balance	Denver Instruments	TP 6101	24750399	Wet Chemistry
Balance	Denver Instruments	TP 6101	24950441	Wet Chemistry

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Balance	Mettler	AE200S	M19170	Wet Chemistry
Balance	Mettler	PM 4600	H31422	Wet Chemistry
Balance	Mettler	AE 163	D91301	Wet Chemistry /South Prep
Balance	Mettler	ML104/03	B439083239	Wet Chemistry /South Prep
Balance	Sartorius	CP124S	19350788	Wet Chemistry Soil TOC
Centrifuge	Beckman-Coulter	Allegra X-22	ALB102L007	Explosives Prep
Centrifuge	IEC Clinical	IEC Clinical	428-25419	Mass Spectrometry
Centrifuge	Sorvall Legend T	Sorvall Legend T	40507140	Metals
Centrifuge	International Equipment Company	K	71652079	North Prep
Centrifuge	International Equipment Company	UV	88340M-4	North Prep
Centrifuge	International Equipment Company	Model K	71654070	TCLP
Centrifuge	Beckman	Beckman GS-G	GA1J23	Wet Chemistry
Chiller	Remcor	CA550A	62A1031LC003	Explosives Prep
Chiller	Brinkman	WK 4600 Lauda	LWG-736-04-0004	North Prep
Chiller	Brinkman	WL 4600 Lauda	B05002	North Prep
Chiller	Neslab	CFT-75	197031137	North Prep
Chiller	Neslab	CFT-75	92EML23290-S	North Prep
Chiller	Brinkman	WL 4600 Lauda	A13015	South Prep
Chiller	Brinkman	WL 4600 Lauda	LWG736-04-0001	South Prep

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
COD Digestor	HACH	DRB 200	10030C0116	Wet Chemistry
Cyanide Digestor	Westco Scientific Instruments, Inc.	V-Distilation Block	1028	Wet Chemistry
Cyanide Digestor	Westco Scientific Instruments, Inc.	Westco Scientific Instruments, Inc.	1228	Wet Chemistry
Digestion System w/ Controller	A I Scientific	AIM 500	4818A13244	Wet Chemistry-TKN
Digestion System w/ Controller	A I Scientific	AIM 500	5146V00546	Wet Chemistry-TKN
Drying Oven	Blue M	Temp-O-Loy Annealing Oven	TLG-102	North Prep
Freezer	GE	FUF 20DTFRWH	FR171928	MS SouthGC North Aliquoting
Freezer	White-Westinghouse	MFU17M3BW2	WB50400991	GC-VOA/Log-in
Freezer	GE	FUF 14DTCRWH	DR169039	LCMS North AliquotingMS South Aliquoting
Freezer	Kenmore	5	881200048	MS South Aliquoting
Freezer	Fisher Scientific	Isotemp (13-986-149)	0168153201110318	MS-VOA
Freezer	Fisher Scientific	Isotemp (13-986-149)	0168246901110414	MS-VOA
Grinder	Humboldt	H-4199	12014199	Explosives Prep
Grinder	Humboldt	H-4199	10014199	Explosives Prep
Grinder	Cutler-Hammer	Ring in puck	--	Grinding Room
Grinder	US Stoneware	Ball mill	CS04003	Grinding Room
Hot Block	Environmental Express	SC100	145CEC0266	Metals Prep
Hot Block	Environmental Express	SC100	No tag	Metals Prep
Hot Block	Environmental Express	SC100	5873CEC2707	Metals Prep

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Hot Block	Environmental Express	SC100	No tag	Metals Prep
Hot Block	Environmental Express	SC100	145CEC0267	Metals Prep
Hot Block	Environmental Express	SC100	145CEC0275	Metals Prep
Hot Block	Environmental Express	SC100	No tag	Metals Prep
Hot Block	Environmental Express	SC100	3366CEC1595	Metals Prep
Hot Block	Environmental Express	SC100	3366CEC1596	Metals Prep
Hot Block	Environmental Express	SC151	6435CECW3032	Metals Prep
Hot Block	Environmental Express	SC151	6435CECW3033	Metals Prep
Hot Block	Environmental Express	SC154	8297CECW3531	Metals Prep
Hot Block	Environmental Express	SC154	2015CECW4171	Metals Prep
Hot Block	Environmental Express	SC100	3703CEC1727	Metals-Hg
Hot Block	Environmental Express	SC100	3366CEC1603	Metals-Hg
Hot Block	Environmental Express	SC154	6435CECW3006	Metals-Hg
Hot Block	Environmental Express	SC154	6435CECW3007	Metals-Hg
Hot Bblock	CPI	Modblock	None	South Prep
Incubated Shaker Table	Lab Line Industries, Inc	3527	1196 0534	South Prep

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Incubator	Fisher Scientific	11-679-25C Low Temperature Incubator	2018090422353--	Wet Chemistry
Incubator	Fisher Scientific	FFV20F9GWO	W880520744	Wet Chemistry
Incubator	Thermo Electron Corporation	BOD50A15	P20R-610933-PR	Wet Chemistry
Microwave Extraction	CEM Corporation	MARSXpress Xtraction	MD1875	North Prep
Midi-Vap/Vacuum Pump	Environmental Express EMS	EMD1920-106	2336 22401	Wet Chemistry
Midi-Vap/Vacuum Pump	Environmental Express EMS	EMD1920-106	2337 22404	Wet Chemistry
Muffle Furnace	Lindberg	51828	919081	South Prep
N-Evap	Organomation Associates, Inc.	N-Evap II Nitrogen Evaporator	50320	North Prep
N-Evap	Organomation Associates, Inc.	N-Evap II Nitrogen Evaporator	10262	North Prep
N-Evap	Organomation Associates, Inc.	N-Evap II Nitrogen Evaporator Model 111	7243	South Prep
Oil and grease Machine	Horizon Technology	Controller SPE-DEX 3000 XL Speed VAP II 9000 Vac Generator	09-1126 50-0412-02 00-245 03-0424	Wet Chemistry
Oven	Precision	Oven	602051362	GC-VOA
Oven	Blue M	Temp O Lay – TLG-36-1G-2	TLG 102	North Prep
Oven	Fisher Scientific	Isotemp Muffle Furnace	01511060452701	North Prep

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Oven	VWR	1320	1320587	South Prep
Oven	Fisher Scientific	Isotemp Oven	212N0439	TCLP
Oven	Labline	L-C Oven	OL85-0192	TCLP
Oven	VWR/SHEL-Lab	1310	1310886	TCLP
Oven (A)	Yamato	Mechanical Convection Oven DKN 810	DKN811B4Y00090	Wet Chemistry
Oven (B)	Yamato	Mechanical Convection Oven DKN 812C	J1406090	Wet Chemistry
Oven (E)	Fisher Scientific	750F	407N0067	Wet Chemistry
Oven (F)	Fisher Scientific	6925	275807-283	Wet Chemistry
Refrigerator	Frigidaire	FKCH17F7HWD	WB33778319	GC North Aliquoting
Refrigerator	Frigidaire	FKCH17FHWE	WB41560082	GC North Aliquoting
Refrigerator	Lab Line Industries, Inc	Frigid Cab	--	GC North Aliquoting
Refrigerator	Beverage Air	--	4007882	GC-VOA
Refrigerator	Frigidaire	FKC17F7QTA	WB42948212	GC-VOA
Refrigerator	Frigidaire	FKCH17FHWE	WB41560080	GC-VOA
Refrigerator	Summit	SCRR490	7.61101E+11	GC-VOA
Refrigerator	VWR Scientific	--	902331	GC-VOA
Refrigerator	Frigidaire	FKCH17F7HWD	WB33778320	LCMS
Refrigerator	Frigidaire	FKC17F7QTA	WB42948283	LCMS North Aliquoting
Refrigerator	Atosa	MBF8005	MBF8005150505C40	Log-in
Refrigerator	Sanyo	SR1287X	880508138	Log-in
Refrigerator	Beverage Air	--	8548726	MS-VOA
Refrigerator	Fisher Scientific	13-986-2Y9R	119243901100628	MS-VOA

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Refrigerator	Fisher Scientific	Isotemp Plus (13-986-126)	512N0035	MS-VOA
Refrigerator	Fisher Scientific	NSPR522WWW/0	11120168	MS-VOA
Refrigerator	Hoshizaki	RH2AAC	M60350G	MS-VOA
Refrigerator	Hoshizaki	RH2AAC	M60349G	MS-VOA
Refrigerator	Intertek	MBF8005	MBF8005150127C4 007	MS-VOA
Refrigerator	Trautsen	G20010	T39912A03	MS-VOA
Refrigerator	Fisher Scientific	3556FS	0119097301100515	North OP
Refrigerator	Fisher Scientific	Isotemp - 3556FS	0119097401100515	North OP
Refrigerator	Fisher Scientific	Isotemp (13-986-245G)	407N0077	North OP
Refrigerator	Glenco	XL Series E (ALA-48-TE)	EE-319830-C	North OP
Refrigerator	Lab Line Industries, Inc	VWR Frigid Cab	--	North OP
Refrigerator	Trautsen	G20010	T39703A03	North OP
Refrigerator	Frigidaire	FKCH17FHWE	WB41560092	Wet Chemistry
Refrigerator	Frigidaire	FKCH17FHWE	WB41560078	Wet Chemistry
Refrigerator /Freezer	Vulcan	CRA2	3202290	MS Aliquotting
Refrigerator/Freezer	Fisher Scientific	--	--	Explosives Prep
Refrigerator/Freezer	VWR	--	--	Explosives Prep
Refrigerator/Freezer	Frigidaire	Crown Series (F44C18SHW0R4 C18571)	BA01927318	GC North Aliquoting
Refrigerator/Freezer	GE	GTH17DBDDRW W	AA813320	GC North Aliquoting
Refrigerator/Freezer	GE	TBF22306	RN507856	GC North Aliquoting
Refrigerator/Freezer	Hotpoint	HTS18GBSBRW W	HS748902	GC North Aliquoting
Refrigerator/Freezer	Lab Line Industries, Inc	Frigid Cab	--	GC North Aliquoting
Refrigerator/Freezer	Lab Line Industries, Inc	Frigid Cab (EEL14ZCTWR0)	E03532259	GC North Aliquoting
Refrigerator/Freezer	Lab Line Industries, Inc	VWR Frigid Cab	S63228358	GC North Aliquoting

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Refrigerator/Freezer	Hotpoint	HTS18GBSARWW	HR731980	GC-VOA
Refrigerator/Freezer	Lab Line Industries, Inc	VWR Frigid Cab	88-002	GC-VOA
Refrigerator/Freezer	Precision	R12813	14AW-5	GC-VOA
Refrigerator/Freezer	Sears	25367800792	BA81102895	GC-VOA
Refrigerator/Freezer	Fisher Scientific	--	--	MS South Aliquoting
Refrigerator/Freezer	Fisher Scientific	--	--	MS South Aliquoting
Refrigerator/Freezer	Fisher Scientific	97-925-1	0119104401100518	MS-VOA
Refrigerator/Freezer	Fisher Scientific	TDX15SNBRWH	GH812576	MS-VOA
Refrigerator/Freezer	Fisher Scientific	13-986-111A	016875390110908	MS-VOA
Refrigerator/Freezer	Fisher Scientific	97-925-1	0119196001100611	MS-VOA
Refrigerator/Freezer	Lab Line Industries, Inc	VWR Frigid Cab	S82927189	MS-VOA
Refrigerator/Freezer	Curtin Matheson Scientific	P73953-33WW	CK3737-5084-8	North OP
Refrigerator/Freezer	Fisher Scientific	97-925-1	0119104401100518	North OP
Refrigerator/Freezer	Fisher Scientific	TDX15SNSBRWH	MH732121	North OP
Rotary Agitation Apparatus	Associated Mfg	--	1192	TCLP Prep
Rotary Agitation Apparatus	Associated Mfg	--	1184	TCLP Prep
Rotary Agitation Apparatus	Associated Mfg	--	1198	TCLP Prep
Separatory Funnel Rotators	Ap and R Machine Tool	Ap and R Machine Tool	--	North Prep
Separatory Funnel Rotators	Ap and R Machine Tool	Ap and R Machine Tool	--	North Prep
Separatory Funnel Rotators	Ap and R Machine Tool	Ap and R Machine Tool	--	North Prep

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Separatory Funnel Rotators	AP and R Machine Tool	AP and R Machine Tool	--	South Prep
Separatory Funnel Rotators	AP and R Machine Tool	AP and R Machine Tool	--	South Prep
Shaker	New Brunswick Scientific	Innova 2100	300443795	Explosives Prep
Shaker Table	Barnstead/ Thermolyne	M49235	721950689273	Metals-ICP
Sieve Shaker	Humboldt	--	--	Grinding Room
Solvent Evaporator with Digital Temperature Control System	UA-SYS	UA-SYS Heating System S-EVAP KD	68984	Wet Chemistry
Sonic Bath	Fischer Scientific	FS60D	RUC100966684A	Metals
Sonicator	Fisher Scientific	550 Sonic Dismembrator	F2448	North Prep
Sonicator	Fisher Scientific	550 Sonic Dismembrator	F1858	North Prep
Sonicator	Fisher Scientific	F550	F1860	North Prep
Sonicator	Heat Systems	Sonicator Ultrasonic Processor XΔ	G1970	North Prep
Sonicator	Heat Systems	XL-2020	G1971	North Prep
Sonicator	Heat Systems	XL-2020	G1464	North Prep
Sonicator	Heat Systems	XL-2020	G1969	North Prep
Sonicator	Misonix	Sonicator 3000	R1373	North Prep
Sonicator	Misonix	Sonicator 3000	R1374	North Prep
Sonicator Bath	Branson	5510	RNA010513460E	Explosives Prep
Sonicator Bath	Branson	5510	RNA030516341E	Explosives Prep
TOX Sample Preparation	Microcoulometric Titration System	Microcoulometric Titration System	Not visible	Wet Chemistry

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
TOX Sample Preparation	Microcoulometric Titration System	Microcoulometric Titration System	Not visible	Wet Chemistry
TOX Sample Preparation	Microcoulometric Titration System	Microcoulometric Titration System	Not visible	Wet Chemistry
TOX Sample Preparation	Microcoulometric Titration System	Microcoulometric Titration System	Not visible	Wet Chemistry
Turbo Vap	Caliper Life Science	Turbo Vap II	TV0532N12460	North Prep
Turbo Vap	Caliper Life Science	Turbo Vap II	TV0532N12459	North Prep
Turbo Vap	Zymark	Turbo Vap II	TV9452N5926	North Prep
Vacuum Manifold	Waters/KNF	Vacuum Manifold/Pump	4458745	South Prep
Vacuum Manifold	Waters/VWR	Vacuum Manifold/Pump	None	South Prep
Walk-in Refrigerator	Bally Engineered Structures	3478-3-P-M	DX205276-02	Archive
Walk-in Refrigerator (#2)	Master-Bilt	V39RCH9xx	PV0-83	Log-in
Walk-in Refrigerator (#3)	Bally Engineered Structures	3478-3L	DX110981-01	Log-in
Walk-in Refrigerator (Large Main)	Dixon ware	None	--	Log-in
Water Bath	Waterlow	Waterlow	--	North Prep
Water Bath	Waterlow	Waterlow	--	North Prep
Water Purifier	ELGA	Ultra Analytic	UAJ214452	Bottle Prep
Water Purifier	ELGA	Pure lab Classic	CLUVG273290	North Prep
Water Purifier	ELGA	Pure Lab Classic	CLUVH273307	South Prep
Water Purifier	ELGA	Ultra Scientific	USM203643	Wet Chemistry

Table 20-2. Example: Schedule of Routine Maintenance

Instrument	Procedure	Frequency
Cetac Mercury Analyzers	• Change Lamp • Clean cell and GLS as needed • Check pump tubing and pump flow • Check Waste Container • Fill reductant bottle with 10% Stannous Chloride and check acid reagent	As needed As needed Daily Daily Daily
GFAA	• Check fluid level in rinse and waste containers • Check condition of autosampler tubing • Check the condition of graphite tube and replace as needed • Check coolant level in chiller and replace as needed • Check condition of Contact Rings and replace as needed • Clean or replace air filters	Daily Daily Daily Daily Daily As needed
ICP	• Check pump tubing • Check fluid level in waste container • Clean or replace air filters • Check torch for residue • Check nebulizer flow • Clean nebulizer and drain chamber • Fill rinse solution/ IS solution • Replace capillary tubing/sipper probe • Change internal cooling fluid	Daily Daily As needed Daily Daily Daily Daily As needed Quarterly
ICP MS	• Change pump tubing • Check level of tuning solution • Check waste container • Load printer with paper • Check air filters • Replace coolant on chiller • Clean or change nebulizer • Clean or replace torch • Replace sample tubing • Change oil in vacuum pumps • Remove and clean cones	Daily Daily Daily Daily As needed As needed As needed As needed As needed As needed As needed
UV-Vis Spectrophotometer	• Clean ambient flow cell • Precision check/alignment of flow cell • Wavelength verification check	As required As required Semi-annually
Colorimetric Analyzer	• Clean detector • Clean filters • Check tubing • Clean sample probe shaft • Clean pump, diluter, and XYZ sampler. • Lubricate pump roller	Daily Daily Daily Daily Monthly Semi-annually

Instrument	Procedure	Frequency
Ion Chromatograph	• Check plumbing for leaks • Check gases • Check pump pressure • Check eluent level • Check conductivity meter • De-gas pump head when flow is erratic • Change analytical columns and bed supports guard • Check and replace any damaged/discolored tubing	Daily Daily Daily Daily Daily As needed As needed As needed As needed As needed
Total Organic Halide Analyzer	• Check electrodes/polish if needed • Replace dehydrating fluid /electrolyte fluid • Clean quartz boat • Perform cell performance check • At the end of each day of use, wash out the absorption module, empty the electrolyte and fill chamber with DI water, empty dehydrator tube • Clean or replace pyrolysis tube • Clean titration cell • Replace reference electrode fluid • Change quartz wool • Replace o-rings and seals	Daily Daily Daily Daily Daily As needed As needed As needed As needed As needed
Hewlett Packard GC/MS	• Check Septa and clean injection port • Check carrier gas supply • Check tune parameters • Check oil levels in mechanical pumps and the diffusion pump if the vacuum is insufficient • Replace electron multiplier • Clean Source • Replace filaments • Change rough pump oil and exhaust filters • Relubricate the turbomolecular pump-bearing wick	Daily Daily Daily As needed As needed As needed As needed Annually Annually
Gas Chromatograph	• Check carrier gas supply • Check temperatures of inlet, detectors, verify temperature program • Check septa clean injection port or replace injection port liner and cut column if needed • Reactivate carrier gas drying agents • Replace or repair flow controllers if constant flow cannot be maintained	Daily Daily As needed As needed As needed
Electron Capture Detector (ECD)	• Detector wipe test (Ni-63) • Detector cleaning	Semi-annually As needed
Flame Ionization Detector (FID)	• Detector cleaning	As needed

Instrument	Procedure	Frequency
Nitrogen Phosphorus Detector (NPD)	• Replace bead • Replace ceramic rings	As needed As needed
Photoionization Detector (PID)	• Change O-rings • Clean lamp window	As needed As needed
HPLC	• Check level of eluent vessels • Change pump seals • Change the column frit • Change fuses in power supply • Filter all samples • Change autosampler rotor or oil autosampler slides • Change or backflush columns • Replace needle • Replace needle seat assembly • Replace Active Inlet Valve (AIV) cartridge • Replace lamps	Daily As needed As needed As needed Daily As needed As needed As needed As needed As needed As needed
APCI/ESI LC/MS/MS	• Check solvent reservoirs • Verify that pump is primed and operating pulse free • Verify temperatures for capillary heater/vaporizer heater • Verify pressure of manifold/fore-pump • Verify that corona and multiplier are functional • Clean Lenses • Clean skimmer • Replace column • Oil autosampler • Change autosampler filters • Replace sample inlet tube • Replace fused silica tubing at ESI interface • Replace rough pump oil • Replace turbo pump oil • Vacuum system components including fans and fan covers	Daily Daily Daily Daily Daily As needed As needed As needed As needed As needed As needed As needed Annually Annually Annually
Balances	• Class “S” traceable weight check • Clean pan and check if level • Field service	Daily, when used Daily At least Annually
Sonicator	• Inspect probe for etching/pitting • Tune sonicator assembly • Disassemble and clean probe tips	Daily Weekly As needed
Conductivity Meter	• Standardize with KCL • Conductivity cell cleaning • Check probes and cables	Daily As needed As needed
Flash Point Tester	• Check stirrer • Check tubing • Check gas supply • Check thermometer against NIST thermometer	Daily Daily Daily Quarterly by QA

Instrument	Procedure	Frequency
Digestion Block	• Check with NIST thermometer	Annually
Turbidimeter	• Check light bulb • Inspect cells • Clean housing	Daily, when used Monthly Monthly
Deionized/Distilled Water	• Conductivity check • System cleaning • Replace cartridge and large mixed bed resins	Daily As needed As needed
Drying Ovens	• Temperature monitoring • Temperature adjustments	Daily As required
Refrigerators/ Freezers	• Temperature monitoring • Temperature adjustment • Defrosting/cleaning	Daily As required As required
pH/Specific Ion Meter	• Calibration/check slope • Clean electrode	Daily As required
BOD Incubator	• Temperature monitoring	Daily
Water baths	• Temperature monitoring • Water replaced	Daily Monthly or as needed

SECTION 21. MEASUREMENT TRACEABILITY

21.1 Overview

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices. (Refer to Section 20.3). With the exception of Class A Glassware and Glass microliter syringes, daily accuracy and precision checks are performed for all mechanical volumetric devices. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A Glassware and Glass microliter syringes should be routinely inspected for chips, acid etching or deformity (e.g., bent needle). If the Class A glassware or syringe is suspect, the accuracy of the glassware will be assessed prior to use.

21.2 NIST-Traceable Weights and Thermometers

Reference standards of measurement shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), or another accreditation organization that is a signatory to a MRA (Mutual Recognition Arrangement) of one or more of the following cooperations – ILAC (International Laboratory Accreditation Cooperation) or APLAC (Asia–Pacific Laboratory Accreditation Cooperation). A calibration certificate and scope of accreditation is kept on file at the laboratory.

The calibration laboratory's policy for achieving measurement traceability is defined and includes the subsequent elements of uncertainty.

The uncertainty calculations of the calibration laboratory are supported by uncertainty budgets and are represented by expanded uncertainties typically using a coverage factor of k=2 to approximate the 95% confidence level. This explanation accompanies the measurement result and the associated uncertainty.

The tolerance uncertainty ratio (TUR) is calculated using the expanded uncertainty of the measurement, not the collective uncertainty of the measurement standards. A statement to this effect accompanies the TUR along with the coverage factor and confidence level.

The calibration report or certificate submitted to TestAmerica Denver contains, in a well-designed format, a traceability statement, the conditions under which the calibrations were made in the context of any potential influence, a compliance statement with an identified metrological specification and the pertinent clauses, a clearly identified record of the quantities and functional test results before and after re-calibration, and no recommendation on the calibration interval. Opinions and interpretations of results are presented along with the basis

upon which they were made and identified as such. The report may be submitted by facsimile or other electronic means as long as the requirements of the International Standard are achieved. If significant amendments are made to a calibration certificate, a supplemental certificate for the serial-number-specified piece of equipment is so identified. When a new certificate is offered, it uniquely identifies and references the one it replaces. All calibration reports are filed in the QA Office.

The calibration laboratory supports in-house calibration systems: documented procedures for in-house calibrations, evidence by a report, certificate, or sticker, for an appropriate amount of time; training records of calibration personnel; certificates from accreditation services demonstrating traceability to national or international standards of measurement; procedures for evaluating measurement uncertainty; timely and documented recalibration of reference standards. When subcontracting to a calibration laboratory, TestAmerica Denver does not use a firm who subcontracts the work.

An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balance calibrations are checked each day of use. All mercury thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use.

21.3 Reference Standards / Materials

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared reference standards, to the extent available, are purchased from vendors that are accredited to ISO Guide 34 and ISO/IEC Guide 17025. All reference standards from commercial vendors shall be accompanied with a certificate that includes at least the following information:

- Manufacturer
- Analytes or parameters calibrated
- Identification or lot number
- Calibration method
- Concentration with associated uncertainties
- Purity

If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. The receipt of all reference standards must be documented. Reference standards are labeled with a unique Standard Identification Number and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the 'true' value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor certified different lot is acceptable for use as a second source. For unique situations, such as Disodium Iminodiacetate (IDA) analysis where no other source or lot is available, a standard made by a different analyst

would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g., calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. Refer to the Corporate Environmental Health and Safety Manual or laboratory SOPs. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

Standards and reference materials shall not be used after their expiration dates unless their reliability is verified by the laboratory and their use is approved by the Quality Assurance Manager. The laboratory must have documented contingency procedures for re-verifying expired standards.

21.4 Documentation and Labeling of Standards, Reagents, and Reference Materials

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company-wide purchase. (Refer to TestAmerica's Corporate SOP (CA-Q-S-001), *Solvent and Acid Lot Testing and Approval*.)

All manufacturer or vendor supplied Certificate of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained by the analytical groups and by QA on the laboratory network or TestAmerica Intranet Oasis. Certificates of analysis for standards are also attached to the standard record in the Reagent Module in the LIMS. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on documentation and labeling, please refer to SOP DV-QA-0015, *Verification and Storage of Calibration Standards*.

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96% a correction will be made to concentrations applied to solutions prepared from the stock commercial material. Blended gas standard cylinders use a nominal concentration if the certified value is within +/-15%, otherwise the certified values are used for the canister concentration.

21.4.1 All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into the laboratory's LIMS system, and are assigned a unique identification number. The following information is typically recorded in the electronic database within the LIMS.

- Standard ID
- Description of Standard
- Department
- Preparer's name

- Final volume and number of vials prepared
- Solvent type and lot number
- Preparation Date
- Expiration Date
- Standard source type (source or intermediate)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained electronically for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

21.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Expiration Date (include prep date for reagents)
- Standard ID from LIMS
- Special Health/Safety warnings if applicable

Records must also be maintained of the date of receipt for commercially purchased items or date of preparation for laboratory prepared items. Special Health/Safety warnings must also be available to the analyst. This information is maintained in the LIMS and TestAmerica Intranet Oasis.

21.4.3 In addition, the following information may be helpful:

- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Recommended Storage Conditions
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include an expiration date and an ID number to trace back to preparation.

Procedures for preparation of reagents can be found in the Method SOPs.

Standard ID numbers must be traceable through associated logbooks, worksheets and preparation/analytical batch records.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods as specified in the laboratory SOP.

SECTION 22. SAMPLING

22.1 Overview

The laboratory does not provide sampling services. The laboratory's responsibility in the sample collection process lies in supplying the sampler with the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms, and packing materials required to properly preserve, pack, and ship samples to the laboratory

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Certificates of cleanliness for the bottles and preservatives are provided by the supplier and are maintained at the laboratory.

22.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In some cases containers may be purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Bisulfate – ACS Grade or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent

22.3 Definition of Holding Time

The date and time of sampling documented on the COC form establishes the day and time zero. As a general rule, when the maximum allowable holding time is expressed in "days" (e.g., 14 days, 28 days), the holding time is based on calendar day measured without regard to time zero. Holding times expressed in "hours" (e.g., 6 hours, 24 hours, etc.) are measured from date and time zero, the time sampled. Holding times for analysis include any necessary reanalysis.

There are some programs that determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of how long the holding time is. This must be documented as part of the project records prior to acceptance of samples.

22.4 Sampling Containers, Preservation Requirements, Holding Times

The preservation and holding time criteria specified in the laboratory SOPs are derived from the source documents for the methods. If method required holding times or preservation requirements are not met, the reports will be qualified using a flag, footnote or case narrative. As soon as possible or "ASAP" is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 Sample Aliquots / Subsampling

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation. It is the laboratory's responsibility to take a representative subsample or aliquot of the sample provided for analysis.

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis.

Guidelines on taking sample aliquots and subsampling are located in SOP DV-QA-0023, *Subsampling.*

SECTION 23. HANDLING OF SAMPLES

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

23.1 Chain of Custody (COC)

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)

- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collector's name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g., quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

When the sampling personnel deliver the samples directly to TestAmerica personnel, the samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory personnel. The sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the sample control personnel at the laboratory or to a TestAmerica courier. When sampling personnel deliver the samples through a common carrier (Fed-Ex, UPS), the COC relinquished date/time is completed by the field personnel and samples are released to the carrier. Samples are only considered to be received by lab when personnel at the fixed laboratory facility have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler.

23.1.2 Legal / Evidentiary Chain-of-Custody

If samples are identified for legal/evidentiary purposes on the COC, Login will complete the custody seal, retain the shipping record with the COC, and initiate an internal COC for laboratory use by analysts and a sample disposal record.

23.2 Sample Receipt

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections. Refer to SOP DV-QA-0003, *Sample Management and Chain of Custody* for detailed information on receipt of samples.

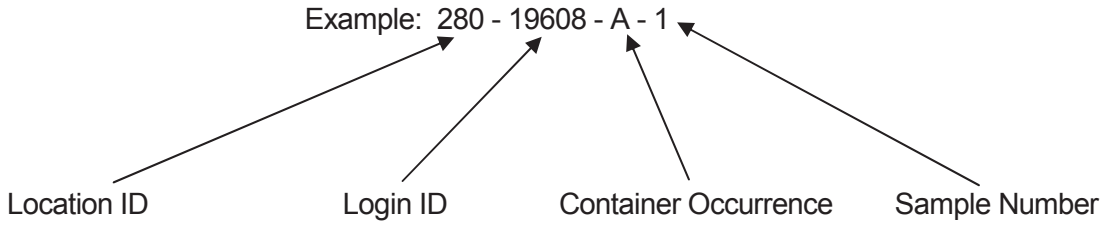
23.2.1 Laboratory Receipt

When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance, irregularity, or compromised sample receipt must be documented on a Condition Upon Receipt Anomaly Form (CUR) and brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record.

23.2.1.1 Unique Sample Identification

All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at anytime. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory. This Primary ID is made up of the following information (consisting of four components):



The above example states that the laboratory is TestAmerica Denver (Location 280). Login ID is 19608 (unique to a particular client/job occurrence). The container code indicates it is the first container ("A") of Sample #1.

If the primary container goes through a prep step that creates a "new" container, then the new container is considered secondary and gets another ID. An example of this being a client sample in a 1-Liter amber bottle is sent through a Liquid/Liquid Extraction and an extraction vial is created from this step. The vial would be a SECONDARY container. The secondary ID has 5 components.

Example: 280 - 19608 - A - 1 - **A** ← **Secondary Container Occurrence**

Example: 280-19608-A-1-A, would indicate the PRIMARY container listed above went through a step that created the first occurrence of a SECONDARY container.

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Figure 23-2) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- a COC filled out completely;
- samples must be properly labeled;
- proper sample containers with adequate volume for the analysis (Sampling Guide) and necessary QC;
- samples must be preserved according to the requirements of the requested analytical method (Sampling Guide);
- sample holding times must be adhered to (Sampling Guide);
- all samples submitted for water/solid Volatile Organic analyses must have a Trip Blank submitted at the same time;
- the project manager will be notified if any sample is received in damaged condition.

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined.

23.3.1 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.3.2 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or
- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

> Note: North Carolina requires that they be notified when samples are processed that do not meet sample acceptance criteria.

The samples are logged into the LIMS according to DV-QA-0003, *Sample Management and Chain of Custody.* Deviations from the sample acceptance criteria are noted on the Condition Upon Receipt Form (CUR) by sample receiving staff. These deviations are resolved with the client by the PM or PMA.

23.4 Sample Storage

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators, freezers or protected locations suitable for the sample matrix, except metals sample containers for only ICP or ICPMS analysis which may be stored unrefrigerated. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every two weeks.

Analysts and technicians retrieve the sample container(s) allocated to their analysis from the designated refrigerator, place them on carts, document the transfer of containers in LIMS, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came, documenting the return in LIMS. Empty containers are stored in the sample archive area until disposal. This transfer is documented in LIMS. All unused samples are kept in the refrigerators until the project is invoiced. At this time, the samples will be retained for an additional thirty days, either in the refrigerators or in the sample archive area. Special arrangements may be made to store samples for longer periods of time. This extended holding period allows additional analyses to be performed on the archived sample and assists clients in dealing with legal matters or regulatory issues. Upon disposal, the drum number used for disposal is logged into LIMS.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

23.5 Hazardous Samples and Foreign Soils

Any sample that is received from a foreign country or from a USDA quarantine area within the United States must be sent with a copy of the laboratory's soil import permit and each cooler must have affixed a soil import permit label (Form 550) with the accompanying soil import permit number. See SOP DV-QA-0019, *Quarantine Soils Procedure.*

For any sample that is known to be hazardous at the time of receipt or, if after completion of analysis the result exceeds the acceptable regulatory levels, this is documented in a nonconformance memo. Analysts will notify the entire laboratory of any sample determined to be hazardous during handling or analysis by sending an email. All hazardous samples are either returned to the client or disposed of appropriately through a hazardous waste disposal firm that lab-packs all hazardous samples and removes them from the laboratory. Foreign soil samples are sent out for incineration by a USDA-approved waste disposal facility.

23.6 Sample Shipping

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses (see Note). The chain-of-custody form is signed by the sample control technician and attached to the shipping paperwork. Details of the procedure for shipping samples to another location are described in SOP DV-QA-0036, *Sub-out Work Sample Management and Chain of Custody.* Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

23.7 Sample Disposal

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP: DV-HS-0005, *Excess Sample Material Management).* All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

If a sample is part of a known litigation, the affected legal authority, sample data user, and/or submitter of the sample must participate in the decision about the sample's disposal. All documentation and correspondence concerning the disposal decision process must be kept on file. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, return to client), names of individuals who conducted the arrangements and physically completed the task. The laboratory will remove or deface sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated). A Hazardous Waste Manifest will be prepared to document the disposal of each drum. Additional detail is in SOP DV-HS-0004, *Hazardous Waste Manifesting.*

Figure 23-1. Example: Chain of Custody (COC)

>>> Select a Laboratory <<<
#N/A
#N/A
#N/A
#N/A

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratories, Inc.

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

Client Contact	Project Manager:	Site Contact:	Date:	COC No:
Your Company Name here	Tel/Fax:	Lab Contact:	Carrier:	_____ of _____ COCs
Address	Analysis Turnaround Time			Sampler:
City/State/Zip	☐ CALENDAR DAYS ☐ WORKING DAYS			For Lab Use Only:
(xxx) xxx-xxxx Phone	TAT if different from Below _____			Walk-in Client:
(xxx) xxx-xxxx FAX	☐ 2 weeks			Lab Sampling:
Project Name:	☐ 1 week			
Site:	☐ 2 days			Job / SDG No.:
P O #	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)															Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H_2SO_4; 4=HNO_3; 5=NaOH; 6= Other _____

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for _____ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No | Custody Seal No.: | Cooler Temp. (°C): Obs'd: _____ Corr'd: _____ | Therm ID No.: _____

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Form No. CA-C-WI-002, Rev. 4.4, dated 07/15/2014

Figure 23-2. Example: Sample Acceptance Policy

All incoming work will be evaluated against the criteria listed below. Where applicable, data from any samples that do not meet the criteria listed below will be noted on the laboratory report defining the nature and substance of the variation. In addition the client will be notified either by telephone, fax or e-mail as soon as possible after the receipt of the samples.

Per State and/or Federal Regulation, the client is responsible to ensure that samples are shipped in accordance with DOT/IATA requirements, and that radioactive materials may only be delivered to licensed facilities. Any samples containing (or suspected to contain) Source, Byproduct, or Special Nuclear Material as defined by 10 CFR should be delivered directly to facilities licensed to handle such radioactive material. Natural material or ores containing naturally occurring radionuclides may be delivered to any TestAmerica facility or courier as long as the activity concentration of the material does not exceed 270 pCi/g alpha or 2700 pCi/g beta (49 CFR Part 173).

1) Samples must arrive with labels intact with a Chain of Custody filled out completely. The following information must be recorded.
   - *Client name, address, phone number and fax number (if available)*
   - *Project name and/or number*
   - *The sample identification*
   - *Date, time and location of sampling*
   - *The collector's name*
   - *The matrix description*
   - *The container description*
   - *The total number of each type of container*
   - *Preservatives used*
   - *Analysis requested*
   - *Requested turnaround time (TAT)*
   - *Any special instructions*
   - *Purchase Order number or billing information (e.g., quote number) if available*
   - *The date and time that each person received or relinquished the sample(s), including their signed name.*
   - *The date and time of receipt must be recorded between the last person to relinquish the samples and the person who receives the samples in the lab, and they must be exactly the same.*
   - Information must be legible
2) Samples must be properly labeled.
   - Use durable labels (labels provided by TestAmerica are preferred)
   - Include a unique identification number
   - Include sampling date and time and sampler ID
   - Include preservative used.
   - Use indelible ink
   - Information must be legible
3) Proper sample containers with adequate volume for the analysis and necessary QC are required for each analysis requested. See Lab Sampling Guide.
4) Samples must be preserved according to the requirements of the requested analytical method (See Sampling Guide**.**
5) Most analytical methods require chilling samples to 4° C (other than water samples for metals analysis). For these methods, the criteria are met if the samples are chilled to below 6° C and above freezing (0°C). For methods with other temperature criteria (e.g., some bacteriological methods require $\leq$ 10 ^{o}C), the samples must arrive within $\pm$ 2° C of the required temperature or within the method specified range.

Note: Samples that are hand delivered to the laboratory immediately after collection may not have had time to cool sufficiently. In this case the samples will be considered acceptable as long as there is evidence that the chilling process has begun (arrival on ice).

5i.) Samples that are delivered to the laboratory on the same day they are collected may not meet the requirements of Section 5. In these cases, the samples shall be considered acceptable if the samples were received on ice.

5ii.) If sample analysis is begun within fifteen (15) minutes of collection, thermal preservation is not required.

5iii.) Thermal preservation is not required in the field if the laboratory receives and refrigerates the sample within fifteen (15) minutes of collection.

- Chemical preservation (pH) will be verified prior to analysis and documented, either in sample control or by the analyst. The project manager will be notified immediately if there is a discrepancy. If analyses will still be performed, all affected results will be flagged to indicate improper preservation.
- For Volatile Organic analyses in drinking water (Methods 502.2 or 524.2) residual chlorine must be neutralized prior to preservation. If there is prior knowledge that the samples are not chlorinated, state it on the COC and use the VOA vials pre-preserved with HCl. The following are other options for a sampler and laboratory where the presence of chlorine is not known:
  - 1. Test for residual chlorine in the field prior to sampling.
    - If no chlorine is present, the samples are to be preserved using HCl as usual.
    - If chlorine is present, add either ascorbic acid or sodium thiosulfate prior to adding HCl.
  - 2. Use VOA vials pre-preserved with sodium thiosulfate or ascorbic acid and add HCl after filling the VOA vial with the sample.
- **FOR WATER SAMPLES TESTED FOR CYANIDE (by Standard Methods or EPA 335)**
  - In the Field: Samples are to be tested for Sulfide using lead acetate paper prior to the addition of Sodium Hydroxide (NaOH). If sulfide is present, the sample must be treated with Cadmium Chloride and filtered prior to the addition of NaOH.
    - If the sulfide test and treatment is not performed in the field, the lab will test the samples for sulfide using lead acetate paper at the time of receipt and if sulfide is present in the sample, the client will be notified and given the option of retaking the sample and treating in the field per the method requirements or the laboratory can analyze the samples as delivered and qualify the results in the final report.
  - It is the responsibility of the client to notify the laboratory if thiosulfate, sulfite, or thiocyanate are known or suspected to be present in the sample. This notification may be on the chain of custody. The samples may need to be subcontracted to a laboratory that performs a UV digestion. If the lab does not perform the UV digestion on samples that contain these compounds, the results must be qualified in the final report.
  - The laboratory must test the sample for oxidizing agents (e.g., chlorine) prior to analysis and treat according to the methods prior to distillation. (Ascorbic acid or sodium arsenite are the preferred choice.)

6) Sample Holding Times

- TestAmerica will make every effort to analyze samples within the regulatory holding time. Samples must be received in the laboratory with enough time to perform the sample analysis. Except for short holding time samples (< 48 hr HT) sample must be received with at least 48 hrs (working days) remaining on the holding time for the laboratory to ensure analysis.

- Analyses that are designated as “field” analyses (Odor, pH, Dissolved Oxygen, Disinfectant Residual; a.k.a. Residual Chlorine, and Redox Potential) should be analyzed ASAP by the field sampler prior to delivering to the lab (within 15 minutes). However, if the analyses are to be performed in the laboratory, TestAmerica will make every effort to analyze the samples within 24 hours from receipt of the samples in the testing laboratory. Samples for “field” analyses received after 4:00 pm on Friday or on the weekend will be analyzed no later than the next business day after receipt (Monday unless a holiday). Samples will remain refrigerated and sealed until the time of analysis. The actual times of all “field” sample analyses are noted on the “Short Hold Time Detail Report” in the final report. Samples analyzed in the laboratory will be qualified on the final report with an ‘H’ to indicate holding time exceedance.

7) All samples submitted for Volatile Organic analyses must have a Trip Blank submitted at the same time. TestAmerica will supply a blank with the bottle order.

8) The project manager will be notified if any sample is received in damaged condition. TestAmerica will request that a sample be resubmitted for analysis.

9) Recommendations for packing samples for shipment:

- Pack samples in Ice rather than “Blue” ice packs.
- Soil samples should be placed in plastic zip-lock bags. The containers often have dirt around the top and do not seal very well and are prone to intrusion from the water from melted ice.
- Water samples would be best if wrapped with bubble-wrap or paper (newspaper, or paper towels work) and then placed in plastic zip-lock bags.
- Fill extra cooler space with bubble wrap.

Figure 23-3. Example: Cooler Receipt Form

TestAmerica Denver **Sample Receiving Checklist**

Login #:_____ Date/Time Received:_____

Company Name & Sampling Site: _____

Time Zone: • EDT/EST • CDT/CST • MDT/MST • PDT/PST • OTHER State:

Document any problems or discrepancies and the actions taken to resolve them on a Condition Upon Receipt Anomaly Report (CUR)

N/A Yes No *Initials* _____

☐ ☐ ☐ 1. Is radioactivity at or below background? BKG CPM:_____ CPM Reading: _____

☐ ☐ ☐ 2a. Is a custody seal present on the cooler?

☐ ☐ ☐ 2b. If yes, is the cooler's custody seal intact?

☐ ☐ ☐ 2c. Do cooler or samples appear to not have been compromised or tampered with?

☐ ☐ ☐ 3a. Were samples received on ice?

☐ ☐ ☐ 3b. Is cooler temperature acceptable?

☐ ☐ ☐ 3c. Has temperature been recorded?

☐ ☐ ☐ 4. Is COC present; filled out in ink and legible; and filled out with all pertinent information?

☐ ☐ ☐ 5. Is the Field Sampler's name present on the COC?

☐ ☐ ☐ 6a. Are there no discrepancies between the **sample IDs** and/or **collection date and time** on the containers and the COC?

☐ ☐ ☐ 6b. Are there no discrepancies between the container types and those listed on the COC?

☐ ☐ ☐ 7. Are samples received within Holding Time?

☐ ☐ ☐ 8. Do sample containers have legible labels?

☐ ☐ ☐ 9. Are all sample containers intact (not broken or leaking)?

☐ ☐ ☐ 10a. Are appropriate sample containers used?

☐ ☐ ☐ 10b. Are sample bottles completely filled? (Perchlorate bottles ≥ 1/3 head space)

☐ ☐ ☐ 10c. Is sufficient vol. for all requested analyses, incl. any requested MS/MSDs provided?

☐ ☐ ☐ 11. No splitting or compositing of samples required?

☐ ☐ ☐ 12. Do all VOA sample vials have no headspace or bubbles >6 mm (1/4") in diameter?

☐ ☐ ☐ 13. Were VOA vials labeled as preserved? ☐ HCl ☐ 0-6°C ☐ Sodium Thiosulfate ☐ Ascorbic Acid ☐ Other

☐ ☐ ☐ 14. Are all samples single phase? (i.e., no multiphasic samples are present.)

Login Checks: *Initials* _____

☐ ☐ ☐ 15. Was a Priority Form completed for any short holds or quick TATs?

☐ ☐ ☐ 16. Were any tests logged for subcontract?

☐ ☐ ☐ 17. Were special archiving instructions and login instructions indicated in the Project Notes?

Note Archive Requirements: _____

☐ ☐ ☐ 18. Were multiple Series logged for this job?

Labeling and Storage Checks: *Initials* _____

DOE/DoD: ☐ Yes ☐ No Residual chlorine check required: ☐ Yes ☐ No Quarantined: ☐ Yes ☐ No

☐ ☐ ☐ 19. Was Sample Preservation verified and found to be correct? (excluding VOA, Oil & Grease, and TOC volumes)

☐ ☐ ☐ 20. Was Residual Chlorine checked and noted on the CUR if present?

☐ ☐ ☐ 21. If subcontract work was requested, was volume placed on sub shelf?

☐ ☐ ☐ 22. Were Terracore/Encores delivered to VOA lab? *Verified by:* _____

☐ ☐ ☐ 23. Did the sample ID on TA label match the client's sample ID on container?

☐ ☐ ☐ 24. Were stickers for special archiving instructions affixed to each box?

R:\QA\Edit\FORMS\Sample Receiving\Att 1a_DV-QA-0003_Sample Receiving Checklist Rev 13.doc 11/7/2014

SECTION 24. ASSURING THE QUALITY OF TEST RESULTS

24.1 Overview

In order to assure clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control measurements (e.g., Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. Quality control samples are to be treated in the exact same manner as the associated field samples being tested. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

24.2 Controls

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 Negative Controls

Table 24-1. Example – Negative Controls

Control Type	Details
Method Blank (MB)	Used to assess preparation and analysis for possible contamination during the preparation and processing steps.
	The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is one for each batch of samples; not to exceed 20 environmental samples.
	The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including, as necessary: filtration, clean-ups, etc.).
	Reanalyze or qualify associated sample results when the concentration of a targeted analyte in the blank is at or above one-half the reporting limit as established by the method or by regulation, AND is greater than 1/10 of the amount measured in the sample. For some wet chemistry methods, the allowable blank may contain up to the reporting limit, as defined in the method SOP.
Calibration Blanks	Prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.
Instrument Blanks	Blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.

Table 24-1. Example – Negative Controls

Control Type	Details
Trip Blank [1]	Required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses (or as specified in the client's project plan). Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples.
Field Blanks [1]	Sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)
Equipment Blanks [1]	Sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (TNI)
Holding Blanks	Also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory.

[1] When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.4 Positive Controls

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) (Matrix spikes are not applicable to air) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch.

Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In

some instances where there is no practical clean solid matrix available, aqueous LCS's may be processed for solid matrices; final results may be calculated as mg/kg or µg/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g., solid matrix LCS for metals, TDS, etc.).

The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally one for each batch of samples; not to exceed 20 environmental samples.

If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g., no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. The laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

- For methods that have 1-10 target analytes, spike all components.
- For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.
- For methods with more than 20 target analytes, spike at least 16 components.
- Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.
- Exception: Due to analyte incompatibility between the various PCB aroclors, Aroclors 1016 and 1260 are used for spiking as they cover the range of all of the aroclors. Specific aroclors may be used by request on a project specific basis.

24.5 Sample Matrix Controls

Table 24-2. Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	To assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;
	Typical Frequency [1]	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects. If the mandated or requested test method does not specify the spiking components, the laboratory shall spike the same set of compounds in both the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	A sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.
Duplicates[2]	Use	As a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency [1]	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] See the specific analytical SOP for type and frequency of sample matrix control samples.
[2] LCSD's are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 Acceptance Criteria (Control Limits)

As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method or program requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

Laboratory generated Percent Recovery acceptance (control) limits are generally established by taking ± 3 standard deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

- Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV). (Unless the analytical method specifies a tighter limit).
- In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) can be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.
- The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5% and the analyte must be detectable and identifiable.
- If either the high or low end of the control limit changes by ≤ 5% from previous, the control chart is visually inspected and, using professional judgment, they may be left unchanged if there is no affect on laboratory ability to meet the existing limits.

24.6.1 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical control limits. Refer to SOP DV-QA-003P, *Quality Assurance Program* for a detailed description of the control charting procedure.

24.6.2 A LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

- The analyte results are below the reporting limit and the LCS is above the upper control limit.
- The analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

For TNI and Department of Defense (DOD) work, there are an allowable number of Marginal Exceedances (ME):

<11 analytes	0 marginal exceedances are allowed.
11 – 30 Analytes	1 marginal exceedance is allowed
31-50 Analytes	2 marginal exceedances are allowed
51-70 Analytes	3 marginal exceedances are allowed
71-90 Analytes	4 marginal exceedances are allowed
> 90 Analytes	5 marginal exceedances are allowed

- Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit (TNI).
- Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

Though marginal exceedances may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

24.6.3 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.6.4 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client). Under certain circumstances, where all of the samples are from the same location and share similar chromatography, the reanalysis may be performed on a single sample rather than all of the samples and if the surrogate meets the recovery criteria in the reanalysis, all of the affected samples would require reanalysis.

24.7 Additional Procedures to Assure Quality Control

The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21) and use of PT samples (see Section 15).

A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

- Use of formulae to reduce data is discussed in the method SOPs and in Section 20.
- Selection of appropriate reagents and standards is included in Section 9 and 21.
- A discussion on selectivity of the test is included in Section 5.
- Constant and consistent test conditions are discussed in Section 18.
- The laboratories sample acceptance policy is included in Section 23.

SECTION 25. REPORTING RESULTS

25.1 Overview

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation

requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client. Review of reported data is included in Section 19.

25.2 Test Reports

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report, containing the laboratory name on the cover page, is reviewed, and signed by the appropriate project manager (or designee). At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title (e.g., Analytical Report For Samples) with a "sample results" column header.

25.2.2 Each report cover page includes the laboratory name, address and telephone number.

25.2.3 A unique identification of the report (e.g., job number) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

Note: Page numbers of the report are represented as page # of ##. Where the first number is the page number and the second is the total number of pages.

25.2.4 A copy of the chain of custody (COC) and any COCs involved with Subcontracting are included.

25.2.5 The name and address of client and a project name/number, if applicable.

25.2.6 Client project manager or other contact

25.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

25.2.8 Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.

25.2.9 Date reported or date of revision, if applicable.

25.2.10 Method of analysis including method code (EPA, Standard Methods, etc.).

25.2.11 Reporting limit.

25.2.12 Method detection limits (if requested)

25.2.13 Definition of Data qualifiers and reporting acronyms (e.g., ND).

25.2.14 Sample results.

25.2.15 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

25.2.16 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets.

25.2.17 A statement expressing the validity of the results, that the source methodology was followed and all results were reviewed for error.

25.2.18 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

25.2.19 A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory.

25.2.20 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Authorized signatories are qualified Project Managers appointed by the Manager of Project Managers.

25.2.21 When TNI accreditation is required, the lab shall certify that the test results meet all requirements of TNI or provide reasons and/or justification if they do not.

25.2.22 Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.

25.2.23 When soil samples are analyzed, a specific identification as to whether soils are reported on a “wet weight” or “dry weight” basis.

25.2.24 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.25 If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report (e.g., partial report or preliminary report). A complete report must be sent once all of the work has been completed.

25.2.26 Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

25.2.27 A Certification Summary Report, where required, will document that, unless otherwise noted, all analytes tested and reported by the laboratory were covered by the noted certifications.

Note: Refer to Corporate SOP No. CA-I-P-002, *Electronic Reporting and Signature Policy*, for details on internally applying electronic signatures of approval.

25.3 Reporting Level or Report Type

The laboratory offers four levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Level I is a report with the features described in Section 25.2 above, excluding 25.2.15 (QC Data)
- Level II is a Level I report plus summary information, including results for the method blank, percent recovery for laboratory control samples and matrix spike samples, and the RPD values for all MSD and sample duplicate analyses.
- Level III contains all the information supplied in Level II, but presented on the CLP-like summary forms, and relevant calibration information. A Level II report is not included, unless specifically requested. No raw data are provided.
- Level IV is the same as Level III with the addition of all raw supporting data.

In addition to the various levels of QC packaging, the laboratory also provides reports in diskette deliverable form. Initial (preliminary) reports may be provided to clients by facsimile. Procedures used to ensure client confidentiality are outlined in Section 25.6.

25.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica's services. The Denver laboratory offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), New Agency Standard (NAS), Format A, Excel, Dbase, GISKEY, SEDD2A, and Text Files.

EDD specifications are submitted to the IT department by the PM for review and undergo the contract review process. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff coding the EDD.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.4 Supplemental Information for Test

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet TNI sample acceptance requirements such as improper container, holding time, or temperature.

Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This necessitates a limited scope of interpretation, and this work is performed by the QA Department. This is the only form of "interpretation" of data that is routinely performed by the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.5 Environmental Testing Obtained From Subcontractors

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP No. CA-L-S-002).

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of TestAmerica are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.6 Client Confidentiality

In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

TestAmerica will not intentionally divulge to any person (other than the Client or any other person designated by the Client in writing) any information regarding the services provided by TestAmerica or any information disclosed to TestAmerica by the Client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.6.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are faxed with a cover sheet or e-mailed with the following note that includes a confidentiality statement similar to the following:

This material is intended only for the use of the individual(s) or entity to which it is addressed, and may contain information that is privileged and confidential. If you are not the intended recipient, or the employee or agent responsible for delivering this material to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this communication is strictly prohibited. If you have received this communication in error, please notify us immediately by e-mail or by phone (1-800-765-0980) and delete this material from any computer).

25.7 Format of Reports

The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.8 Amendments to Test Reports

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

The revised report is retained on the Archive data server, as is the original report. The revised report is stored in the Archive data server under the job number followed by "Rev#". The revised report will have the word "revised" or "amended" next to the date rather than the word "reported".

When the report is re-issued, a notation of "Revision #" is placed on the cover/signature page of the report. The revision history, revision number and date, is listed in the narrative with a brief explanation of reason for the re-issue. *For Example*: *Revision 1: June 19, 2014 This revision was necessary to change the 8270 SVOC analyte bis(2-Chloroisopropyl)ether to 2,2'-oxybis(1-chloropropane) per client request. No changes to the data results were required. The Level IV report has been revised to reflect this change.*

25.9 Policies on Client Requests for Amendments

25.9.1 Policy on Data Omissions or Reporting Limit Increases

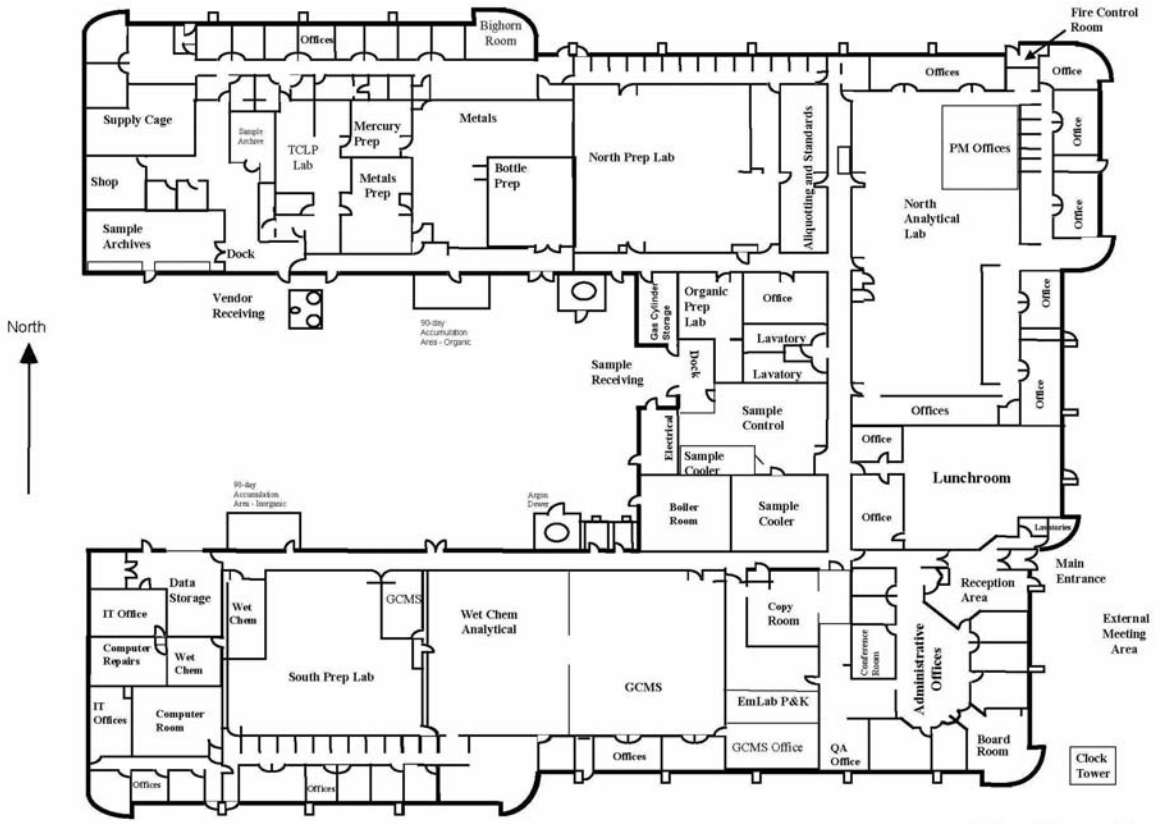
Fundamentally, laboratory policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely *no possible* impact on the interpretation of the analytical results and there is *no possibility* of the change being interpreted as misrepresentation by anyone inside or outside of TestAmerica.

25.9.2 Multiple Reports

TestAmerica does not issue multiple reports for the same work order where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1. Laboratory Floor Plan



Appendix 2. Glossary/Acronyms (EL-V1M2 Sec. 3.1)

Glossary:

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis. (TNI)

Anomaly: A condition or event, other than a deficiency, that may affect the quality of the data, whether in the laboratory's control or not.

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation). (TNI)

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. (TNI)

Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples. (TNI)

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). (TNI)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. (TNI)

1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve: The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (TNI)

Calibration Standard: A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM): A reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute. (TNI)

Chain of Custody (COC) Form: Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses. (TNI)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. TNI and its representatives agree to safeguard identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to Second Column Confirmation; Alternate wavelength; Derivatization; Mass spectral interpretation; Alternative detectors or Additional Cleanup procedures. (TNI)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction: Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis. No significant action is taken to change behavior, process or procedure.

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria).

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collation into a more useable form. (TNI)

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item, whether in the laboratory's control or not. (ASQC)

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. (TNI)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Equipment Blank: Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures.

External Standard Calibration: Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Field Blank: Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Holding Times: The maximum time that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (TNI)

Internal Standard Calibration: Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ± 100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as

total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Least Squares Regression (1st Order Curve): The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit(s) of Detection (LOD) [a.k.a., Method Detection Limit (MDL)]: A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility. (TNI)

LOD Verification [a.k.a., MDL Verification]: A processed QC sample in the matrix of interest, spiked with the analyte at no more than 3X the LOD for single analyte tests and 4X the LOD for multiple analyte tests and processed through the entire analytical procedure.

Limit(s) of Quantitation (LOQ) [a.k.a., Reporting Limit]: The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. (TNI)

(QS) Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater effluents, and TCLP or other extracts.

Drinking Water: Any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Non-Aqueous Liquid: Any organic liquid with <15% settleable solids.

Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Solids: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.

Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.

Air and Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter, or other device. (TNI)

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A replicate matrix spike prepared and analyzed to obtain a measure of the precision of the recovery for each analyte.

Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

Non-conformance: An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Observation: A record of phenomena that (1) may assist in evaluation of the sample data; (2) may be of importance to the project manager and/or the client, and yet not at the time of the observation have any known effect on quality.

Performance Audit: The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (TNI)

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis. (TNI)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (TNI)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within specified acceptance criteria. (TNI)

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item or service is of the type of quality needed and expected by the client. (TNI)

Quality Assurance [Project] Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control: The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against “out of control” conditions and ensuring that the results are of acceptable quality. (TNI)

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. (TNI)

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (TNI)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities. (TNI)

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. (TNI)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material: Material or substance one or more properties of which are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (TNI)

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or a given location. (TNI)

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. (TNI)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (TNI)

Spike: A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies. (TNI)

Standard Operating Procedures (SOPs): A written document which details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. (TNI)

Storage Blank: A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Manager: A member of the staff of an environmental laboratory who exercises actual day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (TNI)

Trip Blank: A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty: A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

Acronyms:

CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DUP - Duplicate
EHS – Environment, Health and Safety
EPA – Environmental Protection Agency
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
HPLC - High Performance Liquid Chromatography
ICP - Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP/MS – ICP/Mass Spectrometry
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
LOD – Limit of Detection
LOQ – Limit of Quantitation
MDL – Method Detection Limit
MDLCK – MDL Check Standard
MDLV – MDL Verification Check Standard
MRL – Method Reporting Limit Check Standard
MS – Matrix Spike
MSD – Matrix Spike Duplicate
SDS - Safety Data Sheet
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
TNI – The NELAC Institute
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Standard Deviation
SOP – Standard Operating Procedure
TAT – Turn-Around-Time
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3. Laboratory Certifications, Accreditations, Validations

TestAmerica Denver maintains accreditations, certifications, and approvals with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Certifications

Laboratory	Program	Authority	Identification	Expiration Date
TestAmerica Denver	A2LA	Wyoming (UST)	2907.01	10/31/2015
TestAmerica Denver	DoD ELAP	A2LA	2907.01	10/31/2015
TestAmerica Denver	Federal	USDA	P330-13-00202	07/02/2016
TestAmerica Denver	ISO/IEC 17025	A2LA	2907.01	10/31/2015
TestAmerica Denver	NELAP	Florida	E87667	06/30/2015 *
TestAmerica Denver	NELAP	Illinois	200017	04/30/2016
TestAmerica Denver	NELAP	Kansas	E-10166	09/30/2015
TestAmerica Denver	NELAP	Louisiana	02096	06/30/2016
TestAmerica Denver	NELAP	Minnesota	8-999-405	12/31/2015
TestAmerica Denver	NELAP	New Hampshire	205310	04/28/2016
TestAmerica Denver	NELAP	New Jersey	CO004	09/30/2015
TestAmerica Denver	NELAP	New York	11964	04/01/2016
TestAmerica Denver	NELAP	Oregon	4025	01/09/2016
TestAmerica Denver	NELAP	Pennsylvania	68-00664	07/30/2015
TestAmerica Denver	NELAP	Texas	T104704183-13-8	09/30/2015
TestAmerica Denver	NELAP	Utah	CO00026	07/31/2015
TestAmerica Denver	NELAP	Virginia	460232	06/14/2016
TestAmerica Denver	State Program	Alaska (UST)	UST-30	04/05/2016
TestAmerica Denver	State Program	Arizona	AZ0713	12/19/2015
TestAmerica Denver	State Program	Arkansas DEQ	88-0687	06/01/2016
TestAmerica Denver	State Program	California	2513	08/31/2016
TestAmerica Denver	State Program	Connecticut	PH-0686	09/30/2016
TestAmerica Denver	State Program	Georgia	N/A	01/09/2015 *
TestAmerica Denver	State Program	Iowa	370	11/30/2016
TestAmerica Denver	State Program	Maine	CO0002	03/03/2017
TestAmerica Denver	State Program	Nevada	CO0026	07/31/2015
TestAmerica Denver	State Program	North Carolina (WW/SW)	358	12/31/2015
TestAmerica Denver	State Program	North Dakota	R-034	01/09/2016
TestAmerica Denver	State Program	Oklahoma	8614	08/31/2015
TestAmerica Denver	State Program	South Carolina	72002001	06/30/2015 *
TestAmerica Denver	State Program	Washington	C583	08/03/2015
TestAmerica Denver	State Program	West Virginia DEP	354	11/30/2015
TestAmerica Denver	State Program	Wisconsin	999615430	08/31/2015

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* Certification Valid - Laboratory is Pending Renewal with the Program Authority

For more information, or to contact a local TestAmerica representative nearest you, please visit our website at www.testamericainc.com

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The certificates and accredited parameter lists are available for each State/Program at www.testamericainc.com under Analytical Services Search – Certifications.

Attachment 2

Laboratory Certifications

Accredited Laboratory

A2LA has accredited

TESTAMERICA DENVER

Arvada, CO

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 2009 TNI Environmental Testing Laboratory Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.0 of the DoD Quality System Manual for Environmental Laboratories (QSM), 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).

AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION
CORPORATE SEAL 1978
DISTRICT OF COLUMBIA
A2LA

Presented this 14th day of December 2015.

President & CEO
For the Accreditation Council
Certificate Number 2907.01
Valid to October 31, 2017

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

December 14, 2015

Margaret Sleevi
TestAmerica Denver
4955 Yarrow Street
Arvada CO 80002

Dear Ms. Sleevi:

Your laboratory has been approved for continued accreditation by the American Association for Laboratory Accreditation (A2LA) in the Environmental field of testing for the tests listed on the enclosed Scope of Accreditation. An A2LA Certificate numbered 2907.01 is enclosed and may be displayed in a prominent place in your facility. Your renewed Certificate and Scope of Accreditation have also been added to the searchable database of accredited laboratories contained on our website, www.A2LA.org.

Your laboratory is now accredited to ISO/IEC 17025:2005 through **October 31, 2017**, by virtue of the reassessment of your laboratory and an evaluation by the Accreditation Council of all activity related to this assessment and any recent proficiency testing results. One year prior to your accreditation expiration date, you must pay an annual review fee and submit updated information on your laboratory. This process will be initiated three months prior to the expected completion date to allow sufficient time for submittal of required information and fees. In addition, A2LA must be notified in writing within 30 days at any time that significant changes occur in your laboratory's location, ownership, management, authorized representative, primary contact or major facilities.

We hope that you have been enjoying the benefits of using your A2LA accreditation for promotional and advertising purposes. Such publicity strengthens our own public information program and leads to broader recognition and acceptance of A2LA accredited laboratories. A2LA has made the promotion of your A2LA Accreditation ***easy*** by providing you with helpful tips and advice in our '*A2LA Promotion of Accreditation Package*' brochure located on your CAB Portal. Please be sure to read this and also A2LA *R105 – Requirements When Making Reference to A2LA Accredited Status* to ensure you are maximizing the benefits of promoting your A2LA Accreditation. When promoting or providing proof of your accreditation, please use your Scope of Accreditation, as this document details the specific tests which are accredited. The certificate is to be used for display purposes only.

We are pleased that you have chosen to continue as an A2LA accredited laboratory.

Sincerely,

Peter S. Unger
President

Enclosures

Asst ID: 24277
Master Code: 131040
Cert No: Environmental (2907.01)

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

TESTAMERICA DENVER
4955 Yarrow Street
Arvada, CO 80002
Margaret S. Sleevi Phone: 303-736-0100
www.testamericainc.com

ENVIRONMENTAL

Valid To: October 31, 2017 Certificate Number: 2907.01

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 2009 TNI Environmental Testing Laboratory Standard, the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.0 of the DoD Quality Systems Manual for Environmental Laboratories), and for the test methods applicable to the Wyoming Storage Tank Remediation Laboratory Accreditation Program, accreditation is granted to this laboratory to perform recognized EPA 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, Misc.- Electronic Probes (pH, O_2), Oxygen Demand, Hazardous Waste Characteristics Tests, Spectrophotometry (Visible), Spectrophotometry (Automated), Titrimetry, Total Organic Carbon, Total Organic Halide

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Metals				
Aluminum	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Antimony	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Arsenic	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Barium	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010 / 6020/6020A
Beryllium	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Boron	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Cadmium	EPA 6010C	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Calcium	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Chromium	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Cobalt	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Copper	----------	----------	EPA 6010B/6010C/ 6020 /6020A	EPA 6010B/6010C/ 6020/6020A
Iron	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Lead	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Lithium	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Magnesium	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Manganese	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Mercury	----------	----------	EPA 7470A	EPA 7471A/7471B
Molybdenum	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Nickel	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Potassium	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Selenium	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Silica	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Silicon	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Silver	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Sodium	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Strontium	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Thallium	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Tin	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Titanium	----------	----------	EPA 6010B/6010C	EPA 6010B/6010C
Vanadium	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Zinc	----------	----------	EPA 6010B/6010C/ 6020/6020A	EPA 6010B/6010C/ 6020/6020A
Nutrients				
Nitrate (as N)	----------	By calculation	By calculation/EPA 9056/9056A/300.0	By calculation /EPA 9056/9056A
Nitrate-nitrite (as N)	----------	EPA 353.2	EPA 353.2/9056/ 9056A/300.0	EPA 9056/9056A
Nitrite (as N)	----------	SM 4500-NO2 B	SM 4500-NO2 B; EPA 9056/9056A/300.0	EPA 9056/9056A
Orthophosphate (as P)	----------	----------	EPA 9056/9056A/ 300.0	EPA 9056/9056A
~~Total Phosphorus~~	~~----------~~	~~----------~~	~~EPA 6010B/6010C~~	~~EPA 6010B/6010C~~
Demands	----------			
Total Organic Carbon	----------	----------	EPA 9060/9060A	EPA 9060/9060A
Total Organic Halides	----------	----------	EPA 9020B	----------

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Wet Chemistry	----------			----------
Alkalinity (Total Bicarbonate, Carbonate, and Hydroxide Alkalinty)	----------	SM 2320 B_1997	SM 2320 B	SM 2320 B
Ammonia	----------	EPA 350.1	EPA 350.1	----------
Biological Oxygen Demand	----------	SM 5210B	SM 5210B	----------
Bromide	----------	----------	EPA 9056/9056A/ 300.0	EPA 9056/9056A
Chloride	----------	----------	EPA 9056/9056A/ 300.0	EPA 9056/9056A
Chemical Oxygen Demand	----------	EPA 410.4	EPA 410.4	----------
Conductivity	----------	----------	EPA 9050/9050A	EPA 9050/9050A
Cyanide	----------	----------	9012A/9012B	9012A/9012B
Ferrous iron	----------	SM 3500 Fe B, D	SM 3500 Fe B, D	----------
Fluoride	----------	----------	EPA 9056/9056A 300.0	EPA 9056/9056A
Hexavalent chromium	EPA 7196A	----------	EPA 7196A	----------
pH	----------	----------	EPA 9040B/9040C	EPA 9045C/9045D
Oil and Grease (HEM and SGT-HEM)	----------	----------	EPA 1664A/1664B	9071B
Percent moisture	----------	----------	----------	ASTM D2216
Perchlorate	----------	----------	EPA 6860	EPA 6860
Phenols	----------	----------	EPA 9066	
Solids, total	----------	SM 2540 B	SM 2540 B	SM 2540 B
Solids, Total Suspended	----------	SM 2540 D	SM 2540 D	SM 2540 D
Solids, Total Dissolved	----------	SM 2540 C	SM 2540 C	SM 2540 C
Sulfate	----------	----------	EPA 9056/9056A/ 300.0	EPA 9056/9056A
Sulfide, total	----------	----------	EPA 9034	EPA 9034
Sulfide	----------	----------	EPA 9030B	EPA 9030B
Total Kjeldahl Nitrogen	----------	----------	EPA 351.2	----------
Purgeable Organics (volatiles)				----------
Acetone	----------	----------	EPA 8260B	EPA 8260B
Acetonitrile	----------	----------	EPA 8260B	EPA 8260B
Acrolein	----------	----------	EPA 8260B	EPA 8260B
Acrylonitrile	----------	----------	EPA 8260B	EPA 8260B
Allyl Chloride	----------	----------	EPA 8260B	EPA 8260B
tert-Amyl Methyl Ether	EPA 8260B			
Benzene	EPA 8260B/ 8021B	----------	EPA 8260B/8021B/ AK101/OK DEQ	EPA 8260B/8021B/ AK101/OK DEQ
			GRO/8260B SIM	GRO
Bromobenzene	----------	----------	EPA 8260B	EPA 8260B
Bromochloromethane	----------	----------	EPA 8260B	EPA 8260B
Bromodichloromethane	----------	----------	EPA 8260B	EPA 8260B
Bromoform	----------	----------	EPA 8260B	EPA 8260B
Bromomethane	----------	----------	EPA 8260B	EPA 8260B
2-Butanone	----------	----------	EPA 8260B	EPA 8260B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
n-Butyl alcohol	----------	----------	EPA 8260B/8015B/ 8015C	EPA 8260B/8015B/ 8015C
tert-Butyl alcohol (2-Methyl-2-propanol)	EPA 8260B		EPA 8260B/8260B SIM	EPA 8260B
n-Butylbenzene	----------	----------	EPA 8260B	EPA 8260B
sec-Butylbenzene	----------	----------	EPA 8260B	EPA 8260B
tert-Butylbenzene	----------	----------	EPA 8260B	EPA 8260B
Carbon disulfide	----------	----------	EPA 8260B	EPA 8260B
Carbon tetrachloride	----------	----------	EPA 8260B	EPA 8260B
Chlorobenzene	----------	----------	EPA 8260B/8021B	EPA 8260B/8021B
2-Chloro-1,3-butadiene	----------	----------	EPA 8260B	EPA 8260B
Chloroethane	----------	----------	EPA 8260B	EPA 8260B
2-Chloroethyl vinyl ether	----------	----------	EPA 8260B	EPA 8260B
Chloroform	----------	----------	EPA 8260B	EPA 8260B
1-Chlorohexane	----------	----------	EPA 8260B	EPA 8260B
Chloromethane	----------	----------	EPA 8260B	EPA 8260B
Chloroprene	----------	----------	EPA 8260B	EPA 8260B
4-Chlorotoluene	----------	----------	EPA 8260B	EPA 8260B
2-Chlorotoluene	----------	----------	EPA 8260B	EPA 8260B
Cyclohexane	----------	----------	EPA 8260B	EPA 8260B
Cyclohexanone	----------	----------	EPA 8260B	EPA 8260B
Dibromochloromethane	----------	----------	EPA 8260B	EPA 8260B
1,2-Dibromo-3-chloropropane (DBCP)	----------		EPA 8260B/8011	EPA 8260B/8011
Dibromochloromethane	----------	----------	EPA 8260B	EPA 8260B
Dichlorodifluoromethane	----------	----------	EPA 8260B	EPA 8260B
Dibromomethane	----------	----------	EPA 8260B	EPA 8260B
1,2 Dibromoethane (EDB)	EPA 8011		EPA 8260B/8011	EPA 8260B/8011
1,2-Dichlorobenzene	----------	----------	EPA 8260B/8021B	EPA 8260B/8021B
1,3-Dichlorobenzene	----------	----------	EPA 8260B/8021B	EPA 8260B/8021B
1,4-Dichlorobenzene	----------	----------	EPA 8260B/8021B	EPA 8260B/8021B
cis-1,4-Dichloro-2-butene	----------	----------	EPA 8260B	EPA 8260B
trans-1,4-Dichloro-2-butene	----------	----------	EPA 8260B	EPA 8260B
1,1-Dichloroethane	----------	----------	EPA 8260B	EPA 8260B
1,2-Dichloroethane	----------	----------	EPA 8260B	EPA 8260B
1,1-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
1,2-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
cis-1,2-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
trans-1,2-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
Dichlorofluoromethane	----------	----------	EPA 8260B	EPA 8260B
1,2-Dichloropropane	----------	----------	EPA 8260B	EPA 8260B
1,3-Dichloropropane	----------	----------	EPA 8260B	EPA 8260B
2,2-Dichloropropane	----------	----------	EPA 8260B	EPA 8260B
1,1-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
1,3-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
cis-1,3-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
trans-1,3-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
Diethyl ether	----------	----------	EPA 8260B	EPA 8260B
Di-isopropylether	----------	----------	EPA 8260B	EPA 8260B
1,4-Dioxane	----------	----------	EPA 8260B/8260B SIM	EPA 8260B/8260B SIM

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Ethanol	----------	----------	EPA 8260B/8015B/ 8015C	EPA 8260B/8015B/ 8015C
Ethyl acetate	----------	----------	EPA 8260B	EPA 8260B
Ethyl benzene	EPA 8260B/8021B	----------	EPA 8260B/8021B/ AK101/OK DEQ GRO	EPA 8260B/8021B/ AK101/OK DEQ GRO
Ethyl methacrylate	----------	----------	EPA 8260B	EPA 8260B
Ethyl tert-butyl ether	EPA 8260B	----------	----------	----------
Ethylene glycol	----------	----------	EPA 8015C	EPA 8015C
Gas Range Organics (GRO)	EPA 8015C	----------	EPA 8015B/8015C/ AK101/8015D/ OK DEQ GRO	EPA 8015B/8015C/ AK101/8015D/ OK DEQ GRO
Hexane	----------	----------	EPA 8260B	EPA 8260B
2-Hexanone	----------	----------	EPA 8260B	EPA 8260B
Hexachlorobutadiene	----------	----------	EPA 8260B	EPA 8260B
Isobutyl alcohol (2-Methyl-1-propanol)	----------	----------	EPA 8260B/8015B/ 8015C	EPA 8260B/8015B/ 8015C
Isopropyl alcohol	----------	----------	EPA 8260B	EPA 8260B
Isopropylbenzene	----------	----------	EPA 8260B	EPA 8260B
1,4-Isopropyltoluene	----------	----------	EPA 8260B	EPA 8260B
Iodomethane	----------	----------	EPA 8260B	EPA 8260B
Methacrylonitrile	----------	----------	EPA 8260B	EPA 8260B
Methanol	----------	----------	EPA 8015B/8015C	EPA 8015B/8015C
Methyl acetate	----------	----------	EPA 8260B	EPA 8260B
Methyl cyclohexane	----------	----------	EPA 8260B	EPA 8260B
Methylene chloride	----------	----------	EPA 8260B	EPA 8260B
Methyl ethyl ketone (MEK)	----------	----------	EPA 8260B	EPA 8260B
Methyl isobutyl ketone	----------	----------	EPA 8260B	EPA 8260B
Methyl methacrylate	----------	----------	EPA 8260B	EPA 8260B
Methyl tert-butyl ether (MtBE)	EPA 8260B/ 8021B	----------	EPA 8260B/8021B/ OK DEQ GRO	EPA 8260B/8021B/ OK DEQ GRO
4-Methyl-2-pentanone	----------	----------	EPA 8260B	EPA 8260B
Naphthalene	EPA 8260B/ 8021B	----------	EPA 8260B/OK DEQ GRO	EPA 8260B/OK DEQ GRO
2-Nitropropane	----------	----------	EPA 8260B	EPA 8260B
2,2' Oxybisethanol	----------	----------	EPA 8015C	EPA 8015C
2-Pentanone	----------	----------	EPA 8260B	EPA 8260B
Propionitrile	----------	----------	EPA 8260B	EPA 8260B
n-Propylbenzene	----------	----------	EPA 8260B	EPA 8260B
Propylene glycol	----------	----------	EPA 8015C	EPA 8015C
Styrene	----------	----------	EPA 8260B	EPA 8260B
1,1,1,2-Tetrachloroethane	----------	----------	EPA 8260B	EPA 8260B
1,1,2,2-Tetrachloroethane	----------	----------	EPA 8260B	EPA 8260B
Tetrachloroethene	----------	----------	EPA 8260B	EPA 8260B
Tetrahydrofuran	----------	----------	EPA 8260B	EPA 8260B
Toluene	EPA 8260B/ 8021B	----------	EPA 8260B/8021B/ AK101/OK DEQ GRO	EPA 8260B/8021B/ AK101/OK DEQ GRO
Total Petroleum Hydrocarbons (TPH)	----------	EPA 1664A/ 1664B	EPA 1664A/1664B	----------

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
1,2,3-Trichlorobenzene	----------	----------	EPA 8260B	EPA 8260B
1,1,1-Trichloroethane	----------	----------	EPA 8260B	EPA 8260B
1,1,2-Trichloroethane	----------	----------	EPA 8260B	EPA 8260B
Trichloroethene	----------	----------	EPA 8260B/8260B SIM	EPA 8260B
Trichlorofluoromethane	----------	----------	EPA 8260B	EPA 8260B
1,2,3-Trichlorobenzene	----------	----------	EPA 8260B	EPA 8260B
1,2,4-Trichlorobenzene	----------	----------	EPA 8260B	EPA 8260B
1,2,3-Trichloropropane	----------		EPA 8260B/8011	EPA 8260B/8011
1,1,2-Trichloro-1,2,2-trifluoroethane	----------	----------	EPA 8260B	EPA 8260B
Triethylene glycol	----------	----------	EPA 8015C	EPA 8015C
1,2,3-Trimethylbenzene	----------	----------	EPA 8260B	EPA 8260B
1,2,4-Trimethylbenzene	----------	----------	EPA 8260B	EPA 8260B
1,3,5-Trimethylbenzene	----------	----------	EPA 8260B	EPA 8260B
Vinyl acetate	----------	----------	EPA 8260B	EPA 8260B
Vinyl chloride	----------	----------	EPA 8260B/8260B SIM	EPA 8260B
Xylenes, total	EPA 8260B/ 8021B	----------	EPA 8260B/8021B/ AK101/OK DEQ GRO	EPA 8260B/8021B/ AK101/OK DEQ GRO
1,2-Xylene	EPA 8260B/ 8021B	----------	EPA 8260B/8021B/ AK101/OK DEQ GRO	EPA 8260B/8021B/ AK101/OK DEQ GRO
M+P-Xylene	EPA 8260B/ 8021B	----------	EPA 8260B/8021B/ AK101/OK DEQ GRO	EPA 8260B/8021B/ AK101/ K DEQ GRO
Methane	----------	----------	RSK-175	----------
Ethane	----------	----------	RSK-175	----------
Ethylene (Ethene)	----------	----------	RSK-175	----------
Acetylene	----------	----------	RSK-175	----------
Acetylene ethane	----------	----------	RSK-175	----------
Extractable Organics (semivolatiles)	----------			
Acenaphthene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Acenaphthylene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Acetophenone	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2-Acetylaminofluorene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Alachlor	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
4-Aminobiphenyl	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Aniline	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Anthracene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Aramite	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Atrazine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Azobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Benzaldehyde	----------	----------	EPA 8270C 8270D	EPA 8270C/8270D
Benzidine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Benzoic acid	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Benzo (a) anthracene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Benzo (b) fluoranthene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Benzo (k) fluoranthene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Benzo (ghi) perylene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Benzo (a) pyrene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Benzyl alcohol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
bis (2-Chloroethoxy) methane	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
bis (2-Chloroethyl) ether	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
bis (2-Chloroisopropyl) ether (2,2'Oxybis(1-chloropropane)	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
bis (2-Ethylhexyl) phthalate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
4-Bromophenyl phenyl ether	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
butyl Benzyl phthalate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2-sec-butyl-4,6-Dinitrophenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Carbazole	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
4-Chloroanilene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Chlorobenzilate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
4-chloro-3-Methylphenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1-Chloronaphthalene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2-Chloronaphthalene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2-Chlorophenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
4-Chlorophenyl phenyl ether	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Chrysene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Cresols	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Diallate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Dibenzo (a,h) anthracene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Dibenzofuran	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1,2-Dichlorobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1,3-Dichlorobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1,4-Dichlorobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
3,3'-Dichlorobenzidine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dichlorophenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2,6-Dichlorophenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Diethyl phthalate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Dimethoate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
3,3-Dimethylbenzidine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
p-Dimethylaminoazobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
7,12-Dimethylbenz(a)anthracene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
alpha-,alpha-Dimethylphenethylamine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dimethylphenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Dimethyl phthalate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
di-n-butyl Phthalate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
di-n-octyl Phthalate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1,3-Dinitrobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1,4-Dinitrobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dinitrophenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dinitrotoluene	----------	----------	EPA 8270C/8270D	EPA 8270 C/8270D
2,6-Dinitrotoluene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1,4-Dioxane	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Diphenylamine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1,2-Diphenylhydrazine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Disulfoton	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Diesel Range Organics (DRO)	EPA 8015C (WY: C10-C32)	----------	EPA 8015B/8015C, AK102/8015D/OK DEQ DRO	EPA 8015B/8015C, AK102/8015D/OK DEQ DRO
ethyl Methanesulfonate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Famphur	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Fluoroanthene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Fluorene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Hexachlorobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Hexachlorobutadiene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Hexachlorocyclopentadiene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Hexachloroethane	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Hexachloropropene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Indeno (1,2,3-cd) pyrene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Isodrin	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Isophorone	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Isosafrole	----------	----------	EPA 8270C/8270D	EPA 8270 C/8270D
Methapyrilene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
3-Methylcholanthrene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2-methyl-4,6-Dinitrophenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
methyl Methane sulfonate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1-Methylnaphthalene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
2-Methylnaphthalene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
2-Methylphenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
3+4-Methylphenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Naphthalene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
1,4-Naphthoquinone	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1-Naphthylamine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2-Naphthylamine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2-Nitroaniline	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
3-Nitroaniline	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
4-Nitroaniline	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Nitrobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2-Nitrophenol	----------	----------	EPA 8270C /8270D	EPA 8270C/8270D
4-Nitrophenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Nitroquinoline-1-oxide	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosodiethylamine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosodimethylamine	----------	----------	EPA 8270C/8270D/ 8270D SIM	EPA 8270C/8270D/ 8270D SIM
N-Nitrosodi-n-butylamine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosodi-n-propylamine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosodiphenylamine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosomethylethylamine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosomorpholine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosopiperidine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosopyrrolidine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
5-nitro-o-Toluidine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2,2-oxybis(1-chloropropane)	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Parathion, methyl	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Parathion, ethyl	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Pentachlorobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Pentachloroethane	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Pentachloronitobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Pentachlorophenol	----------	----------	EPA 8270C/8270D/ 8321A/8321B	EPA 8270C/8270D/ 8321A/8321B
Phenacetin	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Phenanthrene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Phenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Phorate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2-Picoline	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Pronamide	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Pyrene	----------	----------	EPA 8270C/8270D/ 8270SIM	EPA 8270C/8270D/ 8270SIM
Pyridine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Safrole	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Sulfotepp	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1,2,4,5-Tetrachlorobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2,3,4,6-Tetrachlorophenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Thionazin	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
o-Toluidine	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1,2,4-Trichlorobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2,4,5-Trichlorophenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
2,4,6-Trichlorophenol	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
o,o,o-triethyl Phosphorothioate	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
1,3,5-Trinitrobenzene	----------	----------	EPA 8270C/8270D	EPA 8270C/8270D
Motor Oil (Residual Range Organics)	----------	----------	EPA 8015B/8015C/ 8015D, AK103/OK DEQ RRO	EPA 8015B/ 8015C/ 8015D, AK103/ OK DEQ RRO

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Pesticides/Herbicides/PCBs				
Aldrin	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Atrazine	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Azinophos ethyl	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Azinophos methyl	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
alpha-BHC	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
beta-BHC	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
delta-BHC	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
gamma-BHC	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Bolstar	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
alpha-Chlordane	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
gamma-Chlordane	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Chlordane (technical)	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Chloropyrifos	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Coumaphos	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
2,4-D	----------	----------	EPA 8151A/8321A	EPA 8151A/8321A
Dalapon	----------	----------	EPA 8151A/8321A	EPA 8151A/8321A
2,4-DB	----------	----------	EPA 8151A/8321A	EPA 8151A/8321A
4,4'-DDD	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
4,4'-DDE	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
4,4'-DDT	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Demeton-O	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Demeton-S	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Demeton, total	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Diazinon	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Dicamba	----------	----------	EPA 8151A/8321A	EPA 8151A/8321A
Dichlorovos	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Dichloroprop	----------	----------	EPA 8151A/8321A	EPA 8151A/8321A
Dieldrin	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Dimethoate	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Dinoseb	----------	----------	EPA 8151A/8321A	EPA 8321A
Disulfoton	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Endosulfan I	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Endosulfan II	----------	----------	EPA 8081A /8081B	EPA 8081A/8081B
Endonsulfan sulfate	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Endrin	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Endrin aldehyde	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Endrin ketone	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
EPN	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Ethoprop	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Ethyl Parathion	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Famphur	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Fensulfothion	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Fenthion	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
Heptachlor	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Heptachlor epoxide	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Hexachlorobenzene	----------	----------	EPA 8081A/8081B	EPA 8081A/8081B
Malathion	----------	----------	EPA 8141A/8141B	EPA 8141A/8141B
MCPA	----------	----------	EPA 8151A/8321A	EPA 8151A/8321A

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
MCPP	----------	----------	EPA 8151A /8321A	EPA 8151A/8321A
Merphos	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
Methoxychlor	----------	----------	EPA 8081A /8081B	EPA 8081A/8081B
Methyl parathion	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
Mevinphos	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
Naled	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
PCB-1016 (Arochlor)	----------	----------	EPA 8082 /8082A	EPA 8082/8082A
PCB-1221	----------	----------	EPA 8082 /8082A	EPA 8082/8082A
PCB-1232	----------	----------	EPA 8082 /8082A	EPA 8082/8082A
PCB-1242	----------	----------	EPA 8082 /8082A	EPA 8082/8082A
PCB-1248	----------	----------	EPA 8082 /8082A	EPA 8082/8082A
PCB-1254	----------	----------	EPA 8082 /8082A	EPA 8082/8082A
PCB-1260	----------	----------	EPA 8082 /8082A	EPA 8082/8082A
PCB-1262	----------	----------	EPA 8082 /8082A	EPA 8082/8082A
PCB-1268	----------	----------	EPA 8082 /8082A	EPA 8082/8082A
Total PCBs	----------	----------	EPA 8082 /8082A	EPA 8082/8082A
Phorate	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
Phosmet	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
Propazine	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
Ronnel	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
Simazine	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
Stirophos	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
Sulfotepp	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
2,4,5-T	----------	----------	EPA 8151A /8321A	EPA 8151A/8321A
Thionazin	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
Tokuthion	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
2,4,5-TP	----------	----------	EPA 8151A /8321A	EPA 8151A/8321A
Toxaphene	----------	----------	EPA 8081A /8081B	EPA 8081A/8081B
Trichloronate	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
o,o,o-triethylphos Phorothioate	----------	----------	EPA 8141A /8141B	EPA 8141A/8141B
Explosives				
1,3,5-Trinitrobenzene	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
1,3-Dinitrobenzene	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
2,4,6-Trinitrotoluene	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
3,5-Dinitroaniline	----------	----------	EPA 8330B	EPA 8330B
2,4-Dinitrotoluene	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
2,6-Dinitroltoluene	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
2-amino-4,6-Dinitrotoluene	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
2-Nitrotoluene	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
3-Nitrotoluene	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
4-amino-2,6-Dinitrotoluene	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
4-Nitrotoluene	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
Nitrobenzene	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
Nitroglycerin	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
octahydro-1,3,5,7-tetrabitro-1,3,5,7-Tetrazocine (HMX)	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
Pentaerythritoltetranitrate (PETN)	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
Picric acid	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
RDX (hexahydro-1,3,5-trinitro-1,3,5-Triazine)	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
Tetryl (methyl 2,4,6-Trinitrophenylnitramine	----------	----------	EPA 8330A/8330B/ 8321A/8321B	EPA 8330A/8330B/ 8321A/8321B
Perfluorinated Hydrocarbons (PFCs) and Perfluorinated Sulfonates (PFSs)				
Perfluorobutanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoropentanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorohexanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoroheptanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorononanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorodecanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoroundecanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorododecanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorotridecanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorotetradecanoic acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorobutane sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorohexane sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctane sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorodecane sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctane sulfonamide	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Hazardous Waste Characteristics				
Conductivity	----------	----------	EPA 9050A	EPA 9050A
Corrosivity	----------	----------	EPA 9040B/9040C	EPA 9045C/9045D
Ignitibility	----------	EPA 1010/1010A	EPA 1010/1010A	EPA 1010/1010A
Paint filter liquids test	----------	----------	EPA 9095A	EPA 9095A
Synthetic Precipitation Leaching Procedure (SPLP)	----------	----------	EPA 1312	EPA 1312
Toxicity Characteristic Leaching Procedure	----------	----------	EPA 1311	EPA 1311

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Organic Prep Methods				
Separatory funnel liquid-liquid extraction	----------	----------	EPA 3510C	----------
Continuous liquid-liquid extraction	----------	----------	EPA 3520C	----------
Soxhlet extraction	----------	----------	----------	EPA 3540C
Microwave extraction	----------	----------	----------	EPA 3546
Ultrasonic extraction	----------	----------	----------	EPA 3550B/3550C
Waste dilution	----------	----------	EPA 3580A	EPA 3580A
Solid phase extraction	----------	----------	EPA 3535A	----------
Volatiles purge and trap	----------	----------	EPA 5030B	EPA 5030A/5035A/ 5035
Organic Cleanup Procedures				
Florisil cleanup	----------	----------	EPA 3620B	EPA 3620B
Florisil cleanup	----------	----------	EPA 3620C	EPA 3620C
Sulfur cleanup			EPA 3660A	EPA 3660A
Sulfuric acid/Permanganate cleanup	----------	----------	EPA 3665A	EPA 3665A
Metals Digestion				
Acid digestion total recoverable or dissolved metals	----------	----------	EPA 3005A	----------
Acid digestion for total metals	----------	----------	EPA 3010A	----------
Acid digestion for total metals	----------	----------	EPA 3020A	----------
Acid digestion of sediments, sludges and soils	----------	----------	----------	EPA 3050B

Joint ISO-ILAC-IAF Communiqué **8 January 2009**

ILAC members will be aware that many of their accredited laboratories have been experiencing difficulty convincing their customers they should be asking laboratories to be accredited to ISO/IEC 17025, (prior to 1999 ISO Guide 25) rather than be certified (registered) to ISO 9001. The situation became more acute with the publication of ISO 9001:2008, as some customers continually asked laboratories to be certified, when they really meant accredited. The confusion is caused by the perception that accredited laboratories do not operate a recognised quality management system.

To address this problem the ILAC Laboratory Committee asked that a statement be put on accreditation (attestation) certificates, issued by their accreditation body, stating that an accredited laboratory's management system meets the principles of ISO 9001:2008. The same statement could also be used by accredited laboratories on their calibration certificates and test reports.

Working through the ISO-ILAC-IAF Joint Working Group (JWG), ILAC is pleased to be able to advise it's member accreditation bodies that the problem raised by the Laboratory Committee may now be addressed as follows:-

On accreditation (attestation) certificates, accreditation bodies may add the following:

"This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF Communiqué dated January 2009)"

Accreditation Bodies choosing to use the above statement on their accreditation certificates should either supply, or provide access to (via a website), the Joint ISO-ILAC-IAF Communiqué as part of the package. (It may be convenient for accreditation bodies to do this when they issue new accreditation certificates for ISO/IEC 17025:2005 to their accredited laboratories.)

Accredited laboratories choosing to use the above statement on their test reports and calibration certificates should also either supply, or provide access to (via a website), the Joint ISO-ILAC-IAF Communiqué as part of the package for their laboratory customers.

The Joint Communiqué is available on the ILAC website at www.ilac.org on the publications and resources page.

The ILAC Laboratory Committee thanks the members of the ILAC and IAF Executive Committees and the ISO-ILAC-IAF JWG, for developing a solution to a critical market issue facing some accredited laboratories.

Daniel Pierre, ILAC Chair

Secretariat: PO Box 7507, Silverwater, NSW 2128, Australia
7 Leeds Street, Rhodes, NSW 2138, Australia

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**

January 2009

Kansas Health & Environmental Laboratories
Environmental Laboratory Improvement Program
6810 SE Dwight Street
Topeka, KS 66620-0001

Kansas

Phone: 785-296-3811
Fax: 785-296-1638
http://www.kdheks.gov/labs/

Susan Mosier, MD, Secretary | Department of Health & Environment | Sam Brownback, Governor

April 27, 2016

Margaret S. Sleevi
TestAmerica Laboratories, Inc. – Denver E-10166
4955 Yarrow Street
Arvada, Co 80002

Dear Ms. Sleevi,

Due to continued staffing changes our office has not been able to complete the processing of your application. Therefore, we are unable to send you an updated certificate at this time.

We are granting an extension to your current accreditation so that we can process your application without your laboratory losing certification with the State of Kansas. If you have any concerns or problems you can contact me at (785) 291-3162 or email me at shoffman@kdheks.gov.

Please allow this letter to stand as proof that **TestAmerica Laboratories, Inc. – Denver** has continued accreditation until **July 31, 2016**. We will update our database to reflect this change as well.

Regards,

Sara Hoffman
Section Chief
Quality, Preparedness and Certifications Section

STATE OF KANSAS

DEPARTMENT OF HEALTH AND ENVIRONMENT

CERTIFICATE

This is to certify that Certificate No. E-10166

TestAmerica Laboratories, Inc. - Denver
4955 Yarrow Street
Arvada, CO 80002

has been accredited in accordance with K.S.A. 65-1,109a under the standards adopted in K.A.R. 28-15-36 for performing environmental analyses for the parameters listed on the attached form. Continuous accreditation depends on successful, ongoing participation in the program. Clients are urged to verify with this agency the laboratory's certification status for particular methods and analytes.

EFFECTIVE DATE: 05/01/2015

EXPIRATION DATE: 04/30/2016

Susan K Mosier

Secretary
Department of Health and Environment

Section chief
Environmental Laboratory Certifications

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
ENVIRONMENTAL LABORATORY ACCREDITATION
CLEAN WATER ACT PROGRAM - NON-POTABLE WATER MATRIX

This certificate supersedes all previous certificates

TestAmerica Laboratories, Inc. - Denver
4955 Yarrow Street
Arvada, CO 80002

Certificate Number: E-10166
Effective Date: 05/01/2015
Expiration Date: 04/30/2016
Reciprocity: OR

The laboratory listed above is hereby approved for environmental laboratory accreditation in accordance with K.S.A. 65-1, 109a for the following:

****DEMANDS**
BOD {SM 5210 B}
cBOD {SM 5210 B}
COD {EPA 410.4}
Total Organic Carbon {SM 5310 B, C, or D}

****METALS**
Aluminum {EPA 200.7}
Antimony {EPA 200.7}
Antimony {EPA 200.8}
Arsenic {EPA 200.7}
Arsenic {EPA 200.8}
Barium {EPA 200.7}
Barium {EPA 200.8}
Beryllium {EPA 200.7}
Beryllium {EPA 200.8}
Boron {EPA 200.7}
Cadmium {EPA 200.7}
Cadmium {EPA 200.8}
Calcium {EPA 200.7}
Chromium {EPA 200.7}
Chromium {EPA 200.8}
Chromium, VI {SM 3500-Cr B}
Cobalt {EPA 200.7}
Cobalt {EPA 200.8}
Copper {EPA 200.7}
Copper {EPA 200.8}
Iron {EPA 200.7}
Iron {SM 3500-Fe B}
Lead {EPA 200.7}
Lead {EPA 200.8}
Magnesium {EPA 200.7}
Manganese {EPA 200.7}
Manganese {EPA 200.8}
Mercury {EPA 245.1}
Molybdenum {EPA 200.7}
Molybdenum {EPA 200.8}
Nickel {EPA 200.7}
Nickel {EPA 200.8}
Potassium {EPA 200.7}
Selenium {EPA 200.7}
Selenium {EPA 200.8}
Silica, Dissolved {EPA 200.7}
Silver {EPA 200.7}
Silver {EPA 200.8}
Sodium {EPA 200.7}
Thallium {EPA 200.7}
Thallium {EPA 200.8}
Tin {EPA 200.7}
Titanium {EPA 200.7}
Vanadium {EPA 200.7}
Vanadium {EPA 200.8}
Zinc {EPA 200.7}
Zinc {EPA 200.8}

NELAP ACCREDITED TNI LABORATORY

****METALS - 503 Regs**
Arsenic {EPA 6010}
Arsenic {EPA 6020}
Cadmium {EPA 6010}
Cadmium {EPA 6020}
Chromium, Total {EPA 6010}
Chromium, Total {EPA 6020}
Copper {EPA 6010}
Copper {EPA 6020}
Lead {EPA 6010}
Lead {EPA 6020}
Mercury {EPA 7470}
Mercury {EPA 7471}
Molybdenum {EPA 6010}
Molybdenum {EPA 6020}
Nickel {EPA 6010}
Nickel {EPA 6020}
Selenium {EPA 6010}
Selenium {EPA 6020}
Zinc {EPA 6010}
Zinc {EPA 6020}

****MINERALS**
Acidity {SM 2310 B}
Alkalinity {SM 2320 B}
Chloride {EPA 300.0}
Fluoride {EPA 300.0}
Hardness {EPA 200.7}
Hardness {SM 2340 B or C}
Sulfate {EPA 300.0}
Sulfide {SM 4500-S-2 D}
Sulfide {SM 4500-S-2 F}
Sulfite {SM 4500-SO3-2 B}

****MISCELLANEOUS**
Bromide {EPA 300.0}
Color {SM 2120 B}
Conductivity {SM 2510 B}
Cyanide {EPA 335.4}
Cyanide {SM 4500-CN C}
Cyanide {SM 4500-CN E}
Hydrogen Ion (pH) {SM 4500-H B}
Oil & Grease {EPA 1664}
Phenolics {EPA 420.1}
Phenolics {EPA 420.4}
Turbidity {EPA 180.1}

****NUTRIENTS**
Ammonia {EPA 350.1}
K Nitrogen {EPA 351.2}
Nitrate-Nitrite {EPA 300.0}
Nitrate-Nitrite {EPA 353.2}
Nitrate {EPA 300.0}
Nitrate {EPA 353.2}
Nitrite {EPA 300.0}
Nitrite {SM 4500-NO2 B}
Organic-Nitrogen {TKN-NH3-CAL}
Ortho-phosphate {EPA 300.0}
Ortho-phosphate {EPA 365.1}
Phosphorus {EPA 365.1}

****ORGANIC CHEMISTRY VOLATILES (MEASUREMENT BY GC)**
{EPA 602} 1,2-Dichlorobenzene
{EPA 602} 1,3-Dichlorobenzene

{EPA 602} 1,4-Dichlorobenzene
{EPA 602} Benzene
{EPA 602} Chlorobenzene
{EPA 602} Ethylbenzene
{EPA 602} Toluene

**ORGANIC CHEMISTRY VOLATILES (MEASUREMENT BY GC/MS)
{EPA 624} 1,1-Dichloroethane
{EPA 624} 1,1-Dichloroethene
{EPA 624} 1,1,1-Trichloroethane
{EPA 624} 1,1,2-Trichloroethane
{EPA 624} 1,1,2,2-Tetrachloroethane
{EPA 624} 1,2-Dichlorobenzene
{EPA 624} 1,2-Dichloroethane
{EPA 624} 1,2-Dichloropropane
{EPA 624} 1,3-Dichlorobenzene
{EPA 624} 1,4-Dichlorobenzene
{EPA 624} 2-Chloroethyl vinyl ether
{EPA 624} Acrolein
{EPA 624} Acrylonitrile
{EPA 624} Benzene
{EPA 624} Bromodichloromethane
{EPA 624} Bromoform
{EPA 624} Bromomethane (Methyl bromide)
{EPA 624} Carbon tetrachloride
{EPA 624} Chlorobenzene
{EPA 624} Chloroethane
{EPA 624} Chloroform
{EPA 624} Chloromethane (Methyl chloride)
{EPA 624} cis-1,3-Dichloropropene
{EPA 624} Dibromochloromethane
{EPA 624} Ethylbenzene
{EPA 624} Methylene chloride (Dichloromethane)
{EPA 624} Tetrachloroethene (Perchloroethylene)
{EPA 624} Toluene
{EPA 624} trans-1,2-Dichloroethene
{EPA 624} trans-1,3-Dichloropropene
{EPA 624} Trichloroethene (Trichloroethylene)
{EPA 624} Trichlorofluoromethane
{EPA 624} Vinyl chloride

**ORGANIC CHEMISTRY (MEASUREMENT BY GC)
{EPA 608} 4,4'-DDD
{EPA 608} 4,4'-DDE
{EPA 608} 4,4'-DDT
{EPA 608} Aldrin
{EPA 608} alpha-BHC (alpha-Hexachlorocyclohexane)
{EPA 608} beta-BHC (beta-Hexachlorocyclohexane)
{EPA 608} Chlordane
{EPA 608} delta-BHC
{EPA 608} Dieldrin
{EPA 608} Endosulfan I
{EPA 608} Endosulfan II
{EPA 608} Endosulfan Sulfate
{EPA 608} Endrin
{EPA 608} Endrin aldehyde
{EPA 608} gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)
{EPA 608} Heptachlor
{EPA 608} Heptachlor epoxide
{EPA 608} PCB-1016
{EPA 608} PCB-1221
{EPA 608} PCB-1232
{EPA 608} PCB-1242
{EPA 608} PCB-1248

NELAP ACCREDITED TNI LABORATORY

{EPA 608} PCB-1254
{EPA 608} PCB-1260
{EPA 608} Toxaphene
{EPA 614} Azinphos-methyl (Guthion)
{EPA 614} Diazinon
{EPA 614} Disulfoton
{EPA 614} Malathion
{EPA 614} Parathion ethyl
{EPA 614} Parathion methyl

****ORGANIC CHEMISTRY (MEASUREMENT BY GC/MS)**
{EPA 625} 1,2,4-Trichlorobenzene
{EPA 625} 2-Chloronaphthalene
{EPA 625} 2-Chlorophenol
{EPA 625} 2-Methyl-4,6-dinitrophenol
{EPA 625} 2-Nitrophenol
{EPA 625} 2,2'-Oxybis(1-chloropropane)
{EPA 625} 2,4-Dichlorophenol
{EPA 625} 2,4-Dimethylphenol
{EPA 625} 2,4-Dinitrophenol
{EPA 625} 2,4-Dinitrotoluene (2,4-DNT)
{EPA 625} 2,4,6-Trichlorophenol
{EPA 625} 2,6-Dinitrotoluene
{EPA 625} 3,3'-Dichlorobenzidine
{EPA 625} 4-Bromophenyl phenyl ether
{EPA 625} 4-Chloro-3-methylphenol
{EPA 625} 4-Chlorophenyl phenyl ether
{EPA 625} 4-Nitrophenol
{EPA 625} Acenaphthene
{EPA 625} Acenaphthylene
{EPA 625} Anthracene
{EPA 625} Benzidine
{EPA 625} Benzo(a)anthracene
{EPA 625} Benzo(a)pyrene
{EPA 625} Benzo(b)fluoranthene
{EPA 625} Benzo(g,h,i)perylene
{EPA 625} Benzo(k)fluoranthene
{EPA 625} Benzyl butyl phthalate
{EPA 625} Bis(2-chloroethoxy)methane
{EPA 625} Bis(2-chloroethyl)ether
{EPA 625} Bis(2-ethylhexyl)phthalate
{EPA 625} Chrysene
{EPA 625} Di-n-butyl phthalate
{EPA 625} Di-n-octyl phthalate
{EPA 625} Dibenzo(a,h)anthracene
{EPA 625} Diethyl phthalate
{EPA 625} Dimethyl phthalate
{EPA 625} Fluoranthene
{EPA 625} Fluorene
{EPA 625} Hexachlorobenzene
{EPA 625} Hexachlorobutadiene
{EPA 625} Hexachlorocyclopentadiene
{EPA 625} Hexachloroethane
{EPA 625} Indeno(1,2,3-cd) pyrene
{EPA 625} Isophorone
{EPA 625} N-nitroso-di-n-propylamine (NDPA)
{EPA 625} N-nitrosodimethylamine (NDMA)
{EPA 625} N-Nitrosodiphenylamine
{EPA 625} Naphthalene
{EPA 625} Nitrobenzene
{EPA 625} Pentachlorophenol
{EPA 625} Phenanthrene
{EPA 625} Phenol
{EPA 625} Pyrene

**ORGANIC CHEMISTRY (MEASUREMENT BY HPLC)
{EPA 610} Acenaphthene
{EPA 610} Acenaphthylene
{EPA 610} Anthracene
{EPA 610} Benzo(a)anthracene
{EPA 610} Benzo(a)pyrene
{EPA 610} Benzo(b)fluoranthene
{EPA 610} Benzo(g,h,i)perylene
{EPA 610} Benzo(k)fluoranthene
{EPA 610} Chrysene
{EPA 610} Dibenzo(a,h)anthracene
{EPA 610} Fluoranthene
{EPA 610} Fluorene
{EPA 610} Indeno(1,2,3-cd) pyrene
{EPA 610} Naphthalene
{EPA 610} Phenanthrene
{EPA 610} Pyrene

**RESIDUES
Residue, Filterable (TDS) {SM 2540 C}
Residue, Non Filterable (TSS) {SM 2540 D}
Residue, Settleable {SM 2540 F}
Residue, Total {SM 2540 B}
Residue, Volatile {EPA 160.4}

End of Parameter List

ELAP ACCREDITED
TNI
LABORATORY

NELAP ACCREDITED

TNI

LABORATORY

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
ENVIRONMENTAL LABORATORY ACCREDITATION
RCRA PROGRAM - NON-POTABLE WATER AND SOLID/CHEMICAL WASTE MATRICES

This certificate supersedes all previous certificates

TestAmerica Laboratories, Inc. - Denver
4955 Yarrow Street
Arvada, CO 80002

Certificate Number: E-10166
Effective Date: 05/01/2015
Expiration Date: 04/30/2016
Reciprocity: OR

The laboratory listed above is hereby approved for environmental laboratory accreditation in accordance with K.S.A. 65-1, 109a for the following:

****CHARACTERISTICS**
Ignitability {EPA 1010}
Synthetic-Precipitation Leaching Procedure {EPA 1312}
Toxic-Characteristic-Leaching Procedure {EPA 1311}

****DEMANDS**
Total Organic Carbon {EPA 9060}

****METALS**
Aluminum {EPA 6010}
Aluminum {EPA 6020}
Antimony {EPA 6010}
Antimony {EPA 6020}
Arsenic {EPA 6010}
Arsenic {EPA 6020}
Barium {EPA 6010}
Barium {EPA 6020}
Beryllium {EPA 6010}
Beryllium {EPA 6020}
Boron {EPA 6010}
Cadmium {EPA 6010}
Cadmium {EPA 6020}
Calcium {EPA 6010}
Chromium {EPA 6010}
Chromium {EPA 6020}
Chromium, VI {EPA 7196}
Cobalt {EPA 6010}
Cobalt {EPA 6020}
Copper {EPA 6010}
Copper {EPA 6020}
Iron {EPA 6010}
Lead {EPA 6010}
Lead {EPA 6020}
Lithium {EPA 6010}
Magnesium {EPA 6010}
Manganese {EPA 6010}
Manganese {EPA 6020}
Mercury {EPA 7470}
Mercury {EPA 7471}
Molybdenum {EPA 6010}
Nickel {EPA 6010}
Nickel {EPA 6020}
Phosphorus {EPA 6010}
Potassium {EPA 6010}
Selenium {EPA 6010}
Selenium {EPA 6020}
Silica {EPA 6010}
Silver {EPA 6010}
Silver {EPA 6020}
Sodium {EPA 6010}
Strontium {EPA 6010}
Thallium {EPA 6010}
Thallium {EPA 6020}
Tin {EPA 6010}

NELAP ACCREDITED TNI LABORATORY

Titanium {EPA 6010}
Vanadium {EPA 6010}
Vanadium {EPA 6020}
Zinc {EPA 6010}
Zinc {EPA 6020}

****MINERALS**
Bromide {EPA 9056}
Chloride {EPA 9056}
Fluoride {EPA 9056}
Sulfate {EPA 9056}
Sulfide {EPA 9030}
Sulfide {EPA 9034}

****MISCELLANEOUS**
Conductivity {EPA 9050}
Cyanide {EPA 9012}
Cyanide, Amenable to CL {EPA 9012}
Hydrogen Ion (pH) {EPA 9040}
Hydrogen Ion (pH) {EPA 9045}
Oil & Grease {EPA 9071}
Paint Filter Liquids Test {EPA 9095}
Phenolics {EPA 9066}
Total Organic-Halides {EPA 9020}

****NUTRIENTS**
Nitrate {EPA 9056}
Nitrite {EPA 9056}
Ortho-phosphate {EPA 9056}

****ORGANIC CHEMISTRY VOLATILES (MEASUREMENT BY GC)**
{EPA 8015} Ethanol
{EPA 8015} Isobutyl Alcohol
{EPA 8015} Isopropanol
{EPA 8015} Methanol
{EPA 8015} n-Butyl alcohol
{EPA 8021} 1,2-Dichlorobenzene
{EPA 8021} 1,3-Dichlorobenzene
{EPA 8021} 1,4-Dichlorobenzene
{EPA 8021} Benzene
{EPA 8021} Chlorobenzene
{EPA 8021} Ethylbenzene
{EPA 8021} meta-Xylene
{EPA 8021} Naphthalene
{EPA 8021} ortho-Xylene
{EPA 8021} para-Xylene
{EPA 8021} Toluene

****ORGANIC CHEMISTRY VOLATILES (MEASUREMENT BY GC/MS)**
{EPA 8260} 1-Chlorohexane
{EPA 8260} 1,1-Dichloroethane
{EPA 8260} 1,1-Dichloropropene
{EPA 8260} 1,1,1-Trichloroethane
{EPA 8260} 1,1,1,2-Tetrachloroethane
{EPA 8260} 1,1,2-Trichloroethane
{EPA 8260} 1,1,2,2-Tetrachloroethane
{EPA 8260} 1,2-Dichlorobenzene
{EPA 8260} 1,2-Dichloroethane
{EPA 8260} 1,2-Dichloropropane
{EPA 8260} 1,2,3-Trichlorobenzene
{EPA 8260} 1,2,3-Trichloropropane
{EPA 8260} 1,2,4-Trichlorobenzene
{EPA 8260} 1,2,4-Trimethylbenzene
{EPA 8260} 1,3-Dichlorobenzene

{EPA 8260} 1,3-Dichloropropane
{EPA 8260} 1,3,5-Trimethylbenzene
{EPA 8260} 1,4-Dichlorobenzene
{EPA 8260} 1,4-Dioxane
{EPA 8260} 2-Chloro-1,3-butadiene
{EPA 8260} 2-Chloroethyl vinyl ether
{EPA 8260} 2-Chlorotoluene
{EPA 8260} 2-Hexanone
{EPA 8260} 2-Nitropropane
{EPA 8260} 2-Pentanone
{EPA 8260} 2-Propanol
{EPA 8260} 2,2-Dichloropropane
{EPA 8260} 4-Chlorotoluene
{EPA 8260} 4-Isopropyltoluene
{EPA 8260} 4-Methyl-2-Pentanone (MIBK)
{EPA 8260} Acetone
{EPA 8260} Acetonitrile
{EPA 8260} Acrolein
{EPA 8260} Acrylonitrile
{EPA 8260} Allyl Chloride
{EPA 8260} Benzene
{EPA 8260} Bromobenzene
{EPA 8260} Bromochloromethane
{EPA 8260} Bromodichloromethane
{EPA 8260} Bromoform
{EPA 8260} Bromomethane (Methyl bromide)
{EPA 8260} Carbon disulfide
{EPA 8260} Carbon tetrachloride
{EPA 8260} Chlorobenzene
{EPA 8260} Chloroethane
{EPA 8260} Chloroform
{EPA 8260} Chloromethane (Methyl chloride)
{EPA 8260} cis-1,2-Dichloroethylene
{EPA 8260} cis-1,3-Dichloropropene
{EPA 8260} cis-1,4-Dichloro-2-butene
{EPA 8260} Dibromochloromethane
{EPA 8260} Dibromochloropropane (DBCP)
{EPA 8260} Dibromomethane
{EPA 8260} Dichlorodifluoromethane
{EPA 8260} Dichloromethane (Methylene chloride)
{EPA 8260} Diethyl ether
{EPA 8260} Ethanol
{EPA 8260} Ethyl acetate
{EPA 8260} Ethyl methacrylate
{EPA 8260} Ethylbenzene
{EPA 8260} Ethylene dibromide (EDB, 1,2-Dibromoethane)
{EPA 8260} Ethylene oxide
{EPA 8260} Hexachlorobutadiene
{EPA 8260} Iodomethane
{EPA 8260} Isobutyl Alcohol
{EPA 8260} Isopropylbenzene
{EPA 8260} meta-Xylene
{EPA 8260} Methacrylonitrile
{EPA 8260} Methyl ethyl ketone
{EPA 8260} Methyl tert-butyl ether (MTBE)
{EPA 8260} Methylmethacrylate
{EPA 8260} n-Butyl alcohol
{EPA 8260} n-Butylbenzene
{EPA 8260} n-Propylbenzene
{EPA 8260} Naphthalene
{EPA 8260} ortho-Xylene
{EPA 8260} para-Xylene
{EPA 8260} Propionitrile
{EPA 8260} sec-Butylbenzene

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{EPA 8260} Styrene
{EPA 8260} t-Butyl alcohol
{EPA 8260} tert-Butylbenzene
{EPA 8260} Tetrachloroethene (Perchloroethylene)
{EPA 8260} Toluene
{EPA 8260} trans-1,2-Dichloroethylene
{EPA 8260} trans-1,3-Dichloropropene
{EPA 8260} trans-1,4-Dichloro-2-butene
{EPA 8260} Trichloroethene (Trichloroethylene)
{EPA 8260} Trichlorofluoromethane
{EPA 8260} Vinyl Acetate
{EPA 8260} Vinyl chloride

****ORGANIC CHEMISTRY (MEASUREMENT BY GC)**
{EPA 8011} Dibromochloropropane (DBCP)
{EPA 8011} Ethylene dibromide (EDB, 1,2-Dibromoethane)
{EPA 8081} 4,4'-DDD
{EPA 8081} 4,4'-DDE
{EPA 8081} 4,4'-DDT
{EPA 8081} Aldrin
{EPA 8081} alpha-BHC (alpha-Hexachlorocyclohexane)
{EPA 8081} alpha-Chlordane
{EPA 8081} beta-BHC (beta-Hexachlorocyclohexane)
{EPA 8081} Chlordane (Tech)
{EPA 8081} Chlorobenzilate
{EPA 8081} delta-BHC
{EPA 8081} Diallate
{EPA 8081} Dicofol
{EPA 8081} Dieldrin
{EPA 8081} Endosulfan I
{EPA 8081} Endosulfan II
{EPA 8081} Endosulfan Sulfate
{EPA 8081} Endrin
{EPA 8081} Endrin aldehyde
{EPA 8081} Endrin ketone
{EPA 8081} g-Chlordane
{EPA 8081} gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)
{EPA 8081} Heptachlor
{EPA 8081} Heptachlor epoxide
{EPA 8081} Hexachlorobenzene
{EPA 8081} Isodrin
{EPA 8081} Methoxychlor
{EPA 8081} Mirex
{EPA 8081} Toxaphene
{EPA 8082} PCB-1016
{EPA 8082} PCB-1221
{EPA 8082} PCB-1232
{EPA 8082} PCB-1242
{EPA 8082} PCB-1248
{EPA 8082} PCB-1254
{EPA 8082} PCB-1260
{EPA 8141} Atrazine
{EPA 8141} Azinphos-ethyl (Ethyl guthion)
{EPA 8141} Azinphos-methyl (Guthion)
{EPA 8141} Bolstar (Sulprofos)
{EPA 8141} Carbophenothion
{EPA 8141} Chlorpyrifos
{EPA 8141} Coumaphos
{EPA 8141} Demeton-o
{EPA 8141} Demeton-s
{EPA 8141} Diazinon
{EPA 8141} Dichlorovos (DDVP, Dichlorvos)
{EPA 8141} Dimethoate
{EPA 8141} Disulfoton

{EPA 8141} EPN
{EPA 8141} Ethoprop
{EPA 8141} Famphur
{EPA 8141} Fensulfothion
{EPA 8141} Fenthion
{EPA 8141} Malathion
{EPA 8141} Merphos
{EPA 8141} Mevinphos
{EPA 8141} Naled
{EPA 8141} Parathion ethyl
{EPA 8141} Parathion methyl
{EPA 8141} Phorate
{EPA 8141} Phosmet (Imidan)
{EPA 8141} Ronnel
{EPA 8141} Simazine
{EPA 8141} Stirophos
{EPA 8141} Tetraethyl dithiopyrophosphate (Sulfotepp)
{EPA 8141} Thionazine
{EPA 8141} Tokuthion
{EPA 8141} Trichloronate
{EPA 8151} 2,4-D
{EPA 8151} 2,4-DB
{EPA 8151} 2,4,5-T
{EPA 8151} 2,4,5-TP (Silvex)
{EPA 8151} Dalapon
{EPA 8151} Dicamba
{EPA 8151} Dichlorprop
{EPA 8151} Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)
{EPA 8151} MCPA
{EPA 8151} MCPP
{EPA 8151} Picloram

**ORGANIC CHEMISTRY (MEASUREMENT BY GC/MS)
{EPA 8270} 1-Chloronaphthalene
{EPA 8270} 1-Naphthylamine
{EPA 8270} 1,2-Dichlorobenzene
{EPA 8270} 1,2-Diphenylhydrazine
{EPA 8270} 1,2,4-Trichlorobenzene
{EPA 8270} 1,2,4,5-Tetrachlorobenzene
{EPA 8270} 1,3-Dichlorobenzene
{EPA 8270} 1,3-Dinitrobenzene
{EPA 8270} 1,3,5-Trinitrobenzene
{EPA 8270} 1,4-Dichlorobenzene
{EPA 8270} 1,4-Dinitrobenzene
{EPA 8270} 1,4-Naphthoquinone
{EPA 8270} 1,4-Phenylenediamine
{EPA 8270} 2-Acetylaminofluorene
{EPA 8270} 2-Chloronaphthalene
{EPA 8270} 2-Chlorophenol
{EPA 8270} 2-Methyl-4,6-Dinitrophenol
{EPA 8270} 2-Methylnaphthalene
{EPA 8270} 2-Methylphenol (o-Cresol)
{EPA 8270} 2-Naphthylamine
{EPA 8270} 2-Nitroaniline
{EPA 8270} 2-Nitrophenol
{EPA 8270} 2-Picoline
{EPA 8270} 2,3,4,6-Tetrachlorophenol
{EPA 8270} 2,4-Dichlorophenol
{EPA 8270} 2,4-Dimethylphenol
{EPA 8270} 2,4-Dinitrophenol
{EPA 8270} 2,4-Dinitrotoluene (2,4-DNT)
{EPA 8270} 2,4,5-Trichlorophenol
{EPA 8270} 2,4,6-Trichlorophenol
{EPA 8270} 2,6-Dichlorophenol

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{EPA 8270} 2,6-Dinitrotoluene
{EPA 8270} 3-Methylcholanthrene
{EPA 8270} 3-Methylphenol (m-Cresol)
{EPA 8270} 3-Nitroaniline
{EPA 8270} 3,3'-Dichlorobenzidine
{EPA 8270} 3,3'-Dimethylbenzidine
{EPA 8270} 4-Aminobiphenyl
{EPA 8270} 4-Bromophenyl phenyl ether
{EPA 8270} 4-Chloro-3-methylphenol
{EPA 8270} 4-Chloroaniline
{EPA 8270} 4-Chlorophenyl phenyl ether
{EPA 8270} 4-Methylphenol (p-Cresol)
{EPA 8270} 4-Nitroaniline
{EPA 8270} 4-Nitrophenol
{EPA 8270} 4,4'-Methylenebis(2-chloroaniline)
{EPA 8270} 5-Nitro-o-toluidine
{EPA 8270} 7,12-Dimethylbenz(a)anthracene
{EPA 8270} Acenaphthene
{EPA 8270} Acenaphthylene
{EPA 8270} Acetophenone
{EPA 8270} alpha-alpha-Dimethylphenethylamine
{EPA 8270} Aniline
{EPA 8270} Anthracene
{EPA 8270} Aramite
{EPA 8270} Benzidine
{EPA 8270} Benzoic acid
{EPA 8270} Benzo(a)anthracene
{EPA 8270} Benzo(a)pyrene
{EPA 8270} Benzo(b)fluoranthene
{EPA 8270} Benzo(g,h,i)perylene
{EPA 8270} Benzo(k)fluoranthene
{EPA 8270} Benzyl alcohol
{EPA 8270} Bis(2-chloroethoxy)methane
{EPA 8270} Bis(2-chloroethyl)ether
{EPA 8270} Bis(2-chloroisopropyl)ether
{EPA 8270} Bis(2-ethylhexyl)phthalate
{EPA 8270} Butyl benzyl phthalate
{EPA 8270} Chlorobenzilate
{EPA 8270} Chrysene
{EPA 8270} Di-n-butyl phthalate
{EPA 8270} Di-n-octyl phthalate
{EPA 8270} Diallate
{EPA 8270} Dibenzofuran
{EPA 8270} Dibenzo(a,h)anthracene
{EPA 8270} Dibenz(a,j)acridine
{EPA 8270} Diethyl phthalate
{EPA 8270} Dimethoate
{EPA 8270} Dimethyl phthalate
{EPA 8270} Disulfoton
{EPA 8270} Ethyl methanesulfonate
{EPA 8270} Famphur
{EPA 8270} Fluoranthene
{EPA 8270} Fluorene
{EPA 8270} Hexachlorobenzene
{EPA 8270} Hexachlorobutadiene
{EPA 8270} Hexachlorocyclopentadiene
{EPA 8270} Hexachloroethane
{EPA 8270} Hexachloropropene
{EPA 8270} Indeno(1,2,3-cd) pyrene
{EPA 8270} Isodrin
{EPA 8270} Isophorone
{EPA 8270} Isosafrole
{EPA 8270} Methapyrilene
{EPA 8270} Methylmethanesulfonate

{EPA 8270} N-nitroso-di-n-butylamine (NDBA)
{EPA 8270} N-nitroso-di-n-propylamine (NDPA)
{EPA 8270} N-nitrosodiethylamine (NDEA)
{EPA 8270} N-nitrosodimethylamine (NDMA)
{EPA 8270} N-Nitrosodiphenylamine
{EPA 8270} N-Nitrosomethylethylamine
{EPA 8270} N-Nitrosomorpholine
{EPA 8270} N-Nitrosopiperidine
{EPA 8270} N-Nitrosopyrrolidine
{EPA 8270} Naphthalene
{EPA 8270} Nitrobenzene
{EPA 8270} Nitroquinoline-1-oxide
{EPA 8270} o-Toluidine
{EPA 8270} O,O,O-Triethylphosphorothioate
{EPA 8270} Parathion ethyl
{EPA 8270} Parathion methyl
{EPA 8270} Pentachlorobenzene
{EPA 8270} Pentachloronitrobenzene (PCNB)
{EPA 8270} Pentachlorophenol
{EPA 8270} Phenacetin
{EPA 8270} Phenanthrene
{EPA 8270} Phenol
{EPA 8270} Phorate
{EPA 8270} Phthalic anhydride
{EPA 8270} Pyrene
{EPA 8270} Pyridine
{EPA 8270} Safrole
{EPA 8270} Tetraethyl dithiopyrophosphate (Sulfotepp)
{EPA 8270} Thionazine
{EPA 8270} Tris(2,3-dibromopropyl)phosphate

**ORGANIC CHEMISTRY (MEASUREMENT BY HPLC)
{EPA 8310} Acenaphthene
{EPA 8310} Acenaphthylene
{EPA 8310} Anthracene
{EPA 8310} Benzo(a)anthracene
{EPA 8310} Benzo(a)pyrene
{EPA 8310} Benzo(b)fluoranthene
{EPA 8310} Benzo(g,h,i)perylene
{EPA 8310} Benzo(k)fluoranthene
{EPA 8310} Chrysene
{EPA 8310} Dibenzo(a,h)anthracene
{EPA 8310} Fluoranthene
{EPA 8310} Fluorene
{EPA 8310} Indeno(1,2,3-cd) pyrene
{EPA 8310} Naphthalene
{EPA 8310} Phenanthrene
{EPA 8310} Pyrene
{EPA 8330} 1,3-Dinitrobenzene
{EPA 8330} 1,3,5-Trinitrobenzene
{EPA 8330} 2-Amino-4,6-dinitrotoluene
{EPA 8330} 2-Nitrotoluene (ortho-Nitrotoluene)
{EPA 8330} 2,4-Dinitrotoluene (2,4-DNT)
{EPA 8330} 2,4,6-Trinitrotoluene (TNT)
{EPA 8330} 2,6-Dinitrotoluene
{EPA 8330} 3-Nitrotoluene (meta-Nitrotoluene)
{EPA 8330} 4-Amino-2,6-dinitrotoluene
{EPA 8330} 4-Nitrotoluene (para-Nitrotoluene)
{EPA 8330} Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
{EPA 8330} Methyl-2,4,6-trinitrophenylnitramine
{EPA 8330} Nitrobenzene
{EPA 8330} Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)

**TOTAL PETROLEUM HYDROCARBONS

{EPA 8015} DRO
{EPA 8015} GRO

End of Parameter List

Attachment 3

Reference Limits and Project Screening Levels

Attachment 3 - Table 1 Reference Limits and and Project Screening Levels
Matrix: Soil
Analytical Group: Metals by SW6020A-Strother Field Disposal Area RI, KS

			Laboratory Specific Limits			Control Limits		Project Action Levels							
								Human Heath				Ecological	Soil Leaching to Groundwater		
Analyte	CAS Number	Units	Lab LOQ	Lab LOD	Lab DL	Accuracy (%R)	Precision (% RPD)	2015 EPA Residential RSL (THQ=0.1; TR=1E-06)[a]		2015 EPA Industrial RSL (THQ=0.1; TR=1E-06)[a]		EPA Eco-SSL[b]	2015 EPA MCL-Based SSL (THQ=0.1; TR=1E-06)[a]	2015 EPA Risk-Based SSL (THQ=0.1; TR=1E-06)[a]	
Antimony	7440-36-0	mg/kg	0.2	0.05	0.014	72 - 124	20	3.1	n	47	n	0.27	0.27	NA	
Copper	7440-50-8	mg/kg	2.5	0.2	0.0711	84 - 119	20	310	n	4,700	n	28	46	NA	
Lead	7439-92-1	mg/kg	0.4	0.07	0.0182	84 - 118	20	400	L	800	L	11	14	NA	
Zinc	7440-66-6	mg/kg	2.5	0.95	0.316	82 - 119	20	2,300	n	35,000	n	46	NP	37	n

Notes:
Control limits are laboratory provided acceptance criteria; set at DOD QSM criteria.
Less than the LOD but greater than the DL
Less than the LOQ but greater than the LOD
%R - percent recovery
c - carcinogen, EPA RSLs based on a TR of 1E-06, KDHE values based on 1E-05
CAS - Chemical Abstract Service
DL - detection limit
EPA - United States Environmental Protection Agency
L - As recommended in the RSL User's Guide (EPA, May 2016), the residential lead soil level of 400 mg/kg will be used to screen the soil/sediment.
LOD - limit of detection
LOQ - limit of quantification
MCL - Maximum contaminant level
mg/kg - milligram per kilogram
n - noncancer; EPA RSLs based on THQ of 0.1, KDHE values based on THQ = 1
NA - Not applicable, MCL-based SSL available
NP - not published
RPD - Relative Percent Difference
RSL - Regional Screening Level
SSL - Soil Screening Level
THQ - target hazard quotient
TR - target risk level

[a] - EPA May 2016 Regional Screening Level (http://www2.epa.gov/risk/risk-based-screening-table-generic-tables)
[b] - EPA Ecological Soil Screening Level; available online at: https://www.epa.gov/risk/ecological-soil-screening-level-eco-ssl-guidance-and-documents

Attachment 3 - Table 2 Reference Limits and Project Screening Levels
Matrix: Sediment
Analytical Group: Metals by SW6020A-Strother Field Disposal Area RI, KS

			Laboratory Specific Limits			Control Limits		Project Action Levels					
								Human Heath		Ecological			
Analyte	CAS Number	Units	Lab LOQ	Lab LOD	Lab DL	Accuracy (%R)	Precision (% RPD)	2015 EPA Residential RSL (THQ=0.1; TR=1E-06)[a]		Threshold Effect Concentration[b]	Probable Effect Concentration[b]	Effects Range Low[c]	Effects Range Median[c]
Antimony	7440-36-0	mg/kg	0.2	0.05	0.014	72 - 124	20	3.1	n	NP	NP	2	25
Copper	7440-50-8	mg/kg	2.5	0.2	0.0711	84 - 119	20	310	n	31.6	149	70	390
Lead	7439-92-1	mg/kg	0.4	0.07	0.0182	84 - 118	20	400	L	35.8	128	35	110
Zinc	7440-66-6	mg/kg	2.5	0.95	0.316	82 - 119	20	2,300	n	121	459	120	270

Notes:

Control limits are laboratory provided acceptance criteria set at DOD QSM criteria.
Less than the LOQ but greater than the LOD
c - carcinogen, EPA RSLs based on a TR of 1E-06, KDHE values based on 1E-05
%R - percent recovery
CAS - Chemical Abstract Service
DL - detection limit
EPA - United States Environmental Protection Agency
L - As recommended in the RSL User's Guide (EPA, May 2016), the residential lead soil level of 400 mg/kg will be used to screen the soil/sediment.
LOD - limit of detection
LOQ - limit of quantification
mg/kg - milligram per kilogram
n - noncancer; EPA RSLs based on THQ of 0.1, KDHE values based on THQ = 1
NP - not published
RPD - Relative Percent Difference
RSL - Regional Screening Level
THQ - target hazard quotient
TR - target risk level

[a] - EPA May 2016 Regional Screening Level (http://www2.epa.gov/risk/risk-based-screening-table-generic-tables)

[b] MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39: 20-31.

[c] Long, E.R. and L.G. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the national status and trends program. NOAA Technical Memorandum NOS OMA 52.

Attachment 3 - Table 3 Reference Limits and Project Screening Levels
Matrix: Surface Water
Analytical Group: Metals by SW6020A-Strother Field Disposal Area RI, KS

			Laboratory Specific Limits			Control Limits		Project Action Levels		
Analyte	CAS Number	Units	Lab LOQ	Lab LOD	Lab DL	Accuracy (%R)	Precision (% RPD)	NRWQC for Human Health Water + Organism [a]	2015 EPA Tapwater RSL (THQ=0.1; TR=1E-06)[b]	
Antimony	7440-36-0	ug/L	6	1	0.4	85 - 117	20	5.6	0.78	n
Copper	7440-50-8	ug/L	2	1.8	0.56	85 - 118	20	1300	80	n
Lead	7439-92-1	ug/L	3	0.7	0.18	88 - 115	20	NP	15	L
Zinc	7440-66-6	ug/L	20	8	2	83 - 119	20	7400	600	n

Notes:
Control limits are laboratory provided acceptance criteria. Lab limits are set at DOD QSM criteria when published. If no QSM criteria are published, then the lab limits are in-house limits.
Less than the DL
Less than the LOD but greater than the DL
Less than the LOQ but greater than the LOD

%R - percent recovery
c - carcinogen, EPA RSLs based on a TR of 1E-06
CAS - Chemical Abstract Service
DL - detection limit
EPA - United States Environmental Protection Agency
L - As recommended in the RSL User's Guide (EPA, May 2016), the residential lead water level of 15 ug/L will be used to screen surface water.
LOD - limit of detection
LOQ - limit of quantification
n - noncancer; EPA RSLs based on THQ of 0.1
NP - not published
RPD - Relative Percent Difference
ug/L - microgram per liter

a - National Recommended Water Quality Criteria, Aquatic Life Criteria Table and Human Health Criteria Table: https://www.epa.gov/wqc/national-recommended-water-quality-criteria
b - EPA May 2016 Regional Screening Level (http://www2.epa.gov/risk/risk-based-screening-table-generic-tables)

Attachment 3 - Table 4 Reference Limits and Project Screening Levels
Matrix: Soil
Analytical Group: Explosives by SW8330B-Strother Field Disposal Area RI, KS

			Laboratory Specific Limits			Control Limits		Project Action Levels					
								Human Health		Ecological		Soil Leaching to	
Analyte	CAS Number	Units	Lab LOQ	Lab LOD	Lab DL	Accuracy (%R)	Precision (% RPD)	2015 EPA Residential RSL (THQ=0.1; TR=1E-06)[a]	2015 EPA Industrial RSL (THQ=0.1; TR=1E-06)[a]	Mammal Soil Benchmark[b]	Avian Soil Benchmark[b]	2015 EPA MCL-Based SSL (THQ=0.1; TR=1E-06)[a]	2015 EPA Risk-Based SSL (THQ=0.1; TR=1E-06)[a]
1,3,5-Trinitrobenzene	99-35-4	mg/kg	0.1	0.04	0.0138	80 - 116	20	220 n	3,200 n	120	NP	NP	0.21 n
1,3-Dinitrobenzene	99-65-0	mg/kg	0.1	0.04	0.0166	73 - 119	20	0.63 n	8.2 n	0.073	0.079	NP	0.00018 n
2,4,6-Trinitrotoluene	118-96-7	mg/kg	0.1	0.1	0.0307	71 - 120	20	21 c 3.6 n	96 c 51 n	NP	7.6	NP	0.0057 n
2,4-Dinitrotoluene	121-14-2	mg/kg	0.1	0.04	0.0147	75 - 121	20	1.7 c 13 n	7.4 c 160 n	13	96	NP	0.00032 c
2,6-Dinitrotoluene	606-20-2	mg/kg	0.1	0.04	0.0191	79 - 117	20	0.36 c 1.9 n	1.5 c 25 n	4.1	52	NP	0.000067 c
2-Amino-4,6-dinitrotoluene	35572-78-2	mg/kg	0.1	0.1	0.0329	71 - 123	20	15 n	230 n	12	NP	NP	0.003 n
4-Amino-2,6-dinitrotoluene	19406-51-0	mg/kg	0.1	0.1	0.0299	64 - 127	20	15 n	230 n	14	NP	NP	0.003 n
HMX	2691-41-0	mg/kg	0.1	0.04	0.0227	74 - 124	20	390 n	5700 n	300	NP	NP	0.13 n
3-Nitrotoluene	99-08-1	mg/kg	0.2	0.1	0.064	67 - 129	20	0.63 n	8.2 n	12	NP	NP	0.00016 n
Nitrobenzene	98-95-3	mg/kg	0.3	0.1	0.085	67 - 129	20	5.1 c 13 n	22 c 130 n	4.9	NP	NP	0.000092 c
Nitroglycerin	55-63-0	mg/kg	2	0.4	0.215	73 - 124	20	32 c 0.63 n	140 c 8.2 n	71	NP	NP	0.000085 n
2-Nitrotoluene	88-72-2	mg/kg	0.2	0.1	0.0472	70 - 124	20	3.2 c 7 n	15 c 110 n	9.9	NP	NP	0.0003 c
PETN	78-11-5	mg/kg	2	1	0.493	72 - 128	20	140 c 13 n	570 c 160 n	100	NP	NP	0.0058 n
Picric acid	88-89-1	mg/kg	0.1	0.1	0.0563	38 - 154	20	5.7 n	74 n	NP	NP	NP	0.0084 n
4-Nitrotoluene	99-99-0	mg/kg	0.2	0.1	0.0365	71 - 124	20	34 c 25 n	140 c 330 n	22	NP	NP	0.004 c
RDX	121-82-4	mg/kg	0.2	0.1	0.043	67 - 129	20	6.1 c 23 n	28 c 330 n	16	2.3	NP	0.00027 c
Tetryl	479-45-8	mg/kg	0.2	0.1	0.0439	68 - 135	20	16 n	230 n	1.5	NP	NP	0.037 n

Notes:
Control limits are laboratory provided acceptance criteria. Lab limits are set at DOD QSM criteria when published. If no QSM criteria are published, then the lab limits are in-house limits

Less than the DL
Less than the LOD but greater than the DL
Less than the LOQ but greater than the LOD

%R - percent recovery
c - carcinogen, EPA RSLs based on a TR of 1E-06, KDHE values based on 1E-05
CAS - Chemical Abstract Service
cs - The value is based upon health risk; however, the calculated saturation value is lower than the health risk value
DL - detection limit
EPA - United States Environmental Protection Agency
LOD - limit of detection
LOQ - limit of quantification
MCL - Maximum contaminant level
mg/kg - milligram per kilogram
n - noncancer; EPA RSLs based on THQ of 0.1, KDHE values based on THQ = 1
ns - The value is based upon health risk; however, the calculated saturation value is lower than the health risk value
NP - not published
RPD - Relative Percent Difference
RSL - Regional Screening Level
SSL - Soil Screening Level
THQ - target hazard quotient
TR - target risk level

[a] - EPA May 2016 Regional Screening Level (http://www2.epa.gov/risk/risk-based-screening-table-generic-tables)

[b] Los Alamos National Laboratory (LANL). 2015. ECORISK Database Release 3.3. Environmental Programs, Engineering and Technology Division. October 2015. http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php

Attachment 3 - Table 5 Reference Limits and Project Screening Levels
Matrix: Sediment
Analytical Group: Explosives by SW8330B-Strother Field Disposal Area RI, KS

			Laboratory Specific Limits			Control Limits		Project Action Levels	
								Human	Ecological
Analyte	CAS Number	Units	Lab LOQ	Lab LOD	Lab DL	Accuracy (%R)	Precision (% RPD)	2015 EPA Residential RSL (THQ=0.1; TR=1E-06)[a]	Freshwater Sediment ESV[b]
1,3,5-Trinitrobenzene	99-35-4	mg/kg	0.1	0.04	0.0138	80 - 116	20	220 n	0.012
1,3-Dinitrobenzene	99-65-0	mg/kg	0.1	0.04	0.0166	73 - 119	20	0.63 n	0.034
2,4,6-Trinitrotoluene	118-96-7	mg/kg	0.1	0.1	0.0307	71 - 120	20	21 c 3.6 n	0.023
2,4-Dinitrotoluene	121-14-2	mg/kg	0.1	0.04	0.0147	75 - 121	20	1.7 c 13 n	0.127
2,6-Dinitrotoluene	606-20-2	mg/kg	0.1	0.04	0.0191	79 - 117	20	0.36 c 1.9 n	0.271
2-Amino-4,6-dinitrotoluene	35572-78-2	mg/kg	0.1	0.1	0.0329	71 - 123	20	15 n	0.041
4-Amino-2,6-dinitrotoluene	19406-51-0	mg/kg	0.1	0.1	0.0299	64 - 127	20	15 n	0.025
HMX	2691-41-0	mg/kg	0.1	0.04	0.0227	74 - 124	20	390 n	0.042
3-Nitrotoluene	99-08-1	mg/kg	0.2	0.1	0.064	67 - 129	20	0.63 n	0.133
Nitrobenzene	98-95-3	mg/kg	0.3	0.1	0.085	67 - 129	20	5.1 c 13 n	0.559
Nitroglycerin	55-63-0	mg/kg	2	0.4	0.215	73 - 124	20	32 c 0.63 n	0.0049
2-Nitrotoluene	88-72-2	mg/kg	0.2	0.1	0.0472	70 - 124	20	3.2 c 7 n	0.185
PETN	78-11-5	mg/kg	2	1	0.493	72 - 128	20	140 c 13 n	NP
Picric acid	88-89-1	mg/kg	0.1	0.1	0.0563	38 - 154	20	5.7 n	NP
4-Nitrotoluene	99-99-0	mg/kg	0.2	0.1	0.0365	71 - 124	20	34 c 25 n	0.131
RDX	121-82-4	mg/kg	0.2	0.1	0.043	67 - 129	20	6.1 c 23 n	0.041
Tetryl	479-45-8	mg/kg	0.2	0.1	0.0439	68 - 135	20	16 n	NP

Notes:
Control limits are laboratory provided acceptance criteria. Lab limits are set at DOD QSM criteria when published. If no QSM criteria are published, then the lab limits are in-house limits.

Less than the DL
Less than the LOD but greater than the DL
Less than the LOQ but greater than the LOD

%R - percent recovery
c - carcinogen, EPA RSLs based on a TR of 1E-06, KDHE values based on 1E-05
CAS - Chemical Abstract Service
DL - detection limit
EPA - United States Environmental Protection Agency
ESV - Ecological Screening Value
LOD - limit of detection
LOQ - limit of quantification
mg/kg - milligram per kilogram
n - noncancer; EPA RSLs based on THQ of 0.1, KDHE values based on THQ = 1
ns - The value is based upon health risk; however, the calculated saturation value is lower than the health risk value
NP - not published
RPD - Relative Percent Difference
RSL - Regional Screening Level
THQ - target hazard quotient
TR - target risk level

[a] EPA May 2016 Regional Screening Level (http://www2.epa.gov/risk/risk-based-screening-table-generic-tables)

[b] EPA Region 4 2015 surface water and sediment ecological screening values for explosives (Region 4 Ecological Risk Assessment Supplemental Guidance Interim Draft)

Attachment 3 - Table 6 Reference Limits and Project Screening Levels
Matrix: Surface Water
Analytical Group: Explosives by SW8330B-Strother Field Disposal Area RI, KS

			Laboratory Specific Limits			Control Limits		Project Action Levels				
								Human Health		Ecological		
Analyte	CAS Number	Units	Lab LOQ	Lab LOD	Lab DL	Accuracy (%R)	Precision (% RPD)	NRWQC for Human Health Water + Organism [c]	2015 EPA Tapwater RSL (THQ=0.1; TR=1E-06)[d]	Freshwater Surface Water Screening Values - Acute[a]	Freshwater Surface Water Screening Values - Chronic[b]	EPA Region 3 BTAG Freshwater Benchmark[d]
1,3,5-Trinitrobenzene	99-35-4	ug/L	1	0.4	0.2	73 - 125	20	NP	59 n	27	11	NA
1,3-Dinitrobenzene	99-65-0	ug/L	0.4	0.2	0.0887	78 - 120	20	NP	0.2 n	100	22	NA
2,4,6-Trinitrotoluene	118-96-7	ug/L	0.4	0.2	0.0724	71 - 123	20	NP	0.98 n	120	13	NA
2,4-Dinitrotoluene	121-14-2	ug/L	0.4	0.2	0.0838	78 - 120	20	0.049	0.24 c	390	44	NA
2,6-Dinitrotoluene	606-20-2	ug/L	0.2	0.2	0.0645	77 - 127	20	NP	0.049 c	730	81	NA
2-Amino-4,6-dinitrotoluene	35572-78-2	ug/L	0.2	0.12	0.0507	79 - 120	20	NP	3.9 n	160	18	NA
4-Amino-2,6-dinitrotoluene	19406-51-0	ug/L	0.2	0.12	0.0577	76 - 125	20	NP	3.9 n	98	11	NA
HMX	2691-41-0	ug/L	0.4	0.2	0.0876	65 - 135	20	NP	100 n	1200	220	NA
3-Nitrotoluene	99-08-1	ug/L	0.4	0.2	0.0834	73 - 125	20	NP	0.17 n	380	42	NA
Nitrobenzene	98-95-3	ug/L	0.4	0.2	0.091	65 - 134	20	10	0.14 c	2000	380	NA
Nitroglycerin	55-63-0	ug/L	3	2	0.921	74 - 127	20	NP	0.2 n	160	18	NA
2-Nitrotoluene	88-72-2	ug/L	0.4	0.2	0.0855	70 - 127	20	NP	0.31 c	640	71	NA
PETN	78-11-5	ug/L	2	1.2	0.416	73 - 127	20	NP	3.9 n	NP	NP	85000
Picric Acid	88-89-1	ug/L	0.4	0.12	0.0436	80 - 120	20	NP	1.8 n	NP	NP	NP
4-Nitrotoluene	99-99-0	ug/L	1	0.4	0.2	71 - 127	20	NP	4.3 c	410	46	NA
RDX	121-82-4	ug/L	0.2	0.12	0.0523	68 - 130	20	NP	0.7 c	520	79	NA
Tetryl	479-45-8	ug/L	0.24	0.2	0.0793	64 - 128	20	NP	3.9 n	NP	NP	NP

Notes:
Control limits are laboratory provided acceptance criteria. Lab limits are set at DOD QSM criteria when published. If no QSM criteria are published, then the lab limits are in-house limits.

Less than the DL
Less than the LOD but greater than the DL
Less than the LOQ but greater than the LOD

BTAG - Biological Technical Assistance Group
c - carcinogen, EPA RSLs based on a TR of 1E-06
CAS - Chemical Abstract Service
DL - detection limit
EPA - United States Environmental Protection Agency
LOD - limit of detection
LOQ - limit of quantification
MCL - Maximum contaminant level
n - noncancer; EPA RSLs based on THQ of 0.1
NA - not applicable; only used if other sources are not available
NP - not published
THQ - target hazard quotient
TR - target risk level
ug/L - microgram per liter

[a] EPA Region 4 2015 surface water and sediment ecological screening values for explosives (Region 4 Ecological Risk Assessment Supplemental Guidance Interim Draft)
[b] EPA July 2006 Region 3 BTAG Freshwater Benchmarks. http://www2.epa.gov/sites/production/files/2015-09/documents/r3_btag_fw_benchmarks_07-06.pdf
[c] - National Recommended Water Quality Criteria, Aquatic Life Criteria Table and Human Health Criteria Table: https://www.epa.gov/wqc/national-recommended-water-quality-criteria
[d] - EPA May 2016 Regional Screening Level (http://www2.epa.gov/risk/risk-based-screening-table-generic-tables)

Attachment 4

Laboratory Reference and Control Limits

ATTACHMENT 4

Laboratory MDLs, RL, and Contol Limits-Strother Field Disposal Area RI, KS

Analysis Group	Method Description	Method Code	Prep Method	Analyte Description	CAS Number	RL	MDL	LOD	Units	LCS - Low	LCS - High	LCS - RPD %	MS - Low	MS - High	MS - RPD %	Surrogate Low	Surrogate High
Solid	Nitroaromatics and Nitramines (HPLC)	8330B_DOD5	8330B_Sonc_10g/ ISM_DD_SI_SS	1,3,5-Trinitrobenzene	99-35-4	0.100	0.0138	0.0400	mg/Kg	80	116	20	80	116	20		
				1,3-Dinitrobenzene	99-65-0	0.100	0.0166	0.0400	mg/Kg	73	119	20	73	119	20		
				2,4,6-Trinitrotoluene	118-96-7	0.100	0.0307	0.100	mg/Kg	71	120	20	71	120	20		
				2,4-Dinitrotoluene	121-14-2	0.100	0.0147	0.0400	mg/Kg	75	121	20	75	121	20		
				2,6-Dinitrotoluene	606-20-2	0.100	0.0191	0.0400	mg/Kg	79	117	20	79	117	20		
				2-Amino-4,6-dinitrotoluene	35572-78-2	0.100	0.0329	0.100	mg/Kg	71	123	20	71	123	20		
				4-Amino-2,6-dinitrotoluene	19406-51-0	0.100	0.0299	0.100	mg/Kg	64	127	20	64	127	20		
				HMX	2691-41-0	0.100	0.0227	0.0400	mg/Kg	74	124	20	74	124	20		
				m-Nitrotoluene	99-08-1	0.200	0.0640	0.100	mg/Kg	67	129	20	67	129	20		
				Nitrobenzene	98-95-3	0.300	0.0850	0.100	mg/Kg	67	129	20	67	129	20		
				Nitroglycerin	55-63-0	2.00	0.215	0.400	mg/Kg	73	124	20	73	124	20		
				o-Nitrotoluene	88-72-2	0.200	0.0472	0.100	mg/Kg	70	124	20	70	124	20		
				PETN	78-11-5	2.00	0.493	1.00	mg/Kg	72	128	20	72	128	20		
				Picric acid	88-89-1	0.100	0.0563	0.100	mg/Kg	38	154	20	38	154	20		
				p-Nitrotoluene	99-99-0	0.200	0.0365	0.100	mg/Kg	71	124	20	71	124	20		
				RDX	121-82-4	0.200	0.0430	0.100	mg/Kg	67	129	20	67	129	20		
				Tetryl	479-45-8	0.200	0.0439	0.100	mg/Kg	68	135	20	68	135	20		
				1,2-Dinitrobenzene	528-29-0	0.100	0.0190	0.0400	mg/Kg							78	119
Solid	pH	9045C	DI_LEACH_NP	pH adj. to 25 deg C	STL00204	0.100		0.100	SU	97	103	5					
				Temperature	STL00038	1.00		1.00	Degrees C								
Solid	Metals (ICP/MS)	6020A_DOD5	3050B	Antimony	7440-36-0	0.2	0.014	0.05	mg/Kg	72	124	20	72	124	20		
				Copper	7440-50-8	2.50	0.0711	0.200	mg/Kg	84	119	20	84	119	20		
				Lead	7439-92-1	0.400	0.0182	0.0700	mg/Kg	84	118	20	84	118	20		
				Zinc	7440-66-6	2.50	0.316	0.950	mg/Kg	82	119	20	82	119	20		
Aqueous	Nitroaromatics and Nitramines (HPLC)	8330B_DOD5	3535	1,3,5-Trinitrobenzene	99-35-4	1.00	0.200	0.400	ug/L	73	125	20	73	125	20		
				1,3-Dinitrobenzene	99-65-0	0.400	0.0887	0.200	ug/L	78	120	20	78	120	20		
				2,4,6-Trinitrotoluene	118-96-7	0.400	0.0724	0.200	ug/L	71	123	20	71	123	20		
				2,4-Dinitrotoluene	121-14-2	0.400	0.0838	0.200	ug/L	78	120	20	78	120	20		
				2,6-Dinitrotoluene	606-20-2	0.200	0.0645	0.200	ug/L	77	127	20	77	127	20		
				2-Amino-4,6-dinitrotoluene	35572-78-2	0.200	0.0507	0.120	ug/L	79	120	20	79	120	20		
				4-Amino-2,6-dinitrotoluene	19406-51-0	0.200	0.0577	0.120	ug/L	76	125	20	76	125	20		
				HMX	2691-41-0	0.400	0.0876	0.200	ug/L	65	135	20	65	135	20		
				m-Nitrotoluene	99-08-1	0.400	0.0834	0.200	ug/L	73	125	20	73	125	20		
				Nitrobenzene	98-95-3	0.400	0.0910	0.200	ug/L	65	134	20	65	134	20		
				Nitroglycerin	55-63-0	3.00	0.921	2.00	ug/L	74	127	20	74	127	20		
				o-Nitrotoluene	88-72-2	0.400	0.0855	0.200	ug/L	70	127	20	70	127	20		
				PETN	78-11-5	2.00	0.416	1.20	ug/L	73	127	20	73	127	20		
				Picric acid	88-89-1	0.400	0.0436	0.120	ug/L	80	120	20	80	120	20		
				p-Nitrotoluene	99-99-0	1.00	0.200	0.400	ug/L	71	127	20	71	127	20		
				RDX	121-82-4	0.200	0.0523	0.120	ug/L	68	130	20	68	130	20		
				Tetryl	479-45-8	0.240	0.0793	0.200	ug/L	64	128	20	64	128	20		
				1,2-Dinitrobenzene	528-29-0	0.200	0.0500	0.120	ug/L							83	119
Aqueous	pH	9040B		pH adj. to 25 deg C	STL00204	0.100		0.100	SU	99	101	5					
				Temperature	STL00038	1.00		1.00	Degrees C								
Aqueous	Metals (ICP/MS)	6020A_DOD5	3020A	Antimony	7440-36-0	6.00	0.400	1.00	ug/L	85	117	20	85	117	20		
				Copper	7440-50-8	2.00	0.56	1.80	ug/L	85	118	20	85	118	20		
				Lead	7439-92-1	3.00	0.18	0.70	ug/L	88	115	20	88	115	20		
				Zinc	7440-66-6	20.00	2.00	8.00	ug/L	83	119	20	83	119	20		

Attachment 5

Laboratory Standard Operating Procedures

TestAmerica Denver

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Title: Acid Digestion of Aqueous Samples for Metals Analysis by ICP

Approvals (Signature/Date):

Doug Gomer	6/26/15	Adam W Alban	26 June 15
Doug Gomer Technical Specialist	Date	Adam Alban Health & Safety Manager / Coordinator	Date
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1.0 Scope and Application

1.1 This standard operating procedure (SOP) describes the acid digestion of aqueous samples by EPA Method 200.7, SW-846 Method 3005A or SW-846 Method 3010A prior to the determination of the concentration of individual metallic elements by inductively coupled plasma atomic emission spectroscopy (ICP). These methods include digestions for total, total recoverable, dissolved, and potentially dissolved analytes (see definitions in Section 3).

1.2 This SOP is applicable to ground water, surface water, domestic and industrial wastewater, TCLP leachates, and other aqueous media. This SOP is not applicable to oils or other liquids that are not miscible with water.

NOTE: Samples that are found to be immiscible with water, e.g., contain oil or other immiscible organic solvents, are subcontracted to other labs that are capable of handling such samples. If during the preparation process it is discovered that the sample is immiscible with water or is biphasic, the analyst notifies the Technical Specialist and Project Manager, who can subcontract the samples to a laboratory with the capability to handle the sample.

1.3 The following table summarizes the applicability of the various digestion methods referenced in this SOP. All sample digestates are analyzed by ICP in accordance with SOPs DV-MT-0012, DV-MT-0019 and DV-MT-0021.

Method	Title	Summary	SOP Section
3005A/200.7_Prep	Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by ICP	Preparation of surface and ground water samples for total recoverable or dissolved metals for analysis by ICP.	10.5
3010A	Acid Digestion of Aqueous Samples and Extracts for Total Metals Analysis by ICP	Preparation of aqueous samples, EP and mobility procedure extracts, and wastes that contain suspended solids for total metals analysis by ICP.	10.7

1.4 Sample digestion requirements are established by the laboratory Project Manager before samples are received. TestAmerica LIMS (TALS) method codes are applied to samples at Login to indicate which digestion is to be used for each sample.

1.5 This procedure can be used for all of the elements listed in Table 1. Additional elements may be analyzed using the digestion methods in this SOP provided the method performance criteria specified in Section 12 and the Quality Control (QC) acceptance criteria specified in Section 9 of this SOP and the ICP determinative SOPs DV-MT-0012, DV-MT-0019 and DV-MT-0021 are met.

1.6 All samples require digestion prior to analysis, with the possible exception of "direct analysis" of dissolved metals in filtered and acidified aqueous samples. Although digestion is not specifically required by the method, some clients and regulators do require digestion of dissolved samples. This must be determined by the laboratory Project Manager before projects start, and is communicated to the analysts through Method Comments in TALS.

2.0 Summary of Method

2.1 Method 3005A/200.7_Prep, Total Recoverable, Dissolved Metals or Potentially Dissolved Metals

A representative portion of sample is heated with diluted nitric and hydrochloric acids until substantially reduced in volume. The digestate is filtered (if necessary) and diluted to volume.

2.2 Method 3010A Total Metals

A representative portion of sample is refluxed with nitric acid. This step is repeated until the digestate is light in color or until its color has stabilized. After the digestate has been reduced to a low volume, it is refluxed with hydrochloric acid, filtered (if necessary), and brought up to volume.

3.0 Definitions

3.1 Dissolved Analyte: The concentration of analyte in an aqueous sample that will pass through a 0.45-µm membrane filter prior to acidification (sample is acidified after filtration).

3.2 Potentially Dissolved Metals: The concentration of elements in solution after acidifying the sample with nitric acid to pH < 2, holding at room temperature for 8 to 96 hours, and then filtering through a 0.45-µm membrane filter. This definition is based on the Colorado surface water regulations.

3.3 Total Recoverable Analyte: The concentration of analyte determined by analysis of the solution extract of a solid sample or an unfiltered aqueous sample following digestion by refluxing with hot dilute mineral acid(s).

3.4 Total Metals: The concentration of elements in an unfiltered sample subject to a more rigorous nitric acid / hydrochloric acid digestion than is used for total recoverable metals.

3.5 General Analytical Terms: Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, “Quality Assurance Program,” for definitions of general analytical and QA/QC terms.

4.0 Interferences

4.1 Potential sources of trace metals contamination include metallic or metal-containing labware (e.g., talc powdered gloves which contain high levels of zinc), containers, impure reagents, dirty glassware, improper sample transfers, dirty work

areas, and atmospheric inputs such as dirt and dust, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.2 Physical interference effects may contribute to inaccuracies in the determinations of trace elements. Oils, solvents, and other matrices may not be digested using these methods if they are not miscible with acids. If physical interferences are present, they should be documented in the final report case narrative.

4.3 Visual interferences or anomalies (such as foaming, emulsions, precipitates, etc.) must be documented in the final report case narrative.

4.4 Allowing samples to boil or go dry during digestion may result in the loss of volatile metals. If this occurs, the sample must be re-prepared. Antimony is easily lost by volatilization from hydrochloric acid media.

4.5 Precipitation of silver chloride (AgCl) may occur when chloride ions and high concentrations of silver (i.e., greater than 1 mg/L) are present in the sample. Method 3005 or 3010 samples containing more than 1 mg/L silver are redigested at a reduced sample volume and reanalyzed to produce more accurate results. Method 200.7 requires samples to be redigested if the silver is greater than 0.1 mg/L.

4.6 Specific analytical interferences are discussed in the ICP determinative methods. See SOPs DV-MT-0012, DV-MT-0019, and DV-MT-0021.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.3.2 Samples that contain high concentrations of carbonates or organic material, or samples that are at elevated pH can react violently when acids are added.

5.3.3 Care must be taken when handling the digestion tubes. The tubes may become very hot during the digestion procedure. Allow the tubes to cool before attempting to touch the digested samples.

5.4 Primary Materials Used

5.4.1 The following is a list of the materials used in this method which have a serious or significant hazard rating.

5.4.2 A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time.

Material (1)	Hazards	Exposure Limit(2)	Signs and Symptoms of Exposure
Stock Standard Solutions	Oxidizer Corrosive Poison	5 mg/m^3 as HNO_3	Toxic. Causes irritation to the respiratory tract. Causes irritation. Symptoms include redness and pain. May cause burns. May cause sensitization. Can be absorbed through the skin with symptoms to parallel ingestion. May affect the central nervous system. Causes irritation and burns to eyes. Symptoms include redness, pain, and blurred vision; may cause serious and permanent eye damage.
Nitric Acid (HNO_3)	Corrosive Oxidizer Poison	2 ppm (TWA) 4 ppm (STEL)	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrochloric Acid (HCl)	Corrosive Poison	5 ppm (Ceiling)	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.

(1) Always add acid to water to prevent violent reactions.
(2) Exposure limit refers to the OSHA regulatory exposure limit.

6.0 EQUIPMENT AND SUPPLIES

6.1 Instrumentation

6.1.1 Digestion blocks, with adjustable heating, capable of maintaining a sample temperature of 90 - 95 °C.

6.1.2 Thermometer that covers a temperature range of at least 80 - 110 °C, in increments of 1 °C.

6.1.3 Liquid-filled thermometers must have a tag indicating that the accuracy was checked by the QA group within the last 12 months.

6.1.4 Digital thermometers must have a tag showing that they were checked within the last three months.

6.1.5 See SOP DV-QA-0001 for details of the thermometer calibration procedure.

6.1.6 Centrifuge (when the desired method of removing particulates is centrifugation).

6.1.7 Calibrated mechanical pipettes with disposable pipette tips. Pipette calibration is checked in accordance with SOP DV-QA-0008.

6.2 Supplies

6.2.1 Disposable digestion tubes, with volume accuracy verified to ± 3% gravimetrically prior to use. See SOP DV-QA-0008.

6.2.2 Watch glasses, ribbed or equivalent, or disposable digestion tube covers.

6.2.3 Whatman GD/XP - PVDF membrane, 0.45-micron syringe filters (No. 6973-2504), for trace metal analysis, or equivalent. When used to filter any sample in a preparation batch or analytical batch, filters of the same type are also used to filter the method blank and the LCS in the batch. Acceptable results for the QC samples demonstrate that the filters neither add nor subtract analytes.

6.2.4 Syringes or equivalent filtration apparatus.

6.2.5 Re-pipettors or suitable reagent dispensers.

6.2.6 Class A volumetric graduated cylinders.

6.2.7 pH indicator strips.

6.2.8 Plastic digestate storage bottles.

7.0 Standards and Reagents

7.1 Standards must be NIST traceable, where available. Multi-element standards are verified against a second-source standard before they are put into use (the only exception is standards purchased directly from NIST), which is described in SOP DV-QA-0015.

7.2 Stock standards are purchased as custom multi-element mixes or as single-element solutions. Standards are logged into the TALS Reagent Module and are assigned unique identification numbers that can be used to access traceability information.

7.3 All standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles.

7.4 Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year and must be replaced sooner if verification from an independent source indicates a problem.

7.5 Standards containing silver must be protected from light using either a cardboard box or amber containers.

7.6 Shelf-Life

7.6.1 Stock standards, standards as received from the vendor, expire on the date assigned by the vendor. If no date is assigned by the vendor, then a one-year expiration will be assigned by the laboratory.

7.6.2 Intermediate concentration standards or working standards may be used for up to six months. The expiration date cannot be later than the date assigned to the stock standard.

7.6.3 Any suspect standards are re-verified, and replaced if re-verification fails.

7.7 Laboratory Control Sample (LCS) Spike Stock Standards

The LCS spike stock standards are custom-made standards purchased from Inorganic Ventures. The standards are designated ICP-SPK-3A (ICP-1) and ICP-SPK-2B (ICP-2) and contain the following elements at ready-to-use concentrations:

LCS Spike Stock Standards

Elements in LCS Spike	Concentration in ppm (µg/mL)
Ca, K, Mg, Na	5,000
P, Si	1,000
Al, Ba, Bi, Se, Tl, U, Sn, S	200
Fe, Sr, Li, B, Mo, Ti, As, Th	100
Co, Mn, Ni, Pb, V, Zn, Sb, Zr	50
Cu	25

Elements in LCS Spike	Concentration in ppm (µg/mL)
Cr	20
Cd	10
Ag, Be	5

7.8 TCLP Spike Stock Standard (TCLP Spike)

The TCLP spike stock standard is purchased from commercial sources. The stock is a custom-made standard purchased at ready-to-use concentrations and designated as TCLP Spike, as follows:

TCLP Spike Stock Standard

Elements in TCLP Spike	Concentration in ppm (µg/mL)
Ba	1,000
Cr, Pb	500
As	300
Cu, Zn	200
Ag, Cd, Se	100

7.9 TCLP Mercury Spike Solution

TCLP leachate matrix spike samples are spiked for both ICP elements and mercury at the time of sample preparation but before preservation. The mercury spike standard is prepared by the mercury analyst as the mercury daily spike solution (Hg Daily Spk) at a concentration of 100 µg/L (SOP DV-MT-0015).

7.10 Reagent Water

Reagent water must be produced by a Millipore de-ionized system or equivalent and must achieve the performance specifications for ASTM Type II water, i.e., conductivity < 1.0 µmhos/cm; resistivity > 1.0 megohms-cm; silica < 3.0 µg/L. In addition, the reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks as defined in the determinative SOPs DV-MT-0012, DV-MT-0019, and DV-MT-0021.

7.11 Nitric acid (HNO_3), concentrated, trace metal grade or better.

7.12 Hydrochloric acid (HCl), concentrated, trace metal grade or better.

8.0 Sample Collection, Preservation, Shipment and Storage

Preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time [1]	Reference
Water	HDPE	500 mL	HNO_3, pH < 2	180 Days	40 CFR Part 136.3

[1] Inclusive of digestion and analysis.

9.0 Quality Control

9.1 The minimum required QC, acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the TALS Method Comments to determine which specific QC requirements apply to each job.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Control Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, QA/QC Requirements for Federal Programs.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in TALS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. Ongoing proficiency must be demonstrated by each analyst on an annual basis. See Section 12 for more details on initial demonstrations of capability, analyst training and qualification.

9.3 Preparation Batch

A preparation batch is a group of up to 20 samples that are of the same matrix and are processed together using the same procedures and reagents. The preparation batch must contain a method blank, an LCS, a matrix spike (MS), and a matrix spike duplicate (MSD). In some cases, at client request, it may be appropriate to process a matrix spike and sample duplicate in place of the MS/MSD. If clients specify samples for the MS/MSD pair, then the batch may contain multiple MS/MSD pairs to accommodate client requests. Clients may also request a duplicate LCS (LCSD). In cases where the client has not provided sufficient sample to prepare an MS and MSD, an LCS and LCSD will be prepared instead.

9.4 Sample Count

Laboratory-generated QC samples (method blanks, LCSs) are not included in the sample count for determining the size of a preparation batch. The MS and MSD are not included in the sample count unless specifically requested by the client. The prep batch consist of the laboratory generated QC and no more than twenty field samples.

9.5 Method Blank (MB)

9.5.1 The method blank consists of reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis. When samples are filtered in the laboratory for determination of dissolved metals, then the blank is filtered using a filter of the same type that was used for the samples.

9.5.2 TCLP method blanks are prepared by taking 50 mL of TCLP leachate fluid (see SOP DV-IP-0012) through the appropriate procedure as described in Section 10. TCLP method blanks are referred to as LB (extraction fluid 1) and LB2 (extraction fluid 2) in TALS and on the final reports.

9.5.3 One method blank must be processed with each preparation batch. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false-positive data. Method blank results are evaluated by the ICP analysts as described in SOPs DV-MT-0012, DV-MT-0019 and DV-MT-0021.

9.5.4 Acceptance Criteria

The method blank should not contain any analyte of interest at or above ½ the reporting limit (RL) or at or above 10% of the measured concentration of that analyte in associated samples, whichever is higher. In other words, the sample result must be a minimum of 10 times higher than the blank contamination level. Method blank results that are greater than ½ the RL may also be reported if the associated sample results fall below the RL and the client accepts the data.

9.5.5 Corrective Action

If the method blank does not meet the acceptance criteria, the blank and all associated samples in the batch must be re-digested and reanalyzed.

9.6 Laboratory Control Sample (LCS)

9.6.1 One aqueous LCS must be processed with each preparation batch. The LCS must contain all analytes of interest and must be carried through the entire analytical procedure. When samples are filtered in the laboratory for determination of dissolved metals, then the LCS is filtered using a filter of the same type that was used for the samples.

9.6.2 An LCS for a batch of aqueous samples is prepared by adding 0.5 mL of each of the LCS spike stock standards, ICP-1 and ICP-2 (Section 7.7), to 50 mL of reagent water. This produces the final concentrations shown in Table 1.

9.6.3 An LCS for a TCLP batch is prepared by adding 0.5 mL of each of the LCS spike stock standards, ICP-1 and ICP-2 (Section 7.7), plus 0.5 mL of the TCLP Spike stock standard (Section 7.8) to 50 mL of the TCLP leachate solution (see SOP DV-IP-0012). This produces the final concentrations shown in Table 2.

9.6.4 The LCS is used to monitor the accuracy of the analytical process. LCS results are evaluated by the ICP analyst as described in SOP DV-MT-0012. Ongoing monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

9.6.5 Acceptance Criteria

LCS recovery control limits are set at ± 3 standard deviations about the historical mean. These limits must not be wider than 85 - 115 % recovery for Method 200.7 or 80 - 120 % for Method 6010. The control limits are maintained in the LIMS system.

9.6.6 Corrective Action

If the LCS percent recovery falls outside of the control limits for any analyte, that analyte is judged to be out of control. All associated samples must be reprocessed for analysis. One possible exception is a recovery for a given element above the upper control limit with no

detection for the same element in the samples. This latter case must be documented in an NCM and explained in the case narrative.

9.7 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

9.7.1 A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. Normally, one MS/MSD pair is digested with each preparation batch. Samples identified as field blanks, equipment blanks, or rinse blanks are not appropriate for use as the batch MS/MSD.

9.7.2 Some programs (e.g., South Carolina and North Carolina) require that MS/MSD pairs are run at a 10% frequency. Also, some clients may require unspiked duplicate samples in place of or in addition to an MS/MSD pair. Check special project instructions attached as Method Comments in TALS and any project QASs before starting the batch.

NOTE: This method does not require a sample duplicate. Precision is measured using the MS/MSD. Use of the MS/MSD precision is preferred as not all samples will contain measurable concentrations of target analytes. Samples that have target analytes at low concentrations or non-detectable levels do not provide useful precision data. When an MS/MSD is not available, the LCS and LCSD are used to measure precision.

9.7.3 If insufficient sample is available to process an MS/MSD pair, then a duplicate LCS must be processed and an NCM generated. The LCS pair is then evaluated according to the MS/MSD criteria.

9.7.4 The purpose of analyzing matrix spike samples is to assess the effect of the sample matrix on the accuracy and precision of the analysis. MS/MSD results are evaluated by the ICP analysts as described in SOPs DV-MT-0012, DV-MT-0019 and DV-MT-0021. If the MS/MSD results fail to meet control limits while the LCS results are in control, then something about the sample matrix is interfering with the analysis.

9.7.5 Matrix spikes for aqueous sample batches are prepared by adding 0.5 mL of each of the LCS spike stock standards, ICP-1 and ICP-2 (Section 7.7), to a digestion tube containing 50 mL of the selected sample. The final spike concentrations are shown in Table 1.

9.7.6 Matrix spikes for TCLP batches are prepared by adding 0.5 mL of the TCLP Spike stock standard (Section 7.8) plus 0.5 mL of each of the LCS spike stock standards, ICP-1 and ICP-2 (Section 7.7), to 50 mL of the parent TCLP aliquot. A second aliquot is spiked for mercury analysis at by adding 1.5 mL of the 100 mg/L Hg standard (Hg Daily Spk) to 30ml of parent sample. The matrix spike samples are then preserved with HNO_3 to pH < 2. The final spike concentrations are shown in Table 2.

NOTE: The MS and MSD must be spiked prior to preservation of the leachate.

9.7.7 Acceptance Criteria

The recovery for each analyte must fall within established limits. The relative percent difference (RPD) between the MS and MSD must be less than or equal to the established RPD limit. If any analyte recovery or relative percent difference (RPD) between the MS and MSD falls outside the acceptance range, the recovery of that analyte must be in control for the LCS.

9.7.8 Corrective Action

If MS/MSD results fail to meet control limits, but the LCS results are within limits, then samples do not require re-preparation and reanalysis unless the results indicate that a spiking error may have occurred. If the recovery of the LCS also failed acceptance criteria, then corrective action must be taken. Corrective action will include re-preparation and reanalysis of the batch. One possible exception is an LCS recovery for a given element above the upper control limit with no detection for the same element in the samples. This latter case must be documented in an NCM and explained in the case narrative.

9.8 Continuing Calibration Verification Standard (CCV)

Continuing calibration verification standards (CCVs) are not digested but are instead created and evaluated by the ICP analysts as described in SOPs DV-MT-0012, DV-MT-0019 and DV-MT-0021.

9.9 Second-Source Initial Calibration Verification (ICV) Standard

Initial calibration verification standards (ICVs) are not digested but are instead created and evaluated by the ICP analysts as described in SOPs DV-MT-0012, DV-MT-0019 and DV-MT-0021.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 All data shall be recorded directly on the described forms, logbooks, electronic forms, or directly in TALS at the time of data generation. It is not acceptable to record data on loose papers, scraps of paper, gloves, sample vials, or "Post-It" notes. Data may be recorded on paper bench sheets if the sheets are subsequently scanned and saved in a designated folder on the company server.

10.4 Sample Preparation

10.4.1 Samples are typically logged in as either water or solid. Waste such as organic liquids or sludges and tissues (animal/vegetable) are usually logged in with solid test codes. When initiating sample preparation, examine the sample to see if the sample matches the matrix designation. If the sample is logged in as aqueous, but it appears to be a waste (biphasic, oil, sludge-like, organic liquid, lots of sediment, etc.), contact the project manager and the laboratory Technical Specialist for further instructions. It may be necessary to subcontract these samples to a laboratory with the capability to digest organic matrices.

NOTE: TestAmerica Denver has not implemented digestion methods for water-immiscible organic matrices, e.g., oils. Samples that are known to be incompatible with TestAmerica Denver digestion techniques are typically subcontracted to other laboratories.

10.4.2 All samples are to be electronically checked out of sample control using the TALS Internal Chain of Custody (ICOC) module.

10.4.3 Proper sample identification is extremely important in any preparation procedure. Labeling of beakers, digestion tubes, and bottles must be done in a manner to ensure connection with the proper sample.

10.4.4 If possible, prepare all the samples of a project at the same time to minimize the QC required and streamline the flow of the project through the lab, data review and reporting.

10.4.5 Guidelines are provided in Appendix 1 on procedures to minimize contamination of samples and standards.

10.5 Aqueous Sample Preparation Setup

The following setup procedure must be followed for all aqueous samples prior to performing the specific digestion procedure. The sample preparation procedures for Methods 3005A and 3010A detailed in the following sections are also summarized in work instruction WI-DV-016.

10.5.1 Verify sample pH

10.5.1.1 Measure the sample pH with pH paper using a separate aliquot of sample. This can be done using disposable plastic droppers or pouring the sample on to the pH paper. Do not put the pH paper directly into the bottle. Record the pH on a

copy of the internal chain of custody (ICOC). When all of the samples have been tested, initial and date the copy of the ICOC, scan it, and save it to the Metals folder on the G: drive.

10.5.1.2 All water sample pH's must be verified and documented before digestion.

10.5.1.3 If the pH>2 for a sample requiring acidic preservation, record the job in the Sample Filtration and Preservation Logbook.

10.5.1.4 If laboratory preservation is required, add 1-2 mL of conc. HNO_3 to the sample. Replace the lid and mix the sample. If the pH is still >2 add another addition of HNO_3. Do not add more than 5 mL. If the pH is still >2 create an NCM saying the sample will not preserve.

10.5.1.5 Allow the sample to sit for 8-16 hours following acidification.

10.5.1.6 Recheck the pH of the sample. If the pH>2, repeat Section 10.5.1.4 until the pH holds at <2 or 5 mL of HNO_3 has been added. If the pH is still >2 after the addition of 5 mL of HNO_3 create an NCM saying the sample will not preserve.

10.5.1.7 Samples cannot be digested for 24 hours after preservation. Note the date/time of this pH recheck in the Metals Prep Log in the LIMS.

10.5.1.8 Leachates or portions of leachates for metallic analyte deteminations must be acidified with nitric acid to a pH <2 unless precipitation occurs. Test a small portion of sample to see if precipitation occurs. If a precipitate forms do not acidify the leachate and analyze as soon a possible. Leachates may be digested as soon as they are acidified.

10.5.2 Select the unfiltered fraction for a total or total recoverable analysis or the filtered fraction for a dissolved analysis. If requested by the client, select the filtered fraction for a total dissolved analysis. For TCLP and SPLP, select the proper sample leachates.

NOTE: Samples requiring dissolved metals determination are either filtered and preserved in the field or are filtered and preserved by the laboratory as soon as possible after receiving the samples. When filtered in the laboratory, the filtration and preservation are recorded in the Laboratory Sample Filtration and Preservation Logbook, including the preservative type and lot number. Filter acceptability is demonstrated by using filters of the same type to filter samples and batch QC samples when preparation batches include samples that were filtered in the laboratory. The results of the analysis of the batch QC samples are used to demonstrate that the filtration process neither adds nor subtracts target analytes from samples. The performance of

the filtration process is recorded in TALS.

10.5.3 Mix the sample by shaking the container.

10.5.4 Measure and transfer 50 mL of the sample into a digestion tube (record the lot number of the digestion tubes used in the LIMS). When using calibrated digestion tubes, pour the sample into the tube to the 50 mL mark. For TCLP sample batches pour 10 mL of samples and bring to 50 mL with reagent water. Unless specifically required for a project, all samples are measured by volume and not by weight. Record the volume and units on the preparation bench sheet in TALS. If the digestion cup is filled beyond the required mark, the excess sample must not be poured back into the original container, but must be disposed of as waste.

10.5.5 Mix the sample by shaking the container and then measure two extra aliquots of the sample that is selected for the MS/MSD analysis. Spike each aliquot as described in Section 9.7. Refer to Section 9.7.6 for specific instructions for spiking the selected TCLP sample. Record the standards and pipette identifications in TALS.

10.5.6 Measure and transfer 50 mL of reagent water into a digestion tube for the method blank. If a determination of dissolved metals is requested (LIMS 3005A), use filtered reagent water for the method blank. For TCLP sample batches, measure 10 mL of the TCLP leachate solution and bring to 50 mL with reagent water for the blank. See Section 9.5 for a detailed description of the method blank.

10.5.7 Measure and transfer 50 mL of reagent water into a digestion tube for the LCS and add the spiking solutions as described in Section 9.6.2. For TCLP sample batches, use 10 mL of TCLP leachate fluid and bring to a final volume of 50ml with reagent water for preparing the LCS (Section 9.6.3). Record the standards and pipette identifications in TALS. If determination of dissolved metals is requested and one or more samples were filtered in the laboratory, then filter the LCS using a filter of the same type that was used to filter the sample(s).

10.5.8 If the analysis is for total recoverable, dissolved metals, or potentially dissolved metals, continue on with Section 10.5. If the analysis is for total metals, skip Section 10.6 and go to Section 10.7.

10.6 Total Recoverable, Dissolved, or Potentially Dissolved Digestion for Waters by 3005A and 200.7_Prep.

10.6.1 Add 1 mL of concentrated HNO_3 and 2.5 mL of concentrated HCl to the sample in the digestion tube.

10.6.2 Heat at 90-95 °C until the volume is reduced to between 15 and 20 mL. Record the start and stop times, digestion block temperature (observed and corrected) and the thermometer ID in TALS.

CAUTION: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY. Doing so will result in the loss of analyte and the sample must be re-prepared.

10.6.3 Allow the digestion tube to cool in a fume hood.

10.6.4 Wash down the digestion tube walls with reagent water.

10.6.5 Add 1.5 mL of concentrated HNO_3 to the digestate.

10.6.6 Revolume to 50 mL with reagent water. Cap and shake to mix.

10.6.7 If insoluble materials are present, the sample will be filtered at the instrument by the analyst.

NOTES: If any samples in a preparation batch are filtered, the method blank and LCS associated with that batch must also be filtered.

Instead of filtering, the samples may be diluted and mixed and then centrifuged or allowed to settle overnight to remove insoluble material from the supernatant solution.

10.6.8 The sample is now ready for analysis.

10.7 Total Metals Digestion for Waters or TCLP Leachates by 3010A

10.7.1 Add 1.5 mL of concentrated HNO_3 to the sample in the digestion tube.

10.7.2 Heat at 90-95 °C until volume is reduced to 10 ± 5 mL. Record the start and stop times, digestion block temperature (observed and corrected) and the thermometer ID in TALS.

CAUTION: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY. Doing so will result in the loss of analyte and the sample must be re-prepared.

10.7.3 Allow the digestion tube to cool in a fume hood.

10.7.4 Add another 1.5 mL portion of concentrated HNO_3 and cover the sample with a watchglass.

10.7.5 Continue refluxing until the digestion is complete.

NOTE: Digestion is complete when the digestate is light in color or does not change in appearance. For most samples the addition of two nitric acid aliquots is sufficient. Additional aliquots of nitric acid may be added if necessary.

10.7.6 Evaporate to a low volume of 5 to 10 mL. If the sample does go to dryness, the digestion must be started over using a fresh portion of sample.

10.7.7 Allow the digestion tube to cool in a fume hood.

10.7.8 Add 2.5 mL of concentrated HCl.

10.7.9 Cover and reflux for an additional 15 minutes to dissolve any precipitate or residue.

10.7.10 Wash down the digestion tube walls and watch glass (or digestion tube cover) with reagent water.

10.7.11 Adjust to 50 mL final volume with reagent water. This must be done volumetrically, and not using a balance.

10.7.12 If insoluble materials are present, the sample will be filtered at the instrument by the analyst.

NOTES: If any samples in a preparation batch are filtered, the method blank and LCS associated with that batch must also be filtered.

Instead of filtering, the samples may be diluted and mixed and then centrifuged or allowed to settle overnight to remove insoluble material from the supernatant solution.

10.7.13 The sample is now ready for analysis.

10.8 Calibration

10.8.1 The digestion block temperature must be maintained between 90 and 95 °C. The temperature must be monitored continuously while in use and must be recorded in TALS. The temperature must be monitored by measuring the temperature of reagent water contained in a capped digestion tube that is placed in each digestion block. The thermometer used and the start and end times for all temperature cycles are recorded in TALS.

10.8.2 The thermometer is calibrated in accordance with SOP DV-QA-0001, Thermometer Calibration Procedures.

11.0 Calculations / Data Reduction

11.1 This SOP does not produce any analytical data. See the determinative method SOPs DV-MT-0012, DV-MT-0019 or DV-MT-0021 for data analysis and applicable calculations.

11.2 Documentation

11.2.1 All of the preparation information is recorded and stored in TALS.

11.2.2 The preparation information includes:

11.2.2.1 Batch number, job and sample numbers, preparation date, and analyst name;

11.2.2.2 Matrix and prep type;

11.2.2.3 Initial sample pH, Initial sample volume and final volume;

11.2.2.4 Reagent manufacturer and lot number for each reagent used;

11.2.2.5 Digestion tube lot information;

11.2.2.6 Standard identification number for each standard used;

11.2.2.7 Start and stop times for digestions;

11.2.2.8 Observed and corrected temperature readings during digestion;

11.2.2.9 Identification numbers of calibrated measuring equipment used (thermometers, balances, pipettes, etc.).

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

12.1.1 An initial method detection limit study is performed for each analyte and each sample matrix type in accordance with Policy DV-QA-005P. An MDL verification is performed once a year to satisfy NELAC 2003/2009 requirements. For DoD, AFCEE and Texas TRRP projects, an MDL verification is performed quarterly. MDLs are stored in TALS.

12.1.2 The current MDL value is maintained in TALS.

12.2 Demonstration of Capabilities

An initial demonstration of capability for each method must be performed prior to analyzing samples.

12.2.1 For the standard analyte list, the initial demonstration consists of the preparation and analysis of a QC check sample containing all of the standard analytes for the method, as well as a method detection limit (MDL) study.

12.2.2 Four aliquots of the QC check sample are analyzed with the same procedures used to analyze samples, including sample preparation.

12.2.3 The mean recovery and standard deviation are calculated for each analyte of interest. These results are compared with the established or project-specific acceptance criteria. All four results must meet acceptance criteria before the method can be used to analyze samples.

12.2.4 For non-standard analytes, an MDL study must be performed and calibration curve generated before analyzing any samples, unless lesser requirements are previously agreed to with the client. In any event, the minimum initial demonstration required is successful analysis of an extracted standard at the reporting limit and a single point calibration.

12.3 Training Requirements

12.3.1 The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

12.3.2 Each analyst performing the method must complete a demonstration of capability (DOC) by successfully preparing and/or analyzing four consecutive LCSs, or a blind performance evaluation (PE) sample, or other acceptable QC samples. The results of the DOC study are summarized in the NELAC format, as described in SOP DV-QA-0024. DOCs are approved by the Quality Assurance Manager and the Technical Director. DOC records are maintained by the QA staff in the central training files. Analysts who continue to perform the method must successfully complete a demonstration of capability annually.

13.0 Pollution Control

13.1 This method allows for the proportional reduction of sample and reagent volumes to decrease waste generation.

13.2 Standards and reagents should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in Section 13, *Waste Management and Pollution Prevention*, of the Environmental Health and Safety Manual, and DV-HS-001P, *Waste Management Plan*.

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Expired Chemicals/Reagents/Standards: Contact Waste Coordinator

14.2.2 Acidic waste from sample digests: Waste Stream J.

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure

15.0 References / Cross-References

15.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

15.1.1 Method 3005A, Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by FLAA or ICP Spectroscopy, Revision 1, July 1992.

15.1.2 Method 3010A, Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by FLAA or ICP Spectroscopy, Revision 1, July 1992.

15.2 Method 200.7, Determination of Metals And Trace Elements In Water And Wastes By Inductively Coupled Plasma-Atomic Emission Spectrometry, Revision 4.4, 1994.

16.0 Method Modifications

16.1 Modifications Specific to MCAWW Methods (200.7_Prep)

It was determined by technical review that several of the MCAWW methods were equivalent to the SW-846 methods and therefore were combined under the scope of this SOP as described in Section 10.0. The nature of the differences were deemed insignificant in regards to the amount of acid added and the evaporative volume based on the flexibility allowed by the methods (i.e., add additional acid as required) and the subjective wording of the methods (i.e., evaporate to near dryness versus an exact volume).

16.2 Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the MDL. This SOP states that the method blank must not contain any analyte of interest at or above ½ the reporting limit. Common laboratory contaminants are allowed up to two times the reporting limit in the blank following consultation with the client.

16.3 The referenced methods use 100 mL of sample for digestion. This SOP uses a 50 mL aliquot, with a proportional reduction in digestion reagents. This change is made to allow better control of temperature and potential sample contamination with the use of the digestion block. It is also considered one of the laboratory's hazardous waste reduction initiatives.

16.4 The use of reduced sample volumes are supported in EPA's document "Response to Public Comments Background Document, Promulgation of the Second Update to SW-846, Third Edition" dated November 3, 1994. This document states "flexibility to alter digestion volumes is addressed and 'allowed' by the table (3-1)

and is also inherently allowed by specific digestion methods. Table 3-1 is only to be used as guidance when collecting samples..." EMSL-Ci has also taken the stance that "reduction in sample size and appropriate corresponding reduction in sample volume is not considered a significant change in the methodology."

17.0 Attachments

Table 1. Matrix Spike and Aqueous Laboratory Control Sample Levels

Table 2. TCLP Reporting Limits, Regulatory Limits, and Matrix Spike Levels

Appendix 1. Contamination Control Guidelines

18.0 Revision History

- Revision 8 dated 30 June 2015
  - Updated Section 10.5.1.1 to include statement about not putting the pH paper into the bottle
  - Added language to Section 4.5 for clarification
  - Added new Section 10.3 reminding analysts to enter data directly at time of acquisition

- Revision 7 dated 31 October 2014
  - Annual technical review
  - Removed reference to SOP DV-IP-0017 for oils in section 1.2
  - Added maximum silver concentration to section 4.5 for method 200.7
  - Updated standard ID's for sections 7.7 and 7.8 and added Sulfur to the spike list
  - Corrected intermediate standard expirations from three months to six months
  - Removed duplicate analyte spike levels in ICP spike standards
  - Changed references from LIMS to TALS
  - Corrected concentration of Hg Daily spike standard
  - Removed Figures 1 and 2
  - Corrected various grammar and language errors
  - Corrected analyte spike levels in Table 1

- Revision 6 dated 08 October 2013
  - Updated sections 10.4.1.3, 10.4.1.4 and 10.4.1.6 about preservation procedure and removed the comment about recording the amount of acid added in the preservation logbook

- Revision 5, dated 15 July 2013
  - Annual review
  - Changed section 10.5.5, 7.3, 9.4, 9.5.2, 9.5.4, 10.3.1, 10.3.2, 10.4, 10.4.4, 10.5.2, 10.6.2, 11.2.2, 12.1.1 and 12.3 to reflect current practices
  - Corrected formatting and grammatical errors
  - Clarified sample matrices for this method in section 1.2
  - Corrected references in table associated with section 1.3
  - Added ICP determinative SOPs to sections 1.5, 4.6, 7.10, 9.5.3, 9.7.4
  - Added 200.7_Prep whenever 3005A was referenced
  - Edited section 3.5 to reflect current reference
  - Removed note associated with section 5.4.1
  - Added SOP reference to section 6.2.1
  - Removed references to Denver Standards Log and replaces those references with TALS reagent module

- Correct standard names in section 7.7
- Removed references to Supplemental Metals Prep Sheet
- Updated sections 10.4.4, 10.4.6 and 10.4.7 for 10 mL TCLP sample aliquot
- Added reference to 200.7 in Section 15

- Revision 4.7, dated 18 July 2012
  - Annual review
  - Updated Section 9.1, 10.1 and 10.2 to reflect current practice
  - Updated Section 9.7.6 on spiking TCLP aliquots
  - Added section 10.4.1.9 for TCLP preservation
  - Removed Appendix 2. Added reference to work instruction in Section 10.4
  - Updated Figures 1 and 2 to reflect current practice.
  - Formatting and editorial changes throughout

- Revision 4.6, dated 24 August 2011
  - Added recommendation to use disposable bulbs for pH checking in section 10.8.1.
  - Added requirement to store samples with a Rush form after preserving in section 10.8.1.2.

- Revision 4.5, dated 31 January 2011
  - Change note in section 10.8.1.8 to be 24 hours before preparation.

Earlier revision histories have been archived and are available upon request.

Table 1.

Matrix Spike and Aqueous Laboratory Control Sample Levels

Element	LCS Concentration (ug/L)	Matrix Spike Concentration (ug/L)
Aluminum	2,000	2,000
Antimony	500	500
Arsenic	1,000	1,000
Barium	2,000	2,000
Beryllium	50	50
Bismuth	2,000	2,000
Boron	1,000	1,000
Cadmium	100	100
Calcium	50,000	50,000
Chromium	200	200
Cobalt	500	500
Copper	250	250
Iron	1,000	1,000
Lead	500	500
Lithium	1,000	1,000
Magnesium	50,000	50,000
Manganese	500	500
Molybdenum	1,000	1,000
Nickel	500	500
Phosphorous	10,000	10,000
Potassium	50,000	50,000
Selenium	2,000	2,000
Silicon	10,000	10,000
Si (as SiO2)	21,400	21,400
Silver	50	50
Sodium	50,000	50,000
Strontium	1,000	1,000
Thallium	2,000	2,000
Tin	2,000	2,000
Titanium	1,000	1,000
Uranium	2,000	2,000
Vanadium	500	500
Zinc	500	500
Zirconium	500	500

Table 2.

TCLP Reporting Limits, Regulatory Limits, and Matrix Spike Levels

Element	RL (mg/L)	Regulatory Limit (mg/L)	Spike Level (mg/L)
Arsenic	0.1	5,000	5.0
Barium	1.0	100,000	12.0
Cadmium	0.05	1,000	1.05
Chromium	1.0	5,000	5.2
Lead	0.03	5,000	5.5
Selenium	0.05	1,000	3.0
Silver	0.1	5,000	1.05

Appendix 1.

Contamination Control Guidelines

The following procedures are strongly recommended to prevent contamination:

- All work areas used to prepare standards and spikes should be cleaned before and after each use.
- All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.
- Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.
- Powdered or latex gloves must not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes. Only vinyl or nitrile gloves should be used in the metals laboratory.
- Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.
- Autosampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

- Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.
- Improper cleaning of glassware can cause contamination.
- Separate glassware if an unusually high sample is analyzed and soak with sulfuric acid prior to routine cleaning.

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Title: Acid digestion of Aqueous Samples for Analysis by ICP- MS [SW-846 3005A, 3020A, 3050B and EPA Method 200.8.]

Approvals (Signature/Date):

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1.0 Scope and Application

1.1 This procedure describes the preparation of aqueous samples for the analysis of metals by Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) using EPA Method 200.8, and SW-846 Methods 3005A, 3020A, and 3050B.

1.2 Aqueous samples also include TCLP & SPLP Leachates, aqueous equipment rinse blanks for soil sampling. In some cases, where the associated soil samples require the SW-846 Method 3050B, Section 7.5, optional treatment to improve solubility and recovery of Sb, Ag, and Sn. The client may require that the aqueous equipment blank receive the same treatment. Refer to section 10.14 for this prep.

1.3 The applicability of each of these preparation protocols to specific analytes is detailed in the TestAmerica LIMS System (TALS). Additional elements may be analyzed following digestion by these protocols, provided that the method performance criteria specified in Section 12.0 of this SOP are met.

1.4 This SOP provides procedures applicable to the preparation of dissolved, total recoverable, potentially dissolved, and total metallic elements in ground water, aqueous samples, aqueous sludges, aqueous wastes, aqueous air sampling media, and leachates/extracts. This SOP is not applicable to samples that contain or consist of oil or other immiscible organic solvents.

NOTE: Samples that are known to be immiscible with water, e.g., contain or consist of oil or other immiscible organic solvents should be logged with a waste matrix and subbed out to a different TestAmerica laboratory for digestion and analysis.

1.5 SW-846 Method 3005A is used to prepare surface and groundwater samples for total recoverable and dissolved metals determination by ICP-MS. Although digestion is not specifically required by the method (SW-846 3005A section 2.2) for dissolved samples, the standard operating procedure at TestAmerica Denver is for all matrices to be digested prior to analysis.

1.6 EPA Method 200.8 Section 11.2 is used to prepare surface water, drinking water, and domestic and industrial waste samples for total recoverable and dissolved metals.

1.7 SW-846 Method 3020A is used to prepare aqueous samples, TCLP leachates, SPLP leachates and aqueous wastes that contain suspended solids for total metals analysis by ICP-MS.

1.8 The following table lists the sample preparation methods that are covered in this SOP and the specific section of this SOP for each preparation method. Prepared samples are analyzed by inductively coupled plasma-mass spectrometry (ICP-MS).

PREPARATION METHOD	SOP SECTION	DETERMINATIVE METHOD	ANALYTICAL SOPS #
Method – 3020A Total	10.11	ICP-MS	DV-MT-0018 DV-MT-0022
Method – 3005A Total Rec./Dissolved	10.12	ICP-MS	DV-MT-0018 DV-MT-0022
Method 200.8 – Total Rec.	10.13	ICP-MS	DV-MT-0002
Method 200.8 – Dissolved	10.13	ICP-MS	DV-MT-0002
Method - 3050B Special Sb Prep	10.14	ICP-MS	DV-MT-0018 DV-MT-0022

2.0 Summary of Method

2.1 Method 3005A, Acid Digestion of Waters for Total Recoverable or Dissolved Metals.

This preparation method is used for total recoverable and dissolved metals analysis by ICP-MS method 6020 and 6020A. A representative aliquot of sample is heated with nitric acid and substantially reduced in volume. The digestate is diluted to volume and then filtered (if necessary).

2.2 Method 3020A, Acid Digestion of Aqueous Samples and TCLP/SPLP Leachates for Total Metals.

This preparation method is used for total metals analysis by ICP-MS method 6020 and 6020A. A representative aliquot of sample is refluxed with nitric acid. This step is repeated until the digestate is light in color or until its color has stabilized. The digestate is diluted to volume and then filtered (if necessary).

2.3 Method 200.8, Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma - Mass Spectrometry.

This preparation method is used for metals analysis by ICP-MS method 200.8. A representative aliquot of sample is refluxed with nitric and hydrochloric acids. The digestate is diluted to volume and then filtered (if necessary).

3.0 Definitions

Additional definitions of terms used in this SOP may be found in the glossary of the QAM.

- Dissolved Metals: The concentration of metals determined in a sample after the sample is filtered through a 0.45-μm membrane (Method 3005A). (The sample is acidified after filtration).

- Total Metals: The concentration of metals determined in an unfiltered sample following digestion (Method 3020A).

- Total Recoverable Metals: The concentration of metals determined in an unfiltered sample following treatment with hot, dilute mineral acid (Method 200.8 and Method 3005A).

- Potentially Dissolved Metals: An acidified sample is filtered between 8- 96 hours following acidification and the filtrate is digested using Method 3005A.

- Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, *Quality Control Program*, for definitions of general analytical and QA/QC terms.

4.0 Interferences

4.1 There are numerous routes by which samples may become contaminated. Potential sources of trace metals contamination include the following: metallic or metal-containing labware (e.g., latex gloves coated with talc, which contains high levels of zinc), containers, impure reagents, dirty glassware, improper sample transfers, dirty work areas, atmospheric inputs such as dirt and dust, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.2 The entire work area, including the bench top and fume hood, should be thoroughly cleaned on a routine schedule in order to minimize the potential for environmental contamination. Refer to Appendix A for additional contamination control guidelines.

4.3 Physical interference effects may contribute to inaccuracies in the determinations of trace elements. Oils, solvents, and other matrices may not be digested using these methods if they are not soluble in acids. If physical interferences are present, they should be documented.

4.4 Visual interferences or anomalies (such as foaming, emulsions, precipitates, etc.) must be documented.

4.5 Allowing samples to boil or go dry during digestion may result in the loss of volatile metals. If this occurs, the sample must be re-prepared.

4.6 Specific analytical interferences are discussed in the ICP-MS determinative method SOPs, e.g., DV-MT-0002, DV-MT-0018, and DV-MT-0022.

5.0 Safety

Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual, and this document.

5.1 Specific Safety Concerns

5.1.1 Samples that contain high concentrations of carbonates or organic material, or samples that are at elevated pH can react violently when acids

are added.

5.1.2 The digestion solution must be cooled sufficiently before adding hydrogen peroxide (H_2O_2) to avoid a reaction and possible violent effervescence, or boiling over of the digestion solution.

5.1.3 Care must be taken when handling the digestion tubes. The tubes may become very hot during the digestion procedure. Allow the tubes to cool before attempting to touch the sample digestate.

5.1.4 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.2 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating.This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material [(1)]	**Hazards**	**Exposure Limit** [(2)]	**Signs and Symptoms of Exposure**
Hydrogen Peroxide	Oxidizer Corrosive	1 ppm (TWA)	Vapors are corrosive and irritating to the respiratory tract. Vapors are very corrosive and irritating to the eyes and skin.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm (TWA) 4 ppm (STEL)	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage

Material (1)	Hazards	Exposure Limit (2)	Signs and Symptoms of Exposure
Hydrochloric Acid	Corrosive Poison	5 ppm (Ceiling)	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
(1) Always add acid to water to prevent violent reactions. (2) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Digestion block, with adjustable heating, capable of maintaining a sample temperature of 85 - 95 °C.

6.1.2 Thermometer that covers a temperature range of at least 80 - 110 °C.

6.1.3 Centrifugation equipment (if desired method of removing particulate material is centrifugation).

6.2 Supplies

6.2.1 Disposable digestion tubes, with volume accuracy verified to ± 3% gravimetrically prior to use. See SOP DV-QA-0008.

6.2.2 Watch glasses, ribbed or equivalent, or disposable digestion tube covers.

6.2.3 Whatman GD/XP - PVDF membrane, 0.45-micron syringe filters, No. 6973-2504, for trace metal analysis, or equivalent. When used to filter any sample in a preparation batch or analytical batch, filters of the same type are also used to filter the method blank and the LCS in the batch. Acceptable results for the QC samples demonstrate that the filters neither add nor subtract analytes.

6.2.4 Syringes or equivalent filtration apparatus.

6.2.5 Repipettors or suitable reagent dispensers.

6.2.6 Calibrated automatic pipettes with pipette tips or Class A glass volumetric pipettes.

6.2.7 Class A volumetric flasks.

6.2.8 pH indicator strips (pH range 0 - 6).

6.2.9 Plastic digestate storage bottles.

7.0 Reagents and Standards

7.1 Reagent water must be produced by a Millipore DI system or equivalent. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks as defined in the determinative method SOPs, e.g., DV-MT-0002, DV-MT-0018, and DV-MT-0022.

7.2 Laboratory control sample (LCS), and matrix spike and matrix spike duplicate (MS/MSD) spike solutions are purchased as custom TestAmerica Denver solutions. Standards are logged into the Reagents module of TALS and are assigned unique identification numbers that can be used to access traceability information. The TALS identification numbers are recorded on the metals prep bench sheet.

7.2.1 All standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. These plastic bottles may be stored in a glass jar.

7.2.2 Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year and must be replaced sooner if verification from an independent source indicates a problem.

7.2.3 See TALS for the list of spiking levels. A volume of 0.1 mL of each working spike solution is added to the 50-mL final sample volume.

7.3 Nitric Acid (HNO_3), concentrated, trace-metal grade or better.

NOTE: When preparing diluted acids, always add acid to water. If the water is added to the acid, the sudden increase in temperature may cause splashing.

7.4 Nitric Acid, 1:1

Dilute concentrated HNO_3 with an equal volume of reagent water.

7.5 30% Hydrogen Peroxide (H_2O_2), ultra pure grade.

7.6 Hydrochloric Acid (HCl), concentrated, trace metal grade or better.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time [1]	Reference
Waters	HDPE Or Glass	500 mLs	HNO_3, pH < 2;	180 Days	40 CFR Part 136.3
Soils	Glass	4 oz	Cool 4 $\pm$ 2°C	180 Days	N/A

[1] Inclusive of digestion and analysis.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the TALS login, sample or method comments and/or program QAS to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver Policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver Policy DV-QA-024P, *QA/QC Requirements for Federal Programs*.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in TALS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified appropriately. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Table 2 provides a summary of quality control requirements, including type, frequency, acceptance criteria, and corrective action.

9.3 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. Ongoing

proficiency must be demonstrated by each analyst on an annual basis. See Section 12.1 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.4 Preparation Batch

A preparation batch is a group of up to 20 samples that are of the same matrix and are processed together using the same procedures and reagents. The preparation batch must contain a method blank, an LCS, a matrix spike (MS), and a matrix spike duplicate (MSD). For samples logged in under Method 200.8, there must be two MS/MSD pairs for every batch containing more than ten samples. In some cases, at client request, it may be appropriate to process a matrix spike and sample duplicate in place of the MS/MSD. If clients specify samples for the MS/MSD pair, then the batch may contain multiple MS/MSD pairs to accommodate client requests. Clients may also request a duplicate LCS (LCSD). In cases where the client has not provided sufficient sample to prepare an MS and MSD, an LCS and LCSD will be prepared instead.

9.5 Sample Count

Laboratory-generated QC samples (method blanks, LCSs) are not included in the sample count for determining the size of a preparation batch. The MS and MSD are usually not included in the sample count.

NOTE: For samples prepared under any AFCEE QAPP, all MSs and MSDs are included in the sample count.

9.6 Method Blank (MB)

The method blank consists of reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis. When samples are filtered in the laboratory for determination of dissolved metals, then the blank is filtered using a filter of the same type that was used for the samples. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false-positive data.

Acceptance Criteria: The method blank should not contain any analyte of interest at or above ½ the reporting limit (RL) or at or above 10% of the measured concentration of that analyte in associated samples, whichever is higher. In other words, the sample result must be a minimum of 10 times higher than the blank contamination level when the blank level is greater than ½ the RL. An exception is made for common laboratory contaminants (see section 16.1.1).

Corrective Action: If the method blank does not meet the criteria, the blank and all associated samples in the batch must be re-digested and reanalyzed. If the method blank is greater than ½ the RL and the samples have no detectable concentration of the

analyte of interest at or above the RL, the sample results may be reported with appropriate qualifiers if allowed by the project requirements. If allowed the PM must be notified and an NCM generated.

9.7 Laboratory Control Sample (LCS)

One aqueous LCS must be processed with each preparation batch. The LCS must contain all analytes of interest and must be carried through the entire analytical procedure. When samples are filtered in the laboratory for determination of dissolved metals, then the LCS is filtered using a filter of the same type that was used for the samples. The LCS is used to monitor the accuracy of the analytical process. Ongoing monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

Acceptance Criteria: LCS recovery control limits are set at ± 3 standard deviations about the historical mean. These limits must not be wider than 85 - 115 % recovery for Method 200.8, or 80 - 120 % for Method 6020. The control limits are maintained in TALS.

Corrective Action: If the LCS % recovery falls outside of the control limits for any analyte, that analyte is judged to be out of control. All associated samples must be reprocessed for analysis. One possible exception is a recovery for a given element above the upper control limit with no detection for the same element in the samples. This latter case must be explained in the case narrative.

9.8 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. Some client-specific data quality objectives (DQOs) may require the use of sample duplicates in place of or in addition to MS/MSDs. At least one MS/MSD pair must be processed for each preparation batch. Some client programs require a 10 % MS/MSD analysis frequency. If insufficient sample is available to process an MS/MSD pair, then a second LCS must be processed. The LCS pair is then evaluated according to the MS/MSD criteria.

The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process. Samples identified as field blanks, equipment blanks, or rinse blanks cannot be used for MS/MSD analysis.

Acceptance Criteria: The recovery for each analyte must fall within established limits. The relative percent difference (RPD) between the MS and MSD must be less than or equal to the established RPD limit. If any analyte recovery or relative percent difference (RPD) between the MS and MSD falls outside the

acceptance range, the recovery of that analyte must be in control for the LCS.

Corrective Action: If MS results fail to meet control limits, but the LCS results are within limits, then samples do not require re-preparation and reanalysis unless the results indicate that a spiking error may have occurred.

9.9 Quality Assurance Summaries

Certain clients may require specific project or program QC that may supersede the SOP requirements. Quality Assurance Summaries (QASs) are developed to address these requirements.

10.0 Procedure

Sample Preparation

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervisors to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

10.3 All samples are to be checked out of Sample Control with the Internal Chain of Custody in TALS properly completed.

10.4 Proper sample identification is extremely important in any preparation procedure. Labeling of beakers, digestion tubes, and bottles must be done in a manner to ensure connection with the proper sample.

10.5 Samples are typically logged in as either waters or soils. Wastes such as organic liquids or sludges and tissues (animal/vegetable) are usually logged in with solid test codes. When initiating sample preparation, examine the sample to see if the sample matches the matrix designation. If the sample is logged in as aqueous, but it appears to be more like a waste (biphasic, oil, sludge-like, organic liquid, lots of sediment, etc.), then contact the project manager and the laboratory group leader for further instructions.

10.6 If possible, prepare all the samples of a project at the same time to minimize the QC required and streamline the flow of the project through the lab, data review, and reporting groups.

10.7 Guidelines are provided in Appendix A on procedures to minimize contamination of

samples and standards.

10.8 All data shall be recorded directly on the described forms, logbooks, electronic forms, or directly in TALS at the time of data generation. It is not acceptable to record data on loose papers, scraps of paper, gloves, sample vials, or "Post-It" notes. Data may be recorded on paper bench sheets if the sheets are subsequently scanned and saved in a designated folder on the company server.

10.9 Aqueous Sample Preparation Setup

The following setup procedure must be followed for all aqueous samples prior to performing the specific digestion procedure:

10.9.1 Sample pH is verified during sample receipt. When a sample is received with improper/insufficient preservation, the sample is delivered with notification of the deficiency.

10.9.1.1 Measure the sample pH with pH paper using a separate aliquot of sample. Do not put the pH paper directly into to bottle. Record the pH on a copy of the internal chain of custody (ICOC). When all of the samples have been tested, initial and date the copy of the ICOC, scan it, and save it to the Metals folder on the G: drive.

10.9.1.2 If the pH>2 for a sample requiring acidic preservation, add 1-2 mL of conc. HNO_3 to the sample. Replace the lid and mix.

10.9.1.3 Recheck the pH of the sample. If the pH<2, record the sample in the Metals preservation logbook. If the pH>2, repeat 10.9.1.2 until pH<2 or 5mls has been added. If the sample still has a pH greater than 2 do not add any additional acid and create an NCM. Add the sample to the Metals preservation logbook

10.9.1.4 Allow the sample to sit for 8-16 hours following acidification.

10.9.1.5 After 8-16 hours, recheck the pH of the sample. If the pH<2, proceed with the appropriate digestion procedure. Note the date/time of this pH recheck in the Metals preservation logbook.

10.9.1.6 If after 8-16 hours the pH>2, repeat steps 10.9.1.2 through 10.9.1.5 until the pH remains <2 following the 8-16 hour period or 5mls of HNO_3 has been added.

Note: Acid must be added at least 24 hours before analysis.

10.9.2 Select the unfiltered fraction for a total or total recoverable analysis or the filtered fraction for a dissolved analysis. For SPLP select the proper

sample leachates.

NOTE: Samples requiring dissolved metals determination are either filtered and preserved in the field or are filtered and preserved by the laboratory as soon as possible after receiving the samples. When filtered in the laboratory, the filtration and preservation are recorded in the Laboratory Sample Filtration and Preservation Logbook, including the preservative type and lot number. Filter acceptability is demonstrated by using filters of the same type to filter samples and batch QC samples when preparation batches include samples that were filtered in the laboratory. The results of the analysis of the batch QC samples are used to demonstrate that the filtration process neither adds nor subtracts target analytes from samples.

10.9.3 Mix the sample by shaking the container.

10.9.4 Measure and transfer 50 mL of the sample into a digestion tube. When using calibrated digestion tubes, pour the sample into the tube to the 50-mL mark. Record the lot number of the digestion tubes in TALS.

10.9.5 Measure two extra aliquots of the sample that is selected for the MS/MSD analysis. Spike each aliquot with 0.1 mL of each spiking solution (see TALS). Record the standards and pipette identifications in TALS.

10.9.6 Measure and transfer 50 mL of reagent water into a digestion tube for the method blank. If a determination of dissolved metals is requested, use filtered reagent water for the method blank.

10.9.7 Measure and transfer 50 mL of reagent water into a digestion tube for the LCS and add 0.1 mL of spiking solution (see Table 2). Record the standards and pipette identifications in TALS. If determination of dissolved metals is requested (preparation method 3005A), and one or more samples were filtered in the laboratory, then filter the LCS using a filter of the same type that was used to filter the sample(s).

10.10 Proceed to the appropriate Section of this SOP for the desired preparation method as follows:

Preparation Method*	SOP Section	Analytical Method
3020A Total Metals	10.11	Method 6020
3005A Total Recoverable	10.12	Method 6020
3005A Dissolved Metals	10.12	Method 6020

200.8 Total Recoverable Metals	10.13	Method 200.8
200.8 Dissolved Metals	10.13	Method 200.8
3050B Special Sb prep	10.14	Method 6020

(See also WI-DV-017)

10.11 Method 3020A - Preparation for Total Metals Analysis by ICP-MS Method 6020 and 6020A

10.11.1 To the sample in a digestion tube, add 1.5 mL of concentrated HNO_3.

10.11.2 Heat at 90 - 95 °C until the volume is reduced to approximately 5 mL. Record the start time and the Hot Block temperature in TALS.

CAUTION: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY. Doing so will result in the loss of analyte and the sample must be re-prepared and reanalyzed.

10.11.3 Allow the digestion tube to cool in a fume hood.

10.11.4 Add 1.5 mL of concentrated HNO_3. Cover and reflux gently.

10.11.5 Continue heating, adding additional acid as necessary in 1-2 mL increments to ensure a complete digestion. Record the start and stop times and the Hot Block temperature in TALS.

NOTE: Digestion is complete when the digestate is light in color and does not change in appearance with continued refluxing.

10.11.6 Evaporate to low volume, approximately 3 - 5 mL.

10.11.7 Allow the digestion tube to cool, then add about 10 mL of reagent water.

10.11.8 Replace the cover and continue warming for 10 to 15 minutes to allow additional solubilization of any residue to occur. Record the stop time in TALS.

10.11.9 Allow the sample to cool and rinse the watch glass into the digestion tube with reagent water.

10.11.10 Re-Volume to 50 mL with reagent water, cap and mix thoroughly.

10.11.11 The sample is now ready for ICP-MS analysis. Refer to SOP DV-MT-0018 or DV-MT-0022.

NOTE: If insoluble materials are present in a sample digestate, the ICP-MS analyst may filter the sample prior to analysis. Refer to SOP DV-MT-0018 or DV-MT-0022 for additional details.

10.12 Method 3005A - Preparation for Total Recoverable and Dissolved Metals Analysis by ICP-MS Method 6020 and 6020A

10.12.1 To the sample in a digestion tube, add 2.0 mL of concentrated HNO_3.

10.12.2 Heat the sample to 90 - 95 °C and cautiously evaporate to a low volume of 15 - 20 mL, while ensuring that no portion of the sample container is allowed to go dry. Record the start and stop times and the Hot Block temperature in TALS.

CAUTION: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY. Doing so will result in the loss of analyte and the sample must be re-prepared.

10.12.3 Allow the sample to cool in a fume hood.

10.12.4 Rinse the digestion tube with reagent water.

10.12.5 Re-Volume to 50 mL with reagent water, cap and mix thoroughly.

10.12.6 The sample is now ready for ICP-MS analysis. Refer to SOP DV-MT-0018.

NOTE: If insoluble materials are present in a sample digestate, the ICP-MS analyst may filter the sample prior to analysis. Refer to SOP DV-MT-0018 or DV-MT-0022 for additional details.

10.13 Method 200.8 - Preparation for Total Recoverable/Potentially Dissolved/Dissolved Metals Analysis by ICP-MS

10.13.1 To the sample, add 0.5 mL of concentrated HNO_3 and 0.25 mL of concentrated HCl.

10.13.2 Adjust the digestion block temperature so the solution in a covered container rises to approximately 90 - 95 ºC. Record temperature on bench sheet.

10.13.3 Heat the sample until it evaporates to approximately 10 mL, while ensuring that no portion of the bottom of the digestion tube is allowed to go dry.

CAUTION: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY. Doing so will result in the loss of analyte and the sample must be reprepared.

10.13.4 Cover the sample and gently reflux for an additional 30 minutes. Avoid

vigorous boiling to prevent the loss of the HCl-H_2O azeotrope. Record the start and stop times and the Hot Block temperature in TALS.

10.13.5 Allow the sample to cool in a fume hood.

10.13.6 Rinse the watch glass or cover into the container and re-volume to 25 mL with reagent water. Cap and mix thoroughly.

NOTE: If the samples are being prepared to satisfy drinking water compliance requirements, bring the samples to a final volume of 50 mL before capping and mixing. Samples logged for this purpose will have attached TALS Method Comments to that effect.

10.13.7 The sample is now ready for ICP-MS analysis. Refer to SOP DV-MT-0002.

NOTE: If insoluble materials are present in a sample digestate, the ICP-MS analyst may filter the sample prior to analysis. Refer to SOP DV-MT-0002 for additional details.

10.14 Method 3050B – Special Prep for Sb, Sn and Ag for Analysis by ICP-MS Method 6020

10.14.1 To 25 mL of sample in a digestion tube, add 2.5 mL of HNO_3 and 2.5 mL of HCl.

10.14.2 Heat at 90-95 °C until the sample has reduced to a volume of 10-15 mL ensuring that no portion of the sample container is allowed to go dry.

Record the start and stop times and the Hot Block temperature in TALS.

10.14.3 Remove the sample from the Hot Block and allow it to cool in a fume hood.

10.14.4 Add 1.0 mL of HCl to the digestion tube and cover with a ribbed watch glass.

10.14.5 Replace the watch glass and heat the sample for 15 minutes.

Record the start and stop times and the Hot Block temperature in TALS.

10.14.6 Remove the sample from the Hot Block and allow it to cool in a fume hood.

10.14.7 Re-volume to 100 mL with reagent water, cap and mix thoroughly.

10.15 Calibration

The digestion block temperature must be maintained between 90 and 95 °C. The temperature must be monitored continuously while in use and must be recorded on the metals preparation bench sheet. The temperature must be monitored by measuring the temperature of reagent water contained in a digestion tube that is placed in each digestion block. The thermometer used and the start and end time temperatures are recorded in TALS. The thermometer is calibrated in accordance with SOP DV-QA-0001, *Thermometer Calibration Procedures*.

11.0 Calculations / Data Reduction

11.1 Not applicable. See the determinative method SOPs, DV-MT-0002, DV-MT-0018 and DV-MT-0022 for data analysis and applicable calculations.

11.2 Documentation

11.2.1 All of the preparation information is recorded and stored in TALS.

11.2.2 The preparation information includes:

11.2.2.1 Batch number, job and sample numbers, preparation date, and analyst name;

11.2.2.2 Matrix and prep type;

11.2.2.3 Initial sample pH, Initial sample volume and final volume;

11.2.2.4 Reagent manufacturer and lot number for each reagent used;

11.2.2.5 Digestion tube lot information;

11.2.2.6 Standard identification number for each standard used;

11.2.2.7 Start and stop times for digestions;

11.2.2.8 Observed and corrected temperature readings during digestion;

11.2.2.9 Identification numbers of calibrated measuring equipment used (thermometers, balances, pipettes, etc.).

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in DV-QA-005P. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

12.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. Ongoing proficiency must be demonstrated annually. IDOCs and ongoing proficiency demonstrations are conducted as follows.

12.2.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

12.2.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.2.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.2.4 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

13.1 This method allows for the proportional reduction of sample and reagent volumes to decrease waste generation.

13.2 Standards and reagents should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in Section 13, *Waste Management and Pollution Prevention*, of the Corporate Safety Manual, and DV-HS-001P, *Waste Management Plan*.

14.2 The following waste streams are produce when this method is carried out:

14.2.1 Expired Chemicals/Reagents/Standards: Contact Waste Coordinator

14.2.2 Acidic waste from sample digests: Waste Stream J.

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

15.1.1 Method 3005A, Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by FLAA or ICP Spectroscopy, Revision 1, July 1992.

15.1.2 Method 3020A, Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by GFAA Spectroscopy, Revision 1, July 1992.

15.1.3 Method 6020, Inductively Coupled Plasma - Mass Spectrometry, Revision 0, September 1994.

15.1.4 Method 3050B, Acid Digestion of Sediments, sludges and soils, Rev. 2, Dec. 1996.

15.2 Methods for the Chemical Analysis of Water and Waste (MCAWW), 1983.

15.3 Method 200.8, Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectroscopy, Revision 5.4, May 1994.

16.0 Method Modifications:

16.1 Modifications and Interpretations Applicable to SW-846 Reference Methods

16.1.1 Chapter 1 of SW-846 states that the method blanks should not contain any analyte of interest at or above the MDL. This SOP states that the method blank must not contain any analyte of interest at or above one-half of the reporting limit. Common lab contaminants are allowed up to two times the reporting limit in the blank following consultation with the client.

16.1.2 The referenced methods, as well as Table 3-1 of SW-846, refer to the use of a 100-mL aliquot for digestion. This SOP requires the use of a 50-mL sample size to reduce waste generation. The use of reduced sample volumes is supported in EPA's document "Response to Public Comments Background Document, Promulgation of the Second Update to SW-846, Third Edition", dated November 3, 1994. This document stated, "...flexibility to alter digestion volumes is addressed and 'allowed' by the table (3-1) and is also inherently allowed by specific digestion methods. Table 3-1 is only to be used as guidance when collecting samples..."

EMSL-Ci has also taken the stance that "reduction in sample size and appropriate corresponding reduction in sample volume is not considered a significant change in the methodology." Additionally, in written correspondence from the Office of Solid Waste, Oliver Fordham stated. " As a 'representative sample' can be assured, scaling causes no loss of precision and accuracy in the analysis."

16.2 Modifications Specific to Method 3005A

An additional 1.0 mL of HNO_3 was included to replace the 5.0 mL of HCl. HCl was eliminated to reduce interferences from chloride.

16.3 Modifications and Interpretations Specific to Method 3020A

16.3.1 Section 10.11.6 of this SOP requires that the sample be reduced to a volume of 3 -5 mL. Section 7.2 of Method 3020A states that the volume should be reduced to 3 mL, but also states that no portion of the bottom of the digestion tube should go dry. The volume required by this SOP is a closer approximation of the volume required to provide an adequate covering of the bottom of the digestion tube so as to prevent the loss of critical analytes through volatilization.

16.3.2 The scope of 3020A has been expanded to include silver, based on comparison studies with 7760A. Method 3020A consistently demonstrated improved accuracy and precision over Method 7760A in the matrices tested (reagent water, surface water, and TCLP leachate) up to a concentration of 1 ppm silver.

17.0 Attachments

Table 1.TCLP Reporting Limits, Regulatory Limits, and Matrix Spike Levels

Table 2.Summary of Quality Control Requirements

Appendix A.Contamination Control Guidelines

18.0 Revision History

- Revision 8, Dated 30 September 2015
  - Added drinking water to Section 1.6.
  - Corrected Section reference tables.
  - Added note to Section 10.13.6 describing changed final volume requirement.

- Revision 7, Dated 30 June 2015
  - Updated Section 10.13.2 for temperature requirement of 90-95 for method 200.8
  - Updated Section 10.9.1.1 for proper technique when using pH paper.
  - Added new Section 10.8 reminding analysts to enter data directly at time of acquisition
  - Added Section 11.2 describing required data to be recorded
  - Removed Section 11.4

- Revision 6, Dated 29 September 2014
  - Annual review
  - Removed references to microwave procedure
  - Removed direct-shoot for dissolved analysis
  - Corrected section references
  - Replaced LIMS and Standards Log references with TALS
  - Clarified the number of MS/MSDs per prep batch based on method
  - Removed workflow diagrams Figures 1-4
  - Removed Tables 1 and 2
  - Minor spelling and language corrections throughout
- Revision 5, Dated 30 September 2013
  - Reference to SOP DV-IP-0017 for preparation of organic waste
  - Formatting updates
  - Updated section 9, 12 & 14 to include more detail
  - Annual review
  - Updated sections 10.8.1.2 - 10.8.1.4 to removed reference to amount of HNO_3 acid added.
  - Added to Section 10.8.1.6 that a maximum of 5mls of HNO_3 can be added.
- Revision 4, Dated 28 September 2012
  - Annual review
  - Section 9.6 Updated method blank control limits to ½ the reporting limit.
  - Updated appendix B with revised Work Instruction.
- Revision 3.5, dated 23 September 2011
  - Annual Technical Review
  - Removed reference to Supplemental Metals Prep Sheets in Sections 10.10.8 and 10.13.5.1
  - Removed reference to Clouseau in Section 10.8.1.2
  - Removed references to LIMS codes in Appendix B

Earlier revision histories have been archived and are available upon request.

Table 1.

TCLP Reporting Limits, Regulatory Limits and Matrix Spike Levels

ELEMENT	RL (ug/L)	Regulatory Limit (ug/L)	Spike Level (ug/L)
Arsenic	500	5000	5000
Barium	10000	100000	50000
Cadmium	100	1000	1000
Chromium	500	5000	5000
Lead	500	5000	5000
Selenium	250	1000	1000
Silver	500	5000	1000

Table 2.

Summary of Quality Control Requirements

QC Parameter	Frequency	Acceptance Criteria	Corrective Action
Method Blank	One per sample preparation batch of up to 20 samples.	Refer to determinative SOP: DV-MT-0002	Re-digest and reanalyze samples associated with the method blank.
Laboratory Control Sample (LCS)	One per sample preparation batch of up to 20 samples.	Refer to determinative SOP: DV-MT-0002	Re-digest and reanalyze all samples associated with the LCS.
Matrix Spike (MS)	One per sample preparation batch of up to 20 samples.	Refer to determinative SOP: DV-MT-0002	Re-prep not required unless preparation error suspected.
Matrix Spike Duplicate (MSD)	See Matrix Spike	Refer to determinative SOP: DV-MT-0002	See Corrective Action for Matrix Spike.

Appendix A.

Contamination Control Guidelines

The following procedures are strongly recommended to prevent contamination:

All work areas used to prepare standards and spikes should be cleaned before and after each use.

All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.

Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.

Powdered or latex gloves must not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes. Only vinyl or nitrile gloves should be used in the metals laboratory.

Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.

Autosampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.

Improper cleaning of glassware can cause contamination.

Separate glassware if an unusually high sample is analyzed and soak with sulfuric acid prior to routine cleaning.

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Title: ACID DIGESTION OF SOLIDS [Method EPA 3050B]

Approvals (Signature/Date):

Doug Gomer 10/29/15 Doug Gomer Date Technical Specialist	Adam W Alban 29 Oct 15 Adam Alban Date Health & Safety Manager / Coordinator
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1.0 Scope and Application

1.1 This is a strong acid digestion procedure for the preparation of sediments, sludge, soils, and other types of solid materials by EPA Method 3050B for analysis by inductively coupled plasma atomic emission spectroscopy (ICP) or inductively coupled plasma-mass spectrometry (ICP/MS).

1.2 Method 3050B is designed to determine the concentration of "environmentally available" metals, and is not a true "total metals" digestion (see discussion below). The procedure is used primarily for hazardous waste characterization and other Resource Conservation and Recovery Act (RCRA) compliance testing.

1.3 The elements approved for Method 3050B are shown in Table I. The source method also mentions that other elements may be prepared by the method if the quality control requirements are met. The complete list of elements routinely included in this procedure by TestAmerica Denver is shown in Table II.

1.4 If sample preparation utilizing the Incremental Sampling Method is required, see SOP DV-OP-0013 for the procedure required prior to acid digestion for metals incorporating this procedure.

2.0 Summary of Method

A representative 1 to 2 gram portion of sample is digested with two cycles of nitric acid additions, followed by hydrogen peroxide digestion. For ICP analysis, the sample is also refluxed with hydrochloric acid. The resulting solution is filtered and diluted to 100 mL with reagent water. For the Incremental Sampling Method, 10 g of sample is used and brought to a final volume of 500 ml.

3.0 Definitions

3.1 **Total Metals -** Although Method 3050B is often referred to as a "total metals" digestion, it is important to understand that there are many compounds formed from these elements that are not efficiently dissolved using this digestion procedure. It is more accurately termed a strong acid digestion procedure. The limitations are discussed further in Section 4 (Interferences) below. The method itself states, "This method is not a total digestion technique for most samples." There are a variety of total digestion procedures used for metal assay, geochemical analysis, etc., that involve more vigorous digestions than 3050B.

3.2 **Preparation Batch -** A group of up to 20 samples that are of the same matrix and are processed together using the same lots of reagents and standards. The minimum QC elements in a batch are outlined in Section 9.

3.3 **Reagent Water –** Water that is free of the analytes of interest. In the Metals group, reagent water is obtained from a Barnstead E-Pure water purification system.

3.4 Other quality control terminology used in this procedure is based on SW-846, and is defined in the glossary section of the TestAmerica Denver Quality Assurance Manual (QAM) and Policy DV-QA-003P, *Quality Control Program*.

4.0 Interferences

4.1 There are common compounds formed by the elements of interest (e.g., barium sulfate, beryllium oxide, silicon dioxide, crystalline silicates, titanium dioxide, etc.) that are not efficiently dissolved using this EPA approved procedure.

4.2 Silicon or silica are occasionally requested as part of the Method 3050B digestion. However, this digestion will include only acid-soluble silicon, and will not dissolve crystalline silica. The analysis is for silicon, but the final result is sometimes expressed as silica rather than silicon.

4.3 Antimony and silver have poor solubility in dilute nitric acid solution. Therefore it is strongly recommended that these elements are determined by the ICP procedure that includes HCl as the final digestion acid. See Section 11.8 of this SOP.

4.4 Potential sources of trace metals contamination include metallic or metal-containing labware (e.g., powdered gloves which contain high levels of zinc), containers, impure reagents, dirty glassware, improper sample transfers, dirty work areas, atmospheric inputs such as dirt and dust, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them. See Attachment 1 for more information regarding contaminant control.

4.5 The entire work area, including the bench top and fume hood, should be thoroughly cleaned on a routine schedule in order to minimize the potential for environmental contamination.

4.6 For critical low-level determinations of boron and silica, only quartz and/or plastic labware should be used.

4.7 Physical interference effects may contribute to inaccuracies in the determinations of trace elements. Oils, solvents, and other matrix materials may not be digested using these methods if they are not soluble in acids. If physical interferences are present, they should be documented.

4.8 Allowing samples to boil or go dry during digestion may result in the loss of volatile metals or conversion of metals to insoluble forms. For example, antimony is easily lost by volatilization from hydrochloric media. If this occurs the sample must be re-prepared.

4.9 Visual interferences or anomalies (such as foaming, emulsions, precipitates, etc.) must be documented.

4.10 Samples Requiring Additional Digestion Reagents

A few examples of types of samples that might require additional digestion reagents follow. It is very important to note situations where samples are not behaving normally. However, do not assume that adding additional reagents will be acceptable for the project, even if it is obvious that the digestion will be incomplete without it. The situation must be discussed with the project manager

and documented in a Nonconformance Memo (NCM), whether or not the variations suggested in the following examples are approved.

4.10.1 Samples with high organic content may require additional nitric acid and/or hydrogen peroxide for a thorough digestion, but these oxidizing reagents should be added very carefully to avoid violent reactions.

4.10.2 Samples with high concentrations of metal in the elemental form or refractory oxides may require additional hydrochloric acid for a thorough digestion. As an example, blasting sand used to remove paint from the hull of ships typically consists of 30% cupric oxide. Following 3050B exactly will produce results as low as 0.1% without additional hydrochloric acid. Increasing the volume of hydrochloric acid can produce results approaching the true copper concentration. Samples that appear to have nonstandard matrices or have visible metal particles should be documented in an NCM.

4.10.3 Highly alkaline materials may require larger volumes of acid than specified in this procedure.

4.10.4 If the use of extra digestion reagents is approved, the same volume of reagents must be added to all field samples and QC samples in the batch. Usually the method blank results will not be elevated. To ensure that the QC sample results accurately reflect sample results, the QC samples must be treated exactly like the samples.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Samples that contain high concentrations of carbonates or organic materials or samples that are at elevated pH can react violently when acids are added. If any solid sample appears to be a chemical substance rather than an environmental sample, consult with the group supervisor or the Project Manager (PM) before adding acid.

5.3.2 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material (1)	Hazards	Exposure Limit(2)	Signs and Symptoms of Exposure
Hydrogen Peroxide, H_2O_2	Oxidizer Corrosive Poison	1 ppm TWA 1.4 mg/m^3 TWA 75 ppm IDLH	Contact with other materials may cause fire. Eye contact may result in permanent eye damage. Causes eye and skin burns. Corrosive: May cause severe respiratory tract irritation. Harmful if swallowed, may cause digestive tract irritation or burns.
Nitric Acid, HNO_3	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrochloric Acid, HCl	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.

(1) Always add acid to water to prevent violent reactions.

(2) Exposure limit refers to the OSHA regulatory exposure limit.

6.0 Equipment and Supplies

6.1 Top-loading balance capable of accurately weighing to the nearest 0.01 grams.

Note: Balances are serviced annually and the accuracy checked daily using three standard masses. See SOP DV-QA-0014 for details.

6.2 Digestion "Hot Block" or equivalent heating device capable of maintaining a temperature of 90-95 °C. The Hot Block temperature must be monitored separately for each unit. The temperature of each Hot Block is checked by placing a calibrated thermometer through a cap on a digestion tube that is partially filled with water. The water in the tube must be high enough to cover the thermometer past the minimum immersion line. The temperature is directly recorded in the Batch Information area in the TestAmerica LIMS (TALS).

6.3 Thermometers (non-mercury liquid filled or digital) that cover a temperature range including 80-110 °C with clearly visible 1 °C increments.

Note: Thermometers are calibrated before use and periodically as described in SOP DV-QA-0001.

6.4 Hot Block plastic digestion tubes, 50 mL and 125 mL, disposable.

6.5 Ribbed plastic cover, similar to a watch glass, for the digestion tubes; disposable.

6.6 Whatman 541 (acid washed) filter paper, or equivalent.

6.7 Disposable plastic funnels.

6.8 Disposable wooden spatulas for subsampling.

6.9 Centrifuge, capable of at least 2,000 rpm.

6.10 Graduated cylinders, 100 mL and 500 mL, capable of ± 3% accuracy.

6.11 Calibrated automatic pipettes with corresponding pipette tips or Class A glass volumetric pipettes.

Note: Mechanical pipettes are calibrated before use as described in SOP DV-QA-0008.

6.12 Class A volumetric flasks.

6.13 pH indicator strips (pH range 0 – 6).

6.14 Computer software and hardware. Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for date processing.

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 Reagent water – Millipore DI system or equivalent, 10-18.2 megohm-cm. See SOP DV-QA-0026 for daily water monitoring procedure.

7.2 Nitric acid (HNO_3), concentrated - Trace metal grade or better.

7.3 Nitric acid (HNO_3), 5% - Add 50 mL of concentrated HNO_3 to approximately 900 mL of reagent water and dilute to 1 liter.

7.4 Hydrochloric acid (HCl), concentrated - Trace metal grade or better.

7.5 30% Hydrogen peroxide (H_2O_2) - Reagent grade.

7.6 Glass beads, $\leq$ 1 mm diameter, washed with aqua regia (for AFCEE and DoD projects).

7.7 Standards

7.7.1 All standards must be NIST traceable. Unless purchased directly from NIST, the accuracy of each standard is verified before the initial use, as described in SOP DV-QA-0015.

7.7.2 Storage and Shelf Life of Metal Standards

7.7.2.1 Standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. They are stored at room temperature.

7.7.2.2 Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year and must be replaced sooner if verification from an independent source indicates a problem.

7.7.3 LCS and MS Spike Solutions

7.7.3.1 ICP and ICP/MS spike solutions are purchased as custom-made solutions from a commercial vendor at ready-to-use concentrations. No further dilutions are needed.

7.7.3.2 If a non-routine element is required that is not contained in the custom-made solution, single-element solutions from a commercial vendor may also be used.

7.7.3.3 Intermediate standards prepared in the laboratory may be used for spiking as long as the procedures for standard recording and verification outlined in SOP DV-QA-0015 are followed.

7.7.3.4 Typical LCS and MS/MSD spike standard concentrations are shown below.

Analysis	Standard	Elements	Conc. (mg/L)
ICP	ICP SPK 3A	Ag, Be, Cd Cr Cu Co, Mn, Ni, Pb, V, Zn As, Fe, Li, Sr, Th Al, Ba, Bi, Se, Tl, U P Ca, K, Mg, Na	5 10 20 25 50 100 200 1,000 5,000
ICP	ICP SPK 2B	Sb, Zr B, Mo, Ti Sn, S Si (SiO_2)	50 100 200 1,000 (2,140)
ICP-MS	MS CALSTD-1	Ag, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Ni, Pb, Se, Th, Tl, U, V, Zn	20
ICP-MS	MS spike 2	Mo, Sb, Sn, W, Zr Al, Fe	20 200

Note: ICP or ICP-MS digestions may select different combinations of spikes in order to satisfy client requests. All spikes used for sample digestion will be recorded in the Reagent module in TALS.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Sample holding time for metals included under the scope of this SOP is 180 days from the date of collection to the date of analysis.

8.2 Soil samples do not require chemical preservation, but are stored at ≤6 °C until the time of analysis.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time [1]	Reference
Soils	Glass	3 grams	Cool ≤ 6 °C	180 Days	N/A

[1] Inclusive of digestion and analysis.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. The process of establishing control limits and the use of control charts are described more completely in DV-QA-003P, *Quality Control Program*. Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is approved by the supervisor and then automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group also receives NCMs by e-mail for tracking and trending purposes. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in TALS and the Quality Assurance Summaries (QASs) in the public folders.

9.3 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver Policy DV-QA-024P, *QA/QC Requirements for Federal Programs*. This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated. Any deviation or exceptions from QSM 5.0 requirements must have prior approval in the project requirements.

9.4 Preparation batches may consist of up to 20 field samples. Laboratory generated QC samples (method blanks, LCS, MS/MSD) are not counted towards the maximum 20 samples in a batch. Field QC samples are included in the batch count.

9.5 Minimum QC Requirements

Each preparation batch must contain a method blank (MB), a laboratory control sample (LCS), and a matrix spike/matrix spike duplicate (MS/MSD) pair. Note that some programs require an unspiked duplicate sample in place of or in addition to the duplicate matrix spike. Be sure to check special instructions in TALS. If clients specify specific samples for the MS and MSD, the batch may contain multiple MS/MSD pairs.

9.5.1 Method Blank (MB)

One method blank must be processed with each preparation batch. The method blank consists of reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis. Soil method blanks are prepared by taking 5 mL or 5 g of reagent water through the procedure described in Section 11. Add 1.0 g of prewashed glass beads to the blank if required by the client to better simulate a solid matrix.

The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false positive data.

Acceptance Criteria: Criteria for the acceptance of blanks are contained within the individual analytical method SOPs.

Corrective Action: If the method blank does not meet the criteria contained within the analytical method SOPs, the blank and all associated samples in the batch must be re-digested and reanalyzed.

9.5.2 Laboratory Control Sample (LCS)

One aqueous LCS must be processed with each preparation batch. The LCS contains reagent water that is spiked with all the analytes of interest and is carried through the entire analytical procedure. A duplicate LCS (LCSD) may be prepared at client request or when there is insufficient sample volume to perform an MS/MSD. The LCS is used to monitor the accuracy of the analytical process. Ongoing monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines. Add 1.0 g of prewashed glass beads to the LCS if required by the client to better simulate a solid matrix.

The spike solutions described in Section 7.7.3 are used to prepare LCSs as follows:

- Routine ICP: Add 1.0 mL of spike
- AFCEE/DoD ICP: Add 1.0 mL of spike to 1.0 g of glass beads
- Routine ICP-MS: Add 1.0 mL of spike
- AFCEE/DoD ICP-MS: Add 1.0 mL of spike to 1.0 g of glass beads

The resulting spike concentrations for each element are given in Table 2 and Table 3.

Incremental Sampling Method LCSs are spiked with 5 ml of spike.

Acceptance Criteria: Criteria for the acceptance of LCS results are contained within the individual analytical method SOPs.

Corrective Action: When LCS results fail to meet control limits, the LCS and all associated samples in the batch must be re-prepared and reanalyzed.

9.5.3 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

One MS/MSD pair must be processed for each preparation batch. A matrix spike (MS) is a second aliquot of a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a third aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. Samples identified as field blanks cannot be used for MS/MSD analysis. The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process.

The spike solution described in Section 7.7.3 is also used to prepare matrix spikes, as follows:

- ICP: Add 1.0 mL of spike
- ICP-MS: Add 1.0 mL of spike

The resulting spike concentrations for each element are given in Tables II through IV. Incremental Sampling Method MS/MSD pairs are spiked with 5 ml of spike.

Note: The spike must be added after the sample aliquot but before any reagents.

Acceptance Criteria: Criteria for the acceptance of MS and MSD recoveries and the relative percent difference (RPD) between the MS and MSD results are contained within the individual analytical method SOPs.

Corrective Action: If any analyte recovery or RPD falls outside the established acceptance range, the recovery of that analyte must be in control for the LCS. If the recovery for the LCS is also outside of established limits, corrective action must be taken. Corrective action may include re-preparation and reanalysis of the batch. Corrective action when MS results alone fail to meet control limits does not include repreparation of samples unless the results indicate that a spiking error may have occurred.

Note: This method does not require a sample duplicate. Precision is measured using the MS/MSD. Use of the MS/MSD precision is preferred as not all samples will contain measurable concentrations of the target analytes. Samples that have target analytes at low concentrations or non-detectable levels do not provide useful precision data. When an MS/MSD pair is not available, an LCS and LCSD are used to measure precision.

10.0 Calibration

Not applicable. This SOP addresses sample preparation only for subsequent ICP or ICP/MS analysis. Calibration of the measurement system is covered in the SOPs for the determinative methods.

11.0 Procedure

11.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is approved by the supervisor and then automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA department also receives NCMs by e-mail for tracking and trending purposes. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

11.2 Sample Custody

11.2.1 Samples are transferred from the Sample Control group to the Metals group and the transfer is documented using the Sample Transfer function of the Internal Chain of Custody in TALS (see SOP DV-QA-0003 for details).

11.2.2 Proper sample identification is extremely important in any preparation procedure. Labeling of digestion tubes and bottles must be done in a manner to ensure connection with the proper sample.

11.3 Subsampling

11.3.1 It is not acceptable to simply collect 1.0 g off of the top of the sample. Samples must be mixed and incrementally subsampled to obtain a representative portion. At a minimum, mix by stirring with a disposable wooden spatula. If there is insufficient room in the sample container to allow for proper mixing, refer to SOP DV-QA-0023, *Subsampling*, for directions.

11.3.2 Select at least three incremental subsamples from different locations in the original sample and place them in a tared 50 mL digestion tube. The final sample weight should be between 1.0 and 1.5 g. Record the weight to the nearest 0.01 g.

11.3.3 Measure additional aliquots for QC samples required in the batch and spike as required (see Section 9 for details).

NOTE: When adding glass beads to the Method Blank and LCS digestion tubes, the nominal weight must be entered into the Initial Amount field in TALS. The true weight of glass beads should be recorded in the Notes field on the Worksheet tab in the preparation batch.

11.4 Incremental Sampling Method Digestion

For the Incremental Sampling Method approximately 10 g of sample is weighed out by the Organic Prep group following the procedure described in SOP DV-OP-0013. This pre-weighed sample is then delivered to the Metals group for digestion and analysis. The sample weight is recorded on the ISM Worksheet and attached to the incremental sampling batch in TALS. The pre-weighed aliquots are delivered in 125 mL digestion tubes which are ready for spike standards and reagents to be added. The Method 3050B digestion reagents are increased 5x to maintain the same proportions as are used for a 1-2 gram sample. When required, 10 g of glass beads are added to the Method Blank and LCS prior to digestion.

11.5 Initial Digestion Cycle with 1:1 Nitric Acid

11.5.1 Add approximately 5 mL of reagent water to each digestion tube.

11.5.2 Add 5 mL of concentrated HNO_3.

11.5.3 After all of the acid has been added to the preparation batch, gently swirl the samples to mix and then place the sample rack on the Hot Block.

11.5.4 Place a ribbed cover on each tube.

11.5.5 Heat samples to 95 °C, and reflux for 15 minutes without boiling.

NOTE: **DO NOT ALLOW SAMPLES TO BOIL OR GO DRY** during any part of the digestion. Doing so will result in the loss of analyte and the sample must be re-prepared.

11.5.6 Remove the samples from the Hot Block and allow them to cool before proceeding with the next step.

11.5.7 Record the start time, starting temperature, end time, and ending temperature in TALS.

11.6 Second Digestion Cycle Using Concentrated Nitric Acid

11.6.1 Add 5 mL of concentrated HNO_3, and replace the ribbed cover.

11.6.2 Place samples back on the Hot Block and reflux at 95 °C for 30 minutes. Add reagent water as needed to ensure that the volume of solution is not reduced to less than 5 mL.

11.6.3 If brown fumes are observed, this means that material in the sample is actively being oxidized. There may not be enough HNO_3 acid to complete the oxidation, and there could be violent reaction of the sample with peroxide in the third digestion step. For that reason, it is necessary to repeat the previous two steps until no more fumes are evolved.

11.6.4 Heat the samples at 95 °C for 2 hours.

11.6.5 Allow the samples to thoroughly cool before proceeding.

11.7 Third Digestion Cycle Using Hydrogen Peroxide

11.7.1 Add 2 mL of reagent water to each tube.

11.7.2 Add 3 mL of 30% H_2O_2 a few drops at a time. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence.

11.7.3 Replace the ribbed cover and heat samples until effervescence subsides.

11.7.4 Allow the samples to cool.

11.7.5 Continue adding 30% H_2O_2 in 1 mL increments with warming until effervescence is minimal or sample appearance is unchanged. If additional peroxide is added to a sample then it must also be added to the method blank and LCS.

NOTE: Do not add more than a total of 10 mL of 30% H_2O_2. If 10 mL have been added and the samples are still vigorously effervescing, document the situation with an NCM and continue with the digestion.

11.7.6 Heat the samples at 95 °C for 2 hours.

11.7.7 Allow the samples to cool.

11.7.8 If samples will be analyzed by ICP, continue on with the fourth digestion step using HCl in Section 11.8. If the samples will be analyzed by ICP-MS, skip the HCl digestion step and go to step 11.9.

11.8 Fourth Digestion Cycle for ICP Using Concentrated Hydrochloric Acid

11.8.1 If the samples are being prepared for ICP analysis, add 10 mL of concentrated HCl to the samples in the digestion tubes and cover with ribbed covers.

11.8.2 Reflux for an additional 15 minutes without boiling.

11.8.3 Allow the samples to cool.

11.9 Separating Undigested Solids from the Digestion Solution

11.9.1 Filter samples through Whatman 541 or equivalent fiber filters into a graduated 125 mL digestion tube whose accuracy is documented to be better than ± 3%.

NOTE: In place of filtering, the samples, after dilution and mixing, may be centrifuged or allowed to settle by gravity overnight to remove insoluble material.

11.9.2 For samples digested by the Incremental Sampling Method use a 500 mL poly bottle that has been measured after measuring out 500 mL of DI water from a graduated cylinder.

11.9.3 Wash the original digestion tube and ribbed cover with reagent water to ensure quantitative transfer of all of the digestion solution into the new digestion tube.

11.9.4 Rinse the funnel and filter paper with reagent water to ensure complete sample transfer into the new digestion tube.

11.9.5 Re-volume sample to 100 mL with reagent water. This must be done volumetrically, rather than by weight. Record the final volume in TALS. For Multi-Incremental samples the final volume is 500 mL.

11.10 Documentation and Record Management

The following information must be recorded for each preparation batch. This information is directly entered into TALS.

- Initial sample weight and final digestion volume
- Preparation analyst and date
- Identification of all reagents and standards
- Identification of all measuring and test equipment used (e.g., balances, thermometers, pipettes)
- Glass beads lot number
- Filter paper lot number
- Digestion tube lot number
- Hot Block ID number
- Fume Hood ID number

11.11 Alternate Antimony Preparation for Analysis by ICP-MS

11.11.1 Weigh out 1.0-1.5 g soil samples according to the procedure in Section 11.3.

11.11.2 Add approximately 5 mL of reagent water to each digestion tube.

11.11.3 Spike the LCS, LCSD, MS, and MSD with 1.0 mL of the MS spike 2 standard.

11.11.4 Add 2.5 mL concentrated HNO_3 and 2.5 mL concentrated HCl to each sample and batch QC.

11.11.5 Cover each tube with a watch glass and reflux on hot block at 95 °C for 15 minutes.

11.11.6 Filter through Whatman 541 or equivalent filter paper into a new 125 mL digestion tube while still hot.

11.11.7 Rinse the filter and funnel with 1.25 ml of hot (~95 °C) concentrated HCl.

11.11.8 Rinse three times with hot (~95 °C) reagent water (5 mL rinses.)

11.11.9 Place the filter paper and soil residue back into the original sample digestion vessel. Add 2.5 mL concentrated HCl, cover and reflux on the hot block for 20 minutes or until paper dissolves.

11.11.10 Filter through a fresh filter into the original filtrate. Rinse three times with reagent water (5 mL rinses).

11.11.11 Bring to final volume of 100 mL with reagent water.

12.0 Calculations / Data Reduction

Not applicable. Calculations of final results are described in the determinative analytical SOPs.

13.0 Method Performance

13.1 Method Detection Limit (MDL)

An MDL must be determined for each analyte/matrix prior to the analysis of any samples. See the SOPs for the determinative analysis methods for details.

13.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) for the preparation methods they will be performing before client samples may be prepared. Ongoing proficiency must be demonstrated annually. IDOCs and ongoing proficiency demonstrations are conducted as follows.

13.2.1 Four aliquots of the QC check sample (LCS) are prepared and passed to the appropriate analysts using the procedures detailed in this SOP and the determinative SOPs.

13.2.2 Calculations and acceptance criteria for QC check samples are given in the determinative SOPs for ICP-MS and ICP (DV-MT-0018 and DV-MT-0019, respectively).

13.2.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test

need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the procedure and take corrective action.

13.2.4 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

13.3 Training Requirements

The group leader or supervisor is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered in the batch record (View Batch Information)until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

14.0 Pollution Control

14.1 It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, order chemicals based on quantity needed, and prepare reagents based on anticipated usage and reagent stability).

14.2 Standards and reagents should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

15.0 Waste Management

15.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in Section 13, *Waste Management and Pollution Prevention*, of the Environmental Health and Safety Manual, and DV-HS-001P, *Waste Management Program*.

15.2 The following waste streams are produced when this method is carried out:

15.2.1 Aqueous Acidic (Metals) - Corrosive – Waste Stream J

15.2.2 Radioactive waste, mixed waste, and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of these materials.

16.0 References

16.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update III, December 1996; Method 3050B.

16.2 Department of Defense Quality Systems Manual for Environmental Laboratories,

Final Version 4.2, 10/25/2010.

16.3 Department of Defense Quality Systems Manual for Environmental Laboratories Version 5.0, July 2013.

17.0 Method Modifications:

Item	Method	Modification
1	3050B	Method 3050B Section 7.1 states that a 1-2 g aliquot is to be used. The amount specified by TestAmerica Denver in this procedure is limited to 1-1.5 g in order to prevent increased instrument maintenance and sample reruns due to dilutions.

18.0 Figures, Tables, and Attachments

Table 1: Method 3050B Approved Analyte List for ICP/ICP-MS

Table 2: Soil LCS and MS/MSD Spikes for ICP

Table 3: Soil LCS and MS/MSD Spikes for ICP-MS

Attachment 1: Contamination Control Guidelines

19.0 Revision History

- Revision 8 dated 31 October 2015
  - Annual Review
  - Edited Sections 9.5.1 and 9.5.2 to clarify glass bead requirement
  - Added definition of reagent water
  - Updated Section 11.6.4 and 11.7.6 to reflect current practice
  - Removed Method exception 1 regarding method blank limits as it no longer applies
  - Added detail to training requirements for new analysts Section 13.3
  - Added note to Section 9.5.3 regarding precision requirements
  - Added note to Section 11.3 regarding recording of glass bead weights

- Revision 7 dated 31 March 2015
  - Annual Review
  - In Section 11.7.8 the section referenced was updated to 11.8
  - Updated spike standard name to MS spike 2 in Section 11.11.3
  - Formatting and grammar corrections throughout
  - Section 6.4 removed reference to calibrating digestion tubes
  - Section 6.6 changed name of filter paper to match current practice
  - Section 6.14 added to define computer systems used
  - Sections 7.7.3.1 and 7.7.3.2 combined
  - New Sections 7.7.3.2 - 7.7.3.4 added to define spikes used
  - Table of spike names and concentrations added to Section 7.7.3.4

- Changed LIMS to TALS throughout
- Section 8.2 changed storage temperature to ≤6 °C
- Deleted Section 9.3, duplicated in 13.2
- Added new Section 9.3 to address federal requirements
- Rewrote Section 9.5
- Changed Sections 9.6 – 9.8 to be subsections of the new 9.5
- Rewrote Section 11.2.1
- Removed method modification 2 because it referred to the analytical SOP
- Created new method modification 2 explaining the 1-1.5 g sample aliquot
- Section 11.3.2 changed required sample aliquot to 1-1.5 g to help avoid targeting
- Rewrote Section 11.4 to define and explain the Incremental Sampling Method
- Added new Section 11.5.3 to explain sample mixing
- Section 11.7.5 added language to note regarding samples that require more than 10 mL of H2O2
- Added detail into Sections 11.9.1 – 11.9.5
- Folded Section 11.10.1 into 11.10
- Rewrote list of data to be entered into TALS in Section 11.10
- Rewrote Section 13.2 to match boilerplate
- Deleted flowcharts Figures 1 and 2
- Corrected element list in Table 2

- Revision 6 dated 31 March 2014
  - Annual Review
  - Formatting changes throughout document
  - Added to Section 11.7.5 to add additional peroxide to QC if added to samples
  - Updated section number in text to 11.8 in section 11.7.8
  - Added references for DoD QSM
  - Removed Attachment 2

- Revision 5 dated 04 March 2013
  - Section 7.7.3.1 Added DoD to the glass beads requirement
  - Section 11.11.2 Added that 5ml of water is added to the samples
  - Section 11.11.3 Changed spike name to 200.8 Cal-2
  - Updated spike level to 1.0ml in Table 3
  - Updated work instructions to current revision.
  - Formatting changes throughout document

- Revision 4 dated 3 February 2012
  - Changed references of Multi-Incremental Sampling to Incremental Sampling Method throughout document
  - Section 2.0 Added reference to Incremental Sampling Method
  - Section 6.4 Added 50 mL digestion tubes
  - Added introductory statement to section 7.0 regarding reagent purity
  - Section 7.1 Updated acceptable criteria for the reagent water
  - Section 9.7.2 Added LCS Incremental Sampling Method spike amounts
  - Section 9.8.2 Added MS/MSD Incremental Sampling Method spike amounts
  - Section 11.4 Updated sample amount for Incremental Sampling Method to 1 10g aliquot

- Section 11.9 Added Incremental Sampling Method final volume

- Revision 3.5, dated 24 August 2011
  - A note has been added to section 9.8.3 for the addition of the LCS/MS spike before reagents.

- Revision 3.4, dated 01 September 2010
  - Annual Technical Review
  - Updated documentation in section 11.10 to reference new LIMS.
  - Updated Section 11.11 and Figure 2 to reference current HCL amount used. Added method modification to digestion in Section 17.
  - Added Bismuth to Table 2
  - Updated Figure 2
  - Removed Example prep sheets (Attachments 2 – 4)
  - Updated work instruction WI-DV-015 (Attachment 5 now Attachment 2)

Earlier revision histories have been archived and are available upon request.

Table 1.

Method 3050B Approved Analyte List for ICP/ICP-MS

Element	Symbol	CAS Number
Aluminum	Al	7429-90-5
Antimony	Sb	7440-36-0
Arsenic	As	7440-38-2
Barium	Ba	7440-39-3
Beryllium	Be	7440-41-7
Cadmium	Cd	7440-43-9
Calcium	Ca	7440-70-2
Chromium	Cr	7440-47-3
Cobalt	Co	7440-48-4
Copper	Cu	7440-50-8
Iron	Fe	7439-89-6
Lead	Pb	7439-92-1
Magnesium	Mg	7439-95-4
Manganese	Mn	7439-96-5
Molybdenum	Mo	7439-98-7
Nickel	Ni	7440-02-0
Potassium	K	7440-09-7
Selenium	Se	7782-49-2
Silver	Ag	7440-22-4
Sodium	Na	7440-23-5
Thallium	Tl	7440-28-0
Vanadium	V	7440-62-2
Zinc	Zn	7440-66-6

Table 2.

Soil LCS and MS/MSD Spikes for ICP

ELEMENT	Stock Standard (mg/L)	Sample Spike (mg/kg)	Final Digested Solution (mg/L)
Aluminum	200	200	2.0
Antimony	50	50	0.5
Arsenic	100	100	1.0
Barium	200	200	2.0
Beryllium	5	5	0.050
Bismuth	200	200	2
Boron	100	100	1.0
Cadmium	10	10	0.1
Calcium	5,000	5,000	50.
Chromium	20	20	0.20
Cobalt	50	50	0.50
Copper	25	25	0.25
Iron	100	100	1.0
Lead	50	50	0.50
Lithium	100	100	1.0
Magnesium	5,000	5,000	50.
Manganese	50	50	0.50
Molybdenum	100	100	1.0
Nickel	50	50	0.50
Phosphorous	1,000	1,000	10.
Potassium	5,000	5,000	50.
Selenium	200	200	2.0
Silicon	1,000	1,000	10.
Silver	5	5	0.050
Sodium	5,000	5,000	50.
Strontium	100	100	1.0
Sulfur	200	200	2.0
Thallium	200	200	2.0
Thorium	100	100	1.0
Tin	200	200	2.0
Titanium	100	100	1.0
Uranium	200	200	2.0
Vanadium	50	50	0.50
Zinc	50	50	0.50
Zirconium	50	50	0.5

NOTE: Final soil spike concentration based on the addition of 1.0 mL stock standard to 1.0 g of sample, which is then digested to produce a 100 mL final volume.

Table 3.

Soil LCS and MS/MSD Spikes for ICP-MS

ELEMENT	Stock Standard (mg/L)	Sample Spike (mg/kg)	Final Digested Solution (µg/L)
Aluminum	200	200	2,000
Antimony	20	20	200
Arsenic	20	20	200
Barium	20	20	200
Beryllium	20	20	200
Cadmium	20	20	200
Chromium	20	20	200
Cobalt	20	20	200
Copper	20	20	200
Iron	200	200	2,000
Lead	20	20	200
Manganese	20	20	200
Molybdenum	20	20	200
Nickel	20	20	200
Selenium	20	20	200
Silver	20	20	200
Thallium	20	20	200
Thorium	20	20	200
Tin	20	20	200
Titanium	20	20	200
Tungsten	20	20	200
Uranium	20	20	200
Vanadium	20	20	200
Zinc	20	20	200
Zirconium	20	20	200

NOTE: Final soil spike concentration based on the addition of 1.0 mL stock standard to 1.0 g of sample, which is then digested to produce a 100 mL final volume.

Attachment 1

Contamination Control Guidelines

The following procedures are strongly recommended to prevent contamination:

- All work areas used to prepare standards and spikes should be cleaned before and after each use.
- All glassware should be washed with 5% HNO_3 according to the procedure described in SOP DV-IP-0005.
- Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.
- Powdered should not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes.
- Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.

The following are helpful hints in the identification of the source of contaminants:

- Yellow pipette tips and volumetric caps can sometimes contain cadmium.
- Some sample cups have been found to contain lead or cobalt.
- New glassware can be a source of silica and boron.
- Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.
- Improper cleaning of glassware can cause contamination.
- Latex gloves contain over 500 ppb of zinc.

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Title: Nitroaromatic and Nitroamine Explosive Compounds by High Performance Liquid Chromatography (HPLC) [SW-846 8330A & 8330B]

Approvals (Signature/Date):

Sarah Tinkham 03/27/15	Alan Fay 3/27/15
Sarah Tinkham — Date	For Adam Alban — Date
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1.0 Scope and Application

1.1 This standard operating procedure (SOP) describes the determination of nitroaromatic and nitroamine explosive residues by high performance liquid chromatography (HPLC) using dual columns and dual UV wavelengths. This includes analysis in water, soil, and sediment matrices. The instrumental analysis is based on EPA Methods 8330A and 8330B.

1.2 This SOP does not include the extraction procedures. For those details, please refer to DV-OP-0017 *Solid Phase Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from water samples by SW-846 3535A* and DV-OP-0018 *The Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Soil Samples by SW-846 8330A and 8330B.*

1.3 On occasion, clients may request modifications to this SOP. Requests for modifications must be received in writing and will be communicated to the laboratory through method comments in the LIMS.

1.4 Application of 8330A versus 8330B

1.4.1 This procedure is for analysis by either Method 8330A or 8330B. The most important differences in the two source methods are the more rigorous sample collection and preparation measures in 8330B, which are designed to produce more representative results. The more rigorous 8330B process is specifically intended to complement the multi-increment field sampling process described in Appendix A of 8330B. If multi-increment or equivalent systematic sampling processes are not employed in the field, then the extra laboratory homogenization and subsampling effort 8330B requires (see details in DV-OP-0018) may add little or no improvement in the overall precision of results.

1.4.2 For soil analysis, a larger sample size is used for 8330B (10 g) than is used for 8330A (2 g).

1.4.3 8330A only describes the cyano (CN) column for confirmation. 8330B gives the option of either cyano (CN) or pheny-hexyl columns for confirmation. Because it provides better sensitivity and resolution, TestAmerica Denver routinely confirms using the Phenomenex Luna Phenyl-Hexyl column for both methods.

1.4.4 8330B also added compounds to the potential analyte list. TestAmerica Denver offers all of the compounds shown in Appendix 1 of this SOP by both methods, except 3,5-dinitroaniline, which is only analyzed by 8330B.

1.5 Analytes, Matrix(s), and Reporting Limits

1.5.1 The list of analytes, CAS numbers, abbreviations and TA-Denver's standard reporting limits can be found in Appendix 1.

1.5.2 The working ranges of this method are as follows:

Analytes	8330A Soil (2g prep)	8330B Soil (10g prep)	Water
All Analytes except nitroglycerin and PETN	0.1 µg/g – 25 µg/g	0.04 µg/g – 10 µg/g	0.1 µg/L - 25 µg/L
Nitroglycerin and PETN	1.0 µg/g – 250 µg/g	0.40 µg/g – 100 µg/g	1.0 µg/L - 250 µg/L

2.0 Summary of Method

2.1 Instrument calibration is performed by external standardization using a minimum of five concentration levels.

2.2 An acetic acid and phosphate buffer in water / methanol gradient program is used for HPLC separation (see details in Section 7.8.10 and Appendix 4). Compounds are tentatively identified based on retention time and detection by the UV detector using the primary Agilent Poroshell 120 EC-C18 column. Confirmation is performed by the UV detector using a Phenomenex Luna Phenyl-Hexyl column (see Appendix 4 for instrument conditions).

3.0 Definitions

3.1 Explosives: As used in this SOP, the term “explosives” refers specifically to the analytes listed in Appendix 1. These include compounds that can be readily detonated with heat, shock, or ignition, such as nitroglycerin, RDX, and TNT. It also includes production by-products and degradation products of true explosives.

3.2 Definition of terms used in this SOP may be found in the Glossary section of the TestAmerica Denver Quality Assurance Manual (QAM) and in SOP QA-DV-003P.

4.0 Interferences

4.1 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.

4.2 Contamination by carryover can occur when a low-concentration sample is analyzed immediately following a high-concentration sample. This potential is minimized by continuously flushing the needle with solvent. If contamination is suspected, the sample should be re-aliquoted and re-analyzed.

4.3 Co-elution of target analytes with non-target analytes can occur, resulting in false positives or biased high results.

4.4 Co-elution between target analytes can occur when high concentrations of individual compounds are present in samples, see Section 12.2.3.5for details.

4.5 The inclusion of vegetation is not recommended given the nature of the detector and different uses the data will potentially support (USACE comment – Issue #306 TA Denver Audit Database).

4.6 Tetryl decomposes rapidly in methanol/water solutions, as well as with heat. All samples are acidified prior to extraction to preserve tetryl. Working-level calibration standards are also prepared with acidified water to preserve and stabilize tetryl. All samples expected to contain tetryl should not be exposed to temperatures above room temperature. (Reference: EPA Method 8330A & 8330B, Section 4.3)

5.0 Safety

Employees must abide by the policies and procedures in the Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual (RSM) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; non-disposable gloves must be cleaned immediately.

5.1.2 If a sample is expected to have an explosive concentration ≥2% (but less than 10%), the EH&S Coordinator and Group Leader shall be notified before any work is performed. Additional safety precautions may be implemented as required due to high concentrations of explosives.

WARNING: Soil samples with explosive concentrations greater than 2% cannot be accepted by the laboratory unless they have a moisture content of 25% or greater. Under no circumstances shall a soil sample with an explosive concentration greater than 10% be accepted by the laboratory.

5.1.3 Soil samples with high concentrations (between 2 and 10%) of explosives should not be ground using a mortar and pestle. Visual observation of a soil samples is important prior to grinding samples. Any samples containing metal fragments, powders, waxy appearing pieces, or other suspicious material should be brought to the attention of the Group Leader and the EH&S Coordinator before proceeding with the procedure. Bypassing the grinding step and proceeding to solvent dilution is an alternative for samples that are determined to be unsafe to grind.

5.2 Primary Materials Used

The following is a list of materials used in this method, which have a serious or significant hazard rating.

NOTE: This list does not contain all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.

A complete list of materials used in the method can be found in the reagent and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

MATERIAL (1)	HAZARDS	EXPOSURE LIMIT (2)	SIGNS AND SYMPTOMS OF EXPOSURE
Acetonitrile	Flammable Poison	40 ppm – TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
Glacial Acetic Acid	Corrosive Poison Flammable Liquid and Vapor	10 ppm - TWA	Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur. Can cause serious damage to skin, including redness, pain, and burns. Contact with eyes may cause severe damage followed by loss of sight.
Methanol	Flammable Poison Irritant	200 ppm - TWA	A slight irritant to the mucous membranes. Toxic effects are exerted upon the nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness, and dizziness. Methyl alcohol is a defatting agent and may cause the skin to be become dry and cracked. Skin absorption can occur, symptoms may parallel inhalation exposure. Irritant to the eyes.
Phosphoric Acid	Corrosive	1 ppm - TWA	Ingestion can cause severe burns to the throat, mouth, and stomach, abdominal pain and nausea. Severe exposures by ingestion can lead to shock, circulatory collapse, and death. Inhalation is not an expected hazard unless misted. Corrosive, contact with skin or eyes can cause redness, pain, severe burns, blurred vision, and permanent eye damage.
Sodium hydroxide	Corrosive Poison	2 mg/m^3	Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat, runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes and can cause burns that may result in permanent impairment of vision, even blindness with greater exposures.

(1) Always add acid to water to prevent violent reactions.
(2) Exposure limit refers to the OSHA regulatory exposure limit.

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 HPLC System

HPLC, equipped with a pump capable of achieving 6000 psi, a 100 µL loop injector, and a Diode Array Detector (DAD) or Multi-Wavelength Detector (MWD), Hewlett Packard Model 1100, or equivalent.

6.1.2 Primary Column: Reverse phase HPLC column, Agilent Poroshell 120, EC-C-18, 4.6mm x 150mm (2.7 µm) or equivalent.

6.1.3 Confirmation Column: Phenomenex Luna Phenyl-Hexyl reverse phase HPLC column, 15 cm x 4.6 mm (3 µm) or equivalent.

6.1.4 Hewlett Packard HPLC Chem Station for instrument control.

6.2 Supplies

6.2.1 Glass vials, various sizes.

6.2.1.1 Amber glass, 8.0 mL, with Teflon-lined screw caps, for the storage of standards.

6.2.1.2 Crimp-top vial with caps for analysis, 1.8 mL.

6.2.2 Disposable pipettes, used for non-quantitative transfers only.

6.2.3 Volumetric flasks, various sizes.

6.2.4 Hamilton syringes, various sizes.

6.3 Computer Software and Hardware

Please refer to the master list of documents and software located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Stock Standards

7.1.1 Stock standards are purchased as certified solutions or prepared from 100%, neat materials. Stock standard solutions are stored at -10 ℃ to -20

℃, or per vendor instructions. All stock standard s must be protected from light and should be brought to room temperature before using.

7.1.2 Stock standard solutions must be replaced after 1 year or sooner if comparison with check standards prepared from an independent source indicates a problem. Expiration times for all standards are measured from the time the standard is prepared or from the time that the standard ampoule is opened, if the standard is supplied in a sealed ampoule.

7.1.3 3,5-Dinitroaniline is purchased at a concentration of 100 µg/mL in acetonitrile, equivalent to our High-Level Calibration Mix. This standard is added directly to the Intermediate Level Calibration Standard. (Section 7.4).

7.1.4 PETN and Nitroglycerin are purchased as separate individual standards at a concentration of 1000 ug/mL in acetonitrile. These standards are added directly to the Intermediate Level Calibration Standard (Section 7.4).

7.1.5 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene are purchased as separate individual standards at a concentration of 100 ug/mL in acetonitrile, equivalent to the High-Level Calibration Mix. These standards are added directly to the Intermediate Level Calibration Standard (Section 7.4).

7.1.6 MNX is purchased as a pre-weighed neat standard and comes in powder form. A quantitative transfer is performed and the final concentration calculated for the high level MNX standard. The volume of this standard used for intermediate stock preparation will vary depending on the initial weight of MNX sent. This is the only known source of MNX and we do not currently have a second source for this compound.

7.2 Volume Measurements for all Standards Preparation

The volume of stock and intermediate standard solutions used in subsequent dilutions is measured using Hamilton syringes appropriate for the volume being measured and accurate to 2%. Standards are prepared either by (1) using a syringe to measure the standard solution and bringing to volume with the appropriate solvent in a Class A volumetric flask, or by (2) measuring the volumes of both the standard solution and the solvent using a calibrated syringe or Class A pipette and combining them in a vial.

7.3 High-Level Calibration Mix, Prepared from Stock Standards

This high level standard must be replaced every 1 year or sooner if comparison with check standards prepared from independent sources indicates a problem.

A solution is prepared to contain most standard analytes at a concentration of 100 µg/mL each in acetonitrile (see details in standards database instructions). Nitroglycerin, PETN, 3,5-Dinitroaniline, 2,4-diamino-6-nitrotoluene and 2,6-

diamino-4-nitrotoluene are purchased as separate stock standards, and are not included in this mixture. They are added to the intermediate level standards in section 7.4.

7.4 Intermediate Level Calibration Standards

8330IntermStk: Prepare a 20 µg/mL solution (nitroglycerin and PETN at 200 µg/mL) from the high-level calibration mix (see Section 7.3) by diluting 1.0 ± 0.02 mL of the High-Level Calibration mix along with 1.0 ± 0.02 mL each of stock standards of nitroglycern and PETN to a final volume of 5.0 mL in acetonitrile. The shelf life of this material is 6 months.

8330_ADDs: Prepare a 20 µg/mL solution from stock standards by diluting 1.0 ± 0.02 mL each of stock standards of 3,5 -dinitroaniline, 2,4-diamino-6-nitrotoluene, and 2,6-diamino-4-nitrotoluene to a final volume of 5.0 mL in acetonitrile. The shelf life of this material is 6 months.

7.5 Working Level Standards for Calibration Curve

Prepare calibration standards by diluting the intermediate standard solutions as shown in the table below using the 75%:25% (v/v) acidic water:ACN solution (described in Section 7.8.7). These standards must be prepared fresh on the day of calibration and refrigerated if not used immediately. All volumes are measured using the appropriately sized Hamilton syringe.

7.5.1 On the primary (C18) column, the 8330IntermStk and 8330_ADDs standards must be calibrated using separate sets of calibration standards due to co-elutions with other target compounds. The intermediate standards are prepared at the same concentration; therefore, the calibrations are made with the same volumes of intermediate stock and solvent in the following table.

7.5.2 On the confirmation (phenyl-hexyl) column, the intermediate full-list and intermediate 3,5-dinitroaniline stocks can be combined into the same calibration standards and follow the “Confirmation (Phenyl-Hexyl) Column Calibration” recipes in the following table.

Recommended Calibration Levels

Calibration Level	Final Concentration (µg/mL)		Primary (C18) Column Calibration		Confirmation (Phenyl-Hexyl) Column Calibration	
	Standard Analytes	*NG & PETN*	*Vol. Intermediate (µL)*	*Vol. Solvent (µL)*	*Vol. EACH Intermediate (µL)*	*Vol. Solvent (µL)*
8	2.5	25.0	125 ± 1	875 ± 9	125 ± 1	750 ± 9
7	1.0	10.0	50 ± 0.5	950 ± 10	50 ± 0.5	900 ± 10

Calibration Level	Final Concentration (µg/mL)		Primary (C18) Column Calibration		Confirmation (Phenyl-Hexyl) Column Calibration	
	Standard Analytes	*NG & PETN*	*Vol. Intermediate (µL)*	*Vol. Solvent (µL)*	*Vol. EACH Intermediate (µL)*	*Vol. Solvent (µL)*
6	0.7	7.0	35 ± 0.4	965 ± 10	35 ± 0.4	930 ± 10
5	0.4	4.0	20 ± 0.2	980 ± 10	20 ± 0.2	960 ± 10
4*	0.25	2.5	12.5 ± 0.1	988 ± 10	12.5 ± 0.1	975 ± 10
3	0.1	1.0	5 ± 0.05	995 ± 10	5 ± 0.05	990 ± 10
2	0.05	0.5	2.5 ± 0.02	998 ± 10	2.5 ± 0.02	995 ± 10
1	0.01	0.1	10 ± 0.1 µL of Level 7	990 ± 10	10 ± 0.1 µL of Level 7	990 ± 10
*** Level 4 concentration is used for the daily and continuing calibrations.**						

7.6 Extractions Standards

7.6.1 LCS Spike Solution

The LCS spike solution is prepared at a working level concentration of 10 µg/mL (nitroglycerin and PETN at 100 µg/mL) in acetonitrile. This standard is stored in a freezer at –20℃ to –10℃ and given a six-month expiration date. The standard is allowed to come to room temperature before use and returned to the freezer as soon as possible.

This standard contains all explosives target compounds except 3,5-dinitroaniline, 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene.

7.6.2 3,5-Dinitroaniline LCS Solution

The 3,5-DNA LCS solution is prepared at a working level concentration of 10 µg/mL in acetonitrile. This standard is stored in a freezer at –20℃ to –10℃ and given a six-month expiration date. The standard is allowed to come to room temperature before use and returned to the freezer as soon as possible. This standard is used only for method 8330B and is added to separate LCS and MS/MSD samples as this compound cannot be completely resolved from tetryl and nitrobenzene on the primary column.

7.6.3 Diamino LCS Solution

The Diamino LCS solution is prepared at a working level concentration of 10 µg/mL in acetonitrile of 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-

nitrotoluene. This standard is stored in a freezer at –20℃ to –10℃ and given a six-month expiration date. The standard is allowed to come to room temperature before use and returned to the freezer as soon as possible. This standard is generally added to separate LCS and MS/MSD samples, although it can be spiked in addition to the 3,5-Dinitroaniline LCS Solution.

7.6.4 Working Level Surrogate (1,2-Dinitrobenzene) Solution

The 8330 surrogate solution is prepared at a working level concentration of 10 µg/mL in acetonitrile. This standard is stored in a freezer at –20℃ to –10℃ and given a six-month expiration date. The st andard is allowed to come to room temperature before use and returned to the freezer as soon as possible.

7.7 Second Source Initial Calibration Verification Solution

The second source standard must be obtained from a different source than the standards used for initial calibration. This standard is used to verify the accuracy of the calibration standards.

NOTE: There is currently no second source available for MNX.

7.7.1 Working-Level Second Source Mix

Prepare a solution containing all compounds except 3,5-dinitroaniline, 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene at a concentration of 0.40 µg/mL (nitroglycerin and PETN at 4.0 µg/mL). A separate solution containing 3,5-dinitroaniline, 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene is prepared at a concentration of 0.40 µg/mL when analyzing on the primary (C18) column; the standards can be combined for analysis on the confirmation (phenyl-hexyl) column. These solutions are prepared using the 75%:25% (v/v) acidic water:ACN solution (described in Section 7.8.7). These standards must be prepared fresh on the day of calibration. All volumes are measured using the appropriately sized Hamilton syringe.

7.8 Reagents

7.8.1 Reagent Water

For method blanks and laboratory control samples reagent water is generated by an ELGA water purification system. The performance of the water polishing system is checked daily and recorded per SOP DV-QA-0026.

7.8.2 HPLC Grade Water

7.8.3 Acetonitrile, CH_3CN (ACN) - HPLC grade

7.8.4 Methanol - HPLC grade

7.8.5 Glacial Acetic Acid – Reagent Grade

7.8.6 85% Phosphoric acid, H_3PO_4 – Reagent Grade.

7.8.7 Acidified Water (75%) : Acetonitrile Solution (25%)

Take 250 mL of acetonitrile (ACN), and bring to 1.0 L with Elga or HPLC-grade water. Acidify the solution to a pH of approximately 3 by adding 20 drops (1 mL) of 85% phosphoric acid (H_3PO_4).

7.8.8 Acidified Calcium Chloride, $CaCl_2$ Solution, 5 g/L

Place 5 ± 0.05 g of reagent grade $CaCl_2$ into a one-liter volumetric flask containing approximately 500 mL of deionized water. Swirl the solution until the $CaCl_2$ is dissolved. Add approximately 1 mL of 85% H_3PO_4 to acidify the solution and bring to volume with deionized water.

7.8.9 Sodium Phosphate Buffer Stock

Slowly add 115.29 grams of 85% phosphoric acid (molecular weight = 97.9924 g/mol) to approximately 500 mL of water in a 1 L beaker. Place a stir bar in the beaker and the beaker in an ice bath on top of a magnetic stirrer. Slowly add 150 mL of 10 M (10 M = 10 N) sodium hydroxide, allowing time for the mixture to cool down between additions. Transfer to a 1 L volumetric flask and bring to volume with Elga or HPLC-grade water. The final pH of this solution should be 7.2.

7.8.10 Buffer Eluents for Analysis:

Make up the HPLC eluents for each column as described in Sections 7.8.10.1 and 0. The pH of the working eluents *must* be modified by the analyst by changing the volume of glacial acetic acid added to ensure compound resolution. This is particularly necessary when the column is replaced, to ensure that picric acid does not co-elute with any other target compound. Increasing the concentration (or volume added) of glacial acetic acid will result in greater retention of picric acid.

7.8.10.1 Working Eluent for Primary (C18) Column:

Combine 1 L of water, 1 mL of Sodium Phosphate Buffer Stock solution (Section 7.8.9), and 50 µL of Glacial Acetic acid to adjust the pH of the buffer to approximately 6.5. Make fresh before each run.

7.8.10.2 Working Eluent for Confirmation (Phenyl-Hexyl) Column:

Combine 1 L of water, 2 mL of Sodium Phosphate Buffer Stock solution (Section 7.8.9), and 65 µL of Glacial Acetic acid to adjust the pH of the buffer to approximately 6.5. Make fresh before each run.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Aqueous Samples

Water samples should be collected in duplicate 500 mL amber glass bottles with Teflon-lined caps. +

8.2 Soil and Sediment Samples

8.2.1 For method 8330A, soil samples should be collected in eight-ounce wide mouth jars with Teflon-lined caps. When sampling for DoD projects that must comply with the DoD QSM Version 3 requirements for drying and grinding the entire contents of a soil sample container, a separate container should be used to collect a soil sample for this analysis.

8.2.2 For method 8330B, it is not uncommon to receive samples of 1 kg or more. Samples may be shipped in wide mouth jars or clean plastic bags.

8.3 Samples and sample extracts must be stored in amber glass containers at ≤ 6℃ from the time of collection through analysis, except during drying.

8.4 Soil and sediment samples should be air dried at ambient temperature until dry enough to sieve. See DV-OP-0018 for details. Once the sample is air dried, the sample can be stored at room temperature.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time	Reference
Water	Amber glass	1 Liter (2 x 500 mL)	Cool; ≤ 6°C	7 Days to Extraction 40 Days to Analysis	SW846 8330A
Soil	Glass / plastic	4 grams (8330A) / up to 1 kg (8330B)	Cool; ≤ 6°C	14 Days to Extraction 40 Days to Analysis	SW846 8330A/B

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs. This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each column on which the associated samples are analyzed. See QC Policy DV-QA-003P for further details.

9.3 Method Blank (MB)

A method blank (MB) must be prepared and analyzed with each batch of samples. The MB consists of reagent water for aqueous samples, and Ottawa sand for soil samples, with surrogates added. The MB is created at the time of extraction after the samples have been dried, sieved, and ground and is then carried through all extraction and analysis steps. The method blank is used to identify any system

and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false-positive data.

Acceptance Criteria: The MB must not contain any analyte of interest at or above one-half the RL or at or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.

Method blanks are evaluated on each column on which associated samples are analyzed, when confirmation data are required. If there is a detection on either column in the MB, then detections for that target compound are suspect in associated samples.

Corrective Action: When the MB fails acceptance criteria, the source of contamination must be investigated and measures taken to correct, minimize, or eliminate the problem. All samples in the QC batch that have concentrations of affected target analytes greater than the RL, but less than 10 times the concentration in the MB must be re-prepared and reanalyzed.

If there are no target analytes greater than the RL, then the data may be reported with qualifiers if this is acceptable to the client.

If the MB acceptance criteria are not met and re-preparation and reanalysis are not possible, then the sample data associated with the unacceptable MB must be qualified. This nonconformance must be addressed in the project or case narrative and the client must be notified.

9.4 Laboratory Control Sample (LCS)

One LCS must be analyzed with each batch of samples. The LCS must contain specified analytes of interest and must be carried through the entire analytical procedure. For water samples, the LCS is prepared by spiking the analytes of interest into reagent water. For soil samples, the LCS is prepared by spiking the analytes of interest into Ottawa sand. The LCS is created at the time of sample extraction after the samples have been dried, sieved and ground. The LCS is used to monitor the accuracy of the analytical process. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

Acceptance Criteria: The LCS recovery for each spiked analyte must be within established control limits. Laboratory default control limits are calculated as ± 3 standard deviations

around the mean of historical data, as described in SOP DV-QA-003P. Control limits are maintained in the LIMS.

In accordance with the NELAC 2003 Standard (Quality Systems, Appendix D), a marginal exceedance within ± 4 standard deviations is allowed for one of the analytes. This is based on the number of analytes typically spiked for this method, which is between 11 and 30. These acceptance criteria may be superseded by project-specific limits, as applicable.

Corrective Action: If recoveries for all spiked analytes are not within the acceptance limits, including the one allowed marginal exceedance, the analytical system is out of control and corrective action must occur. Generally this requires re-extraction and reanalysis of all associated samples. If the LCS is biased high and all associated samples are ND, not detected, it may be possible to report results with an NCM (see requirements for individual programs).

9.5 Matrix Spike Sample (MS) and Matrix Spike Duplicate (MSD)

A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. The soil matrix spikes are created at the time of extraction. Spikes and surrogate compounds are added after the sample has been dried, sieved, and ground. One MS/MSD pair must be processed for each preparation batch. The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process. Samples identified as field blanks, equipment blanks, or rinse blanks cannot be used for MS/MSD analysis.

NOTE: The MS/MSD must be analyzed at the same dilution as the unspiked sample, even if the matrix spike compounds will be diluted out, or will exceed the linear range of the calibration standards.

Acceptance Criteria: The spike recoveries must fall within established control limits. The relative percent difference (RPD) between the MS and MSD must be less than or equal to the established RPD limit. Control limits are calculated as ± 3 standard deviations around the mean of historical data, as described in Policy DV-QA-003P. Control limits are maintained in the LIMS. Some federal programs require LCS limits to be used for MS/MSD evaluation (see SOP DV-QA-024P).

Corrective Action: If analyte recovery in the MS and/or MSD or the RPD between the MS and MSD fail acceptance criteria, but

the recovery of the LCS is in control, then the method is considered to be in control and the samples in the batch do not require re-preparation and reanalysis, unless the results indicate that a spiking error may have occurred. The reasons for accepting the batch must be documented in the case narrative. If the recovery of the LCS also fails acceptance criteria, then the samples in the batch must be re-prepared and reanalyzed.

9.6 Sample Duplicate

Although not typically required for organic analyses, a duplicate sample may be required for project-specific quality control. In this case, a sample duplicate is a second aliquot of one of the samples in the batch. Field blanks cannot be used for duplicate testing. The results for duplicates are reported separately, and cannot be averaged when reporting results. Sample duplicate results are used to evaluate the precision of the method. As such, results should be greater than or equal to the RL for a valid statistical comparison.

Acceptance Criteria: The RPD between the sample and the sample duplicate results must be less than the established limit.

Corrective Action: Results for samples that do not meet acceptance limits, particularly if due to difficulties in subsampling, shall be discussed in the final report case narrative, after client notification and agreement.

9.7 Sample Replicates

Replicate analyses are not part of the laboratories standard quality control samples. In the event that replicate analyses are required for a given project, the lab will extract triplicate aliquots after grinding on the client designated sample. The lab will determine the %RSD as defined below. Results for the %RSD as well as the individual replicate results will be reported to the client. The method suggests that the %RSD for the subsampling error is acceptable if it is <10%.

The percent relative standard deviation (%RSD) is calculated as follows:

$$\%RSD = \frac{s}{\overline{C}} \times 100\% \qquad \textit{Equation 1}$$

Where s is the standard deviation of the average concentration ($\overline{C}$) and is calculated as follows:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (C_i - \overline{C})^2}{n-1}} \qquad \textit{Equation 2}$$

In the event that the laboratory is requested to perform the evaluation of field replicate precision, three field replicates designated by the client will be processed through the entire homogenization and extraction steps. The %RSD for these replicates will be calculated as indicated above and reported to the client.

9.8 Grinding Blank (GB)

Refer to SOP DV-OP-0018 for details on how the grinding blanks for soils by method 8330B are prepared.

Acceptance Criteria: The grinding blank must not contain any analyte of interest at or above one-half of the RL or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.

Corrective Action: Per the method, the entire client sample is ground initially. Therefore, it is not possible to re-grind client samples if the grinding blank fails. Sample results will be reported with an NCM (see requirements for individual programs).

If the composite grinding blank results are greater than the acceptance limits, then the individual grinding blanks will be extracted and analyzed to determine when the contamination occurred and exactly which samples were affected. The potential carry-over between samples associated with a contaminated grinding blank producing positive results for the same contaminant must be described in a non-conformance memo and discussed in the final report case narrative.

9.9 Grinding LCS (LCSSRM)

Refer to SOP DV-OP-0018 for details on how the grinding LCS for soils by method 8330B is prepared. The grinding LCS is spiked by an outside vendor, and then ground with the associated samples.

Acceptance Criteria: The grinding LCS recovery for each spiked analyte must be within established control limits. Control limits are maintained in the LIMS.

Corrective Action: Per the method, the entire client sample is ground initially. Therefore, it is not possible to re-grind client samples if the grinding LCS fails. Sample results will be reported with an NCM (see requirements for individual programs).

If the surrogate compound recovers below control limits, or every compound recovers outside of control limits, but

at approximately the same percentage, this could be an indication of a bad extraction (post-grinding). Associated samples will be sent for re-extraction and re-analysis.

9.10 Sample QC Frequency

The following quality control samples are prepared with each batch of samples.

Quality Controls	Frequency
Method Blank (MB)	1 in 20 or fewer samples
Laboratory Control Sample (LCS)[1]	1 in 20 or fewer samples
Matrix Spike (MS)[2]	1 in 20 or fewer samples
MS Duplicate (MSD)[2]	1 in 20 or fewer samples
Surrogates	every sample[3]

[1] LCS Duplicate (LCSD) is performed if insufficient sample is available for the MS/MSD and it is requested by the client/project/contract.

[2] The sample for MS/MSD is randomly selected, unless specifically requested by a client. This is predetermined by the extraction lab.

[3] Analytical and QC samples (MB, LCS, MS/MSD)

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Extraction of Water Samples – *Please reference DV-OP-0017 for details*

Samples are extracted using a 500 mL initial volume and are concentrated to a 5 mL final volume.

10.4 Extraction of Soil Samples – *Please reference DV-OP-0018 for details*

10.4.1 Samples for method 8330A are extracted using a 2 g initial weight and delivered to the analytical group with a 10 mL final volume. Samples for method 8330B are extracted using a 10 g initial weight and delivered to the analytical group with a 20 mL final volume.

10.4.2 TALS prep batches for soils will show a final volume of 20 mL for 8330A extracts, and 40 mL for 8330B extracts. These final volumes include the 1:1 dilutions with the acidified calcium chloride done by the analyst prior to instrument analysis. (See Section 10.5.2.)

10.5 HPLC Analysis

10.5.1 HPLC Startup: All electronic equipment should be allowed to warm up for 30 minutes. During this period, at least 15 void volumes of mobile phase are passed through the column. Continue until the detector's baseline has stabilized.

10.5.2 Prior to analysis, soil extracts (or a portion of the extract) must be diluted exactly 1:1 with the acidified calcium chloride solution that is described in section 7.8.8.

10.5.3 Analyze the samples using the chromatographic conditions given in Appendix 4. All positive measurements above the method detection limit observed on the primary C18 column are confirmed by injection of the sample extract onto the confirmation Phenyl-Hexyl column.

10.5.4 Analytes are introduced by direct injection of the extract. Samples, standards, and QC samples must be introduced using the same procedure.

10.5.5 It has been demonstrated that water samples with total concentrations of 16,000 µg/L can yield low recoveries due to saturation of the extraction cartridge. The client should be contacted to determine if re-extraction using a smaller sample aliquot size is required for samples with concentrations in this range. The low extraction recovery may meet the client's action limit, such that a re-extraction may not be necessary to prevent possible laboratory contamination.

10.5.6 Analytical Sequence

10.5.6.1 The analytical sequence starts with either an initial calibration or a Continuing Calibration Verification (CCV).

10.5.6.2 The CCV includes analyzing standards that contain all target analytes, and updating the retention time windows. If 3,5-dinitroaniline, 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-

nitrotoluene are not target compounds, it is not required to analyze a CCV for these analytes.

10.5.6.3 If there is a break in the analytical sequence greater than 12 hours since the analysis of a CCV standard, a new CCV standard must be analyzed before proceeding with the sequence.

10.5.7 Retention Time Windows

10.5.7.1 Retention time windows must be determined for all analytes. Make an injection of all analytes of interest each day for a three-day period. Calculate the standard deviation of the three retention times for each analyte (relative retention times may also be used). The width of the retention time window for each analyte is defined as ± three times the standard deviation.

10.5.7.2 The chromatograms in Appendices 5 and 6 summarize the estimated retention times on both the C18 and Phenyl-Hexyl columns for many of the compounds analyzed using this method.

10.5.7.3 The center of the retention time window is the retention time from the last of the three standards. The centers of the windows are updated with the mid-point of the initial calibration, and each subsequent CCV. The widths of the windows will remain the same until new windows are generated following the installation of a new column.

10.5.7.4 If the retention time window, as calculated above, is less than ± 0.035 minutes for the C18 column or less than ± 0.07 minutes for the phenyl hexyl column, use ± 0.035 or ± 0.07 minutes as the retention time window. This allows for slight variations in retention times caused by sample matrix. The absolute retention time windows are closely monitored and adjusted based on each calibration verification standard. This minimizes the possibility of false positive and false negative qualitative identifications.

10.5.7.5 The laboratory must calculate new retention time windows each time a new column is installed. Until these standards have been run on the new column, the retention time windows from the old column may be used, but updated with the retention times from the new initial calibration.

10.5.8 Daily Retention Time Windows

The center of the retention time window is adjusted to the retention time of each analyte, as determined in each CCV.

Corrective Action:

If there are shifts in retention times for target compounds between CCVs that are outside the established retention time window (see Section 10.5.7), all samples analyzed after the last compliant standard must be reanalyzed unless the following conditions are met for any compound that elutes outside the retention time window:

- The retention time of that compound in the standard must be within the retention time range equal to twice the original window, as determined by the opening CCV of a bracket.

- No peak that would be reportable may be present on the sample chromatogram within an elution time range equal to three times the original retention time window.

10.6 Calibration Range and Dilutions

10.6.1 If the concentration of any analyte exceeds the working range as defined by the calibration standards, then the sample must be diluted and reanalyzed. Dilutions should target the most concentrated analyte in the upper half (between the CCV and highest standard) of the calibration range.

10.6.2 Samples that are analyzed immediately following a sample with an unusually high concentration of explosives must be evaluated for carryover. The potential for carryover is minimized in the analytical system by continuously flushing the HPLC needle with solvent. If contamination is suspected, the sample should be re-aliquoted and re-analyzed.

10.6.3 Guidance for Dilutions Due to Matrix Interference:

It may also be necessary to dilute samples because of matrix interferences. If the sample is initially run at a dilution and only minor matrix peaks are present, then the sample should be reanalyzed at a more concentrated dilution. Analyst judgment is required to determine the most concentrated dilution that will not result in instrument contamination. Ideally, the dilution chosen will make the response of the matrix interferences equal to approximately half the response of the mid-level calibration standard.

10.6.4 Reporting Dilutions

Some projects require reporting of multiple dilutions (check method comments in the LIMS). In other cases, the lowest dilution with no target compounds above the calibration range will be reported. In general, a maximum of two dilutions will be reported; one at the lowest dilution and one in which the most concentrated target analyte is in the upper half of the calibration range.

10.7 Instrument Maintenance and Troubleshooting

10.7.1 Minor instrument maintenance may include back flushing the column, changing the guard cartridge, and changing the frit on the front end of the column.

10.7.2 The solvent channel on which the buffer is run should be rinsed weekly with pure water followed by pure methanol and finally pure water again before reloading the buffer in order to prevent the buildup of salts and prevent bacterial growth in the system.

10.7.3 A cleanup method is provided in the instrument software to remove the buffer from the column. It should be run as the last injection of any run sequence. The buffer solution should not be left on the column for extended periods when the instrument is not in use or decreased column lifetime will observed.

10.7.4 Noisy baseline, particularly noticeable in RL level standards and MDLV samples, is normally due to a noisy UV Lamp. If the noise is sufficient to interfere with the quantitation of these samples, the lamp should be replaced and the instrument recalibrated. Less commonly, noisy baselines are the result of dirty flow cell windows, which should be cleaned or replaced according the manufacturer's instructions.

10.7.5 Unstable retention times are normally due to a malfunction somewhere in the flow path of the instrument. Likely sources are the active inlet valve, outlet ball valve, multichannel gradient valve or purge valve. Dirty solvent inlet filters can starve the pump and may also result in unstable retention times.

11.0 <u>Instrument Calibration</u>

11.1 Detailed calibration equations can be found in the corporate SOP CA-Q-S005, "Calibration Curves" and under the public folder, Arizona Calibration Training.

11.2 Instrument QC

11.2.1 External calibration is used for this analysis. Prepare standards containing each analyte of interest at a minimum of five concentration levels. The low level standard should be at or below the reporting limit. The other standards define the working range of the detector. Recommended calibration levels are given in Appendix 2.

11.2.2 A new calibration curve must be generated after major changes to the system or when the continuing calibration criteria cannot be met. Major changes include a new column and any changes in instrument operating parameters (including solvent flows, replacement of a detector lamp, replacement of the flow cell windows, etc.).

11.2.3 With the exception noted in Section 11.2.4 below, it is NOT acceptable to remove points from the calibration curve for the purpose of meeting criteria, unless the points are the highest or lowest on the curve AND the reporting limit and/or linear range is adjusted accordingly. In any event, at least 5 points must be included in the calibration curve.

11.2.4 A level may be removed from the calibration if the reason can be clearly documented (i.e., a broken vial or an injection error). A minimum of five levels must remain in the calibration. The documentation must be retained with the initial calibration.

11.3 Initial Calibration

Calibrations are modeled either as average response factors or as calibration curves, using a systematic approach to selecting the optimum calibration function in order as follows. When calibration acceptance criteria cannot be met for a model, appropriate corrective action must be taken. This may include processing the data using another model, instrument maintenance and or re-preparation of standards followed by recalibration.

11.3.1 The following requirements must be met for any calibration to be used:

11.3.1.1 Response must increase with increasing concentration.

11.3.1.2 Calibration curves will not be forced through the origin.

11.3.1.3 The absolute value of the intercept of the curve at zero response should ideally be less than the MDL for the analyte. At a minimum the intercept must be less than ½ the on-column equivalent of the reporting limit.

11.3.2 Linear Calibration Using Average Calibration Factors

11.3.2.1 External standard calibration using average calibration factors involves the comparison of instrument response (e.g., peak area or peak height) from the target compounds in the sample to the responses of the target compounds in the calibration standards. The ratio of the detector response to the concentration of target analyte in the calibration standard is defined as the calibration factor (CF), as follows:

$$CF = \frac{R_x}{C_s} \qquad \textit{Equation 3}$$

Where: R_x = Response for analyte
C_s = Concentration in calibration standard, µg/mL

11.3.2.2 For each target analyte, calculate the average calibration factor ($\overline{CF}$) as follows:

$$\overline{CF} = \frac{\sum_{i=1}^{n} CF_i}{n}$$ *Equation 4*

Where: n = Number of calibration levels
CF_i = Calibration factor for the ith level

11.3.2.3 The calibration relationship can be graphically represented as a line through the origin with a slope equal to the average calibration factor.

11.3.2.4 The relative standard deviation (RSD) is calculated as follows:

$$RSD = \frac{SD}{\overline{CF}} x100\%$$ *Equation 5*

Where SD is the standard deviation of the average CF, which is calculated as follows:

$$SD = \sqrt{\frac{\sum_{i=1}^{n} \left(CF_i - \overline{CF}\right)^2}{n-1}}$$ *Equation 6*

11.3.2.5 To calculate the concentration in an unknown sample extract, the equation is solved for concentration, resulting in the following equation:

$$C_{ex} = \frac{R_x}{\overline{CF}}$$ *Equation 7*

Where: C_{ex} = Extract analyte concentration, µg/mL
R_x = Response for analyte
$\overline{CF}$ = Average Calibration Factor

11.3.3 Average Calibration Factor Evaluation

Examine the residuals, i.e., the difference between the actual calibration points and the plotted line. Particular attention should be paid to the residuals for the highest points, and if the residual values are relatively large, a linear regression should be considered.

Acceptance Criteria: The RSD of the average response factor must be <20%. Also examine the residuals, especially for the high points versus the fitted function. If the residual values are large, a linear regression should be considered.

Corrective Action: If the RSD is > 20%, average response factor cannot be used and least-squares linear regression should be attempted.

11.3.4 Linear Calibration Using Least-Squares Regression

Calibration using least-squares linear regression produces a straight line that does not pass through the origin. The calibration relationship is constructed by performing a linear regression of the instrument response (peak area or peak height) versus the concentration of the standards. The instrument response is treated as the dependent variable (y) and the concentration as the independent variable (x).

The weighting used is the reciprocal of the concentration or the reciprocal of the square of the concentration. The regression produces the slope and intercept terms for a linear equation in the following:

$$R_x = m_1(C_s) + b \qquad \textit{Equation 8}$$

Where:

C_s	=	Concentration in calibration standard, µg/mL
R_x	=	Response for analyte
b	=	y - Intercept
m_1	=	Slope

To calculate the concentration in an unknown sample extract, the regression equation is solved for concentration, resulting in the following equations, where C_{ex} is the concentration of the target analyte in the unknown sample:

$$C_{ex} = \frac{[R_x - b]}{m_1} \qquad \textit{Equation 9}$$

Where:

C_{ex}	=	Extract analyte concentration, µg/mL
R_x	=	Response for analyte
b	=	y - Intercept
m_1	=	Slope

11.3.5 Evaluation of the Linear Least-Squares Regression Calibration Function:

With an unweighted linear regression, points at the lower end of the calibration curve have less weight in determining the curve than points at the high concentration end of the curve. For this reason, inverse weighting

of the linear function is recommended to optimize the accuracy at low concentrations.

Note that the August 7, 1998 EPA memorandum "Clarification Regarding Use of SW-846 Methods", Attachment 2, Page 9, includes the statement "The Agency further recommends the use of this for weighted regression over the use of an unweighted regression."

Acceptance Criteria:

11.3.5.1 Examine the residuals, but with particular attention to the residuals at the bottom of the curve. If the intercept or the residuals are large, a second-order regression should be considered.

11.3.5.2 The linear regression must have a correlation coefficient (r) ≥ 0.995 ($r^2 \geq 0.990$).

11.3.6 Non-linear Calibration Using a Second-Order Equation

When the instrument response does not follow a linear model over a sufficiently wide working range, or when the previously described calibration approaches fail acceptance criteria, a non-linear, second-order calibration model may be employed. The second-order calibration uses the following equation:

$$R_x = m_2(C_s)^2 + m_1(C_s) + b$$ *Equation 10*

Where:

C_s	=	Analyte concentration in calibration standard, µg/mL
R_x	=	Response for analyte
m_2	=	Curvature
m_1	=	Slope
b	=	y - Intercept

To calculate the concentration in an unknown sample extract, the roots of the quadratic equation are solved for:

$$C_{ex} = \frac{-m_1 \pm \sqrt{(m_1)^2 - 4(m_2)(b - R_x)}}{2m_2}$$ *Equation 11*

Where:

C_{ex}	=	Extract analyte concentration, µg/mL
R_x	=	Response for analyte
m_2	=	Curvature
m_1	=	Slope
b	=	y – Intercept

11.3.7 Evaluation of Second-Order Regression Calibration:

A minimum of six points must be used for a second-order regression fit.

Acceptance Criteria:

11.3.7.1 Second-order regressions should be the last option, and note that some programs (e.g., South Carolina) do not allow the use of second-order regressions.

11.3.7.2 The coefficient of determination (COD, r^2) must be ≥ 0.99.

11.3.7.3 The response increases significantly with increasing standard concentration (i.e., the instrument response does not plateau at high concentrations).

11.3.7.4 The distribution of concentrations is adequate to characterize the curvature.

11.4 Calibration Verification

11.4.1 Initial Calibration Verification (ICV)

A second-source verification standard must be analyzed with each initial calibration. The calculated concentration of the analytes in this standard may not be greater than 20% different from the calibration standard.

11.4.2 Continuing Calibration Verification (CCV)

The working calibration curve or RF must be verified by the analysis of a mid-point continuing calibration standard at the beginning of the analysis sequence, after every 10 samples, and at the end of the analysis sequence.

Acceptance Criteria:

Results are acceptable for any individual compound if the %D (percent difference between the standard and measured values of the CCV standard) is ≤ 20%.

According to SW-846 Method 8000B, the calibration verification is also acceptable if the average of the %D values for all the analytes is ≤ 15%. This average is calculated by summing all the absolute %D results in the calibration (including surrogates) and dividing by the number of analytes. However, TestAmerica Denver also requires that no single analyte result exceeds 30% D.

NOTE: In order to comply with DoD QSM requirements, the use of the grand mean is not acceptable (refer to policy DV-QA-024P). Results are acceptable for individual compounds if the %D is:

8330A		8330B	
QSM 3	%D ≤ 20%	QSM 3	%D ≤ 20%
QSM 4	%D ≤ 15%	QSM 4	%D ≤ 20%
QSM 5	%D ≤ 15%	QSM 5	%D ≤ 20%

Corrective Action:

If the percent difference for any analyte falls outside of ± 20%, corrective action must be taken. This may include back flushing the column, changing the guard cartridge, changing the frit on the front end of the column, or other minor instrument adjustments, followed by reanalyzing the standard. If the response for any analyte still varies by more than 20%, a new calibration curve must be prepared and analyzed. The column may also need to be replaced based on the chromatography.

Reported sample results must be bracketed by successful CCVs. When a CCV fails, all samples run since the last successful calibration verification must be reanalyzed. If the CCV recovery is >20% D and the associated samples are ND, the samples may be reported without reanalysis. Flag the data and document the decision in an NCM.

12.0 Calculations / Data Reduction

12.1 Detailed calibration equations can be found in the corporate SOP CA-Q-S005, “Calibration Curves” and under the public folder, Arizona Calibration Training.

12.2 Qualitative Identification

12.2.1 Tentative identification occurs when a peak is found within the retention time window for an analyte, at a concentration above the method detection limit. The required quantitation level is defined as the LIMS test code reporting limit for standard reports, adjusted for initial weight and volume and any dilutions. A UV detector wavelength of 254 nm is used to quantify and report all analytes except PETN and Nitroglycerin that are quantified and reported using a UV detector wavelength of 215 nm.

12.2.2 Identification is confirmed if a peak is also detected within the retention time window on a dissimilar column (Section 12.3).

12.2.3 Sample Evaluation:

12.2.3.1 Analyst judgment weighs heavily in the evaluation of retention time shifts for client samples. The evaluation may be based on RT shifts of the surrogate standard. The chromatograms must be examined closely to ensure that false positive / negative results are not reported. In the absence of significant shifts of the surrogate, peaks within a ± 0.035 minutes (C18 column) or ± 0.07 minutes (phenyl hexyl column) window must be considered positive results.

12.2.3.2 If the sample required significant dilution due to high levels of target peaks or interfering compounds, the surrogate peak may not be obvious. In this case, an adjustment of RTs due to matrix for target compounds cannot be done reliably, and ± 0.035 minutes (C18 column) or ± 0.07 minutes (phenyl hexyl column) (or the established RT window described in Section 10.5.7) from the most recent CCV will be used for all compounds.

12.2.3.3 The expected retention time for target analytes is updated with the retention times of each CCV. If sample matrix is causing significant retention time shifts between CCVs, samples may require dilution and reanalysis to minimize the matrix effects.

12.2.3.4 Method Blank Detections:

When a detection is observed in the method blank on either column, detections in associated samples for this target compound are suspect. If the associated samples are ND for this target compound (as determined by an ND result on either column), then the results will be reported with an NCM. If there is a detection for this target compound on both columns that is greater than the RL but less than 10x the detection in the MB, the sample and MB may be analyzed by LCMS for confirmation.

Water samples are difficult to analyze by LCMS due to the high concentration of $CaCl_2$ with which the samples are extracted. Dilution of the samples is required to preserve the integrity of the instrument. Therefore, low-level hits may not be able to be confirmed by LCMS.

12.2.3.5 Interferences:

2,4,6-Trinitrotoluene elutes closely with 4-amino-2,6-dinitrotoluene on the primary (C18) column. Because of this close elution, high levels of 2,4,6-trinitrotoluene can overlap the retention time window for, and thus mask the presence of, low levels of 4-amino-2,6-dinitrotoluene. Therefore, 4-amino-2,6-

dinitrotoluene may be reported as a detection from the confirmation (phenyl-hexyl) column, even though no peak could be detected on the primary column. In this event, an NCM is necessary.

Other target compound interferences may be observed in samples. Analyst judgment will be necessary to evaluate sample chromatograms and potentially report additional detections without confirmation and/or analyze samples at dilutions. In this event, an NCM is necessary, documenting the decision.

12.3 Second-Column Confirmation

Detection of compounds on the primary column is confirmed using a second, dissimilar column. This column is calibrated using the same calibration levels as the primary column. The analysis on the second column must meet all of the instrument QC described in Section 11.0. Identification is confirmed if a peak is also present in the retention time window for that analyte on the confirmatory column. As specified in Method 8000, mass spectrometric confirmation may also be used.

The RPD between two results is calculated using the following equation:

$$\%RPD = \frac{\left|R_1 - R_2\right|}{\frac{1}{2}\left(R_1 + R_2\right)} \times 100\% \qquad \textit{Equation 12}$$

Where R_1 is the result for the first column and R_2 is the result for the second column.

Acceptance Criteria:

The RPD between confirmed results should agree within 40%; results will then be reported from the primary column.

Corrective Action:

If the RPD is >40% and there is visible positive interference, e.g., co-eluting peaks, elevated baseline, etc., for one column and not the other, then report the results from the column without the interference with the appropriate data qualifier flag, footnote, and/or narrative comment in the final report.

If the RPD is >40% and there is visible positive interference for both columns, then report the lower of the two results with the appropriate flag, footnote, and/or narrative comment in the final report.

12.4 Manual Integrations

Raw instrument data is automatically transferred to Chrom at the completion of each run for further processing. Review the chromatograms to ensure correct assigning of peaks and correct integration of each peak. If manual data manipulations are necessary, they must be justified and documented. See DV-QA-011P for requirements for manual integration.

12.5 % Difference Calculation for ICV / CCV Evaluation

The percent difference for the analysis of a CCV standard is calculated as follows:

$$\%\ \text{Difference} = \left(\frac{\text{Expected Value} - \text{Measured Value}}{\text{Expected Value}}\right) \times 100\% \qquad \textit{Equation 13}$$

12.6 Concentration in Aqueous Samples

The concentration of analyte in the original aqueous sample is calculated as follows:

$$\text{Concentration, } \mu\text{g/L} = \frac{C_{ex}V_t}{V_o} xDF \qquad \textit{Equation 14}$$

Where:

C_{ex}	=	Extract analyte concentration, µg/mL
V_t	=	Volume of total extract in mL (normally 5 mL)
V_o	=	Volume of water extracted in liters (normally 0.5 L)
DF	=	Dilution factor, as appropriate

12.7 Concentration in Soil Samples

The concentration of analyte in the original non-aqueous sample is calculated as follows:

$$\text{Concentration, } \mu\text{g/kg} = \frac{C_{ex}V_t}{W} \times DF \qquad \textit{Equation 15}$$

Where:

C_{ex}	=	Concentration of analyte in the extract (µg/mL)
V_t	=	Total volume of original extract in mL (normally 20 mL for 8330A or 40 mL for 8330B); this volume includes the extracted volume in ACN and the 1:1 dilution with $CaCl_2$
W	=	Weight (mass) of sample extracted in kg (normally 0.002 kg for 8330A or 0.010 kg for 8330B)
DF	=	Dilution factor, as appropriate

12.8 Concentration of Ammonium Picrate

Ammonium picrate is requested by some clients as a target compound. This is the ammonium salt of picric acid. Chromatographically, there is no difference between these two compounds, therefore, upon request, the result for ammonium picrate (C_{AP}) is calculated based on the measured concentration of picric acid, as follows:

$$C_{AP} = Picric\ Acid\ Result \times \left(\frac{246.13\,(Molar\ Mass\ of\ Ammonium\ Picrate)}{229.11\,(Molar\ Mass\ of\ Picric\ Acid)} \right)$$

Equation 16

In TALS, this calculation is accomplished by opening the batch information in the analytical batch, and setting the calculation line to 1 (Yes).

12.9 LCS and CCV Percent Recovery

$$\text{Control Spike Recovery} = \frac{S_{SR}}{S_A} \times 100\%$$

Equation 17

Where S_{SR} = Calculated analyte concentration of spiked sample
S_A = Concentration of standard added

12.10 MS / MSD Percent Recovery Calculation

$$\text{Matrix Spike Recovery} = \frac{S_{SR} - S_R}{S_A} \times 100\%$$

Equation 18

Where S_{SR} = Calculated analyte concentration of spiked sample
S_R = Calculated analyte concentration of parent sample
S_A = Concentration of standard added

12.11 Relative Percent Difference Calculation for the MS/MSD

$$RPD = \frac{|MS_R - MSD_R|}{1/2(MS_R + MSD_R)} \times 100$$

Equation 19

Where RPD = Relative percent difference
MS_R = Matrix spike result of analyte
MSD_R = Matrix spike duplicate result of analyte

12.12 Reporting limits are shown in Table 1. If samples require dilutions or smaller volumes than normally used, the MDLs and RLs will be correct based on the actual volume used and/or the dilution factor. Reporting limits for soil samples are

adjusted for the actual weight of sample extracted. As samples are dried prior to subsampling for analysis percent moisture is not determined.

12.13 All results are subject to two levels of technical review. See SOP DV-QA-0020 for a more detailed description for data review and an example of this checklist.

13.0 Method Performance

13.1 Initial Method / Instrument Demonstration of Capability

13.1.1 An initial demonstration of capability for each method must be performed on each instrument prior to analyzing samples.

13.1.2 For the standard analyte list, the initial demonstration consists of the preparation and analysis of a method detection limit (MDL) study, described in Section 13.2 as well as four QC check samples containing all of the standard analytes for the method

For the QC samples, the mean recovery and standard deviation are calculated for each analyte of interest. These results are compared with the established or project-specific acceptance criteria. All four results must meet acceptance criteria before the method can be used to analyze samples.

13.1.3 For non-standard analytes an MDL study must be performed and calibration curve generated before analyzing any samples, unless lesser requirements are previously agreed to with the client. In any event, the minimum initial demonstration required is successful analysis of an extracted standard at the reporting limit and a single point calibration.

13.2 Method Detection Limit (MDL)

A valid method detection limit (MDL) study for each analyte of interest must be performed on each instrument prior to analyzing samples for the first time. Separate soil MDL studies are performed for 8330A using 2 g and 8330B using 10 g of Ottawa Sand. The procedure for determining detection limits is defined in Policy DV-QA-005P.

13.3 MDL Verification (MDLV)

13.3.1 Calculated MDLs are subject to verification by analyzing an MDLV standard prepared at 2-4 times the calculated MDL concentration. An MDLV standard is analyzed immediately after each MDL study and quarterly thereafter. This standard is subject to the entire preparation and analysis process. The calculated MDL is verified if the MDLV standard is detected under routine instrument conditions.

13.3.2 If the first MDLV is not detected, the MDLV standard will be re-prepared and analyzed at twice the original concentration. The lowest concentration that produces a detectable signal will then be reported as the MDL.

13.3.3 MDLs are verified at least annually unless program requirements stipulate a greater frequency (e.g., DoD).

13.4 Analyst Training and Qualification

13.4.1 The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See SOP DV-QA-0024 for details of training requirements.

13.4.2 Each analyst performing the method must complete an initial demonstration of capability (IDOC) by successfully preparing and/or analyzing four consecutive LCSs, or a blind performance evaluation (PE) sample, or other acceptable QC samples. The results of the IDOC study are summarized in the NELAC format, as described in SOP DV-QA-0024. IDOCs are approved by the Quality Assurance Manager and the Technical Director. IDOC records are maintained by the QA staff in the central training files. Analysts who continue to perform the method must successfully complete a demonstration of capability annually.

14.0 Pollution Control

Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

15.0 Waste Management

15.1 All waste will be disposed of in accordance with Federal, State, and local regulations. When reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, “Waste Management and Pollution Prevention”, of the Corporate Environmental Health and Safety Manual, and DV-HS-001P, “Waste Management Program.”

15.2 The following waste streams are produced when this method is carried out:

15.2.1 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

15.2.2 Flammable solvent waste – Waste Stream C

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

16.0 References / Cross-References

16.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

16.1.1 Method 3535A, Solid Phase Extraction (SPE), Revision 0, December 1996.

16.1.2 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

16.1.3 Method 8000C, Determinative Chromatographic Separations, Revision 3, March 2003.

16.1.4 Method 8330, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 0, September 1994.

16.1.5 Method 8330A, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 1, January 1998.

16.1.6 Method 8330B, Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography, Revision 2, October 2006.

16.2 Department of Defense Quality Systems Manual for Environmental Laboratories, Final Version 4.2, 10/25/2010.

16.3 Department of Defense Quality Systems Manual for Environmental Laboratories Version 5.0, July 2013.

17.0 Method Modifications:

17.1 Deviations from Method Source and Rationale

Method 8330 prescribes the shelf life for standards as follows:

Standards	Concentration	Shelf Life per 8330A	Shelf Life per 8330B
Stock standards	1,000,000 µg/L (1,000 ppm)	One year	One year
Intermediate standards	2.5 to 10,000 µg/L	Thirty days	One year
Working standards	1 to 500 µg/L	Daily	Daily

This SOP describes the use of 100,000 µg/L high-level standards, which are assigned a one year shelf life based on TestAmerica's experience with these materials. Further, a 20,000 µg/L standard mix is characterized as an intermediate-level, and assigned a six month shelf life.

17.2 Acidic water (pH < 3) is added to the concentrated extract, dilutions, and all calibration and check standards in place of reagent water. This is to preserve any Tetryl present in the extract.

18.0 Attachments

Appendix 1. Analyte List

Appendix 2. Suggested Calibration Levels (µg/mL)

Appendix 3. Spike Levels

Appendix 4. Suggested Instrument Conditions

Appendix 5. Example Chromatogram from Primary Column – Ultracarb ODS (20)

Appendix 6. Example Chromatogram from Confirmation Column – Luna Phenyl-Hexyl

19.0 Revision History

- Revision 16, dated 31 March 2015
  - Annual Review
  - Updated section 1.4.4 to reflect current analyte exceptions
  - Expanded and clarified section 7.1
  - Made minor corrections to sections 7.3 and 7.4.
  - Moved Instrument Maintenance and Troubleshooting section 13.5 to section 10.7
  - Expanded the Instrument Maintenance and Troubleshooting section 10.7

- Revision 15, dated 31 March 2014
  - Updated Sections 2.2, 6.1.2, 7.8.10, Appendix 4 and Appendix 5 with a new primary column (Agilent Poroshell 120, EC-C18)
  - Added Section 13.5 as a DoD QSM 5.0 requirement
  - Added QSM reference information
  - Annual Review
- Revision 14, dated 30 April 2013
  - Updated Sections 9.1, 10.1 and 10.2
  - Annual Review
- Revision 13, dated 04 April 2012
  - Updated calibration section.
  - Updated standards section.
  - Replaced chromatograms in Appendices 5 and 6 with current chromatograms from Chrom.
  - Source method review.
- Revision 12.2, dated 15 February 2011
  - Added a comment to section 10.3 regarding saturation concentrations for the solid phase extraction cartridges.
  - Added section 11.1 referencing corporate SOP CA-Q-S005, “Calibration Curves”.
- Revision 12.1, dated 19 November 2010

- Added requirements for recording the calcium chloride lot number in section 10.3.8.

- Revision 12, dated 16 June 2010
  - Added Section 7.1.3 Standard information for MNX.
  - Added 5th dot to Section 9.18.3 – Reference to Corporate Calibration SOP
  - Added Section 11.8 – Calculation for the concentration of Ammonium Picrate.
  - Updated Appendix 5 Chromatogram to included MNX.
- Revision 11, dated 10 April 2009
  - The details on the extraction procedures have been removed from this SOP. These details can be found in DV-OP-0017 and DV-OP-0018
  - The table in Section 1.4 was revised to include 3,5-dinitroaniline
  - Section 6.2 was revised to include a 500 µL re-pipettor. The pipettor is used to perform the 2X dilution of the soil acetonitrile extracts with the calcium chloride solution.
  - Section 7.8.9 Eluents for Standard Analytes was revised to correct the confirmation column eluent. The eluent is made from methanol and reagent water. Acetonitrile is not used in this reagent.
  - Section 7.8.10 Eluents for Picric Acid was revised to describe more clearly exactly how this reagent is brought up to final volume.
  - Section 7.8.12 Working Eluent Confirmation Column was revised to correct the volume of primary stock solution and glacial acetic acid used in this reagent.
  - Section 9.8 *Method Blank* and Section 9.13 *Grinding Blank* were revised to reflect the laboratory's current practice of controlling method blanks to ½ the reporting limit, or 1/10 of the concentration found in the samples.
  - Section 9.18.3 was revised to state the intercept should be less than the MDL, but at least less than ½ the RL.
  - Section 10.3.1 was revised to state that all detections on the primary column above the method detection limit are confirmed.
  - Section 10.3.3 was revised to clarify that a sequence can either start with an ICAL or a CCV.
  - Section 12.1 *Initial Demonstration of Capability* was revised to eliminate the need for a QC check sample that contains all analytes to be processed through the drying and grinding procedure. The laboratory has performed PT samples that have gone through the grinding process described in method 8330B, but per the PT instructions the sample was not dried prior to grinding.
  - Appendix 1 was revised to remove the approximate retention times from the table. The retention times are updated from each CCV. See Sections 10.3.4 through 10.3.6 for details. This Appendix was also revised to indicate that 3,5-dinitroaniline is only spiked when specifically requested.
  - Appendix 4 was revised to correct the length of the primary column and the column parameters for both primary and confirmation column.
  - Appendix 5 *Organic Extractions Checklist* was removed and replaced with *Example Chromatogram from Primary Column*
  - Appendix 6 *Explosive Soil Extraction Checklist* was removed and replaced with *Example Chromatogram from Confirmation Column*

- Revision 10, dated 01 October 2008
  - Re-formatted SOP
  - Updated reference section to reflect the SW-846 update IV method 3535A.
  - Updated all reference to method 3535 to method 3535A.
  - Added 3,5-dinitroaniline as a spike compound for method 8330B
  - Revised the extraction of water samples so that the SPE cartridge is eluted directly into the extract storage vial.
  - Added clarification and requirements for the storage of the working level LCS and surrogate standards.
  - Revised section 9.13.1 to have the grinding blanks associated with the sample that is ground after the blank instead of before the blank in order to ensure that any contamination could be more easily traced.
- Changes from Previous Version
  - The type of SPE cartridge was changed in order to achieve better recoveries of picric acid.

Appendix 1. Analyte List

Compound	Peak#		CAS #	Symbol	Standard Reporting Limits		
	Col A	Col B			Water (µg/L)	Soil, 2 g (mg/Kg)	Soil, 10 g (mg/Kg)
2,6-Diamino-4-nitrotoluene**	1	2	59229-75-3	2,6-DA-4-NT	1.0	2.0	1.0
Octahydro-1,3,5,7-tetranitro-1,3,5,7,-tetrazocine	2	5	2691-41-0	HMX	0.40	0.25	0.10
2,4-Diamino-6-nitrotoluene**	3	3	6629-29-4	2,4-DA-6-NT	1.0	2.0	1.0
Hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine	4	6	5755-27-1	MNX	2.0	0.25	0.10
Hexahydro-1,3,5-trinitro-1,3,5-triazine	5	7	121-82-4	RDX	0.20	0.26	0.20
Picric Acid (2,4,6-Trinitrophenol)	6	4	88-89-1	PA	2.0	0.25	0.10
1,3,5-Trinitrobenzene	7	18	99-35-4	1,3,5-TNB	1.0	0.25	0.10
1,2-Dinitrobenzene (surrogate)	8	9	528-29-0	1,2-DNB	NA	NA	NA
1,3-Dinitrobenzene	9	11	99-65-0	1,3-DNB	0.40	0.25	0.10
Methyl-2,4,6-trinitrophenyl nitramine	10	21	479-45-8	Tetryl	0.24	0.50	0.20
3,5-Dinitroaniline** (8330B only)	11	10	618-87-1	3,5-DNA	0.40	NA	0.10
Nitrobenzene	12	8	98-95-3	NB	0.40	0.25	0.30
Nitroglycerin	13	12	55-63-0	NG	3.0	5.1	2.0
2,4,6-Trinitrotoluene	14	22	118-96-7	2,4,6-TNT	0.40	0.25	0.10
4-Amino-2,6-dinitrotoluene	15	15	19406-51-0	4-Am-DNT	0.20	0.25	0.10
2-Amino-4,6-dinitrotoluene	16	17	35572-78-2	2-Am-DNT	0.20	0.25	0.10
2,6-Dinitrotoluene	17	19	606-20-2	2,6-DNT	0.20	0.25	0.10
2,4-Dinitrotoluene	18	20	121-14-2	2,4-DNT	0.40	0.25	0.10
2-Nitrotoluene (o-Nitrotoluene)	19	13	88-72-2	2-NT	0.40	0.25	0.20
4-Nitrotoluene (p-Nitrotoluene)	20	14	99-99-0	4-NT	1.0	0.40	0.20
PETN	21	23	78-11-5	PETN	2.0	4.0	2.0
3-Nitrotoluene (m-Nitrotoluene)	22	16	99-08-1	3-NT	0.40	0.50	0.20

**Non-standard spike analytes, only spiked when specifically requested.
A: - UltraCarb5uDODS
B: - Lina-Phenyl Hexyl

Appendix 2. Suggested Calibration Levels (µg/mL)

Compound	Level 1	Level 2	Level 3	Level 4*	Level 5	Level 6	Level 7	Level 8
HMX	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
RDX	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
1,3,5-Trinitrobenzene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
1,3-Dinitrobenzene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Tetryl	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Nitrobenzene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,4,6-Trinitrobenzene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
4-Amino-2,6-dinitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2-Amino-4,6-dinitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,4-Dinitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,6-Dinitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2-Nitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
3-Nitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
4-Nitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Nitroglycerin	0.1	0.5	1.0	2.5	4	7	10.	25
PETN	0.1	0.5	1.0	2.5	4	7	10.	25
2,4-Diamino-6-ditrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,6-Diamino-4-nitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Picric Acid	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
1,2-Dinitrobenzene (surrogate)	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5

* This level is used for the daily and continuing calibration standards.

Appendix 3. Spike Levels

LCS / MS / MSD Spike Levels					
Method and Matrix	Working Solution		Spike Amount	Final Concentrations	
	Standard Analytes	Nitroglycerin & PETN		Standard Analytes	Nitroglycerin & PETN
Water, Methods 8330A and 8330B	10 µg/mL	100 µg/mL	0.1 mL	2 µg/L	20 µg/L
Soil Method 8330A (2 g prep)	10 µg/mL	100 µg/mL	0.5 mL	2.5 mg/Kg	25 mg/Kg
Soil Method 8330B (10 g prep)	10 µg/mL	100 µg/mL	1.0 mL	1.0 mg/Kg	10 mg/Kg

Surrogate Spike Levels			
Method and Matrix	Working Solution 1,2-DNB	Spike Amount	Final Concentration
Water, Methods 8330A and 8330B	10 µg/mL	0.1 mL	2 µg/L
Soil Method 8330A (2 g prep)	10 µg/mL	0.5 mL	2.5 mg/Kg
Soil Method 8330B (10 g prep)	10 µg/mL	1.0 mL	1.0 mg/Kg

Appendix 4. Suggested Instrument Conditions

Instrument Conditions			
Column Types	Primary Column: Agilent Poroshell 120, EC-C18, 4.6 mm x 150 mm (2.7 µm)		
	Confirmation Column: Phenomenex Luna Phenyl-Hexyl, 4.6mm x 150mm (3.0 µm)		
Detector - 1st Channel	uv 254 nm, 40 R 550 nm		
Detector - 2nd Channel	uv 215 nm, 40 R 450 nm		
General Parameters		Primary Column	Confirmation Column
	Injection Volume:	50 µL	100 µL
	Column Temperature:	26.9℃	24.3℃

Suggested Column Parameters						
	Stop Time (min.)	**Post Time (min.)**	**Flow Rate (mL/min.)**	**Time (minutes)**	**% H_2O**	**% Methanol**
Gradient: Primary (C18) Column	15.5	5.0	0.75	0.0, 2.0,2.98, 13.0, 13.5, 15.0, 15.5	90, 90, 41, 40,10, 10, 90	10, 10, 59, 60, 90, 90, 10
Gradient: Confirmation (Phenyl-Hexyl) Column	26.0	4.0	0.8	0.0, 26.0, 30.0	50, 25, 50	50, 75, 50

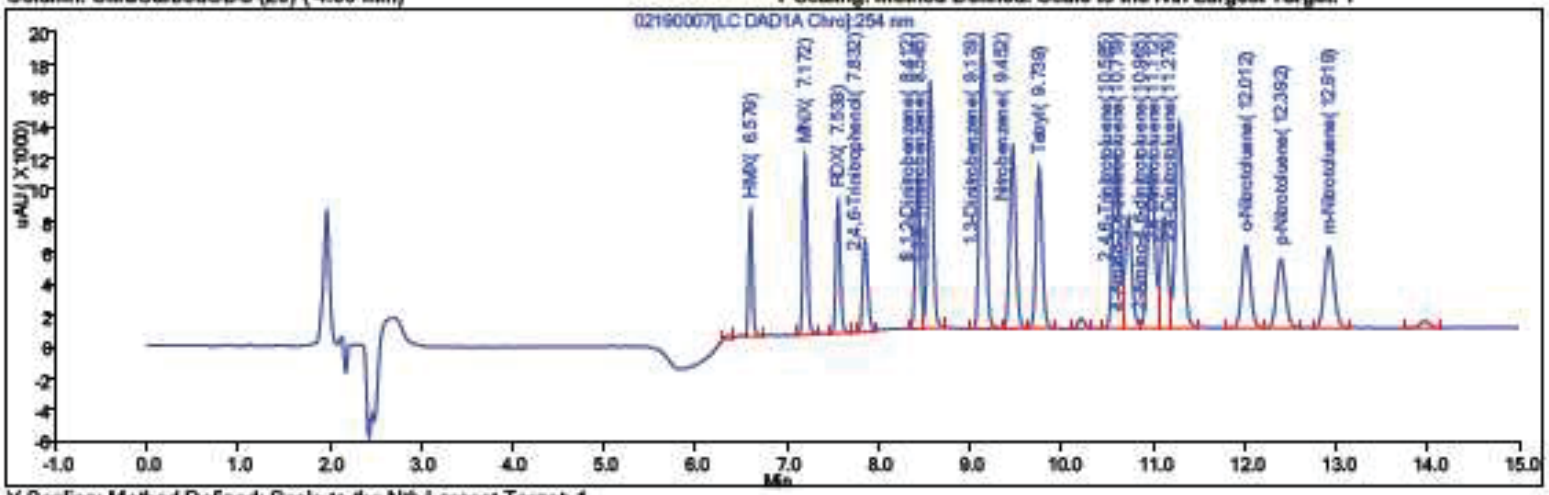
Appendix 5. Example Chromatograms from Primary (C18) Column

8330IntermStk:

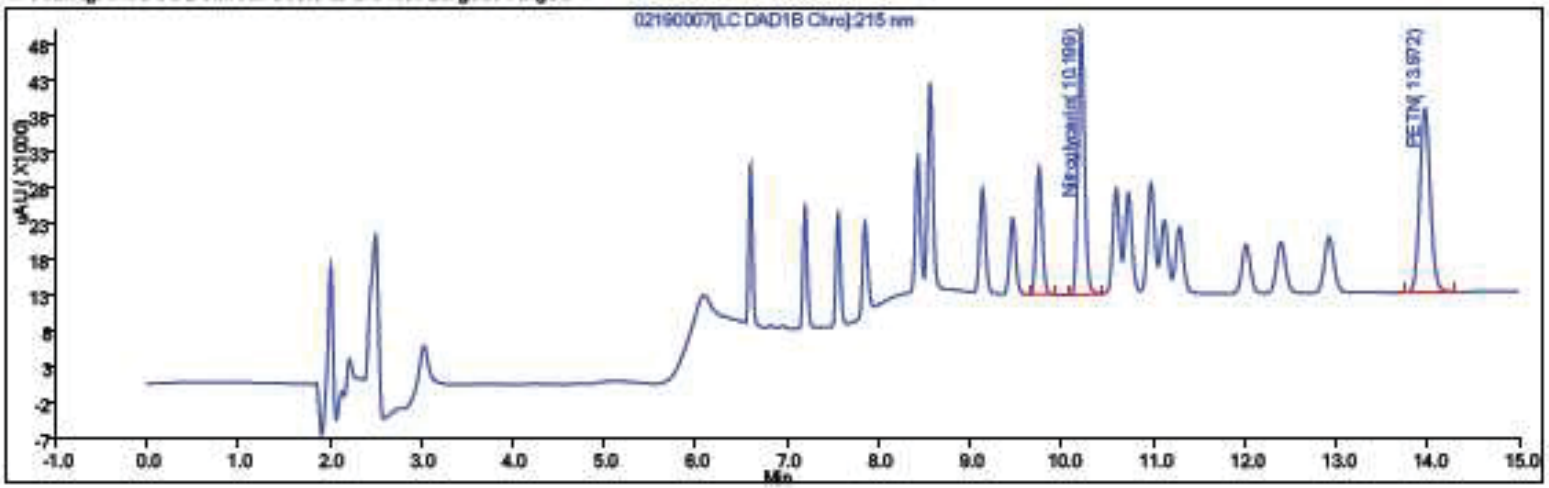
Report Date: 21-Feb-2014 10:36:40 Chrom Revision: 2.1 15-Jan-2014 14:08:26

TestAmerica Denver

Data File: \\denchrom\ChromData\CHHPLC_X\20140219-20212.b\02190007.D
Injection Date: 19-Feb-2014 12:38:09 Instrument ID: CHHPLC_X3 Operator ID: MPK
Lims ID: CCV MAIN L4 Lab Sample ID: Worklist Smp#: 7
Client ID:
Injection Vol: 100.0 ul Dil. Factor: 1.0000 ALS Bottle#: 7
Method: 8330_X3 Limit Group: GCSV - 8330
Column: UltraCarb5uODS (20) (4.60 mm) Y Scaling: Method Defined: Scale to the Nth Largest Target: 1



Y Scaling: Method Defined: Scale to the Nth Largest Target: 1



8330_ADDs:

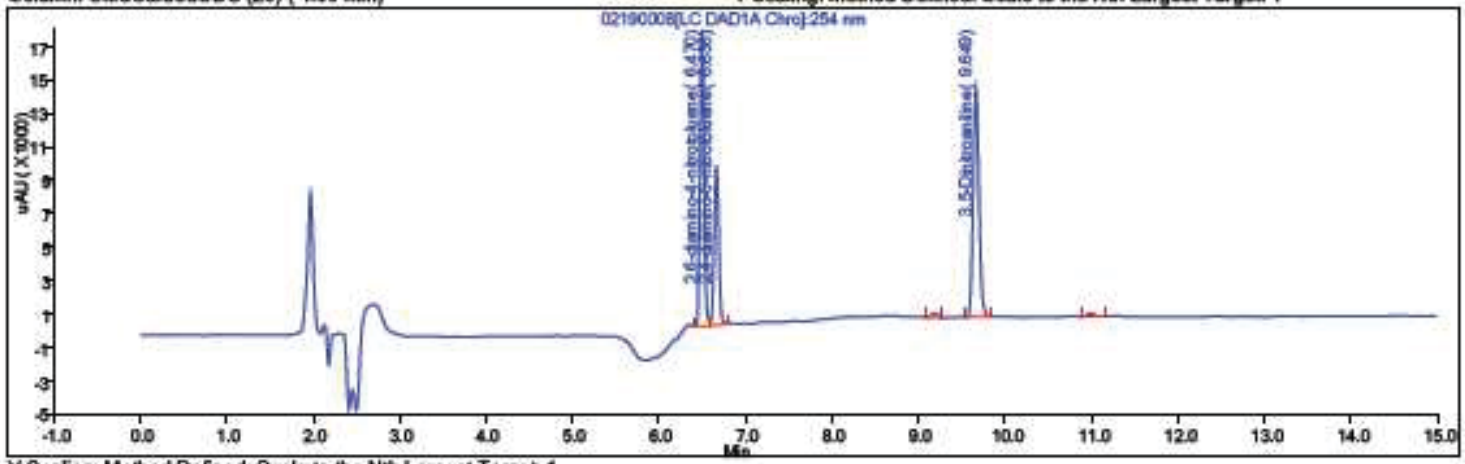
Report Date: 21-Feb-2014 10:36:40 Chrom Revision: 2.1 15-Jan-2014 14:06:26

TestAmerica Denver

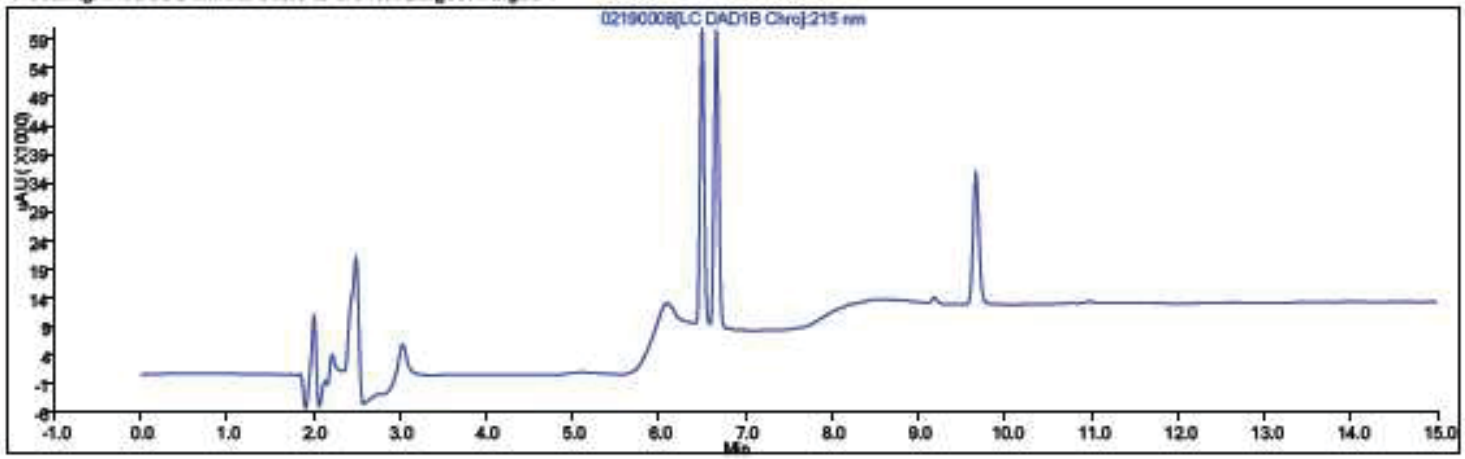
Data File:	\\denchrom\ChromData\CHHPLC_X\20140219-20212.b\02190008.D				
Injection Date:	19-Feb-2014 13:00:06	Instrument ID:	CHHPLC_X3	Operator ID:	MPK
Lims ID:	CCV ADDs L4	Lab Sample ID:		Worklist Smpl#:	8
Client ID:					
Injection Vol:	100.0 ul	Dil. Factor:	1.0000	ALS Bottle#:	8
Method:	8330_X3	Limit Group:	GCSV - 8330		

Column: UltraCarb5uODS (20) (4.60 mm)

Y Scaling: Method Defined: Scale to the Nth Largest Target: 1



Y Scaling: Method Defined: Scale to the Nth Largest Target: 1



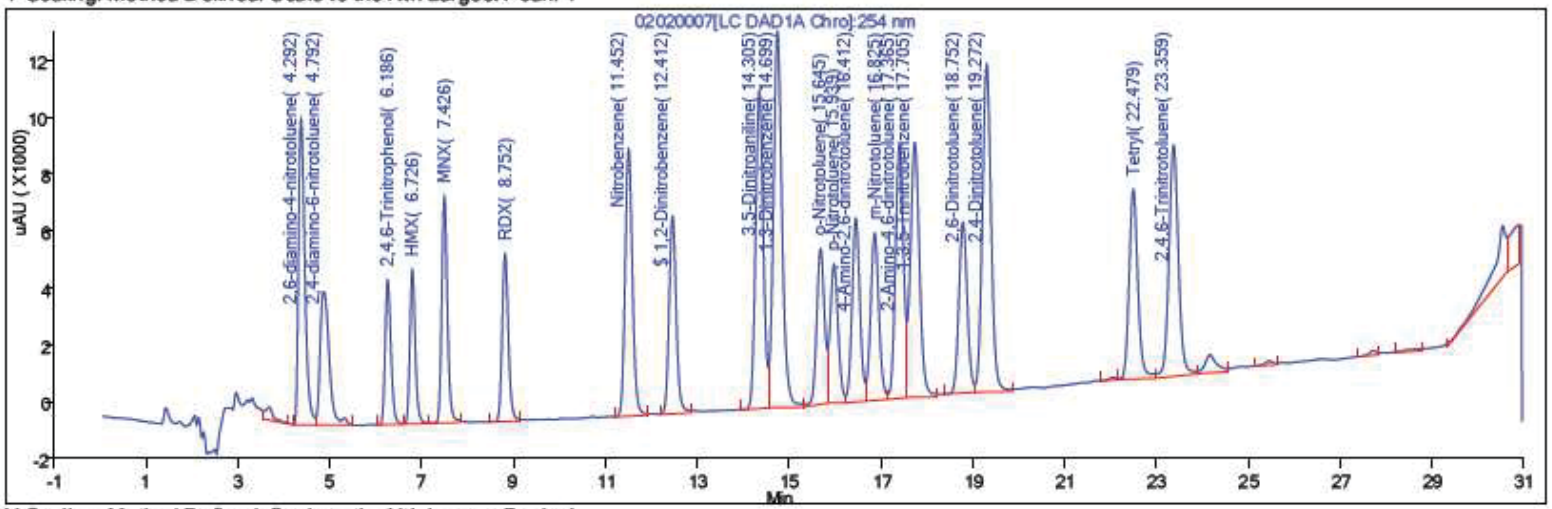
Appendix 6. Example Chromatogram from Confirmation (Phenyl-Hexyl) Column

Report Date: 06-Feb-2012 07:55:10 Chrom Revision: 2.0 18-Jan-2012 10:56:12

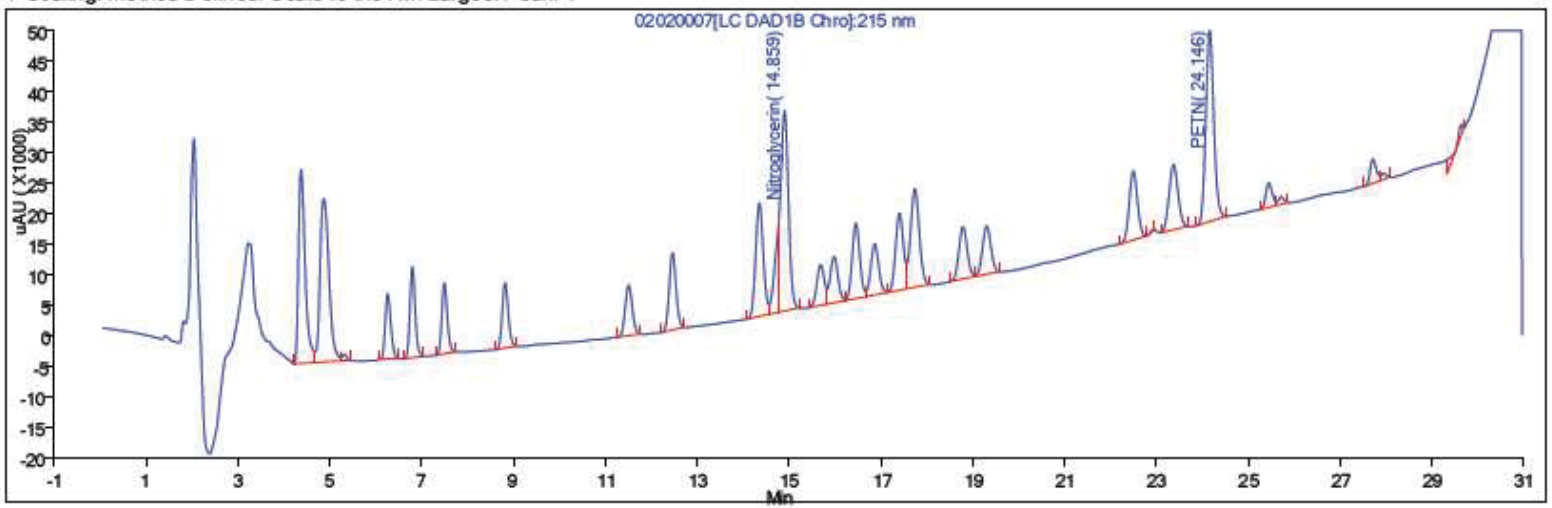
Preliminary Report

Data File:	\\Denchrom\ChromData\G2_LUNA\20120202-3022.b\02020007.D		
Injection Date:	02-Feb-2012 13:18:47	Limit Group:	GCSV - 8330
Client ID:		Instrument ID:	CHHPLC_G2_LUNA
Lims Batch ID:	3022	Lims Sample ID:	7
Operator ID:	MPK	Injection Vol:	100.00 ul

Y Scaling: Method Defined: Scale to the Nth Largest Peak: 1



Y Scaling: Method Defined: Scale to the Nth Largest Peak: 1



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ICP Analysis for Trace Elements by SW-846 Method 6010C/D

Approvals (Signature/Date):

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1.0 Scope and Application

1.1 This procedure describes the analysis of trace elements including metals in solution by Inductively Coupled Plasma -Atomic Emission Spectroscopy (ICPAES). This procedure references Method 6010C and 6010D for hazardous waste (RCRA) testing.

1.2 The elements that can be determined by this procedure are listed in Attachment 1, together with the routine reporting limits. Additional elements may be analyzed under Method 6010C and 6010D provided that the method performance criteria presented in Section 12.0 are met.

1.3 The laboratory digests all water samples according to SOP DV-IP-0010.

1.4 Silver concentrations must be below 1.0 mg/L in aqueous sample digestates and 100 mg/kg in solid matrix sample digestates. Precipitation may occur in samples where silver concentrations exceed these levels and lead to the generation of erroneous data. Samples with silver concentrations exceeding these levels must be re-prepared and reanalyzed using a smaller sample amount.

1.5 The digestion procedure for soil samples is described in SOP DV-IP-0015.

1.6 State or client specific requirements may take precedence over this SOP for water analyses. Review special instructions for each project before starting work.

2.0 Summary of Method

2.1 The laboratory uses simultaneous ICPAES instruments, with both axial and radial viewing configurations. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs.

2.2 Characteristic atomic-line emission spectra are produced by a radio frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating spectrometer and the intensities of the emission lines are monitored by a charge injection device (CID). The photo-currents from the charge injection device (CID) are processed and controlled by a computer system.

2.3 A background correction technique is required to compensate for variable background contribution to the determination of trace elements. Background must be measured adjacent to analyte lines during analysis. The position selected for the background intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used must be free of spectral interferences and reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result.

2.4 Refer to the appropriate SOPs for details on sample preparation methods: DV-IP-0010 for aqueous samples and DV-IP-0015 for soil samples.

3.0 Definitions

3.1 **Dual View ICP** – an ICP equipped with both radial and axial viewing capabilities.

3.2 **Dissolved Metals -** Those elements which pass through a 0.45-µm membrane. (The sample is acidified after filtration).

3.3 **Potentially Dissolved Metals -** Potentially dissolved metals is the concentration of metals in solution after acidifying the sample with nitric acid to pH <2, holding at room temperature for 8 to 96 hours, and then filtering through a 0.45-µm membrane filter. This definition is based on the Colorado surface water regulations.

3.4 **Suspended Metals -** Those elements which are retained by a 0.45-µm membrane.

3.5 **Total Metals -** The concentration determined on an unfiltered sample following vigorous digestion.

3.6 **Total Recoverable Metals -** The concentration determined on an unfiltered sample following treatment with hot, dilute mineral acid.

3.7 **Reporting Limit (RL) -** The lowest concentration to which results are reported without qualification. Details concerning RLs are presented in Policy DV-QA-009P.

3.8 Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and Policy DV-QA-003P, *Quality Control Program*, for definitions of general analytical and QA/QC terms.

4.0 Interferences

4.1 Spectral, physical, and chemical interference effects may contribute to inaccuracies in the determinations of trace elements by ICP. Spectral interferences are caused by the following:

4.1.1 Overlap of a spectral line from another element.

4.1.2 Unresolved overlap of molecular band spectra.

4.1.3 Background contribution from continuous or recombination phenomena.

4.1.4 Stray light from the line emission of high concentration elements.

4.2 A background correction technique is used to compensate for variable background contribution to the determination of trace elements. Background correction is not required in cases where a background corrective measurement would actually degrade the analytical result.

4.3 **Spectral Interferences**

Inter-element correction factors (IECs) are necessary to compensate for spectral overlap. Inter-element interferences occur when elements in the sample emit radiation at wavelengths so close to that of the analyte that they contribute

significant intensity to the analyte signal. If such conditions exist, the intensity contributed by the matrix elements will cause an excessively high (or sometimes low) concentration to be reported for the analyte. Inter-element corrections must be applied to the analyte to compensate for the effects of these unwanted emissions.

4.4 Physical Interferences

An internal standard (IS), yttrium or other suitable element, is added to all solutions to correct and monitor physical interferences. Use of a peristaltic pump and the mass flow controller also help to overcome physical interferences. Physical interferences are generally considered to be effects associated with sample transport, nebulization, and conversion within the plasma. These interferences may result in differences between instrument responses for the sample and the calibration standards. Physical interferences may occur in the transfer of solution to the nebulizer (e.g., viscosity effects), at the point of aerosol formation and transport to the plasma (e.g., surface tension), or during excitation and ionization processes within the plasma itself. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or high acid concentrations. If internal standard recoveries are not acceptable (see Section 9.11), then dilution of the sample may be necessary to overcome the interferences.

4.5 Chemical Interferences

Chemical interferences are characterized by molecular compound formation, ionization effects, and solute vaporization effects. Normally these effects are not significant with the ICP technique, but if observed, can be minimized by buffering the sample, matrix matching, or standard addition procedures.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.3.2 The ICP plasma emits strong UV light and is harmful to vision. All analysts must avoid looking directly at the plasma. The RF Generator produces

strong radio frequency waves, most of which are unshielded. People with pacemakers should not go near the instrument while in operation.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material (1)	Hazards	Exposure Limit(2)	Signs and Symptoms of Exposure
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.

1 – Always add acid to water to prevent violent reactions.
2 – Exposure limit refers to the OSHA regulatory exposure limit.

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Thermo Fischer ICP 6500E Trace Analyzers are currently used. Instruments with demonstrated equivalent performance can also be used

6.1.2 Radio Frequency Generator.

6.1.3 Argon gas supply, 99.99%

6.1.4 Coolflow or appropriate water-cooling device.

6.1.5 Peristaltic Pump.

6.1.6 Autosampler.

6.2 Supplies

6.2.1 Calibrated automatic pipettes or Class A glass volumetric pipettes.

6.2.2 Class A volumetric flasks.

6.2.3 Autosampler tubes.

6.3 Computer Software and Hardware

Please refer to the master list of documents and software located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination. All standards used in calculations shall be entered into the TALS Reagent Module with all applicable information (e.g., components, concentrations, expiration, etc.).

7.2 Shelf-Life

7.2.1 Stock standards, standards as received from the vendor, expire on the date assigned by the vendor. If no date is assigned by the vendor, a one-year expiration will be assigned by the laboratory.

7.2.2 The expiration date of intermediate concentration standards or working standards cannot be later than the date assigned to any of the stock standards used to prepare the intermediate solution.

7.2.3 If visible deterioration is noted for any standard, it must be re-verified against a second-source. Any standard that does not verify must be replaced immediately.

7.3 Standards

7.3.1 Standards used for calibration and quality control purposes must be NIST traceable, where available. Multi-component custom blend standards must be verified against a second-source standard before they are put into use

(the only exception is standards purchased directly from NIST), as described in SOP DV-QA-0015.

7.3.2 Stock standards are purchased as custom multi-element mixes or as single-element solutions. All standards must be stored in FEP fluorocarbon, polyethylene, or polypropylene bottles. Silver standards must be protected from light. The preparation frequency is governed by the parent standard with the earliest expiration date unless specified otherwise in this SOP. Detailed instructions regarding the preparation of standards and reagents are given in this section. Alternate procedures are allowed as necessary to accommodate volume requirements as long as final concentrations are maintained and an accurate description of the standard or reagent used is entered into the Reagent Module in TALS.

7.3.3 Intermediate calibration and QC standards are prepared in water with hydrochloric and nitric acids in order to approximate the acidic matrix of the various digests analyzed. This is an important point. Even with the use of yttrium as an internal standard, deviations from these concentrations can cause physical effects, as discussed in Section 4.4 of this procedure.

7.4 Reagent Blank / Initial Calibration Blank (ICB) / Continuing Calibration Blank (CCB)

Fill a 20-liter carboy with about 18 liters of reagent water. Slowly add 1 liter of concentrated nitric acid and 1 liter of concentrated hydrochloric acid. Adjust the total volume to 20 liters. Mix carefully. Record the acid lot number and other required information in the Blank Reagent Logbook stored in the metals prep area.

7.5 Stock ICSA and ICSAB Standards

The following standards are purchased from commercial sources:

Stock ICSA & ICSAB Standard	Elements	Concentration (mg/L)
Icp stk ICSA	Fe Al, Ca, Mg	2,000 5,000
ANALYTES B	Ba, Be, Co, Cr, Cu, Mn, V Ag, Cd, Ni, Pb, Zn	50 100
ICP ISAB STD1	Li, Mo, Sb, Sr As, B, P Se K, Na	100 200 500 5,000

Stock ICSA & ICSAB Standard	Elements	Concentration (mg/L)
ICP ISAB STD2	Ti Sn	100 1,000
10000 Si	Si	10,000
10000 Th	Th	10,000
1000 Tl	Tl	1,000
1000 Zr	Zr	1,000
1000 S	S	1,000
1000 Bi	Bi	1,000

7.6 ICSA Working Standard (ICP ICSA)

A combined working ICSA standard is made in a 250-mL volumetric flask using the following volumes of the Stock ICSA and ICSAB Standards:

Stock Standard	Volume of Stock Added (mL)
ICSA Std	25

Adjust to volume (250 mL) using the reagent blank solution. This produces the final ICSA standard concentrations shown in Attachment 4.

7.7 ICSAB Working Standard

A combined working ICSAB standard is made in a 250-mL volumetric flask using the following volumes of the Stock ICSAB Standards:

Stock Standard	Volume of Stock Added (mL)
Icp stk ICSA	25
ANALYTES B	2.5
ICP ISAB STD1	2.5
ICP ISAB STD2	2.5
10000 Si	0.25
10000 Th	0.05
1000 Tl	2.5
1000 Zr	0.25
1000 S	0.25
1000 Bi	0.25

Adjust to volume (250 mL) using the reagent blank solution. This produces the final ICSAB standard concentrations shown in Attachment 4.

7.8 Calibration Check Standard (S1, S2)

The two calibration check standards are the same as the working ICAL standards (ICP ICAL1A and ICP ICAL2A) described in Section 7.12.

7.9 Laboratory Control Sample (LCS) Stock Standards

The LCS stock standards are purchased from commercial sources. The stocks are custom-made standards purchased at ready-to-use concentrations as follows:

LCS Stock Standards	Elements	Concentration (mg/L)
ICP SPK 3A	Ca, K, Mg, Na	5,000
	P	1,000
	Al, Ba, Bi, Se, Tl, U,	200
	As, Fe, Li, Sr, Th	100
	Co, Mn, Ni, Pb, V, Zn	50
	Cu	25
	Cr	20
	Cd	10
	Ag, Be	5
ICP SPK 2B	Sb, Zr	50
	B, Mo, Ti	100
	Sn	200
	Si	1,000
	(SiO_2)	(2,140)
	S	200

The soil and water LCSs are prepared according to the instructions in SOPs DV-IP-10 and DV-IP-0015. Final concentrations are shown in Attachment 2.

7.10 Matrix Spike / Matrix Spike Duplicate (MS/MSD)

The same LCS stock standards described in Section 7.8 are also used to prepare matrix spikes and matrix spike duplicates. Final concentrations are shown in Attachment 2.

7.11 Post Digestion Spike (PDS) Standards (Analyte Addition Spike Standards)

The custom standards tabulated below are purchased from a commercial source. Add 0.06 mL of each to 6 mL (100X) of digestate or dilution of digestate.

PDS Stock	Elements	Conc. (mg/L)
ICP PDS 1	Ag, Be, Cd, Co, Cr, Cu, Mn, Ni, Sr, V Ba, Li, Pb, As, Se, Th, Tl, Zn U Al, Fe P Ca, K, Mg, Na,	5 5 10 20 50 100 200 2,000
ICP PDS 2	Mo, Ti, Zr B, Sb, Sn Si (SiO_2)	5 10 500 (1,070)

7.12 Initial Calibration (ICAL) Standards

7.12.1 Stock Calibration Standards

The following stock solutions are purchased from commercial sources.

Stock Standard	Elements	Conc. (mg/L)
Icp cal std 2	Mo, Ti, Zr Sn Si (SiO_2)	100 200 1,000 (2,140)
Icp cal std 3	Ag, Al, B, Ba, Be, Cd, Co, Cr, Cu, Mn, Ni, Sr, V, Zn Li, P Fe Ca, Na Mg K	100 100 200 500 1,000 4,000 10,000
Al, Ca, Fe, Na, S, Th Stocks	Al, Ca, Fe, Na, S, Th	10,000
As, Pb, Sb, Se, Tl, U, Bi Stocks	As, Pb, Sb, Se, Tl, U, Bi	1,000

7.12.2 Working Initial Calibration Standard (ICP ICAL1A)

Add 5.0 mL each of Icp cal std 2 and Icp cal std 3 to a 500-mL volumetric flask partially filled with reagent blank solution. Add 1 mL of the As, Pb, Sb, Se, and Tl stocks. Dilute to the mark with reagent blank solution.

7.12.3 Working Initial Calibration Standard (ICP ICAL2A)

Add 10 mL of the Al and Fe and 50 mL of the Na 10,000 mg/L stock solutions; 1 mL of the Th and 20 mL of the U 1,000 mg/L stock solutions; 2ml of the 1,000 mg/l Bi solution and 1 mL of the 10,000 mg/L S solution to a 1,000-mL volumetric flask partially filled with reagent blank and dilute to the mark with reagent blank.

7.13 Initial Calibration Verification (ICV)

7.13.1 ICV Stock Standards

The following stock solutions are purchased from commercial sources:

Stock Standard	Elements	Conc. (mg/L)
Icp ICVL A	Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Li, Mn, Ni, Pb, Sr, V, Zn Se, Tl Ca, Na Mg K	25 25 50 200 1,000 2,000
Icp ICVL B	Ag, Mo, Sb, Ti, Zr Sn P, Si (SiO_2)	25 50 200 (428)
Icp ICVH	Al, Na Fe U Th	4,000 8,000 500 300
Bi, S Stocks	Bi, S	1,000

7.13.2 Working High Initial Calibration Verification (ICP ICVH)

Add 1.0 mL of the ICVH Stock, 0.05 ml Bi and 0.4 mL of the Sulfur to a 100 mL volumetric flask partially filled with reagent blank solution and dilute to the mark.

Note: For Method 6010D the ICV working solutions must be prepared daily.

7.13.3 Working Initial Calibration Verification (ICP ICV)

Add 1.0 mL of each of the Icp ICVL A and Icp ICVL B stock solutions to a 100-mL volumetric flask partially filled with reagent blank solution and dilute to the mark.

Note: For Method 6010D the ICV working solutions must be prepared daily.

7.14 Reporting Limit Standard (RLSTD)

7.14.1 RL Stock Standard

The following stock solutions are purchased from commercial sources:

Standard	Elements	Conc. (mg/L)
ICP RLSTD 1A	As, Sb, Se, Tl Pb	10 3
ICP RL STD 2A	Mo, Ti, Zr Sn Si (SiO2)	10 20 500 1,070
ICP RL STD3A	Ag, Cr, Cu, Li, Ni, Th, V, Zn, Al, B Ba, Cd, Co, Sr Be Ca, Mg Fe K, Na, P Mn U	10 100 5 1 200 30 1,000 3 60
100 mg/L S	S	100
100 mg/L Bi	Bi	100

7.14.2 Daily Reporting Limit Standard (ICP CRI)

Add 0.1 mL of each of ICP RLSTD 1A, ICP RL STD 2A, ICP RL STD 2A, 100 mg/L Bi and 100 mg/L S to a 100-mL volumetric flask partially filled with reagent blank and dilute to the mark. The Working RL standard must be prepared fresh each day.

7.15 High Continuing Calibration Verification (ICP CCVH)

Perform a 2x dilution of the working ICP ICAL2A solution (Section 7.11.3) with reagent blank solution.

7.16 Continuing Calibration Verification (ICP CCV)

Perform a 2x dilution of the working ICP ICAL1A solution (Section 7.11.2) with reagent blank solution.

7.17 Low Level ICV/Low Level CCV (ICP LLCCV)

The low level ICV/CCV verification stock standards are custom-made commercial standards as follows:

LLICV/LLCCV Stock Standard	Elements	Conc. (mg/L)
ICP LLCCV-1	K	300
	Na	100
	Ca, Mg	20
	Al, Bi, Fe	10
	U	6
	Ni	4
	Zn	2
	As, Cu, Se, Tl, Th	1.5
	Ba, Cr, Co, Li, Mn, Ag, Sr,	1
	V	1
	Pb	0.9
	Cd	0.5
	Be	0.1
ICP LLCCV-2	P	300
	Si	50
	B	10
	Sn	10
	Mo	2
	Zr	1.5
	Sb	1
	Ti	1

7.17.1 Low Level ICV \ Low Level CCV, Working Standards

RL Standard	Vol. of Stock Added (mL)
ICP-LLCCV-1	1
ICP-LLCCV-2	1

Adjust to volume (100 mL) using the reagent blank solution.

7.18 Reagents

7.18.1 Concentrated nitric acid (HNO_3), trace metals grade or better.

7.18.2 Concentrated hydrochloric acid (HCl), trace metals grade or better.

7.18.3 Reagent water must be produced by a Millipore DI system or equivalent, with a minimum resistivity of 1.0 Mohm/cm at 25˚C.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client

requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation [1]	Holding Time [2]	Reference
Waters	HDPE	50 mLs	HNO_3, pH < 2; Cool ≤ 6°C	180 Days	40 CFR Part 136.3
Soils	Glass	3 grams	Cool ≤ 6 °C [3]	180 Days	N/A

[1] Aqueous samples are preserved with nitric acid to a pH of <2 and may be stored in either plastic or glass. If boron or silica are to be determined, plastic containers are preferred. Refrigeration is not required for most programs. Preservation must be verified prior to analysis.

[2] Inclusive of digestion and analysis.

[3] Although ICP analysis of soil does not require refrigeration of the samples, mercury analysis does require refrigeration. Samples which will be used to aliquot volume for both analyses must be refrigerated.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the TALS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver Policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver Policy DV-QA-024P, *QA/QC Requirements for Federal Programs*. DoD QSM 5.0 QC Acceptance Criteria for ICP analyses are presented in Attachment 11. The criteria must be met unless otherwise documented in the project documents.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in TALS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. See Policy DV-QA-003P for further details.

9.3 Method Blank

The blank is de-ionized water taken through the procedure as if it were a sample. For soil samples analyzed under the DoD QAPPs, the method blank consists of <1 mm glass beads that have been processed in the same manner as the samples. A method blank is required with every batch of 20 or less samples.

Acceptance Criteria: The method blank must not contain any analyte of interest above ½ the reporting limit or above one-tenth of the concentration found in the associated samples (for samples with concentrations above the RL).

Corrective Action: If the method blank exceeds allowable levels, all associated samples must be redigested and reanalyzed. A possible exception is the situation in which the analyte is not detected in any of the associated samples, but this can only be done with client approval and it must be addressed in the final report case narrative.

9.4 Laboratory Control Sample (LCS)

The LCS is prepared as described in Section 7.8. One LCS is required with each analytical batch.

Acceptance Criteria: The recovery of the LCS must be within historical control limits. Historical control limits are based on three standard deviations of past results, and must be 80-120% or tighter. In the instance where the LCS recovery is greater than 120% and the sample results are < RL, the data may be reported with qualifiers. Such action must be taken in consultation with the client and must be addressed in the report narrative. The process of establishing control limits is described in more detail in the Policy DV-QA-003P. The control limits are stored in TALS.

Corrective Action: If the LCS recovery falls outside of the established limits, all associated samples must be redigested and reanalyzed

9.5 Matrix Spike / Matrix Spike Duplicate (MS/MSD)

MS/MSDs are prepared as described in Section 7.10. One MS/MSD pair is required with each analytical batch. Note that some programs (e.g., North Carolina and South Carolina) require the MS/MSDs to be run at a 10% frequency. Some client specific data quality objectives (DQOs) may require the use of sample duplicates in

place of or in addition to MS/MSDs. The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process. Due to the potential variability of the matrix of each sample, these results may have immediate bearing on only the specific sample spiked. Samples identified as field blanks cannot be used for MS/MSD analysis. Note that if client instructions on the chain of custody form tell the lab to use a field blank for the MS/MSD, this should be double-checked with the laboratory PM.

Acceptance Criteria: The recoveries for the MS and MSD must be within the historical control limits or the project-required control limits, whichever are appropriate. Historical control limits are based on three standard deviations of past results, and should be within the established project-specific method control limits, if they exist. The process of establishing control limits is described in more detail in Policy DV-QA-003P. The control limits are stored in TALS. Acceptance limits derived from historical data should be no wider than +/-25%.

Corrective Action: If MS/MSD recoveries fall outside of the established limits and the LCS is in control, the data will be flagged as outside of control limits. The failure will be documented by the PM in the case narrative to alert the client that a matrix affect may be present.

Acceptance Criteria: The relative percent difference (RPD) between the MS and MSD is evaluated to measure precision and must be less than or equal to the historical RPD control limit. Historical control limits are based on three standard deviations of past results, and must be no greater than 20%.

Corrective Action: If the RPD fails to meet precision limit and the recoveries pass, the control limits should be checked as this would be a very rare occurrence if the limits are set properly. If the LCS is in control, it indicates long-term precision, and precision failures within the batch may be due to sample non-homogeneity. MS/MSD results which fall established control limits must be addressed in the narrative.

NOTE: This method does not require a sample duplicate. Precision is measured using the MS/MSD. Use of the MS/MSD is preferred as not all samples will contain measurable concentrations of the target analytes. Samples that have target analytes at low concentrations or non-detectable levels do not provide useful precision data. When an MS/MSD is not available, an LCS and LCSD will be used to measure precision.

9.6 Serial Dilution Test

A dilution test is performed for each batch of samples. The purpose of this test is to ensure that neither positive nor negative interferences are biasing the analytical

results. The serial dilution test should be performed on the same sample used to perform the MS/MSD.

Acceptance Criteria: If the analyte concentration is sufficiently high (minimally, a factor of 50 times the MDL), an analysis of a 1:5 dilution (e.g., 1 mL of sample diluted to 5 mL with reagent blank solution) must agree within ± 10% of the original determination. For DoD QSM 5.0 the serial dilution is required if the MS or MSD fails and the parent concentration is greater than 50x the LOQ prior to dilution. 6010D requires the parent sample to be at least 25x higher than the RL to be calculable and sets the recovery limit at 20%.

Corrective Action: If the two results do not agree within the required limits, then a chemical or physical interference is suspected. A qualifier flag is assigned to the data and the failure is addressed in the case narrative to alert the client that a matrix affect may be present. For DoD QSM 5.0 a J-flag is added to the parent sample for the specific analyte if the acceptance criteria are not met.

9.7 Post Digestion Spike (PDS)

Whenever the MS/MSD recoveries are unacceptable, a PDS spike must be performed. The PDS spike is prepared as described in Section 7.10. Some programs (e.g., AFCEE) require a PDS analysis whenever the serial dilution test fails. Other programs (e.g., DoD QSM 5.0) require a PDS to be included in every batch. Check project requirements. For programs where a PDS is required, the same sample that was used for the serial dilution test should be used for the PDS.

Acceptance Criteria: An analyte spike added to a portion of a prepared sample, or its dilution, should be recovered to within 80-120% for Method 6010C and 75-125% for 6010D.

Corrective Action: If the spike is not recovered within the specified limits, a matrix effect is confirmed. For DoD QSM 5.0 a J-flag is added to the parent sample if the sample concentration is less than 50x the LOQ prior to dilution. Any failures are flagged and should be described in the report case narrative.

9.8 Method of Standard Additions (MSA)

This technique involves constructing a calibration curve in the sample matrix itself to compensate for a sample interferent that may enhance or depress the analyte signal, thus producing a different slope from that of the calibration standards. It will not correct for additive interferences that cause a baseline shift. Attachment 8 provides more guidance on performing MSA analyses.

9.9 Interference Check Analysis (ICSA / ICSAB)

The ICSA contains only interfering elements, the ICSAB contains analytes and interferents. Refer to Sections 7.4, 7.5, and 7.6 for the preparation of the ICSA and ICSAB solutions. Attachment 4 lists the final concentrations. All analytes are spiked into the ICSAB solution. The ICSA and ICSAB solutions are analyzed at the beginning of the run.

Acceptance Criteria: The ICSAB results for the all analytes must fall within 80-120% of the true value. If any ICSAB analyte result fails criteria, the analysis should be terminated, the problem corrected, the instrument recalibrated, and the samples rerun.

The absolute value of ICSA results for the non-interfering elements must be ≤ 2 x RL. The DoD and AFCEE programs have their own criteria based on the version used. For DoD QSM 5.0 the non-spiked analytes must be less than the absolute value of the LOD unless they are verified impurities. For 6010D the non-spiked analytes must be less than the absolute value of the RL.

Corrective action: If the ICSA results for the non-interfering elements do not meet these limits, the field sample data must be evaluated as follows: If the non-interfering element concentration in the ICSA is the result of contamination versus a spectral interference, and this reason is documented, the field sample data can be accepted. If the affected element was not required, then the sample data can be accepted. If the interfering elements are not present in the field sample at a concentration which would result in an absolute value > 2x RL, then the field sample data can be accepted. If the interfering element is present in the field sample at a level which would result in a false analyte signal > 2x RL, the data can be accepted only if the concentration of the affected analyte in the field sample is more than 10x the analyte signal in the ICSA. If the data do not meet the above conditions, then the IECs must be re-evaluated and corrected if necessary and the affected samples reanalyzed.

9.10 Monitoring Internal Standard Results

Yttrium is automatically added as an internal standard (IS) to every solution tested through use of a third pump channel and mixing coil. The analyst must monitor the response of the internal standard throughout the sample analysis run. This information is used to detect potential problems and identify possible background contributions from the sample (i.e., natural occurrence of IS analyte).

Acceptance Criteria: If the internal standard counts fall within ±30% of the counts observed in the ICAL blank, then the data are acceptable.

Corrective Action: If the internal standard counts in the field samples are outside of the control limits, the field samples must be diluted and reanalyzed;

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any unauthorized deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Sample Preparation

Solid and aqueous samples must be digested prior to analysis by the appropriate method (see SOPs DV-IP-0010, DV-IP-0015, and DV-IP-0017).

10.4 Calibration

10.4.1 Instrument Start Up

Set up the instrument with the operating parameters recommended by the manufacturer. Complete any required preventative maintenance and record in the ICPAES Preventative Maintenance Log. Preventive maintenance recommendations are listed in the TestAmerica Denver Quality Assurance Manual. Allow the instrument to become thermally stable before beginning calibration (approximately 30 minutes of warm-up is required).

10.4.2 Initial Calibration (ICAL)

The calibration curve is established on each day of operation using a blank and one standard. The preparation of the ICAL standards is described in Section 7. The final concentrations of the ICAL standards are presented in Attachment 6. The validity of the calibration curve is confirmed by analysis of the ICV, CCV, ICB, RL Check standard and Low Level ICV/CCV) which are run immediately after the ICAL. Some programs require a high-level verification check as well.

10.4.3 Initial Calibration Verification (ICV)

Calibration accuracy is verified using a second-source standard (ICV) that is at or below a concentration near the mid-point of the working range. The ICV is analyzed immediately after the ICAL. The preparation of this standard is described in Section 7. The concentration of the ICV standard is presented in Attachment 6.

Acceptance Criteria: The ICV result must fall within 10% of the true value for that solution. The standard deviation must be < 5% (the laboratory is using at least two exposures for all ICP analyses).

Corrective Action: If the ICV fails to meet acceptance limits, the standard may be reanalyzed without modification to the instrument operating conditions. Two consecutive, acceptable analyses are required before the analytical run may continue. Otherwise, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration re-verified.

10.4.4 Mid Level Continuing Calibration Verification (CCV)

The preparation of the CCV solution is described in Section 7. The final concentrations of the CCVs are presented in Attachment 6. Note that the CCV is made at a different concentration than the ICV to meet NELAC requirements. CCVs are analyzed after the ICV, after every ten samples, and at the end of the analytical run.

Acceptance Criteria: The CCV must be within 10% of the expected value. The relative standard deviation must be <5%.

Corrective Action: If the CCV fails to meet any of these criteria, the standard may be reanalyzed without modification to the instrument operating conditions. *Two consecutive, acceptable analyses are required before the analytical run may continue*. Otherwise, the instrument must be recalibrated and the samples reanalyzed since the last successful CCV must be reanalyzed.

10.4.5 6010C - Low Level Initial Calibration (LLICV) and Continuing Calibration Verification (LLCCV)

The preparation of the LLCCV solution is described in Section 7. The low-level CCV needs to be analyzed at the beginning and end of every run sequence. If low level samples are expected then the low-level CCV should also be run every ten samples.

Acceptance Criteria: The LLCCV must be within +/-30% of the expected value to meet Method 6010C requirements.

Corrective Action: If the LLCCV fails to meet any of these criteria, the standard may be reanalyzed without modification to the instrument operating conditions. *Two consecutive, acceptable analyses are required before the analytical run may continue*. If the calibration cannot be verified within theses specified limits, the analysis of samples containing the affected analytes at similar concentrations cannot continue until the cause is determined and the LLCCV standard successfully analyzed. Otherwise, the instrument must be recalibrated and the samples reanalyzed since the last successful CCV must be reanalyzed. TestAmerica will not hold samples with concentrations greater than 10x the reporting limit to the 30% acceptance criteria.

10.4.6 Initial Calibration Blank (ICB)

System cleanliness is verified by analyzing an ICB after the first CCV. The preparation of the ICB is described in Section 7.

Acceptance Criteria: Absolute values for the calibration blanks must be less than ½ the standard RL. Common lab contaminants such as sodium must be less than the RL. Client specific requirements take precedence. For example, DoD QSM 5.0 requires control of blanks to a concentration less than or equal to the LOD.

Corrective Action: If the ICB fails to meet acceptance limits, a single reanalysis may be attempted without modification to the instrument operating conditions. Otherwise, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration re-verified.

10.4.7 RL/ Calibration Check Standard (ICP CRI)

Calibration accuracy at the RL is verified by analyzing a standard prepared at a concentration at or below the laboratory's standard reporting limit. The preparation of this standard is described in Section 7. Alternate RLSTD concentrations may be used as necessary to meet client requirements as long as an accurate description of the standard used is entered into the Reagents Module in TALS.

Acceptance Criteria: For routine work and for programs that allow the RL to be as low as 2x MDL (e.g., AFCEE), the acceptance limits are ± 50% of the expected value.

For **6010D and DoD QSM** the acceptance limit is ± 20%.

Corrective Action: If the RL Check standard fails to meet acceptance limits, a single reanalysis may be attempted without modification to the instrument operating conditions. Otherwise, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration re-verified.

10.4.8 Lower Limit of Quantitation Check (LLQC)

The lower limit of quantitation check (LLQC) sample should be analyzed after establishing the lower laboratory reporting limits, quarterly and on an as needed basis to demonstrate the desired detection capability. The difference between the LLQC and the LLICV/CCV is that this standard is carried through the entire preparation and analytical procedure. Prepare 7 aliquots spiked at the LLOQ.

Acceptance Criteria: LLQC is verified when all analytes are detected within ±30% of their true value with an RSD ≤20%.

Corrective Action: If the LLQC fails to meet acceptance limits, a single reanalysis may be attempted without modification to the instrument operating conditions. Otherwise, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration re-verified.

10.4.9 High-Level Calibration Check Standard

The method 6010C defines the linear working range used for daily analysis based on the LDR studies performed every six months, in which case this standard is not required. However, some programs require verification of the high end of the linear range at different frequencies. For 6010D and DOD QSM the upper linear range must be defined daily

Acceptance Criteria: The result for this standard must be within 10% of the expected value.

Corrective Action: If the High-Level Calibration Check standard fails to meet acceptance limits, a single reanalysis may be attempted without modification to the instrument operating conditions. Otherwise, the analyst must run a standard at a lower concentration until the criteria is met for this calibration or the sample results cannot exceed the level of the highest calibration standard.

10.4.10 Continuing Calibration Blank (CCB)

CCBs, prepared as in Section 7.3, are analyzed after each CCV.

Acceptance Criteria: Absolute values for the calibration blanks must be less than ½ the standard RL. Common lab contaminants such as sodium must be less than the RL. Client specific requirements take precedence. For example, DoD requires control of blanks to a concentration less than or equal to the LOD. Method 6010D sets the CCB upper limit at the RL.

Corrective Action: If the CCB is greater than these limits, a single reanalysis may be attempted without modification to the instrument operating conditions. Otherwise, instrument maintenance should be considered, the calibration re-verified, and all samples analyzed since the last successful CCB must be reanalyzed.

10.5 Sample Analysis

10.5.1 Replicate Readings

The laboratory averages the results from two exposures for Axial and Dual View ICP for each standard, field sample, and QC sample due to sample volume limitations of the autosampler tube.

10.5.2 Rinse Time Between Samples

Prior to calibration and between each sample/standard, the system is rinsed with the calibration blank solution. The minimum rinse time between analytical samples is 60 seconds unless, following the protocol outlined in 12.7, it can be demonstrated that a shorter rinse time may be used.

10.5.3 The following analytical sequence is used:

Instrument Calibration
High Standard Verification
ICV
LLICV (6010C only)
CCV
ICB
RL Verification Standard
LLQC (as needed)
ICSA
ICSAB
LRA
CCV
CCB
LLCCV (6010C only)

10 samples
CCV
CCB
LLCCV (6010C)
10 samples
CCV
CCB
LLCCV (6010C)
Repeat sequence with 10 samples between CCV/CCB pairs
CCV
CCB
LLCCV (6010C)

10.5.4 Full method-required QC must be available for each wavelength used in determining reported analyte results. Guidelines are provided in the appendices for minimizing contamination of samples and standards (Attachment 10) and troubleshooting (Attachment 9).

10.5.5 Dilutions for High Levels of Elements of Interest

For 6010, results must fall within the linear range. Dilute and reanalyze all samples for required analytes that exceed the linear range or use an alternate wavelength for which QC data are established. Dilutions must be prepared using the reagent blank solution to maintain the correct acid concentration.

10.5.6 6010D Mid-Run Recalibration

During the course of an analytical run, the instrument may be recalibrated to correct for instrument drift. A recalibration must then be followed immediately by a new analysis of a CCV and CCB before any further samples may be analyzed.

10.5.7 Dilutions for High Levels of Interfering Elements

Dilutions are also required for an element that is included in an IEC calculation if it exceeds the linear range. If a dilution is not performed, the IEC may be inaccurately applied. Therefore, even if an over-range analyte may not be required to be reported for a sample, if that analyte is an interferent for any requested analyte in that sample, the sample must be diluted until the interferent is at or below the working range. An NCM will be written in these instances.

10.6 Instrument Maintenance

See Section 20 in the QAM.

10.7 Troubleshooting

See Attachment 9.

11.0 Calculations / Data Reduction

11.1 Detailed calibration equations can be found in the corporate Policy CA-Q-P-003, *Calibration Curves & Selection of Calibration Points*, and under the public folder, *Arizona Calibration Training*.

11.2 ICV percent recoveries are calculated according to the following equation:

$$\%R = \left(\frac{\text{ICV Found Value}}{\text{ICV True Value}}\right) \times 100\%$$

11.3 CCV percent recoveries are calculated according to the following equation:

$$\%R = \left(\frac{\text{CCV Found Value}}{\text{CCV True Value}}\right) \times 100\%$$

11.4 Matrix Spike Recoveries are calculated according to the following equation:

$$\%R = \left(\frac{SSR - SR}{SA}\right) \times 100\%$$

Where:

SSR	=	Spike Sample Result
SR	=	Sample Result
SA	=	Spike Added

The relative percent difference (RPD) of a matrix spike/matrix spike duplicate pair is calculated according to the following equation:

$$RPD = \left[\frac{|MSD - MS|}{\left(\frac{MSD + MS}{2}\right)}\right] \times 100$$

Where:

MS	=	determined spiked sample concentration
MSD	=	determined matrix spike duplicate concentration

11.5 The final concentration for a digested aqueous sample is calculated as follows:

$$\text{Final Concentration (mg/L)} = \frac{C \times V1 \times D}{V2}$$

Where:

C	=	Concentration (mg/L) from instrument readout
D	=	Instrument dilution factor
V1	=	Final volume in liters after sample preparation
V2	=	Initial volume of sample digested in liters

11.6 The final concentration determined in digested solid samples when reported on a dry weight basis is calculated as follows:

$$\text{Final Concentration (mg/kg), dry weight} = \frac{C \times V \times D}{W \times S}$$

Where:

C	=	Concentration (mg/L) from instrument readout
D	=	Instrument dilution factor
V	=	Final volume in liters after sample preparation
W	=	Weight in Kg of wet sample digested
S	=	Percent solids/100

NOTE: A Percent Solids determination must be performed on a separate aliquot when dry weight concentrations are to be reported. If the results are to be reported on wet weight basis the "S" factor should be omitted from the above equation.

11.7 The LCS percent recovery is calculated according to the following equation:

$$\%R = \left(\frac{\text{LCS Found Value}}{\text{LCS True Value}}\right) \times 100\%$$

11.8 The IEC's are calculated according to the following equation:

$$IEC = \left(\frac{\text{observed concentration}}{\text{observed concentration of the interfering element}}\right)$$

11.9 The dilution test percent difference for each component is calculated as follows:

$$\%Difference = \frac{|I - S|}{I} \times 100$$

Where:

I	=	Sample result (Instrument reading)
S	=	Dilution test result (Instrument reading × 5)

Appropriate factors must be applied to sample values if dilutions are performed.

11.10 Documentation and Record Management

11.10.1 All sample data is uploaded to TALS. All sample preparation and analytical batch information, including the batch number(s), list of samples, preparation analyst and date, instrument analyst and date, identification of reagents and standards used, and identification of all measuring equipment used (e.g., balances, thermometers, pipettes) is recorded in TALS.

11.10.2 Raw data is scanned or saved directly as a PDF and is attached to the analytical batch in TALS.

11.10.3 The initial data review is performed by the analyst and a second-level review is performed by the area supervisor or designee. Both reviews are documented on a Data Review Checklist. See SOP DV-QA-0020 for more detail on the review process.

11.10.4 If dilutions are required due to insufficient sample, interferences, or other problems, the reporting limit and MDL are multiplied by the dilution factor and the data may require flagging.

NOTE: Unless special instructions indicate otherwise, sample results less than the reporting limit are reported as ND.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. An initial method detection limit study is performed in accordance with Policy DV-QA-005P. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency. For DoD, AFCEE, and DOE projects, an MDL verification is performed quarterly. DoD QSM 5.0 requires the MDLV spike level to be 2-4 times the calculated MDL.

12.2 Instrument Detection Limit Study

12.2.1 Instrument detection limit (IDL) studies are conducted quarterly for each instrument and each wavelength used for analysis.

12.2.2 Run seven blanks on three non-consecutive days.

12.2.3 Calculate the standard deviation for each day. The final IDL concentration is the average of the three daily standard deviation values.

12.2.4 See Policy DV-QA-014P for a discussion of IDL studies and evaluation of IDL results.

12.2.5 For Method 6010D the IDL solutions:

- Should be prepared with each of the different matrices analyzed on the instrument;
- Should be prepared with 10 replicates for each matrix;
- Should have all the replicates for each matrix analyzed in a single day.

12.3 Linear Dynamic Range (LDR)

12.3.1 The LDR must be determined initially (i.e., at initial setup) and then every three months for each analyte wavelength used on each instrument. The linear range is the concentration above which results cannot be reported without dilution of the sample.

12.3.2 The LDR must be determined from a linear calibration prepared in the normal manner using the normal operating procedures described in Sections 10 and 11.

12.3.3 The LDR is determined by analyzing successively higher standard concentrations of the analyte. A minimum of three standards is required for the initial and on-going studies, and one of the levels must be close to the upper end of the range. The highest concentration must be within 10% of the stated concentration.

12.3.4 The highest standard that meets this criterion defines the maximum concentration that can be reported for sample analysis without dilutions. Certain programs do not allow the use of LDRs for reporting purposes and instead require all sample results to fall below the highest daily standard analyzed.

12.3.5 If the instrument is adjusted in any way that may affect the LDRs, new dynamic ranges must be determined. The LDR data must be documented and kept on file.

12.4 Background Correction Points

12.4.1 To determine the appropriate location for off-line background correction when establishing methods, the user must scan the area on either side adjacent to the wavelength of interest and record the apparent emission intensity from all other method analytes. The location selected for background correction must be either free of off-line interelement spectral interference or a computer routine must be used for automatic correction on all determinations.

12.4.2 Tests to determine spectral interference must be done using analyte concentrations that will adequately describe the interference. Background correction points must be set prior to determining IECs. Refer to the ICP instrument manual for specific procedures to be used in setting background correction points.

12.5 Interelement Corrections (IECs)

12.5.1 ICP interelement correction (IEC) factors must be determined prior to the analysis of samples and every six months thereafter. If the instrument is adjusted in any way that may affect the IECs, the IECs must be re-determined.

12.5.2 When initially determining IECs for an instrument, wavelength scans must be performed to ensure that solutions in use are free from contaminants. If an IEC varies significantly from the previously determined IEC, then the possibility of contamination should be investigated. The purity of the IEC check solution can be verified by using a standard from a second source or an alternate method (i.e., GFAA or ICP-MS). Published wavelength tables (e.g., MIT tables, Inductively Coupled Plasma-Atomic Spectroscopy: Prominent Lines) can also be consulted to evaluate the validity of the IECs.

12.5.3 Refer to the facility-specific instrument operation SOP and instrument manufacturer's recommendations for specific procedures to be used in setting IECs. An IEC must be established to compensate for any interelement interference which produces a false analytical result with an absolute value greater than the RLs shown in Attachment 1. Note that the USACE program requires a control limit of 2x |MDL|, which is feasible when verified MDLs are used.

12.5.4 To determine IECs, run a single element standard at the established linear range. To calculate an IEC, divide the observed concentration of the analyte by the observed concentration of the "interfering element." Method 6010D requires that the IEC standards include Al, B, Ba, Ca, Cu, Fe, Mg, Mn, Mo, Na, Ni, Se, Si, Sn, V, and Zn.

12.5.5 Dual-View ICP IECs are more sensitive to small changes in the plasma and instrument setup conditions. Adjustments in the IECs will be required on a more frequent basis for the CID detector instruments as reflected by the ICSA response.

12.6 Rinse Time Determination

12.6.1 Rinse times must be determined annually.

12.6.2 To determine the appropriate rinse time for a particular ICP system, a standard containing the highest concentration level that would be reported for samples is aspirated as a regular sample followed by the analysis of a series of rinse blanks. The length of time required to reduce the analyte signals to < RL will define the rinse time for a particular ICP system.

12.6.3 For some analytes it may be impractical to set the rinse time based on the linear range standard result (i.e., analyte not typically detected in environmental samples at that level and an excessive rinse time would be required at the linear range level).

12.6.4 Rinse time studies can be conducted at additional concentration levels. These additional studies must be documented and kept on file if a concentration other than the linear range level is used to set the rinse time. The concentration levels used to establish the rinse time must be taken into consideration when reviewing the data.

12.6.5 The ICP instruments use an intelligent rinse program. The intelligent rinse lengthens the rinse time whenever a sample result for a known problem analyte is above a set concentration.

12.7 Demonstration of Capabilities

12.7.1 All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows:

12.7.2 Four LCSs are run using the same instrumental conditions and procedures used to analyze samples. Using these four LCSs demonstrates the analyst's ability to optimize and calibrate the instrument and to prepare analytical solutions. Calculate the mean recovery and standard deviation of the mean recovery for each analyte of interest.

12.7.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.7.4 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.7.5 The group/team leader has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience. Further details concerning the training program are described in SOP DV-QA-0024.

12.8 Training Requirements

The group/team leader has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience. Further details concerning the training program are described in SOP DV-QA-0024.

13.0 Pollution Control

13.1 It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, order chemicals based on quantity needed, and prepare reagents based on anticipated usage and reagent stability).

13.2 Standards and reagents should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with federal, state, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in Section 13, *Waste Management and Pollution Prevention*, of the Corporate Safety Manual, and DV-HS-001P, *Waste Management Plan*.

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Acid solutions from ICP drain - Waste Stream J

14.2.2 Metals waste potentially contaminated with Cat 1 radioactive materials – Waste Stream RJ

Note: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846), Third Edition and all promulgated updates, EPA Office of Solid Waste, through January 2008.

15.1.1 Method 6010C, Revision 3, Update IV, February 2007.

15.1.2 Method 6010D, Revision 4, Update V, July 2014.

15.2 Department of Defense Quality Systems Manual for Environmental Laboratories, Final Version 4.2, 10/25/2010.

15.3 Department of Defense Quality Systems Manual for Environmental Laboratories Version 5.0, July 2013.

16.0 Method Modifications:

Item	Method	Modification
1	EPA 6010C	This procedure uses mixed calibration standard solutions purchased from approved vendors instead of using individual mixes prepared in house as recommended by the subject methods.
2	EPA 6010C	The alternate run sequence presented in Section 10.5.3 is consistent with method requirements. Additional QC (i.e., ICSA) analyses were added to accommodate the CLP protocol requirements.
3	EPA 6010C	Method 6010 states that if the correction routine is operating properly, the determined apparent analyte(s) concentration from analysis of each interference solution should fall within a specific “concentration range around the calibration blank.” Because of the lack of definition for “concentration range around the calibration blank,” the laboratory has adopted the procedure in EPA CLP ILMO4.0 for determining IECs,

Item	Method	Modification
4	EPA 6010C	Section 9.9 of Method 6010C states: "If less than acceptable accuracy and precision data are generated, additional quality control tests are recommended prior to reporting concentration data for the elements in this method." The dilution test helps determine if a chemical or physical interference exists. Because the laboratory sometimes does not have prior knowledge if the MS/MSD will be within criteria, the analyst may select to perform a dilution test on one sample in each preparation batch. According to the method, the post digestion spike (PDS) determines any potential matrix interferences. In this procedure, matrix interference is determined by evaluating data for the LCS, MS/MSD, and serial dilutions. The laboratory must request documented, clear guidance when an unusual matrix will be received for a project and a request to perform the dilution test or PDS on a client-identified sample.

17.0 Attachments

Attachment 1 Metals Analyzed by ICP and Reporting Limits
Attachment 2 Matrix Spike and Aqueous Laboratory Control Sample Levels
Attachment 3 Low Level ICV and CCV Spiking Levels
Attachment 4 Interference Check Sample Concentrations
Attachment 5 TCLP Reporting Limits, Regulatory Limits and Matrix Spike Levels
Attachment 6 6500 Initial Calibration &Continuing Calibration Verification Standards
Attachment 7 Summary of Quality Control Requirements
Attachment 8 MSA Guidance
Attachment 9 Troubleshooting Guide
Attachment 10 Contamination Controls
Attachment 11 DoD QSM 5.0 QC Acceptance Criteria

18.0 Revision History

Revision 4, dated 31 December 2015
- Added requirements for Method 6010D to the SOP
- Minor grammar and formatting corrections throughout
- Added list of IEC test analytes to Section 12.5.4
- Added Section 10.5.6 regarding mid-run recalibration
- Added Section 12.2.5 defining 6010D IDL studies

Revision 3, dated 31 July 2015
- Annual review
- Updated Section 7.4 for how to make the 5% HNO_3/5% HCl solution
- Updated Section 12.2 for MDLV spike level to 2-4x MDL
- Updated Section 12.8.2 to use LCSs instead of ICVs for the DOC
- Reformatting throughout
- Removed reference to silica holding time
- Added Maintenance and troubleshooting sections
- Replaced Section 11.10 to match current practice
- Removed Section 12.2
- Removed Sections 1.3.1 and 1.3.2

- Added new Section 1.6
- Removed reference to glass beads in Section 6.2
- Corrected Reagent and Standard formulae throughout to agree with current practice

Revision 2, dated 31 July 31 2014
- Annual review
- Updated Section 6.1.3 to specify purity of argon gas
- Added statement to section 9.1.2 to reference DoD QSM 5.0 criteria in Attachment 11
- Removed references to preparation of oil/oily samples throughout the document as the lab no longer supports this digestion method
- Added references for prep methods to section 15
- Added DOD QSM 5.0 QC acceptance criteria as Attachment 11

Revision 1, dated 15 July 2013
- Annual review
- Removed section 1.7
- Added section 3.8
- Corrected formatting
- Added section 11.12
- Removed Attachment 8, renumbered attachments and fixed references to attachments throughout the document

Revision 0.3, dated 13 July 2012
- Annual Review
- Clarified soil preservation for ICP only analysis, Section 8
- Updated section 9.1, 10.1, 10.2, and 12.1 to reflect current practice
- Updated sections 10.4.6 and 10.4.10 to control calibration blanks to ½ the RL

Revision 0.2, dated 30 June 2011
- Added reference to DV-IP-0017 “Microwave Digestion” throughout document
- Added section 6.3 “Computer Software and Hardware”
- Removed Uranium from the ICSA/ICSAB tables in sections 7.4, 7.5, and 7.6
- Updated sections 7.14 and 7.15 to reflect current practices
- Updated the Acceptance Criteria in sections 9.4, 9.6, and 9.10
- Referenced the TestAmerica Denver Quality Assurance Manual in section 10.4.1
- Updated section 11 to reference corporate SOP CA-Q-S-005, “Calibration Curves” and Arizona Calibration Training spreadsheet
- Added IEC calculation to section 11

Earlier revision histories have been archived and are available upon request.

Attachment 1

Metals Analyzed by ICP and Reporting Limits

ELEMENT	Symbol	CAS #	6010 Analyte	Reporting Limit (µg/L) Water	Reporting Limit (mg/kg) Soil
Aluminum	Al	7429-90-5	X	100	10
Antimony[trace]	Sb	7440-36-0	X	10	1
Arsenic[trace]	As	7440-38-2	X	15	1
Barium	Ba	7440-39-3	X	10	1
Beryllium	Be	7440-41-7	X	1	0.1
Bismuth	Bi	7440-69-9		100	10
Boron	B	7440-42-8	X	100	10
Cadmium[trace]	Cd	7440-43-9	X	5	0.5
Calcium	Ca	7440-70-2	X	200	20
Chromium	Cr	7440-47-3	X	10	1
Cobalt	Co	7440-48-4	X	10	1
Copper	Cu	7440-50-8	X	15	2
Iron	Fe	7439-89-6	X	100	10
Lead[trace]	Pb	7439-92-1	X	9	0.8
Lithium	Li	7439-93-2	X	10	5
Magnesium	Mg	7439-95-4	X	200	20
Manganese	Mn	7439-96-5	X	10	1
Molybdenum	Mo	7439-98-7	X	20	2
Nickel	Ni	7440-02-0	X	40	4
Phosphorus	P	7723-14-0	X	3,000	300
Potassium	K	7440-09-7	X	3,000	300
Selenium[trace]	Se	7782-49-2	X	15	1.3
Silicon	Si	7631-86-9		500	50
Silver[trace]	Ag	7440-22-4	X	10	1
Sodium	Na	7440-23-5	X	1	100
Strontium	Sr	7440-24-6	X	10	1
Sulfur	S	7704-34-9	X	200	2
Thallium[trace]	Tl	7440-28-0	X	15	1.2
Thorium	Th	7440-29-1		15	15
Tin	Sn	7440-31-5	X	100	10
Titanium	Ti	7440-32-6	X	10	1
Uranium	U	7440-61-1		60	20
Vanadium	V	7440-62-2	X	10	2
Zinc	Zn	7440-66-6	X	20	2
Zirconium	Zr	7440-67-7		15	1

Attachment 2

Matrix Spike and Aqueous Laboratory Control Sample Levels

ELEMENT	LCS Level (µg/L)	Matrix Spike Level (µg/L)
Aluminum	2,000	2,000
Antimony	500	500
Arsenic	2,000	2,000
Barium	2,000	2,000
Beryllium	50	50
Bismuth	2,000	2,000
Boron	1,000	1,000
Cadmium	50	50
Calcium	50,000	50,000
Chromium	200	200
Cobalt	500	500
Copper	250	250
Iron	1,000	1,000
Lead	500	500
Lithium	1,000	1,000
Magnesium	50,000	50,000
Manganese	500	500
Molybdenum	1,000	1,000
Nickel	500	500
Phosphorous	10,000	10,000
Potassium	50,000	50,000
Selenium	2,000	2,000
Silicon	10,000	10,000
Si (as SiO_2)	21,400	21,400
Silver	50	50
Sodium	50,000	50,000
Strontium	1,000	1,000
Sulfur	2,000	2,000
Thallium	2,000	2,000
Thorium	2,000	2,000
Tin	2,000	2,000
Titanium	1,000	1,000
Uranium	2,000	2,000
Vanadium	500	500
Zinc	500	500
Zirconium	500	500

Attachment 3

Low Level ICV/CCV

ELEMENT	LCS Level (µg/L)
Aluminum	100
Antimony	10
Arsenic	15
Barium	10
Beryllium	1
Bismuth	100
Boron	100
Cadmium	5
Calcium	200
Chromium	10
Cobalt	10
Copper	15
Iron	100
Lead	9
Lithium	10
Magnesium	200
Manganese	10
Molybdenum	20
Nickel	40
Phosphorous	3,000
Potassium	3,000
Selenium	15
Silicon	500
Si (as SiO_2)	1070
Silver	10
Sodium	1,000
Strontium	10
Thallium	15
Thorium	15
Tin	10
Titanium	10
Uranium	60
Vanadium	10
Zinc	20
Zirconium	15

Attachment 4

Interference Check Sample Concentrations

Element	ICSA (µg/L)	ICSAB (µg/L)
Aluminum	500,000	500,000
Antimony	-	1,000
Arsenic	-	2,000
Barium	-	500
Beryllium	-	500
Bismuth	-	1,000
Boron	-	2,000
Cadmium	-	1,000
Calcium	500,000	500,000
Chromium	-	500
Cobalt	-	500
Copper	-	500
Iron	200,000	200,000
Lead	-	1,000
Lithium	-	1,000
Magnesium	500,000	500,000
Manganese	-	500
Molybdenum	-	1,000
Nickel	-	1,000
Phosphorous	-	2,000
Potassium	-	50,000
Selenium	-	5,000
Silicon	-	10,000
Silica	-	21,400
Silver	-	1,000
Sodium	-	50,000
Strontium	-	1,000
Sulfur	-	1,000
Thallium	-	10,000
Titanium	-	1,000
Vanadium	-	500

Attachment 4

Interference Check Sample Concentrations (cont'd)

Element	ICSA (µg/L)	ICSAB (µg/L)
Zinc	-	1,000
Tin	-	10,000
Thorium	-	10,000
Uranium	2,000	2,000
Zirconium	-	1,000

Attachment 5

TCLP Reporting Limits, Regulatory Limits and Matrix Spike Levels

ELEMENT	Reporting Level (µg/L)	Regulatory Limit (µg/L)	Spike Level (µg/L)
Arsenic	500	5000	4000
Barium	10000	100000	12000
Cadmium	100	1000	1100
Chromium	500	5000	5200
Lead	500	5000	5500
Selenium	250	1000	3000
Silver	500	5000	1050
Copper	100	N/A	2250
Zinc	200	N/A	2500

Attachment 6

6000 Dual View Calibration, ICV & CCV Standards

Element	Calibration Level	ICV (µg/L)	CCV (µg/L)
Aluminum Lo	1,000	250	500
Aluminum Hi	100,000	40,000	50,000
Antimony	2,000	250	1,000
Arsenic	2,000	250	1,000
Barium	1,000	250	500
Beryllium	1,000	250	500
Bismuth	2,000	500	1000
Cadmium	1,000	250	500
Calcium	10,000	2,000	5,000
Chromium	1,000	250	500
Cobalt	1,000	250	500
Copper	1,000	250	500
Iron Lo	5,000	250	2,500
Iron Hi	100,000	80,000	50,000
Lead	2,000	250	1000
Magnesium	40,000	10,000	20,000
Manganese	1,000	250	500
Molybdenum	1,000	250	500
Nickel	1,000	250	500
Phosphorous	2,000	2,000	1,000
Potassium	100,000	20,000	50,000
Selenium	2,000	500	1,000
Silver	1,000	250	500
Sodium Lo	10,000	2000	5,000
Sodium Hi	500,000	40,000	250,000
Strontium	1,000	250	500
Sulfur	10,000	4,000	5,000
Thallium	2,000	500	1,000
Thorium	10,000	3,000	5,000
Tin	2,000	500	1,000
Vanadium	1,000	250	500
Uranium	20,000	5,000	10,000
Zinc	1,000	250	500
Zirconium	1,000	250	500

Attachment 7
Summary Of Quality Control Requirements

QC Parameter	Frequency	Acceptance Criteria	Corrective Action
Two-point Initial Calibration	Beginning of every analytical run, every 24 hours, whenever instrument is modified, or CCV criterion is not met	RSD between multiple exposures ≤5%	Terminate analysis; Correct the problem; Prepare new standards; Recalibrate following system performance.
ICV	Beginning of every analytical run.	90 - 110 % recovery.	Terminate analysis; Correct the problem; Recalibrate.
CCV	After the ICV, after every 10 samples and at the end of the run.	90-110% recovery	Terminate analysis; Correct the problem; Recalibrate and rerun all samples not bracketed by acceptable CCV.
RL Standard	At the beginning of the run	Results must within 50%	Terminate analysis; Correct the problem; Recalibrate.
LLICV/CCV	At the beginning of the run and after every 10 samples	Recovery must be within 30%	Terminate analysis; Correct the problem; Recalibrate and rerun all samples not bracketed by acceptable LLCCV.
ICB	Beginning of every analytical run, immediately following the initial CCV.	The result must be within +/- ½ RL from zero.	Terminate analysis; Correct the problem; Recalibrate.
CCB	Immediately following each CCV (except for the CCV following the ICV).	The result must be within +/- ½ RL from zero.	Terminate analysis; Correct the problem; Recalibrate and rerun all samples not bracketed by acceptable CCB.
ICSA	Beginning of every run	See Section 9.10	See Section 9.10
ICSAB	Immediately following each ICSA.	Results must be within 80 - 120% recovery.	See Section 9.10
Dilution Test	One per prep batch.	For samples > 10x LOD (after dilution)' dilutions must agree within 10%.	Narrate the possibility of physical or chemical interference per client request.

See Section 10.5.3 for run sequence to be followed.

Attachment 7

Summary of Quality Control Requirements (Continued)

QC Parameter	Frequency	Acceptance Criteria	Corrective Action
Method Blank (MB)	One per sample preparation batch of up to 20 samples.	The result must be less than or equal to ½ the RL. Sample results greater than 10x the blank concentration are acceptable. Samples for which the contaminant is < ½ RL may not require redigestion or reanalysis (see Section 9.3)	Re-run once in a clean tube. If > ½ RL, re-digest and reanalyze samples. Note exceptions under criteria section. See Section 9.4 for additional requirements.
Laboratory Control Sample (LCS)	One per sample preparation batch of up to 20 samples.	LCS must be within 80 - 120% recovery or in-house control limits. Samples for which the contaminant is < RL and the LCS results are > 120% may not require redigestion or reanalysis (see Section 9.4)	Terminate analysis; Correct the problem; Redigest and reanalyze all samples associated with the LCS.
Matrix Spike (MS)	One per sample preparation batch of up to 20 samples.	75 – 125% recovery or tighter in-house control limits.	In the absence of client specific requirements, flag the data; no flag required if the sample level is > 4x the spike added.
Matrix Spike Duplicate (MSD)	One per sample preparation batch of up to 20 samples. 10% frequency for some programs (see 9.5)	75 – 125 % recovery; RPD ≤ 20% or tighter in-house control limits.	See Corrective Action for Matrix Spike.

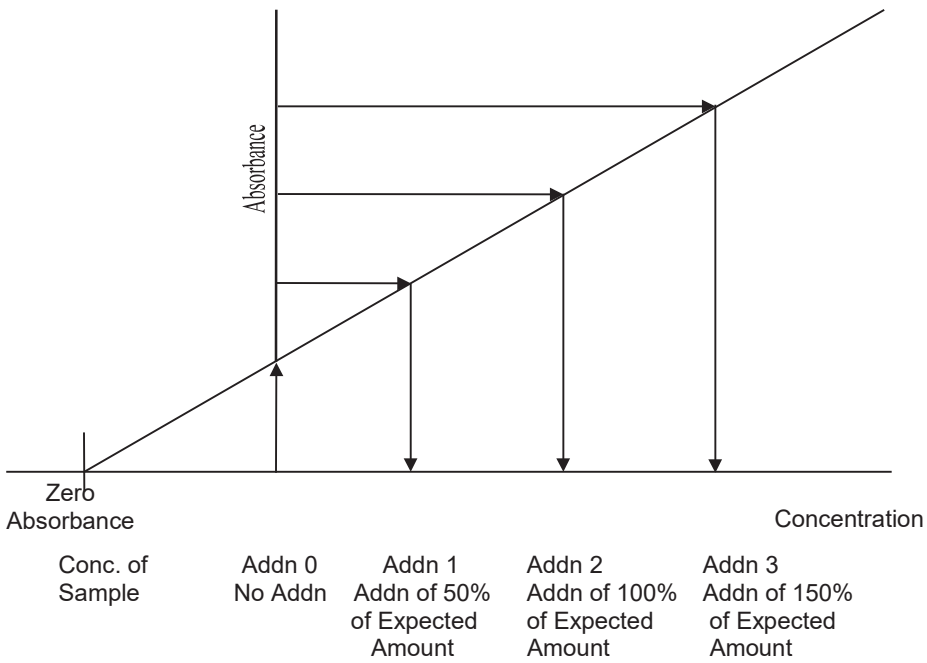
Attachment 8

MSA Guidance

Method of Standard Addition

Four equal volume aliquots of sample are measured and known amounts of standards are added to three aliquots. The fourth aliquot is the unknown and no standard is added to it. The concentration of standard added to the first aliquot should be 50% of the expected concentration. The concentration of standard added to the second aliquot should be 100% of the expected concentration and the concentration of standard added to the third aliquot should be 150% of the expected concentration. The volume of the unspiked and spiked standard should be the same.

In order to determine the concentration of analyte in the sample, the analytical value of each solution is determined and a plot or linear regression performed. On the vertical axis the analytical value is plotted versus the concentrations of the standards on the horizontal axis. An example plot is shown in Figure 1. When the resulting line is extrapolated back to zero absorbance, the absolute value of the point of interception of the horizontal axis is the concentration of the unknown.



For the method of standard additions to be correctly applied, the following limitations must be taken into consideration:

- The plot of the sample and standards must be linear (r=0.995 or greater) over the concentration range of concern. For best results, the slope of the curve should be similar to that of a plot of the aqueous standard curve.
- The effect of the interference should not vary as the ratio of the standard added to the sample matrix changes.

Attachment 9

Troubleshooting Guide

Problem	Possible Cause/ Solution
High Blanks	Increase rinse time Clean or replace tip Clean or replace torch Clean or replace sample tubing Clean or replace nebulizer
Instrument Drift	RF not cooling properly Vacuum level is too low Replace torch (Crack) Clean or replace nebulizer (blockage) Check room temperature (changing) Replace pump tubing Room humidity too high Clean torch tip (salt buildup) Check for argon leaks Adjust sample carrier gas Replace RF generator
Erratic Readings, Flickering Torch or High RSD	Check for argon leaks Adjust sample carrier gas Replace tubing (clogged) Check drainage(back pressure changing) Increase uptake time (too short) Increase flush time (too short) Clean nebulizer, torch or spray chamber Increase sample volume introduced Check that autosampler tubes are full Sample or dilution of sample not mixed Increase integration time (too short) Realign torch Reduce amount of tubing connectors
Standards reading twice normal absorbance or concentration	Incorrect standard used Incorrect dilution performed

Attachment 10

Contamination Control Guidelines

The following procedures are strongly recommended to prevent contamination:

All work areas used to prepare standards and spikes should be cleaned before and after each use.

All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.

Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.

Powdered gloves should not be used in the metals laboratory because the powder contains silica and zinc as well as other metallic analytes.

Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.

The following are helpful hints in the identification of the source of contaminants:

Yellow pipette tips and volumetric caps can sometimes contain cadmium.

Some sample cups have been found to contain lead.

The markings on glass beakers have been found to contain lead. If acid baths are in use for glassware cleaning, they should be periodically checked for contaminants since contaminant concentrations will increase over time.

New glassware especially beakers can be a source of silica and boron.

Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.

Improper cleaning of glassware can cause contamination.

Latex gloves contain over 500 ppb of zinc.

Attachment 11
DoD QSM 5.0 QC Criteria for Analysis by ICP

QSM 5.0 Table 8. Inorganic Analysis by ICP	
Requirement	**DoD QSM 5.0 and DOE QSAS 3.0**
Linear Dynamic Range (LDR) or high-level standard check	Run an LDR or high-level check standard at least once every 6 months. When calibrating with a single standard and a blank, the daily LDR standard must be analyzed at a concentration greater than any samples analyzed that day. Data cannot be reported above the high calibration range without an established/passing high-level check standard. Must be within ± 10% of expected value. Dilute samples within the calibration range or re-establish/verify the LDR.
Initial Calibration (ICAL)	Measure a minimum of one high standard and a calibration blank, daily. If more than one standard used, then $r^2 \geq 0.99$ ($r \geq 0.995$), otherwise no acceptance criteria. The ICAL must pass before running any samples. NOTE: The laboratory currently performs duplicate burns for the ICPAES method.
Initial Calibration Verification (ICV)	Run second-source standard once after each ICAL and prior to sample analysis. All reported analytes must be within ± 10% of expected value. Correct any problems, verify standard, and rerun ICV. If that fails, correct problem and rerun ICAL. Verification must pass before running any samples.
Continuing Calibration Verification (CCV)	Run CCV after every 10 field samples, and at the end of the analysis sequence. All reported values within ± 10% of expected value If the CCV is above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project (3HR). Correct any problems then rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since last successful CCV. Results cannot be reported without a valid CCV. Or Immediately (within one hour) analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analytes(s) in all samples since the last acceptable CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Low-Level Calibration Check Standard (Low-level ICV)	Run low-level standard at a concentration ≤ LOQ daily after one-point ICAL. All reported analytes must be within ± 20% of expected value. Correct any problems, then reanalyze or repeat ICAL. Results cannot be reported without a valid low-level calibration check standard.

Attachment 11
DoD QSM 5.0 QC Criteria for Analysis by ICP
(continued)

QSM 5.0 Table 8. Inorganic Analysis by ICP	
Requirement	**DoD QSM 5.0 and DOE QSAS 3.0**
Initial and Continuing Calibration Blank (ICB.CCB)	Analyze calibration blank before analyzing samples, after every 10 field samples, and at the end of the analysis sequence. No analytes detected > ½ LOQ (RL) or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. (13ICP) If not accepted by client, ICB/CCB must be <LOD. If criteria not met, correct problem If reanalysis is not possible, apply B-flag to all results for the specific analyte(s) in all samples processed with the contaminated blank. Must be explained in the case narrative. Flagging is only appropriate when samples cannot be reanalyzed. Correct any problems and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed. CCB failures due to carryover may not require an ICAL.
Interference Check Solution (ICS)	Run the ICS at the beginning of an analytical run (after ICAL and prior to sample analysis). ICS-A: Absolute value of concentration for all non-spiked analytes must be < LOD (unless they are a verified trace impurity from one of the spiked analytes). ICS-AB: Within ± 20% of expected value. (Note: ICS-AB not needed if instrument can read negative responses.) Correct any problems and reanalyze ICS. Do not analyze samples without a valid ICS. NOTE: TAL Denver has a letter from the ICSA standards manufacturer for many of the elements.
Method Blank	One per prep batch. No analytes detected > ½ LOQ (RL) or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. Common lab contaminants not detected > LOQ. (2CLC) For ICP, common lab contaminants are: Al, Ca, Fe, K, Mg, Na, Si, Zn (Ba for TCLP) If criteria not met, correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank. If reanalysis is not possible, apply B-flag to all results for the specific analyte(s) in all samples processed with the contaminated blank. Must be explained in the case narrative. Flagging is only appropriate when samples cannot be reanalyzed.
LCS	One per prep batch. Recovery must meet DoD QSM limits. If the LCS recovery is above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project (3HR). Correct any problems, then re-prep and reanalyze LCS and associated samples for failed analytes in all samples in the associated batch. If corrective action fails, apply Q-flag to specific analyte(s) in all samples in associated batch.

Attachment 11
DoD QSM 5.0 QC Criteria for Analysis by ICP
(continued)

QSM 5.0 Table 8. Inorganic Analysis by ICP	
Requirement	**DoD QSM 5.0 and DOE QSAS 3.0**
Matrix Spike (MS)	One MS per prep batch. Use DoD acceptance criteria for LCS. If MS fails, consult project-specific DQOs and contact client to see if additional measures need to be taken. For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MS falls outside LCS limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error.
MSD or Sample Duplicate	Analyze one MSD or sample duplicate per prep batch per matrix. RPD between duplicates must be ≤ 20%. For failures, consult project-specific DQOs and contact client for additional measures to be taken. If acceptance criteria are not met, apply J-flag. If MS falls outside LCS limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error.
Dilution Test	One per prep batch if MS or MSD fails. Only applicable for samples with concentrations >50x LOQ (prior to dilution). For samples with lower concentrations perform PDS. Five-fold dilution must agree within ± 10% of the original result. Apply J-flag if acceptance criteria not met and explain in the case narrative.
Post-Digestion Spike (PDS) Addition	Perform Recovery Test when dilution test fails or analyte concentration in all samples is <50 x LOQ. Recovery must be within 80-120 % of expected result. If test fails, then run samples by MSA or apply J-flag to all sample results (for same matrix) in which MSA was not run when recovery is outside of 80 - 120%.
Method of Standard Additions	When dilution or post digestion spike fails and if required by the project. Document use of MSA in case narrative.

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Inductively Coupled Plasma Mass Spectrometry for Trace Element Analysis by SW-846 Method 6020A/B

Electronic Copy Only

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1.0 Scope and Application

1.1 This procedure describes multi-elemental analysis by inductively coupled plasma-mass spectrometry (ICP-MS) based on EPA Method 6020A and 6020B.

1.2 Method 6020A and 6020B lists twenty-three elements approved for analysis by ICP-MS (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Tl, V, and Zn). This procedure has been developed for twenty elements and additional elements may be included provided that the method performance criteria presented in Sections 9 and 12 are met. However, project approval may be required from the controlling agencies for compliance testing beyond the elements included in the promulgated methods.

1.3 The procedure is applicable to the analysis of acid digested waters, sediments, sludges and soils. Standard reporting limits are listed in Attachment 1 for water and soil. The preliminary acid digestion for aqueous samples is described in SOP DV-IP-0014, and the digestion procedure for solids is given in SOP DV-IP-0015.

2.0 Summary of Method

2.1 Aqueous digestates are nebulized into a spray chamber where a stream of argon carries the sample aerosol through the quartz torch and injects it into a radiofrequency (RF) plasma. There the sample is decomposed and desolvated.

2.2 The ions produced are entrained in the plasma gas and by means of a water-cooled, differentially pumped interface, introduced into a high-vacuum chamber that houses a quadrapole mass spectrometer capable of providing a mass resolution better than or equal to 0.9 amu (see Section 3) peak width at 10% of the peak height. The ions are sorted according to their mass-to-charge ratio and measured with a channel electron multiplier.

2.3 A collision/reaction cell utilizing He and (optionally) H_2 gases is used to remove molecular interferences. As the ion beam passes through the cell chamber, a diffuse cloud of He or H_2 gas is injected into its path. Collisions between the ions and the atoms in the gas deflect and remove interferences. See Section 4.2.3 for more information.

2.4 Interferences must be assessed and valid corrections applied, or the data flagged to indicate problems. Interference corrections must include compensation for background ions contributed by the plasma gas, reagents, and the constituents of the sample matrix. Recommended elemental equations, which correct for many of these interferences, are listed in Attachment 2. Interference equations may vary or be unnecessary depending on the instrument setup and choice of collision/reaction gas.

2.5 Use of the internal standard technique is required to compensate for suppressions and enhancements caused by sample matrices. Internal standard assignments are listed in Attachment 4.

3.0 Definitions

3.1 Atomic Mass Unit (amu) – Obsolete term replaced by "unified atomic mass unit (u)" or "dalton (Da)", which denotes a small unit of mass that is used to express atomic and molecular masses. It is defined to be 1/12 of the mass of one atom of carbon-12.

3.2 Batch – The batch is a set of up to 20 samples of the same or similar matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches are defined at the sample preparation stage. See Policy DV-QA-003P for further details.

3.3 Dissolved Metals - Those elements which pass through a 0.45-µm membrane filter (sample is acidified after filtration).

3.4 Total Metals - The concentration determined on an unfiltered sample following vigorous acid digestion.

3.5 Total Recoverable Metals - The concentration determined on an unfiltered sample following treatment with hot, dilute mineral acids.

3.6 Instrument Detection Limit (IDL) - See Section 12.3.

3.7 Sensitivity - The slope of the analytical curve (i.e., the functional relationship between raw instrument signal and the concentration).

3.8 Tuning Solution - This is a multi-element solution containing analytes which are representative of the entire mass range capable of being scanned by the instrument. It is used to optimize the sensitivity of the instrument and to verify the mass resolution meets method criteria.

3.9 Initial Calibration Verification / Quality Control Standard (ICV) - A multi-element standard of known concentrations prepared to verify instrument calibration. This solution must be an independent standard prepared near the mid-point of the calibration curve, and at a concentration other than that used for instrument calibration.

3.10 Continuing Calibration Verification (CCV) - A multi-element standard of known concentrations prepared to monitor and verify the instrument daily continuing performance.

3.11 Interference Check Standard (ICS) - A solution containing both interfering and analyte elements of known concentration that is used to correction factors.

3.12 Laboratory Control Sample / Laboratory Fortified Blank (LCS/LFB) - A multi-element standard of known concentrations that is carried through the entire sample preparation and analysis procedure. This solution is used to verify the accuracy of the sample preparation.

3.13 Reagent Blank - High purity (> 18 megohm-cm) water containing the same acid matrix as the calibration standards that is carried through the entire digestion

process.

3.14 **Calibration Blank -** High purity (> 18 megohm- cm) water acidified with the same acid concentrations present in the standards and samples. Also referred to as the Initial Calibration Blank (ICB) and Continuing Calibration Blank (CCB).

3.15 **Method Detection Limit (MDL) -** The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

3.16 **Low Level ICV (LLICV) / Continuing Calibration Verification (LLCCV) -** A multi-element standard of known concentrations prepared to monitor and verify the instrument performance at the reporting limit (RL).

3.17 Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and Policy DV-QA-003P, *Quality Control Program*, for definitions of general analytical and QA/QC terms.

4.0 Interferences

4.1 Elemental Isobaric Interferences

Elemental isobaric interferences in the ICPMS are caused by isotopes of different elements forming ions with the same nominal mass-to-charge ratio (m/z). Most interferences of this type are corrected for by the instrument software and by the careful selection of isotopes for analysis.

4.2 Isobaric Molecular Interferences

4.2.1 Polyatomic interferences are derived from the plasma gas, reagents or sample matrix. Isobaric molecular interferences are caused by ions consisting of more than one atom or charge. Attachment 3 lists isobaric interferences which might possibly affect required analytes. These molecular interferences are minimized by use of the collision cell utilizing He and/or H_2 gases. When these interferences cannot be avoided by the use of another isotope with sufficient natural abundance, corrections must be applied and the data flagged to indicate the presence of interferences.

4.2.2 Chloride in samples can produce low recoveries for antimony and silver. If chloride interference is a concern, 1% HCl can be added during digestion, but calibration standards must be adjusted to include 1% HCl also. The use of hydrochloric and sulfuric acids should be minimized due to higher incidence of molecular-ion interferences with the presence of these acids. Excessive amounts of nitric acid can also lead to molecular interferences.

4.2.3 Collision cell interference removal works both by causing the interfering molecular ion to dissociate and by reducing the kinetic energy of the ion. The latter is termed Kinetic Energy Discrimination (KED), and is the

primary mechanism for interference removal. Polyatomic ions are larger than elemental ions and so collide with the helium atoms in the collision cell more frequently than the smaller elemental ions. Each collision reduces the energy of the ion, so the molecular ions lose energy more quickly. At the end of the collision cell a positive voltage plate prevents passage of the now low energy molecular ions. Thus, the interference is eliminated because the molecular ions do not reach the detector.

4.3 Doubly Charged Ion Interferences

Doubly charged elemental ion interferences are possible in cases where the second ionization potential of the element is significantly below the first ionization potential for argon (15.7 eV). If a doubly charged ion is formed, it will cause a response at half of its elemental mass, potentially causing interference. Most elements have high enough second ionization potentials that formation of doubly charged ions is not an issue. The percentage of doubly charged ions being formed in the plasma is monitored on a daily basis during the instrument tuning process.

4.4 Physical Interferences

4.4.1 Physical interferences are associated with the transport and nebulization process. Internal standards are used to compensate for these types of interferences.

4.4.2 Internal standards should be added at a level to give approximately 100,000 – 20,000,000 counts of raw signal intensity. The mass of the internal standard should ideally be within 50 amu of the mass of the measured analyte.

4.4.3 Matrix effects are monitored by comparing the internal standard intensity in the sample to the internal standard intensity of the calibration blank. When performing method 6020A, the internal standard recoveries in samples can not fall below 70% of the intensity of the calibration standard. If they fall outside this window, a five-fold dilution (1:4) is performed on the sample to correct for matrix effects and the sample is reanalyzed.

4.4.4 Memory effects or carry-over can occur when there are large relative concentration differences between samples and/or standards which are analyzed sequentially. The rinse period between samples must be long enough to eliminate significant memory interference.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use.

It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.3.2 The ICP-MS plasma emits strong UV light and is harmful to vision. All analysts must avoid looking directly at the plasma. The RF Generator produces strong radio frequency waves, most of which are unshielded. People with pacemakers should not go near the instrument while in operation.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material[1]	Hazards	Exposure Limit[2]	Signs and symptoms of exposure
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1 – Always add acid to water to prevent violent reactions. 2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Inductively Coupled Plasma-Mass Spectrometer (ICP-MS) capable of providing resolution less than or equal to 0.9 amu at 10% peak height and 1.0 amu at 5% peak height in the mass range from 6-253 with a data system that allows corrections for isobaric interferences and the application of the internal standard technique. The ICP-MS must be equipped with a collision cell for the removal of molecular interferences.

6.1.2 A four-channel peristaltic pump.

6.1.3 Autosampler with autosampler tubes.

6.1.4 Appropriate water cooling device.

6.2 Supplies

6.2.1 Argon gas: High purity grade (99.99%).

6.2.2 Calibrated automatic pipettes or Class A glass volumetric pipettes.

6.2.3 Class A volumetric flasks.

6.3 Computer Software and Hardware

Please refer to the master list of documents and software located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination. All standards must be entered into the TestAmerica LIMS (TALS) Reagent Module. Reagents that are not used for calculating results may either be recorded in the Reagent Module or may be entered into batch worksheets.

7.1 Storage and Shelf-Life

7.1.1 All standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. Standards stored at concentrations as received from the vendor and mid-level dilutions must be replaced prior to the expiration date assigned by the vendor. If no expiration date is provided, the stocks and mid-level standards may be stored for up to one year. They must be replaced sooner if verification from an independent source indicates a problem.

7.1.2 Working standards, i.e., all standards at concentrations ready to analyze on the ICP-MS (except tuning mixes, ICSA and ICSAB mixes, which are received at ready-to-use concentrations) are prepared fresh daily.

7.1.3 For more information on standard storage and shelf-life, see SOP DV-QA-0015.

7.2 Standards

Detailed instructions regarding the preparation of standards and reagents are given in this section. Alternate procedures are allowed as necessary to accommodate volume requirements as long as final concentrations are maintained and an accurate description of the standard or reagent used is entered into the Reagent Module in TALS.

7.2.1 Tuning Solution

The parent tuning solution is purchased as a custom multi-element mix. The elements and concentrations of the constituents are shown in Attachment 7. Prepare the working tuning Solution as detailed below.

7.2.1.1 Obtain a clean 1 L volumetric flask

7.2.1.2 Place 500 mL of reagent water and 10 mL of conc. HNO3 in the flask

7.2.1.3 Pipette 1mL of the Tuning Solution Stock into the flask

7.2.1.4 For the Agilent 7700 also add 50 µL of a 500 mg/L Mg solution and 30 µL of a 1000 mg/L Be solution.

7.2.1.5 Dilute to volume with reagent blank (See Section 7.3). Stopper and mix.

7.2.2 P/A factor solution

7.2.2.1 The Pulse/Analog (P/A) solution is used to monitor the correlation between the Pulse counting and Analog modes of the electron multiplier. The diluted solution must be prepared at different concentrations depending on the current instrument conditions. Multiple dilutions may be required to cover the required intensity range for all elements.

7.2.2.2 The P/A solution may be commercially purchased as a custom multi-element mix. See Attachment 7 for a list of the constituents and concentrations.

7.2.2.3 Prepare and use the P/A solution as recommended by the instrument manufacturer. The P/A solution should be analyzed daily.

7.2.3 Calibration Standard

Stock calibration standards are purchased as custom multi-element mixes or as single element solutions. Each day of analysis, the standards are diluted to working levels using reagent blank (see Section 7.3). The concentrations are given in Attachment 10. Prepare the Daily Working Calibration Standard as shown.

7.2.3.1 Daily Working Calibration Standard for Instruments 077 and 078 (ms 77 cal std)

7.2.3.1.1 Obtain a clean 100 mL volumetric flask.

7.2.3.1.2 Place 50 mL of reagent blank in the flask.

7.2.3.1.3 Pipette 0.5 mL of the MS CALSTD-1 stock standard into the flask.

7.2.3.1.4 Pipette 0.5 mL of the MS CALSTD-2 stock standard into the flask.

7.2.3.1.5 Pipette 0.5 mL of the MS CALSTD-3 stock standard into the flask.

7.2.3.1.6 Pipette 0.5 mL of the MS BRC CALSTD stock standard into the flask.

7.2.3.1.7 Pipette 0.5 mL of a 20 mg/L Zr standard into the flask.

7.2.3.1.8 Dilute to volume with reagent blank. Stopper and mix.

7.2.3.2 Daily Working Calibration Standard for Instrument 024 (MS CAL DAILY)

7.2.3.2.1 Obtain a clean 100 mL volumetric flask.

7.2.3.2.2 Place 50 mL of reagent blank in the flask.

7.2.3.2.3 Pipette 0.5 mL of the MS CALSTD-1 stock standard into the flask.

7.2.3.2.4 Pipette 0.5 mL of the MS CALSTD-2 stock standard into the flask.

7.2.3.2.5 Pipette 0.5 mL of the MS CALSTD-3 stock standard into the flask.

7.2.3.2.6 Pipette 0.5 mL of a 20 mg/L W standard into the flask.

7.2.3.2.7 Dilute to volume with reagent blank. Stopper and mix.

7.2.4 Initial Calibration Verification (ICV) Standard

The ICV stock is from a source different than the source for the calibration standards. Each day of analysis, the ICV standards are prepared new in reagent blank to the concentrations shown in Attachment 10. Prepare the ICV as shown below:

7.2.4.1 Initial Calibration Verification Standard for Instruments 077 and 078 (MS 77 ICV)

7.2.4.1.1 Obtain a clean 50 mL volumetric flask.

7.2.4.1.2 Place 25 mL of reagent blank in the flask.

7.2.4.1.3 Pipette 0.1 mL of the MS ICV StockA Standard into the flask.

7.2.4.1.4 Pipette 0.1 mL of the MS ICV StockB Standard into the flask.

7.2.4.1.5 Pipette 0.1 mL of the MS ICV Alt HP Standard into the flask.

7.2.4.1.6 Pipette 0.1 mL of the MS ICV BRC HP Standard into the flask.

7.2.4.1.7 Dilute to volume with reagent blank. Stopper and mix.

7.2.4.2 Initial Calibration Verification Standard for Instrument 024 (MS ICV)

7.2.4.2.1 Obtain a clean 50 mL volumetric flask.

7.2.4.2.2 Place 25 mL of reagent blank in the flask.

7.2.4.2.3 Pipette 0.1 mL of the MS ICV StockA Standard into the flask.

7.2.4.2.4 Pipette 0.1 mL of the MS ICV StockB Standard into the flask.

7.2.4.2.5 Pipette 0.1 mL of the MS ICV Alt HP Standard into the flask.

7.2.4.2.6 Dilute to volume with reagent blank. Stopper and mix.

7.2.5 Continuing Calibration Verification (CCV) Standard

The CCV is prepared from the same source as the calibration standards. The CCV standards are prepared fresh each day of analysis in reagent blank. The concentration is shown in Attachment 10.

7.2.5.1 Continuing Calibration Verification for Instruments 077 and 078 (ms 77 ccv)

7.2.5.1.1 Obtain a clean 100 mL volumetric flask.

7.2.5.1.2 Place 50 mL of the Daily Working Calibration Standard in the flask.

7.2.5.1.3 Dilute to volume with reagent blank. Stopper and mix.

7.2.5.2 Continuing Calibration Verification for Instrument 024 (MS CCV)

7.2.5.2.1 Obtain a clean 100 mL volumetric flask.

7.2.5.2.2 Place 50 mL of reagent blank in the flask.

7.2.5.2.3 Pipette 0.25 mL of the MS CALSTD-1 stock standard into the flask.

7.2.5.2.4 Pipette 0.25 mL of the MS CALSTD-2 stock standard into the flask.

7.2.5.2.5 Pipette 0.25 mL of the MS CALSTD-3 stock standard into the flask.

7.2.5.2.6 Pipette 0.25 mL of a 20 mg/L W standard into the flask.

7.2.5.2.7 Dilute to volume with reagent blank. Stopper and mix.

7.2.6 Reporting Limit (RL) Standards

The reporting limit standards are prepared fresh daily from the same stock as the calibration standards using the reagent blank. The analyte concentrations must be less than or equal to the respective reporting limits. Multiple solutions may be required in order to satisfy all of the project and client specific reporting limits. Alternate reporting limit concentrations may be used as necessary to meet client requirements as long as an accurate description of the standard used is entered into the Reagents module in TALS. Prepare the Reporting Limit Standard for the Agilent 7700 as detailed below.

7.2.6.1 RL Standard for Instruments 077 and 078 (ms 77 RL)

7.2.6.1.1 Obtain a clean 50 mL volumetric flask.

7.2.6.1.2 Place 30 mL of reagent blank in the flask.

7.2.6.1.3 Pipette 0.5 mL of the ms 77 cal std solution into the flask.

7.2.6.1.4 Dilute to volume with reagent blank. Stopper and mix.

7.2.6.2 RL Standard for Instrument 024 (MS RL STD)

7.2.6.2.1 Obtain a clean 10 mL autosampler tube.

7.2.6.2.2 Place 5 mL of reagent blank in the flask.

7.2.6.2.3 Pipette 0.1 mL of the MS CAL DAILY standard into the flask.

7.2.6.2.4 Pipette 0.09 mL of a mixed 1 mg/L Sn and Zn standard into the flask.

7.2.6.2.5 Dilute to volume with reagent blank and mix well.

7.2.7 Daily Linear Range Standard

The Linear Range standard is prepared from the same stock as the calibration standards using reagent blank.

7.2.7.1 Daily Linear Range Standard for Instruments 077 and 078 (MS 77 LR STD)

7.2.7.1.1 Obtain a clean 500 mL volumetric flask.

7.2.7.1.2 Place 50 mL of reagent blank in the flask.

7.2.7.1.3 Pipette 1.0 mL of a 1,000 mg/L As standard into the flask.

7.2.7.1.4 Pipette 2.5 mL of a 1,000 mg/L Ba standard into the flask.

7.2.7.1.5 Pipette 1.0 mL of a 1,000 mg/L Be standard into the flask.

7.2.7.1.6 Pipette 1.0 mL of a 1,000 mg/L Cd standard into the flask.

7.2.7.1.7 Pipette 1.0 mL of a 1,000 mg/L Co standard into the flask.

7.2.7.1.8 Pipette 2.5 mL of a 1,000 mg/L Cr standard into the flask.

7.2.7.1.9 Pipette 2.5 mL of a 1,000 mg/L Cu standard into the flask.

7.2.7.1.10 Pipette 5.0 mL of a 1,000 mg/L Mn standard into the flask.

7.2.7.1.11 Pipette 1.0 mL of a 1,000 mg/L Mo standard into the flask.

7.2.7.1.12 Pipette 2.5 mL of a 1,000 mg/L Ni standard into the flask.

7.2.7.1.13 Pipette 2.5 mL of a 1,000 mg/L Pb standard into the flask.

7.2.7.1.14 Pipette 0.5 mL of a 1,000 mg/L Sb standard into the flask.

7.2.7.1.15 Pipette 1.0 mL of a 1,000 mg/L Se standard into the flask.

7.2.7.1.16 Pipette 1.0 mL of a 1,000 mg/L Sn standard into the flask.

7.2.7.1.17 Pipette 0.5 mL of a 1,000 mg/L Tl standard into the flask.

7.2.7.1.18 Pipette 1.0 mL of a 1,000 mg/L U standard into the flask.

7.2.7.1.19 Pipette 1.0 mL of a 1,000 mg/L V standard into the flask.

7.2.7.1.20 Pipette 2.5 mL of a 1,000 mg/L Zn standard into the flask.

7.2.7.1.21 Pipette 0.05 mL of a 10,000 mg/L Th standard into the flask.

7.2.7.1.22 Dilute to volume with reagent blank. Stopper and mix.

7.2.7.2 Daily Linear Range Standard for Instrument 024 (MS LR STD)

7.2.7.2.1 Obtain a clean 10 mL autosampler tube.

7.2.7.2.2 Place 5 mL of reagent blank in the flask.

7.2.7.2.3 Pipette 0.5 mL of the MS CALSTD-1 stock standard into the flask.

7.2.7.2.4 Pipette 0.5 mL of the MS CALSTD-2 stock standard into the flask.

7.2.7.2.5 Pipette 0.5 mL of a 20 mg/L W standard into the flask.

7.2.7.2.6 Dilute to volume with reagent blank and mix well.

7.2.8 Internal Standard (IS) Solution (77 I.S. / MS I.S. INT)

The internal standard solution is added continuously by peristaltic pump through a mixing tee. The concentrations and components are specified in Attachment 4. Prepare the IS solution as follows:

7.2.8.1 Obtain a clean 250 mL volumetric flask.

7.2.8.2 Place 100 mL of reagent blank in the flask.

7.2.8.3 Pipette 1.2 mL of the 1,000 mg/L Ge Standard into the flask.

7.2.8.4 Pipette 0.4 mL of the 1,000 mg/L Ho Standard into the flask.

7.2.8.5 Pipette 0.4 mL of the 1,000 mg/L In Standard into the flask.

7.2.8.6 Pipette 0.75 mL of the 1,000 mg/L Sc Standard into the flask.

7.2.8.7 Pipette 1.5 mL of the 1,000 mg/L ^{6}Li Standard into the flask.

7.2.8.8 Dilute to volume with the appropriate reagent blank. Stopper and mix.

7.2.9 Interference Check Standard Solutions (ICSA / ICSAB)

The interference check standard solution (ICSA) and the spiked interference check standard solution (ICSAB) are prepared as follows:

7.2.9.1 ICSA Standard (ms 77 icsa / MS ICSA)

7.2.9.1.1 Obtain a clean 100 mL volumetric flask.

7.2.9.1.2 Place 50 mL of reagent blank in the flask.

7.2.9.1.3 Pipette 10.0 mL of the MS ICSA STOCK standard into the flask.

7.2.9.1.4 Dilute to volume with the appropriate reagent blank. Stopper and mix.

7.2.9.2 ICSAB Standard (MS 77 ICSAB / MS ICSAB)

7.2.9.2.1 Obtain a clean 100 mL volumetric flask.

7.2.9.2.2 Place 50 mL of reagent blank in the flask.

7.2.9.2.3 Pipette 0.5 mL of the MS CALSTD-1 stock standard into the flask.

7.2.9.2.4 Pipette 0.5 mL of the MS CALSTD-2 stock standard into the flask.

7.2.9.2.5 Pipette 0.5 mL of the MS CALSTD-3 stock standard into the flask.

7.2.9.2.6 For the Agilent 7700 instruments pipette 0.5 mL of the MS BRC CALSTD stock standard into the flask.

7.2.9.2.7 For the Agilent 7500 instrument pipette 0.5 mL of a 20 mg/L W standard into the flask.

7.2.9.2.8 Pipette 10.0 mL of the MS ICSA STOCK standard into the flask.

7.2.9.2.9 Dilute to volume with the appropriate reagent blank. Stopper and mix.

7.2.10 6020A only -Low Level Initial Calibration Verification and Low-Level Continuing Verifications (ms 77 LLCCV / MS LCCV)

The low level ICV / low level CCV solution is prepared from the same source as the calibration standards. The low level standard is prepared fresh each day of analysis in reagent blank. The concentration is shown in Attachment 10. Prepare the low level standard solution as follows:

7.2.10.1 Obtain a clean 100 mL volumetric flask.

7.2.10.2 Place 50 mL of reagent blank in the flask.

7.2.10.3 Pipette 1.0 mL of the MS LLCCV1 stock standard into the flask.

7.2.10.4 Pipette 1.0 mL of the MS LLCCV 2A stock standard into the flask.

7.2.10.5 Dilute to volume with the appropriate reagent blank. Stopper and mix.

7.3 Reagents

7.3.1 Reagent Water - ASTM Type I or equivalent for the elements of interest, generated using an ion-exchange water polishing system capable of achieving 18.0 megohm-cm.

7.3.2 Reagent Blank - Agilent 7500, 5% HNO3 - Carefully dilute 50 mL of concentrated HNO_3 in 1.0 L of reagent water. This solution is used to dilute samples and it is used for the initial and continuing calibration blanks.

7.3.3 Reagent Blank - Agilent 7700, 2% HNO3/0.5% HCl – Carefully dilute 40 mL of concentrated HNO3 and 10 mL of HCl in 2.0 L of reagent water. This solution is used to dilute samples and it is used for the initial and continuing calibration blanks.

7.3.4 Reagent Blank - Agilent 7700, 5% HNO3/5% HCL (Zr only) – Carefully dilute 100 ml of concentrated HNO_3 and 100 ml if HCL in 2.0 L of reagent water. This solution is used to dilute samples and it is used for calibration blanks.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation[1]	Holding Time[2]	Reference
Water[3]	HDPE	50 mLs	HNO_3, pH < 2	180 Days	SW-846
Soil	Glass	4 oz	Cool $\leq$ 6°C[4]	180 Days	SW-846

[1]SW-846 specifies a holding time but does not specify a preservation for solid samples for total metals. TAL-Denver refrigerates these samples.

[2]Samples must be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Holding Times are calculated from the date the sample was collected.

[3]Water samples collected for dissolved elements are filtered immediately on-site by the sampler before adding preservative.

[4]Although ICP analysis of soil does not require refrigeration of the samples, mercury analysis does require refrigeration. Samples which will be used to aliquot for both analyses must be refrigerated.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the

TALS Method Comments to determine specific QC requirements that apply. Quality control requirements are summarized in Attachment 9.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver Policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver Policy DV-QA-024P, *QA/QC Requirements for Federal Programs*. This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in TALS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Method Blank (MB)

For aqueous and soil samples, the method blank consists of reagent water that has been processed in the same manner as the samples. For soil samples analyzed under the AFCEE and DoD QAPPs, the method blank consists of <1 mm glass beads that have been processed in the same manner as the samples. One method blank must be processed with each preparation batch.

Acceptance Criteria: Method blank results are acceptable if the concentration for each analyte of interest is less than ½ the reporting limit (RL). For DoD QSM 5.0 the control limit is less than ½ LOQ. In the absence of project specific reporting limits, if the blank is less than 10% of the lower limit of quantitation check sample concentration, less than 10% of the regulatory limit, or less than 10% of the lowest sample concentration for each analyte in a given preparation batch, whichever is greater, then the method blank is considered acceptable.

Corrective Action: If the method blank does not meet the acceptance criteria, the source of contamination should be investigated to determine if the problem can be minimized or eliminated.

Samples associated with the contaminated blank shall be reprocessed for analysis or, under the following circumstances, may be reported as qualified (qualifier flags or narrative comments):

- The same analyte was not detected in the associated samples;
- The method blank concentration is less than 1/10 of the measured concentration of any sample in the batch;
- The method blank concentration is less than 1/10 the specified regulatory limit; or
- The analyte is a common laboratory contaminant (e.g., copper, zinc, iron, or lead) less than 2 times the RL. Note that some programs do not recognize common lab contaminants or have a more stringent criterion (e.g., DoD QSM 5.0 allows common laboratory contaminants up to the RL).

If the above criteria are not met and reanalysis is not possible, then the sample data must be qualified. This anomaly must be addressed in the project narrative and the client must be notified.

9.3 Laboratory Control Sample (LCS)

The LCS consists of reagent water that is spiked with the analytes of interest at the project specific action level or, when lacking specific action levels, at approximately the mid-point of the calibration range (summarized in Attachment 10). For soil samples analyzed under the AFCEE and DoD QAPPs, the LCS consists of <1 mm glass beads that have been spiked with the analytes of interest and processed in the same manner as the samples. One LCS must be processed for each preparation batch.

Acceptance Criteria: LCS control limits are based on three standard deviations of past laboratory results or program specific requirements. These limits must not exceed 80-120%. The control limits are maintained in TALS. For DoD QSM 5.0 the laboratory must use QSM Appendix C Limits for batch control if project limits are not specified.

Corrective Action: If the LCS recovery falls outside of the control limits for any analyte, that analyte is judged to be out of control. All associated samples must be reanalyzed One possible exception is a recovery for a given element above the upper control limit with no detection for the same element in the samples. If project requirements allow this exception, the data may be accepted with qualifiers, an NCM must be generated, and the failure narrated in the final report.

9.4 Matrix Spike / Matrix Spike Duplicate (MS / MSD)

The MS is prepared by taking a second aliquot of a selected sample and spiking it with the analytes of interest at the same level as the LCS (summarized in Attachment 10). An MSD is prepared by taking a third aliquot of the selected sample and spiking it with the analytes of interest at the same level as the LCS (summarized in Attachment 10). The MS and MSD are processed in the same manner as the samples. One MS/MSD pair must be processed for each preparation batch. Some programs (e.g., AFCEE) require that matrix spikes can be performed only on project samples, and that the samples to be used are identified on the chain of custody form. The spike concentration should be the same level as the LCS.

Acceptance Criteria: Control limits are based on historical data or project specific requirements. Historical control limits are based on three standard deviations of past laboratory results. These limits are not to exceed 75-125% recovery, and 20% relative percent difference (RPD). The control limits are maintained in TALS. For DoD QSM 5.0 the laboratory must use QSM Appendix C limits for batch control if project limits are not specified.

Corrective Action: If MS/MSD results do not meet the acceptance criteria and all other quality control criteria have been met, then matrix interference is suspected. Failed matrix spikes are flagged automatically, and are discussed in the final report case narrative. In addition, a serial dilution and PDS must be run. For DoD QSM 5.0 a “J” flag is applied to the parent sample if the acceptance criteria is not met.

NOTE: This method does not require a sample duplicate. Precision is measured using the MS/MSD. Use of the MS/MSD is preferred as not all samples will contain measurable concentrations of the target analytes. Samples that have target analytes at low concentrations or non-detectable levels do not provide useful precision data. When an MS/MSD is not available, an LCS and LCSD will be used to measure precision.

9.5 Interference Check Solutions (ICSA/ICSAB)

The interference check solution is prepared with known concentrations of interfering elements so a determination may be made as to the magnitude of the interference on analytes of interest as well as a test of any software corrections. The required elements and their concentrations are listed in Attachment 5. The interference check solutions must be analyzed at the beginning of every analytical run and once every 12 hours thereafter. The results of solution "A" and solution "AB" should be monitored for possible interferences.

Acceptance Criteria: The non-spiked analytes in the A solution must be less than 2x the RL. The results for the trace elements (B portion) must be ± 20% of the expected value. In addition,

the internal standard recoveries for both the ICSA and AB must be within 70-150%. Some programs have control limits for the non-spiked elements in the ICSA. Please check the client specific requirements. For DoD QSM 5.0 the ICSA for non-spiked elements is controlled to less than the absolute value of the LOD unless they are a verified impurity.

Corrective Action: If the ICSAB results exceed the 20% limit or the ICSA is out for DoD QSM 5.0, then the analysis sequence must be terminated. For DoD QSM 5.0 if the ICSA is outside of the control limits for the non-spiked elements the sequence must also be terminated. The problem must be investigated and fixed. The ICSA and all affected samples must be re-analyzed.

NOTE: It may not be possible to obtain absolutely clean ICSA/ICSAB standards. If contamination can be confirmed by another method (e.g., ICPAES), acceptance criteria will be applied at that level and the data accepted.

9.6 Internal Standards Evaluation for Samples

The IS recovery in samples cannot fall below 70% or be above 150% of the intensity of the calibration blank for 6020A and 30-150% for 6020B. If sample IS recoveries fall outside of these criteria, a five-fold (1:4) dilution must be performed, the dilution analyzed, and the same acceptance criteria applied. For DoD QSM 5.0 the internal standard for samples is controlled to 30-120%.

9.7 Serial Dilution

One serial five-fold dilution should be analyzed per preparation batch. If the analyte concentration is within the linear range of the instrument and sufficiently high (minimally, a factor of 50 times above the MDL), the serial dilution must agree to within 10% of the original analysis. If not, an interference effect is suspected, which must be described in an anomaly report and included in the final report narrative. Samples identified as blanks should not be used for serial dilution. For DoD QSM 5.0 the serial dilution is evaluated if the parent sample concentration is greater than 50x the LOQ prior to dilution. If the acceptance criteria are not met then the parent sample is flagged “J”. Method 6020B sets the calculation level at 25x RL and the required limit at 20%.

9.8 Post-Digestion Spike Addition (PDS)

A PDS is performed for each batch. An analytical spike added to a portion of a prepared sample, or its dilution, should be recovered to within 80 - 120% of the known value. If the PDS fails to meet this criterion, matrix interference should be suspected. Typically the concentration of the PDS is 200 µg/L for each element except silver which is spiked at 50 µg/L. For DoD QSM 5.0 if the parent sample concentration is less than 50x the LOQ prior to dilution then the PDS must recover within 80-120%. If the recovery is outside of the control limits for a given element then the parent sample is flagged “J”. Method 6020B allows limits of ± 25%.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is approved by the supervisor and then automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any unauthorized deviations from this procedure identified after the work has been completed must also be documented in an NCM, with a cause and corrective action described.

10.3 Instrument Maintenance

See Section 20 in the QAM

10.4 Instrument Troubleshooting

See Attachment 11

10.5 Sample Preparation

Solid and aqueous samples must be digested prior to analysis by the appropriate method (see SOPs DV-IP-0014 and DV-IP-0015).

10.6 Calibration

10.6.1 Instrument Start Up

Set up the instrument according to manufacturer's operating instructions. Allow the instrument to become thermally stable for at least 30 minutes before tuning. It is recommended that the instrument be flushed with the ICSA solution to help condition the cones and improve stability. Allow the instrument time to rinse completely before tuning the instrument.

10.6.2 Oxide\Doubly Charge Performance Check

With the sample probe in the Tune solution verify that the oxides and doubly charged ions are less the 3% by running the Tune report.

10.6.3 Instrument Tuning / Mass Calibration

Tune the instrument with a solution containing elements representing all of the mass regions of interest. The relative standard deviations must be less than 5% after running the tuning solution a minimum of 5 times. Mass calibration and resolution checks using the tuning solution must be completed at the beginning of every day. If either of the following

conditions fails the instrument setup must be re-evaluated and the solution rerun.

Mass Calibration Check – The mass calibration results must be within 0.1 amu from the true value. If this criterion is not met, the mass calibration must be adjusted before running samples.

Mass Resolution Check - The resolution must be verified to be less than 0.9 amu full width at 10% peak height.

10.6.4 Initial Calibration

The ICP-MS is calibrated each day of operation using a blank and a single standard (see Section 7.2.3). At least three integrations are employed. The validity of the calibration is determined by the subsequent calibration verifications, which are performed at concentrations as described in the next sections.

10.6.5 6020A Only - Low-Level Initial Calibration Verification (LLICV/ICVL)

A low-level ICV standard at or below the reporting limit (see Section 7.2.10) is analyzed after the initial calibration. This is a standard obtained from the same vendor used for calibration.

Acceptance Criteria: The ICVL recovery must be within 70-130%. The ICVL can be reanalyzed, but two consecutive successful results must be obtained or corrective action is taken.

Corrective Action: If the ICVL results are outside of the acceptance limits, investigate the accuracy of the standards, correct as necessary, and recalibrate.

10.6.6 Mid-Level Second-Source Initial Calibration Verification (ICV)

A 40 µg/L ICV standard (see Section 7.2.4) is analyzed immediately after the initial calibration. This is a standard obtained from a different vendor than the standard used for calibration.

Acceptance Criteria: The ICV recovery must be within 90-110%. The ICV can be reanalyzed, but two consecutive successful results must be obtained or corrective action is taken.

Corrective Action: If the ICV results are outside of the acceptance limits, investigate the accuracy of the standards, correct as necessary, and recalibrate.

10.6.7 Calibration Blank

An initial calibration blank (ICB) is analyzed after the ICV. Continuing calibration blanks (CCBs) are analyzed after each continuing calibration verification. The appropriate reagent blank is used for the blanks.

Acceptance Criteria: Absolute values for the calibration blanks must be less than ½ the standard RL. Common lab contaminants such as sodium must be less than the RL. In addition, the internal standard recoveries must be within 70-150% of the associated calibration blank. Client specific requirements take precedence. DoD QSM 5.0 requires control of blanks to a concentration less than or equal to the LOD.

Corrective Action: If the calibration blank exceeds acceptance limits, then the possibility of instrument contamination should be examined, particularly the possibility of carry-over from high level samples. The blank can be reanalyzed, and if successful, analysis can continue. However, samples tested after high-level samples should be retested. If the reanalysis is not successful, then the analysis should be terminated. After the problem is corrected, recalibrate and reanalyze all samples tested since the last acceptable CCB.

10.6.8 Reporting Limit (RL/CRI) Verification Standard

Because the ICP-MS calibration does not include multiple calibration levels, an independent standard is analyzed after the ICV to monitor the lab's ability to produce reliable results at RL-level concentrations. The RL verification standard (see Section 7.2.6) is analyzed after the daily ICB.

Acceptance Criteria: For standard projects, the results should be within 50% of the expected value. Some programs may require tighter controls. For 6020B and DoD QSM 5.0 the control limits are 80-120%.

Corrective Action: If the RL verification fails to meet acceptance limits, data for the associated samples must be assessed. For example, if the results are high, consider blank contamination, and if the results are low, consider MDL verifications. At a minimum, sample results must be qualified in the final report. For DoD QSM 5.0, if the low-level standard does not meet the limits when spiked at

the required project RL, the run sequence must be terminated.

10.6.9 Lower Limit of Quantitation Check (LLQC)

The lower limit of quantitation check (LLQC) sample should be analyzed after establishing the lower laboratory reporting limits, quarterly and on an as needed basis to demonstrate the desired detection capability. The difference between the LLQC and the RL is that this standard is carried through the entire preparation and analytical procedure. Prepare 7 aliqouts

Acceptance Criteria: LLQC is verified when all analytes are detected within ± 30% of their true value. The RSD should be <=20%

Corrective Action: If the LLQC fails to meet acceptance limits, a single reanalysis may be attempted without modification to the instrument operating conditions. Otherwise, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration re-verified.

10.6.10 6020A Only - Low-Continuing Calibration Verification (LLCCV/CCVL) Standard

A low-level CCV standard is analyzed after every set of ten samples and at the end of the analytical sequence.

Acceptance Criteria: The CCVL recovery must be within 70-130%. In addition, the IS recovery must be within method limits. If CCVL results are not within these limits, the CCVL can be reanalyzed, but it must be successful twice in succession. If the calibration cannot be verified within these specified limits, the analysis of samples containing the affected analytes at similar concentrations cannot continue until the cause is determined and the CCVL standard successfully analyzed.

Corrective Action: If the CCVL fails acceptance criteria, then the analysis should be terminated. Recalibrate and reanalyze all samples tested since the last acceptable CCVL. If the associated samples are at levels greater than 10X the level of the CCVL the data may be considered acceptable but the failure must be documented with an NCM and addressed in the case narrative.

10.6.11 Continuing Calibration Verification (CCV) Standard

A 50 µg/L CCV standard (see Section 7.2.5) is analyzed after every set of ten samples or every 2 hours, whichever is most frequent, and at the end of the analytical sequence.

Acceptance Criteria: The CCV recovery must be within 90-110%. In addition, the IS recovery must be within 70-150%. If CCV results are not within these limits, the CCV can be reanalyzed, but it must be successful twice in succession or further corrective action must be taken.

Corrective Action: If the CCV fails acceptance criteria, then the analysis should be terminated. Recalibrate and reanalyze all samples tested since the last acceptable CCV.

10.7 Sample Analysis

10.7.1 Report the average of at least three integrations for all field and QC samples analyzed.

10.7.2 Flush the system with the rinse blank for at least 30 seconds between samples and standards during the analytical run.

10.7.3 All soil samples and associated QC samples are diluted 5X prior to analysis on the Agilent 7500. This dilution is performed in an effort to reduce the impact of matrix interference on the performance of the ICPMS. The reported method detection limit has been corrected for the 5X dilution. The dilution factor on the report will be a 1X unless a subsequent dilution is required.

10.7.4 Masses which would affect the data quality must be monitored during the analytical run to determine the potential effects of matrix on a given element. See Attachment 3 for examples.

10.7.5 Dilute and reanalyze samples that are more concentrated than the linear range for an analyte. DoD QSM 5.0 requires that samples be diluted and reanalyzed if they are above the daily linear range check standard. No analyte may be reported from an analysis of a diluted sample in which the analyte concentration is less than 5 times the RL. (The sample should be diluted to the approximate midrange of the analytical curve.)

10.7.6 The analytical run sequence should be performed as follows to meet all quality control criteria:

Instrument initialization / Warm-Up
Tune instrument
Perform mass calibration
Perform resolution check
Validate tuning criteria
Calibration blank
Calibration standard
ICV
ICB
LLICV
RL verification standard
LLQC(as needed)
ICSA
ICSAB
LRA
CCV
CCB
LLCCV (6020B)
10 Samples (which can include all sample types)
CCV
CCB
LLCCV (6020B)
Reslope
CCV
CCB
LLCCV

11.0 Calculations / Data Reduction

11.1 Detailed calibration equations can be found in the corporate Policy CA-Q-P-003, *Calibration Curves and the Selection of Calibration Points*, and under the public folder, *Arizona Calibration Training*.

11.2 ICV percent recoveries are calculated according to the equation:

$$\%R = \left(\frac{\text{ICV Found Value}}{\text{ICV True Value}}\right) \times 100\%$$

11.3 CCV percent recoveries are calculated according to the equation:

$$\%R = \left(\frac{\text{CCV Found Value}}{\text{CCV True Value}}\right) \times 100\%$$

11.4 Matrix Spike Recoveries are calculated according to the following equation:

Where:

SSR = Spike Sample Result
SR = Sample Result

$$\%R = \left(\frac{\text{SSR - SR}}{\text{SA}}\right) \times 100\%$$

SA = Spike Added

NOTE: When the sample concentration is less than the detection limit, use SR = 0 for the purpose of calculating %R.

11.5 The relative percent difference (RPD) between sample duplicates is calculated according to the following equation:

$$RPD = \left[\frac{DU1 - DU2}{\frac{1}{2}(DU1 + DU2)}\right] \times 100$$

Where:

DU1 = Sample result
DU2 = Sample duplicate result

11.6 The final concentration for an aqueous sample is calculated as follows:

$$\text{Result } (\mu\text{g/L}) = \frac{C \times V1 \times D}{V2}$$

Where:

C = Concentration from instrument readout, ppb
D = Instrument dilution factor
V1 = Final volume in liters after sample preparation
V2 = Initial volume of sample digested in liters

11.7 The concentration determined in digested solid samples when reported on a dry weight basis is as follows:

$$\text{Result } (\mu\text{g/kg}) = \frac{C \times V \times D}{W \times S}$$

Where:

C = Concentration from instrument readout, ppb
D = Instrument dilution factor
V = Final volume in liters after sample preparation
W = Weight, in g, of wet sample digested
S = Percent solids/100

11.8 Sample data are reviewed by the analyst (Level 1 data review) and documented on the data review checklist (See SOP DV-QA-0020). The data package is then submitted for level 2 review by another analyst or data reviewer. Second level review is documented on the same checklist initiated by the analyst. The data review process is explained in SOP DV-QA-0020.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. An initial method detection limit study is performed in accordance with Policy DV-QA-005P. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency. For DoD, AFCEE, and DOE projects, an MDL verification is performed quarterly.

12.2 MDL Verification (MDLV)

Calculated MDLs from the annual studies are subject to quarterly verification by analyzing an MDLV standard.

12.2.1 Prepare an MDLV standard at 2-4 times the calculated MDL concentration.

12.2.2 Analyze the MDLV standard immediately after each MDL study and quarterly thereafter. This standard is subject to the entire preparation and analysis process.

12.2.3 The calculated MDL is verified if the MDLV standard is detected, nominally signal to noise ratio > 3, under routine instrument conditions.

12.2.4 If the first MDLV is not detected, re-prepare the MDLV standard at twice the original concentration and analyze. The lowest concentration that produces a detectable signal will then be reported as the MDL.

12.3 Instrument Detection Limit Study

Instrument detection limit (IDL) studies are conducted quarterly for each instrument and each analyte used for analysis in accordance with Policy DV-QA-014.

12.3.1 Pour out seven undigested calibration blanks and run them on three non-consecutive days.

12.3.2 Calculate the standard deviation for each day. The final IDL concentration is the average of the three daily standard deviation values.

12.3.3 See Policy DV-QA-014P for a discussion of IDL studies and evaluation of IDL results.

12.4 Linear Dynamic Range (LDR)

12.4.1 The LDR must be determined initially (i.e., at initial setup) and then every three months for each analyte used on each instrument. The linear range is the concentration above which results cannot be reported without dilution of the sample.

12.4.2 The LDR must be determined from a linear calibration prepared in the normal manner using the normal operating procedures described in Sections 10 and 11.

12.4.3 The LDR is determined by analyzing successively higher standard concentrations of the analytes of interest. A minimum of three standards are required for the initial and on-going studies, and one of the levels must be at the upper end of the range. The calculated concentrations must be within 10% of the stated concentrations.

12.4.4 The highest standard that meets this criterion defines the maximum concentration that can be reported for sample analysis without dilutions.

12.4.5 If the instrument is adjusted in any way that may affect the LDRs, new dynamic ranges must be determined. The LDR data must be documented and kept on file.

12.5 Linear Range Verification (LRA/LRC)

The LDRs should be verified whenever, in the judgment of the analyst, a change in the analytical performance caused by either a change in instrument hardware or operating conditions would dictate the necessity to re-establish them. 6020B and DoD QSM require verification of linear ranges in each analytical run. As described in Section 7.2.7, a lower concentration is used for the daily check than is used for the quarterly determination.

Acceptance Criteria: The result for this standard must be within 10% of the expected value.

Corrective Action: If the Linear Range Verification standard fails to meet acceptance limits, a single reanalysis may be attempted without modification to the instrument operating conditions. Otherwise, the analyst must run a standard at a lower concentration until the criteria is met or the samples cannot exceed the level of the highest calibration standard.

12.6 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going

proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.6.1 Four aliquots of an LCS are analyzed using the same instrumental conditions and procedures used to analyze samples. The analyst must employ ICV's from four distinct analytical sequences. Using these four LCSs demonstrates the analyst's ability to optimize and calibrate the instrument and to prepare analytical solutions. Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.6.2 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.6.3 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.7 Training Requirements

12.7.1 The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

12.7.2 Each analyst performing the method must complete a demonstration of capability (DOC) by successfully preparing and/or analyzing four consecutive LCSs, or a blind performance evaluation (PE) sample, or other acceptable QC samples. The results of the DOC study are summarized in the NELAC format, as described in SOP DV-QA-0024. DOCs are approved by the Quality Assurance Manager and the Technical Director. DOC records are maintained by the QA staff in the central training files. Analysts who continue to perform the method must successfully complete a demonstration of capability annually.

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, order chemicals based on quantity needed, and prepare reagents based on anticipated usage and reagent stability).

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in Section 13, *Waste Management and Pollution Prevention*, of the Corporate Environmental Health and Safety Manual, and DV-HS-001P, *Waste Management Program*.

14.2 The following waste streams are produce when this method is carried out:

14.2.1 **Aqueous Acidic (Metals) -** Corrosive - Waste Stream J

14.2.2 **Expired reagents and standards –** Contact the Waste Coordinator.

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 Test Methods For Evaluating Solid Waste, EPA SW-846, Update IV, Method 6020A: *Inductively Coupled Plasma - Mass Spectrometry*, Revision 1, February 2007.

15.2 Method 6020B: Inductively Coupled Plasma - Mass Spectrometry, Revision 2, July 2014.

15.3 Method 6020: Inductively Coupled Argon Plasma - Mass Spectrometry, Revision 0, September 1994.

15.4 Department of Defense Quality Systems Manual for Environmental Laboratories, Final Version 4.2, 10/20/2010

15.5 U.S.EPA Statement of Work for Inorganics Analysis, ILMO3.0.

15.6 Department of Defense Quality Systems Manual for Environmental Laboratories, Version 5, July 2013.

16.0 Method Modifications:

Item	Method	Modification
1	EPA 6020A	Commercially available standards are purchased and verified at the laboratory rather than being prepared from the solid material. These verification records are kept on file with QA.
2	EPA 6020A	Milli-Q or Nanopure water is substituted when reagent water is called for. This water is tested to be free of contaminants by conductivity (18megOhm) and by the analysis of blanks.
3	EPA 6020A	Corrective action for a PDS failure will be limited to flagging the PDS indicating the failed analyte and the recovery rather than diluting and reanalyzing the sample.
4	EPA 6020A	Internal standard recoveries are based on the intensities of the internal standards in the most recent calibration blank rather than the intensities of the internal standards in the initial calibration standard.

Item	Method	Modification
5	EPA 6020A	Method 6020A states that the dilution test is applicable if the matrix sample is at least 50x the reporting limit. TestAmerica uses the tighter limit of 50x the MDL.

17.0 Attachments

Attachment 1: Standard Reporting Limits for Water and Soil
Attachment 2: Recommended Elemental Equations
Attachment 3: Isobaric Molecular-Ion Interferences Which Could Affect the Analytes
Attachment 4: Internal Standards and Corresponding Metals
Attachment 5: Interference Check Sample Components and Concentrations
Attachment 6: Suggested Mass Choices
Attachment 7: Tuning Solution and P/A Solution
Attachment 8: Suggested Tuning and Response Factor Criteria
Attachment 9: Summary of Quality Control Requirements
Attachment 10: Calibration, Calibration Verification, and Spike Concentrations
Attachment 11: Troubleshooting

18.0 Revision History

Revision 4, Dated 31 December 2015

- Added method 6020B
- Added 6020B limits to Section 9.7 and 9.8, P5 and PDS
- Corrected references

Revision 3, Dated 30 April 2015

- Annual Review
- Language and formatting changes throughout
- Corrected tuning sample requirement from 4 replicates to five replicates
- Changed 12.4.2 to 12.5
- Added Section 2.1
- Added new Section 2.3 to describe reaction cell
- Added new Section 4.2.3
- Added batch definition
- Deleted Attachment 2
- Deleted Attachment 4
- Added new Attachment 1 standard reporting limits
- Section 4.3.2 enlarged expected IS intensities
- Integrated Sections 4.4 and 4.5 into 4.2
- Created new Section 4.3 Doubly charged ions
- Added new Section 6.2.3 volumetric flasks
- Section 7.2.1.4 corrected Mg addition to standard
- Section 7.2.2 replaced P/A section with same section from DV-MT-0025
- Added P/A section to Attachment 7
- Section 7.1.3 added reference to standards SOP
- Added all new standard prep information into Sections 7.2.3 – 7.2.9
- Section 9.3 changed spike level from midpoint of LR to midpoint of cal curve
- Added note to Section 9.4
- Changed timing of ICSA to beginning of analytical run and every 12 hours

- Changed concentration limits for SD in Section 9.7 to 50x MDL
- Added method modification 5 to address SD limit
- 10.6.7 added DoD 5.0 language to corrective action
- Removed Section 10.3
- 10.7.5 added DoD requirement to dilute above daily LR
- 11.5 Corrected RPD calculation
- 11.7 changed to dry weight correction
- 12.2.1 changed MDLV spike level to 2-4x MDL

Revision 2, dated 09 April 2014

- Annual review
- Updated Section 7.2 for standards to reference TALS for how to make
- Added Section 7.4.4 for 5%HNO3/5%HCL for Zirconium
- Added Section 10.4 for Maintenance
- Added Section 10.5 for Troubleshooting
- Updated Sections 9 and 10 to include requirements for DoD QSM 5.0
- Added reference to DoD QSM 5.0.

Revision 1, dated 15 July 2013

- Annual review
- Corrected formatting
- Added section 3.16
- Added reference to data review in section 10.7
- Added documentation information in section 11.8
- Added detail to note associated with section 14.2
- Updated reference in section 15.2
- Removed Attachment 13

Revision 0.3, dated 13 July 2012

- Revised standards preparation procedures in Section 7
- Added section 7.2.2
- Split acid diluent into two solutions depending upon instrument
- Updated standard mixes used to prepare standards; instrument specific mixes as needed
- Clarified requirements for preservation of soil samples for ICPMS only analysis, Section 8
- Revised list of common lab contaminants in method blank corrective action (Section 9.2)
- Added section 10.5.2: oxide/doubly charged performance check
- Updated Sections 9.2 and 10.5.7 to control method blanks and calibration blanks to ½ the RL
- Updated Sections 9.1, 10.1, 10.2 and 12.1 to reflect current practice.

Revision 0.2, dated 08 July 2011

- Added Section 4.4 on polyatomic interferences
- Added Instruments to Section 6.1
- Section 10.5.1 Added to condition cones with the ICSA solution
- Added Section 10.6.3 to reflect soil dilution practices
- Section 11.4 Corrected the RPD calculation
- Added section 11.1 referencing corporate SOP CA-Q-S-005 “Calibration Curves”
- Added section 12.2 “MDL Verification (MDLV)”
- Added Attachment 13 “ICP-MS Technical Data Review Checklist”

Attachment 1

Standard Reporting Limits for Water and Soil

Element Name	Element Symbol	Water (ug/L)	Soil (ug/Kg)
Aluminum	Al	30	5,000
Antimony	Sb	2.0	200
Arsenic	As	5.0	600
Barium	Ba	1.0	200
Beryllium	Be	1.0	100
Cadmium	Cd	1.0	100
Chromium	Cr	2.0	200
Cobalt	Co	1.0	100
Copper	Cu	2.0	250
Iron	Fe	50	5,000
Lead	Pb	1.0	150
Manganese	Mn	1.0	250
Molybdenum	Mo	2.0	200
Nickel	Ni	2.0	150
Selenium	Se	5.0	500
Silver	Ag	5.0	100
Thallium	Tl	1.0	100
Thorium	Th	5.0	200
Tin	Sn	10	2,500
Tungsten	W	5.0	500
Uranium	U	1.0	100
Vanadium	V	5.0	500
Zinc	Zn	10	1,000
Zirconium	Zr	0.5	---

Attachment 2

Recommended Elemental Equations

Element	Isobaric Correction	Mathematical Equation
Al	none	(1.0000)(27M)
Sb	none	(1.0000)(121M)
As	ArCl, Se	(1.0000)(75M) - (3.1278)(77M) + (1.0177)(78M)
Ba	none	(1.0000)(135M)
Be	none	(1.0000)(9M)
Cd	MoO, Sn	(1.0000)(114M) - (0.0268)(118M) - (1.0000)(135M)
Ca	none	(1.0000)(44M)
Cr	none	(1.0000)(52M)
Co	none	(1.0000)(59M)
Cu	none	(1.0000)(65M)
Fe	none	(1.0000)(57M)
Pb	none	(1.0000)(208M) + (1.0000)(207M) + (1.0000)(206M)
Mg	none	(1.0000)(25M)
Mn	none	(1.0000)(55M)
Ni	none	(1.0000)(60M)
K	none	(1.0000)(39M)
Se	Ar2	(1.0000)(78M) - (1.1869)(76M)
Ag	none	(1.0000)(107M)
Na	none	(1.0000)(23M)
Tl	none	(1.0000)(205M)
V	ClO, Cr	(1.0000)(51M) - (3.1081)(53M) + (0.3524)(52M)
Zn	none	(1.0000)(66M)
6Li	Li (natural)	(1.0000)(6M) - (0.0813)(7M)
Sc	none	(1.0000)(45M)
Y	none	(1.0000)(89M)
Rh	none	(1.0000)(103M)
In	Sn	(1.0000)(115M) - (0.0149)(118M)
Tb	none	(1.0000)(159M)
Ho	none	(1.0000)(165M)
Bi	none	(1.0000)(209M)

Where M = Total ion count rate at the specified mass.

Attachment 3

Isobaric Molecular-Ion Interferences Which Could Affect the Analytes

Analyte	Interferences						
	Oxygen	Hydroxyl	Nitrogen	Chlorine	Sulfur	Carbon	Other
^{121}Sb	PdO		AgN			AgC	
^{123}Sb	AgO		AgN	SrCl	ZrS	CdC	
^{75}As	CoO	NiOH	NiN	ArCl	CaS	CuC	
^{138}Ba	SnO	SbOH					
^{137}Ba	SbO	SnOH		MoCl			
^{136}Ba	SnO	SnOH				SnC	
^{135}Ba	SnO	SnOH		MoCl			
^{134}Ba	SnO	SnOH	SnN	MoCl		SnC	
^{132}Ba	SnO, CdO	InOH	SnN	MoCl	MoS	SnC	
^{130}Ba	CdO	CdOH	SnN, CdN	MoCl	MoS	SnC	
^{9}Be							
^{114}Cd	MoO	MoOH	MoN	SeCl	SeS		
^{112}Cd	MoO, ZrO	MoOH	MoN	AsCl, SeCl	SeS	MoC	
^{111}Cd	MoO	MoOH	MoN	GeCl			
^{110}Cd	MoO, ZrO		MoN, ZrN	GeCl, AsCl	SeS	MoC	
^{113}Cd	MoO	MoOH		SeCl, AsCl			
^{116}Cd	MoO						
^{106}Cd	ZrO		MoN, ZrN		GeS	MoC, ZrC	
^{108}Cd	MoO, ZrO	ZrOH	MoN, ZrN	GeCl	SeS, GeS	MoC, ZrC	
^{52}Cr	ArO	ClOH				ArC	
^{53}Cr	ClO	ArOH	KN	NCl, OCl		KC	
^{50}Cr	SO		ArN		SO	ArC	Mo^{++}
^{54}Cr		ClOH	ArN, CaN			CaC	
^{59}Cr	CaO	CaOH	ScN	MgCl	AlS	TiC	Sn^{++}
^{63}Cu	TiO, PO_2	TiOH	TiN	SiCl, MgCl	PS	VC	ArNa
^{65}Cu	TiO	TiOH	VN	SiCl	SS, SO_2H	CrC	
^{208}Pb							
^{206}Pb							
^{207}Pb							
^{204}Pb							
^{55}Mn	KO	ArOH	KN		NaS	CaC	Cd^{++}

Attachment 3 (cont.)
Isobaric Molecular-Ion Interferences Which Could Affect the Analytes

Analyte	Interferences						
	Oxygen	Hydroxyl	Nitrogen	Chlorine	Sulfur	Carbon	Other
^{202}Hg	WO						
^{200}Hg	WO	WOH	WN				
^{199}Hg	WO	WOH					
^{201}Hg		WOH					
^{198}Hg	WO	TaOH	WN			WC	
^{204}Hg							
^{196}Hg			WN				
^{58}Ni	CaO	KOH	CaN	NaCl	MgS	TiC	Cd^{++}, Sn^{++}
^{60}Ni	CaO	CaOH	TiN	MgCl, NaCl	SiS	TiC	Sn^{++}
^{62}Ni	TiO	ScOH	TiN	AlCl, MgCl	SiS	TiC, CrC	Sn^{++}
^{61}Ni	SeO	CaOH	TiN	MgCl	SiS	TiC	
^{64}Ni	TiO	TiOH	TiN, CrN	SiCl, AlCl	SS	CrC	
^{80}Se	ZnO	CuOH	ZnN	ScCl, CaCl	TiS	ZnC	
^{78}Se	NiO	NiOH	ZnN	CaCl, KCl	TiS	ZnC	
^{82}Se	ZnO	CuOH	ZnN	TiCl, ScCl	TiS, CrS		
^{76}Se	NiO	CoOH	NiN	KCl	CaS	ZnC	
^{77}Se	NiO	CuN	CuN	CaCl, ArCl	ScS	CuC	
^{74}Se	NiO	NiN	NiN	ClCl, KCl	CaS	NiC	
^{107}Ag	ZrO	ZrOH		GeCl	AsS	MoC	
^{109}Ag		MoOH	MoN	GeCl	SeS	MoC	
^{205}Tl							
^{203}Tl		WOH					
^{51}V	ClO	SOH	ClN	ClO, ClN	FS	KC	
^{50}V	SO		ArN			ArC	Mo
^{64}Zn	TiO	TiOH	TiN, CrN	SiCl, AlCl	SS	CrC	
^{66}Zn	TiO	TiOH	CrN	PCl, SiCl	SS	FeC	
^{68}Zn	CrO	VOH	FeN	PCl	ArS	FeC	Ba^{++}
^{67}Zn	VO	TiOH, Cr	CrN	SCl	ClS	MnC	Ba^{++}
^{70}Zn	FeO	CrOH	GeN	ClCl	ArS	NiC	

NOTE: The information provided in this table does not indicate that all of the described interferences need to be tested. However, the table can be consulted for informational purposes if unusual samples are encountered.

Attachment 4
Internal Standards and Corresponding Metals

IS	ICP-MS 077/078	ICP-MS 024
^{6}Li	Be	Be
Sc	Na, Mg, Al, K, Ca	Na, Mg, Al, K, Ca
Ge	V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se	V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se
In	Mo, Ag, Cd, Sn, Sb, Ba	Mo, Ag, Cd, Sn, Sb, Ba
Ho	Tl, Pb, Th, U, W	Tl, Pb, Th, U, W

Attachment 5
Interference Check Sample Components and Concentrations

Interference Component	Solution A Concentration (mg/L)	Solution AB Concentration (mg/L)
Al	100.0	110.0
Ca	100.0	110.0
Fe	100.0	110.0
Mg	100.0	110.0
Na	100.0	110.0
P	100.0	100.0
K	100.0	110.0
S	100.0	100.0
C	200.0	200.0
Cl	1000.0	1000.0
Mo	2.0	2.1
Ti	2.0	2.0
As	0.0	0.1
Sb	0.0	0.1
Be	0.0	0.1
Ba	0.0	0.1
Cd	0.0	0.1
Cr	0.0	0.1
Co	0.0	0.1
Cu	0.0	0.1
Pb	0.0	0.1
Mn	0.0	0.1
Ni	0.0	0.1
Nb	0.0	0.2
Pd	0.0	0.1
Pt	0.0	0.1
Se	0.0	0.1
Tl	0.0	0.1
Th	0.0	0.1
Sn	0.0	0.1
Ag	0.0	0.1
U	0.0	0.1
V	0.0	0.1
W	0.0	0.1
Zn	0.0	0.1

Attachment 6
Suggested Mass Choices

Boldface masses indicate the masses which must have the most impact on data quality and the elemental equations used to collect the data. It is strongly recommended that elements other than those of interest be monitored to indicate other potential molecular interferences which could affect the data quality.

Mass	Element of Interest
“**27**”	Aluminum
121, “**123**”	Antimony
“75”	Arsenic
138, “137”, 136, **135**, 134, 132, 130	Barium
“9”	Beryllium
114, 112, “111”, 110, 113, 116, 106	Cadmium
42, 43, **44**, 46, 48	Calcium
“**52**”, **53**, **50**, 54	Chromium
“**59**”	Cobalt
“**63**”, **65**	Copper
56, **54**, **57**, 58	Iron
“**208**”, “**207**”, “**206**”, 204	Lead
24, **25**, **26**	Magnesium
“**55**”	Manganese
58, “**60**”, 62, **61**, 64	Nickel
93	Niobium
105	Palladium
195	Platinum
39	Potassium
80, **78**, “**82**”, **76**, **77**, 74	Selenium
“**107**”, **109**	Silver
23	Sodium
“**205**”, 203	Thallium
232	Thorium
192	Tungsten
“**51**”, **50**	Vanadium
64, “**66**”, **68**, **67**, 70	Zinc
139	Lanthanum
118	Tin
238	Uranium
35, 37	Chlorine
98, 96, 92, **97**, 94, “95”	Molybdenum
72	Germanium (IS)
165	Holmium (IS)
115	Indium (IS)
6	Lithium (6+) (IS)
45	Scandium (IS)

Attachment 7: Tuning Solution and P/A Solution

A tuning solution containing elements representing all of the mass regions of interest must be analyzed. Below is a suggested solution covering a typical mass calibration range. Instrument manufacturer recommendations should be followed for tuning solutions.

The P/A solution is used to monitor the correlation between the Pulse and Analog parts of the electron multiplier. This solution is prepared at different concentrations depending on the current instrument conditions. The parent standard concentration is shown below.

Element	Tuning Concentration (µg/L)	P/A Concentration (mg/L)
Al		5
As		20
Ba	10	5
Be	10	20
Bi		5
Cd		20
Ce	10	
Co	10	5
Cr		5
Cu		5
Ge		10
In	10	5
Ir		5
^{6}Li		5
Li	10	
Lu		5
Mg	10	10
Mn		5
Mo		10
Na		5
Ni		10
Pb	10	10
Pd		10
Rh	10	
Ru		10
Sb		10
Sc		5
Sn		10
Sr		5
Tb		2.5
Th		50
Ti		50
Tl	10	50
U	10	50
V		50
Y	10	2.5
Zn		20

Attachment 8:

Suggested Tuning and Response Factor Criteria

Minimum Response from Tuning Solution:

Be	>1,000
Mg	>2,000
Rh	>20,000
Pb	>10,000
Li	>2,000
Co	>20,000
In	>1,000
Tl	>1,000

Suggested Mass Calibration:

Be	9.0122
Mg	23.98
Rh	102.91
Pb	207.98
Li	7.016
Co	58.9332
In	114.904
Tl	204.9744

Attachment 9:

Summary of Quality Control Requirements

QC Parameter	Frequency*	Acceptance Criteria	Corrective Action
LLOQ	With initial setup, Quarterly and on an as needed basis	70 - 130% recovery.	Terminate analysis; correct the problem; recalibrate.
LLICV (6020A only)	Beginning of every analytical run.	70 - 130% recovery. 6020A IS, 70-150% rec.	Terminate analysis; correct the problem; recalibrate.
ICV	Beginning of every analytical run.	90 - 110% recovery.	Terminate analysis; correct the problem; recalibrate.
ICB/CB	Immediately after each ICV	The result is < ½ RL.	Terminate analysis; correct the problem; recalibrate.
LLCCV (6020A only)	Beginning and end of run and every 10 samples OR every 2 hours, whichever is more frequent.	70 - 130% recovery. 6020A IS, 70-150% rec.	See Section 10.6.10. Reanalyze twice in succession. If acceptable, continue. If unacceptable, terminate analysis; correct the problem recalibrate the instrument, reverify calibration and rerun all samples since the last acceptable CCV.
CCV	Beginning and end of run and every 10 samples OR every 2 hours, whichever is more frequent.	90 - 110% recovery.	Reanalyze twice in succession. If acceptable, continue. If unacceptable, terminate analysis; correct the problem recalibrate the instrument, reverify calibration and rerun all samples since the last acceptable CCV.

Attachment 9: Summary of Quality Control Requirements (Continued)

QC Parameter	Frequency*	Acceptance Criteria	Corrective Action
CCB	Immediately following each CCV.	The result must be < ½ RL. .	Reanalyze once. If acceptable, continue. If unacceptable, terminate analysis; correct the problem recalibrate the instrument, reverify calibration and rerun all samples since the last acceptable CCB.
ICSA	Beginning and every 12 hours.	Monitor for possible interferences.	See Section 9.5
ICSAB	Immediately following each ICSA.	Monitor for possible interferences.	See Section 9.5
Method Blank	One per lot of 20 field samples or fewer.	The result must be < ½ RL. Sample results greater than 10x the blank concentration or samples for which the contaminant is < RL, do not require redigestion or reanalysis.	Re-run once. If > ½ RL, redigest and reanalyze samples. Note exceptions under criteria section. See Section 9.2 for additional requirements.
Serial Dilution	One per batch of 20 field samples or fewer.	90 - 110% recovery	See Section 9.7 for additional requirements.
Post-Digestion Spike	One per batch of 20 field samples or fewer.	80-120% recovery	See Section 9.8.
Laboratory Control Sample	One per batch of 20 field samples or fewer.	Must be within laboratory control limits	See Section 9.3
Matrix Spike	One per lot of 20 field samples or fewer.	Must be within laboratory control limits	See Section 9.6 for additional requirements.

Attachment 10
Calibration, Calibration Verification, and Spike Concentrations

Element	Initial Calibration (µg/L)	ICV (µg/L)	CCV (µg/L)	LCS (µg/L)	MS/MSD (µg/L)	Post Digestion Spike (ug/L)
Aluminum	10000	40	50	400	400	20000
Antimony	100	40	50	40	40	200
Arsenic	100	40	50	40	40	200
Barium	100	40	50	40	40	200
Beryllium	100	40	50	40	40	200
Cadmium	100	40	50	40	40	200
Calcium	10000	4000	5000	--	--	--
Chromium	100	40	50	40	40	200
Cobalt	100	40	50	40	40	200
Copper	100	40	50	40	40	200
Iron	10000	4000	5000	400	400	20000
Lead	100	40	50	40	40	200
Magnesium	10000	4000	5000	--	--	--
Manganese	100	40	50	40	40	200
Molybdenum	100	40	50	40	40	200
Nickel	100	40	50	40	40	200
Selenium	100	40	50	40	40	200
Silver	100	40	50	40	40	50
Thallium	100	40	50	40	40	200
Thorium	100	40	50	40	40	--
Tin	100	40	50	40	40	200
Tungsten	100	40	50	40	40	200
Uranium	100	40	50	40	40	200
Vanadium	100	40	50	40	40	200
Zinc	100	40	50	40	40	200
Zirconium	100	40	50	40	40	--

This procedure has been developed for twenty elements. Additional elements may be included in the calibration solution at the above levels. Levels may be adjusted to meet specific regulatory or client programs.

Attachment 11

ICP-MS Troubleshooting Guide

Problem	Possible Cause/ Solution
High Calibration Blanks	Inspect historical blank data to determine root cause Inspect, clean or replace torch Inspect, clean or replace pump tubing or sample tubing Inspect, clean or replace nebulizer Remake blank solution Recalibrate instrument
Instrument Drift	Make sure instrument has warmed properly Condition cones to aid stability Reslope to correct for changing cone conditions during run Stop run, clean cones and start over with a new calibration
Erratic Readings, High RSDs	Check nebulizer pressure Check sample flow around the pump, adjust tension on pump tubing to ensure smooth flow Check for clogs in the uptake tubing, nebulizer, or valve Clean or replace nebulizer
Low Sensitivity	Clean cones Adjust lens voltages Remove and clean lens, remove and clean or replace reaction cell
Bad Tune: Bad Mass Cal	Adjust lens voltages, remove and clean lens
Bad Tune: High Oxides	Inspect, clean, or replace torch, nebulizer, and spray chamber

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Title: INCREMENTAL SAMPLING METHODOLOGY FOR SOILS AND SEDIMENTS [ASTM D 6323]

Approvals (Signature/Date):

2/25/2015	2/27/15
Susan Oster Technical Specialist	Date	~~Adam Alban~~ Alan Frey for AA Health & Safety Coordinator	Date
2/27/15	2/27/15
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1.0 Scope and Application

1.1 The purpose of this procedure is to obtain sub-samples from client provided samples which represent the concentration of the analytes of interest in the entire parent sample. This is based on the guidance in ASTM Standard D-6323 "Laboratory Subsampling of Media Related to Waste Management Activities," a DoD Quality Systems Manual (QSM) requirement.

1.2 This procedure applies to soils, sediments and other particulate matter. This method is highly dependent on client provided Data Quality Objectives. This procedure presents the laboratory's standard approach, but details at all stages of this procedure can vary from project to project. All project-specific variations must be documented and approved in writing. It is important that the analyst always check special project instructions in LIMS before proceeding.

1.3 TestAmerica has used incremental sampling methodology (ISM) for non-volatile organics (e.g., explosives residues by Method 8330), prior to acid digestion for metals analysis (e.g., Method 3050), and prior to analysis for volatile organics collected in multiple increments in the field and preserved in methanol (e.g., Method 5035). It can be used for a wide range of other analytical methods as well. However, this procedure is not applicable to soil samples to be analyzed for volatile organic compounds in which the entire sample provided by the lab's client is used for a single analysis (see the lab's volatile organics SOP for those details).

1.4 This SOP addresses the pre-preparation of samples. The details of the twelve QC Elements, not otherwise addressed, are described in the associated preparation and/or analytical SOPs.

2.0 Summary of Method

2.1 For non-volatile analytes, the entire sample received from the client is air dried. Large non-representative pieces (rocks and twigs that will not pass through the sieve) may be removed manually. Other extraneous materials are removed by sieving. A mortar and pestle or sieve shaker or mechanical grinder may be used to break up soil agglomerates during the sieving process. Depending on the analytical method to be used after subsampling and project objectives, the sample may be ground. The grinding options available at the laboratory include ball mill and ring-and-puck mill. A subsample is then taken using a multi-incremental approach.

2.2 ISM for Metals Analysis - the routine approach is to air dry, sieve to sub-10 mesh (2.1 mm), and collect 10 gram subsamples using 30 increments. The expectation is that the variability due to subsampling error will then be no more than 15% relative standard deviation (RSD) (see ASTM D-6323 for explanation and guidance for other acceptable variations). The Method 3050B digestion reagents are then increased proportionally to maintain the same chemistry as is used for 1 gram subsamples.

2.3 ISM for Explosives Analysis - the routine approach is to air dry, sieve to sub-10 mesh, grind, and collect 10 gram subsamples using 30 increments. If the samples are from firing points, then ring-and-puck grinding is required. Samples from other locations can be ground using a ball mill. The goal is to achieve 10% or less RSD from subsampling

variability. Further details for explosives are given in SOP DV-OP-0018 and are not discussed in this SOP.

2.4 ISM for Volatile Analysis – the multi-incremental sampling is done in the field, with the 30 increments of 5 grams are added to a septum-cap bottle containing 200 mL methanol provided by the laboratory. From that point on, the lab's procedure for medium level soils (SOP DV-MS-0002) is followed.

2.5 The basic formula to use when working with clients to select the optimal approach for other methods or other precision objectives is given in Attachment 1 to this SOP. The Attachment defines the trade off between subsample size, particle size, and the desired level of precision.

3.0 Definitions

3.1 Basic QA/QC terms are defined in the TestAmerica Denver Quality Assurance Manual (QAM).

3.2 Sample or Client Sample – refers to the entire quantity of material delivered to the laboratory for testing.

3.3 Subsample – refers to the portion of sample taken in the laboratory for a given analysis. The objective of this procedure is to ensure that the subsample is a reasonably accurate representation of the entire sample.

4.0 Interferences

4.1 If multi-incremental or equivalent systematic sampling processes are not employed in the field, then the extra laboratory effort entailed in this SOP may add little or no improvement in results.

4.2 Potential loss of lighter semi-volatile compounds (e.g., naphthalene) through the drying and grinding process has not been well studied. Before employing the procedure for such compounds, the possible loss of lighter compounds should be discussed with the client and if possible, investigated before the procedure is performed.

4.3 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or contamination causing misinterpretation of results. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by running blanks.

4.4 Contamination by carryover can occur when a low concentration sample is processed immediately following a high concentration sample. For this reason, special care must be taken to follow the equipment cleaning steps.

4.5 As described in this SOP, the lab does not routinely grind samples for metals testing. It is expected that detection limits and reporting limits for some metals would have to be elevated based on long-term blank results if grinding is required.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, TestAmerica Denver Addendum to the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Anyone working in the grinding room needs to be enrolled in the Hearing Conservation Program. See DV-HS-0010 for details. Personnel operating grinding equipment are required to wear ear plugs when the equipment is turned on. When standing next to the Humbolt mechanical grinder described in Section 6.1.10 during operation, the decibel levels are above 80 decibels, therefore anyone operating the grinder must be enrolled in the Hearing Conservation Program and wear hearing protection. While the grinder is running, the decibel levels in the room are below 80 decibels, therefore personnel not enrolled in the Hearing Conservation Program can be in the room. Hearing protection is always available to ever analyst and they are encouraged to use it.

5.3.2 Operations involving handling samples outside of sealed containers, e.g., sieving, are conducted in ventilation hoods to avoid exposure to dust. Dust masks are available for use in the grinding room, but are optional.

5.3.3 Operations involving the grinding of radioactive samples can be particularly hazardous due to the increased potential for exposure from airborne dust. If a sample is labeled as “CAT 1”, “CAT 2”, “CAT 3” or “CAT 4” and requires grinding through the ring and puck or ball mill, contact the RSO immediately.

5.4 Primary Chemical and Material Hazards – cleaning solvents

MATERIAL	HAZARDS	EXPOSURE LIMIT (1)	SIGNS AND SYMPTOMS OF EXPOSURE
Acetonitrile	Flammable Poison	40 ppm – TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
Acetone	Flammable	1000 ppm – TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
(1) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Equipment

6.1.1 Balance, capable of measuring ± 0.01 g. Calibration checked per SOP DV-QA-0014

6.1.2 Sieve Shaker – used to facilitate the sieving of large sample volumes.

6.1.3 Ring and Puck - The grinding bowl and puck are cleaned after each use by washing with soap and water with a plastic brush, rinsing with hot tap water, rinsing with DI water, and then rinsing with a 10% acetonitrile solution in acetone. A final wipe down of the bowl and puck while still wet with solvent is done with a Kimwipe

6.1.4 Ball Mill - Ceramic grinding stones are cleaned after each use by rinsing with hot tap water, washing with soap and water, rinsing with hot tap water, rinsing with DI water, and then rinsing with a 10% solution of acetonitrile in acetone. The stones are allowed to dry then tumbled in a clean can with clean Ottowa Sand for 2 hours. The stones are then removed from the can, rinsed with hot tap water, rinsed with DI water, and then rinsed with 10% acetonitrile in acetone. The stones are allowed to dry again before use.

Paint Cans – Disposable, 1 gallon, ½ gallon, or 1 pint in size. Cans and lids are cleaned prior to use by rinsing with 10% acetonitrile in acetone and wiping with a Kim-wipe while still wet.

Spacer Cans – cans or PVC pipe that is filled with sand or other material used to prevent sample cans from “walking” off of the mill.

6.1.5 Trays – “baker’s rack” type stack for air drying soils

6.1.6 Sieves - 10 and 30 mesh, brass for general use, stainless steel for metals testing. Sieves are cleaned after each use by washing with soap and water with a green plastic brillo pad (be careful not to damage the mesh), rinsing with hot tap water, rinsing with DI water. Prior to use, the sieves are rinsed with 10% acetonitrile in acetone and wiped with a Kim Wipe. Sieves are allowed to dry in a hood prior to use.

6.1.7 Mortar and pestle – Porcelain, various sizes cleaned after each use by washing with soap and water, rinsing with hot tap water, and then rinsing with DI water. Prior to use, the mortars and pestles are rinsed with 10% acetonitrile in acetone and wiped with a Kim Wipe and allowed to dry in a hood prior to use.

6.1.8 Mechanical Grinder – Humbolt Manufacturing Part Number H-4199. Used in place of a mortar and pestle to quickly reduce cakes of dry soil. The stainless steel grinder reduces soil agglomerates and sieves the soil through a 10 mesh sieve. The mechanical grinder is used to break up soil agglomerates, but it is not an alternative to Ring and Puck or Ball Mill grinding. The mechanical grinder is cleaned after each sample by removing the hopper. The hopper is washed with soap and water, rinsed with tap water, rinsed with DI water, and then rinsed with

90:10 Acetone:Acetonitrile. The Hopper is then wiped dried with a laboratory tissue. The hammers and body of the grinder are cleaned after each sample by rinsing with DI water and wiping dry with a laboratory tissue.

6.2 Expendable Supplies

6.2.1 Plastic sample scoops – square-ended

6.2.2 Aluminum foil to line trays

6.2.3 Parchment paper to line trays for metals testing

6.2.4 Alconox detergent

6.2.5 Ottawa Sand – blank media for organics

6.3 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on G:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revisionfor the current software and hardware to be used for data processing.

7.0 Reagents and Standards

None

8.0 Sample Collection, Preservation, Shipment and Storage

Container Type	Preservative	Holding Time
Plastic or glass	By individual test *	By individual test *

After air drying, samples can be stored at room temperature.

* - Reference the analytical SOPs.

9.0 Quality Control

9.1 When processing samples in the laboratory, use special instructions in the method comments field to determine specific QC requirements that apply. Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via method comments in the LIMS.

9.2 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is approved by the supervisor and then automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.3 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs. This procedure meets all criteria of DoD QSM 5.0 unless otherwise stated.

9.4 Grinding Blanks

9.4.1 Ring and Puck Grinding Blanks.

Before each sample is processed through the ring and puck mill, the ring and puck will be cleaned per Section 6.1. Then approximately 200g of Ottawa sand will be ground. This ground sand will be saved and labeled with the sample ID of the next sample ground with the suffix “blank”. After a batch of samples has been processed through the ring and puck, a composite will be generated using sub-aliquots from all blanks ground before the samples. This is done by placing approximately 1 tablespoon of material fro each of the individual sample blanks in a clean re-sealable plastic bag. The bag is then sealed and the material is mixed and homogenized by shaking and kneading the bag. A 10g aliquot is then removed from the bag and labeled as the batch grinding blank. This composite is extracted and analyzed in the same manner as the field samples.

9.4.2 Ball Mill Grinding Blanks.

With every batch of samples processed with the ball mill, approximately 200g of clean Ottawa sand will also be processed in the same manner. This ground sand will then be extracted and analyzed in the same manner as the field samples.

9.4.3 Corrective Action:

If grinding blank results are greater than the acceptance limit, then any samples producing positive results for the same contaminant must be reprocessed and reanalyzed. If un-ground sample is not available, then the potential carry-over between samples must be described in a non-conformance memo and discussed in the final report case narrative.

9.5 Precision

9.5.1 On a project basis, the lab will discuss precision objectives with the client prior to initiating work. If evaluation of the RSD is needed, the laboratory will need to analyze at least one set of triplicate samples in every preparation batch. In other cases, the lab will employ duplicate matrix spikes and control limits will be expressed as relative percent difference (RPD).

9.5.2 If the client supplies multiple field samples to use for replicate testing, then the laboratory will compare results to acceptance limits and qualify data if the precision limits are not met. If the replicates are prepared from the single field sample that is dried, ground, and sieved, then the acceptability of each grinding batch can be controlled based on the precision objectives established for the project.

9.6 Other QC samples (method blank, LCS, and MS/MSD) are created after subsampling, and vary depending on the analytical method. See DV-OP-0018 for special QC

requirements for explosives, which usually require grinding a standard reference material.

10.0 Procedure

10.1 Dry the Samples

10.1.1 The entire contents of the sample container must be processed. It is not acceptable to remove any aliquots until after the sample has been dried, sieved, and ISM performed. If the client requests aliquots to be taken before the sample is dried, sieved, and ISM performed, an NCM should be written to document this was done per client request.

10.1.2 Depending on the sample size, the samples are laid out in aluminum pans, or on large trays lined with aluminum foil to dry. Some clients may request metals analysis on the dried samples. In those cases, samples are laid out on parchment paper.

10.1.3 Spread the samples out in a thin layer to facilitate drying. Use a disposable wooden spatula to break up any clumps and agglomerates.

10.1.4 The tray or pan that the sample is laid out into is labeled with the sample ID. A second analyst checks to make sure that the labels on the tray or pan match the labels on the client sample container to ensure samples are not accidently mixed up. This check is documented in TALS.

10.1.5 Place the samples in a hood or well ventilated area at room temperature. Document in TALS the date and time the samples were laid out to dry. If the samples are very wet, a fan can be used to help facilitate the drying process, but care should be taken so that the air flow is not strong enough to cause cross-contamination between samples. An electronic temperature recording device records the temperature of the room and the data is downloaded weekly.

10.1.6 When the samples appear to be dry enough that they can be sieved without caking, proceed to Section 10.2.

10.2 Sieve the Samples

10.2.1 Clean the sieves prior to use following the instructions in Section 6.

10.2.2 Some samples may require the use of a mortar and pestle or a mechanical grinder to break up dried clumps. Refer to Section 6.1 on how to clean and rinse the mortar and pestles and the mechanical grinder before use.

10.2.3 Sieve the entire dried sample through the appropriate sized sieve. Care must be exercised not to eliminate soil agglomerates during this step. The soil can be broken into small pieces with a gloved hand or another instrument (a wooden spatula for example). If a gloved hand is used, care should be taken to change out gloves in between samples so not to cross- contaminate samples.

10.2.4 Remove large rocks, vegetation, and twigs that do not pass through the sieve. Mosses and other types of fine vegetation should be physically shredded while

sieving to release trapped soil and residues. The only materials that should be eliminated by sieving are rocks and vegetation. All soil must be broken up to pass through the sieve.

10.2.5 Place any soil that does not pass through the sieve into a clean mortar. Break up soil agglomerates using the pestle. Or as an alternative use the mechanical grinder. Be sure to break up all soil so that it can pass through the sieve. Only extraneous material such as rocks and vegetation should be removed with the sieve. Describe all extraneous material that did not pass through the sieve in an NCM.

NOTE: Some clients may request the portion of the sample that did not pass through the sieve to be saved and weighed. Check Method Comments before discarding any sample material.

10.2.6 Collect all of the material that passes through the sieve on a clean piece of foil or parchment paper.

10.2.7 An automatic sieve shaker can be used to help facilitate the sieving of samples. A receiver pan is placed under a sieve and the sample is added to the sieve with 1 or 2 small grinding stones. Then a lid or another receiver pan for a second sample is placed on top. The stack is then clamped inside the sieve shaker for no more than 30 minutes. Inspect the samples to ensure that only extraneous material such as rocks and vegetation should be removed with the sieve. If needed use a mortar and pestle to break up soil agglomerates. Describe all extraneous material that did not pass through the sieve in an NCM.

10.2.8 If metals analyses are requested on the sample, perform ISM on the portion of the sample that passed through the sieve at this time before proceeding to any grinding steps in Section 10.4. Refer to Method Comments, Sample comments, and Login Comments for instructions if any other tests besides metals analyses are to be performed on an un-ground aliquot before proceeding to Section 10.34

10.3 Incremental Sampling Methodology for Metals and other methods requested on un-ground material.

10.3.1 Remove the cap from a 100mL digestion cup and place on a balance and tare. The entire sieved sample is spread out on a sheet of parchment paper to a 1 cm thickness.

10.3.2 Using a disposable square-ended spatula, take an appropriately sized subsample by collecting at least 30 increments from random locations through the entire thickness, top to bottom, of the layer of ground material.

10.3.2.1 For methods 6010B, 6010C, 6020, and 6020A a 10g-11g aliquot is required for each sample and each MS/MSD sample. Collect one extra 10g-11g aliquot per sample in case re-digestion is needed.

10.3.2.2 For method 7471A and 7471B, a 3g-3.05g aliquot is required for each sample and each MS/MSD sample. Collect one extra 3g-3.05g aliquot per sample in case re-digestion is needed.

10.3.3 Record the sample weight on the ISM Worksheet described in Attachment 2.

10.4 Grinding

The instructions in this section are to be used as a general procedure when grinding is requested prior to extraction and analysis for any method. Reference DV-OP-0018 for details on grinding samples for explosive samples.

10.4.1 Ball Mill Grinding –

10.4.1.1 If the sample is logged for ball mill grinding, prepare a paint can for each sample. See Section 6.1 on how to clean the cans and the grinding stones. Select a can that is large enough that the sample alone would occupy ½ of the can's volume. Prepare the paint can by filling the can full with grinding stones of various sizes, leaving only 1 inch of space at the top. After the stones have been placed in the can, transfer the sample into the labeled can. The sample will fill in the spaces around the grinding stones. If needed, the sample can be split between multiple cans and recombined after grinding. The entire sample must be ground. It is important to fill the can. Add additional stones if needed. Seal the lid by pounding it in place with a rubber mallet and placing duct tape over the top of the lid to secure it.

NOTE: If multiple cans are used for grinding and the sample is recombined, it has been shown in DU/TRL QC that the sample is non-homogenous. To re-homogenize the sample, place all volume in to a clean plastic bag, seal, and carefully shake the bag for 1-2 minutes until sample is homogenous. Lay out the sample back on the foil/parchement paper

NOTE: It is critical that the can has minimal headspace, yet enough stones to grind the sample completely. Excess headspace may result in loss of target compounds.

10.4.1.2 Prepare a grinding blank per Section 9.3.2 with every batch. The grinding blank will be analyzed in addition to the normal extraction blank (method blank).

10.4.1.3 Place the paint cans on the ball mill. To prevent the samples from falling off of the mill, place a spacer can on the ball mill to the right of the cans on each row. Start the ball mill. Document the start time on the benchsheet. The samples should be ground for at least 8 hours. Remove the paint can and in a fume hood open the lid and inspect the sample. It should be the consistency of flour. The consistency of the material is checked by pinching some between fingers of a gloved hand and feeling for grit and by looking for any un-ground fibers. If grit is detected or if fibers are observed, additional grinding is needed. If the sample is not at the correct consistency of flour, either seal the can and return it to the ball mill for further grinding, or transfer the sample to a ring and puck dish to finish the grinding.

NOTE: If the can is re-sealed to be placed back on the ball mill, care must be taken that the lid was not damaged when the can was opened and that the lid still seals well. It may be necessary to use a new lid if the first lid was damaged.

10.4.2 Ring and Puck Mill Grinding –

10.4.2.1 See Section 6.1 on how to clean the ring and puck dish.

10.4.2.2 If the sample is logged for ring and puck grinding, a grinding blank per Section 9.3.1 consisting of baked Ottawa sand will be processed through the ring and puck dish before each sample. These individual blanks will be composited into one grinding blank for the associated samples and will be analyzed in addition to the normal extraction blank.

NOTE: When preparing the grinding blanks, it is not necessary to do five 60-second grinds. One 60-second grind of the Ottawa sand is sufficient.

10.4.2.3 After a grinding blank has been processed through a ring and puck dish, that blank is labeled as the blank associated to the next sample processed through that same dish. It is not necessary to clean the ring and puck dish after the blank.

10.4.2.4 In a hood, transfer the sample into a clean ring and puck dish. Do not overfill the dish (approximately 300g of sample can fit in one dish). If needed, grind the sample in 300g or smaller increments and recombine after all sample has been ground. The entire sample must be ground. Place the dish securely in the holder and close the door on the machine. Grind the sample in five 60-second periods with a one minute cooling time between grinds for a total of 5 minutes of grinding. Remove the dish and in a fume hood, open the lid and inspect the sample. It should be the consistency of flour. The consistency of the material is checked by pinching some between fingers of a gloved hand and feeling for grit and by looking for any un-ground fibers. If grit is detected or if fibers are observed, additional grinding is needed.

10.4.2.5 If the sample reaches a flour-like consistency before all 5 one-minute grinds have been completed, then it might be beneficial to not perform all 5 grinds in order to avoid excessive heat and to avoid packing the sample onto the side of the grinder. If the analyst inspects the sample and it has a four like consistency before all 5 grinds are completed, they can make the decision to stop after less than 5 grinds. A NCM should be written to document the deviation from the source method and the reasoning.

NOTE: During the one-minute cooling time, the dish should be placed in a shallow ice water bath to facilitate cooling. Be sure the bath is shallow enough so that water does not get inside the dish.

NOTE: If multiple 300g increments are used for grinding and the sample is recombined, it has been shown in DU/TRL QC that the sample is non-homogenous. To re-homogenize the sample, place all volume in to a clean plastic bag, seal, and carefully shake the bag for 1-2 minutes until sample is homogenous. Lay out the sample back on the foil/parchement paper

10.5 Incremental Sampling after grinding.

10.5.1 Remove the cap from a 40mL amber vial or other appropriate container and place on a balance and tare. The entire ground sample is spread out on a sheet of parchment paper or aluminum foil to a 1 cm thickness.

10.5.2 Using a disposable square-ended spatula, take an appropriately sized subsample by collecting at least 30 increments from random locations through the entire thickness, top to bottom, of the layer of ground material.

10.5.2.1 For explosives a 10g to 11g aliquot is required for each sample and each MS/MSD sample.

10.5.2.2 For other extractable methods a 30-33g aliquot is common, but reference project instructions and method SOPs.

10.5.3 Record the sample weight on the ISM Worksheet.

10.6 Maintenance

10.6.1 Approximately once a month, the cover on the Ring and Puck should be removed and any dirt should be cleaned up.

10.6.2 When excessive wear is noted, replace the hammers in the Mechanical Grinder.

10.6.3 Occasional lubrication of the Ring and Puck clamp is needed.

10.6.4 The o-rings in the Ring and Puck dishes should be replaced when worn.

10.6.5 Every six months the centrifuge should be lubricated and tightened.

10.7 Troubleshooting

10.7.1 The Ring and Puck dishes are all slightly different depths. Therefore the clamp that holds them to the grinder does not fit snuggly on all dishes without the use of a pad. It is important to have a snug fit to ensure the dish lid seals tightly to avoid sample loss.

11.0 Calculations

Relative Standard Deviation

$$RSD = \frac{S}{\overline{X}}$$

Where: S = standard deviation

$\overline{X}$ = mean

12.0 Method Performance

12.1 Training Requirements

The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See SOP DV-QA-0024 for details of training requirements.

13.0 Pollution Control

The use of organic solvents to complete the equipment cleaning steps is minimized. Quantities are limited to residues on equipment that quickly evaporate in a hood.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Environmental Health and Safety Manual for "Waste Management and Pollution Prevention."

14.2 The following waste streams are produced when this method is carried out:

Solid Waste – Waste Stream D

Flammable Solvent Waste – Waste Stream C

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 "Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples," USEPA, November 2003.

15.2 "Standard Guide for Laboratory Subsampling of Media Related to Waste Management Activities" ASTM D 6323-98 (Reapproved 2003)

16.0 Method Modifications

Item	Method	Modification
N/A	6323	N/A

17.0 Attachments

Attachment 1: Consideration of Fundamental Error in Selecting MIS Options

Attachment 2: ISM Worksheet

18.0 Revision History

Revision 7, dated 28 February 2015

- Annual Technical Review
- Reformatted the SOP
- Added detail to Section 5.3.1 about the Humbolt mechanical grinder.
- Added information to Section 5 about the hazards of grinding radioactive samples.
- Revised Section 9.4.1 to give more detail on how the Ring and Puck composite grinding blanks are created.
- Revised Section 10.6 to include maintenance on the centrifuge.
- Added Attachment 2: ISM Worksheet

Revision 6, dated 05 February 2014

- Annual Technical Review
- Edited Section 6.1, subsection “Ball Mill” to allow for un-baked sand to be used in the cleaning of the ball mill stones and to allow the use of 1 pint cans.
- Edited Section 6.1, subsection “Sieves” to state a brillo pad can be used on the sieves so long as the mesh is not damaged.
- Added a comment to Section 9 stating that this procedure meets DoD QSM 5.0 criteria unless otherwise stated.
- Removed Acceptance Criteria information to Section 9. This information can be found in the analytical SOPs.
- Added a NOTE in Sections 10.4.1.1 and 10.4.2.4 giving instructions on how to ensure the sample is homogenous after it has been split into separate grinding containers and then later re-combined.
- Added Section 10.6 Maintenance and Section 10.7 Troubleshooting per DoD QSM 5.0.

Revision 5, dated 31 January 2013

- Annual Technical Review
- Added Section 1.4 to address the 12 QC Elements.
- Updated Section 2.3 and 10.4.1 to allow the use of Ball Mill grinding. The laboratory successfully completed a Method Validation for Ball Mill grinding and therefore is able to offer this to all clients.
- Section 6 was updated to include cleaning procedures for sieves, Ring and Puck dishes, Ball Mill stones, Mortar & Pestles, and Paint Cans.

- Section 2.1, Section 6, and Section 10.2.2 were updated to include the mechanical grinder that can be used in place of mortar and pestle for samples that do not require metal testing.
- Section 9.3.3 was updated to include acceptance criteria for Grinding Blanks for DoD samples.
- Section 10.3.1 was updated to instruct the analysts to aliquot the samples directly into 100mL digestion cups for metals analysis.
- Removed Attachment 2: How to Batch Samples in LIMS.

Revision 4.2, dated 31 January 2012

- Removed all references to Multi-Incremental Subsampling which is now trade-marked.
- Updated Section 6.1 to reflect the correct number of small and large grinding stones used in the Ball Mill grinding of samples.
- Updated Attachment 2.

Revision 4.1, dated 20 January 2011

- Added detail about the electronic temperature recording device that records the temperature of the room.
- Revised procedure to state that during the one-minute cooling time, the dish <u>will</u> be placed in a shallow ice water bath to facilitate cooling.
- Revised Attachment 2 to include the method Dry_Grind and more details on how to batch samples that are logged for both MULTI_INC and grinding methods.

Revision 4, dated 26 February 2010

- Added instructions for samples logged for metals analyses to replace DV-OP-0014.
- Section 2.1 was revised to clarify that mortar and pestle is used to break soil agglomerates and is not used to reduce particle size of the sample.
- Section 2.1 and Section 6.1 were revised to include the option for a sieve shaker to break up soil agllomerates.
- Added section 6.3.

Revision 3, dated 13 February 2009

- Updated references to other SOPs to match the most current versions.
- Changed solvent used in the cleaning procedure from methanol to a 10% acetonitrile in acetone solution
- Section 4.2 was revised to emphasize the potential loss of lighter organics with this procedure.
- Section 9.3 was revised to associated the grinding blanks to the sample ground after the blank instead of before the blank.
- Removed references to MDL studies and Initial Demonstration of Capability from Section 12 as they are not applicable or feasible to this procedure.
- Revised Section 14 to include the correct waste streams used in this procedure.

Revision 1, dated 1 November 2007

- Added need for initial method performance studies in consideration of potential loss of lighter semi-volatile compounds (e.g. naphthalene) in section 4.2.
- Corrected the number of large grinding stones from 15 to 10 in section 6.1

Revision 0, dated 12 October 2007

- Initial release

Attachment 1

Consideration of Fundamental Error in Selecting MIS Options

The following formula given in ASTM D-6323 was used to produce the table that follows.

$$S^2 = 18 * f * e * d^3 / M_s$$

where,

S^2 = the relative variance of the contaminant concentration due to the fundamental error

f = shape factor, a dimensionless number, a value of 0.5 can be taken as typical (Pierre Gy, 1982)

e = the population's average density (g/cm^3). For this table a typical soil density of 2.5 g/cm^3 was used.

d = the diameter of the largest particle in centimeters, and

M_s = the mass of the sample in grams

Sample Mass and Maximum Particle Size to Achieve a Desired RSD

Subsample Mass (g)	Sieve Size (US Standard Mesh)	At 5% RSD Max Size (cm)	At 10% RSD Max Size (cm)	At 15% RSD Max Size (cm)
0.1	35	0.02	0.04	0.05
1	18	0.05	0.08	0.10
2	13	0.06	0.10	0.13
5	12	0.08	0.13	0.17
10	10	0.10	0.16	0.22
30	7	0.15	0.24	0.31
50	6	0.18	0.28	0.37
100	5	0.22	0.35	0.46

Attachment 2

ISM Worksheet

G:/QA/Edit/FORMS/Organic Prep Forms/MASTER ISM Spreadsheet_Rev1

ISM BATCH:

Use this spreadsheet to document alquot weights when aliquotting into digestion or extraction vessels. If aliquoting into a temporary vessel, no need to document the exact weight because the sample aliquot will be transferred and weighed at the time of analysis.

Login	Sample	Method -->											
			(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)
		ALIQUOT 1											
		ALIQUOT 2											
		ALIQUOT 1											
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Title: Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Soil Samples [SW-846 8330A & 8330B]

Approvals (Signature/Date):

Susan Oster 1/23/2015 Susan Oster — Date Technical Specialist	1/28/15 Adam Alban — Date Health & Safety Manager / Coordinator Andrew Meyer RSO for Adam Alban
Margaret S. Sleevi 1/28/15 Margaret S. Sleevi — Date Quality Assurance Manager	1/30/15 William Cicero — Date Laboratory Director

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1.0 Scope and Application

1.1 This standard operating procedure (SOP) describes the extraction of nitroaromatic and nitroamine explosive residues from soil samples. This procedure is based on SW-846 8330A and 8330B, but can also be performed on samples for analysis by method SW-846 8321A.

1.2 This procedure does not describe the analysis of the extracts. For those details, see the following SOPs:

1.2.1 DV-LC-0002 "*Analysis of Nitroaromatic and Nitroamine Explosive Compounds by HPLC"*

1.2.2 DV-LC-0010 "*Analysis of Nitroaromatic and Nitroamine Explosives Compounds by APCI/LC/MS"*

1.2.3 DV-LC-0025 *"Analysis of Picric Acid by LC/MS/MS"*

1.3 Application of 8330A versus 8330B

1.3.1 This procedure is for extraction by either Method 8330A or 8330B. The most important differences in the two source methods are the more rigorous sample collection and preparation measures in 8330B, which are designed to produce more representative results. The more rigorous 8330B process is specifically intended to complement the incremental field sampling process described in Appendix A of method 8330B. If incremental or equivalent systematic sampling processes are not employed in the field, then the extra laboratory homogenization and subsampling effort 8330B requires may add little or no improvement in the overall precision of results.

1.3.2 A larger sample size is used for 8330B (10 g) than is used for 8330A (2 g). A larger sieve size is used for 8330B (10 mesh) than is used for 8330A (30 mesh)

2.0 Summary of Method

2.1 Solid samples are air dried and sieved. Soil agglomerates are broken with a mortar and pestle, sieve shaker, or mechanical grinder. For samples requiring the more rigorous homogenization techniques found in method 8330B, the analyst employs either a ring and puck grinder or a ball mill grinder. The samples are extracted with a 0.1% acetic acid in acetonitrile mixture on a shaker table.

3.0 Definitions

3.1 Definition of terms used in this SOP may be found in the Glossary section of the TestAmerica Denver Quality Assurance Manual (QAM) or SOP DV-QA-003P.

3.2 Explosives: As used in this SOP, the term "explosives" refers specifically to the analytes listed in Table 1. These include compounds that can be readily detonated with heat, shock, or ignition, such as nitroglycerin, RDX, and TNT. It also includes production by-products and degradation products of true explosives.

3.3 TALS: TestAmerica Laboratory Information Management System

3.4 ISM: Incremental Sampling Methodology - This is a requirement of method 8330B and describes the technique used to take a 10g aliquot from a sample in at least 30 increments.

3.5 Extraction Holding Time: The elapsed time expressed in days from the date of sample collection to the date the extraction starts. The holding time is tracked in the laboratory LIMS system, and is the primary basis of prioritizing work.

3.6 Preparation Batch: A group of up to 20 samples that are of the same matrix and are processed together in the same extraction event using the same procedure and lots of reagents and standards

3.7 Grinding Batch: A grinding batch is up to 20 samples processed through the same grinding procedure. When using the ring and puck mill, the grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples or after 3 days, whichever is sooner, due to the expiration of the grinding LCS**.** When using the ball mill, the grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples, or at the end of the day, whichever is sooner.

3.8 Method Comments: The Method Comments are used to communicate to the bench level chemists special requirements and instructions from the client.

3.9 Quality Assurance Summary (QAS): Certain clients may require extensive specific project instructions or program QC, which are too lengthy to fit conveniently in the Method Comments field in LIMS. In these situations, laboratory Project Managers describe the special requirements in a written QAS to address these requirements. QASs are posted on a public drive for easy accessibility by all lab employees. Normally, QASs are introduced to analysts in an initial project kick-off meeting to be sure that the requirements are understood.

3.10 Aliquot: A part that is a definite fraction of a whole; as in "take an aliquot of a sample for testing or analysis." In the context of this SOP, "aliquot" is also used as a verb, meaning to take all or part of a sample for preparation, extraction, and/or analysis.

4.0 Interferences

4.1 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.

4.2 Contamination by carryover can occur when a low-concentration sample is extracted immediately following a high-concentration sample.

4.3 The inclusion of vegetation is not recommended given the nature of the detector and different uses the data will potentially support (USACE comment – Issue #306 TA Denver Audit Database).

4.4 Samples from an ammunition plant or depot usually contain analytes that were deposited via water and leaching and therefore are more uniformly dispersed. Therefore, as per SW-846 8330B Section 11.1.4.2, ring and puck or ball mill grinding is not necessary.

4.5 Samples from firing ranges and impact zones can contain particles of explosives at a variety of sizes, shapes, and compositions. Therefore the entire sample must be processed through a ring and puck or ball mill prior to removal of the subsample for analysis. Samples collected at the firing point can contain nitrocellulose fibers. These fibers present a special problem in the grinding step. In order to get the fibers to release the target analytes they must be very finely ground. For these samples only the ring and puck should be used. Samples collected at the impact areas usually only contain crystalline residues and can usually be ground satisfactorily with a ball mill as the nitro-cellulose fibers are not present in these areas. The client needs to be consulted when selecting a grinding mechanism.

4.6 Excessive headspace in the ball mill cans may cause loss of target compounds in the grinding LCS. It is important to use cans that are of the appropriate size and fill the cans with grinding stones to minimize headspace. See Section 10.5.2.1 for details.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.2 Specific Safety Concerns or Requirements

5.2.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; non-disposable gloves must be cleaned immediately. When tightening caps on 40mL glass vials, cut resistant gloves must be worn.

WARNING: Soil samples with explosive concentrations greater than 2% cannot be accepted by the laboratory unless they have moisture content of 25% or greater. Under no circumstances shall a soil

sample with an explosive concentration greater than 10% be accepted by the laboratory.

5.2.1.1 If a sample is expected to have an explosive concentration ≥2% (but less than 10%), the EH&S Coordinator and Group Leader shall be notified before any work is performed. Additional safety precautions may be implemented as required due to high concentrations of explosives.

5.2.1.2 Soil samples with high concentrations (between 2 and 10%) of explosives should not be ground using a mortar and pestle. Visual observation of a soil samples is important prior to grinding samples. Any samples containing metal fragments, powders, waxy appearing pieces, or other suspicious material should be brought to the attention of the Group Leader and the EH&S Coordinator before proceeding with the procedure. Bypassing the grinding step and proceeding to solvent dilution is an alternative for samples that are determined to be unsafe to grind.

5.2.2 Anyone working in the grinding room needs to be enrolled in the Hearing Conservation Program. See SOP DV-HS-0010 for details. Personnel operating the grinding equipment are required to wear ear plugs when the equipment is turned on. When standing next to the Humbolt mechanical grinder described in Section 6.1.12 during operation, the decibel levels are above 80 decibels, therefore anyone operating the grinder must be enrolled in the Hearing Conservation Program and wear hearing protection. While the grinder is running, the decibel levels in the room are below 80 decibels, therefore personnel not enrolled in the Hearing Conservation Program can be in the room. Hearing protection is always available to every analyst and they are encouraged to use it.

5.2.3 Operations involving handling samples outside of sealed containers are conducted in ventilation hoods to avoid exposure to dust. Dust masks are available for use, but are optional.

5.2.4 Operations involving the grinding of radioactive samples can be particularly hazardous due to the increased potential for exposure from airborne dust. If a sample is labeled as a “CAT 1”, “CAT 2”, “CAT 3” or “CAT 4” sample, and requires grinding thru the ring and puck or ball mill, contact the RSO immediately.

5.3 Primary Materials Used

The following is a list of materials used in this method, which have a serious or significant hazard rating.

NOTE: This list does not contain all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.

A complete list of materials used in the method can be found in the reagent and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

MATERIAL (1)	HAZARDS	EXPOSURE LIMIT (2)	SIGNS AND SYMPTOMS OF EXPOSURE
ACETONITRILE	Flammable Poison	40 PPM – TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
METHANOL	Flammable Poison Irritant	200 PPM - TWA	A slight irritant to the mucous membranes. Toxic effects are exerted upon the nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness, and dizziness. Methyl alcohol is a defatting agent and may cause the skin to be become dry and cracked. Skin absorption can occur, symptoms may parallel inhalation exposure. Irritant to the eyes.
ACETIC ACID, GLACIAL	Corrosive Poison Flammable Liquid and Vapor	10 PPM - TWA	Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur. Can cause serious damage to skin, including redness, pain, and burns. Contact with eyes may cause severe damage followed by loss of sight.
(1) ALWAYS ADD ACID TO WATER TO PREVENT VIOLENT REACTIONS. (2) EXPOSURE LIMIT REFERS TO THE OSHA REGULATORY EXPOSURE LIMIT.			

6.0 Equipment and Supplies

6.1 Equipment

6.1.1 Balance, capable of measuring ± 0.01 g. Calibration checked per SOP DV-QA-0014

6.1.2 Orbital shaker table, capable of maintaining 150 rpm for 18 hours.

6.1.3 Pipettor with disposable 1.0 mL tips, accurate to ± 2%, calibration checked daily in accordance with SOP DV-QA-0008.

6.1.4 Bottle-top pipettor, able to dispense 8 to 20mL, accurate to ± 2%, calibration checked daily in accordance with SOP DV-QA-0008. If the pipettor does not have a digital display, then the calibration check should be performed whenever the pipette is adjusted.

6.1.5 Ring and Puck - for the grinding of soils per method 8330B

The grinding bowl and puck are cleaned after each use by washing with soap and water with a plastic brush, rinsing with hot tap water, rinsing with DI water, and then rinsing with a 10% acetonitrile solution in acetone. A final wipe down of the bowl and puck while still wet with solvent is done with a Kimwipe (TNT in particular is reported to be prone to adhering to steel surface). In addition,

sand blanks are used to monitor potential carry-over for each batch of samples (see Section 9.9.1 for details).

6.1.6 Ball Mill - for the grinding of soils per method 8330B

Ceramic grinding stones are cleaned after each use by rinsing with hot tap water, washing with soap and water, rinsing with hot tap water, rinsing with DI water, and then rinsing with a 10% solution of acetonitrile in acetone. The stones are allowed to dry then tumbled in a clean can with clean Ottowa Sand for 2 hours. The stones are then removed from the can, rinsed with hot tap water, rinsed with DI water, and then rinsed with 10% acetonitrile in acetone. The stones are allowed to dry again before use. In addition, sand blanks are used to monitor potential carry-over for each batch of samples (see Section 9.9.2 for details)

Paint Cans – disposable, 1 gallon, ½ gallon, or 1 pint in size. Cans and lids are cleaned prior to use by rinsing with 10% acetonitrile in acetone and wiping with a Kim-wipe while still wet.

Spacer Cans – cans or PVC pipe that is filled with sand or other material used to prevent sample cans from “walking” off of the mill.

6.1.7 Trays – “baker’s rack” type of stack for the air drying of soils per method 8330B

6.1.8 Sieves, 10 and 30 mesh – Sieves are cleaned after each use by washing with soap and water and a green plastic brillo pad, (be careful not to damage the mesh), rinsing with hot tap water, rinsing with DI water. Prior to use, the sieves are rinsed with 10% acetonitrile in acetone and wiped with a Kim Wipe. Sieves are allowed to dry in a hood prior to use.

6.1.9 Receiver pans and lids – Receiver pans are cleaned after each use by washing with soap and water, rinsing with hot tap water, rinsing with DI water. Prior to use, the receiver pans are rinsed with a 10% acetonitrile in acetone and wiped dry with a Kim Wipe.

6.1.10 Sieve shaker – used to facilitate the sieving of large sample volumes.

6.1.11 Mortar and pestle – cleaned after each use by washing with soap and water, rinsing with hot tap water, and then rinsing with DI water. Prior to use, the mortars and pestles are rinsed with 10% acetonitrile in acetone and wiped with a Kim Wipe and allowed to dry in a hood prior to use.

6.1.12 Mechanical Grinder – Humbolt Manufacturing Part Number H-4199. Used in place of a mortar and pestle to quickly reduce cakes of dry soil. The grinder reduces soil agglomerates and sieves the soil through a 10 mesh sieve. The mechanical grinder is used to break up soil agglomerates, but it is not an alternative to Ring and Puck or Ball Mill grinding. The mechanical grinder is cleaned after each sample by removing the hopper. The hopper is washed with soap and water, rinsed with tap water, rinsed with DI water, and then

rinsed with 90:10 Acetone:Acetonitrile. The Hopper is then wiped dried with a laboratory tissue. The hammers and body of the grinder are cleaned after each sample by rinsing with DI water and wiping dry with a laboratory tissue.

6.2 Supplies

6.2.1 Glass vials, various sizes.

6.2.1.1 Amber glass, 40 mL, with Teflon-lined screw caps for the sonication of soil samples.

6.2.1.2 Amber glass, 8.0 mL, with Teflon-lined screw caps, for the storage of final extracts.

6.2.2 Aluminum foil and aluminum dishes.

6.2.3 Parchment paper

6.2.4 0.2-µm PTFE syringe filters and disposable syringes.

6.2.5 Wooden spatulas – used to lay samples out to dry.

6.2.6 Plastic square-ended disposable spoons – used to aliquot samples.

7.0 Reagents and Standards

7.1 Ottawa Sand – baked at 400℃ for at least 4 hours.

7.2 Acetonitrile, CH_3CN - HPLC grade (ACN). Each lot is tested per CA-Q-S-001 DV-1.

7.3 Soil Extraction Solvent – approximately 0.1% acetic acid in acetonitrile – Open a new 4-liter bottle of acetonitrile and add 4 mL of acetic acid, then cap and mix. This reagent is given a 1 year expiration date.

7.4 Standards

Please reference SOP DV-OP-0020 for information regarding the surrogate and spike standards used in this procedure.

7.5 Grinding LCS Bulk Material

A standard is purchased in a matrix of -20/+70 Sieved Soil that contains the compounds at the concentrations listed in Table 2. This standard comes packaged in 500 g containers. This standard is stored in a refrigerator at 0℃ to 6℃ and is given a 1 year expiration date. After grinding the ground LCS is stored refrigerated and has a three day expiration date.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Soil samples to be extracted by method 8330A for analysis by either method 8330A or method 8321A should be collected in eight-ounce wide mouth jars with Teflon-lined caps. When sampling for DoD projects that must comply with DoD QSM, version 3, 4 or 5 requirements for drying and sieving the entire contents of a soil sample container, a separate container should be used to collect a soil sample for this analysis.

8.2 For soil samples to be extracted by method 8330B for analysis by either method 8330B or method 8321A, it is not uncommon to receive samples of 1 kg or more. Samples may be shipped in wide mouth jars or clean plastic bags.

8.3 Sample extracts must be stored refrigerated in amber glass containers at ≤ 6 ℃.

8.4 Soil and sediment samples should be air dried at ambient temperature until dry enough to sieve. See Section 10.3 for details. Once the sample is air dried, the sample can be stored at room temperature.

8.5 All soil and sediment samples must be extracted within 14 days of collection and analyzed within 40 days after extraction begins.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time	Reference
Soils	Glass/ plastic	4 grams (8330A)/up to 1 Kg (8330B)	Cool ≤ 6°C	14 Days	SW846 8330A/B

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs. This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via

Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.1 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 11.0 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.2 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument. See QC Policy DV-QA-003P for further details.

Grinding Batches – A grinding batch is up to 20 samples processed through the same grinding procedure. When using the ring and puck mill, the grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples or after 3 days, whichever is sooner, due to the expiration of the grinding LCS**.** When using the ball mill, the grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples, or at the end of the day, whichever is sooner.

9.3 Method Blank (MB)

A method blank (MB) must be prepared and analyzed with each batch of samples. The MB consists of Ottawa sand with surrogates added. The MB is created at the time of extraction after the samples have been dried, sieved, and ground and is then carried through all extraction and analysis steps. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false-positive data.

9.4 Laboratory Control Sample / Laboratory Control Sample Duplicate (LCS/LCSD)

One LCS must be analyzed with each batch of samples. The LCS must contain specified analytes of interest and must be carried through the entire analytical

procedure. The LCS is prepared by spiking the analytes of interest into Ottawa sand. The LCS is created at the time of sample extraction after the samples have been dried, sieved, and ground. The LCS is used to monitor the accuracy of the analytical process. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

9.5 Matrix Spike Sample (MS) and Matrix Spike Duplicate (MSD)

A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. The soil matrix spikes are created at the time of extraction. Spikes and surrogate compounds are added after the sample has been dried, sieved, and ground. One MS/MSD pair must be processed for each preparation batch. The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process.

If insufficient sample volume is available for MS/MSD, a LCSD must be performed and an NCM must be written.

9.6 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, DU, TRL, MS, and MSD) is spiked with surrogate compounds.

9.7 Sample Duplicate (DU)

A duplicate sample is required after ring and puck or ball mill grinding is performed. A duplicate sample is also required for method 8330B, even if grinding is not performed. A sample duplicate is a second aliquot of one of the samples in the batch. Field blanks cannot be used for duplicate testing. The results for duplicates are reported separately, and cannot be averaged when reporting results. Sample duplicate results are used to evaluate the precision of the method. As such, results should be greater than or equal to the RL for a valid statistical comparison.

9.8 Sample Triplicates (TRL)

A triplicate sample is required after ring and puck or ball mill grinding is performed. A duplicate sample is also required for method 8330B, even if grinding is not performed. The lab will determine the %RSD as defined below. Results for the %RSD as well as the individual replicate results will be reported to the client. The method suggests that the %RSD for the subsampling error is acceptable if it is <10%. For DoD QSM 5.0, the %RSD is acceptable if it is <20% for results above the LOQ.

The percent relative standard deviation (%RSD) is calculated as follows:

$$\%RSD = \frac{s}{\bar{C}} \times 100\%$$

Where s is the standard deviation of the average concentration and is calculated as follows:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (C_i - \overline{C})^2}{n-1}}$$

In the event that the laboratory is requested to perform the evaluation of field replicate precision, three field replicates designated by the client will be processed through the entire homogenization and extraction steps. The %RSD for these replicates will be calculated as indicated above and reported to the client.

9.9 Grinding Blank (GB)

9.9.1 Ring and Puck Grinding Blanks

Before each sample is processed through the ring and puck mill, the ring and puck will be cleaned per Section 6.1.5. Then approximately 200 g of Ottawa Sand will be ground. This ground sand will be saved and labeled with the sample ID of the next sample ground with the suffix “blank”. After a batch of samples has been processed through the ring and puck, a composite will be generated using sub-aliquots from all blanks ground before the samples. This is done by placing approximately 1 tablespoon of material from each of the individual sample blanks in a clean re-sealable plastic bag. The bag is then sealed and the material is mixed and homogenized by shaking and kneading the bag. A 10g aliquot is then removed from the bag and labeled as the batch grinding blank. This composite is extracted and analyzed in the same manner as the field samples.

Corrective Action: If the composite grinding blank results are greater than the acceptance limits, then the individual grinding blanks will be extracted and analyzed to determine when the contamination occurred and exactly which samples were affected. Samples associated with a contaminated grinding blank producing positive results for the same contaminant, must be reprocessed and reanalyzed. If un-ground sample is not available, then the potential carry-over between samples must be described in a non-conformance memo and discussed in the final report case narrative.

9.9.2 Ball Mill Grinding Blanks

With every batch of samples processed with the ball mill, approximately 200 g of clean Ottowa Sand will also be processed in the same manner. This ground sand will then be extracted and analyzed in the same manner as the field samples.

Corrective Action: If grinding blank results are greater than the acceptance limits, then any samples producing positive results for the same contaminant must be reprocessed and reanalyzed. If un-ground sample is not available,

then the potential carry-over between samples must be described in a non-conformance memo and discussed in the final report case narrative.

9.10 Grinding LCS (LCSSRM)

One Grinding LCS must be ground and analyzed with each batch of samples that are processed through the ring and puck or ball mill grinder. The Grinding LCS must contain specified analytes of interest and must be carried through the entire analytical procedure. The Grinding LCS is prepared by grinding a 500 g aliquot of the Grinding LCS Bulk Material described in Section 7.5 without having air-dried the material before hand. The Grinding LCS must be ground using the same grinding apparatus (ring and puck or ball mill) as the samples were ground. The Grinding LCS is used to monitor the effects of the grinding process on the analytes of interest. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

Corrective Action: If the Grinding LCS fails the acceptance criteria, samples associated with the Grinding LCS must be reprocessed and reanalyzed. If un-ground sample is not available, then the results of the grinding LCS must be described in a non-conformance memo and discussed in the final report case narrative.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Dry the Samples – Refer to the Flowchart in Appendix 1 and the batching instructions in Appendix 3

10.3.1 Check the Method Comments to see if the samples are for a project with the Department of Defense (DoD), Air Force Center of Environmental Excellence (AFCEE), or Army Corp of Engineers (USACE), If yes, then the entire contents of the sample container must be dried. Check TALS to make sure the client sent more than one container if additional tests are being requested. If additional tests are logged and the client only sent one container, the Project Manager should be notified.

10.3.2 If the sample is logged for method 8330B, or for an ISM method, then the entire contents of the sample container must be dried. Check each sample to make sure the client sent more than one container if additional tests are

being requested. If additional tests are logged and the client only sent one container, the Project Manager should be notified

10.3.3 If the samples do not fall under the descriptions given in Section 10.3.1 or Section 10.3.2 then only a portion of the sample container needs to be dried. In these cases, lay out at least 20 g to dry.

10.3.4 Depending on the sample size, the samples are laid out in aluminum pans, or on large trays lined with aluminum foil to dry. Some clients may request metals analysis on the dried samples. In those cases, samples are laid out on parchment paper.

10.3.5 Spread the samples out in a thin layer to facilitate drying. Use a disposable wooden spatula to break up any clumps and agglomerates.

10.3.6 The tray or pan that the sample is laid out into is labeled with the sample ID. A second analyst checks to make sure that the labels on the tray or pan match the labels on the client sample container to ensure samples are not accidently mixed up. This check is documented in TALS.

10.3.7 Place the samples in a hood or well ventilated area at room temperature. Document in TALS the date and time the samples were laid out to dry. If the samples are very wet, a fan can be used to help facilitate the drying process, but care should be taken so that the air flow is not strong enough to cause cross-contamination between samples. An electronic temperature recording device records the temperature of the room and the data is downloaded weekly.

10.3.8 When the samples appear to be dry enough that they can be sieved without caking, proceed to Section 10.4.

10.4 Sieve the Samples - Refer to the Flowchart in Appendix 2.

10.4.1 If the client requirements specify a particular sieve size, those instructions take precedence.

10.4.2 If the sample is logged for prep method “8330_P_2g” then a 30 mesh sieve should be used.

10.4.3 If the sample is logged for prep method “8330_Sonc_10g” then a 10 mesh sieve should be used.

10.4.4 Some clients will request metals analyses to be performed on the sieved sample. In those cases, a stainless steel sieve should be used. Brass sieves should be avoided.

10.4.5 Clean the sieves prior to use following the instructions in Section 6.1.8.

10.4.6 Some samples may require the use of a mortar and pestle or a mechanical grinder to break up dried clumps. Refer to Sections 6.1.11 and 6.1.12 on how to clean and rinse the mortar and pestles and the mechanical grinder before use.

10.4.7 Sieve the entire dried sample through the appropriate sized sieve. Care must be exercised not to eliminate soil agglomerates during this step. The soil can be broken into small pieces with a gloved hand or another instrument (a wooden spatula for example). If a gloved hand is used, care should be taken to change out gloves in between samples so not to cross- contaminate samples.

10.4.8 Remove large rocks, vegetation, and twigs that do not pass through the sieve. Mosses and other types of fine vegetation should be physically shredded while sieving to release trapped soil and residues. The only materials that should be eliminated by sieving are rocks and vegetation. All soil must be broken up to pass through the sieve.

10.4.9 Place any soil that does not pass through the sieve into a clean mortar. Break up soil agglomerates using the pestle. Or as an alternative use the mechanical grinder. Be sure to break up all soil so that it can pass through the sieve. Only extraneous material such as rocks and vegetation should be removed with the sieve. Describe all extraneous material that did not pass through the sieve in an NCM.

NOTE: Some clients may request the portion of the sample that did not pass through the sieve to be saved and weighed. Some clients may request the weight of the entire sample to be documented as well. Check Method Comments before discarding any sample material.

10.4.10 Collect all of the material that passes through the sieve on a clean piece of foil or parchment paper.

10.4.11 An automatic sieve shaker can be used to help facilitate the sieving of samples. A receiver pan is placed under a sieve and the sample is added to the sieve with 1 or 2 small grinding stones. Then a lid or another receiver pan for a second sample is placed on top. The stack is then clamped inside the sieve shaker for no more than 30 minutes. Inspect the samples to ensure that only extraneous material such as rocks and vegetation should be removed with the sieve. If needed use a mortar and pestle to break up soil agglomerates. Describe all extraneous material that did not pass through the sieve in an NCM.

10.5 Grind the Samples - Refer to the Flowchart in Appendix 2.

10.5.1 If the samples are not logged with a pre-prep method of “ISM_DD_SI_PM_SS” or “ISM_DD_SI_BM_SS” skip this section and proceed to Section 10.6.

10.5.2 Ball Mill Grinding *Samples logged for "ISM_DD_SI_BM_SS"*

10.5.2.1 If the sample is logged for ball mill grinding, prepare a paint can for each sample. See Section 6.1.6 on how to clean the cans and the grinding stones. Select a can that is large enough that the sample alone would occupy ½ of the can's volume. Prepare the paint can by filling the can full with grinding stones of various sizes, leaving only 1 inch of space at the top. After the stones have been placed in the can, transfer the sample into the labeled can. The sample will fill in the spaces around the grinding stones. If needed, the sample can be split between multiple cans and recombined after grinding. The entire sample must be ground. It is important to fill the can. Add additional stones if needed. Seal the lid by pounding it in place with a rubber mallet and placing duct tape over the top of the lid to secure it.

NOTE: If multiple cans are used for grinding and the sample is recombined, it has been shown in DU/TRL QC that the sample is non-homogenous. To re-homogenize the sample, place all volume in to a clean plastic bag, seal, and carefully shake the bag for 1-2 minutes until sample is homogenous. Lay out the sample back on the foil/parchement paper

NOTE: It is critical that the can has minimal headspace, yet enough stones to grind the sample completely. Excess headspace may result in loss of target compounds, especially in the grinding LCS media.

10.5.2.2 Prepare a grinding blank per Section 9.9.2 with every batch. The grinding blank will be analyzed in addition to the normal extraction blank (method blank).

10.5.2.3 Prepare a grinding LCS per Section 9.10 with every batch. The grinding LCS will be analyzed in addition to the normal extraction LCS.

10.5.2.4 Place the paint cans on the ball mill. To prevent the samples from falling off of the mill, place a spacer can on the ball mill to the right of the cans on each row. Start the ball mill. Document the start time on the benchsheet. The samples should be ground for at least 8 hours. Remove the paint can and in a fume hood open the lid and inspect the sample. It should be the consistency of flour. The consistency of the material is checked by pinching some between fingers of a gloved hand and feeling for grit and by looking for any un-ground fibers. If grit is detected or if fibers are observed, additional grinding is needed. If the sample is not at the correct consistency of flour, either seal the can and return it to the ball mill for further grinding, or transfer the sample to a ring and puck dish to finish the grinding.

NOTE: If the can is re-sealed to be placed back on the ball mill, care must be taken that the lid was not damaged when the can was opened and that the lid still seals well. It may be necessary to use a new lid if the first lid was damaged.

NOTE: The Grinding LCS (LCSSRM) should not be ground for more than 8 hours.

NOTE: A grinding batch will consist of no more than 20 samples that have been ground on the same day. The grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples or end of the day, whichever is sooner**.** A grinding batch must have one Grinding LCS, and at least one Grinding Blank. If more than one Grinding Blank is prepared, it must be very clear on the benchsheet which individual sample blanks were used to build each Grinding Blank.

10.5.3 Ring and Puck Grinding *Samples logged for "ISM_DD_SI_PM_SS"*

10.5.3.1 See Section 6.1.5 on how to clean the ring and puck dish.

10.5.3.2 If the sample is logged for ring and puck grinding, a grinding blank per Section 9.9.1 consisting of baked Ottawa sand will be processed through the ring and puck dish before each sample. These individual blanks will be composited into one grinding blank for the associated samples and will be analyzed in addition to the normal extraction blank.

NOTE: When preparing the grinding blanks, it is not necessary to do five 60-second grinds. One 60-second grind of the Ottawa sand is sufficient.

10.5.3.3 After a grinding blank has been processed through a ring and puck dish, that blank is labeled as the blank associated to the next sample processed through that same dish. It is not necessary to clean the ring and puck dish after the blank.

10.5.3.4 Prepare a grinding LCS per Section 9.10 with every batch. The grinding LCS will be analyzed in addition to the normal extraction LCS.

NOTE: A grinding batch will consist of no more than 20 samples that have been ground within three days of each other. The grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples or after 3 days, whichever is sooner**.** A grinding batch must have one Grinding LCS, and at least one Grinding Blank. If more than one Grinding Blank is prepared, it must be

very clear on the benchsheet which individual sample blanks were used to build each Grinding Blank.

10.5.3.5 In a hood, transfer the sample into a clean ring and puck dish. Do not overfill the dish (approximately 300 g of sample can fit in one dish). If needed, grind the sample in 300 g or smaller increments and recombine after all sample has been ground. The entire sample must be ground. Place the dish securely in the holder and close the door on the machine. Grind the sample in five 60-second periods with a one minute cooling time between grinds for a total of 5 minutes of grinding. Remove the dish and in a fume hood, open the lid and inspect the sample. It should be the consistency of flour. The consistency of the material is checked by pinching some between fingers of a gloved hand and feeling for grit and by looking for any un-ground fibers. If grit is detected or if fibers are observed, additional grinding is needed.

10.5.3.6 If the sample reaches a flour-like consistency before all 5 one-minute grinds have been completed, then it might be beneficial to <u>not</u> perform all 5 grinds in order to avoid excessive heat and to avoid packing the sample onto the side of the grinder. If the analyst inspects the sample and it has a flour like consistency before all 5 grinds are completed, they can make the decision to stop after less than 5 grinds. A NCM should be written to document the deviation from the source method and the reasoning.

NOTE: During the one-minute cooling time, the dish should be placed in a shallow ice water bath to facilitate cooling. Be sure the bath is shallow enough so that water does not get inside the dish.

NOTE: If multiple 300 g increments are used for grinding and the sample is recombined, it has been shown in DU/TRL QC that the sample is non-homogenous. To re-homogenize the sample, place all volume in to a clean plastic bag, seal, and carefully shake the bag for 1-2 minutes until sample is homogenous. Lay out the sample back on the foil/parchment paper. This must be done on all samples regardless if this sample will be used for DU/TRL QC.

10.6 Aliquot the Samples

10.6.1 All aliquots should be taken using a square-ended disposable plastic spoon. This is done to ensure that finer sample material does not fall off of the sampling tool, as can happen if a spatula was used instead. This is particularly necessary when samples are not ground to a consistent grain size using the ring and puck or ball mill grinders.

10.6.2 **2 Gram Aliquot – Extraction Method "8330_P_2g"** – Remove the cap from a labeled 40 mL amber vial and place the vial on a balance and tare. Spread the entire sample out to a thickness no greater than 1 cm. Use a disposable plastic square-ended spoon to build a 2.0 g to 2.2 g aliquot by taking at least five small portions from random locations through the entire thickness of the sample. Record the exact sample weights on the benchsheet and cap the vial with a Teflon™ lined lid. Save the remaining soil for possible re-extraction. Create a LCS and a method blank by placing 2.0 g to 2.2 g of baked Ottawa sand in labeled vials.

10.6.3 **10 Gram Aliquot – Extraction Method "8330_Sonc_10g"** – Remove the cap from a labeled 40 mL amber vial and place the vial on a balance and tare. Spread the entire sample out to a thickness no greater than 1 cm. Use a disposable plastic square-ended spoon to build a 10 g to 11 g aliquot by taking at least thirty small portions from random locations through the entire thickness of the sample. Record the exact sample weights on the benchsheet and cap the vial with a Teflon™ lined lid. Save the remaining soil for possible re-extraction. Create a LCS and a method blank by placing 10 g to 11 g of baked Ottowa sand in labeled vials. If the samples were ground create a grinding blank per Section 9.9 by taking approximately equal scoops from each individual grinding blanks. Aliquot the grinding LCS as you would a sample.

10.7 Add Surrogate, Spikes, and Solvent to the Samples

10.7.1 Refer to WI-DV-009 for the correct surrogate and spike standards to use and the correct volume.

10.7.2 The surrogate standards are kept in a freezer, but should be allowed to come to room temperature before use. Record the ID of the standard used on the benchsheet.

10.7.3 The spike standards are kept in a freezer. Only a small aliquot of the standard should be removed from the freezer and allowed to come to room temperature before use. Any remaining standard that has come to room temperature will be disposed.

10.7.4 The addition of spikes and surrogates to samples must be done only immediately after a second analyst has reviewed the batch. Reference work instruction WI-DV-009.

10.7.5 Only one batch should be surrogated at a time to ensure the correct standards are used.

10.7.6 Using a calibrated pipette, add the appropriate volume of the appropriate working surrogate standard to each sample and each QC sample.

10.7.7 Using a calibrated pipette, add the appropriate volume of the appropriate working spike standard to each LCS and MS/MSD.

NOTE: Do not add the spike standard to the grinding LCS. The grinding LCS is created using the material described in Section 7.5 and already contains the analytes of interest.

10.8 Add Extraction Solvent

10.8.1 2 Gram Extraction – Extraction Method "8330_P_2g"

10.8.1.1 Taking into account the volume of surrogate and spike standard added to each sample, bring the extract volume up to 10 mL with the soil extraction solvent described in Section 7.3. Use either a 10 mL Class A graduated cylinder or a bottle top pump that has been calibration checked.

Example: If 0.5 mL of surrogate standard was added to a sample, add exactly 9.5 mL of the soil extraction solvent.

Example: If 0.5 mL of surrogate standard and 0.5 mL of spike standard was added to a LCS, add exactly 9 mL of the soil extraction solvent.

10.8.1.2 Proceed to Section 10.9

10.8.2 10 Gram Extraction – Extraction Method "8330_Sonc_10g"

10.8.2.1 Taking into account the volume of surrogate and spike standard added to each sample, bring the extract volume up to 20 mL with the soil extraction solvent described in Section 7.3. Use either a 25 mL Class A graduated cylinder or a bottle top pump that ahs been calibration checked.

Example: If 1 mL of surrogate standard was added to a sample, add exactly 19 mL of the soil extraction solvent.

Example: If 1 mL of surrogate standard and 1 mL of spike standard was added to a LCS, add exactly 18 mL of the soil extraction solvent.

10.9 Extract the Samples

10.9.1 Cap vial with a Teflon-lined cap, vigorously hand shake the vial for one minute, or until all material is well mixed, and place it in a box. Place the box on the platform shaker so that the vials are lying on their side. Set the platform shaker at 150 rpm and allow the samples to be shaken for at least 18 hours. Record the start time on the benchsheet.

10.9.2 After the 18 hour extraction, remove the vials from the shaker table and record the stop time on the benchsheet.

10.9.3 If needed, centrifuge the vial at 2500 rpm to help separate the solids from the extract. Remove approximately 5 mL of the supernatant solution. Filter the supernatant solution using a 0.2-µm PTFE syringe discarding the first mL into the waste. Filter the remaining supernatant into a labeled 8-mL amber vial.

10.9.4 Submit the extract for analysis to the appropriate analytical lab.

10.10 Maintenance

10.10.1 Approximately once a month, the cover on the Ring and Puck should be removed and any dirt should be cleaned up.

10.10.2 When excessive wear is noted, replace the hammers in the Mechanical Grinder.

10.10.3 Occasional lubrication of the Ring and Puck clamp is needed.

10.10.4 The o-rings in the Ring and Puck dishes should be replaced when worn.

10.10.5 Every 6 months the centrifuge should be lubricated and tightened.

10.11 Troubleshooting

10.11.1 The Ring and Puck dishes are all slightly different depths. Therefore the clamp that holds them to the grinder does not fit snuggly on all dishes without the use of a pad. It is important to have a snug fit to ensure the dish lid seals tightly to avoid sample loss.

11.0 Method Performance

11.1 Initial Demonstration of Capability

11.1.1 An initial demonstration of capability must be performed prior to analyzing samples.

11.1.2 For the standard analyte list, the initial demonstration consists of the preparation and analysis of a QC check sample containing all of the standard analytes for the method, as well as a method detection limit (MDL) study (described in Section 11.2 below).

11.1.3 Four aliquots of the QC check sample are analyzed with the same procedures used to analyze samples, including sample preparation through the drying and grinding process for 8330B soils.

11.1.4 The mean recovery and standard deviation are calculated for each analyte of interest. These results are compared with the established or project-specific acceptance criteria. All four results must meet acceptance criteria before the method can be used to analyze samples.

11.1.5 For non-standard analytes an MDL study must be performed and calibration curve generated before analyzing any samples, unless lesser requirements are previously agreed to with the client. In any event, the minimum initial demonstration required is successful analysis of an extracted standard at the reporting limit and a single point calibration.

11.2 Method Detection Limit (MDL)

A valid method detection limit (MDL) study for each analyte of interest must be performed prior to analyzing samples for the first time and verified annually thereafter. Separate soil MDL studies are performed for 8330A using 2 g and 8330B using 10 g of Ottawa sand. Separate soil MDL studies are performed for explosive method 8321A using 2 g of Ottowa sand and 8321A using 10 g of Ottowa sand. A MDL study for picric acid by method 8321A is performed using 10 g of Ottowa sand. A MDL study for explosives by 8321 LC/MS/MS is performed using 10 g of Ottowa sand. The procedure for determining detection limits is defined in Policy DV-QA-005P. Quarterly MDLV and LOQV studies are performed for the DoD program (QSM 4.2 and 5.0)

11.3 Analyst Training and Qualification

11.3.1 The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See SOP DV-QA-0024 for details of training requirements.

11.3.2 Each analyst performing the method must complete an initial demonstration of capability (IDOC) by successfully preparing and/or analyzing four consecutive LCSs, or a blind performance evaluation (PE) sample, or other acceptable QC samples. The results of the IDOC study are summarized in the NELAC format, as described in SOP DV-QA-0024. IDOCs are approved by the Quality Assurance Manager and the Technical Director.

11.3.3 IDOC records are maintained by the QA staff in the central training files. Analysts who continue to perform the method must successfully complete a demonstration of capability annually.

12.0 Pollution Control

Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

13.0 Waste Management

13.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in Section 13, “Waste Management and Pollution

Prevention", of the Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

13.2 The following waste streams are produced when this method is carried out:

13.2.1 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

13.2.2 Flammable solvent waste – Waste Stream C

13.2.3 Solid sample waste - Waste Stream D

13.2.4 Waste soil sample vials - Waste Stream A

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

14.0 References / Cross-References

14.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

14.2 Method 8330, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 0, September 1994.

14.3 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

14.4 Method 8330A, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 1, January 1998.

14.5 Method 8330B, Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography, Revision 2, October 2006.

15.0 Method Modifications:

15.1 Method 8330 prescribes the shelf life for standards as follows:

Standards	Concentration	Shelf Life
Stock standards	1,000,000 µg/L (1,000 ppm)	One year
Intermediate standards	2.5 to 1,000 µg/L	Thirty days
Working standards	1 to 500 µg/L	Daily

This SOP assigns a six-month shelf life to the working level standard based on TestAmerica's experience with these materials. The standards are stored in a freezer.

15.2 This SOP describes air drying soil samples until the sample is dry enough to pass through a sieve. One source method (SW 8330B) describes air drying to a "constant weight." If this issue is a concern for a client's project needs, the laboratory may be able to perform a separate % moisture determination for the client at 105 degrees C. However, sample results are calculated using the air dried sample as described in this procedure.

16.0 Attachments

Table 1. Analyte List

Table 2. Grinding LCS Bulk Material

Appendix 1 Flowchart for Drying Explosive Soils

Appendix 2 Flowchart for Grinding and Sieving Soils

Appendix 3 Instructions for Batching in TALS

Appendix 4 ISM Worksheet

17.0 Revision History

- Revision 6, dated 31 January 2015
  - Annual Technical Review
  - Reformatted SOP.
  - Revised Section 3.7 and Section 9.2 to state that a Ball Mill grinding batch is opened and closed the same day, while a Ring and Puck grinding batch can be open for up to 3 days.
  - Revised Section 5.2.2 to give information on the hazards of the Humbolt grinder.
  - Revised Section 9.9.1 to give more detail on how the Ring and Puck composite grinding blanks are created.
  - Revised Section 10.3.2 and Appendix 1 to state that any sample logged with an ISM method must have the entire sample container dried.
  - Revised Section 10.10 to include maintenance on the centrifuge.
- Revision 5, dated 27 January 2014
  - Annual Technical Review
  - Removed Section 1.2.3, DV-LC-0028 no longer performed.
  - Added detail about sieve size to Section 1.3.2.
  - Edited Section 6.1, subsection "Ball Mill" to allow for un-baked sand to be used in the cleaning of the ball mill stones and to allow the use of 1 pint cans. The section was also revised to change the minimum time the stones have to be tumbled during the cleaning process from 3 hours to 2 hours. This was done based on analyst's experience.
  - Edited Section 6.1, subsection "Sieves" to state a brillo pad can be used on the sieves so long as the mesh is not damaged.
  - Updated Section 9.1 to reflect current practice, added a comment stating that this procedure meets DoD QSM 5.0 criteria unless otherwise stated.
  - Removed Acceptance Criteria and Corrective Action information to Section 9. This information can be found in the analytical SOPs.
  - Revised Section 9.5 to state that if there is no volume for a MS/MSD, a LCSD must be performed.
  - Added information to Section 9.8 for DoD acceptance criteria for triplicates.

- Updated sections 10.1, 10.2 and 11.2 to reflect current practice
- Added a NOTE in Sections 10.5.2.1 and 10.5.3.6 giving instructions on how to ensure the sample is homogenous after it has been split into separate grinding containers and then later re-combined.
- Added Section 10.5.3.6 giving guidance on what to do if the sample reaches a flour-like consistency before all 5 grinds have been completed. This was done to avoid over-heating samples and packing the sample against the grinding dish wall.
- Added Section 10.10 Maintenance and Section 10.11 Troubleshooting per DoD QSM 5.0.
- Updated Appendix 2 and Appendix 3 to reflect the current method names used in LIMS.
- Formatting changes throughout

- Revision 4, dated 30 October 2012
  - Annual Technical Review
  - Section 4.6 was added to document the adverse affect headspace in the ball mill can has on the grinding LCS.
  - Section 6.1 and Section 10 were revised to include the description of the Spacer Can in the Ball Mill apparatus.
  - Section 6.1 and Section 10 were revised to include the Mechanical Grinder used as an alternative to mortar and pestle.
  - Section 9.6 was revised to state that LCSDs are not required for DoD or AFCEE work.
  - Section 10 was revised to reference the Explosive Review Checklist in WI-DV-0009.
  - Section 10.3.2 was revised to instruct the analyst to eliminate as much headspace as possible during the Ball Mill grinding step.
  - Appendix 3 was revised to give more detail on the steps taken to ensure all pre-ground ISM aliquots are taken before the sample is ground. It was also revised to include the use of the Explosive Extraction Checklist in WI-DV-0009.
- Revision 3, dated 10 October 2011
  - The procedure was revised to have the extraction performed by shaker table instead of cooled sonication bath. This was done to increase lab capacity and to create a more rugged extraction.
  - Section 5 was revised to include the requirement that analysts wear cut-resistant gloves when tightening vial caps.
  - Section 7.2 was revised to include the lot approval process for acetonitrile.
  - Sections 7.5 and 9.3 were revised to mandate a 3 day expiration date on the Grinding LCS after it has been ground.
  - Section 9.8 and 9.9 were revised to require a duplicate and triplicate whenever method 8330B is performed, not just when samples are ground.
  - Section 10.2.2 and 10.2.3 were revised to have the analyst use the prep method instead of the pre-prep method to determine sieve size. This is a simpler determination and matches the flow chart in Appendix 2.
  - Section 10.7.3 was revised to change the speed of the centrifuge to prevent the breakage of the extract vials.
- Revision 2, dated 11 January 2011
  - Details about the surrogate and spike standards used in this procedure have been moved to SOP DV-OP-0020.
  - Revised Section 9 to state that duplicates and triplicates are required when ring and puck or ball mill grinding is performed.

- Revised the procedure to include instructions and details for the laboratory's new LIMS.
- Revised Section 4 to give more details on the grinding of samples.
- The procedure was revised to state that samples should be ground on the ball mill for only 8 hours. At that time, the samples should be inspected and only ground longer if required.
- Added detail in Section 10.1 about the electronic temperature monitoring device that records the temperature of the drying room.
- Revised the flowcharts to be flowcharts only and not worksheets. All data is now recorded in TALs benchsheets.
- Added instructions in Appendix 3 on how to batch samples in TALSs
- Added the option to use an automatic sieve shaker.

- Revision 1, dated 14 August 2009
  - This SOP was revised to include the addition of a Grinding LCS whenever samples are ground through the ring and puck or mall mill grinder. This was done to meet the requirements of method 8330B.
  - Section 9.6 "Initial Performance Studies" was revised to more clearly describe the laboratories procedures for MDLs and IDOCs.
  - Section 9.8 "Method Blank" was revised to correct the acceptance criteria for method blanks for DoD samples.
  - Section 9.9 "Laboratory Control Sample" was revised to give more details about marginal exceedances.
  - This SOP was revised to give additional requirements on sealing the ball mill cans. Duct tape will be used to ensure the lids are secure. Lids that have been opened will be inspected before being re-sealed. Damaged lids will be discarded.
  - Section 5 was revised to give warning about the hazards of grinding potential radioactive samples. Any CAT1 or higher sample cannot be ground without RSO approval.

- Revision 0, dated 06 March 2009
  - This SOP was written to consolidate procedures that used to be documented in several different SOPs. This was done to ensure the analysts had a clear and easy-to-follow procedure at the bench.

Table 1. Analyte List

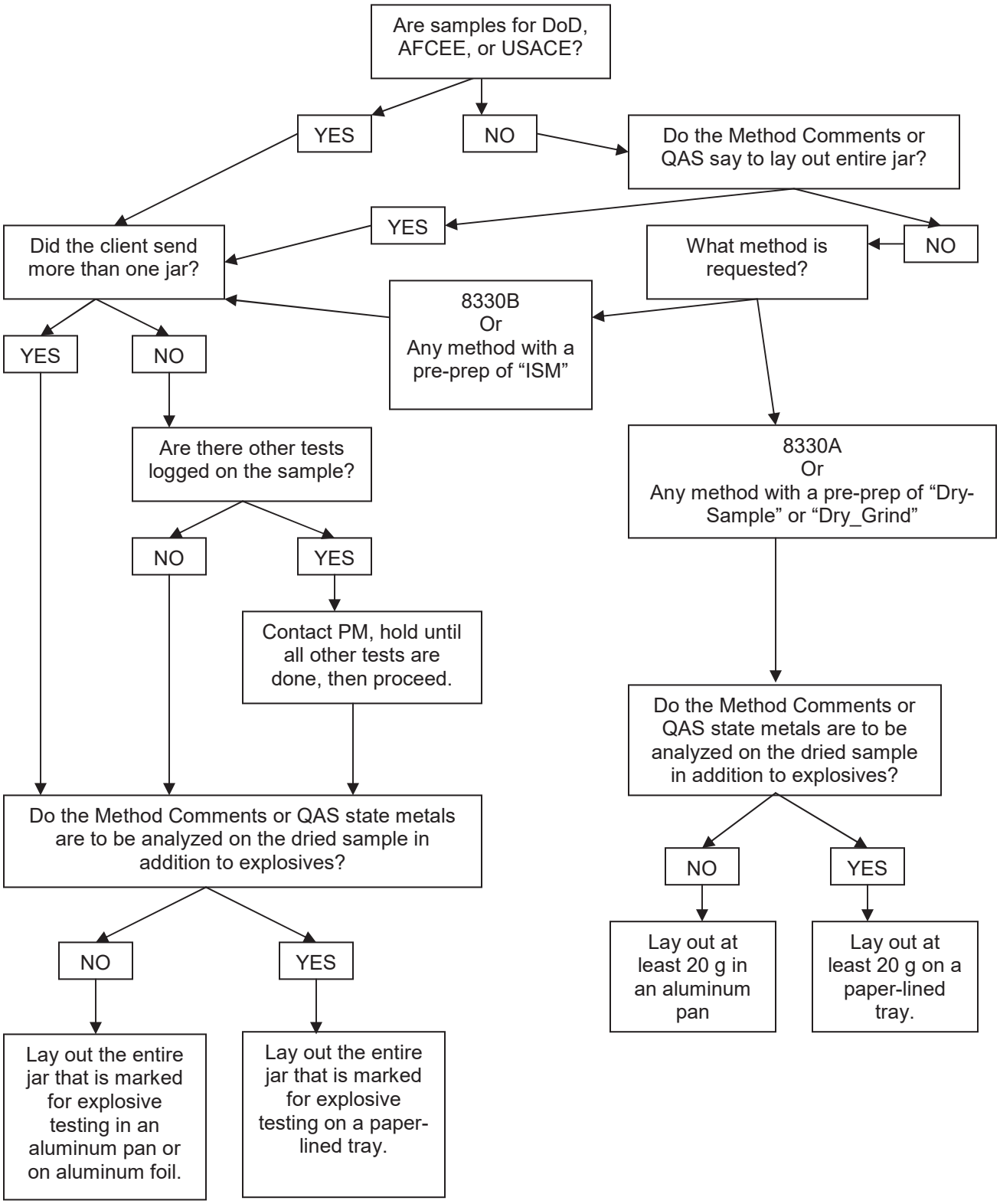
Compound	CAS #	Symbol
Octahydro-1,3,5,7-tetranitro-1,3,5,7,-tetrazocine	2691-41-0	HMX
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4	RDX
1,3,5-Trinitrobenzene	99-35-4	1,3,5-TNB
1,3-Dinitrobenzene	99-65-0	1,3-DNB
Methyl-2,4,6-trinitrophenyl nitramine	479-45-8	Tetryl
Nitrobenzene	98-95-3	NB
2,4,6-Trinitrobenzene	118-96-7	2,4,6-TNT
4-Amino-2,6-dinitrotoluene	19406-51-0	4-Am-DNT
2-Amino-4,6-dinitrotoluene	35572-78-2	2-Am-DNT
2,6-Dinitrotoluene	606-20-2	2,6-DNT
2,4-Dinitrotoluene	121-14-2	2,4-DNT
2-Nitrotoluene	88-72-2	2-NT
4-Nitrotoluene	99-99-0	4-NT
3-Nitrotoluene	99-08-1	3-NT
Nitroglycerin	55-63-0	NG
PETN	78-11-5	PETN
2,4-Diamino-6-nitrotoluene**	6629-29-4	--
2,6-Diamino-4-nitrotoluene**	59229-75-3	--
Picric Acid	88-89-1	PA
1-Nitroso-3,5-dinitro-hexahydro-1,3,5-triazine**	5755-27-1	MNX
3,5-Dinitroaniline**	618-87-1	3,5-DNA
1,2-Dinitrobenzene (8330 surrogate)	528-29-0	1,2-DNB
Nitrobenzene-d5 (8321 surrogate)	--	NB-d5

** Compounds are only analyzed and spiked upon request.

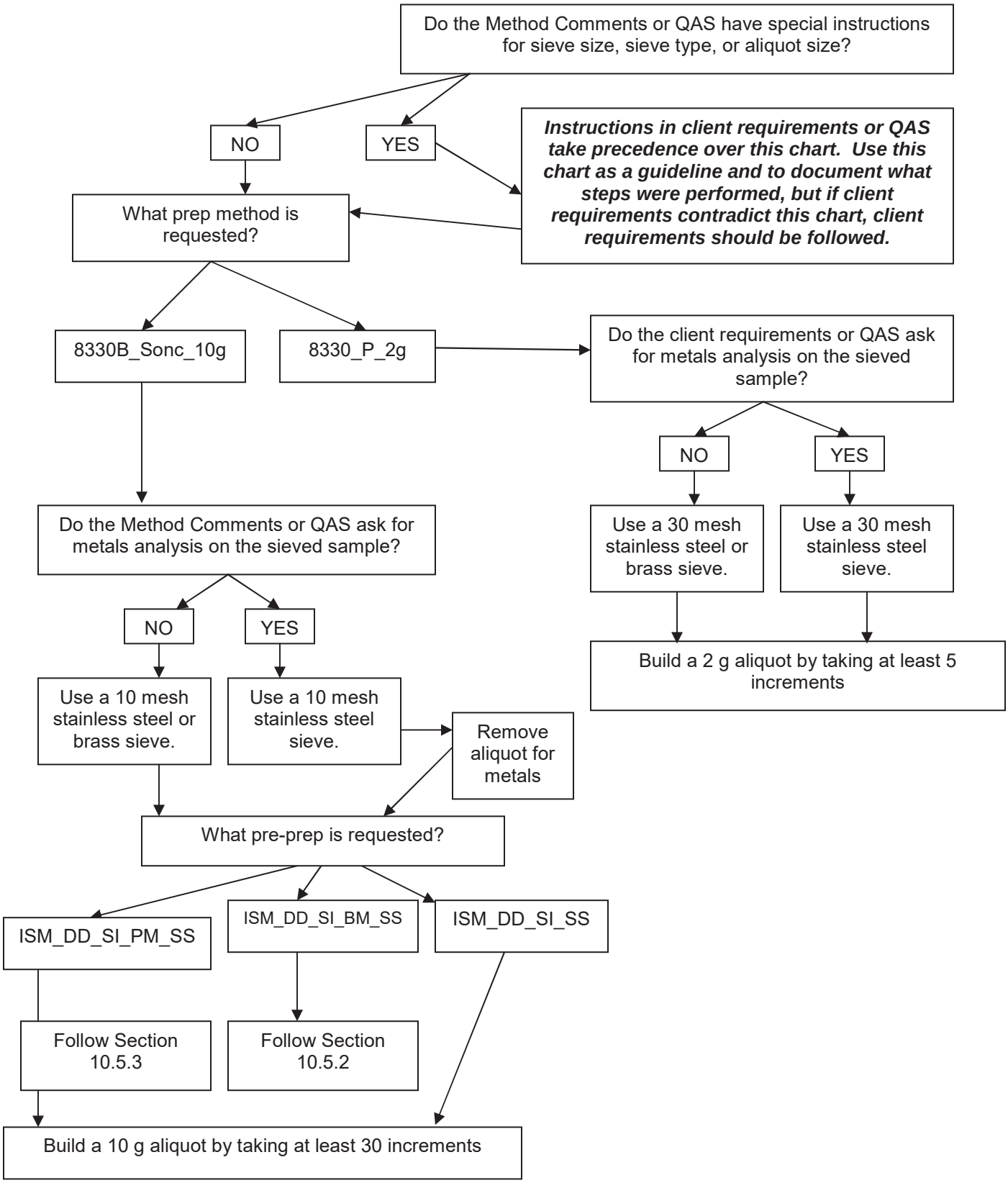
Table 2. Grinding LCS Bulk Material

Compound	Concentration (µg/Kg)
4-Amino-2,6-dinitrotoluene	600
2-Amino-4,6-dinitrotoluene	600
1,3-Dinitrobenzene	600
2,4-Dinitrotoluene	600
2,6-Dinitrotoluene	600
HMX (Octahydro-1,3,5,7-TNTC)	600
1,3,5-Trinitrobenzene	600
Nitrobenzene	600
2-Nitrotoluene	600
3-Nitrotoluene	600
4-Nitrotoluene	600
RDX (Hexahydro-1,3,5-TNTriaz)	600
Tetryl (Methyl-2,4,6-TNPN)	600
Nitroglycerin (Trinitroglycerin)	600
Pentaerythritol tetranitrate (PETN)	600
2,4,6-Trinitrotoluene	600

Appendix 1 – Flowchart and Worksheet for Drying Explosive Soils



Appendix 2 – Flowchart and Worksheet for Grinding and Sieving Explosive Soils



Appendix 3

How to Batch:

ISM_DD_SI_BM_SS (Dry, Disaggregate, Sieve, Ball Mill, Subsample)
ISM_DD_SI_PM_SS (Dry, Disaggregate, Sieve, Ring & Puck, Subsample)
ISM_DD_SI_SS (Dry, Disaggreage, Sieve, Subsample)
Dry_Sample (Dry, Sieve, 2g prep)
Dry_Grind (Dry, Sieve, 2g Prep)

Overview
These five pre-prep methods can be logged in for not just for samples for explosives by 8330A or 8330B and 8321A or 8321B, but also for samples for metals analysis, or perchlorate, or any other method where the client is asking the lab to dry, sieve, and possibly grind the sample before extraction or digestion.

If one sample is logged in for 8330B and 6010B and 6020B and 7471A and all of these methods have the pre-prep of ISM_DD_SI_SS, the sample will show up on the backlog 4 times, (once for each analytical method). This would happen if the client wants us to dry, sieve, and perform ISM for each of these methods.

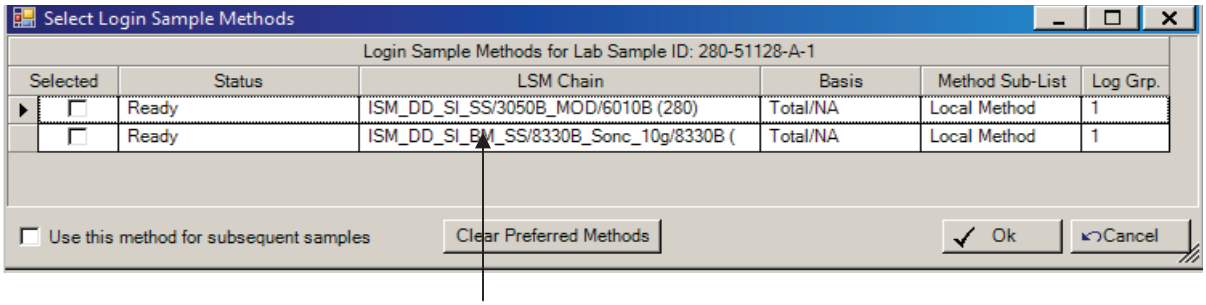
If one sample is logged in for 8330B with a pre-prep of ISM_DD_SI_PM_SS and the same sample is logged in for method 6010B with a pre-prep of ISM_DD_SI_SS, that means that the client wants us to dry, sieve the sample, perform ISM for method 6010B, then ring and puck and perform ISM for 8330B.

We will use a different status to indicate where the samples are.

- A status of “Batched” means the samples have been laid out to dry.
- A status of “Scheduled” on ISM_DD_SI_BM_SS or ISM_DD_SI_PM_SS means the samples have been laid out to dry, but possibly need ISM performed before grinding.
- A status of “Partial” means the samples have been sieved.
- A status of “2nd Level Review” on methods ISM_DD_SI_SS, Dry_Sample, or Dry_Grind means that the aliquots have been taken and someone has checked your work.
- A status of “2nd Level Review” on ISM_DD_SI_BM_SS or ISM_DD_SI_PM_SS means samples have completed the grinding.

Steps for Samples logged for <u>both</u> ISM_DD_SI_SS <u>and</u> Ring & Puck or Ball Mill

1. Run the Dry/Sieve/Grind/ISM backlog. This backlog will only have samples that are logged in for these five pre-preps. This backlog is sorted by sample ID so that if a sample is logged in for ISM_DD_SI_SS for metals and ISM_DD_SI_BM_SS for explosives, you can easily see that the sample needs both preps.
2. Batch the samples under the ISM_DD_SI_SS method.
   NOTE: Do not put samples in the same batch that require different sieve sizes.
3. Scan your samples into the batch. A window will appear called “Select Login Sample Methods”.



4. Select only the methods that have ISM_DD_SI_SS as the pre-prep.
    a. You can only batch ISM samples under a ISM_DD_SI_SS batch.
    b. You can only batch ring and puck samples under a ISM_DD_SI_PM_SS batch.
    c. You can only batch ball mill samples under a ISM_DD_SI_BM_SS batch.
    d. You can batch “Dry_Grind” and “Dry Sample” samples under the same batch.
5. Save the batch and print the benchsheet.
6. Print labels. Print one label for each method logged on each sample. Write on the label the analytical method.
7. Lay out the samples to dry. Place all of the labels on the sample tray for the sample. Also label the tray “Grinding Needed” if the sample is logged for Ball Mill or Ring and Puck.
8. Set the Ball Mill or Ring and Puck Methods to “Scheduled” in the backlog. Do not batch them at this time.
9. Sieve the samples and take the required ISM aliquots. Whenever possible, aliquot the samples directly in the digestion cup for metals, or microwave tube or beaker for organics and record the aliquot masses in the ISM worksheet in Appendix 4. Place the ISM aliquots on the tray with the sample so a 2nd analyst can perform a label check. Document these steps on the TALS batch sheet
10. The Notes field in the Worksheets tab can be used to document if there was rocks or vegetation that did not go thru the sieve. Write NCMs for any samples that contained rocks or vegetation that was removed from the sample.
11. In the Worksheet tab, you can record the weight of the sample before and after drying and the weight of the sample that went through the sieve and the weight of the sample that did not go through the sieve. These measurements are not normally required, so they only need to be performed if client requested.
12. Have a 2nd analyst review the ISM_DD_SI_SS batch to ensure all required ISM aliquots have been performed. Take the ISM_DD_SI_SS batch to 2nd level review.
13. Now the samples are ready to be ground by Ball Mill or Ring and Puck.
14. As the samples are ground, add them to the ISM_DD_SI_BM_SS or ISM_DD_SI_PM_SS batch.
15. As you add samples to the grinding batch, watch the LSM window to ensure that all ISM_DD_SI_SS methods are at 2nd level review. If there are ISM_DD_SI_SS methods that are not at 2nd level review, perform ISM on the sample for the requested methods before grinding the sample.
16. Take the samples to 2nd level review.
17. Return all empty containers to the walk-in refrigerator using ICOC. Any left-over dried and ground material is stored in the walk-in refrigerator on the same shelf as the original client containers.

Steps for Samples logged for Ring & Puck or Ball Mill only. No ISM_DD_SI_SS methods logged.

1. Run the Dry/Sieve/Grind/ISM backlog. This backlog will only have samples that are logged in for these five pre-preps. This backlog is sorted by sample ID so that if a sample is logged in for ISM_DD_SI_SS for metals and ISM_DD_SI_BM_SS for explosives, you can easily see that the sample needs both preps.
2. Pull the samples from the walk-in cooler and take custody of the samples. Take note of what shelf the sample came from.
3. Batch the samples and print out labels. Then remove the samples from the batch to place them back on the backlog.
4. Lay the samples out on parchment or foil. Label each tray with the sample ID and the grinding method (Ball Mill or Ring & Puck)
5. Document the date and time the samples were laid out to dry. Document if the samples were laid out on parchment or foil. Document that a label check was performed.
6. Set the samples to Scheduled in the backlog to show that they are laid out to dry.
7. Once the samples are dry enough to sieve, sieve the samples and document what sieve size on the Explosive Review Checklist.
8. Open the batch with a grinding LCS. As the samples are ground, add them back to the original ISM_DD_SI_BM_SS or ISM_DD_SI_PM_SS batch. There can only be 20 field samples in each batch,. Ring and puck batches can be open for up to 3 days. Ball Mill batches can only be open for one day.
9. As you add samples to the grinding batch, watch the LSM window to ensure that the samples do NOT require any non-ground aliquots.
10. Take the samples to 2nd level review.
11. Return all empty containers to the walk-in refrigerator using ICOC. Any left-over dried and ground material is stored in the walk-in refrigerator on the same shelf as the original client containers.

Steps for Samples logged for only ISM_DD_SI_SS, Dry_Grind, or Dry_Sample. No grinding methods logged.

1. Run the Dry/Sieve/Grind/ISM backlog. This backlog will only have samples that are logged in for these five pre-preps. This backlog is sorted by sample ID so that if a sample is logged in for ISM_DD_SI_SS for metals and ISM_DD_SI_PM_SS for explosives, you can easily see that the sample needs both preps.
2. Batch the samples under the pre-prep method logged. Do not put samples in the same batch that are logged for different pre-prep methods. Do not put samples in the same batch that require different sieve sizes.
3. Scan your samples into the batch. If your samples are logged in for more than one of these three methods, a window will appear called “Select Login Sample Methods”.
4. Select only the methods that have ISM_DD_SI_SS as the pre-prep.
   a. You can only batch ISM samples under a ISM_DD_SI_SS batch.
   b. You can batch “Dry_Grind” and “Dry Sample” samples under the same batch.

   If the LSM window shows methods with pre-preps of ISM_DD_SI_PM_SS or ISM_DD_SI_BM_SS, then stop and follow the instructions above under the header “Steps for Samples logged for both ISM_DD_SI_PM_SS and Ring & Puck or Ball Mill”.
5. Save the batch and print the benchsheet.
6. Print labels. Print one label for each method logged on each sample. Write on the label the analytical method.
7. Lay out the samples to dry. Place all of the labels on the sample tray for the sample.
8. Sieve the samples and take the required aliquots. Whenever possible, aliquot the samples directly in the digestion cup for metals, or microwave tube or beaker for organics and record the

aliquot masses in the ISM worksheet in Appendix 4. Place the aliquots on the tray with the sample so a 2nd analyst can perform a label check.

9. The Notes field in the Worksheets tab can be used to document if there was rocks or vegetation that did not go thru the sieve. Write NCMs for any samples that contained rocks or vegetation that was removed from the sample.
10. In the Worksheet tab, you can record the weight of the sample before and after drying and the weight of the sample that went through the sieve and the weight of the sample that did not go through the sieve. These measurements are not normally required, so they only need to be performed if client requested.
11. Have a 2nd analyst review the batch to ensure all required aliquots have been performed. Take the batch to 2nd level review.
12. Return all empty containers to the walk-in refrigerator using ICOC. Any left-over dried and ground material is stored in the walk-in refrigerator on the same shelf as the original client containers.

Appendix 4

ISM Worksheet

G:/QA/Edit/FORMS/Organic Prep Forms/MASTER ISM Spreadsheet_Rev1

ISM BATCH:

Use this spreadsheet to document alquot weights when aliquotting into digestion or extraction vessels. If aliquoting into a temporary vessel, no need to document the exact weight because the sample aliquot will be transferred and weighed at the time of analysis.

Login	Sample	Method -->											
			(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)
		ALIQUOT 1											
		ALIQUOT 2											
		ALIQUOT 1											
		ALIQUOT 2											
		ALIQUOT 1											
		ALIQUOT 2											
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Title: Soil and Waste pH [SW9045C & SW9045D]

Approvals (Signature/Date):

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1.0 Scope and Application

1.1 This is an electrometric procedure for measuring pH in solid samples. This method is applicable to the analysis of soils, sediments, sludges, or non-aqueous liquids. It does not apply to multiphase wastes where the aqueous phase constitutes more than 20% of the sample. See DV-WC-0031 for the determination of pH in multiphase wastes

1.2 A detection limit (MDL) for pH has not been defined, however, for reporting purposes this laboratory uses 0.1 pH units as the RL and MDL.

1.3 This method is applicable to all ranges of pH.

2.0 Summary of Method

The sample is mixed with reagent water. The pH meter, glass electrode, and reference electrode (or single combination electrode) are standardized against five reference buffer solutions of known pH bracketing the pH expected to be found in the sample. The sample measurement is made by immersing the electrodes into the sample solution and taking a reading from the meter.

3.0 Definitions

3.1 **pH** - At a given temperature, the intensity of the acidic or basic character of a solution is indicated by pH or hydrogen ion activity. Because of ionic interactions in all but very dilute solutions, it is necessary to use the “activity” of an ion and not its molar concentration. The use of the term pH assumes that the activity of the hydrogen ion is being considered. The approximate *equivalence* to molarity can be presumed only in very dilute solutions. A logarithmic scale is used to accommodate the wide range of ionic activities.

3.2 Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, “Quality Assurance Program,” for definitions of general analytical and QA/QC terms.

4.0 Interferences

4.1 The pH response of most glass electrodes is imperfect at both ends of the scale. The indicated pH value of highly alkaline solutions, as measured with the glass electrode, will be too low. The indicated pH value of salts and strong acids, which have a pH less than 1, will often be higher than the true pH value. Interferences can be minimized by the selection of the proper electrodes for these conditions. For example, sodium may interfere at pH > 10, and is controlled by using a “low sodium error” electrode.

4.2 Temperature fluctuations will cause measurement errors.

4.3 Coatings of oil and particulate matter may impair electrode response.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

Eye protection that satisfies ANSI Z87.1 (as per the Corporate Environmental Health and Safety Manual), laboratory coat, and nitrile or latex gloves must be worn while samples, standards, solvents, and reagents are being handled. Disposable gloves that have been contaminated will be removed and discarded; other gloves will be cleaned immediately.

5.4 Primary Materials Used

There are no materials used in this method that have a serious or significant hazard rating. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 pH Meter with temperature compensation ability.

6.1.2 Glass electrode with reference electrode--a calomel, silver-silver chloride or other reference electrode of constant potential may be used; or use a combination electrode that incorporates both measuring and reference functions.

6.1.3 Analytical balance capable of weighing to the nearest 0.1 gram. The balance is checked for accuracy each day it is used in accordance with DV-QA-0014.

6.1.4 Shaker table.

6.2 Supplies

6.2.1 50 dram vials with snap cap or a container large enough to hold sample and cover electrodes.

6.2.2 Glass wool, if oily wastes are to be tested.

6.2.3 50 mL graduated cylinder

6.3 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 Reagent water: ASTM Type II water or equivalent.

7.3 pH Buffers: 2, 4, 7, 10 and 12: Use commercially available solutions that have been validated by comparison to NIST standards. The solution aliquots used to calibrate the pH meter must be replenished each day of use.

7.4 ICV Buffer Solution: A pH 7 buffer solution from a second source provider, obtained commercially and traceable to NIST standards. The ICV solution aliquot used must be replenished each day of use.

7.5 Laboratory Control Sample (LCS) Solution: The LCS solution must be certified for pH and is commercially available. The pH 7 buffer from section 7.2 is normally used as the LCS. Due to the nature of pH determination, a solid matrix is not used.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time [1]	Reference
Solid	4 oz Glass or plastic	50 g	Cool, $\leq 6\,^{o}C$	None	SW-846

[1] Samples must be analyzed the same day that the extraction is performed.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For

SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Control Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs. This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated. Any deviation or exceptions from QSM 5.0 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 **Sample QC** - The following quality control samples are prepared with each batch of samples.

9.2.1 **Laboratory Control Sample (LCS/LCSD**)

One LCS/LCSD is required with each batch of samples processed not to exceed 20 samples. See Section 7.5.

Acceptance Criteria: The LCS must be within ± 0.05 pH units of the true value.

Corrective Action: If the LCS is not within the control limits, rerun all associated samples.

9.2.2 **Duplicate Samples**

One duplicate sample must be analyzed with each batch of samples processed not to exceed 20 samples.

Acceptance Criteria: The two results should agree within ± 0.10 pH units.

Corrective Action: If the difference is greater than ± 0.10 repeat the analysis. If the difference still exceeds the control limit the data will be flagged as outside of the limit.

9.2.3 Method blanks and matrix spikes are not applicable to pH.

9.3 Instrument QC

9.3.1 Initial Calibration Verification

Record the expected pH, manufacturer, and lot number of the verification buffer used for a second source pH 7.0 buffer solution. If this criterion is not met, the problem should be identified, corrected, and the meter recalibrated.

Acceptance Criteria: It should read within ± 0.05 pH units of the true value.

Corrective Action: If this criterion is not met, the problem should be identified, corrected, and the meter recalibrated.

9.3.2 Continuing Calibration Verification

A pH 7.0 buffer check is required after every 10 or fewer samples and at the end of the run.

Acceptance Criteria: The pH buffer checks must be within ± 0.05 units of the true value.

Corrective Action: If the pH 7.0 buffer check is outside of the control limits, rerun all samples since the last acceptable pH 7.0 buffer check.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective described.

10.3 Sample Preparation

10.3.1 Weigh a minimum of 40 g sample into a beaker, add 40 mL deionized water using a graduated cylinder and cap the vial. A sample which is not a soil

but another material may possibly react violently on the addition of water. In such cases, add the water to the solid in a hood. If the sample shows any signs of heat or gas evolution, do not cap the vial as pressure may build up

10.3.1.1 If the samples are oily, filter through glass wool to remove oil. Retain the aqueous phase for analysis.

10.3.1.2 If the sample is hygroscopic and absorbs all the deionized water, add an additional 20 mL of DI water to the extraction vessel and mix to incorporate. Note the increased water volume on the benchsheet.

10.3.1.3 If the sample is a waste and additional water is needed, add an additional 40 mL of water.

10.3.2 Mix on shaker table for the next 5 minutes.

10.3.3 Let the sample settle undisturbed for a minimum of one hour.

10.4 Sample Analysis

10.4.1 Follow the operating instructions supplied by the manufacturer of the pH meter.

10.4.2 Record instrument ID, pH probe ID, thermometer probe ID, and reagent IDs in the batch record in TALS.

10.4.3 When using the Thermo Five Star pH meter, all results are to be temperature corrected to 25oC using the Automatic Temperature Compensation function available with the instrument.

NOTE: Methods 9045C and 9045D state: “The sample temperatures must be within ± 2 °C of the calibrated buffers or temperature corrected.” All samples are automatically corrected for temperature by the instrument.

10.4.4 Calibrate the pH meter using five buffers at pH 2.0, 4.0, 7.0, 10.0 and 12.0. The buffers should be fresh for each day of use.

10.4.4.1 Record the pH, pH result, manufacturer, and lot number of the buffers used. See Attachment 1.

10.4.4.2 The reading of the buffer solutions must be within ± 0.05 pH units of the certified buffer solution values. If they are not, recalibrate.

10.4.4.3 Record the slope in the instrument logbook. The source methods do not provide criteria for acceptance of the slope. If there is a significant variation from previous values, maintenance may be required.

10.4.5 Verify the calibration using a buffer solution (ICV). See Sections 7.4 and 9.3.1.

10.4.5.1 Record the pH, manufacturer, and lot number of the verification buffer used.

10.4.5.2 The reading of the buffer solution should be within ± 0.05 pH units of the true value. If this criterion is not met, the problem should be identified, corrected, and the meter recalibrated.

10.5 Sample Analysis

10.5.1 Samples must be analyzed on the day they are prepared.

10.5.2 Analyze one LCS and one sample duplicate per batch of 20 samples.

10.5.3 Insert the electrode into the aqueous layer just far enough to cover the electrode bulb and junction. Do not allow the electrode to come into direct contact with oil.

10.5.4 Allow the reading to stabilize.

10.5.5 The pH reading, temperature, and time are recorded in the LIMS.

NOTE: Methods 9045C and 9045D require the sample temperature to be reported with each pH result. All sample temperatures are recorded on the instrument raw data. The LIMS reports the pH as pH adj. to 25°C to account for the temperature correction performed by the instrument.

10.5.6 Rinse the electrodes well between measurements.

10.5.7 A pH 7.0 buffer check (CCV) is required after every 10 or fewer samples (excluding the LCS/LCSD) and at the end of the run. See Section 9.3.2.

10.5.8 Record the balance ID, pH meter ID, the pH probe ID and the pH thermometer ID in the batch record.

10.5.9 Follow the instructions supplied with the electrodes for storage after use. Record daily maintenance in the pH Calibration and Maintenance Log. See Attachment 1.

10.6 Troubleshooting

10.6.1 Slow response or a wavering response is indicative of a dirty or oil-coated pH probe or that the probe is not properly connected to the meter. Samples high in dissolved CO_2 can cause the pH to change as the sample is stirred.

10.6.2 No temperature displayed may be a result of the temperature probe not being properly connected to the meter.

10.6.3 Using plastic disposable beakers and a magnetic stir plate and stir bar may generate static electricity that could affect stability. Turn off the stir plate, unplug and allow to sit for a few minutes.

10.7 Maintenance

Clean the electrode as needed following manufacturer's instructions.

11.0 Calculations / Data Reduction

11.1 There are no calculations. This is a direct reading method. Data are manually entered in TALS at time of measurement.

11.2 The initial data review is performed by the analyst and a second-level review is performed by the area supervisor or designee. Both reviews are documented on a Data Review Checklist. See SOP DV-QA-0020 for a copy of the checklist and for more detail on the review process.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

There is no MDL study for pH

12.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows"

12.2.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration. The pH 7 Buffer solution (Section 7.5) is typically used.

12.2.2 The pH of each aliquot must be within 0.05 units of the true value.

12.2.3 If the analyte does not meet the acceptance criteria, the test must be repeated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.2.4 Further details concerning demonstrations of proficiency are described in DV-QA-0024.

12.3 Training Requirements

The group leader has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use, has the required experience, and has successfully analyzed initial demonstration samples (see SOP DV-QA-0024 for details).

13.0 Pollution Control

13.1 It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability).

13.2 This method does not contain any specific modifications that serve to prevent or minimize pollution.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention", of the Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

14.2 The following waste streams are produce when this method is carried out:

14.2.1 Acidic sample waste generated by the analysis – Aqueous Acidic (F).

14.2.2 Alkaline sample waste generated by the analysis – Aqueous Alkaline (E).

14.2.3 Exhausted soil samples utilized in the analysis – Soils (S)

14.2.4 Exhausted acidic and/or alkaline buffer solutions utilized in the analysis and expired standards and reagents – Contact the Waste Coordinator for guidance.

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

15.1.1 Method 9045D, "Soil and Waste pH", Revision 4, November 2004.

15.1.2 Method 9045C, "Soil and Waste pH", SW-846, Revision 3, 1995.

15.2 "Soil pH (Hydrogen Ion Activity)", Methods of Soil Analysis, Second Edition, American Society of Agronomy, 1982.

16.0 Method Modifications

Item	Method	Modification
1	9045C/9045D	Temperature is not reported with the pH result. Sample pH is reported as pH adj. to 25°C.
2	9045C/9045D	Sample size used in this SOP is 40 g solid sample to 40 mL reagent water. This is the same proportion, though larger, than that stated in the source methods. The larger sample size helps ensure a more representative result. The source methods further state that additional dilutions may be made if the sample is hygroscopic. Additional water is added to the sample rather than starting with a new sample aliquot.
3	9045C/9045D	The source method has conflicting statements regarding use of additional dilutions for waste and starting with new aliquot and added double the volume of water. The laboratory adds additional reagent water starting with sample to water ratio of 1:3 rather than 1:2.

17.0 Attachments

Attachment 1: Example pH Calibration and Maintenance Log
Attachment 2: Example Benchsheet

18.0 Revision History

- Revision 11, dated 13 October 2015
  - Updated Section 1.2 to reflect pH RL and MDL used by the laboratory
  - Updated Section 7.4 to include a comment regarding daily replenishment
  - Updated Section 9.1 to be consistent verbiage across SOPs as applicable
  - Added requirement 10 section 10.4.4.1 to record pH result of calibration
  - Updated Attachment 1 to reflect current pH logbook

- Revision 10, dated 31 January 2015
  - Moved Sections 10.5.2 and 10.5.3 to 10.4.2 and 10.4.3
  - Added Section 10.4.4.3 to require recording of slope to meet ORELAP requirement
  - Updated Attachment 1

- Revision 9, dated 31 July 2014
  - Revised Section 6 to reflect current practice
  - Revised Section 10.3 to add additional water when sample is hygroscopic rather than starting with new sample aliquot and to record the volume of water added.
  - Removed reference to recording slope from the calibration in Section 10.4.1.1. The source method does not address this and there is no established acceptance limit for the slope. Revised Attachment 1 to reflect change in documentation requirements.
  - Added Sections 10.6 and 10.7, Troubleshooting and Maintenance, respectively.
  - Revised Section 12.2 to reflect use of pH 7 Buffer solution as QC sample.
  - Expanded Method Modification #2 with more detail and added Method Modification #3.
  - Source method review.

- Revision 8, dated 31 July 2013
  - Added section 3.2
  - Added section 10.5.9
  - Revised section 11.1 to note data are manually entered
  - Annual Review

- Revision 7, dated 27 July 2012
  - Removed HCl and cleaning procedure for probe.
  - Revised Section 5 based on removal of HCl.
  - Replaced magnetic stirrer with shaker table and removed magnetic stirrers in Section 6.
  - Updated Section 7 to include reagent water and second source ICV buffer at pH 7.0.
  - Revised Section 8
  - Revised Section 9.1, 10.1, 10.2 to reflect current practice
  - Revised calibration procedure (Section 10.4)
  - Moved procedural note for cleaning electrode in Section 4 to Section 10.5.3
  - Removed Attachment 2 and added statement about data review with reference to removed checklist. (Section 11.2)
  - Source method review
  - Formatting and editorial changes throughout

- Revision 6.5 dated 31 January 2012
  - Annual Technical review
  - Updated Section 9.1.1 to read LCS/LCSD

- Revision 6.4 dated 11 February 2011
  - Annual Technical review
  - Updated Attachments 1 & 2

Earlier revision histories have been archived and are available upon request.

Attachment 1.

Example pH Calibration and Maintenance Log

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Denver

Calibration and Maintenance Log

Wet Chemistry / pH Probe

Daily Maintenance	Day	Sat	Sun	Mon	Tue	Wed	Thu	Fri
No maintenance required when instrument is not in use.	Date/Time:							
	Analyst:							
1) Inspect the probe for scratches or cracks.								
2) Probe solution refilled.								
3) Store probe in storage solution.								
4) Wipe off apparatus and clean up any spills.								
Calibration Standards:	2.0 Buffer Lot #: Expiration Date:							
	2.0 Buffer Calibration Reading							
	4.0 Buffer Lot #: Expiration Date:							
	4.0 Buffer Calibration Reading							
	7.0 Buffer Lot #: Expiration Date:							
	7.0 Buffer Calibration Reading							
	10.0 Buffer Lot #: Expiration Date:							
	10.0 Buffer Calibration Reading							
	12.0 Buffer Lot #: Expiration Date:							
	12.0 Buffer Calibration Reading							
Calibration Slope:								
Instrument Removed From Service: Y / N	Initials:	Date:	Return to Service with Passing Calibration				Initials:	Date:

Additional Maintenance/Comments:

EXAMPLE

Attachment 2.

Example Benchsheet

Batch: 51316 -- Method: 9045C -- Equipment: WC_pH Probe

#	R	CL	LabId	pH Result	pH Units	pH Final	pH Final Unit	pH F/Q	pH RDF	Temperature Result	Temperature Units	Temperature Final	Temperature Final Unit	Temperature F/Q	Temperature RDF
1	P		ICV 280-51316/1	7.03	SU	P 7.030	SU			26.1	Degrees	A 26.10	Degrees C		
2	⚠		LOW RANGE CHECK	2.01	SU					26.6	Degrees				
3	⚠		HIGH RANGE CHECK	11.96	SU					25.[illegible]	Degrees C				
4	P		LCS 280-51316/4	7.03	SU	P 7.030	SU			21.9	Degrees	A 21.90	Degrees C		
5	P		LCSD 280-51316/5	7.03	SU	P 7.030	SU			21.9	Degrees	A 21.90	Degrees C		
6	P		280-12011-A-3-A (280-575232)	2.03	SU	P 2.03	SU			26.4	Degrees	A 26.[illegible]	Degrees C		
7	P		280-12011-A-3-B DU (280-575233)	2.01	SU	P 2.010	SU			26.2	Degrees	A 26.20	Degrees C		
8	P		CCV 280-51316/8	7.03	SU	P 7.030	SU			21.9	Degrees	A 21.90	Degrees C		
9					SU						Degrees				
10					SU						Degrees				
11					SU						Degrees				
12					SU						Degrees				
13					SU						Degrees				
14					SU						Degrees				
15					SU						Degrees				
16					SU						Degrees				
17					SU						Degrees				
18					SU						Degrees				
19					SU						Degrees				
20					SU						Degrees				

Run Log | Sample Quants | Sample List | Worksheet | Reagents | Batch Results | Sample Results | Conditions Review | QC Links

Ready | Calculate | Auto-link QC: On | Auto-reject: Off

EXAMPLE

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Electronic Copy Only

Title: Percent Moisture in Soils and Wastes

[ASTM D2216, CLP ILM05.3, SW 3550C]

Approvals (Signature/Date):

Roxanne Sullivan 2/9/15	Adam W. Alban 10 Feb 15
Roxanne Sullivan — Date	Adam Alban — Date
Technical Specialist	Health & Safety Manager / Coordinator
Margaret S. Sleevi 2/10/15	2/10/15
Margaret S. Sleevi — Date	William S. Cicero — Date
Quality Assurance Manager	Laboratory Director

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1.0 Scope and Application

1.1 This standard operating procedure (SOP) provides instructions for determining percent moisture (or percent solids) in samples and is based on CLP ILM05.3, ASTM D 2216-05 and.SW-846 Method 3550C.

1.2 This method is applicable to soils and sludges. For the determination of total solids, total suspended solids, total dissolved solids, volatile solids, volatile dissolved solids, and volatile suspended solids, refer to SOP DV-WC-0064.

1.3 The practical range for the determination of percent moisture is from 0.4% to 99.6%, based on the uncertainty of the top loading balance used.

2.0 Summary of Method

2.1 The percent moisture of a solid or semi-solid sample is determined gravimetrically by weighing a 15-gram aliquot of the homogenized "wet" sample, letting the sample dry in an oven at 100 ± 5 ℃ for a minimum of 12 hours and weighing the remaining "dry" residue.

2.2 The moisture lost by the sample is calculated as the difference between the "wet" mass and the "dry" mass. Percent moisture and Percent solids are calculated relative to the original "wet" sample mass.

3.0 Definitions

3.1 Percent Moisture: The amount of water in a solid or semi-solid material that is lost as a result of drying the material in an oven at a defined temperature, typically 100 ºC, and expressed as a percent of the original sample mass. The moisture determined in this manner is not necessarily the total water content of a material. For example, drying a sample at 100 ºC will not remove waters of hydration.

3.2 Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, “Quality Assurance Program,” for definitions of general analytical and QA/QC terms.

4.0 Interferences

4.1 The principal source of error for this method is failure to obtain a representative sample. Non-representative particulates, e.g., rocks and leaves in a soil sample, should be excluded from the sample if it is determined that their inclusion is not desired in the final result.

4.2 Positive biases result from, among others, evaporative losses, loss of water of crystallization, and loss of volatile organic matter during drying.

4.3 Negative biases result from the presence of significant amounts of oil and grease, as well as the absorption of moisture after drying.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.3.2 Be careful when placing samples into and taking samples out of the drying oven (100 ºC). Wear insulated gloves or use tongs when handling hot weighing dishes.

5.4 Primary Materials Used

There are no materials used in this method that have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

6.0 Equipment and Supplies

6.1 Aluminum weigh pans, disposable.

6.2 Disposable wooden spatula.

6.3 Top-loading balance, 0.01-gram sensitivity.

6.4 Drying oven, capable of maintaining a temperature of 100 ± 5 ℃.

6.5 Insulated gloves or tongs

6.6 Desiccator.

6.7 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on

R:\QA\Read\Master List of Documents\Master List of Documents and Software and Hardware.xls (or current revision) for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 DRIERITE desiccant (anhydrous calcium sulfate). Available from commercial sources.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Samples are to be collected in a glass or plastic bottle with a tight fitting cap and refrigerated at ≤ 6℃.

8.2 There is no regulatory holding time for this parameter; however, analysis should begin as soon as possible.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.1 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 QC Samples

9.2.1 A method blank is not applicable to percent moisture determinations and is not required by the source methods.

9.2.2 Laboratory control samples are not applicable to percent moisture determinations and are not required by the source methods.

9.2.3 One sample duplicate is required with each batch of 20 or fewer samples.

Acceptance Criteria: When the moisture content of the sample is greater than 10%, the relative percent difference (RPD) between the sample and sample duplicate must be ≤ 20%.

Corrective Action: If the RPD for the duplicate samples exceeds the established limit, then the sample must be reanalyzed, if any sample is remaining. If no sample is remaining, then the data must be appropriately flagged.

9.2.4 Matrix spikes and matrix spike duplicates are not applicable to percent moisture determinations and are not required by the source methods.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Calibration

10.3.1 The top loading balance is calibrated annually by an outside vendor as described in SOP DV-QA-0014.

10.3.2 Verify the accuracy of the balance daily before use as described in SOP DV-QA-0014. Daily calibration verifications are recorded in the balance logbook.

10.4 Sample Analysis

10.4.1 Perform all weighings as quickly as possible. Wet samples lose mass through evaporation of water. Dried samples can be very hygroscopic and absorb moisture from the air.

10.4.2 Mass measurements are typically electronically captured for direct entry into the LIMS. The LIMS performs all calculations. As needed, the data

may be recorded manually on a bench sheet.

10.4.3 For each sample in the batch, label the aluminum weigh pan with the sample number. Label an additional pan for the sample duplicate.

10.4.4 Weigh each pan on the balance to determine the mass (tare weight) of the pan. Record the tare weight to the nearest 0.01 gram for each pan. Each batch to be analyzed normally has all pans collected onto a single aluminum tray.

10.4.5 Homogenize the sample by stirring and pulverize any large chunks.

10.4.6 Place a 13-17 gram representative subsample into the weigh pan. Record the "wet" sample mass as displayed by the balance.

10.4.7 Note any observations of the sample condition on the benchsheet (e.g., “rocky”).

10.4.8 Carefully place the tray of pans into the drying oven that has been pre-heated to 100 ± 5 ºC. Allow the samples to dry for at least 12 hours. Record the time the samples were placed into the oven, oven temperature when the samples were placed in the oven (observed temperature and corrected temperature) and the time they were removed to document the drying time and the temperature of the oven (observed temperature and corrected temperature). Also record the thermometer ID and balance ID. (See Attachment 1 for example entries in the Batch Editor.)

NOTE: Samples may be dried for less than 12 hours if it can be demonstrated that a constant mass is obtained. In this case, data must be recorded for a minimum of two repetitive weigh/dry/desiccate/weigh cycles with a minimum of 1-hour drying time in each cycle. Constant mass is defined as a loss in mass of no greater than 0.01 gram between the starting weight and the final weight of the last cycle.

10.4.9 At the end of the drying time, remove the tray of pans from the oven and immediately place it in a desiccator. Record the time samples are placed in the desiccator. Allow the samples to cool to room temperature (at least one hour). Record the time the samples are removed from the desicator.

NOTE: The desiccant should have blue indicator remaining. When the desiccant indicator changes to purplish-pink, the indicator must be replaced.

10.4.10 If the sample appears oily, generate an NCM to document the anomaly: "Results for sample (indicate sample number) may be inaccurate - sample appeared oily after drying."

10.4.11 Weigh the dried sample and record the mass to the nearest 0.01 gram. (See Attachment 2.)

10.5 Troubleshooting and Maintenance

10.5.1 DRIERITE in the desiccators should be changed when it turns purplish-pink.

10.5.2 If the temperature cannot be maintained within range, notify facility maintenance.

11.0 Calculations / Data Reduction

11.1 Raw data are entered into the LIMS and calculations are performed by the LIMS. The following calculations represent those performed by the LIMS and can be used to manually verify these calculations.

11.2 Calculation of Solids Fraction

The fraction of solids in the original sample is used to correct the concentration of other measured analytes in a wet sample for the dry sample weight. The fraction of solids in a sample is calculated as follows:

$$\text{solids fraction} = \frac{D - T}{W - T} \qquad \textit{Equation 1}$$

Where:

D = Gross weight (mass) of the dried sample and the weigh pan (grams).
T = Tare weight (mass) of the weigh pan (grams)
W = Gross weight (mass) of the wet sample and the weigh pan (grams).

11.3 Calculation for Percent Solids

The percent solids in a sample is calculated by multiplying the fraction of solids by 100%, as follows:

$$\%\,\text{solids} = \frac{D - T}{W - T} \times 100\% \qquad \textit{Equation 2}$$

11.4 Calculation for Percent Moisture

The LIMS uses the percent moisture value to correct reported wet-weight analyte concentrations to a dry-weight basis. The percent moisture in a sample is calculated by subtracting the percent solids from 100%, as follows:

$$\%\,\text{moisture} = 100\% - \left[\frac{D - T}{W - T} \times 100\%\right] \qquad \textit{Equation 3}$$

11.5 The relative percent difference is calculated for the sample and sample duplicate determination using the formula:

$$\% \, RPD = \frac{R_1 - R_2}{(R_1 + R_2)/2} \, x \, 100\% \qquad \textit{Equation 4}$$

Where R_1 and R_2 are the calculated % moisture results for the sample and sample duplicate.

11.6 When reporting chemical concentrations on a dry-weight basis, divide the wet weight concentration by the fraction of solids in the sample, as follows:

$$\text{Dry Weight Concentration} = \frac{\text{Wet Weight Concentration}}{\text{Solids Fraction}} \qquad \textit{Equation 5}$$

11.7 The initial data review is performed by the analyst and a second-level review is performed by the area supervisor or designee. Both reviews are documented on a Data Review Checklist. See SOP DV-QA-0020 for a copy of the checklist and for more detail on the review process.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

An initial method detection limit study is not performed for percent moisture. The lower limit of quantitation is dictated by the accuracy and sensitivity of the balance used. This test uses a top loading balance with a sensitivity of 0.01 gram. The balance must pass daily calibration verification within ± 0.02 gram for weights less than 20 grams. If the daily calibration verification control limits represent the maximum "noise" level of the balance, then three times this level, or 0.06 gram, would be a reasonable lower limit of quantitation. This translates to a practical measurement range of 0.4 to 99.6 % moisture.

12.2 Demonstration of Capabilities

12.2.1 Since a spiked aliquot is not appropriate for this procedure, initial and continuing demonstration of capability is documented by collecting data for a completed batch. An acceptable IDOC is determined by meeting any method required batch QC.

12.2.2 Further details concerning demonstrations of proficiency are described in SOP# DV-QA-0024.

12.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention," of the Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

14.2.2 Solid Sample Waste – Waste Stream S

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 USEPA Contract Laboratory Program Statement of Work for Inorganic Analytes, Multi-Media, Multi-Concentration, ILMO 5.3, March 2004, Exhibit D, Section 1.6, "Percent Solids Determination Procedure."

15.2 ASTM D 2216, "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass", ASTM International, March 1, 2005.

15.3 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," Method 3550C "Ultrasonic Extraction," Revision 3, December 1996.

16.0 Method Modifications:

Item	Method	Modification
1	ILMO5.3 ASTM D 2216 3550C	ILMO5.3 and 3550C specify a sample aliquot of 5 to 10 grams. ASTM D 2216 lists a minimum sample size of 20 grams, but allows discretion for the use of smaller aliquots. The 15-gram aliquot specified in this SOP is appropriate for the size of the weigh pan used.
2	ILMO5.3, ASTM D 2216 3550C	ILMO5.3 specifies a drying temperature of 103 to 105 ºC. ASTM D 2216 specifies a drying temperature of 110 ± 5 ºC. Method 3550C states a drying temperature of 105ºC. These temperature specifications are based on the boiling point of water at sea level, which is 100 ºC. The boiling point of water at the altitude of the laboratory location is 95 ºC. Therefore, the acceptable drying temperature range for this SOP has

Item	Method	Modification
		been set at 100 ± 5 ºC to provide results comparable to performing this method at sea level. This is justified by the discussion in ASTM D 2216, which notes that materials containing significant amounts of hydrated water (e.g., gypsum) may present a special problem as these materials can slowly dehydrate at the standard drying temperature of 110 ºC and at very low relative humidity.
3	ILMO5.3	ILMO5.3 allows a single weighing of the dried sample, but only if the sample is dried for a period of at least 12 hours and no longer than 24 hours. If the sample is dried for a period of time less than 12 hours, then it must be demonstrated that a constant weight has been achieved by repeating the drying, cooling, and weighing cycle at least twice. This SOP prescribes a drying time of at least 12 hours. Samples may be left in the ovens over the weekend. This is because the determination of moisture content is not affected by longer drying periods.
4	ILMO5.3, ASTM D 2216	Because of the sample aliquot size and the type of balance used, the practical range of the method is limited to 0.4 to 99.6 weight percent.
5	ILMO5.3, ASTM D 2216	Aluminum weigh dishes are used instead of porcelain crucibles as a matter of convenience. The porcelain dish is not necessary, because the determination of volatile solids, which requires heating in a muffle furnace at 550 ºC is not included in the scope of this SOP.
6	ILMO5.3	Method ILM05.3 requires the use of a lid. The lid is not necessary, because the determination of volatile solids in not included in the scope of this SOP. This is consistent with ASTM D 2216 which states the lid is optional.
7	3550C	Method 3550C states to weigh the sample for dry weight determination immediately following the weighing of the aliquot for extraction. In this laboratory, the dry weight determination is done separately from the preparation of that solid sample for any other tests. The dry weight determined is used for dry weight correction of all tests on that sample. The aliquot used for the determination of dry weight is taken from a container that is clearly marked with the client and lab sample IDs for that particular suite of tests. Depending upon the clients' practices, the sample for dry weight may or may not come from the same container used for one of the other tests for that sample..

17.0 Attachments

Attachment 1: Example Batch Editor Screen
Attachment 2: Example Gravimetric Calculation Benchsheet

18.0 Revision History

- Revision 6, dated 28 February 2015
  - Revised section 10.4.6 to specify range of weights for sample
  - Revised Section 10.4.8 to list all items to be documented in the batch record (observed and corrected temperatures both in an out of oven, time in and out of oven)
  - Revised section 10.4.9 to include recording of times in and out of the desiccator
  - Added new Attachment 1 to provide example of documentation of equipment, oven temperatures, and times.

- Annual Technical Review

- Revision 5, dated 28 February 2014
  - Added Section 10.5
  - Annual technical review

- Revision 4, dated 28 February 2013
  - Added Method 3550C as a reference and throughout SOP as needed
  - Added section 3.2
  - Revised section 9.1, 10.1, and 10.2 to reflect current practice
  - Revised section 10.4.2 to reflect that electronic transfer of weights to the LIMS is the preferred practice for recording data
  - Moved section on data review from section 10 to 11.7 for consistency with other documents
  - Revised section 12.2 to describe the appropriate documentation of an IDOC for a non-spiked test
  - Revised Method modifications 1 and 2 to include Method 3550C
  - Added Method Modification 7 to address determination of percent moisture as an independent test from other preparations of that sample for analysis
  - Annual technical review
  - Formatting and grammatical changes throughout

- Revision 3.4, dated 28 February 2012
  - Source method review
  - Added gloves and disposable spatulas to supplies list.
  - Added calculation for % RPD
  - Removed statement that percent moisture of a sample is calculated and entered into the LIMS as raw data are input into the LIMS and result calculated by the LIMS
  - Removed Method EPA 160.3 from references and method modifications. (Previously removed in Revision 3.)
  - Revised method modifications to address sample size, drying temperature and optional use of lid per ASTM D 2216.
  - Removed Attachment 2 and inserted discussion of data review process in section 10.5 with reference to data review SOP and form.

- Revision 3.3, dated 04 March 2011
  - Annual Technical Review.
  - Updated Attachments 1 & 2

- Revision 3.2, dated 01 March 2010
  - Annual Review.
  - Added section 6.1.

- Revision 3.1, dated 29 February 2009
  - Updated method references
  - Updated SOP to allow drying of samples over a weekend
  - Updated Method modifications

- Revision 3, dated 29 February 2008
  - Integration for TestAmerica and STL operations.
  - Updated formatting.

- Replaced references to method EPA 160.3 with Standard Methods 2540B.
- Added the Example Gravimetric Calculation Benchsheet.
- Added the Example Data Review Checklist.

- Revision 2, dated 14 December 2006
  - Changed title and scope to reflect the use of the SOP for the determination or percent moisture only. Deleted all references to determining percent solids and volatile solids from this SOP. The determination of solids in liquid samples is addressed in SOP DEN-WC-0064.
  - Updated formatting to be consistent with Policy QA-001.
  - Incorporated the Safety Bulletin to comply with STL Corporate requirements.
  - Section 9.1 was revised to include a reference to Policy QA-024 for federal program requirements.
  - Eliminated the instruction to determine a default tare weight for the batch of samples by determining the tare weight of a single weigh pan. Instead, each weigh pan used is weighed to determine its specific tare weight (Section 10.4.4).
  - Added Section 10.4.2 to explain that data may be recorded manually or electronically.
  - Changed the drying temperature range to 95 ±5 ºC as explained in Section 17.1.3.

Attachment 1.

Example Batch Editor Screen

Batch: 263139 SubContract Batch Normal Status: APPROVED

Method: 280 Moisture Start Date/Time: 02/05/15 11:34 Analyst: Cherry, Scott V

Equipment: NOEQUIP End Date/Time: Apply all prep factors to reagents

Batch Notes

Description	Value	Units
Balance ID	31422	No Unit
Date samples were placed in the oven	02/05/15	NONE
Time samples were place in the oven	1155	NONE
Uncorrected In Temperature	104	Celsius
Oven Temp when samples are put in	104	Degrees C
Date samples were removed from ove	02/0615	NONE
Time Samples were removed from ov	0655	NONE
Uncorrected Out Temperature	104	Celsius
Oven Temp when samples removed fr	104	Degrees C
Oven ID	F	NONE
ID number of the thermometer	227-694	NONE
Date and Time Samples in Desiccator	02/06/15 0655	NONE
Date and Time Samples out of Desicc	02/06/15 0805 cml	NONE
Batch Comment	na	NONE

Ok Cancel

Attachment 2.

Example Gravimetric Calculation Benchsheet

TALS - TestAmerica Denver - [Analyst Desktop II - 54459]

File View Window Tools Help Customer Service Sample Management Analyst Report Production Invoicing Lab Setup Lab Method Lab Equipment System Administration Global Reference

Edit | Print | Find | Doc's | FAQ | Settings | Help

Batch: 54459 -- Method: Moisture -- Equipment: NO

#	Sample LabId	DISH ID Value	Dish Weight Value	Dish Weight Units	SampleMassWet Value	SampleMassWet Units	SampleMassDry Value	SampleMassDry Units	Notes Value
1	280-12705-A-7 (280-605876	1	1.29	g	16.98	g	12.18	g	
2	280-12705-A-7 DU (280-605	2	1.27	g	17.67	g	12.44	g	
3	280-12756-A-1 (280-608412	3	1.28	g	16.79	g	14.44	g	
4	280-12756-A-2 (280-608415	4	1.28	g	16.95	g	14.96	g	
5	280-12756-A-3 (280-608418	5	1.29	g	16.69	g	[illegible]	g	
6	280-12756-A-7 (280-608424	6	1.28	g	17.36	g	15.0[illegible]	g	
7	280-12756-A-8 (280-608427	7	1.29	g	16.81	g	14.11	g	
8	280-12756-A-9 (280-608430	8	1.29	g	17.32	g	14.39	g	
9	280-12756-A-10 (280-60843	9	1.30	g	16.50	g	1[illegible].57	g	
10	280-12756-A-15 (280-60844	10	1.29	g	17.76	g	15.4[illegible]	g	
11	280-12756-A-16 (280-60844	11	1.[illegible]	g	17.[illegible]2	g	[illegible].24	g	
12	280-12756-A-17 (280-60844	12	1.33	g	17.4[illegible]	g	16.[illegible]0	g	
13	280-12756-A-21 (280-608	13	1.34	g	17.88	g	14.70	g	
14	280-12756-A-22 (280-60846	14	1.30	g	17.35	g	14.21	g	
15	280-12756-A-23 (280-60846	15	1.[illegible]2	g	17.48	g	15.17	g	
16	280-12756-A-[illegible]7 (280-60[illegible]46	16	1.32	g	17.[illegible]5	g	15.22	g	
17	280-12[illegible]56-A-2[illegible] (280-[illegible]047	17	1.29	g	17.12	g	15.02	g	
18	280-12[illegible]56-A-29 (280-608[illegible]	18	1.3[illegible]	g	17.48	g	14.94	g	
19	280-127[illegible]0-B-1 (280-60[illegible]969	19	1.30	g	17.33	g	14.50	g	
20	280-127[illegible]0-B-1 DU (28[illegible]-60[illegible]	20	1.28	g	17.61	g	14.84	g	
21	280-1277[illegible]-2 (280-60[illegible]973	21	1.[illegible]	g	16.64	g	13.47	g	
22	280-12770-B-3 (2[illegible]-6089[illegible]	22	1.31	g	16.75	g	14.48	g	
23	280-12770-B-4 (280-60[illegible]981	23	1.28	g	17.71	g	14.06	g	
24	280-127[illegible]0-B-5 (280-608[illegible]	24	1.30	g	17.40	g	15.19	g	
25	280-127[illegible]0-B-6 (2[illegible]608989	25	1.29	g	17.47	g	14.52	g	
26	280-1258[illegible]-A-17 (280-60075	26	1.33	g	17.32	g	15.45	g	Rocky
27	280-12588-A-17 DU (280-60	27	1.36	g	17.37	g	15.38	g	Rocky
28	280-12588-A-18 (280-60075	28	1.33	g	16.83	g	15.12	g	
29	280-12588-A-20 (280-60075	29	1.32	g	17.53	g	16.10	g	
30	280-12588-A-21 (280-60075	30	1.33	g	17.79	g	16.91	g	
31	280-12588-A-22 (280-60075	31	1.33	g	16.75	g	14.55	g	
32	280-12588-A-23 (280-60075	32	1.32	g	17.15	g	15.20	g	
33	280-12588-A-24 (280-60076	33	1.34	g	17.51	g	16.28	g	
34	280-12588-A-25 (280-60076	34	1.31	g	17.11	g	15.27	g	
35	280-12588-A-26 (280-60076	35	1.32	g	17.34	g	16.20	g	
36	280-12588-A-27 (280-60076	36	1.35	g	16.21	g	14.15	g	
37	280-12588-A-28 (280-60076	37	1.36	g	17.78	g	16.39	g	
38	280-12588-A-29 (280-60076	38	1.37	g	16.75	g	15.74	g	
		39	1.33	g	17.70	g	16.19	g	

Run Log | Sample Quants | Sample List | Worksheet | Reagents | Batch Results | Sample Results | Conditions Review | QC Links

Ready

Start | Inbox - Microsoft Outlook | TALS - TestAmerica D... | G:\QA\Delete\SOPs\Draft... | DV-WC-0023 Rev 3.3 % ... | Document1 - Microsc

Template

TestAmerica Denver

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Electronic Copy Only

Title: Manual and Automated pH [SM 4500-H+ B, SW 9040 B & C]

Approvals (Signature/Date):

Andrew Allen Technical Specialist	Date 10/22/15	Adam Alban Health & Safety Manager / Coordinator	Date 26 Oct 15
Margaret S. Sleevi Quality Assurance Manager	Date 10/26/15	William S. Cicero Laboratory Director	Date 10/26/15

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1.0 Scope and Application

1.1 This is an electrometric procedure for measuring pH in aqueous samples. This method is applicable to the analysis of drinking, surface, and saline waters, and acid rain. It also applies to multiphase wastes where the aqueous phase constitutes at least 20% of the total volume of the waste. Corrosivity of concentrated acids and bases cannot be measured by this procedure.

1.2 Liquid samples which are not miscible with water or solids must be analyzed by DV-WC-0001, Soil and Waste pH.

1.3 A detection limit (MDL) for pH has not been defined, however, for reporting purposes this laboratory uses 0.1 pH units as the RL and MDL.

1.4 This method is applicable to all ranges of pH.

2.0 Summary of Method

The pH meter, glass electrode, and reference electrode (or single combination electrode) are standardized using five reference buffer solutions of known pH bracketing the pH expected to be found in the sample. The sample measurement is made by immersing the electrodes into the test solution and taking a reading from the meter.

3.0 Definitions

3.1 **pH** - At a given temperature, the intensity of the acidic or basic character of a solution is indicated by pH or hydrogen ion activity. Because of ionic interactions in all but very dilute solutions, it is necessary to use the “activity” of an ion and not its molar concentration. The use of the term pH assumes that the activity of the hydrogen ion is being considered. The approximate *equivalence* to molarity can be presumed only in very dilute solutions. A logarithmic scale is used to accommodate the wide range of ionic activities.

3.2 Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, “Quality Assurance Program,” for definitions of general analytical and QA/QC terms.

4.0 Interferences

4.1 The pH response of most glass electrodes is imperfect at both ends of the scale. The indicated pH value of highly alkaline solutions, as measured with the glass electrode, will be too low. The indicated pH value of salts and strong acids having a pH less than 1, will often be higher than the true pH value. Interferences can be minimized by the selection of the proper electrodes for these conditions. For example, sodium may interfere at pH > 10, and is controlled by using a “low sodium error” electrode.

4.2 Coatings of oil and particulate matter may impair electrode response.

4.3 Temperature variations will change the pH of the samples and also affect electrode response. Electronic temperature correction may be used to correct for electrode response.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

Eye protection that satisfies ANSI Z87.1 (as per the Corporate Environmental Health and Safety Manual), laboratory coat, and nitrile or latex gloves must be worn while samples, standards, solvents, and reagents are being handled. Disposable gloves that have been contaminated will be removed and discarded; other gloves will be cleaned immediately.

5.4 Primary Materials Used

There are no materials used in this method that have a serious or significant hazard rating. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS (formerly known as MSDS) for each material before using it for the first time or when there are major changes to the SDS.

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Manual pH

6.1.1.1 pH meter including temperature compensation ability.

6.1.1.2 Glass electrode with reference electrode--a calomel, silver-silver chloride or other reference electrode of constant potential may be used; or use a combination electrode that incorporates both measuring and reference functions.

6.1.1.3 Magnetic stirrer and Teflon-coated stir bars.

6.1.2 Automated pH

6.1.2.1 Man-Tech Autotitrator (AT3), consisting of:

- Burivar I/2 Buret Module

- Titrasip Titration Module
- PC-Tis Interface Module
- PC running PC-Titrate software

6.2 Supplies

6.2.1 Tubes to fit autosampler. These must be thoroughly rinsed to remove all traces of salt if reused.

6.2.2 Pipette calibrated to 5 mL, and disposable tips.

6.2.3 Disposable beakers.

6.2.4 Miscellaneous laboratory apparatus and glassware.

6.3 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

NOTE: TALS reagent codes are given in parentheses.

7.2 pH Buffers, 2, 4, 7,10, and 12: These buffers should be obtained commercially and traceable to NIST standards. Other buffers can be used as appropriate to bracket the range of each sample. (TALS Reagent codes: pH 2.0 Buffer, pH 4.0 Buffer, pH 7.0 Buffer, pH 10 Buffer, pH 12 Buffer). The solution aliquots used to calibrate the pH meter must be replenished each day of use.

7.3 ICV Buffer Solution (pH 7.0 ICV): A pH 7 buffer solution from a second source provider, obtained commercially and traceable to NIST standards. The ICV solution aliquot used must be replenished each day of use.

7.4 Laboratory Control Sample (LCS) Solution (pH 7.0 Buffer): The LCS solution must be certified for pH and is commercially available. The pH 7 buffer from Section 7.2 is normally used as the LCS.

7.5 3 M Potassium Chloride: This solution is purchased from Thermo.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation[1]	Holding Time[2]	Reference
Water	Glass or plastic	100 mL	None	None	SW-846
Water	Glass or plastic	100 mL	None	Analyze within 15 minutes	40 CFR Part 136.3

[1] 40 CFR Part 136.3 and SW-846 indicate no preservation is required for pH. It is intended by both programs that the samples be analyzed in the field. TestAmerica Denver typically refrigerates these samples because the aliquot tested is taken from a sample container that is used for other tests that do require refrigeration.

[2] pH is intended to be a field measurement. The laboratory attempts to measure pH as soon as possible upon receipt.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Control Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs. This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated. Any deviation or exceptions from QSM 5.0 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the

laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Sample QC - The following quality control samples are prepared with each batch of samples.

9.2.1 Laboratory Control Sample (LCS):

One LCS is required with each batch of samples processed not to exceed 20 samples.

Acceptance Criteria: The LCS must be within ± 0.05 pH units of the true value. Note: This limit is presented in TALS as 99-101% based on the use of the pH 7 buffer.

Corrective Action: If the LCS is not within the control limits, rerun all associated samples.

9.2.2 Duplicate Samples:

One duplicate sample must be analyzed for each water sample not to exceed 20 samples.

Acceptance Criteria: The two results should agree within ± 0.10 pH units.

Corrective Action: If the difference is greater than ± 0.10 repeat the analysis. If the difference still exceeds the control limit the data will be flagged as outside of the limit.

9.2.3 Method blanks and matrix spikes are not applicable to pH.

9.3 Instrument QC

9.3.1 Initial Calibration Verification

Record the expected pH, manufacturer, and lot number of the verification buffer used for a second source pH 7.0 buffer solution.

Acceptance Criteria: The ICV buffer must read within ± 0.05 pH units of the true value.

Corrective Action: If this criterion is not met, the problem should be identified, corrected, and the meter recalibrated.

9.3.2 Continuing Calibration Verification

A pH 7.0 buffer check is required after every 10 or fewer samples and at the end of the run. The CCV is the same pH 7 buffer solution used in the initial calibration.

Acceptance Criteria: The CCV pH buffer checks must be within ± 0.05 units of the true value.

Corrective Action: If the pH 7.0 buffer check is outside of the control limits, rerun all samples since the last acceptable pH 7.0 buffer check.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Manual Sample Analysis

10.3.1 Follow the operating instructions supplied by the manufacturer of the pH meter.

10.3.2 Record instrument ID, pH probe ID, thermometer probe ID, and reagent IDs in the batch record in TALS.

10.3.3 When using the Thermo Five Star pH meter, all results are to be temperature corrected to 25°C using the Automatic Temperature Compensation function available with the instrument.

NOTE: Methods 9040 B & C state “The sample temperatures must be within ± 2 °C of the calibrated buffers or temperature corrected.” All samples are automatically corrected for temperature by the instrument.

10.3.4 Calibrate the pH meter using five buffers at pH 2.0, 4.0, 7.0, 10.0, and 12.0. The aliquots of buffers should be fresh for each day of use.

10.3.4.1 Record the expected pH, pH result, manufacturer, and lot number of the buffers used. See Attachment 1.

10.3.4.2 The reading of the buffer solutions must be within ± 0.05 pH units of the certified buffer solution values. If they are not, recalibrate.

10.3.4.3 Record the slope in the instrument logbook. The source methods do not provide criteria for acceptance of the slope. If there is a

significant variation from previous values, maintenance may be required.

NOTE: Internal standard is not an appropriate calibration technique for the determination of pH.

10.3.5 Verify the calibration using a buffer solution (ICV). See Sections 7.3 and 9.3.1.

10.3.5.1 Record the pH, manufacturer, and lot number of the verification buffer used.

10.3.5.2 The reading of the buffer solution should be within ± 0.05 pH units of the true value. If this criteria is not met, the problem should be identified, corrected, and the meter recalibrated.

NOTE: Internal standard is not an appropriate calibration technique for the determination of pH.

10.3.6 Analyze one LCS and one sample duplicate per batch of 20 samples.

10.3.7 Pour enough sample into a beaker to cover the electrodes and place on the magnetic stirrer. Stirring should be fast enough to provide homogeneity and keep solids suspended, but should not disturb the air-water interface. Acid rain samples should not be stirred.

10.3.8 Immerse the electrodes in the sample and allow the reading to stabilize. The pH is recorded to the nearest 0.01 pH.

10.3.9 Repeat measurement on successive volumes of sample until the values differ by less than 0.1 pH units. Two or three volume changes are usually sufficient.

10.3.10 The pH reading, temperature, and time are recorded directly in the LIMS by the analyst at the time of measurement.

NOTE: Methods 9040B & C require the sample temperature to be reported with each pH result. All sample temperatures are recorded on the instrument raw data. The LIMS reports the pH as pH adj. to 25°C to account for the temperature correction performed by the instrument.

10.3.11 Rinse the electrodes with a stream of deionized water in between samples.

10.3.12 Rinse the magnetic stir bars with deionized water in between samples.

10.3.13 A CCV at pH 7.0 is analyzed every 10 or fewer samples (excluding the LCS and LCSD, if analyzed). See Section 9.3.2.

10.3.14 Follow the instructions supplied with the electrodes for storage after use. Record daily maintenance in the pH Calibration and Maintenance Log. See Attachment 1.

10.4 Automated Sample Analysis

10.4.1 The pH meter is calibrated each day of operation.

10.4.2 Be sure the reference electrode has been filled with 3 M potassium chloride.

10.4.3 Calibrate the pH meter using pH 2, 4, 7, 10, and 12 buffers.

10.4.3.1 The reading of the buffer solutions must be within ± 0.05 pH units of the certified buffer solution values. If they are not, recalibrate.

10.4.3.2 Fill the first seven tubes in the autosampler with the following order of samples: pH 2 buffer, pH 4 buffer, pH 7 buffer, pH 10 buffer, pH 12 buffer, and deionized water.

10.4.3.3 Click on the button "PH CALIBRATION" and follow the screens to calibrate.

10.4.4 When calibration has finished, go to titrator and choose "examine calibrations." Print the calibration if instrument states it is valid. If the calibration is not valid, recalibrate.

10.5 Click on the button "PH CALIBRATION" and follow the screens to calibrate.

10.5.1 Check the calibration using a buffer solution (ICV). See Sections 7.3 and 9.3.1.

10.5.1.1 Record the pH, manufacturer, and lot number of the verification buffer used.

10.5.1.2 The reading of the buffer solution should be within ± 0.05 pH units of the true value. If this criteria is not met, the problem should be identified, corrected, and the meter recalibrated.

NOTE: Internal standard is not an appropriate calibration technique for the determination of pH.

10.6 Troubleshooting & Maintenance

10.6.1 See Section 20 of the Denver Quality Assurance Manual for maintenance procedures.

10.6.2 Slow response or a wavering response is indicative of a dirty or oil-coated pH probe or that the probe is not properly connected to the meter. Samples high in dissolved CO_2 can cause the pH to change as the sample is stirred.

10.6.3 No temperature displayed may be a result of the temperature probe not being properly connected to the meter.

10.6.4 Using plastic disposable beakers and a magnetic stir plate and stir bar may generate static electricity that could affect stability. Turn off the stir plate, unplug and allow to sit for a few minutes.

11.0 Calculations / Data Reduction

11.1 For Manual pH, data are entered directly into the worksheet in TALS at the time of observation. There is no transcription of data.

11.2 For Automated pH, the data are recorded by the instrument and uploaded to TALS when the run is complete. There is no transcription of data.

11.3 The initial data review is performed by the analyst and a second-level review is performed by the area supervisor or designee. Both reviews are documented on a Data Review Checklist. See SOP DV-QA-0020 for a copy of the checklist and for more detail on the review process.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

There is no MDL study for pH. The laboratory reports samples to the nearest 0.1 pH units and uses this increment as the MDL for reporting purposes.

12.2 Demonstration of Capabilities

12.2.1 All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows”

12.2.1.1 Four aliquots of the QC check sample (LCS) are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

12.2.1.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.2.1.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.2.1.4 Further details concerning demonstrations of proficiency are described in DV-QA-0024.

12.3 Training Requirements

The group/team leader has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use, has the required

experience, and has successfully analyzed initial demonstration samples (see SOP # DV-QA-0024 for details).

13.0 Pollution Control

13.1 It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability).

13.2 This method does not contain any specific modifications that serve to prevent or minimize pollution.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention", of the Corporate Safety Manual, and HS-001, "Waste Management Program."

14.2 The following waste streams are produce when this method is carried out:

14.2.1 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

14.2.2 Acidic or neutral sample waste – Waste Stream F

14.2.3 Basic sample waste – Waste Stream E

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition and all promulgated updates, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, January 2005.

15.1.1 Method 9040B, "pH Electrometric Measurement", Revision 2, January 1995.

15.1.2 Method 9040C, "pH Electrometric Measurement", Revision 3, November 2004.

15.2 "Standard Methods for the Examination of Water and Wastewater, online Edition; Clesceri, L.S.; Greenberg, A.E.; Eaton, A.D.; Editors; American Public Health Association, American Water Works Association, and Water Environment Federation.

15.2.1 Method 4500-H+ B-2000 or Method 4500--H+ B-2011

16.0 Method Modifications:

Item	Method	Modification
1	9040B 9040C SM 4500 H+ B	Temperature is not reported with the pH result. Sample pH is reported as pH adj. to 25°C.
2	9040B 9040C SM 4500 H+ B	Methods 9040B and 9040C specify use of glass beakers while SM recommends polyethylene. This procedure uses disposable plastic beakers.
3	SM 4500 H+ B	The Standard Methods method states buffer solutions be replaced every 4 weeks. This procedure uses commercially available buffer solutions and uses the manufacturer's expiration date.
4	9040B 9040C SM 4500 H+ B	The source documents do not require preservation of samples for pH as it is intended as a field measurement. The laboratory typically does refrigerate samples during transit and prior to analysis.

17.0 Attachments

Attachment 1: Example pH Calibration and Maintenance Log
Attachment 2: Example Autotitrator pH Calibration Report
Attachment 3: Example Benchsheet

18.0 Revision History

- Revision 11, dated 13 October 2015
  - Added Section 3.2, reference to glossary in the QAM and DV-QA-003P
  - Updated Sections 7.2 and 7.3 to reflect daily replenishment of standards
  - Updated Section 9.1 to be consistent verbiage across SOPs as applicable
  - Added requirement to record pH result of calibration to Section 10.3.4.1
  - Updated Attachment 1 to reflect current pH logbook

- Revision 10, dated 14 January 2015
  - Added procedure sections on use of autotitrator for pH determination and all related information regarding instrument throughout
  - Added requirement to document calibration slope for manual pH
  - Added example autotitration calibration report as new attachment 2
  - Revised Section 11.1 to address both manual data and autotitrator data
  - Renumbered attachments

- Revision 9, dated 31 July 2014
  - Updated table in Section 8 to include both SW846 and 40 CFR Part 136.3 and to reflect the requirements in each of these programs. Added footnote to table in Section 8 regarding preservation of samples.
  - Revised section 10.3.1.1 to remove requirement to record the calibration slope in the logbook. The assessment of the slope is not a method requirement and no acceptance criteria are provided in the methods.
  - Added Sections 10.5 and 10.6 for Maintenance and Troubleshooting.
  - Revised Section 11.1 to note that results are entered directly into TALS with no transcription.

- Updated reference section to reflect requirements of 40 CFR Part 136.3.
- Added method modification item 4 to address refrigeration of samples.
- Updated logbook to remove Calibration Slope entry per Section 10.3.

- Revision 8, dated 31 January 2014
  - Removed section 9.4 and added 2012 MUR QC requirements to the appropriate sections
  - Added note to section 10.3 that IS is not appropriate for this method
  - Added section 10.4.10 to describe cleaning procedure for stir bars
  - Added statement to section 10.4.8 that data are entered directly into the LIMS
  - Added section 10.5 Maintenance
  - Added information to Sections 1.3 and 12.1 about MDL and RL used for reporting purposes
- Revision 7, dated 04 January 2013
  - Added section 9.4 for 2012 MUR QC requirements
- Revision 6, dated 27 July 2012
  - Revised Section 6 to identify replacement pH meter
  - Updated Section 7 to include second source ICV buffer at pH 7.0
  - Removed HCl and cleaning procedure for probe.
  - Revised Section 8 and added footnote
  - Moved procedural note in Section 4 to Section 10.4.5
  - Updated Sections 9.1, 10.1 and 10.2 to reflect current practice
  - Revised calibration procedure (Section 10)
  - Removed ASTM method reference and added SM 4500-H+ B-2000
  - Added Section 11.2 and removed Attachment
  - Updated Section 16
  - Added Attachments 1 and 2.
  - Source method review
  - Formatting and editorial changes throughout
- Revision 5.5, dated 30 December 2011
  - Annual Technical Review
- Revision 5.4, dated 17 January 2011
  - Annual Technical Review
  - Deleted Attachment 1
  - Updated Attachment 2 (now 1)
  - Added section 6.3, Computer Software and Hardware

Earlier revision histories have been archived and are available upon request.

Attachment 1

Example pH Calibration and Maintenance Log

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Denver

Calibration and Maintenance Log

Wet Chemistry / pH Probe

Daily Maintenance	Day	Sat	Sun	Mon	Tue	Wed	Thu	Fri
No maintenance required when instrument is not in use.	Date/Time:							
	Analyst:							
1) Inspect the probe for scratches or cracks.								
2) Probe solution refilled.								
3) Store probe in storage solution.								
4) Wipe off apparatus and clean up any spills.								
Calibration Standards:	2.0 Buffer Lot #: Expiration Date:							
	2.0 Buffer Calibration Reading							
	4.0 Buffer Lot #: Expiration Date:							
	4.0 Buffer Calibration Reading							
	7.0 Buffer Lot #: Expiration Date:							
	7.0 Buffer Calibration Reading							
	10.0 Buffer Lot #: Expiration Date:							
	10.0 Buffer Calibration Reading							
	12.0 Buffer Lot #: Expiration Date:							
	12.0 Buffer Calibration Reading							
Calibration Slope:								
Instrument Removed From Service: Y / N	Initials:	Date:	Return to Service with Passing Calibration				Initials:	Date:

Additional Maintenance/Comments:

\\tafs\Lab2\Denver\Admin\QA\Read\Logbooks\Wet Chemistry\Excel & Word files\pH Probe Calibration and Maintenance Log_07-21-2015.doc

Page 1

EXAMPLE

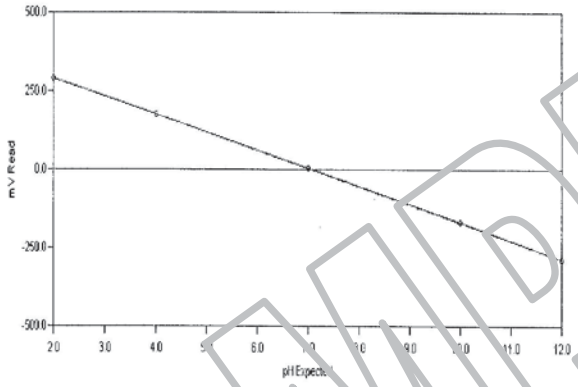
Attachment 2
Example Autotitrator pH Calibration Report

Report Date: 01/06/2015 : 10:10 AM

PC-TitratION PLUS

Calibration Report

Calibration Record # 749



Calibration Settings

Calibration ID	PH	Date	01/06/2015
Channel	1	Time	10:07 AM
Probe Type	pH	Temperature	293.74 K 20.59 C
Probe ID	PH ELECTRODE	Analysis Type	Single Line Fit

Calibration Results

Slope	-57.810	Corr Coeff	1.0000
Intercept	3.074	Equation:	Y = (-57.810) X + (3.074)

Calibration Validity **True** Operator

	Result	Minimum	Maximum
Slope	57.810	-65.00	-53.00
Intercept	3.074	-100.00	100.00
Correlation Coefficient	1.0000	0.99	1.00

Note: "True" means the calibration was within the specified ranges
"False" means the calibration was NOT within the specified ranges

Calibration Data	**Standard**	**Reading**
	2.00	292.23
	4.00	175.65
	7.00	3.17
	10.00	-167.72
	12.00	-287.96

Page: 1 of 1
PC-TitratION PLUS by Man-Tech Associates, Inc.

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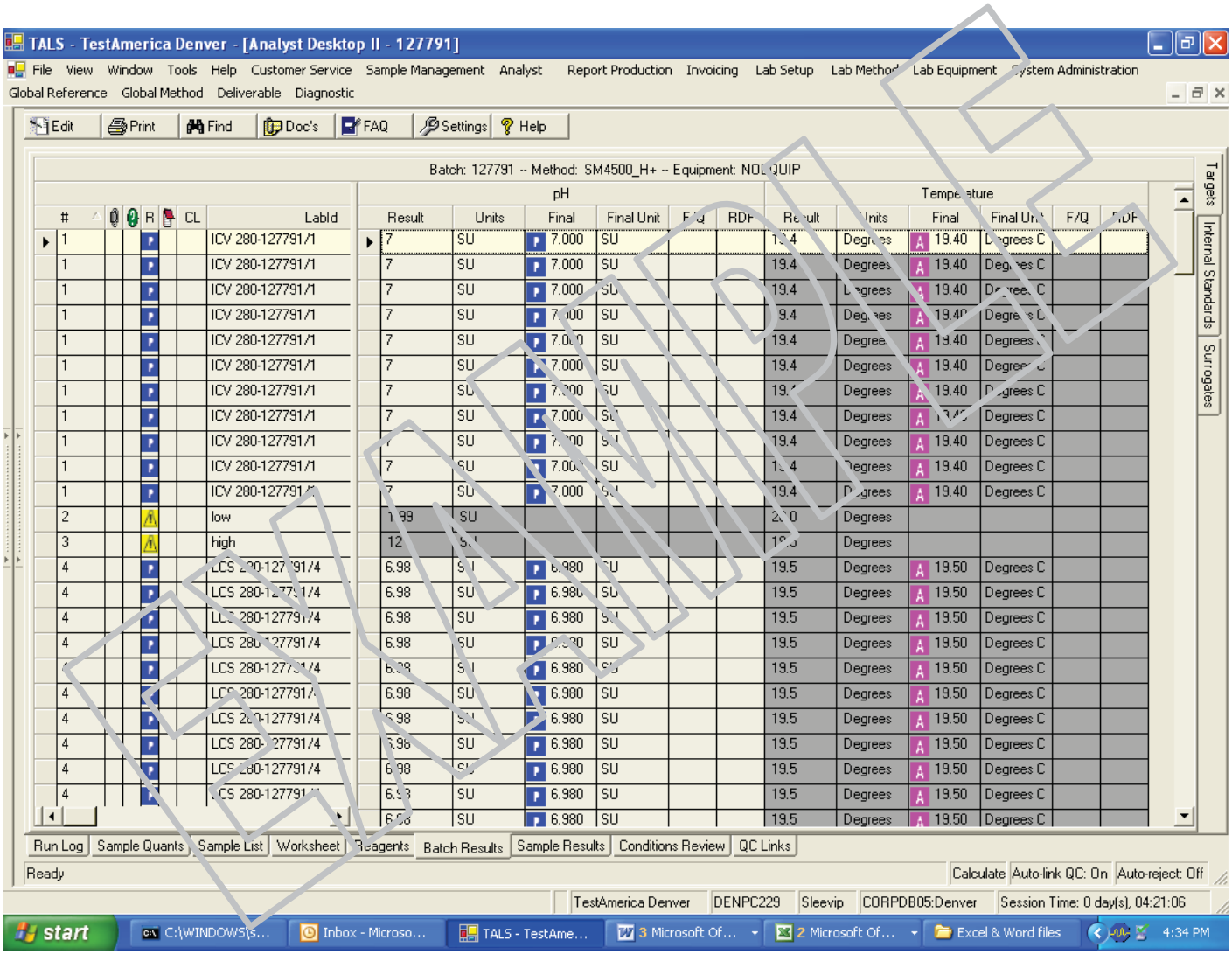
EXAMPLE

Attachment 3
Example Benchsheet



Appendix C

Field Forms

List of Forms

1. **Daily Quality Control Report**
2. **Employee/Subcontractor/Visitor Register and Safety Brief**
3. **Dig Sheet**
4. **Grid Sheet**
5. **MEC Accountability Log**
6. **Explosives Usage Record**
7. **Magazine Data Card**
8. **DD Form 1348-1A**
9. **QC Checklist: Vegetation Removal and Surface Clearance**
10. **QC Checklist: DGM**
11. **QC Checklist: Reacquisition**
12. **QC Checklist: Intrusive**
13. **QC Checklist: MPPEH Management**
14. **QC Checklist: MEC Disposal**
15. **QC Inspection Form for MEC Operations**
16. **Nonconformance Report**
17. **NCR Control Log**
18. **Field Change Request**
19. **Safety and Health Meeting Report**
20. **Training Acknowledgement Form**
21. **Utility Clearance Form**
22. **Safety Inspection Form for MEC Operations**
23. **Hazard Report and Suggestion Form**
24. **Demolition Safety Checklist**
25. **Soil Excavation and Trenching Inspection Form**
26. **Initial Safety Inspection Checklist for Construction Equipment**
27. **Equipment Checklist**
28. **First Report of Injury**
29. **Incident Investigation Report**
30. **Near Miss Investigation Report**
31. **Worksheet for Preliminary Accident Notification**
32. **USACE Accident Investigation Report (ENG Form 3394)**
33. **Motor Vehicle Inspection (DD Form 626)**
34. **Report of Theft or Loss of Explosives (ATF Form 5400.5)**
35. **Soil Sample Collection Log**
36. **Chain of Custody, Environmental Samples**
37. **Bay West Vehicle Accident Report**

DAILY QUALITY CONTROL REPORT

Contract Number: _____ **Date:** _____ **Report Number:** ____

Project Title & Location: _____

Weather: Clear ____ Partly Cloudy ____ Cloudy ____ Precipitation _____ **%** (of work day)
Temperature During Workday: High _____ ° F Low _____ ° F Humidity _____ %

1. WORK PERFORMED BY CONTRACTORS/SUBCONTRACTORS

Name	Contractor	Crafts	Hours	Description of Work

2. OPERATING EQUIPMENT DATA (Not hand tools)

Equipment	Date of Arrival / Departure	Owned or Rented	Hours Used	Hours Idle	Hours of Rep./Main

3. WORK PERFORMED TODAY (Indicate location and description of work performed by prime and/or subcontractors).

4. QUALITY CONTROL INSPECTIONS AND RESULTS (Include a description of preparatory, initial, and/or follow-up inspections or meetings; check of subcontractors work and materials delivered to site compared to submittals and/or specifications; comments on proper storage of materials; and include comments on corrective actions to b e taken).

5. QUALITY CONTROL TESTING AND RESULTS (Comment on tests and attach test reports).

6. DAILY SAFETY INSPECTIONS (Include comments on new hazards to be added to Hazard Analysis and corrective action of any safety issues).

7. REMARKS (Include conversations with or instructions from the Government representatives; delays of any kind that are impacting the job; conflicts in the contract documents; comments on change orders; and environmental considerations; etc.

8. CONTRACTOR'S VERIFICATION: I certify that to the best of my knowledge the above report is complete and correct. All material, equipment used, and work performed during this reporting period is in compliance with the contract plans and specifications except as noted above.

_____

Contractor Quality Control Officer
Bay West LLC

Employee/Visitor Register							
Date:							
Site Entry/Exit		Name (Printed)	Signature	Company	Exclusion Zone Entry/Exit		Acknowledgement of Site-Specific Briefing / Review of APP
Time In	Time Out				Time In	Time Out	

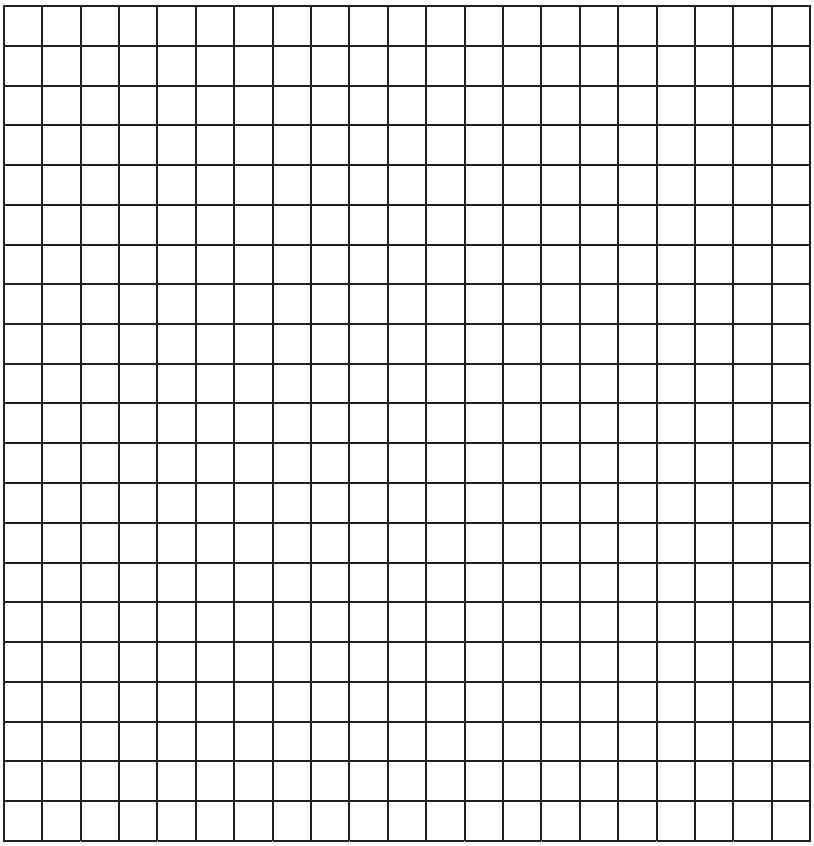
Target Resolution

Location	Target ID	Northing	Easting	Channel ID	MV	Refine mV	Item Description	MEC	MD	NMRD	SAA	Item Count	Depth to top of item (inches)	Estimated Weight (Lbs. and oz.)	Date Resolved	TL mV Reading	QC mV Reading	Project Geo QC Check	Data Processing Comments	Reacqu. Team Comments	Dig Team Comments

Bay West LLC **GRID SHEET**

Project:
Site _____ Grid #_____ Date_____

Team_____ Team Leader _____



SW

	Digs	MEC	MD	OD	Seed Items	% of Grid Complete

UXO/MEC or Other Significant Items

1._____

2._____

3._____

4._____

5.

MEC Accountability Log

Identification			Location		Initial Assessment			Disposal			Outcome of item			Comments
ID #	Date	Area/Grid	N	E	Item	MPPEH, DMM or MEC	Fuze Description	Shot #	Date	By Whom	UXO	DMM	MD	

MPPEH means an item that can not be positively assessed and must be vented. MPPEH must be stored in a properly sited explosives facility or guarded until final disposition.

Because there are only certain inputs possible in risk assesment tools inputs are constrained to the following:

Munition Type	Filler Type	Fuzing Type	Fuze Condition	Location Of Munitions	Bulk Explosives
Rockets: Warheads and Motors	High Explosive	Impact	Armed	Surface Only	Nitrocellulose
Bombs	Low Explosive Filler in a fragmenting round	Graze	Unarmed	Subsurface Only	Nitroglycerin
Guided and Ballistic Missiles: Warheads and Motors	White Phosphorus	Time	UNK	Surface and Subsurface	C-4
Cluster Munitions and Dispensers	Pyrotechnic	Proximity	N/A		Semtex (RDX/PETN)
Submunitions	Propellant	Pressure			RDX
Artillery: Gun Fired Projectiles	Spotting Charge	UNK			TNT
Mortars	Incendiary	Unfuzed			HMX
Grenades: Hand					Other
Grenades: Rifle					
Grenades: Rocket Propelled					
Grenades: 40mm					
Mines: Sea and Land					
Torpedoes					
Depth Charges					
Demolition Materials					
JATOs/RATOs					
Pyrotechnics: Flares, Signals, and Markers					
Cartridge-actuated devices					

Soil Sample Log

Identification		Initial Assessment			Disposal		Live item Count	Soil Sample Taken	Comments
ID #	**Area/Grid**	**Item**	**UXO**	**MD**	**Shot #**	**Date**			

Explosives Use Record

Project: Camp Example

SUXOS Ernie Fernerk

Date: 1-Mar-12

MRA/MRS/POI: Sample MRA

Demo Supervisor: Sonny Daye

Checker: Mooney Knight

Circle one: **Daily Delivery** **Magazine Storage**

Item	Lot Number	Qty Issued	Qty Expended	QTY Returned to Stock
Spartan Boosters, 350	N/A	0	0	0
Perforators	29AUG11C1	5	3	2
Prima Cord #10	010C09G1	2,000	500	1,500
Lead Line	17JU1TW1	5,000	400	4,600
Detonator, 12 ms, 500	30MY11X1	2	2	0
Initials	SD/ MK	SD/ MK	SD/ MK	SD/ MK

The explosives listed above were issued, expended and returned as indicated.

Sonny Daye — Demo Supervisor

Mooney Knight — Checker

Explosives Use Record

Project: _____

SUXOS _____

Date: _____

MRA/MRS/POI: _____

Demo Supervisor: _____

Checker: _____

Circle one: Daily Delivery Magazine Storage

Item	Lot Number	Qty Issued	Qty Expended	QTY Returned to Stock
Initials				

The explosives listed above were issued, expended and returned as indicated.

_____ Demo Supervisor

_____ Checker

EXPLOSIVES STORAGE MAGAZINE DATA

Bay West, LLC Magazine Number: _____ **Project:** _____

Nomenclature: _____

Unit of Issue: _____ Lot #: _____

Line #	Date	Name of Authorized Person	Quantity Received from Supplier	Quantity Issued for Use	Unused Quantity Returned to Storage	Quantity in Magazine	Checker Initials	Comments
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								

Notes:

CLEAR

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

1 2 3 4 5 6 7 23 24 25 26 27 28 29 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

DI ODC EN	RI FROM	M&S	UI NIT	QUANTITY	SER	SUPPLE-MENTARY ADDRESS	SIG	FUND	DIS-TRI-BU-TION	PRO-JECT	PRI	REQD	DEL	DATE	ADV	RI	O/P	COND	MGT	UNIT PRICE DOLLARS	UNIT PRICE CTS	1. TOTAL PRICE DOLLARS	1. TOTAL PRICE CTS	2. SHIP FROM	3. SHIP TO	4. MARK FOR

5. DOC DATE	6. NMFC	7. FRT RATE	8. TYPE CARGO	9. PS

10. QTY. REC'D	11.UP	12. UNIT WEIGHT	13. UNIT CUBE	14. UFC	15. SL

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE

18. TY CONT	19. NO CONT	20. TOTAL WEIGHT	21. TOTAL CUBE

22. RECEIVED BY	23. DATE RECEIVED

24. DOCUMENT NUMBER & SUFFIX (30-44)

25. NATIONAL STOCK NO. & ADD (8-22)

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

27. ADDITIONAL DATA

PREVIOUS EDITION MAY BE USED

FormFlow (DLA)

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

1 2 3 4 5 6 7 23 24 25 26 27 28 29 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

DI ODC EN	RI FROM	M&S	UI NIT	QUANTITY	SER	SUPPLE-MENTARY ADDRESS	SIG	FUND	DIS-TRI-BU-TION	PRO-JECT	PRI	REQD	DEL	DATE	ADV	RI	O/P	COND	MGT	UNIT PRICE DOLLARS	UNIT PRICE CTS	1. TOTAL PRICE DOLLARS	1. TOTAL PRICE CTS	2. SHIP FROM	3. SHIP TO	4. MARK FOR

5. DOC DATE	6. NMFC	7. FRT RATE	8. TYPE CARGO	9. PS

10. QTY. REC'D	11.UP	12. UNIT WEIGHT	13. UNIT CUBE	14. UFC	15. SL

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE

18. TY CONT	19. NO CONT	20. TOTAL WEIGHT	21. TOTAL CUBE

22. RECEIVED BY	23. DATE RECEIVED

24. DOCUMENT NUMBER & SUFFIX (30-44)

25. NATIONAL STOCK NO. & ADD (8-22)

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

27. ADDITIONAL DATA

PREVIOUS EDITION MAY BE USED

FormFlow (DLA)

Three Phase Quality Control Checklist

Vegetation Removal and Surface Clearance

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

WP

Item	Ref.	Inspection Point	**Y**es **N**o **N/A**	Comments
1.	APP, WP	Communications available and checked		
2.	APP	Daily safety meeting conducted by SUXOS/UXOSO/TIII		
3.	WP APP	Vegetation removal personnel have received site-specific safety training		
4.	WP	SUXOS identifies areas requiring vegetation removal		
5.	WP	UXO personnel are performing UXO escort for vegetation removal		
6.	WP	Handheld metal detectors are used to aid for searching for surface MEC if needed		
7.	WP APP	Personnel are wearing proper PPE for vegetation removal		
8.	WP	Area requiring surface clearance is clearly marked		
9.	WP	The visual surface clearance addresses the complete area within the MRS boundary		
10.	WP	The detector-aided surface clearance area to mineral soils to support the DGM transects is clearly identified		
11.	WP	Grid and/or transect size and shape optimized for field condition		

Three Phase Quality Control Checklist

Vegetation Removal and Surface Clearance

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	**Y**es **N**o **N/A**	Comments
12.	WP	Suitable control/sweep lanes used		
13.	ESP WP	MPPEH are positively identified before movement, and those unsafe and/or unidentifiable for avoidance and disposal		
14.	ESP	SUXOS and UXOSO determine if MEC is acceptable to move and document status in their logbooks		
15.	WP	Munitions and other debris properly inspected, segregated, and removed from the work zone		
16.	WP	Team Leaders observe each worker and randomly inspect sweep lanes		
17.	WP	MEC is documented on a photograph with site name, date, standard item nomenclature, GPS coordinate, and description on a whiteboard		

Punch List	

Conducted By: _____

Acknowledged By: _____

Three Phase Quality Control Checklist

DGM

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	**Y**es **N**o **N/A**	Comments
1.	WP APP	Communications available and checked		
2.	WP APP	Daily safety meeting conducted by SUXOS/UXOSO		
3.	Best Practice	Team Leaders are observing each worker for proper procedures and safety		
4.	WP	Instrument verification strip installed		
5.	WP	Geophysical system verification accomplished for all DGM data collection equipment		
6.	WP	Preliminary draft of IVS results submitted to USACE geophysics within 72 hours.		
7.	WP	A surface sweep has been conducted prior to DGM		
8.	WP	BSIs installed in production areas		
9.	WP	Positioning system checked before use each day, and documented.		

Three Phase Quality Control Checklist

DGM

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	**Y**es **N**o **N/A**	Comments
10.	WP	DGM/analog detection instruments checked each day.		
11.	WP	DGM maps show complete coverage.		
12.	WP	DGM data gaps are identified for additional DGM data collection or analog surveys		
13.	WP	100% of all blind seed items identified.		
14.	WP DID MMRP 09-004	First week's mapping and QC data are submitted to USACE geophysicist within 24 hours of collection		
15.	WP DID MMRP 09-004	Each week's DGM data package is submitted to USACE by the following Friday		
16.	WP	All BSIs are recovered and reported.		
17.	WP	All dig locations are rechecked for proper resolution.		
18.	WP	Geophysicist verifies material recovered corresponds to reported geophysical signature.		

Three Phase Quality Control Checklist

DGM

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Punch List	

Conducted By: _____

Acknowledged by:_____

Three Phase Quality Control Checklist

Reacquisition

Team Information		
Team:	Location: Camp Withycombe East and West MRSs	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	**Y**es **N**o **N/A**	Comments
1.	QAPP APP	Communications available and checked		
2.	QAPP APP	Daily safety meeting conducted by SUXOS/UXOSO		
3.	Best Practice	Team Leaders are observing each worker for proper procedures and safety		
4.	QAPP	Instruments are tested before use each day and test documented		
5.	QAPP	An RTK GPS with waypoints and a color-coded map of each anomaly are provided to the reacquisition team		
6.	QAPP	Reacquisition team is navigating to the initial anomaly location using GPS		
7.	QAPP	Reacquisition team is using an EM 61 single coil to reposition the pin flag at the peak instrument response.		
8.	QAPP	Reacquisition team searches for a peak response within the search radius.		
9.	QAPP	Reacquisition team records the peak response and offset from the initial anomaly location		

Three Phase Quality Control Checklist

Reacquisition

Team Information		
Team:	Location: Camp Withycombe East and West MRSs	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Punch List	

Conducted By: _____

Acknowledged by:_____

Three Phase Quality Control Checklist

Intrusive Investigation

Team Information		
Team:	Project:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	**Yes No N/A**	Comments
1.	WP, APP	Communications available and checked		
2.	APP	Daily safety meeting conducted by UXOSO		
3.	APP	Team Leaders observe each worker for proper procedures and safety		
4.	WP	Positioning system (GPS) checked before use each day, and documented		
5.	WP	Detection instruments checked each day and documented		
6.	WP	Dig sheet provided to UXO Team		
7.	ESP	Exclusion zone engaged before intrusive operations begin, and nonessential personnel removed		
8.	ESP	Teams maintain the TSD		
9.	APP	UXO Teams practice safe digging procedures		
10.	WP	UXO Teams fill out dig sheets accurately		
11.	WP	All anomalies within the designated search area of the anomaly location are investigated		
12.	WP	All dig locations rechecked for proper resolution and verified		

Three Phase Quality Control Checklist

Intrusive Investigation

Team Information		
Team:	Project:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	**Y**es **N**o **N/A**	Comments
13.	WP	MEC is documented on a photograph with site name, date, GPS coordinate, standard item nomenclature and description on a whiteboard		
14.	WP	SUXOS and UXOSO determine if MEC is acceptable to move and document status in their logbooks		

Punch List	

Conducted By: _____

Acknowledged By: _____

Three Phase Quality Control Checklist

MPPEH Management

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	**Y**es **N**o **N/A**	Comments
1.	APP	Communications available and checked		
2.	APP	Daily safety meeting conducted by SUXOS/ UXOSO		
3.	ESP	Inspection takes place within MRS		
4.	ESP	MPPEH evaluated before movement		
5.	EM 385-1-97	UXO team members conduct initial inspection and segregation of munitions and cultural debris		
6.	EM 385-1-97	UXO team leader conducts second inspection and segregation of munitions and cultural debris		
7.	DoDI 4140.62; TP-18	Inspectors are technically qualified to assess MPPEH. UXO TII or higher		
8.	DoDI 4140.62	At least one final MPPEH inspector is a U.S. Citizen		
9.	EM 385-1-97	SUXOS oversees the MPPEH inspection process		
10.	EM 385-1-97	UXOQCS conducts random inspections and observations of the MPPEH inspection process		

Three Phase Quality Control Checklist

MPPEH Management

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	**Y**es **N**o **N/A**	Comments
11.	ESP	SUXOS and UXOSO determine if MEC is acceptable to move		
12.	EM 385-1-97	Munitions and cultural debris are properly inspected, segregated, and removed from the work zone		
13.	EM 385-1-97	MDAS is stored in containers with tamper-evident seals		
14.	ESP	MEC is marked for disposal in place or moved to a consolidation point		

Punch List	

Conducted By: _____

Acknowledged By: _____

Three Phase Quality Control Checklist

MEC Disposal

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	Yes No N/A	Comments
1.	APP	Communications available and checked.		
2.	WP	All required publications and necessary equipment on site		
3.	ESP	Exclusion zone established.		
4.	ESP	Nonessential personnel removed from exclusion zone.		
5.	MEC Disposal SOP	All personnel have read.		
6.	Best Practice	All personnel have read Remote Firing Device operations and maintenance manual and quick reference guide.		
7.	Best Practice	All items in the demolition kit are functional.		

Three Phase Quality Control Checklist

MEC Disposal

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	Yes No N/A	Comments
8.	WP	The SUXOS/UXOQCS/ Demo Supervisor have conducted a demolition operational and safety briefing		
9.	WP	Explosives use records are updated for each explosives receipt, and expenditure.		
10.	WP	Explosive materials are properly secured and transported.		
11.	WP	Post shot, the range is inspected for kick-outs and frag policed and inspected.		

Punch List	

Three Phase Quality Control Checklist

MEC Disposal

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Punch List	

Conducted By: _____

Acknowledged by: _____

Prime Contractor: Bay West LLC
Subcontractor:

Quality Control Inspection Form
For MEC Operations

DATE:	**TIME:**	**LOG NO.:**
CONTRACT NO.:	**TASK ORDER NO.:**	
SITE NAME AND LOCATION:		
WEATHER CONDITIONS:		
AREAS INSPECTED: (List by grid number, team, task, or other identifier)		

II. INSPECTION RESULTS

	Pass	Item Description	Pass
1. PPE	Y / N	9. UXO/MEC Specific Equipment	Y / N
2. Compliance with Work Plan	Y / N	10. MOTOR VEHICLES / MHE	Y / N
3. Compliance with Safety and QC Plans	Y / N	11. Other (list):	Y / N
4. Support Equipment	Y / N	12. Other (list):	Y / N
5. On- and Off-Site Communications	Y / N	13. Other (list):	Y / N
6. Explosives / Ordnance Storage Areas	Y / N	14. Other (list):	Y / N
7. MSDSs and Container Labeling per SSHP	Y / N	15. Other (list):	Y / N
8 UXO/MEC Disposal Equipment	Y / N	16. Other (list):	Y / N

SUMMARY OF DEFICIENCIES NOTED: (If Required)

CORRECTIVE ACTIONS RECOMMENDED: (If required)

REINSPECTION RESULTS: (If required)

VI. SIGNATURES:

I acknowledge that I have been briefed on the results of this inspection and will take corrective actions (if necessary).

UXOQCS

Sr. UXO Supervisor / Project Manager

Note: QC Inspections are to be conducted and documented on this form. This form will also be used to document the present status of the site/site operations, and will also be used to note the current status of deficiencies noted during daily inspections. Any daily inspection forms where deficiencies have been noted will be forwarded to the Site Manager and the Corporate QA/QC Manager.

BAY WEST TEAM NONCONFORMANCE REPORT

Project Name: _____ Report No: _____

Project No: _____ Location: _____ Date: _____

Description of Process :

I. Description of Non-conformance *(Items involved; specification, code or standard to which the items do not conform) (Provide sketch if applicable)*

Name & Signature of Person Reporting Non-conformance:	Title/Company:	Date:

II. Root Cause Analysis

Immediate Causes: What actions and conditions contributed to this event? Check all that apply:

Substandard Acts	
☐ Operating equipment without authority	☐ Inadequate inspection/peer review
☐ Failure to follow/improper execution of procedure	☐ Poor judgment
☐ Using equipment improperly	☐ Failure to communicate—written and/or verbal
☐ Improper servicing/maintenance of equipment	☐ Acceptance of defective equipment/material
☐ Under influence of alcohol/drugs	☐ Other substandard acts
☐ Horseplay	

Substandard Conditions	
☐ Personnel not properly qualified or trained	☐ Inadequate oversight
☐ Defective equipment/material	☐ Inadequate procedure/instruction

Enter brief explanation of each *immediate cause* below:

Basic Causes: What specific personal or job management system factors contributed to this event? Check all that apply:

Personal Factors	Job Factors
☐ Inadequate physical/physiological capability	☐ Inadequate leadership and/or supervision
☐ Inadequate mental/psychological capability	☐ Inadequate engineering
☐ Physical or physiological stress	☐ Inadequate purchasing
☐ Lack of knowledge	☐ Inadequate maintenance
☐ Lack of skill	☐ Inadequate tools and equipment
☐ Improper motivation	☐ Inadequate work standards
☐ Other personal factors	☐ Excessive wear and tear
	☐ Abuse and misuse
	☐ Change
	☐ Other job factors

Enter brief explanation of each *basic cause* below:

Name & Signature of Person Conducting RCA:	Title/Company:	Date:

BAY WEST TEAM NONCONFORMANCE REPORT

Project Name: _____ Report No: _____

Project No: _____ Location: _____ Date: _____

Description of Process :

III. Recommended Disposition *(Provide sketch if applicable)*

Name & Signature of Person Recommending Disposition:	Title/Company:	Date:

IV. Corrective Action ☐ Required ☐ Not Required

V. Verification of Disposition/Corrective Action ☐ Required ☐ Not Required

Name & Signature of Person Verifying Disposition/CA:	Title/Company:	Date:

VI. Approvals

☐ QCM	☐ PM	☐ Client	☐ Other
Name(Signature):	Name(Signature):	Name(Signature):	Name(Signature):
Date:	Date:	Date:	Date:
☐ Accepted ☐ Rejected ☐ Accepted with Comments	☐ Accepted ☐ Rejected ☐ Accepted with Comments	☐ Accepted ☐ Rejected ☐ Accepted with Comments	☐ Accepted ☐ Rejected ☐ Accepted with Comments

Distribution

☐ PM ☐ SITE MGR ☐ SUXOS ☐ CLIENT ☐ UXO Quality Manager

11/2014

Root Cause Analysis

Both the deficiency and nonconformance report forms contain an area for the entry of information regarding the cause of the problem and proposed resolution. Determining the root cause of a deficiency or nonconformance is an integral part of the QC process. The depth and extent of the root cause analysis depends on the situation; it may be as simple (minor) as an overlooked step or procedure, or it may be quite complicated. Root cause analysis is the responsibility of the QC Officer for quality related items. Input can be obtained as necessary from field personnel and technical advisors in order to identify the factors that led to the problem. RCA is a tool designed to help identify not only *what* and *how* an event occurred, but also *why* it happened. Only when investigators are able to determine why an event or failure occurred will they be able to specify workable corrective measures that prevent future events of the type observed. Understanding why an event occurred is the key to developing effective recommendations and identifying prevention strategies.

Root causes are specific underlying causes.

- The investigator's goal should be to identify specific underlying causes. The more specific the investigator can be about why an event occurred, the easier it will be to arrive at recommendations that will prevent recurrence.

Root causes are those that can reasonably be identified.

- Occurrence investigations must be cost beneficial. It is not practical to keep valuable manpower occupied indefinitely searching for the root causes of occurrences. Structured RCA helps analysts get the most out of the time they have invested in the investigation.

Root causes are those management has control to fix.

- Avoid using general cause classifications such as operator error, equipment failure or external factor. Such causes are not specific enough to allow management to make effective changes. Management needs to know exactly why a failure occurred before action can be taken to prevent recurrence.

Root causes are those for which effective recommendations for preventing recurrences can be generated.

- Recommendations should directly address the root causes identified during the investigation. If the investigator arrives at vague recommendations such as, "Improve adherence to written policies and procedures," then they probably have not found a basic and specific enough cause and need to expend more effort in the analysis process.

The RCA is a four-step process involving the following:

1. **Data collection.**
   - The first step in the analysis is to gather data. Without complete information and an understanding of the event, the causal factors and root causes associated with the event cannot be identified. The majority of time spent analyzing an event is spent in gathering data.
2. **Causal factor charting.**
   - Causal factor charting provides a structure for investigators to organize and analyze the information gathered during the investigation and identify gaps and deficiencies in knowledge as the investigation progresses. The causal factor chart is simply a sequence diagram with logic tests that describes the events leading up to an occurrence, plus the conditions surrounding these events. Preparation of the causal factor chart should begin as soon as investigators start to collect information about the occurrence. They begin with a skeleton chart that is modified as more relevant facts are uncovered. The causal factor chart should drive the data collection process by identifying data needs.
3. **Root cause identification.**
   - After all the causal factors have been identified, the investigators begin root cause identification. This step involves the use of a decision diagram called the Root Cause Map to identify the

underlying reason or reasons for each causal factor. The map structures the reasoning process of the investigators by helping them answer questions about why particular causal factors exist or occurred. The identification of root causes helps the investigator determine the reasons the event occurred so the problems surrounding the occurrence can be addressed.

4. **Recommendation generation and implementation.**

- The next step is the generation of recommendations. Following identification of the root causes for a particular causal factor, achievable recommendations for preventing its recurrence are then generated. The root cause analyst is often not responsible for the implementation of recommendations generated by the analysis. However, if the recommendations are not implemented, the effort expended in performing the analysis is wasted. In addition, the events that triggered the analysis should be expected to recur. Organizations need to ensure that recommendations are tracked to completion.

Root Cause Analysis Checklist

Activity or Factor	Comment	Completed or N/A
Client Input		☐Completed ☐ N/A
Evidence of previous occurrence		☐Completed ☐ N/A
Documentation		☐Completed ☐ N/A
Schedules and Project Plans		☐Completed ☐ N/A
Equipment / Machinery		☐Completed ☐ N/A
Personnel / Staff		☐Completed ☐ N/A
Measuring / Test Instruments		☐Completed ☐ N/A
Material		☐Completed ☐ N/A
Environment / workspace		☐Completed ☐ N/A
Communication		☐Completed ☐ N/A

The Root Cause Analysis Checklist provides an overall framework to guide your analysis so you don't overlook an area that contributed to the final solution. The Checklist has 3 columns: 1) Activity or factor, 2) Comment and 3) Completed or not applicable.

As you start to analyze the problem, it determines which activities or factors have any possible bearing on the problem/ Mark the rest as "Not Applicable."

Work your way through the remaining items. For instance, under "client input," you would look into client requirements, complaints, purchase orders, etc., searching for breakdown and causes.

Under "personnel," investigate of workers made a mistake, if they had proper procedures, training, etc.

In the "comments" column, record the findings under each activity or factor and check the completed box.

Additional RCA Tools:

The Five WHYS is a very simple technique that requires the investigator / analyst to ask "WHY?" five consecutive times. This forces the investigation deep into the problem area.

When Useful:

1. At the beginning of an investigation asking five WHYS can get the investigator started.

2. When events are known, but conditions and causal factors are not clear, asking five WHYS can help the investigator / analyst to understand factors relating to the event.

3. When human performance problems are suspected, asking five WHYS forces the investigator / analyst to look deep into the situation for factors associated with inadequate performance or human error.

4. State the problem, causal factor, condition, or other information to be analyzed. Ask WHY that problem, causal factor, condition, or information exists or occurred. Answer the WHY question. Ask WHY the answer is so. Repeat the process until WHY has been asked five times through the sequence. Ask more WHY questions if there is reason to expect useful information in the answers.

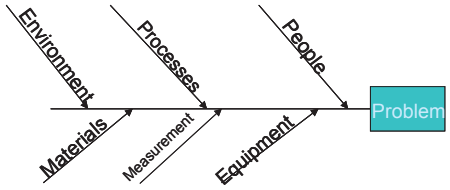
5. Continue asking the "WHY" sequences until all problems, causal factors, conditions or other information of interest is analyzed.

Remember the following cautions in using The Five WHYS:

- Answers could become silly. Ensure you are answering the questions properly.
- Be sure you do not follow one track to the exclusion of others. If a WHY question has more than one answer follow each answer separately with follow up WHY questions.
- Don't stop at five WHY questions if the answer indicates further useful information can be obtained. Five is a recommendation not a maximum.

Cause and Effect Diagram

- Cause and Effect Diagram Defined
  - The cause and effect diagram is also called the Ishikawa diagram or the fishbone diagram.
  - It is a tool for discovering all the possible causes for a particular effect.
  - The major purpose of this diagram is to act as a first step in problem solving by creating a list of possible causes.
- Constructing a Cause and Effect Diagram
  - First, clearly identify and define the problem or effect for which the causes must be identified. Place the problem or effect at the right or the head of the diagram.
  - Identify all the broad areas of the problem. Typical starting points are People, Processes, Environment, Equipment, and Materials.
  - Write in all the detailed possible causes in each of the broad areas.
  - Each cause identified should be looked upon for further more specific causes. Use the five whys.
    - Why is that a problem
    - Why is that a problem? and so on until you have done this five times for each step.
  - View the diagram and evaluate the main causes.
  - Set goals and take action on the main causes.



Bay West Nonconformance Report Control Log

Project Number	Project Name	Preparer	Date

Nonconformance Report ID #	Description of Nonconformance	Report Date	Disposition Decision Date	Corrective Action Completion	
				Initial	Date

Bay West LLC
FIELD CHANGE REQUEST (FCR)

CONTRACT TASK ORDER NAME:	CTO #	CHANGE REQUEST NO.
TO:	LOCATION:	DATE:

RE:

_____ Drawing # _____ Title: _____

_____ Specific Sections: _____ Title: _____

_____ Other: _____

1. DESCRIPTION (items involved, submit sketch, if applicable):

2. REASON FOR CHANGE

3. Quality Control

4. RECOMMENDED DISPOSITION (Submit sketch, if applicable):

_____ Minor Change _____ Major Change (Impacts Cost, Schedule)

5. DISPOSITION: (Approval Required by Client Representative)

_____ Not Approved (give reason).

_____ Considered minor change – APPROVED per recommended disposition – Documents will not be formally revised. Field office to maintain as –built records.

_____ Considered major change – Client approval required via contract modification process

Prepared by (Signature)	Date:
USACE Project Manager / OE Safety Specialist	Date:
Contractor Project Manager (Signature)	Date:
Contractor UXO Safety Manager (Signature)	Date:

Bay West
Customer-Focused Environmental & Industrial Solutions

Safety and Health Meeting Report

Project Name		Date	
Project Number		Location	
Project Manager		SSHO	
Today's Forecast		Duration	

Items Discussed

Notifications / PreWork		Tools / Equipment		Contingencies	
☐ Client	☐ Land Owner	☐ Four-wheeler	☐ Ladders	☐ Hospital Map	☐ Eye Wash
☐ Fire Dept	☐ LOTO	☐ Heavy Equip	☐ Scaffolding	☐ Fire	☐ Stop Work
☐ Govt. Agency	☐ Hot Work	☐ Hand Tools	☐ Air Monitoring	☐ Inclement Weather	
☐ Field Supervisor	☐ PRCS	☐ Vehicle Inspections	☐ Ventilation	☐ MSDS	
☐ One Call	☐ ESP or ESS	☐ Drill Rig	☐ Vacuum Truck	☐ Spill Kit	
☐ Police	☐ Work Zones		☐ Grounding Rod	☐ First Aid Kit	
☐ Work Cycles	☐ AHAs				

Chemical Hazards		Physical Hazards		Radiological Hazards
☐ Corrosive	☐ Particulates	☐ Confined Space	☐ Pinch Points	☐ XRF
☐ VOCs	☐ Acute Toxics	☐ Noise	☐ Slips/Trips/Falls	☐ DGM
☐ SVOCs	☐ Asphyxiant	☐ Lighting	☐ Distractions	☐ DU projectiles
☐ PCBs	☐ Pesticides	☐ Overhead Work	☐ UXO	☐ Solar Radiation
☐ Heavy Metals		☐ Heat	☐ Flammables	
		☐ Cold	☐ Ergonomics	

Biological Hazards	Personnel Requirements		Training	
☐ Animals/Insects	☐ Competent Person	☐ Decontamination	☐ Fall Protection	☐ HazCom
☐ Biological Warfare Agents	☐ Equipment Operator	☐ Incident Reports	☐ Fire Extinguisher	☐ Respirators
☐ Infectious Materials	☐ Medical Clearance	☐ Eye Protection	☐ PPE	☐ Excavations
		☐ Foot Protection	☐ Site Specific	☐ Safe Lifting

Additional Safety Topics Discussed

Safety Concerns	Corrective Action(s)

Incidents / Near Misses from previous workday	Corrective Action(s)

I certify that to the best of my knowledge the above report is an accurate description of the items discussed at the tailgate safety meeting and that everyone on the *Employee/Subcontractors/Visitor Register* has received the safety brief for the date indicated.

SSHO Signature	

Bay West
Customer-Focused Environmental & Industrial Solutions

Training Acknowledgement Form

Project: _____

Location: _____

Employee/Visitor Name: _____

The contract for the above project requires the following:

- that you are provided with and complete formal and site-specific training;
- that you are supplied with proper personal protective equipment including respirators;
- that you are trained in its use; and
- that you receive a medical examination to evaluate your physical capacity to perform your assigned work tasks, under the environmental conditions expected, while wearing the required personal protective equipment (including respiratory protection).

Those things are done at no cost to you. By signing this certificate, you are acknowledging that your employer has met these obligations to you.

I HAVE READ, UNDERSTAND AND AGREE TO FOLLOW THE ACCIDENT PREVENTION PLAN, SITE SAFETY AND HEALTH PLAN AND ACTIVITY HAZARD ANALYSES FOR THIS SITE.

_____ _____

Name Date

FORMAL TRAINING: I have completed the following training courses that meet OSHA requirements:

	Date Completed
40-hour HAZWOPER	_____
8-hour supervisory	_____
8-hour refresher	_____

(You must provide copies of course completion certificates for these courses.)

SITE-SPECIFIC TRAINING: I have been provided and have completed the site-specific training required by this Contract. _____ (Initials)

RESPIRATORY PROTECTION: I have been trained and medically monitored in accordance with the criteria in my employer's respiratory protection program. I have been trained in the proper work procedures and use and limitation of the respirator I will wear. I have been trained in and will abide by the facial hair policy.
_____ (Initials) or _____ Not applicable.

RESPIRATOR FIT-TEST TRAINING: I have been trained in the proper selection, fit, use, care, cleaning, maintenance, and storage of the respirator that I will wear. I have been fit-tested in accordance with the criteria in Bay West's Respiratory Program and have received a satisfactory fit. I have been taught how to properly perform positive and negative pressure fit-checks upon donning negative pressure respirators each time. _____ (Initials) or _____ Not applicable.

MEDICAL EXAMINATION: I have had a medical examination within the last 12 / 24 (circle one) months which was paid for by my employer. The examination met the requirements of 29 CFR 1910.120 and 29 CFR 1910.134. A physician made a determination regarding my physical capacity to perform work tasks on the project while wearing protective equipment, possibly including a respirator. I was personally provided a copy and informed of the results of that examination. The physician determined that there:

_____Were no limitations to performing the required tasks.

_____Were identified physical limitations to performing the required work tasks.

Date of medical examination: _____

Employee/Visitor Signature:	
Printed Name:	
Date:	

DMS# 130349

Bay West
Customer-Focused Environmental & Industrial Solutions

Utility Clearance Form

Project Name		Date Completed	
Project Number		Location	
Client		SSHO	

Underground Utility Checklist (for any excavation/intrusion work)	N/A	YES	NO
For any items answered 'no', Safety and Health Manager approval before work can proceed			
For an emergency locate; was One-Call notified and was sufficient time allowed (e.g., > 3 hours) for a locate to be completed?	☐	☐	☐
For a general locate; was One-Call notified and was sufficient time allowed (e.g., > 72 hours) for a locate to be completed?	☐	☐	☐
Have you contracted a locater company to locate utilities not covered by One-Call?	☐	☐	☐
Have you outlined the excavation or intrusion points at the site using white spray paint?	☐	☐	☐
Have you held a site meet with affected parties?	☐	☐	☐
Have you completed a 'dig permit' as required by the client (if applicable)?	☐	☐	☐
Have you received a positive response from One-Call confirming utilities are marked?	☐	☐	☐
Is your excavation/intrusion work greater than 5 feet away from marked/known utilities?	☐	☐	☐

Public Utility Locate (One-Call)		Private Utility Locate	
Date Called		Company	
Ticket Number		Date Completed	
Valid Until		Method Used	

Meet Request Documentation: attach additional sheet(s) with the following information:

- Date and time of each meet;
- Names, company affiliations, and contact information of the attendees of each meet;
- Diagram, sketch, or description of the precise excavation locations, dates, and times; and
- Schedule of any future meets or communications.

Aboveground Utility Checklist (if within 50 feet of overhead utilities)	N/A	YES	NO
For any items answered 'no', Safety and Health Manager approval before work can proceed			
If power has been shut off, have you locked out/tagged (LOTO) out the line?	☐	☐	☐
Has a written confirmation of outage/isolation been received from the utility company?	☐	☐	☐
Has an inquiry been made as to the voltage of the electrical line, and minimum clearances determined?	☐	☐	☐

Notes: *(e.g., additional actions necessary to protect the affected systems)*

I certify, to the best of my knowledge, the above report is an accurate description of site conditions and precautions made.

SSHO Signature	

Prime Contractor: Bay West LLC
Subcontractor:

Safety Inspection Form
For MEC Operations

DATE:	**TIME:**	**LOG NO.:**
CONTRACT NO.:	**TASK ORDER NO.:**	
SITE NAME AND LOCATION: .		
TEAM OR NAME OF INSPECTED:		
INSPECTED ITEMS OR OPERATIONS: (List by task, item or other specific identifier)		

II. INSPECTION RESULTS

Item Description	Pass	Item Description	Pass
1. PPE (A, B,C,D)	Y / N	9. MEC/UXO Disposal Operations:	Y / N
2. Compliance with Approved SOP's	Y / N	10. Motor Vehicles / MHE Inspections	Y / N
3. Compliance with Approved Safety Plans	Y / N	11. First Aid / Trauma Kit:	Y / N
4. Safety / Support Equipment	Y / N	12. Other (list):	Y / N
5. On- and Off-Site Communications	Y / N	13. Other (list):	Y / N
6. Explosives / Ordnance Reference Material	Y / N	14. Other (list):	Y / N
7. MSDSs and Container Labeling per APP or SOP	Y / N	15. Other (list):	Y / N
8 MEC/UXO Precautions Observed	Y / N	16. Other (list):	Y / N

SUMMARY OF DEFICIENCIES NOTED: (If Required)

CORRECTIVE ACTIONS RECOMMENDED: (If required)

REINSPECTION RESULTS: (If required)

VI. SIGNATURES:

I acknowledge that I have been briefed on the results of this inspection and will take corrective actions (if necessary).

UXOSO / UXOQC

Sr. UXO Supervisor / Project Manager

Note: Safety Inspections are to be conducted each day and documented on this form. This form will also be used to document the present status of the site/site operations, personnel, and will also be used to note the current status of deficiencies noted during daily inspections. Any daily inspection forms where deficiencies have been noted will be forwarded to the Project Manager, Project SUXOS and the Corporate Safety and Health Manager.

	Bay West LLC **HAZARD REPORT AND SUGGESTION FORM**	**Hazard Type:** **Condition** ☐ **Practice** ☐

The form is intended to provide a means for any employee to report hazards in the work place, or to make suggestions that will improve safety, environmental protection, quality or productivity. It may also be used to report Near Miss incidents with a low loss potential. If desired, the Report may be submitted anonymously. Please provide enough information to allow an effective evaluation of the hazard or suggestion. Your input is appreciated and all suggestions will be evaluated. If your name is included, we may request further information, and will inform you of the disposition. Thank You!

DESCRIBE CONDITION OR PRACTICE:

SUBMITTED BY (OPTIONAL):	**DATE:**

IMMEDIATE CORRECTIVE ACTION COMPLETED:	**COMPLETED BY**	**COMPLETION DATE**

RECOMMENDATIONS FOR FURTHER CORRECTIVE ACTION	**RESPONSIBLE PERSON**	**TARGET DATE**	**COMPLETION DATE**

FOR OFFICE USE ONLY

POTENTIAL INCIDENT TYPE:

Slip/Trip/Fall		**Strain/Overexertion**		**Fire**	
Struck By Or Against		**Chemical Exposure**		**Environmental Release**	
Caught In, Between Or		**Property Damage**		**Other (Explain)**	

Project/Office/Location:

Report Given To: _____ Date: _____

Tracking Number:

Demolition Safety Checklist

SUXOS:	DEMO SUP:	UXOSO:
SITE:	DATE:	TIME:
EXCLUSION ZONES: HFD:_____ MFD-H_____ MFD-V_____	FIRING SYSTEM:	NO. OF SHOTS/BURNS:
COMMS CHECK:	ROAD BARRIERS:	NO. OF PERSONNEL:
WEATHER: http://www.weather.gov/briefing/		
NOTIFICATIONS		
☐ USACE OESS: TBD ☐ Bay West Project Manager:(530) 207-6180 ☐ Joint Operations Center: (503) 584-to 800 ☐ Public Affairs Officer: (503) 584-3885		
EXPLOSIVES DRAW		
CAPS:	DET CORD:	COBRA ASSY:
NONEL:	PERF:	FUSE LIGHTER:

WARNING SIGNALS					
5 MINUTE WARNING		1 MINUTE WARNING		ALL CLEAR	
POST BLAST / POST BURN					
START 30 MINUTE POST BURN WAIT TIME:					
CHECK SHOT / BURN					

Demolition Safety Checklist

MEC OR MPPEH ITEMS DESTROYED OR VENTED	
ITEM	QUANTITY

Demolition Safety Checklist

MEC OR MPPEH ITEMS DESTROYED OR VENTED	
ITEM	QUANTITY

Bay West
Customer-Focused Environmental & Industrial Solutions

Soil Excavation and Trenching Inspection Form

Project Name		Date / Time	
Project Number		Location	
Rainfall (last 24 hours)		Competent Person	

Estimated Dimensions			☐ Visual Soil Characteristics			
Depth	_____		☐ Cemented	☐ Cohesive	☐ Layered	
Top	W_____	L_____	☐ Fissured	☐ Granular	☐ Plastic	
Bottom	W	L	☐ Dry	☐ Moist	☐ Saturated	☐ Submerged

☐ Laboratory Data Soil Characteristics	☐ Manual Testing Soil Characteristics
☐ Unconfined Compressive Strength _____ tsf	☐ Plasticity ☐ Dry Strength ☐ Ribbon ☐ Dry Testing
Type A > 1.5 tsf > Type B > 0.5 tsf > Type C	☐ Thumb Penetration ☐ Pocket Penetrometer

Soil Type

☐ Stable Rock (Vertical)	☐ Type A ¾:1	☐ Type B 1:1	☐ Type C 1½:1

Protective Systems	Utilities
☐ Shoring ☐ Benching ☐ Shoring ☐ Shielding	☐ One Call ☐ Private ☐ Client ☐ Marked

Inspection Checklist	N/A	YES	NO
All Excavations			
Is a barrier provided to identify and guard the excavation boundary?	☐	☐	☐
Have underground utilities been identified and marked?	☐	☐	☐
Is clearance (10 feet minimum) or guarding provided to overhead lines?	☐	☐	☐
Is excavated material and equipment placed at least 2 feet from the excavation?	☐	☐	☐
Do ground workers wear safety vests when working near heavy equipment?	☐	☐	☐
Is traffic being adequately kept away from the excavation operations?	☐	☐	☐
Are adjacent structures properly stabilized if affected by the excavation?	☐	☐	☐
Is there evidence of water that may affect the safety of the excavation?	☐	☐	☐
Is there any evidence of fractures, tension cracks, caving, or sloughing?	☐	☐	☐
Excavations > 4 feet deep			
Are means of egress provided no more than 25 feet from the work?	☐	☐	☐
If ladders are used, do they extend 3 feet beyond the top of the excavation?	☐	☐	☐
Is there a potential for a hazardous atmosphere in the excavation?	☐	☐	☐
If yes, is the atmosphere monitored and emergency equipment provided?	☐	☐	☐
Excavations > 5 feet deep			
Is a cave-in protective system employed?	☐	☐	☐
Is sloping at the proper angle?	☐	☐	☐
Is shoring or shielding properly designed, constructed, installed, and maintained?	☐	☐	☐
Excavations > 20 feet deep			
Has a Registered Professional Engineer designed the protective system?	☐	☐	☐
Are the designs followed?	☐	☐	☐

Notes:

I certify, to the best of my knowledge, the above report is an accurate description of conditions and items checked/reviewed during the inspection.

Competent Person Signature	

Retain this completed checklist in the project file

INITIAL SAFETY INSPECTION CHECKLIST FOR CONSTRUCTION EQUIPMENT
(Including Cranes, Derricks, and Hoisting Equipment)

PROJECT:	CONTRACTOR:	CONTRACT NO.:
TYPE AND MAKE OF EQUIPMENT:	MODEL:	SERIAL NO.:

Before any machinery or mechanized equipment is placed in sue, it shall be inspected and tested by a competent mechanic and certified to be in good operating condition. Records of tests and inspections shall be maintained as part of the active contract file at Project or Resident Office. Checklist set forth herein requires the application of EM 385-1-1, Safety and Health Requirements Manual.

CHECKLIST	Yes	No	N/A
1. Are adequate and serviceable fire extinguishers provided?			
2. Are all wire rope cables in good condition?			
3. Are wire rope, sockets, splices, thimbles and clips adequate and properly attached?			
4. Are hooks, safety nooks, shackles, rings, etc., in good condition?			
5. Are necessary platforms, footwalks, etc., provided?			
6. Are access steps, platforms, etc., provided with non-slip surfaces?			
7. Is operator protected against the elements, falling or flying objects, swinging loads, and similar hazards?			
8. Are all glasses in operator's compartment safety glass and in good repair?			
9. Is suitable access provided to lubrication points?			
10. Do all modifications, extensions, replacement parts, and/or repairs to equipment maintain the same factor of safety as original designed equipment?			
11. Are drums for load lines equipped with at least one positive holding device, applied directly to the motor shaft or some part of the train gear?			
12. Is there sufficient cable to allow two full wraps of cable on drums at all working positions?			
13. Are adequate headlights, taillights and turn signals provided and are they in proper operating condition?			
14. Are all approved brakes on wheeled equipment and in good operating condition?			
15. Do windshields have wipers in proper operating condition?			
16. Are rear view mirrors provided?			
17. Are operating levers equipped with latch or other devices to prevent accidental starting?			

CHECKLIST	Yes	No	N/A
18. Is engine equipped with power-operated starting device in operative condition?			
19. Do all pressure vessels have valid inspection certificates?			
20. Are reverse signal alarms on equipment?			
21. Are belts, gears, shafts, electrical contacts, etc., adequately guarded?			
22. Are all hot pipes and surfaces suitably guarded?			
23. Are fuel tanks located so that spills or overflows will not come in contact with engine or exhaust?			
24. Are exhausts and discharges so directed as not to endanger workmen or obstruct view of operator?			
25. Are guards in place on equipment with drop type skip pans?			
26. Are adequate seats provided for all riders?			
27. Are tires in serviceable condition? Are testing/inspections documented?			
28. Is steering linkage and tie rod in good operating condition? Are testing/inspections documented?			
29. Are dump bodies provided with holding device or other suitable device for locking body in raised position?			
30. Are tailgate dumping devices so arranged that operator will be in the clear while dumping loads?			
31. Are trip-handles provided on tailgates to facilitate handling?			
32. Is air hose free from leaks or defects?			
33. Are safety lashings for quick make-up type connections provided?			
34. Is acceptable spark arrestor installed and working?			
35. Do heating devices comply with references?			
36. Does welding equipment comply with code requirements?			
37. Is equipment adequately grounded?			
38. Do electrical components comply with code?			
39. Are required pressure, temperature, or relief gages and valves installed and operable?			
40. Are approved seat belts and rollover protection provided?			
41. Is recommended preventive maintenance being followed?			
42. Do helicopter cranes meet construction requirements?			

CHECKLIST	Yes	No	N/A
43. Do hydraulic jacks meet special safety conditions?			
44. Is concrete equipment fitted with adequate safety devices?			
45. Are elevating and rotating work platforms in conformance with ANSI A92.2?			
46. Do conveyors, cableways, and related equipment conform to ANSI B20.0?			
47. Are pile drivers equipped with all appropriate safety devices?			
48. Do material hoists conform to ANSI A10.5?			
49. Do passenger elevators conform to ANSI A10.4? Do temporary hoists in accordance to ANSI A20.22?			
50. Do hand and power tools comply with applicable ANSI standards?			
The following six questions apply to Cranes and Hoisting Equipment only and need not be answered for other construction equipment.			
51. Is high voltage sign posted?			
52. Is equipment fitted with positive stops for rotation when near power lines?			
53. Is there any visible evidence to damage to boom?			
54. Is the boom position indicator operating and visible to operator?			
55. Have all operators had a current physical examination?			
56. Is braking equipment capable of effectively braking, lowering and safety holding a load of at least the full rated load as required?			

REMARKS:

CERTIFICATION: *I hereby certify that this item of equipment is in good operating condition and that it meets all above requirements except as noted under remarks.*

Signature of Competent Mechanic _____ Date _____

Signature of Superintendent/Quality Control Engineer _____ Date _____

Docs# 101176

Equipment Checklist
Contract No:
Project #

Week Ending: _____

Type of Equipment: _____

Area	Comments	Sat	Sun	Mon	Tues	Wed	Thurs	Fri
Glass								
Hydraulic Cylinders								
Hoses								
Hydraulic Fluid Level								
Fuel								
Engine Oil								
Coolant								
Fire Extinguishers								
Bucket and Pins								
Trax								
Grease								
Grease Fittings								
Box Condition								
Lights								
Belts								
Saftey Guards								

INSPECTED BY: _____

Equipment Checklist
Contract No:
Project #

Week Ending: _____

Type of Equipment:_____

Area	Comments	Sat	Sun	Mon	Tues	Wed	Thurs	Fri
Glass								
Body Condition								
Tires								
Fuel								
Hoses								
Belts								
Engine Oil								
Coolant								
Transmission Fluid								
Brake Fluid								
Lights								
Turn Signals								
Reverse Signals								
Fire Extinguishers								
First Aid Kit								

Vehicle Mileage: _____

Minnesota Department of Labor and Industry
Workers' Compensation Division
PO Box 64221
St. Paul, MN 55164-0221
(651) 284-5030

First Report of Injury

See Instructions on Reverse Side
PRINT IN INK or TYPE
Enter dates in MM/DD/YYYY format.

F R 0 1

DO NOT USE THIS SPACE

1. EMPLOYEE SOCIAL SECURITY #	2. OSHA Case #		
3. DATE OF CLAIMED INJURY	4. Time of injury ☐ am ☐ pm	5. Time employee began work on date of injury ☐ am ☐ pm	
6. EMPLOYEE Name (last, first, middle)		7. Gender ☐ M ☐ F	8. Marital Status ☐ Married ☐ Unmarried
9. Home Address		10. Home phone #	11. Date of birth
City State Zip Code		12. Occupation	13. Regular department / 14. Date hired
15. Average weekly wage	16. Rate per hour	17. Hours per day	18. Days per week / 19. Employment Status ☐ Full time ☐ Part time ☐ Seasonal ☐ Volunteer
20. Weekly value of: Meals	Lodging	2nd Income	21. Apprentice ☐ Yes ☐ No

22. **Tell us how the injury occurred and what the employee was doing before the incident (give details).** *Examples: "Worker was driving lift truck with a pallet of boxes when the truck tipped, pinning worker's left leg under drive shaft." "Worker developed soreness in left wrist over time from daily computer key entry."*

23. **What was the injury or illness (include the part(s) of body)?** *Examples: chemical burn left hand, broken left leg, carpal tunnel syndrome in left wrist.*

24. **What tools, equipment, machines, objects, or substances were involved?** *Examples: chlorine, hand sprayer, pallet lift truck, computer keyboard.*

25. Did injury occur on employer's premises? ☐ Yes ☐ No If no, indicate name and address of place of occurrence	26. Date of first day of any lost time	27. Employer paid for lost time on day of injury (DOI) ☐ Yes ☐ No ☐ No lost time on DOI
	28. Date employer notified of injury	29. Date employer notified of lost time
	30. Return to work date	31. Date of death

32. TREATING PHYSICIAN (name, address, and phone)	33. HOSPITAL/CLINIC (name and address) (if any)	34. Emergency Room Visit ☐ Yes ☐ No 35. Overnight in-patient ☐ Yes ☐ No

36. **EMPLOYER** Legal name BAY WEST LLC	37. EMPLOYER DBA name (if different)	
38. **Mailing** address 5 EMPIRE DRIVE	39. Employer FEIN 41-1234511	40. Unemployment ID#
City State Zip Code SAINT PAUL MN 55103	41. Employer's contact name and phone # JAMISON HARRELL-LATHAM (651) 291-3480	
42. **Physical** address (if different) SAME	43. Witness (name and phone)	
City State Zip Code	44. NAICS code 562910	45. Date form completed

46. **INSURER** name BERKLEY ENVIRONMENTAL		51. **CLAIMS ADMIN COMPANY** (CA) name (check one) BERKLEY ENVIRONMENTAL	☑ Insurer ☐ TPA
47. Insured legal name BAY WEST LLC		52. CA address PO BOX 141299	
48. Policy # or self-insured certificate # WCA201514610		City State Zip Code IRVING TX 75014	
49. Insurer FEIN	50. Date insurer received notice	53. CA FEIN	54. Claim #

Copies to: Insurer, Employer, Employee, and Workers' Compensation Division (if no insurer)

Minnesota workers' compensation system employee information sheet

What does workers' compensation pay for?

• Medical care for the work injury, as long as it is reasonable and necessary
• Wage-loss benefits for part of your lost income (there is a three-calendar-day waiting period before these benefits start)
• Benefits for permanent damage or loss of function of a body part
• Benefits to your spouse and/or dependents if you die of a work injury
• Vocational rehabilitation services if you cannot return to your pre-injury job or to your pre-injury employer

How are workers' compensation benefits paid?

Your workers' compensation benefits are paid by an insurance company or your employer, if your employer is self-insured. State law sets the benefit levels. Please note: pursuant to statute, the insurer can obtain medical information specific to your work injury without your authorization.

If the insurer accepts your claim for wage loss benefits and you have been disabled for more than three calendar days:

• The insurer will send you a copy of the *Notice of Insurer's Primary Liability Determination* form stating your claim is accepted.

• The insurer must start paying wage-loss benefits within 14 days of the date your employer knows about your work injury and lost wages. The insurer must pay benefits on time. Wage-loss benefits are paid at the same intervals as your work paychecks.

If the insurer denies your claim for wage loss benefits:

• The insurer will send you a copy of the *Notice of Insurer's Primary Liability Determination* form stating it is denying primary liability for your claim. The form must clearly explain the facts and reasons why the insurer believes your injury or illness did not result from your work.

• If you disagree with the denial, you should talk with the insurance claims adjuster who is handling your claim. Your employer's insurance company can answer most questions about your claim.

Insurer name: Berkley Environmental
Fax# 1 (866) 303-1404

Phone : 1 (800) 449-2024
environmental.wc.claims@berkleysum.com

• If you are not satisfied with the response you receive from the insurer and still disagree with the denial, you should contact the Department of Labor and Industry at one of the numbers listed below to see what to do next.

If you have other questions or need more help, call the Minnesota Department of Labor and Industry Workers' Compensation Hotline:

Twin Cities and Southern Minnesota: **(651) 284-5005 or 1-800-342-5354; TTY (651) 297-4198**
Duluth and Northern Minnesota: **(218) 733-7810 or 1-800-365-4584**

Your call will be answered by experienced workers' compensation specialists, who will provide **instant, accurate information and assistance.**

Additional workers' compensation information is available on the department's Web site at:
www.doli.state.mn.us

Your employer is required by law to give you this information. This material can be made available in different formats, such as large print, Braille or on audiotape, by calling the numbers printed above.

Updated April 2003 (format-change only). This form may be copied or reproduced electronically. Do not file this form with the department.

Bay West
Customer-Focused Environmental & Industrial Solutions

Incident Investigation Report

Instructions: The Site Supervisor is to notify the Project Manager, Safety and Health Manager (SHM) and Team Leader as soon as practical after the incident. The employee is to complete this form and submit it to the SHM no later than **48 hours** after the incident. The SHM will be responsible for notifying each individual listed below. In the absence of the SHM, the Project Manager will be responsible for routing this form. Questions regarding this form and/or the incident reporting procedure can be directed to the SHM.

	Comments	Initial
Project Manager		
HR		
Shop Manager		
CFO		
Team Leader		
CIH (federal projects)		
Health and Safety	OSHA recordable case? ☐Yes ☐No	

Section 1 – General Incident Information

Date of Report:		Time of Report:	
Person completing this form:		Signature:	
Person(s) involved:			
Witnesses:			
Project Manager:		BW Job #	J
Date of Incident:		Time of Incident:	

Where did the incident occur?	
What happened? – Describe the incident:	
Why did the incident occur? (In your opinion):	
What could have been done to prevent the incident?	

Have unsafe conditions been corrected?	☐Yes ☐No
If yes, what has been done?	
If no, what needs to be done?	
Root Cause Analysis (List underlining cause, i.e. lack of training, poor communication):	

Section 2 – Equipment Damage				
Description of equipment damage:				
Toolwatch #		Cost to replace/repair?		Bay West owned ☐ or rented ☐?

Section 3 – Vehicle Damage					
REQUIRED: Attach Bay West Accident Reporting Kit	☐	Attach Police Report			☐
Name of Driver		Driver's License #		State:	
Description of vehicle damage:					
Toolwatch #		Vehicle Plate #			
Cost to replace/repair?		Bay West owned ☐ or rented ☐?			

Section 4 – Personal Injury or Illness	
Complete **First Report of Injury** form and attach (DMS# 112745)	☐
Treatment received:	

Section 5 – Incident Schematic / Notes
Provide visual aids or additional notes for the persons involved in the incident investigation. Use photographs, sketches, or graphics to document the location of the incident and how the incident occurred.

Bay West
Customer-Focused Environmental & Industrial Solutions

Near Miss Investigation Report

Instructions: A near miss is an unplanned event that did not result in injury, illness, or damage – but had the potential to do so. Only a fortunate break in the chain of events prevented an injury, fatality or damage. In the event of a near miss, take appropriate action to correct the unsafe condition and submit this completed form as soon as practical, but no later than **48 hours** after the near miss. The Safety and Health Manager (SHM) will complete a follow-up investigation and awareness training. **Remember:** Everyone has the right and responsibility to stop work in the event of an unsafe condition. Questions regarding this form can be directed to the SHM.

Date of Report:		Time of Report:	
Person completing this form:		Signature:	
Person(s) involved:			
Witnesses:			
Project Manager:		BW Job #	J
Date of near miss:		Time of near miss:	
Nature of the near miss	☐ Unsafe Act ☐ Unsafe Condition ☐ Unsafe Equipment ☐ Near Collision		
What is the likelihood of a similar near miss happening?	☐ Almost Certain ☐ Likely ☐ Possible ☐ Unlikely ☐ Rare		
What level of consequence could such a near miss event have?	☐ Catastrophe ☐ Major ☐ Moderate ☐ Significant ☐ Negligible		
Where did the near miss occur?			
What happened? – Describe the near miss:			
Why did the near miss occur? (In your opinion):			
Was work stopped as a result of the near miss?	☐ Yes ☐ No		
Have unsafe conditions been corrected?	☐ Yes ☐ No		
If yes, what has been done? What further actions can be made?			
If no, what needs to be done?			

Schematic / Notes: Provide visual aids or additional notes for the persons involved in the near miss investigation. Include photographs, sketches, or graphics to document the location and how the near miss occurred.

WORK SHEET FOR PRELIMINARY ACCIDENT NOTIFICATION

This work sheet is a field tool to assist the collection of information about an accident and facilitate the completion of a Preliminary Accident Notification. For Member of the Public Recreation Visitor accidents use the Initial Notification of Public Recreation Accident Work Sheet

Project Name: _____ Project Office Symbol: _____ Date Worksheet Completed: _____
Date of Accident: _____ Time of Accident: _____ Person Completing Worksheet: _____ Phone #: _____

Location and Incident Information
Exact Location of Accident: _____
Number of Persons Involved: ____ Number of Properties Involved: ____
Personnel Classification
Government: Civilian [ ] Military [ ] Government Direct Contractor [ ] Foreign National [ ] Volunteer [ ]
Contractor [ ] Member of the Public [ ]
Type of Accident (Mark all that are applicable)
Injury/Illness [ ] Fatality [ ] Motor Vehicle [ ] Property Damage [ ] Fire [ ] Diving [ ]
Personal Data (If more than 2 persons involved provide their personal data on a separate sheet)
Person 1 - Name: Last _____ First _____ Middle Initial ___ Age: ___Gender: Male [ ] Female [ ]
Date of Birth: _____ Address: _____
Job Series/Title: _____ Grade: ___ Duty Status: On Duty [ ] Off Duty [ ] TDY [ ] Time Began Work _____
Unit and Station Assignment: _____ Office Symbol: _____ Date Hired: _____
Nature of Injury: _____ Body Part(s) Affected Primary _____ Secondary _____
Type of Injury _____ Source of Injury _____
Severity of Injury: (See definitions on reverse side) Fatality: **Yes/No** Permanent Total Disability: **Yes/No**
Permanent Partial Disability: **Yes/No** Other Serious Injury: **Yes/No**
Estimated Days away from Work: _____ Estimated Days Restricted Duty/Job Transfer: _____
Primary Language Spoken: _____ English Literate: **Yes/No**
Does this person wish to remain anonymous **Yes/No**
What was employee worker doing before the accident occurred? _____
Name of Physician/Health Care Professional: _____
Medical Treatment Facility: _____
Address: _____ Phone # _____
Person 2 - Name: Last _____ First _____ Middle Initial ___ Age: ___Gender: Male [ ] Female [ ]
Date of Birth: _____ Address: _____
Job Series/Title: _____ Grade: ___ Duty Status: On Duty [ ] Off Duty [ ] TDY [ ] Time Began Work _____
Unit and Station Assignment: _____ Office Symbol: _____ Date Hired: _____
Nature of Injury: _____ Body Part(s) Affected Primary _____ Secondary _____
Type of Injury _____ Source of Injury _____
Severity of Injury: (See definitions on reverse side) Fatality: **Yes/No** Permanent Total Disability: **Yes/No**
Permanent Partial Disability: **Yes/No** Other Serious Injury: **Yes/No**
Estimated Days away from Work: _____ Estimated Days Restricted Duty/Job Transfer: _____
Primary Language Spoken: _____ English Literate: **Yes/No**
Does this person wish to remain anonymous **Yes/No**
What was employee worker doing before the accident occurred? _____

Name of Physician/Health Care Professional: _____
Medical Treatment Facility: _____
Address: _____ Phone # _____

Summary of Accident:(Use additional sheet if needed)

Remarks:

Describe Any Information Released to the Public:

Nature of Injury

Amputation	Drowning	Stroke	Tuberculosis
Abrasion	Fracture	Traumatic Food Poisoning	Traumatic Virological/Infective
Back Strain	Hearing Loss	Traumatic Heart Condition	Parasitic Disease
Burn	Hernia	Traumatic Mental Disorder	Traumatic Injury Other(list)
Contusion/Bruise	Laceration/Cut	Traumatic Respiratory	
Concussion	Puncture	(Carbon Monoxide)	
Dislocation of joint	Strain	Traumatic Skin Disease	

Type of Injury

Struck by/against	Punctured/lacerated	Exerted	Ingested
Fell/slipped/tripped	Stung/bit by	Exposed	Absorbed
Caught on/in/between	Contact with/by	Inhaled	Traveling In

Severity of Injury

Injury	Illness	Fatality	Permanent Disability

Source of Injury

Environmental Condition	Mechanical Equipment	Noise	
Building or other Area	Guard/Shield	Radiation	Inanimate Object
Walking surface	Video Display Terminal	Light	Animal Insect
Electricity	Heating	Ventilation	Human (Violence)
Temperature Extreme	Motor Vehicle/Cycle	Smoke	Diving Equipment
Weather	Boat	Stress	Parachute
Fire	Bicycle/Other non-	Confined Space	
Water	motorized vehicle	Carbon Monoxide	

Body Parts

Arm or Wrist	Brain	Face	Vertebrae
Breast	Cranial Bones	Scalp	Trunk Bones other
Testicle	Teeth	Knee	Shoulder
Abdomen	Jaw	Leg	Lung
Chest	Throat/Larynx	Hip	Kidney
Lower Back	Mouth	Ankle	Heart
Penis	Nose	Buttock	Liver
Side	Tongue	Hand	Reproductive Organs
Upper Back	Head Other External	Feet	Stomach
Waist	Elbow	Collar Bone	Intestines
Trunk Other	Finger	Shoulder Blade	Trunk/internal
Ear	Thumb	Rib	
Eye	Toe	Sternum	

(For safety staff only)	REPORT NO.	EROC CODE	**UNITED STATES ARMY CORPS OF ENGINEERS ACCIDENT INVESTIGATION REPORT** For use of this form, see Help Menu and USACE Supplement to AR 385-40 The proponent agency is CESO	REQUIREMENT CONTROL SYMBOL: CEEC-S-8 *(R2)*

1. ACCIDENT CLASSIFICATION

PERSONNEL CLASSIFICATION	INJURY/ILLNESS/FATAL	PROPERTY DAMAGE		MOTOR VEHICLE INVOLVED	DIVING
GOVERNMENT ☐ CIVILIAN ☐ MILITARY	☐	☐ FIRE INVOLVED	☐ OTHER	☐	☐
☐ CONTRACTOR	☐	☐ FIRE INVOLVED	☐ OTHER	☐	☐
☐ PUBLIC	☐ FATAL ☐ OTHER			☐	

2. PERSONAL DATA

a. NAME *(Last, First MI.)*	b. AGE	c. SEX ☐ MALE ☐ FEMALE	d. SOCIAL SECURITY NUMBER	e. GRADE

f. JOB SERIES/TITLE	g. DUTY STATUS AT TIME OF ACCIDENT	h. EMPLOYMENT STATUS AT TIME OF ACCIDENT
	☐ ON DUTY ☐ TDY ☐ OFF DUTY	☐ ARMY ACTIVE ☐ ARMY RESERVE ☐ VOLUNTEER ☐ PERMANENT ☐ FOREIGN NATIONAL ☐ SEASONAL ☐ TEMPORARY ☐ STUDENT ☐ OTHER *(Specify)* _____

3. GENERAL INFORMATION

a. DATE OF ACCIDENT *(YYYYMMDD)*	b. TIME OF ACCIDENT *(Military Time)* hrs.	c. EXACT LOCATION OF ACCIDENT	d. CONTRACTOR'S NAME (1) PRIME (2) SUBCONTRACTOR

e. CONTRACT NUMBER	f. TYPE OF CONTRACT	g. HAZARDOUS/TOXIC WASTE ACTIVITY
_____ ☐ CIVIL WORKS ☐ MILITARY ☐ OTHER *(Specify)* _____	☐ CONSTRUCTION ☐ SERVICE ☐ A/E ☐ DREDGE ☐ OTHER *(Specify)* _____	☐ SUPERFUND ☐ DERP ☐ IRP ☐ OTHER *(Specify)*

4. CONSTRUCTION ACTIVITIES ONLY *(Fill in line and corresponding code number in box from list - see help menu)*

a. CONSTRUCTION ACTIVITY	(CODE)	b. TYPE OF CONSTRUCTION EQUIPMENT	(CODE)
_____	#	_____	#

5. INJURY/ILLNESS INFORMATION *(Include name on line and corresponding code number in box for items e, f & g - see help menu)*

a. SEVERITY OF ILLNESS/INJURY	(CODE)	b. ESTIMATED DAYS LOST	c. ESTIMATED DAYS HOSPITALIZED	d. ESTIMATED DAYS RESTRICTED DUTY
_____	#			

e. BODY PART AFFECTED	(CODE)	g. TYPE AND SOURCE OF INJURY/ILLNESS	(CODE)
PRIMARY _____	#	TYPE _____	#
SECONDARY _____	(CODE) #		(CODE)
f. NATURE OF ILLNESS / INJURY	(CODE)	SOURCE _____	#
_____	#		

6. PUBLIC FATALITY *(Fill in line and correspondence code number in box - see help menu)*

a. ACTIVITY AT TIME OF ACCIDENT	(CODE)	b. PERSONAL FLOTATION DEVICE USED?
_____	#	☐ YES ☐ NO ☐ N/A

7. MOTOR VEHICLE ACCIDENT					
a. TYPE OF VEHICLE	b. TYPE OF COLLISION	c. SEAT BELTS	USED	NOT USED	NOT APPLICABLE
☐☐ PICKUP/VAN ☐☐ AUTOMOBILE ☐☐ TRUCK ☐☐ OTHER *(Specify)* _____	☐ SIDE SWIPE ☐ HEAD ON ☐ REAR END ☐ BROADSIDE ☐ ROLL OVER ☐ BACKING ☐ OTHER *(Specify)* _____	(1) FRONT SEAT	☐	☐	☐
		(2) REAR SEAT	☐	☐	☐

8. PROPERTY MATERIAL INVOLVED		
a. NAME OF ITEM	b. OWNERSHIP	c. AMOUNT OF DAMAGE
(1)		
(2)		
(3)		

9. VESSEL/FLOATING PLANT ACCIDENT *(Fill in line and correspondence code number in box from list - see help menu)*	
a. ACTIVITY AT TIME OF ACCIDENT (CODE) _____ # ☐	a. ACTIVITY AT TIME OF ACCIDENT (CODE) _____ # ☐

10. ACCIDENT DESCRIPTION *(Use additional paper, if necessary, see attached page 4.)*

11. CAUSAL FACTOR*(s) (Read instructions before completing)*

a. *(Explain YES answers in item 13)*	YES	NO
DESIGN: Was design of facility, workplace or equipment a factor?	☐	☐
INSPECTION/MAINTENANCE: Were inspection & maintenance procedures a factor?	☐	☐
PERSON'S PHYSICAL CONDITION: In your opinion, was the physical condition of the person a factor?	☐	☐
OPERATING PROCEDURES: Were operating procedures a factor?	☐	☐
JOB PRACTICES: Were any job safety/health practices not followed when the accident occurred?	☐	☐
HUMAN FACTORS: Did any human factors such as, size or strength of person, etc., contribute to accident?	☐	☐
ENVIRONMENTAL FACTORS: Did heat, cold, dust, sun, glare, etc., contribute to the accident?	☐	☐
CHEMICAL AND PHYSICAL AGENT FACTORS: Did exposure to chemical agents, such as dust, fumes, mists, vapors or physical agents, such as, noise, radiation, etc., contribute to accident?	☐	☐
OFFICE FACTORS: Did office setting such as, lifting office furniture, carrying, stooping, etc., contribute to the accident?	☐	☐
SUPPORT FACTORS: Were inappropriate tools/resources provided to properly perform the activity/task?	☐	☐
PERSONAL PROTECTIVE EQUIPMENT: Did the improper selection, use or maintenance of personal protective equipment contribute to the accident?	☐	☐
DRUGS/ALCOHOL: In your opinion, was drugs or alcohol a factor to the accident?	☐	☐
b. WAS A WRITTEN JOB/ACTIVITY HAZARD ANALYSIS COMPLETED FOR TASK BEING PERFORMED AT TIME OF ACCIDENT? *(If yes, attach a copy.)*	☐	☐

12. TRAINING		
a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK? ☐ YES ☐ NO	b. TYPE OF TRAINING ☐ CLASSROOM ☐ ON JOB	c. DATE OF MOST RECENT FORMAL TRAINING *(YYYYMMDD)*

13. FULLY EXPLAIN WHAT ALLOWED OR CAUSED THE ACCIDENT; INCLUDE DIRECT AND INDIRECT CAUSES *(See instruction for definition of direct and indirect causes.) (Use additional paper, if necessary)*

a. DIRECT CAUSE*(s) (Attach additional sheets as needed, See page 4)*

b. INDIRECT CAUSE*(s) (Attach additional sheets as needed, See page 5)*

14. ACTION*(s)* TAKEN, ANTICIPATED OR RECOMMENDED TO ELIMINATE CAUSE*(s)*		
DESCRIBE FULLY *(Attach additional sheets as necessary, See page 5)*		
15. DATES FOR ACTIONS IDENTIFIED IN BLOCK 14.		
a. BEGINNING *(YYYYMMDD)*	b. ANTICIPATED COMPLETION *(YYYYMMDD)*	
c. DATE SIGNED *(YYYYMMDD)*	d. TITLE OF SUPERVISOR COMPLETING REPORT	e. CORPS SIGNATURE, SUPERVISOR COMPLETING REPORT
c. DATE SIGNED *(YYYYMMDD)*	d. TITLE OF SUPERVISOR COMPLETING REPORT	e. CONTRACTOR SIGNATURE, SUPERVISOR COMPLETING REPORT
f. ORGANIZATION IDENTIFIER *(Division, Branch, Section, etc.,)*		g. OFFICE SYMBOL
16. MANAGEMENT REVIEW *(1st)*		
a. ☐ CONCUR b. ☐ NONCONCUR c. COMMENTS		
DATE *(YYYYMMDD)*	TITLE	SIGNATURE
17. MANAGEMENT REVIEW *(2nd - Chief Operations, Construction, Engineering, etc.,)*		
a. ☐ CONCUR b. ☐ NONCONCUR c. COMMENTS		
DATE *(YYYYMMDD)*	TITLE	SIGNATURE
18. SAFETY AND OCCUPATIONAL HEALTH OFFICE REVIEW		
a. ☐ CONCUR b. ☐ NONCONCUR c. ADDITIONAL ACTIONS/COMMENTS		
DATE *(YYYYMMDD)*	TITLE	SIGNATURE
19. COMMAND APPROVAL		
COMMENTS		
DATE *(YYYYMMDD)*	COMMANDER SIGNATURE	

10. ACCIDENT DESCRIPTION *(Continuation)*

13a. DIRECT CAUSE*(s) (Continuation)*

13b. INDIRECT CAUSE*(s) (Continuation)*

14. ACTION*(s)* TAKEN, ANTICIPATED, OR RECOMMENDED TO ELIMINATE CAUSE*(s) (Continuation)*

GENERAL. Complete a separate report for each person who was injured, caused, or contributed to the accident *(excluding uninjured personnel and witnesses)*. Use of this form for reporting USACE employee first-aid type injuries not submitted to the Office of Workers' Compensation Programs *(OWCP)* shall be at the discretion of the FOA commander. Please type or print legibly. Appropriate items shall be marked with an "X" in box(es). If additional space is needed, provide the information on a separate sheet and attach to the completed form. Ensure that these instructions are forwarded with the completed report to the designated management reviewers indicated in sections 16 and 17.

INSTRUCTIONS FOR SECTION 1 - ACCIDENT CLASSIFICATION

(Mark All Boxes That Are Applicable)

a. GOVERNMENT. Mark "CIVILIAN" box if accident involved government civilian employee; mark "MILITARY" box if accident involved U.S. military personnel.

(1) INJURY/ILLNESS/FATALITY - Mark if accident resulted in any government civilian employee injury, illness, or fatality that requires the submission of OWCP Forms CA-1 *(injury)*, CA-2 *(illness)* or CA-6 *(fatality)* to OWCP; mark if accident resulted in military personnel lost-time or fatal injury or illness.

(2) PROPERTY DAMAGE - Mark the appropriate box if accident resulted in any damage of $1000 or more to government property *(including motor vehicles)*.

(3) VEHICLE INVOLVED - Mark if accident involved a motor vehicle, regardless of whether "INJURY/ILLNESS/FATALITY" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY - Mark if the accident involved an in-house USACE diving activity.

b. CONTRACTOR.

(1) INJURY/ILLNESS/FATALITY - Mark if accident resulted in any contractor lost-time injury/illness or fatality.

(2) PROPERTY DAMAGE - Mark the appropriate box if accident resulted in any damage of $1000 or more to contractor property *(including motor vehicles).*

(3) VEHICLE INVOLVED - Mark if accident involved a motor vehicle, regardless of whether "INJURY/ILLNESS/FATALITY" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY - Mark if the accident involved a USACE Contractor diving activity.

c. PUBLIC.

(1) INJURY/ILLNESS/FATALITY - Mark if accident resulted in public fatality or permanent total disability. *(The "OTHER" box will be marked when requested by the FOA to report an unusual non-fatal public accident that could result in claims against the government or as otherwise directed by the FOA Commander)*.

(2) VOID SPACE - Make no entry.

(3) VEHICLE INVOLVED - Mark if accident resulted in a fatality to a member of the public and involved a motor vehicle, regardless of whether "INJURY/ILLNESS/FATALITY" is marked.

(4) VOID SPACE - Make no entry.

INSTRUCTIONS FOR SECTION 2 - PERSONAL DATA

a. NAME - *(MANDATORY FOR GOVERNMENT ACCIDENTS. OPTIONAL AT THE DISCRETION OF THE FOA COMMANDER FOR CONTRACTOR AND PUBLIC ACCIDENTS)*. Enter last name, first name, middle initial of person involved.

b. AGE - Enter age.

c. SEX - Mark appropriate box.

d. SOCIAL SECURITY NUMBER - *(FOR GOVERNMENT PERSONNEL ONLY*) Enter the social security number *(or other personal identification number if no social security number issued).*

e. GRADE - *(FOR GOVERNMENT PERSONNEL ONLY)* Enter pay grade. Example: 0-6; E-7; WG-8; WS-12; GS-11; etc.

f. JOB SERIES/TITLE - For government civilian employees enter the pay plan, full series number, and job title, e.g., GS-O810/Civil Engineer. For military personnel enter the primary military occupational specialty *(PMOS)*, e.g., 15A30 or 11G50. For contractor employees enter the job title assigned to the injured person, e.g., carpenter, laborer, surveyor, etc.

g. DUTY STATUS - Mark the appropriate box.

(1) ON DUTY - Person was at duty station during duty hours or person was away from duty station during duty hours but on official business at time of the accident.

(2) TDY - Person was on official business, away from the duty station and with travel orders at time of accident. Line-of-duty investigation required.

(3) OFF DUTY - Person was not on official business at time of accident.

h. EMPLOYMENT STATUS - *(FOR GOVERNMENT PERSONNEL ONLY)* Mark the most appropriate box. If "OTHER" is marked, specify the employment status of the person.

INSTRUCTION FOR SECTION 3 - GENERAL INFORMATION

a. DATE OF ACCIDENT - Enter the month, day, and year of accident.

b. TIME OF ACCIDENT - Enter the local time of accident in military time. Example: 1430 hrs *(not 2:30 p.m.)*.

c. EXACT LOCATION OF ACCIDENT - Enter facts needed to locate the accident scene, *(installation/project name, building number, street, direction and distance from closest landmark, etc.).*

d. CONTRACTOR NAME

(1) PRIME - Enter the exact name *(title of firm)* of the prime contractor.

(2) SUBCONTRACTOR - Enter the name of any subcontractor involved in the accident.

e. CONTRACT NUMBER - Mark the appropriate box to identify if contract is civil works, military, or other: if "OTHER" is marked, specify contract appropriation on line provided. Enter complete contract number of prime contract, e.g., DACW 09-85-C-0100.

f. TYPE OF CONTRACT - Mark appropriate box. A/E means architect/engineer. If "OTHER" is marked, specify type of contract on line provided.

g. HAZARDOUS/TOXIC WASTE ACTIVITY *(HTW)* - Mark the box to identify the HTW activity being performed at the time of the accident. For Superfund, DERP, and Installation Restoration Program *(IRP)* HTW activities include accidents that occurred during inventory, predesign, design, and construction. For the purpose of accident reporting, DERP Formerly Used DoD Site *(FUDS)* activities and IRP activities will be treated separately. For Civil Works O&M HTW activities mark the "OTHER" box.

INSTRUCTIONS FOR SECTION 4 - CONSTRUCTION ACTIVITIES

a. CONSTRUCTION ACTIVITY - Select the most appropriate construction activity being performed at time of accident from the list below. Enter the activity name and place the corresponding code number identified in the box.

CONSTRUCTION ACTIVITY LIST

1. MOBILIZATION
2. SITE PREPARATION
3. EXCAVATION/TRENCHING
4. GRADING (EARTHWORK)
5. PIPING/UTILITIES
6. FOUNDATION
7. FORMING
8. CONCRETE PLACEMENT
9. STEEL ERECTION
10. ROOFING
11. FRAMING
12. MASONRY
13. CARPENTRY
14. ELECTRICAL
15. SCAFFOLDING/ACCESS
16. MECHANICAL
17. PAINTING
18. EOUIPMENT/MAINTENANCE
19. TUNNELING
20. WAREHOUSING/STORAGE
21. PAVING
22. FENCING
23. SIGNING
24. LANDSCAPING/IRRIGATION
25. INSULATION
26. DEMOLITION

b. TYPE OF CONSTRUCTION EQUIPMENT - Select the equipment involved in the accident from the list below. Enter the name and place the corresponding code number identified in the box. If equipment is not included below, use code 24, "OTHER", and write in specific type of equipment.

CONSTRUCTION EQUIPMENT

1. GRADER
2. DRAGLINE
3. CRANE *(ON VESSEL/BARGE)*
4. CRANE *(TRACKED)*
5. CRANE *(RUBBER TIRE)*
6. CRANE *(VEHICLE MOUNTED)*
7. CRANE *(TOWER)*
8. SHOVEL
9. SCRAPER
10. PUMP TRUCK *(CONCRETE)*
11. TRUCK *(CONCRETE/TRANSIT MIXER)*
12. DUMP TRUCK *(HIGHWAY)*
13. DUMP TRUCK *(OFF HIGHWAY)*
14. TRUCK *(OTHER)*
15. FORKLIFT
16. BACKHOE
17. FRONT-END LOADER
18. PILE DRIVER
19. TRACTOR *(UTILITY)*
20. MANLIFT
21. DOZER
22. DRILL RIG
23. COMPACTOR/VIBRATORY ROLLER
24. OTHER

INSTRUCTIONS FOR SECTION 5 - INJURY/ILLNESS INFORMATION

a. SEVERITY OF INJURY/ILLNESS - Reference paragraph 2-10 of USACE Supplement 1 to AR 385-40 and enter code and description from list below.

NOI	NO INJURY
FAT	FATALITY
PTL	PERMANENT TOTAL DISABILITY
PPR	PERMANENT PARTIAL DISABILITY
LWD	LOST WORKDAY CASE INVOLVING DAYS AWAY FROM WORK
NLW	RECORDABLE CASE WITHOUT LOST WORKDAYS
RFA	RECORDABLE FIRST AID CASE
NRI	NON-RECORDABLE INJURY

b. ESTIMATED DAYS LOST - Enter the estimated number of workdays the person will lose from work.

c. ESTIMATED DAYS HOSPITALIZED - Enter the estimated number of workdays the person will be hospitalized.

d. ESTIMATED DAYS RESTRICTED DUTY - Enter the estimated number of workdays the person, as a result of the accident, will not be able to perform all of their regular duties.

e. BODY PART AFFECTED - Select the most appropriate primary and when applicable, secondary body part affected from the list below. Enter body part name on line and place the corresponding code letters identifying that body part in the box.

GENERAL BODY AREA	CODE	BODY PART NAME
ARM/WRIST	AB	ARM AND WRIST
	AS	ARM OR WRIST
TRUNK, EXTERNAL MUSCULATURE	B1	SINGLE BREAST
	B2	BOTH BREASTS
	B3	SINGLE TESTICLE
	B4	BOTH TESTICLES
	BA	ABDOMEN
	BC	CHEST
	BL	LOWER BACK
	BP	PENIS
	BS	SIDE
	BU	UPPER BACK
	BW	WAIST
	BZ	TRUNK OTHER
HEAD, INTERNAL	C1	SINGLE EAR INTERNAL
	C2	BOTH EARS INTERNAL
	C3	SINGLE EYE INTERNAL
	C4	BOTH EYES INTERNAL
	CB	BRAIN
	CC	CRANIAL BONES
	CD	TEETH
	CJ	JAW
	CL	THROAT, LARYNX
	CM	MOUTH
	CN	NOSE
	CR	THROAT, OTHER
	CT	TONGUE
	CZ	HEAD OTHER INTERNAL
ELBOW	EB	BOTH ELBOWS
	ES	SINGLE ELBOW
FINGER	F1	FIRST FINGER
	F2	BOTH FIRST FINGERS
	F3	SECOND FINGER
	F4	BOTH SECOND FINGERS
	F5	THIRD FINGER
	F6	BOTH THIRD FINGERS
	F7	FOURTH FINGER
	F8	BOTH FOURTH FINGERS
TOE	G1	GREAT TOE
	G2	BOTH GREAT TOES
	G3	TOE OTHER
	G4	TOES OTHER
HEAD, EXTERNAL	H1	EYE EXTERNAL
	H2	BOTH EYES EXTERNAL
	H3	EAR EXTERNAL
	H4	BOTH EARS EXTERNAL
	HC	CHIN
	HF	FACE
	HK	NECK/THROAT
	HM	MOUTH/LIPS
	HN	NOSE
	HS	SCALP
KNEE	KB	BOTH KNEES
	KS	KNEE
LEG, HIP, ANKLE, BUTTOCKS	LB	BOTH LEGS/HIPS/ ANKLES/
BUTTOCK	LS	SINGLE LEG/HIP/ ANKLE/BUTTOCK
HAND	MB	BOTH HANDS
	MS	SINGLE HAND
FOOT	PB	BOTH FEET
	PS	SINGLE FOOT
TRUNK, BONES	R1	SINGLE COLLAR BONE
	R2	BOTH COLLAR BONES
	R3	SHOULDER BLADE
	R4	BOTH SHOULDER BLADES
	RB	RIB
	RS	STERNUM *(BREAST BONE)*
	RV	VERTEBRAE *(SPINE; DISC)*
	RZ	TRUNK BONES OTHER
SHOULDER	SB	BOTH SHOULDERS
	SS	SINGLE SHOULDER
THUMB	TB	BOTH THUMBS
	TS	SINGLE THUMB
TRUNK, INTERNAL ORGANS	V1	LUNG, SINGLE
	V2	LUNGS, BOTH
	V3	KIDNEY, SINGLE
	V4	KIDNEYS, BOTH
	VH	HEART
	VL	LIVER
	VR	REPRODUCTIVE ORGANS
	VS	STOMACH
	VV	INTESTINES
	VZ	TRUNK, INTERNAL; OTHER

f. NATURE OF INJURY/ILLNESS - Select the most appropriate nature of injury/illness from the list below. This nature of injury/illness shall correspond to the primary body part selected in 5e, above. Enter the nature of injury/illness name on the line and place the corresponding CODE letters in the box provided.
* The injury or condition selected below must be caused by a specific incident or event which occurred during a single work day or shift.

GENERAL NATURE CATEGORY	CODE	NATURE OF INJURY NAME
*TRAUMATIC INJURY OR DISABILITY	TA	AMPUTATION
	TB	BACK STRAIN
	TC	CONTUSION; BRUISE; ABRASION
	TD	DISLOCATION
	TF	FRACTURE
	TH	HERNIA
	TK	CONCUSSION
	TL	LACERATION, CUT
	TP	PUNCTURE
	TS	STRAIN, MULTIPLE
	TU	BURN, SCALD, SUNBURN
	TI	TRAUMATIC SKIN DISEASES/ CONDITIONS INCLUDING DERMATITIS
	TR	TRAUMATIC RESPIRATORY DISEASE
	TQ	TRAUMATIC FOOD POISONING
	TW	TRAUMATIC TUBERCULOSIS
	TX	TRAUMATIC VIROLOGICAL/INFECTIVE/ PARASITIC DISEASE
	T1	TRAUMATIC CEREBRAL VASCULAR CONDITION/STROKE
	T2	TRAUMATIC HEARING LOSS
	T3	TRAUMATIC HEART CONDITION
	T4	TRAUMATIC MENTAL DISORDER, STRESS; NERVOUS CONDITION
	T8	TRAUMATIC INJURY - OTHER *(EXCEPT DISEASE, ILLNESS)*

** A nontraumatic physiological harm or loss of capacity produced by systemic infection; continued or repeated stress or strain; exposure to toxins, poisons, fumes, etc.; or other continued and repeated exposures to conditions of the work environment over a long period of time. For practical purposes, an occupational illness/disease or disability is any reported condition which does not meet the definition of traumatic injury or disability as described above.

GENERAL NATURE CATEGORY	CODE	NATURE OF INJURY NAME
**NON-TRAUMATIC ILLNESS/DISEASE OR DISABILITY		
RESPIRATORY DISEASE	RA	ASBESTOSIS
	RB	BRONCHITIS
	RE	EMPHYSEMA
	RP	PNEUMOCONIOSIS
	RS	SILICOSIS
	R9	RESPIRATORY DISEASE, OTHER
VIROLOGICAL, INFECTIVE & PARASITIC DISEASES		
	VB	BRUCELLOSIS
	VC	COCCIDIOMYCOSIS
	VF	FOOD POISONING
	VH	HEPATITIS
	VM	MALARIA
	VS	STAPHYLOCOCCUS
	VT	TUBERCULOSIS
	V9	VIROLOGICAL/INFECTIVE/ PARASITIC - OTHER
DISABILITY, OCCUPATIONAL	DA	ARTHRITIS, BURSITIS
	DB	BACK STRAIN, BACK SPRAIN
	DC	CEREBRAL VASCULAR CONDITION; STROKE
	DD	ENDEMIC DISEASE *(OTHER THAN CODE TYPES R&S)*
	DE	EFFECT OF ENVIRONMENTAL CONDITION
	DH	HEARING LOSS
	DK	HEART CONDITION
	DM	MENTAL DISORDER, EMOTIONAL STRESS, NERVOUS CONDITION
	DR	RADIATION
	DS	STRAIN, MULTIPLE
	DU	ULCER
	DV	OTHER VASCULAR CONDITIONS
	D9	DISABILITY, OTHER
SKIN DISEASE OR CONDITION		
	SB	BIOLOGICAL
	SC	CHEMICAL
	S9	DERMATITIS, UNCLASSIFIED

g. TYPE AND SOURCE OF INJURY/ILLNESS *(CAUSE)* - Type and Source Codes are used to describe what caused the incident. The Type Code stands for an ACTION and the Source Code for an OBJECT or SUBSTANCE. Together, they form a brief description of how the incident occurred. Where there are two different sources, code the initiating source of the incident *(see example 1, below)*. Examples:

(1) An employee tripped on carpet and struck his head on a desk. TYPE: 210 *(fell on same level)* SOURCE: 0110 *(walking/working surface*).

NOTE: This example would NOT be coded 120 *(struck against)* and 0140 *(furniture)*.

(2) A Park Ranger contracted dermatitis from contact with poison ivy/oak.

TYPE: 510 *(contact)* SOURCE: 0920 *(plant)*

(3) A lock and dam mechanic punctured his finger with a metal sliver while grinding a turbine blade.

TYPE: 410 *(punctured by)* SOURCE: 0830 *(metal)*

(4) An employee was driving a government vehicle when it was struck by another vehicle.

TYPE: 800 *(traveling in)* SOURCE: 0421 *(government-owned vehicle, as driver)*

NOTE: The Type Code 800, "Traveling In" is different from the other type codes in that its function is not to identify factors contributing to the injury or fatality, but rather to collect data on the type of vehicle the employee was operating or traveling in at the time of the incident.

Select the most appropriate TYPE and SOURCE identifier from the list below and enter the name on the line and the corresponding code in the appropriate box.

CODE	TYPE OF INJURY NAME
	STRUCK
0110	STRUCK BY
0111	STRUCK BY FALLING OBJECT
0120	STRUCK AGAINST
	FELL, SLIPPED, TRIPPED
0210	FELL ON SAME LEVEL
0220	FELL ON DIFFERENT LEVEL
0230	SLIPPED, TRIPPED *(NO FALL)*
	CAUGHT
0310	CAUGHT ON
0320	CAUGHT IN
0330	CAUGHT BETWEEN
	PUNCTURED, LACERATED
0410	PUNCTURED BY
0420	CUT BY
0430	STUNG BY
0440	BITTEN BY
	CONTACTED
0510	CONTACTED WITH *(INJURED PERSON MOVING)*
0520	CONTACTED BY *(OBJECT WAS MOVING)*
	EXERTED
0610	LIFTED, STRAINED BY *(SINGLE ACTION)*
0620	STRESSED BY *(REPEATED ACTION)*
	EXPOSED
0710	INHALED
0720	INGESTED
0730	ABSORBED
0740	EXPOSED TO
0800	TRAVELING IN

CODE	SOURCE OF INJURY NAME
0100	BUILDING OR WORKING AREA
0110	WALKING/WORKING SURFACE *(FLOOR, STREET, SIDEWALKS, ETC.)*
0120	STAIRS, STEPS
0130	LADDER
0140	FURNITURE, FURNISHINGS, OFFICE EQUIPMENT
0150	BOILER, PRESSURE VESSEL
0160	EQUIPMENT LAYOUT *(ERGONOMIC)*
0170	WINDOWS, DOORS
0180	ELECTRICITY

0200	ENVIRONMENTAL CONDITION	0631	CARBON MONOXIDE
0210	TEMPERATURE EXTREME *(INDOOR)*	0640	MIST, STEAM, VAPOR, FUME
0220	WEATHER *(ICE, RAIN, HEAT, ETC.)*	0641	WELDING FUMES
0230	FIRE, FLAME, SMOKE *(NOT TOBACCO)*	0650	PARTICLES *(UNIDENTIFIED)*
0240	NOISE	0700	CHEMICAL, PLASTIC, ETC.
0250	RADIATION	0711	DRY CHEMICAL - CORROSIVE
0260	LIGHT	0712	DRY CHEMICAL - TOXIC
0270	VENTILATION	0713	DRY CHEMICAL - EXPLOSIVE
0271	TOBACCO SMOKE	0714	DRY CHEMICAL FLAMMABLE
0280	STRESS *(EMOTIONAL)*	0721	LIQUID CHEMICAL - CORROSIVE
0290	CONFINED SPACE	0722	LIQUID CHEMICAL - TOXIC
0300	MACHINE OR TOOL	0723	LIQUID CHEMICAL - EXPLOSIVE
0310	HAND TOOL *(POWERED; SAW, GRINDER, ETC.)*	0724	LIQUID CHEMICAL - FLAMMABLE
0320	HAND TOOL *(NONPOWERED)*	0730	PLASTIC
0330	MECHANICAL POWER TRANSMISSION APPARATUS	0740	WATER
0340	GUARD, SHIELD *(FIXED, MOVEABLE, INTERLOCK)*	0750	MEDICINE
0350	VIDEO DISPLAY TERMINAL	0800	INAMINATE OBJECT
0360	PUMP, COMPRESSOR, AIR PRESSURE TOOL	0810	BOX, BARREL, ETC.
0370	HEATING EQUIPMENT	0820	PAPER
0380	WELDING EQUIPMENT	0830	METAL ITEM, MINERAL
0400	VEHICLE	0831	NEEDLE
0411	AS DRIVER OF PRIVATELY OWNED/RENTAL VEHICLE	0840	GLASS
0412	AS PASSENGER OF PRIVATELY OWNED/RENTAL VEHICLE	0850	SCRAP, TRASH
0421	DRIVER OF GOVERNMENT VEHICLE	0860	WOOD
0422	PASSENGER OF GOVERNMENT VEHICLE	0870	FOOD
0430	COMMON CARRIER *(AIRLINE, BUS, ETC.)*	0880	CLOTHING, APPAREL, SHOES
0440	AIRCRAFT *(NOT COMMERCIAL)*	0900	ANIMATE OBJECT
0450	BOAT, SHIP, BARGE	0911	DOG
0500	MATERIAL HANDLING EQUIPMENT	0912	OTHER ANIMAL
0510	EARTHMOVER *(TRACTOR, BACKHOE, ETC.)*	0920	PLANT
0520	CONVEYOR *(FOR MATERIAL AND EQUIPMENT)*	0930	INSECT
0530	ELEVATOR, ESCALATOR, PERSONNEL HOIST	0940	HUMAN *(VIOLENCE)*
0540	HOIST, SLING CHAIN, JACK	0950	HUMAN *(COMMUNICABLE DISEASE)*
0550	CRANE	0960	BACTERIA, VIRUS *(NOT HUMAN CONTACT)*
0551	FORKLIFT	1000	PERSONAL PROTECTIVE EQUIPMENT
0560	HANDTRUCK, DOLLY	1010	PROTECTIVE CLOTHING, SHOES, GLASSES, GOGGLES
0600	DUST, VAPOR, ETC.		
0610	DUST *(SILICA, COAL, ETC.)*	1020	RESPIRATOR, MASK
0620	FIBERS	1021	DIVING EQUIPMENT
0621	ASBESTOS	1030	SAFETY BELT, HARNESS
0630	GASES	1040	PARACHUTE

INSTRUCTIONS FOR SECTION 6 - PUBLIC FATALITY

a. ACTIVITY AT TIME OF ACCIDENT - Select the activity being performed at the time of the accident from the list below. Enter the activity name on the line and the corresponding number in the box. If the activity performed is not identified on the list, select from the most appropriate primary activity area *(water related, non-water related or other activity)*, the code number for "Other", and write in the activity being performed at the time of the accident.

WATER RELATED RECREATION

1. Sailing
2. Boating-powered
3. Boating-unpowered
4. Water skiing
5. Fishing from boat
6. Fishing from bank dock or pier
7. Fishing while wading
8. Swimming/supervised area
9. Swimming/designated area
10. Swimming/other area
11. Underwater activities *(skin diving, scuba, etc.)*
12. Wading
13. Attempted rescue
14. Hunting from boat
15. Other

NON-WATER RELATED RECREATION

16. Hiking and walking
17. Climbing *(general)*
18. Camping/picnicking authorized area
19. Camping/picnicking unauthorized area
20. Guided tours
21. Hunting
22. Playground equipment
23. Sports/summer *(baseball, football, etc.)*
24. Sports/winter *(skiing, sledding, snowmobiling etc.)*
25. Cycling *(bicycle, motorcycle, scooter)*
26. Gliding
27. Parachuting
28. Other non-water related

OTHER ACTIVITIES

29. Unlawful acts *(fights, riots, vandalism, etc.)*
30. Food preparation/serving
31. Food consumption
32. Housekeeping
33. Sleeping
34. Pedestrian struck by vehicle
35. Pedestrian other acts
36. Suicide
37. "Other" activities

b. PERSONAL FLOTATION DEVICE USED - If fatality was water-related was the victim wearing a person flotation device? Mark the appropriate box.

INSTRUCTIONS FOR SECTION 7 - MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE - Mark appropriate box for each vehicle involved. If more than one vehicle of the same type is involved, mark both halves of the appropriate box. USACE vehicle(s) involved shall be marked in left half of appropriate box.

b. TYPE OF COLLISION - Mark appropriate box.

c. SEAT BELT - Mark appropriate box.

INSTRUCTIONS FOR SECTION 8 - PROPERTY/MATERIAL INVOLVED

a. NAME OF ITEM - Describe all property involved in accident. Property/material involved means material which is damaged or whose use or misuse contributed to the accident. Include the name, type, model; also include the National Stock Number *(NSN)* whenever applicable.

b. OWNERSHIP - Enter ownership for each item listed. *(Enter one of the following: USACE; OTHER GOVERNMENT; CONTRACTOR; PRIVATE)*

c. $ AMOUNT OF DAMAGE - Enter the total estimated dollar amount of damage *(parts and labor)*, if any.

INSTRUCTIONS FOR SECTION 9 - VESSEL/FLOATING PLANT ACCIDENT

a. TYPE OF VESSEL/FLOATING PLANT - Select the most appropriate vessel/floating plant from list below. Enter name and place corresponding number in box. If item is not listed below, enter item number for "OTHER" and write in specific type of vessel floating plant.

VESSEL/FLOATING PLANTS

1. ROW BOAT
2. SAIL BOAT
3. MOTOR BOAT
4. BARGE
5. DREDGE/HOPPER
6. DREDGE/SIDE CASTING
7. DREDGE/DIPPER
8. DREDGE/CLAMSHELL, BUCKET
9. DREDGE/PIPE LINE
10. DREDGE/DUST PAN
11. TUG BOAT
12. OTHER

b. COLLISION/MISHAP - Select from the list below the object*(s)* that contributed to the accident or were damaged in the accident.

COLLISION/MISHAP

1. COLLISION W/OTHER VESSEL
2. UPPER GUIDE WALL
3. UPPER LOCK GATES
4. LOCK WALL
5. LOWER LOCK GATES
6. LOWER GUIDE WALL
7. HAULAGE UNIT
8. BREAKING TOW
9. TOW BREAKING UP
10. SWEPT DOWN 0N DAM
11. BUOY/DOLPHIN/CELL
12. WHARF OR DOCK
13. OTHER

INSTRUCTIONS FOR SECTION 10 - ACCIDENT DESCRIPTION

DESCRIBE ACCIDENT - Fully describe the accident. Give the sequence of events that describe what happened leading up to and including the accident. Fully identify personnel and equipment involved and their role*(s)* in the accident. Ensure that relationships between personnel and equipment are clearly specified. Continue on blank sheets if necessary and attach to this report.

INSTRUCTIONS FOR SECTION 11 - CAUSAL FACTORS

a. Review thoroughly. Answer each question by marking the appropriate block. If any answer is yes, explain in item 13 below. Consider, as a minimum, the following:

(1) DESIGN - Did inadequacies associated with the building or work site play a role? Would an improved design or layout of the equipment or facilities reduce the likelihood of similar accidents? Were the tools or other equipment designed and intended for the task at hand?

(2) INSPECTION/MAINTENANCE - Did inadequately or improperly maintained equipment, tools, workplace, etc. create or worsen any hazards that contributed to the accident? Would better equipment, facility, work site or work activity inspections have helped avoid the accident?

(3) PERSON'S PHYSICAL CONDITION - Do you feel that the accident would probably not have occurred if the employee was in "good" physical condition? If the person involved in the accident had been in better physical condition, would the accident have been less severe or avoided altogether? Was over exertion a factor?

(4) OPERATING PROCEDURES - Did a lack of or inadequacy within established operating procedures contribute to the accident? Did any aspect of the procedures introduce any hazard to, or increase the risk associated with the work process? Would establishment or improvement of operating procedures reduce the likelihood of similar accidents?

(5) JOB PRACTICES - Were any of the provisions of the Safety and Health Requirements Manual *(EM 385-1-1)* violated? Was the task being accomplished in a manner which was not in compliance with an established job hazard analysis or activity hazard analysis? Did any established job practice *(including EM 385-1-1)* fail to adequately address the task or work process? Would better job practices improve the safety of the task?

(6) HUMAN FACTORS - Was the person under undue stress *(either internal or external to the job)*? Did the task tend toward overloading the capabilities of the person; i.e., did the job require tracking and reacting to many external inputs such as displays, alarms, or signals? Did the arrangement of the workplace tend to interfere with efficient task performance? Did the task require reach, strength, endurance, agility, etc., at or beyond the capabilities of the employee? Was the work environment ill-adapted to the person? Did the person need more training, experience, or practice in doing the task? Was the person inadequately rested to perform safely?

(7) ENVIRONMENTAL FACTORS - Did any factors such as moisture, humidity, rain, snow, sleet, hail, ice, fog, cold, heat, sun, temperature changes, wind, tides, floods, currents, dust, mud, glare, pressure changes, lightning, etc., play a part in the accident?

(8) CHEMICAL AND PHYSICAL AGENT FACTORS - Did exposure to chemical agents *(either single shift exposure or long-term exposure)* such as dusts, fibers *(asbestos, etc.)*, silica, gases *(carbon monoxide, chlorine, etc.,)*, mists, steam, vapors, fumes, smoke, other particulates, liquid or dry chemicals that are corrosive, toxic, explosive or flammable, by products of combustion or physical agents such as noise, ionizing radiation, non-ionizing radiation *(UV radiation created during welding, etc.)* contribute to the accident/incident?

(9**)** OFFICE FACTORS **-** Did the fact that the accident occurred in an office setting or to an office worker have a bearing on its cause? For example, office workers tend to have less experience and training in performing tasks such as lifting office furniture. Did physical hazards within the office environment contribute to the hazard?

(10) SUPPORT FACTORS - Was the person using an improper tool for the job? Was inadequate time available or utilized to safely accomplish the task? Were less than adequate personnel resources *(in terms of employee skills, number of workers, and adequate supervision)* available to get the job done properly? Was funding available, utilized, and adequate to provide proper tools, equipment, personnel, site preparation, etc.?

(11) PERSONAL PROTECTIVE EQUIPMENT - Did the person fail to use appropriate personal protective equipment *(gloves, eye protection, hard-toed shoes, respirator, etc.)* for the task or environment? Did protective equipment provided or worn fail to provide adequate protection from the hazard*(s)*? Did lack of or inadequate maintenance of protective gear contribute to the accident?

(12) DRUGS/ALCOHOL - Is there any reason to believe the person's mental or physical capabilities, judgment, etc., were impaired or altered by the use of drugs or alcohol? Consider the effects of prescription medicine and over the counter medications as well as illicit drug use. Consider the effect of drug or alcohol induced "hangovers".

b. WRITTEN JOB/ACTIVITY HAZARD ANALYSIS - Was a written Job/Activity Hazard Analysis completed for the task being performed at the time of the accident? Mark the appropriate box. If one was performed, attach a copy of the analysis to the report.

INSTRUCTIONS FOR SECTION 12 - TRAINING

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK? - For the purpose of this section "trained" means the person has been provided the necessary information *(either formal and/or on-the-job (OJT) training)* to competently perform the activity/task in a safe and healthful manner.

b. TYPE OF TRAINING - Mark the appropriate box that best indicates the type of training; *(classroom or on-the-job)* that the injured person received, before the accident happened.

c. DATE OF MOST RECENT TRAINING - Enter YYYYMMDD of the last formal training completed that covered the activity task being performed at the time of the accident.

INSTRUCTIONS FOR SECTION 13 - CAUSES

a. DIRECT CAUSES - The direct cause is that single factor, which most directly lead to the accident. See examples below.

b. INDIRECT CAUSES - **I**ndirect causes are those factors which contributed to but did not directly initiate the occurrence of the accident.

Examples for section 13:

a. Employee was dismantling scaffold and fell 12 feet from unguarded opening.

Direct cause: failure to provide fall protection at elevation. Indirect causes: failure to enforce USACE safety requirements; improper training/motivation of employee *(possibility that employee was not knowledgeable of USACE fall protection requirements or was lax in his attitude towards safety)*; failure to ensure provision of positive fall protection whenever elevated; failure to address fall protection during scaffold dismantling in phase hazard analysis.

b. Private citizen had stopped his vehicle at intersection for red light when vehicle was struck in rear by USACE vehicle. *(Note: USACE vehicle was in proper/safe working condition).*

Direct cause: failure of USACE driver to maintain control of and stop USACE vehicle within safe distance.

Indirect cause: failure of employee to pay attention to driving *(defensive driving).*

INSTRUCTIONS FOR SECTION 14 - ACTION TO ELIMINATE CAUSE*(s)*

DESCRIPTION - Fully describe all the actions taken, anticipated, and recommended to eliminate the cause(s) and prevent reoccurrence of similar accidents/ illnesses. Continue on blank sheets of paper if necessary to fully explain and attach to the completed report form.

INSTRUCTIONS FOR SECTION 15 - DATES FOR ACTION

a. **BEGIN DATE** - Enter the date YYYYMMDD when the corrective action(s) identified in section 14 will begin.

b. **COMPLETE DATE** - Enter the date YYYYMMDD when the corrective action(s) identified in section 14 will be completed.

c. **DATE SIGNED** - Enter YYYYMMDD that the report was signed by the responsible supervisor.

d.e.. **TITLE AND SIGNATURE -** Enter the title and signature of supervisor completing the accident report. For a GOVERNMENT employee accident/illness the immediate supervisor will complete and sign the report. For PUBLIC accidents the USACE Project Manager/Area Engineer responsible for the USACE property where the accident happened shall complete and sign the report. For CONTRACTOR accidents the Contractor's project manager shall complete and sign the report and provide to the USACE supervisor responsible for oversight of that contractor activity. This USACE supervisor shall also sign the report. Upon entering the information required in 15c., 15d., 15e., 15f. and 15g. below, the responsible USACE supervisor shall forward the report for management review as indicated in section 16.

f. **ORGANIZATION NAME** - For GOVERNMENT employee accidents enter the USACE organization name *(Division, Branch, Section, etc.)* of the injured employee. For PUBLIC accidents enter the USACE organization name for the person identified in block 15d. For CONTRACTOR accidents enter the USACE organization name for the USACE office responsible for providing contract administration oversight.

g. **OFFICE SYMBOL** - Enter the latest complete USACE Office Symbol for the USACE organization identified in block 15f.

INSTRUCTIONS FOR SECTION 16 - MANAGEMENT REVIEW (1st)

1ST REVIEW - Each USACE FOA shall determine who will provide 1st management review. The responsible USACE supervisor in section 15d. shall forward the completed report to the USACE office designated as the 1st Reviewer by the FOA. Upon receipt, the Chief of the Office shall review the completed report, mark the appropriate box, provide substantive comments, sign, date, and forward to the FOA Staff Chief *(2nd review)* for review and comment.

INSTRUCTIONS FOR SECTION 17 - MANAGEMENT REVIEW (2nd)

2ND REVIEW - The FOA Staff Chief *(i .e., FOA Chief of Construction, Operations, Engineering, Planning, etc.)* shall mark the appropriate box, review the completed report, provide substantive comments, sign, date, and return to the FOA Safety and Occupational Health Office.

INSTRUCTIONS FOR SECTION 18 - SAFETY AND OCCUPATIONAL HEALTH REVIEW

3RD REVIEW - The FOA Safety and Occupational Health Office shall review the completed report, mark the appropriate box, ensure that any inadequacies, discrepancies, etc. are rectified by the responsible supervisor and management reviewers, provide substantive comments, sign, date and forward to the FOA Commander for review, comment, and signature.

INSTRUCTION FOR SECTION 19 - COMMAND APPROVAL

4TH REVIEW - The FOA Commander shall *(to include the person designated Acting Commander in his absence)* review the completed report, comment if required, sign, date, and forward the report to the FOA Safety and Occupational Health Office. Signature authority shall not be delegated.

MOTOR VEHICLE INSPECTION (TRANSPORTING HAZARDOUS MATERIALS)

(Read Instructions before completing this form.)

This form applies to all vehicles which must be marked or placarded in accordance with Title 49 CFR.	1. BILL OF LADING/TRANSPORTATION CONTROL NUMBER

SECTION 1 - DOCUMENTATION	ORIGIN a.	DESTINATION b.
2. CARRIER/GOVERNMENT ORGANIZATION		
3. DATE/TIME OF INSPECTION		
4. LOCATION OF INSPECTION		
5. OPERATOR(S) NAME(S)		
6. OPERATOR(S) LICENSE NUMBER(S)		
7. MEDICAL EXAMINER'S CERTIFICATE*		

8. *(X if satisfactory at origin)*

a. HAZMAT ENDORSEMENT		d. ERG OR EQUIVALENT COMMERCIAL:		YES		NO	
b. VALID LEASE*		e. DRIVER'S VEHICLE INSPECTION REPORT*					
c. ROUTE PLAN		f. COPY OF 49 CFR PART 397					

9. CVSA DECAL DISPLAYED ON COMMERCIAL EQUIPMENT*	YES	NO
a. TRUCK/TRACTOR		
b. TRAILER		

SECTION II - MECHANICAL INSPECTION

All items shall be checked on empty equipment prior to loading. Items with an asterisk shall be checked on all incoming loaded equipment.

10. TYPE OF VEHICLE(S)	11. VEHICLE NUMBER(S)

12. PART INSPECTED *(X as applicable)*	ORIGIN (1)		DESTINATION (2)			ORIGIN (1)		DESTINATION (2)		COMMENTS (3)
	SAT	UNSAT	SAT	UNSAT		SAT	UNSAT	SAT	UNSAT	
a. SPARE ELECTRICAL FUSES					k. EXHAUST SYSTEM					
b. HORN OPERATIVE					l. BRAKE SYSTEM*					
c. STEERING SYSTEM					m. SUSPENSION					
d. WINDSHIELD/WIPERS					n. COUPLING DEVICES					
e. MIRRORS					o. CARGO SPACE					
f. WARNING EQUIPMENT					p. LANDING GEAR*					
g. FIRE EXTINGUISHER*					q. TIRES, WHEELS, RIMS					
h. ELECTRICAL WIRING					r. TAILGATE/DOORS*					
i. LIGHTS AND REFLECTORS					s. TARPAULIN*					
j. FUEL SYSTEM*					t. OTHER *(Specify)*					

13. INSPECTION RESULTS *(X one)* ACCEPTED ☐ REJECTED ☐

(If rejected give reason under "Remarks". Equipment will be approved if deficiencies are corrected prior to loading.)

14. SATELLITE MOTOR SURVEILLANCE SYSTEM: *(X one)* ACCEPTED ☐ REJECTED ☐

15. REMARKS

16. INSPECTOR SIGNATURE *(Origin)*	17. INSPECTOR SIGNATURE *(Destination)*

SECTION III - POST LOADING INSPECTION

This section applies to Commercial and Government/Military vehicles. All items will be checked prior to release of loaded equipment and shall be checked on all incoming loaded equipment.

	ORIGIN (1)		DESTINATION (2)		COMMENTS (3)
	SAT	UNSAT	SAT	UNSAT	
18. LOADED IAW APPLICABLE SEGREGATION/COMPATIBILITY TABLE OF 49 CFR					
19. LOAD PROPERLY SECURED TO PREVENT MOVEMENT					
20. SEALS APPLIED TO CLOSED VEHICLE; TARPAULIN APPLIED ON OPEN EQUIPMENT					
21. PROPER PLACARDS APPLIED					
22. SHIPPING PAPERS/DD FORM 2890 FOR GOVERNMENT VEHICLE SHIPMENTS					
23. COPY OF DD FORM 626 FOR DRIVER					
24. SHIPPED UNDER DOT SPECIAL PERMIT 868					

25. INSPECTOR SIGNATURE *(Origin)*	26. DRIVER(S) SIGNATURE *(Origin)*
27. INSPECTOR SIGNATURE *(Destination)*	28. DRIVER(S) SIGNATURE *(Destination)*

INSTRUCTIONS

SECTION I - DOCUMENTATION

General Instructions.

All items (2 through 9) will be checked at origin prior to loading. Items with an asterisk (*) apply to commercial operators or equipment only. Only Items 2 through 7 are required to be checked at destination.

Items 1 through 5. Self explanatory.

Item 6. Enter operator's Commercial Driver's License (CDL) number or Military OF-346 License Number. CDL and OF-346 must have the HAZMAT and other appropriate endorsements IAW 49 CFR 383.

Item 7. *Enter the expiration date listed on the Medical Examiner's Certificate.

Item 8.a. Hazardous Materials Certification. In accordance with applicable service regulations, ensure operator has been certified to transport hazardous materials. Check the expiration date on driver's HAZMAT Certification.

b. *Valid Lease. Shipper will ensure a copy of the appropriate contract or lease is carried in all leased vehicles and is available for inspection. (49 CFR 376.12 and 376.11(c)(2)).

c. Route Plan. Prior to loading any Hazard Class/Division 1.1, 1.2, or 1.3 (Explosives) for shipment, ensure that the operator possesses a written route plan in accordance with 49 CFR Part 397. Route Plan requirements for Hazard Class 7 (Radioactive) materials are found in 49 CFR 397.101.

d. Emergency Response Guidebook (ERG) or Equivalent. Commercial operators must be in possession of an ERG or equivalent document. Shipper will provide applicable ERG page(s) to military operators.

e. *Driver's Vehicle Inspection Report. Review the operator's Vehicle Inspection Report. Ensure that there are no defects listed on the report that would affect the safe operation of the vehicle.

f. Copy of 49 CFR Part 397. Operators are required by regulation to have in their possession a copy of 49 CFR Part 397 (Transportation of Hazardous Materials Driving and Parking Rules). If military operators do not possess this document, shipper will provide a copy to operator.

Item 9. *Commercial Vehicle Safety Alliance (CVSA) Decal. Check to see if equipment has a current CVSA decal and mark applicable box. Vehicles without CVSA, check documentation of the last vehicle periodic inspection and perform DD Form 626 inspection.

SECTION II - MECHANICAL INSPECTION

General Instructions.

All items (12.a. through 12.t.) will be checked on all incoming empty equipment prior to loading. All UNSATISFACTORY conditions must be corrected prior to loading. Items with an asterisk (*) shall be checked on all incoming loaded equipment. Unsatisfactory conditions that would affect the safe off-loading of the equipment must be corrected prior to unloading.

SECTION II *(Continued)*

Item 12.a. Spare Electrical Fuses. Check to ensure that at least one spare fuse for each type of installed fuse is carried on the vehicle as a spare or vehicle is equipped with an overload protection device (circuit breaker). (49 CFR 393.95)

b. Horn Operative. Ensure that horn is securely mounted and of sufficient volume to serve purpose. (49 CFR 393.81)

c. Steering System. The steering wheel shall be secure and must not have any spokes cracked through or missing. The steering column must be securely fastened. Universal joints shall not be worn, faulty or repaired by welding. The steering gear box shall not have loose or missing mounting bolts or cracks in the gear box mounting brackets. The pitman arm on the steering gear output shaft shall not be loose. Steering wheel shall turn freely through the limit of travel in both directions. All components of a power steering system must be in operating condition. No parts shall be loose or broken. Belts shall not be frayed, cracked or slipping. The power steering system shall not be leaking. (49 CFR 396 Appendix G)

d. Windshield/Wipers. Inspect to ensure that windshield is free from breaks, cracks or defects that would make operation of the vehicle unsafe; that the view of the driver is not obscured and that the windshield wipers are operational and wiper blades are in serviceable condition. Defroster must be operative when conditions require. (49 CFR 393.60, 393.78 and 393.79)

e. Mirrors. Every vehicle must be equipped with two rear vision mirrors located so as to reflect to the driver a view of the highway to the rear along both sides of the vehicle. Mirrors shall not be cracked or dirty. (49 CFR 393.80)

f. Warning Equipment. Equipment must include three bidirectional emergency reflective triangles that conform to the requirements of FMVSS No. 125. FLAME PRODUCING DEVICES ARE PROHIBITED. (49 CFR 393.95)

g. Fire Extinguisher. Military vehicles must be equipped with one serviceable fire extinguisher with an Underwriters Laboratories rating of 10 BC or more. (Commercial motor vehicles must be equipped with one serviceable 10 BC Fire Extinguisher). Fire extinguisher must be located so that it is readily accessible for use and securely mounted on the vehicle. The fire extinguisher must be designed, constructed and maintained to permit visual determination of whether it is fully charged. (49 CFR 393.95)

h. Electrical Wiring: Electrical wiring must be clean and properly secured. Insulation must not be frayed, cracked or otherwise in poor condition. There shall be no uninsulated wires, improper splices or connections. Wires and electrical fixtures inside the cargo area must be protected from the lading. (49 CFR 393.28)

INSTRUCTIONS

SECTION II *(Continued)*

i. Lights/Reflectors. (Head, tail, turn signal, brake, clearance, marker and identification lights, Emergency Flashers). Inspect to see that all lighting devices and reflectors required are operable, of proper color and properly mounted. Ensure that lights and reflectors are not obscured by dirt or grease or have broken lenses. High/Low beam switch must be operative. Emergency Flashers must be operative on both the front and rear of vehicle. (49 CFR 393.24, 25, and 26)

j. Fuel System. Inspect fuel tank and lines to ensure that they are in serviceable condition, free from leaks, or evidence of leakage and securely mounted. Ensure that fuel tank filler cap is not missing. Examine cap for defective gasket or plugged vent. Inspect filler necks to see that they are in completely serviceable condition and not leaking at joints. (49 CFR 393.83)

k. Exhaust System. Exhaust system shall discharge to the atmosphere at a location to the rear of the cab or if the exhaust projects above the cab, at a location near the rear of the cab. Exhaust system shall not be leaking at a point forward of or directly below the driver compartment. No part of the exhaust system shall be located where it will burn, char or damage electrical wiring, fuel system or any other part of the vehicle. No part of the exhaust system shall be temporarily repaired with wrap or patches. (49 CFR 393.83)

l. Brake System (to include hand brakes, parking brakes and Low Air Warning devices). Check to ensure that brakes are operational and properly adjusted. Check for audible air leaks around air brake components and air lines. Check for fluid leaks, cracked or damaged lines in hydraulic brake systems. Ensure that parking brake is operational and properly adjusted. Low Air Warning devices must be operative. (49 CFR 393.40, 41, 42, 43, 44, 45, 47, 48, 49, 50, 51, 52, 53, and 55)

m. Suspension. Inspect for indications of misaligned, shifted or cracked springs, loosened shackles, missing bolts, spring hangers unsecured at frame and cracked or loose U-bolts. Inspect for any unsecured axle positioning parts, and sign of axle misalignment, broken torsion bar springs (if so equipped). (49 CFR 393.207)

n. Coupling Devices (Inspect without uncoupling). Fifth Wheels: Inspect for unsecured mounting to frame or any missing or damaged parts. Inspect for any visible space between upper and lower fifth wheel plates. Ensure that the locking jaws are around the shank and not the head of the kingpin. Ensure that the release lever is seated properly and safety latch is engaged. Pintle Hook, Drawbar, Towbar Eye and Tongue and Safety Devices: Inspect for unsecured mounting, cracks, missing or ineffective fasteners (welded repairs to pintle hook is prohibited). Ensure safety devices (chains, hooks, cables) are in serviceable condition and properly attached. (49 CFR 393.70 and 71)

o. Cargo Space. Inspect to ensure that cargo space is clean and free from exposed bolts, nuts, screws, nails or inwardly projecting parts that could damage the lading. Check floor to ensure it is tight and free from holes. Floor shall not be permeated with oil or other substances. (49 CFR 393.84)

p. Landing Gear. Inspect to ensure that landing gear and assembly are in serviceable condition, correctly assembled, adequately lubricated and properly mounted.

SECTION II *(Continued)*

q. Tires, Wheels and Rims: Inspect to ensure that tires are properly inflated. Flat or leaking tires are unacceptable. Inspect tires for cuts, bruises, breaks and blisters. Tires with cuts that extend into the cord body are unacceptable. Thread depth shall not be less than: 4/32 inches for tires on a steering axle of a power unit, and 2/32 inches for all other tires. Mixing bias and radial on the steering axle is prohibited. Inspect wheels and rims for cracks, unseated locking rings, broken, loose, damaged or missing lug nuts or elongated stud holes. (49 CFR 393.75)

r. Tailgate/Doors. Inspect to see that all hinges are tight in body. Check for broken latches and safety chains. Doors must close securely. (49 CFR 177.835(h))

s. Tarpaulin. If shipment is made on open equipment, ensure that lading is properly covered with fire and water resistant tarpaulin. (49 CFR 177.835(h))

t. Other Unsatisfactory Condition. Note any other condition which would prohibit the vehicle from being loaded with hazardous materials.

Item 14. For AA&E and other shipments requiring satellite surveillance, ensure that the Satellite Motor Surveillance System is operable. The DTTS Message Display Unit, when operative, will display the signal "DTTS ON". The munitions carrier driver, when practical, will position the DTTS message display unit in a manner that allows the shipping inspector or other designated shipping personnel to observe the "DTTS ON" message without climbing aboard the cab of the motor vehicle.

SECTION III - POST LOADING INSPECTION

General Instructions.

All placarded quantities items will be checked prior to the release of loaded equipment. Shipment will not be released until deficiencies are corrected. All items will be checked on incoming loaded equipment. Deficiencies will be reported in accordance with applicable service regulations.

Item 18. Check to ensure shipment is loaded in accordance with 49 CFR Part 177.848 and the applicable Segregation or Compatibility Table of 49 CFR 177.848.

Item 19. Check to ensure the load is secured from movement in accordance with applicable service outload drawings.

Item 20. Check to ensure seal(s) have been applied to closed equipment; fire and water resistant tarpaulin applied on open equipment.

Item 21. Check to ensure each transport vehicle has been properly placarded in accordance with 49 CFR 172.504.

Item 22. Check to ensure operator has been provided shipping papers that comply with 49 CFR 172.201 and 202. For shipments transported by Government vehicle, shipping paper will be DD Form 2890.

Item 23. Ensure operator(s) sign DD Form 626, are given a copy and understand the hazards associated with the shipment.

Item 24. Applies to Commercial Shipments Only. If shipment is made under DOT Special Permit 868, ensure that shipping papers are properly annotated and copy of Special Permit 868 is with shipping papers.

Item 26. Ensure driver/operator signs DD Form 626 at origin.

Item 28. Ensure driver/operator signs DD Form 626 at destination.

OMB No. 1140-0026 (07/31/2014)

U.S. Department of Justice
Bureau of Alcohol, Tobacco, Firearms and Explosives

Report of Theft or Loss-Explosive Materials

For ATF Use Only		
Date Received	Date Faxed to JSOC & Field Division	Unique Identifier
		Case Number

To Be Completed By Person Making Report

Upon discovery of any theft or loss of any of your explosive materials:
- First, contact ATF toll free at 1-800-461-8841 between 8:00 a.m. - 5:00 p.m. EST or after hours and weekends contact ATF at 1-800-800-3855 to report the theft or loss;
- Second, contact your local law enforcement office to report the theft or loss to obtain a police report; and
- Third, complete this form and attach any additional reports, sheets or invoices necessary to provide the required information, and fax the form with additional material(s) to the ATF U.S. Bomb Data Center (USBDC) at 866-927-4570 or email to USBDC@atf.gov.

1. Date

2. Type of Report *(Check one)*: ☐ Theft ☐ Loss ☐ Attempted Theft/Suspicious Activity ☐ Supplement

3. Full Name of Person Making the Report *(Last, First, Middle)*

4a. Licensee or Permittee Name

4b. Federal Explosives License or Permit Number

5a. Office Address *(Street Address, City, State, and Zip Code)*

5b. Telephone Number

5c. E-mail Address

6. Actual Location of Theft or Loss *(If different from item 5a)*

7. Theft or Loss	Date	Time
a. Discovered		
b. When Was the Magazine Last Checked		
c. Occurred *(Show approximate if exact not known)*		
d. Reported to ATF by Telephone		
e. Reported to Local Authorities		

8. Name of Local Law Enforcement Officer to Whom Reported

9. Name and Address of Local Authority to Whom Reported

10. Telephone Number

11. Police Report Number

12. Explosive Materials Lost or Stolen *(Attach invoices or additional sheets, if necessary)*

a. Manufacturer and/or Importer	**b. Brand Name**	**c. Date Shift Code**	**d. Size** *(Length & Diameter)*	**e. Quantity** *(Pounds of Explosives, Number of Dets)*	**f. Type and Description** *(Dynamite, Blasting Agents, Detonators, etc. Include for each type, size, MS delay or length of legwire, as applicable)*

ATF Form 5400.5
Revised July 2012

13. Theft or Loss Occurred from *(Check applicable box on each row)*

a. Magazine Type:

☐ 1 ☐ 2 ☐ 2 Det. Box ☐ 3 Day Box ☐ 4 ☐ 5

☐ Outdoor ☐ Indoor

☐ Permanent ☐ Portable ☐ Mobile Truck ☐ Mobile Trailer

☐ Overnight Storage ☐ Day Storage

b. Types of Locks *(Check all that apply)*:

☐ Padlock ☐ Mortise ☐ 3-Point ☐ Puck Lock ☐ Other *(Explain)* _____

c. Location Description/Type:

☐ Licensed/Permitted Premises ☐ Remote Storage ☐ Work Site ☐ In Transit ☐ During Operations

14. Method of Entry:

☐ Door Was a Key Used? ☐ Yes ☐ No Suspected Employee-Involved Theft? ☐ Yes ☐ No

☐ Wall(s) ☐ Roof ☐ Floor/Bottom

Lock(s) Defeated? *(If yes, check additional appropriate boxes)* ☐ Yes ☐ No

☐ Lock Shackle Cut *(How?)* _____

☐ Lock Left Unlocked

☐ Keyway Drilled Out

☐ Other *(Explain)* _____

☐ Lock Pried, Twisted or Levered

☐ Lock Picked or Shimmed

☐ Lock Body Drilled Out or Cut

Manufacturer and Model of Lock:	Location of Magazine Keys: ☐ Office ☐ Employee ☐ Other *(Address)* _____	Are All Keys Accounted For? ☐ Yes ☐ No

15. Hood Defeated? *(If yes, check all applicable)* ☐ Yes ☐ No

☐ Hood Cut

☐ Other *(Explain)* _____

☐ Hood Removed

☐ Hood Broken

Hood Width *(Inches)* _____ Hood Length (Inches) _____

Hood Depth *(Inches)* _____ Hood Thickness (Inches) _____

16. Other Information Pertinent to the Theft, Loss or Suspicious Activity *(Any details you can provide)*

16a. Was Theft or Loss Disclosed During an ATF Inspection or Being Reported as a Result of Inspection? ☐ Yes ☐ No

16b. Additional Security Measures in Place?

☐ Alarm ☐ Security System/Service ☐ Fencing ☐ Lighting ☐ Other *(Explain)* _____

17. Signature and Title of Person Making Report	18. Date

ATF Form 5400.5
Revised July 2012

Reporting Instructions

Email or fax this completed form to the ATF address listed below or call if no fax is available:

Bureau of Alcohol, Tobacco, Firearms and Explosives
U.S. Bomb Data Center
99 New York Ave., N.E. 8.S-295
Washington, DC 20226
Toll Free Fax: 1-866-927-4570
Email Address: USBDC@atf.gov

Questions regarding the completion of this form should be referred to the U.S. Bomb Data Center toll free at 1-800-461-8841.

Privacy Act Information

The following information is provided pursuant to section 3 of the Privacy Act of 1974 (5 U.S.C. § 522a(e)(3).

1. **Authority.** Solicitation of this information is made pursuant to Title XI of the Organized Crime Control Act of 1970 (18 U.S.C. Chapter 40). Disclosure of a theft or loss of explosive materials is mandatory pursuant to 18 U.S.C. § 842(k) for any person who has knowledge of such theft or loss from his stock.

2. **Purpose.** The purpose for the collection of this information is to give ATF notice of the theft or loss of explosive materials, and to furnish ATF with the pertinent facts surrounding such theft or loss. In addition, the information is used to confirm and verify prior notification of this theft or loss of explosive materials.

3. **Routine Uses.** The information will be used by ATF to aid in the administration of laws within its jurisdiction concerning the regulation of explosive materials and other related areas. In addition, the information may be disclosed to other Federal, State, foreign, and local law enforcement of laws within their jurisdiction. System of records notice Justice/ATF-008 Regulatory Enforcement Record System FR Vol.68 No.16 Page 3558 dated January 24, 2003.

4. **Effects of not supplying information requested.** 18 U.S.C. § 842(k) makes it unlawful for any person, who has knowledge of the theft or loss of explosive materials from his stock, to fail to report such theft or loss within twenty-four hours of discovery thereof, to the Secretary and to appropriate local authorities. The penalty for violation of this section is a fine of not more than $1,000 or imprisonment for not more than one year, or both. 18 U.S.C. § 844(b).

Paperwork Reduction Act Notice

This request in accordance with the Paperwork Reduction Act of 1995. The purpose of this information collection is to report the theft or loss of explosive materials. The information is used for investigative purposes by ATF officials. This information is mandatory by statute. (18 U.S.C. § 842)

The estimated average burden associated with this collection of information is 1 hour and 48 minutes per respondent or recordkeeper, depending on individual circumstances. Comments concerning the accuracy of this burden estimate and suggestions for reducing this burden should be addressed to Reports Management Officer, Document Services, Bureau of Alcohol, Tobacco, Firearms and Explosives, Washington, DC 20226.

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

SOIL SAMPLE COLLECTION FIELD SHEET

GENERAL INFORMATION

SITE NAME: _____ PROJECT NO. _____

SAMPLE NO. _____ BORING NO. _____

DATE/TIME COLLECTED: _____ PERSONNEL: _____

SAMPLE METHOD / DEPTH: _____ _____

SAMPLE MEDIA: SOIL SEDIMENT SLUDGE

SAMPLE QA SPLIT: YES NO SPLIT SAMPLE NO.

SAMPLE QC DUPLICATE: YES NO DUPLICATE SAMPLE NO.

MS/MSD REQUESTED: YES NO

SAMPLE CONTAINERS, PRESERVATIVES, ANALYSIS

Sample Container	Preservative	Analysis Requested

OVA MEASUREMENTS

Background _____

Breathing zone _____

Boring _____

Headspace _____

SAMPLE DESCRIPTION

DEPTH: _____ DESCRIPTION: _____

_____ _____

_____ _____

_____ _____

_____ _____

GENERAL COMMENTS

_____

_____

_____

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Section A **Required** Client Information:	Section B **Required** Project Information:	Section C Invoice Information:	Section D EQuIS Information:	
Company: Bay West LLC	Report To:	Attention: Accounts Payable	Facility_Code:	Page of
Address: 5 Empire Drive	Copy To:	Company Name: Bay West LLC	Subfacility_code:	
St. Paul, MN 55103		Address: 5 Empire Drive		COC#
Email To:	Purchase Order No.:	St. Paul, MN 55103		
Phone:	Project Name:	Lab Project Manager: Lori Castille		**Site Location**
Requested Due Date/TAT:	Project Number:			***STATE:***

Valid Matrix Codes

MATRIX	CODE
Sediment	SE
Soil	SO
Soil QC	SQ
Aqueous	W
Groundwater	WG
Suface	WS

ITEM #	Section E **Required** Client Information **Sample Location ID** (sys_loc_code)	**Sample ID** (sys_sample_code)	MATRIX CODE	SAMPLE TYPE (G=GRAB C=COMP)	Collection DATE	Time	# OF CONTAINERS	*Preservatives* Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	**Requested Analysis**												**Comments**
1																												
2																												
3																												
4																												
5																												
6																												
7																												
8																												
9																												
10																												
11																												
12																												

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME

SAMPLE CONDITIONS			
Temp (°C)	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)

SAMPLER NAME AND SIGNATURE

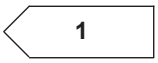
PRINT Name of SAMPLER:

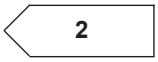
SIGNATURE of SAMPLER: **DATE Signed (MM/DD/YY):**

ACCIDENT SCENE

Instructions for Accident Diagram

Fill in dotted lines to correspond with road at accident site. Show position of all vehicles, pedestrians, etc., as follows:

Your vehicle 

Other vehicle(s) 

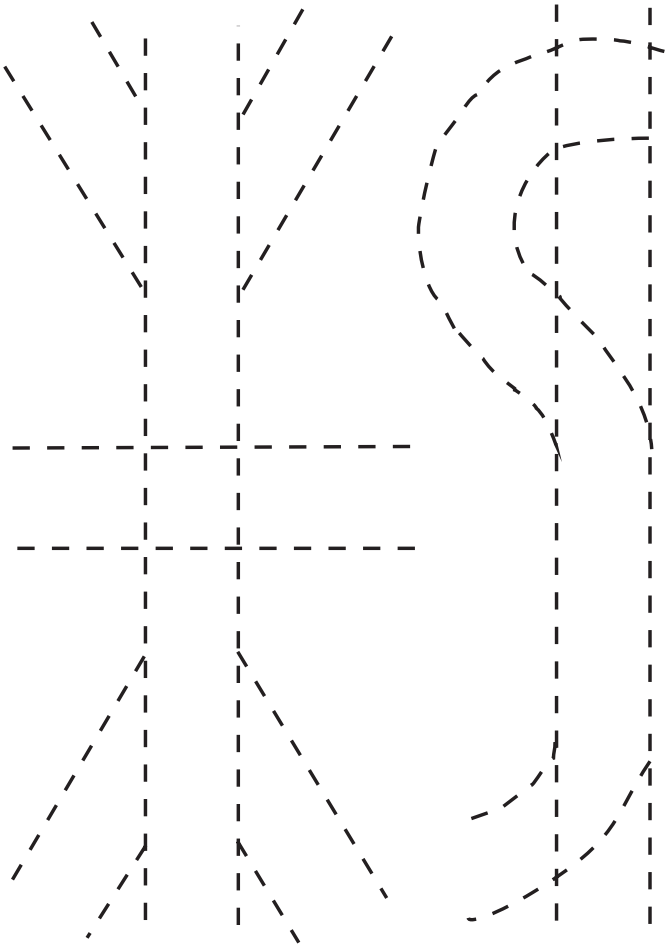
Numbered successively.

Pedestrian

Traffic signal

Traffic sign

(indicate type)



Signature _____

Date _____

DRIVER'S ACCIDENT REPORTING KIT

To Be Completed at Accident Scene

Driver's Name _____ Age _____

License No. _____

Phone No. _____

Vehicle Owner / Home Terminal _____

Equipment No. _____ Tractor: _____ TLR: _____

A. DATE, TIME, PLACE

Date _____ : Time _____ AM; _____ PM _____

In _____
(City or Town) (County) (State)

On _____
(Street or Highway)

At _____
(Street Address or Intersection)

Distance and
Direction from: _____
(Nearest community junction, etc.)

❒ Open Country ❒ Business-Shopping
❒ Residential ❒ Manufacturing-Industrial

❒ Other (Describe) _____

B. WITNESSES

Persons seeing the accident will be of service to our driver by giving their names and addresses.

NAME _____

Address _____ Phone _____

NAME _____

Address _____ Phone _____

License number and descriptions of first vehicles at scene.

_____

_____

INVESTIGATING OFFICER

Name _____

Badge No. _____ Dept. _____

Citation: You _____ Other _____

COR.OOG.0648 (9/94)

C. THOSE INVOLVED

COMPANY VEHICLE (VEHICLE #1)

Make & Model _____

Vin. No. _____ Fleet No. _____

Tag No. & State _____

OTHER VEHICLE (VEHICLE #2)

Make & Model _____

Tag No. & State _____

Driver _____

Address _____

Driver's License No. _____

Name, address and phone of owner (if not the driver) _____

_____

_____

Insurance Co. _____ Policy No. _____

OTHER VEHICLE (VEHICLE #3)

Make & Model _____

Tag No. & State _____

Driver _____

Address _____

Driver's License No. _____

Name, address and phone of owner _____

_____

_____

Insurance Co. _____ Policy No. _____

If other vehicles attach all information.

INJURED PERSONS

Number of persons injured _____ Killed _____

Name _____ Age _____

Address _____

Injuries _____

Where taken _____

Name _____ Age _____

Address _____

Injuries _____

Where taken _____

Estimate of property damage $ _____

D. TYPE OF ACCIDENT

❒ Collision with Other Vehicle ❒ Collision with Fixed Object

	Veh. 1	Veh. 2	Veh. 3
❒ Ran off Road	❒	❒	❒
❒ Overturn in Road	❒	❒	❒
❒ Mechanical Defect	❒	❒	❒
❒ Fire	❒	❒	❒
❒ Loading or Unloading	❒	❒	❒
❒ Boarding / Alighting	❒	❒	❒
❒ Occupant fell out	❒	❒	❒
❒ Occupant injured inside vehicle	❒	❒	❒

❒ Other _____

PEDESTRIAN ACTION

Crossing at Intersection ❒ Between Intersections ❒

With Signal ❒ Against Signal ❒

No Signal ❒ Diagonally ❒

Walking in Roadway ❒ Sidewalk ❒ No Sidewalk ❒

With Traffic ❒ Against Traffic ❒

Other (Describe): _____

_____

E. VEHICLE MOVEMENT

	Veh. 1	Veh. 2	Veh. 3
Straight Ahead	❒	❒	❒
Turning Right	❒	❒	❒
Turning Left	❒	❒	❒
Slowing or Stopping	❒	❒	❒
Stopped in Traffic	❒	❒	❒
Starting in Traffic	❒	❒	❒
Starting from Curb or Shoulder	❒	❒	❒
Parked	❒	❒	❒
Backing	❒	❒	❒
U-Turn	❒	❒	❒
Skidding	❒	❒	❒
Overtaking	❒	❒	❒
Weaving	❒	❒	❒
Wrong Side	❒	❒	❒
Crowded off Road	❒	❒	❒
Evasive Action	❒	❒	❒

Other _____

_____

_____

F. VEHICLE CONDITION

MECHANICAL CONDITION

	Veh. 1	Veh. 2	Veh. 3
No Defect	❒	❒	❒
Lights	❒	❒	❒
Brakes	❒	❒	❒
Tires / Wheels	❒	❒	❒
Engine	❒	❒	❒
Couplings	❒	❒	❒
Windshield / Windows	❒	❒	❒
Disabled	❒	❒	❒

Other _____

G. ROADWAY CONDITIONS AND CONTROLS

❒ Not at Intersection ❒ Bridge / Overpass
❒ Street Intersection ❒ Underpass
❒ Drive or Alley ❒ Private property
❒ Crosswalk ❒ Other off-street
Other (describe) _____
❒ Not Divided ❒ Divided ❒ Limited Access
❒ No. of Lanes 2 3 4 6 _____
(Specify)

ROAD SURFACE

❒ Lanes Marked ❒ Unmarked
❒ Concrete ❒ Gravel
❒ Blacktop ❒ Other Unpaved
❒ Metal Grating (Bridge)
❒ Other (specify) _____
❒ No Defects ❒ Mud
❒ Dry ❒ Loose Material
❒ Wet ❒ Cracks, holes, etc.
❒ Ice ❒ Fresh Oil
❒ Snow ❒ Under construction or repair _____
❒ Other (describe)
❒ Straight ❒ Level ❒ Hills ❒ Steep ❒ Moderate
❒ Curve ❒ R ❒ L ❒ Sharp ❒ Moderate

TRAFFIC CONTOLS

❒ Traffic Light ❒ RR Crossing Signal / Gate
❒ Stop Sign ❒ No Traffic Control
❒ Yield Sign ❒ Posted Speed Limit _____
❒ Police Officer ❒ Other _____
Were controls operating? ❒ Yes ❒ No

WEATHER CONDITIONS

❒ Clear ❒ Daylight
❒ Snow ❒ Dawn
❒ Sleet ❒ Sunset
❒ Fog ❒ Dark - road lighted
❒ Rain ❒ Dark - road unlighted
❒ Other (specify) _____

H. PROPERTY DAMAGE

Point of Impact

	Veh. 1	Veh. 2	Veh. 3
Front	❒	❒	❒
Rear	❒	❒	❒
Right Front	❒	❒	❒
Left Front	❒	❒	❒
Right Rear	❒	❒	❒
Left Rear	❒	❒	❒
Right Side	❒	❒	❒
Left Side	❒	❒	❒
Roof	❒	❒	❒

Other _____
Cargo Weight / Type: _____
Cargo Damage: _____
Other Property Damage: _____

I. MISCELLANEOUS INFORMATION

Time you reported for duty: _____
Total preceding hours off duty: _____
Hours since last sleep at time of going on duty: _____
Hours on duty at time of accident: _____
Total rest-stop time since going on duty: _____
Total other time, loading, etc.: _____

Place of reporting on duty: _____

Destination this trip: _____

Miles traveled this trip
until time of accident: _____

ICC Permits: _____

Trailer owned by others: Yes ❒ No ❒
If yes, by whom _____

Result of drug/alcohol tests _____

J. WHAT HAPPENED?

At what distance did you first see danger? _____ Ft.

How fast were you going? _____ MPH

What was your speed at impact? _____ MPH

How far did your vehicle go after impact? _____ Ft.

Describe in your own words the circumstances of the accident:

Describe damage to:

Your vehicle: _____

Other vehicles: _____

Cargo: _____

Property: _____

COMMENTS AND ADDITIONAL INFORMATION

Appendix D

Standard Operating Procedures (SOPs)

List of SOPs

1. **Data Acquisition**
2. **Data Processing**
3. **Sample Custody**
4. **Sediment Sampling**
5. **Soil Sampling**
6. **Analog Operations**
7. **Anomaly Avoidance**
8. **MEC Disposal**
9. **Intrusive Operations**
10. **Surface Clearance**
11. **Vegetation Removal**
12. **Surface Water Sampling**
13. **Target Reacquisition**
14. **Classification and Description of Soil, Sediment and Rock**
15. **Field Equipment Decontamination**
16. **Packaging and Shipping of Environmental Samples**
17. **Soil Sampling (Incremental Sampling Methodology)**

Standard Operating Procedures for DGM Data Acquisition

(DGM -001)

EM61 MK2

1. Purpose

The purpose of this standard operating procedure (SOP) is to provide procedures and technical guidance on performing digital geophysical mapping (DGM).

2. Equipment

This SOP is applicable for the Geonics EM61-MK2 and Leica Differential Global Positioning System (DGPS) and Robotic Total Station (RTS) systems.

The EM61-MK2 is a high-resolution time-domain electromagnetic instrument designed to detect shallow ferrous and non-ferrous metallic objects. The Standard EM61-MK2 system consists of two coils, a digital data recorder, batteries and processing electronics. The EM61-MK2's transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects. Each of the two spatially separated receiver coils measures these eddy currents. The EM61-MK2 measures the eddy currents at four distinct time intervals in the bottom coil or at three intervals on the bottom and one on the top coil. For this work, the top coil will not be used. The secondary EM fields will be measured at 216, 366, 660 and 1266 microseconds after the transmitter current has turned off with the lower coil. These time gates are typically referred to a Channels 1-4 respectively. The secondary voltages induced in the coil are measured in millivolts (mV). The data is collected into Geonics' EM61MK2 or Geomar's Nav61MK2 program and temporarily stored in an Allegro CX prior to downloading to a laptop computer.

Leica GPS 1200 series and VIVA RTK-DGPS systems provide sub-centimeter accuracy and can be combined with DGM data in real-time. The reported accuracy for real-time corrections is 8mm + 1 ppm (horz.), and 15mm + 1ppm (vertical).

The Leica TPS1200 RTS precision angle-measurement system uses a visible red laser, has auto-lock capability, and measures to prisms and reflective tape. The range is 3 km to a single prism and the accuracy is 1 mm + 1.5 ppm.

3. DGM Procedures

The following are the standard procedures for DGM data collection.

3.1 Instrument Standardization

All instruments will be assembled and calibrated (where required) as specified in their User Manuals. Additionally, each instrument will be field tested daily to ensure that the instrument is operating properly and capable of meeting the project MPC detailed in the Work Plan. If at any time it is determined that a piece of equipment requires maintenance or calibration it will be removed from production until necessary maintenance or calibration has been performed and the geophysical system has been verified to meet the criteria.

3.2 Navigation

Depending on site conditions, navigation of the system is accomplished through either Fiducial (FID) method, GPS method, or RTS method.

3.2.1 The FID method is used in wooded areas where GPS/RTS positioning is unavailable. This

method uses painted ropes and/or flags positioned across each grid for the placement of fiducial marks within the recorded data. Local coordinates are warped to geodetic using reference locations (stakes) surveyed in by licensed surveyors on evenly spaced centers. Grid lanes must be set to the project defined line-spacing and fiducial markers must be present at a minimum of every 25 ft.

3.2.2 The second method of navigation is GPS. The base station is setup on a control point and corrections are sent via radio link to the rover receiver. The rover GPS antenna is mounted over the center of the EM61-MK2 coil and provides real time positional tracking capabilities that is streamed into the same software program as the EM61-MK2 data. Work instructions for setting up the GPS are in Attachment 3 of this SOP. GPS must demonstrate the accuracy required to meet the project objectives.

3.2.3 The third method of navigation is RTS. The RTS uses known points, typically the surveyed grid corners, to provide geodetic locations based on reflection time calculations for calibrated lasers and a prism located above the DGM coil. The positional data recorded by the RTS is merged with the EM61 data in post processing. Geodetic locations can also be reacquired using the RTS. Work instructions for setting up the RTK are not attached to this SOP but will be provided for review if it is determined that the positioning system is needed at this site. RTS must demonstrate the accuracy required to meet the project objectives.

3.3 Instrument Setup

When the instrument is operated in wheel mode, it is setup according to Geonics EM61- MK2 manual. For litter mode, the EM61-MK2 coils are centered and suspended on two fiberglass poles. The instrument is attached to the poles using PVC/fiberglass standoffs, zip ties and/or webbing so that the coil height meets the project requirements when the litter is carried. For skirt mode a 1m x 1m coil is worn like a skirt with an adjustable harness that should be set to the project defined coil height. For all modes of data collection, the cables are taped and secured to prevent them from getting tangled and possibly disturbed by movement or vegetation. If GPS/RTS is used, a PVC or fiberglass GPS mount is used to position the receiver/prism over the center of the coil.

For the EM61s utilized in a vehicle towed array (VTA) the array should arrive at the site already constructed or with detailed instructions on how to assemble the array platform.

3.4 Data Acquisition

Whether the survey area is established as grids or as transect lines, the EM61-MK2 is operated at a walking pace by one or two people. In the case of the VTA, the cart is towed with an ATV at a speed less than 4mph, unless a higher speed is demonstrated at the IVS. For fiducially positioned data, the data will be collected on wheels at one reading/10 cm or in litter or skirt mode with readings triggered at 10 readings/second. Selection of the appropriate method is based primarily on local terrain conditions. When GPS or RTS positioning is used, data are collected in automatic mode at 10 readings/second regardless of collection method. During data collection the battery level will be monitored and the battery will be replaced immediately if the voltage drops below 11.5. Specific work instruction for data collection using different navigational methods can be found in Attachments 1 and 2 of this SOP. These work instructions are intended to be used following all daily QC requirements outlined in Table 7-3 of the Work Plan. These requirements are not repeated here in an effort to prevent inconsistency, but the field teams will be trained on all requirements for DGM data collection.

3.5 Data Storage and Preliminary Processing

Man-portable EM61-MK2 data are temporarily stored in the Allegro data logger via Geonics' EM61MK2 or Geomar's NAV61 software and then downloaded into a laptop computer for further on-site processing using Geonics' DAT61MK2 or Geomar's Trackmaker and Geosoft Oasis Montaj software. VTA data are collected on a field laptop with the Geomar Multi61 software and processed using the same software as man-portable data. When GPS is used the positional data is merged with the EM61 data in real-time and stored in the same way. RTS data is stored on the robot and downloaded to a field laptop at the end of each day.

4. Documentation

If grids are defined, each grid shall be documented on a Field Data Sheet similar to the one found in Attachment 4 of this SOP. For VTA sites each distinct area will be documented on the Field Data Sheet. One member of each DGM team will be responsible for maintaining the field notes which can be digital or written in a log book. An example of field notes for fiducial data is shown at the end of Attachment 1. Attachment 5 of this SOP contains additional examples of documentation for DGM. The information shown on these checklists must be recorded either digitally or on paper for each day DGM data is collected or at the frequency defined in the Work Plan.

5. Quality Control

Quality control activities are discussed in the Work Plan and in the Geophysical Verification Plan. The geophysical system must meet the defined MPCs at the frequency defined in the Work Plan in order for the data to be considered usable. All non-conformances must be reported and followed by a root-cause analysis.

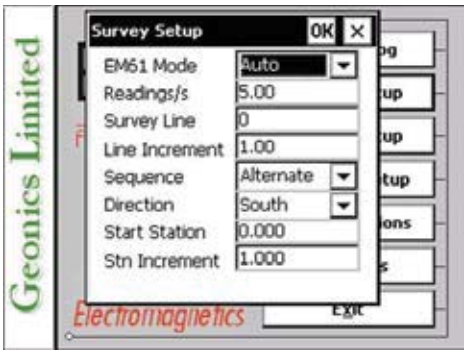
Attachment 1: Data Collection with Fiducial or RTS

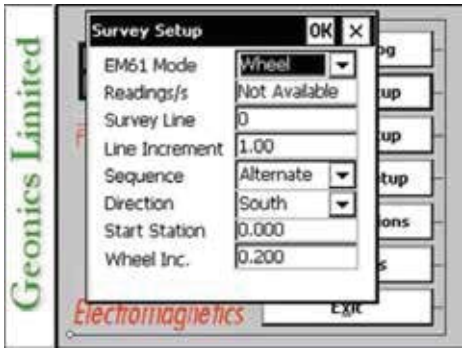
Data collection Steps

The following steps are followed to begin surveying with the **EM61-MK2 with fiducial or RTS positioning**:

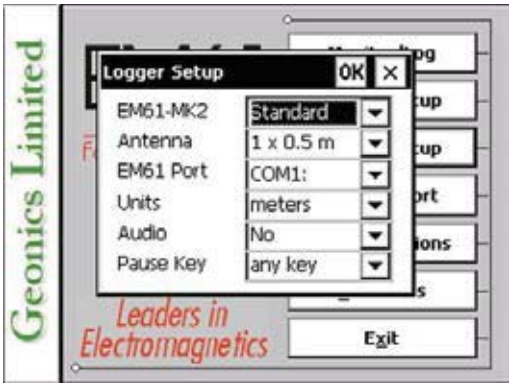
1. Turn on the EM61-MK2 by pushing in the fuse on the top of the console/electronics. Switches should be set to “4” and “M”.
2. Allow the instrument to warm up for at least 15 minutes.
3. Turn on the Allegro CX, and open the EM61MK2 program. The screen below will be displayed.

4. Click on “Survey Setup”, and specify the following options. Depending on surface conditions, the Mode is set to “Auto” and Readings/s is set to “10” (auto mode should be used for RTS) or the Mode is set to “Wheel”, Readings/s to “Not Available”, and Wheel Inc. to 0.1. The remaining options become important for maintaining positioning. When in Auto mode it is crucial that the operator walk at a consistent pace for fiducial data. When in Wheel mode it is crucial that the operator maintains contact between the cart wheels and the ground to insure accurate distances are measured.

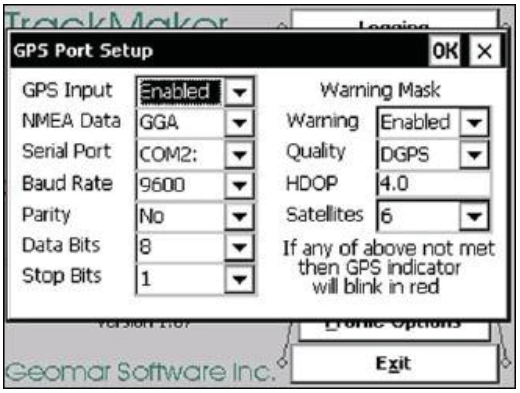




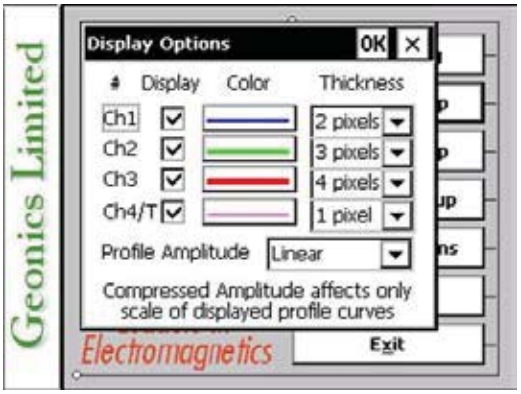
5. Click on “Logger Setup”, and specify the following options. These settings will remain as defaults throughout the project.



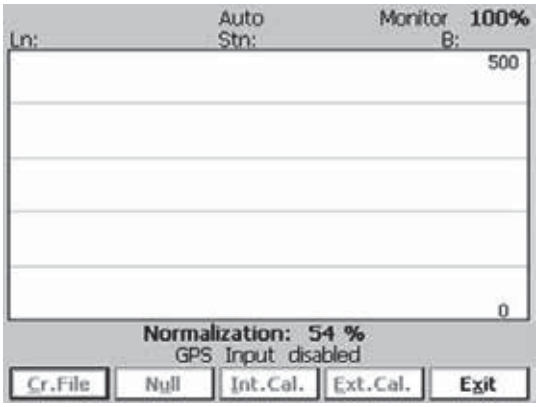
6. Click on “GPS Port Setup”, and make sure the *GPS Input* is set to “Disabled”, and all other options are grayed out.



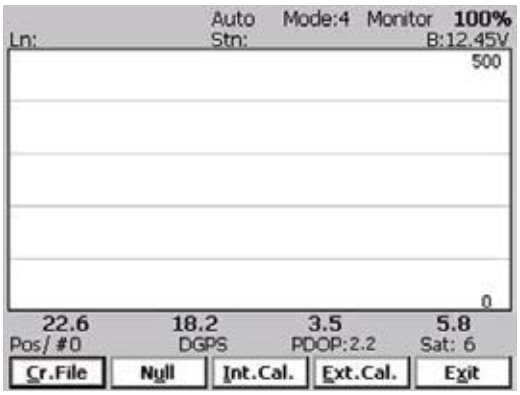
7. Click on “Display Options”, and specify the following options. These options are also operator preferences for aesthetics and do not affect the collected data.

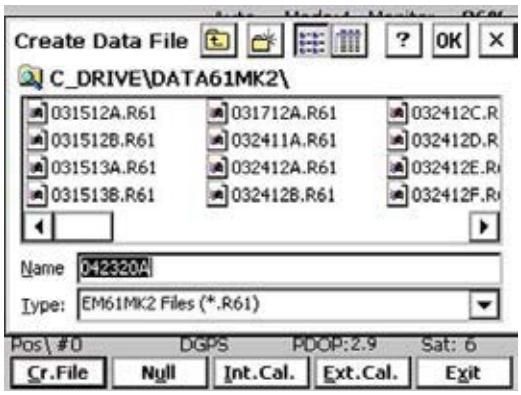


8. Once all parameters are set, click on “Monitor/Log”. The screens shown below will be displayed while the instrument is normalizing.

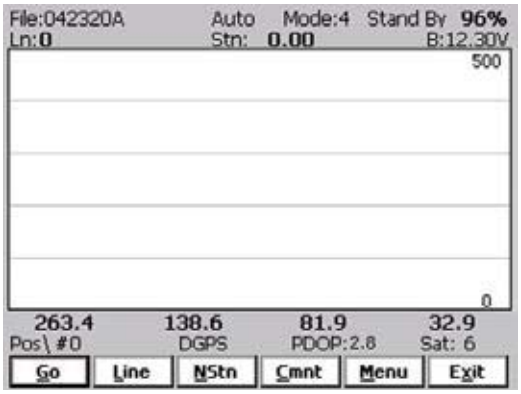


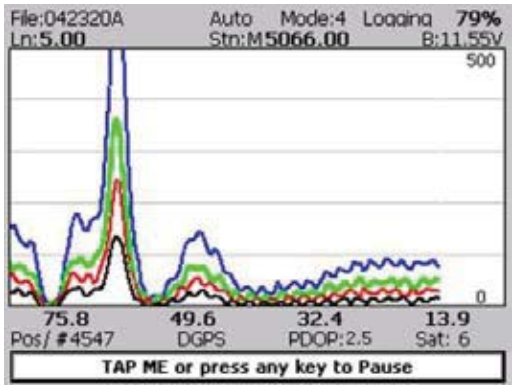
9. Once the Instrument has finished normalizing, find a quiet spot and *Null* the instrument. Then click on *Cr. File* and name and save the file.





10. Perform daily QC checks.
11. Line up on the grid or transect and select *Go*. The software will begin logging the readings, and a *Pause* button will appear at the bottom of the screen. As the operator crosses over each rope (reference location) the fiducial button is hit adding a marker
in the data which is later used in the editing of the data to accurately position the data. At the end of the line, tap the *Pause* button or hit enter on the keypad.





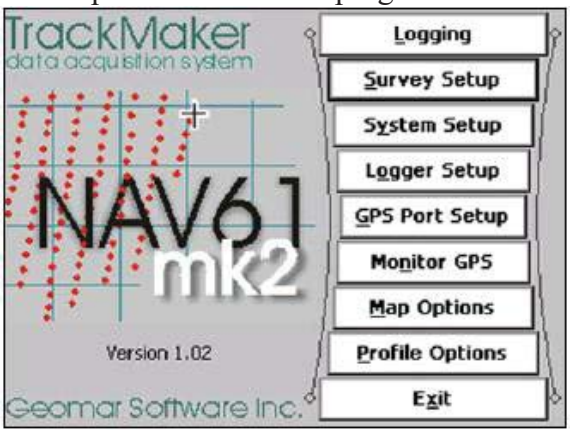
12. On the screens shown above, the EM61-MK2 data are monitored.
13. At the end of the file, select the *Exit* button. The file automatically saves at the end of every line.
14. Start and stop stations should be noted for each obstacle encountered on a line for fiducially positioned data.

Dataset ID: 010515A1G3			
Date: 10/01/2013			
Person Collecting: MDW			
Note Taker: EMG			
File: 010515A1G3			
Fiducial Locations: 24, 49, 101, 151, 174, 204			
Line	Start	Stop	Comments
0	0	92	tree
0a	95	118	tree
0b	121	157	streeump
0c	159	204	
2.5	204	172	tree
2.5a	170	166	tree
2.5b	164	0	
5	0	16	tree
5a	21	64	tree
5b	67	72	tree
5c	75	174	tree
5d	177	204	
7.5	204	176	tree
7.5a	173	155	trees
7.5b	151	19	tree
7.5c	16	0	
10	0	94	tree
10a	97	113	trees
10b	116	154	trees

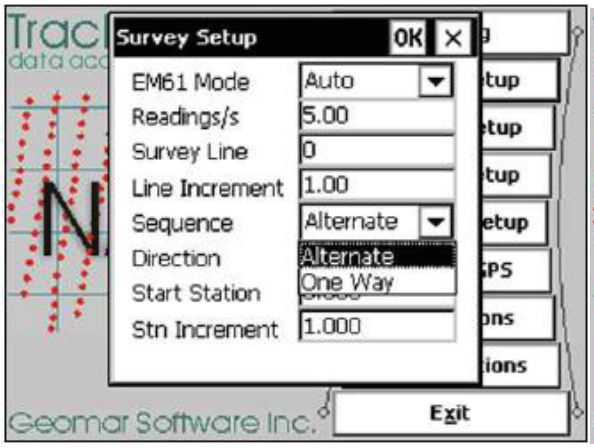
Attachment 2: Man-Portable Data Collection with RTK DGPS

The following steps are followed to begin surveying with the **EM61-MK2 with RTK GPS positioning:**

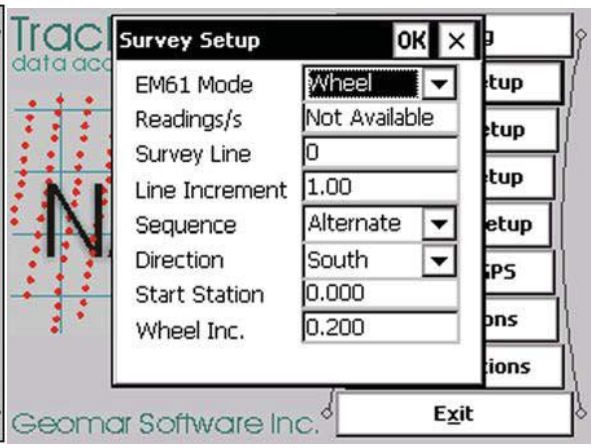
1. Turn on instrument by pushing in the fuse on the top of the console/electronics. Switches should be set to "4" and "M".
2. Allow instrument to warm up for at least 15 minutes
3. Turn on Allegro CX and open NAV61MK2 program. The screen below will be displayed.



4. Click on "Survey Setup" and specify the below options. For this GPS/RTK Method, the Mode is set to "Auto" and Readings/s is set to "10". For Fid Method, the Mode is set to "Wheel", Readings/s is "Not Available", and Wheel Inc. now shows up instead of Stn Increment and it is set to 0.1. If the data is collected in locals using fiducials, the remaining options become important for maintaining positioning.

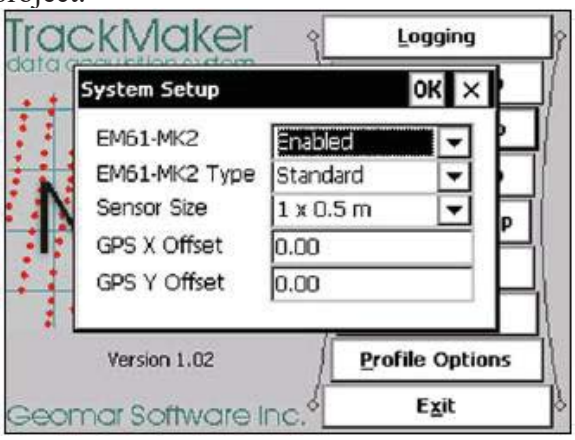


GPS/RTK Method

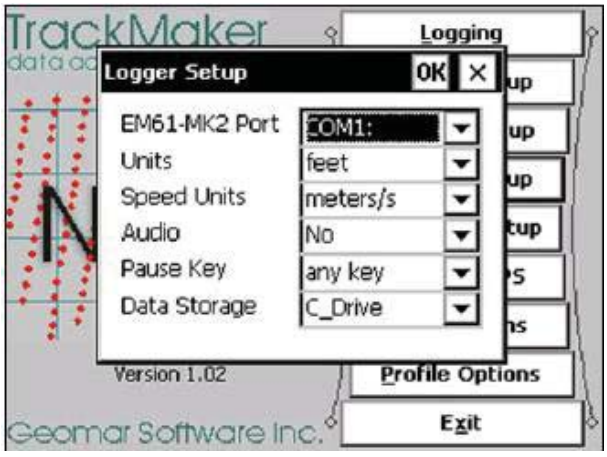


Fiducial Method

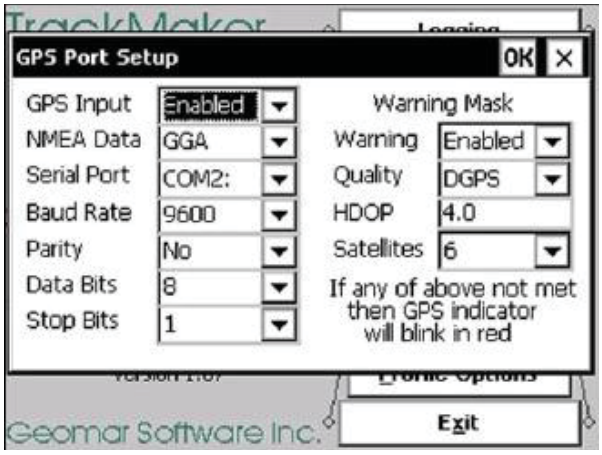
5. Click on "System Setup" and specify the below options. These setting will usually remain the same throughout the project.



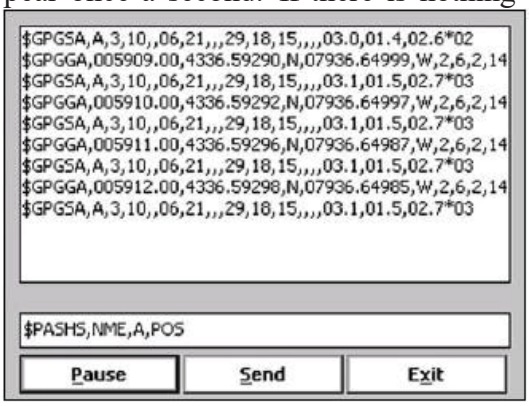
6. Click on "Logger Setup" and specify the below options. These setting will remain the same throughout the project.

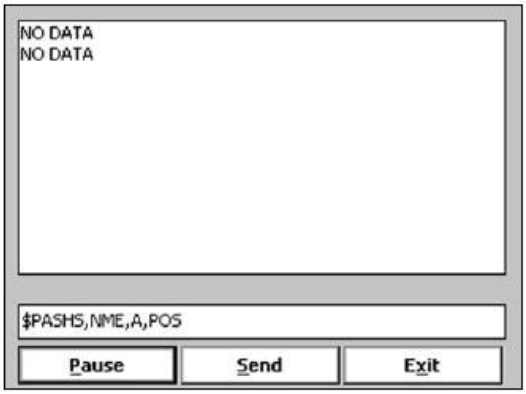


7. Click on "GPS Port Setup" and specify the below options. When using GPS the below setting will be used. For Fiducials, the *GPS Input* is set to "Disabled" and everything else is grayed out. On the left side of the screen is where parameters can be set for alerts to go off if the GPS string is inadequate.

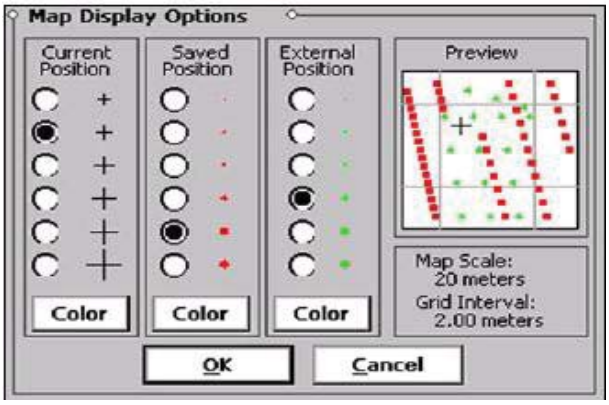


8. Click on "Monitor GPS" and the below window will open. If the NMEA string is coming in correctly, the screen will appear like the one on the left. If there is a problem with the baud rate, "No Data" will appear once a second. If there is nothing coming through "No Data" will flash once every 6 seconds.

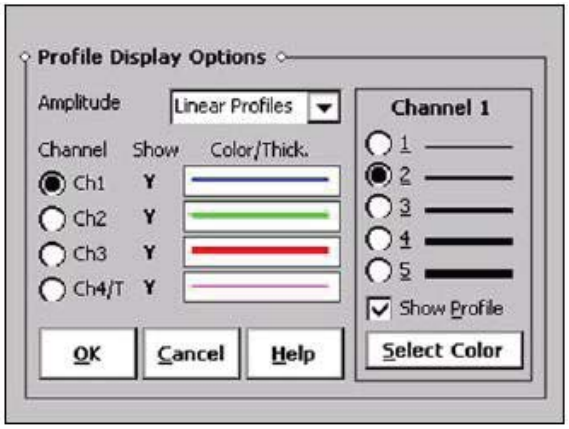




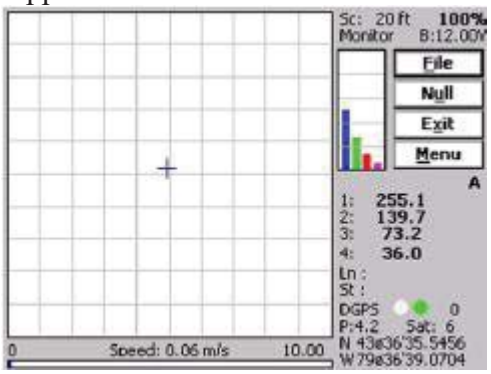
9. Click on "Map Options" and specify the below options. These are more operator preferences for aesthetics then for performance of the software.

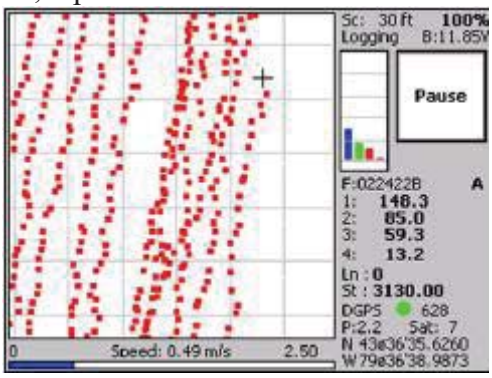


10. Click on "Profile Options" and specify the below options. These are more operator preferences for aesthetics then for performance of the software.



11. Once all the parameters are set click on the logging screen. The below screens will be displayed. Find a quiet spot and *Null* the instrument, then click on *File* and name your file and save it. Line up on the grid or transect and select *Go*. The software will start logging the readings and a large *Pause* button will appear on the screen. At the end of the line, tap the *Pause* button or hit enter on the keypad.

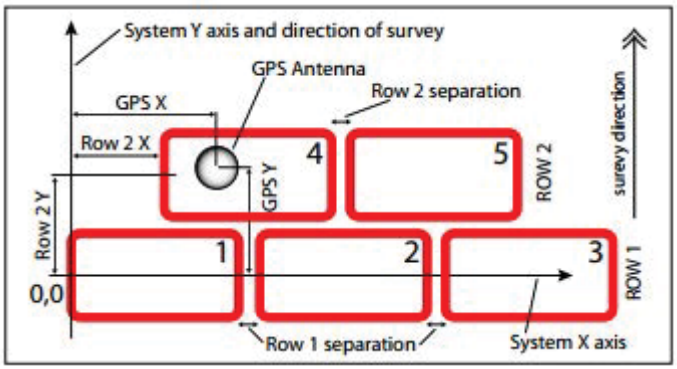


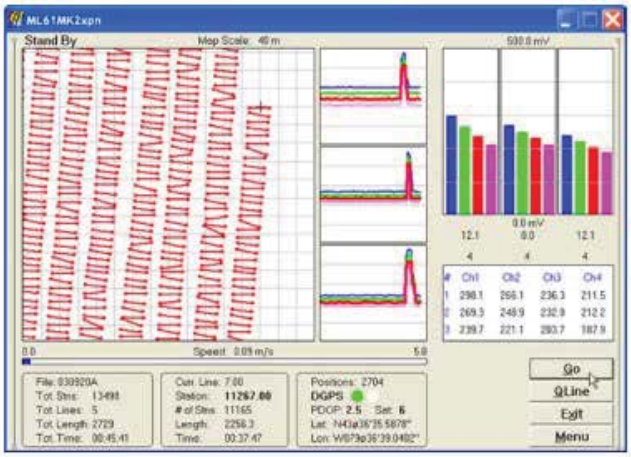


12. On the above screens, both the EM61-MK2 data and the GPS/RTK data are monitored, as well as the data coverage.
13. At the end of the file, the *Exit* button is selected. The file automatically saves at the end of every line.

VTA Data Collection

For data collected with Geomars Multi61 software follow the same instructions for the TrackMaker software after setting up the array configuration using the figure below on the left for guidance.





The data collection display will look like the figure above on the right.

Attachment 3: DGPS Set-up

The Leica Base Station (or "Reference") is setup on a benchmark with known coordinates. Then, as the receiver determines its location from the satellites, it compares these "calculated" positions to the know coordinates to determine the error in the calculated position. These errors can be recorded, and used to "correct" data collected by various GPS receivers in the field ("Rovers"), as long as the data from the Rovers is collected simultaneously with the reference data.

The use of a reference to provide error corrections forms the basis of "Differential GPS" and has dramatically improved the accuracy of GPS systems from several meters to less than a few centimeters. Error corrections are broadcast (via radio modem) to rover units (also equipped with radio modems) to correct data in "real-time".

The following procedure describes the basic setup of the Leica Base Station for use as a reference for Differential GPS applications:

- Equipment Needed:
    - Tripod – Two each
    - Batteries – One 12-volt, two large lithium, one small lithium
    - Base station (red box) – with Leica Viva
    - Radio transmitter (black box) – Pacific Crest
- Set-up Base:
    - Set-up Base tri-pod over known base point as level as possible. If it is not initially level you can adjust each leg by raising or lowering it to make it level.
    - Open red box, open back flap with the two Velcro straps.
    - Retrieve base level pad with level bubble on it.

    - Set level pad on the tri-pod plate and screw in lightly from the bottom. Leave enough slack on the screw to adjust.
    - Looking through the peep sight, center level pad over known point (should appear as a black dot through the peep sight).
    - Level bubble using three black leveling dials on all sides.

- Once level check peep sight again to re-center and check level again.
- Once base is completely leveled and centered completely screw it to the tri-pod plate. Ensure that it is screwed enough so that it doesn't move, but not so tight that you have problems removing it at the end of the day.
- Screw dish to dish stand and attach to level pad.

- Lock in with black lever on the side.
- Screw co-axel cable to dish and other end to base box.
- Install two large lithium batteries into base.
    - If using 12-volt battery to power base station (instead of lithium batteries), take out black box cable with the two alligator clips on the other end.
    - Attach black box to tri-pod.

    - Attach power cable to black box at one end and then to base station at the other end.
    - Line up red dot on cable to red dot on plug.

- Set-up Radio:
    - Set-up radio tri-pod next to base tri-pod – close enough for cable to reach from radio to base.
        - Cable is usually 5' long.
    - Put radio on tri-pod and assemble antenna.

- Screw wide bottom antenna rod onto antenna base with cable attached.
- Add antenna tip (usually black or chrome).

o Screw rod onto tri-pod

o Raise and lock in place.

o Attach antenna wire to radio.

o Attach transmitting/power cable to radio.

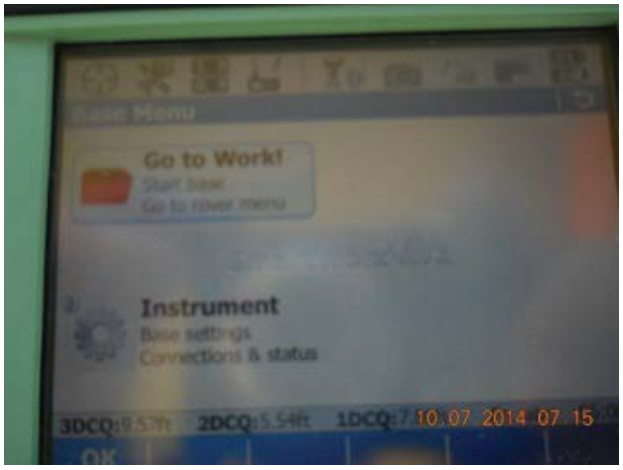
- The end of the transmitting/power cable with the battery plug goes to the radio.

- The other end goes to P2 or P3 on base.
- Line up red dot on cable to red dot on plug.

- Plug in battery LAST.
- Check switch on back of radio above antenna plug – make sure it is set to LOW (down).
- Push power button – lights should flash on the front of the radio.
- Look for radio channel on the front of the radio – make sure it's on channel 3.

- Entering Known Point:
  - Turn on base – push power button and hold until lights on bottom turn green.
  - Turn on hand-held (put in small lithium battery) – hold power button until screen flashes.
  - At main menu:

  - Go to (2) – Jobs & Data.
  - Choose "Control Job".
  - Make new control job (name it whatever your base name is, i.e. Rucker Base).
  - Make sure before you store it that you page over (F6) to "Coordinates" and input proper ones – then store.
  - State plain coordinates should already be provided to you prior to initial setup.
  - Once stored the handheld will automatically go back to the main menu.
  - Go to (2) – Jobs & Data again.
  - Choose "Working Job".
  - Select your new stored base name.
  - Push OK (F1) or enter.
  - Select "Go To Work" (1).
  - Select "Switch to Base Menu":



- Select (1) – Go To Work.
- Select (1) – Start Base Over Known Point.
- Next menu – enter antenna height.
- Tri-pod type – AS10 Tri-pod.
- Push “Next” (F1) and enter the following:
  - Select Known Point
  - Name or ID
  - Northing (123456.78)
  - Easting (123456.78)
  - Height (123.4’)
  - F1 – Next
  - Base set-up complete
- Push F6 for base menu
- Once you are at the base menu you are officially done.
- To save battery you can turn off hand held.

- Day 2 Set-Up For Hand Held Operations:
  - When you turn on the hand held it will automatically go to Base Menu.
  - Select (1) – Go To Work.
  - Select “Start Base Over Known Point”.
  - Next screen should already have the info you’ve already provided.
  - Click (F1) “Next”.
  - Same info.
  - Click (F1) “Next”.
  - Base set-up complete.
  - Push (F6) for Base Menu.

Attachment 4: Example Field Data Sheet

☐ QC checked by _____
Date: _____

Field Data Sheet

☐ QA checked by _____
Date: _____

Project Name: _____ **Project Location:** _____

Geophysical Contractor: _____ **Design Center POC:** _____

Project Geophysicist: _____ **Site Geophysicist:** _____

Survey Area ID: _____ **Date:** _____ **Field Team:** _____

Survey Type: ☐Grid ☐Meandering Path ☐Transect ☐Other _____

Coordinate System: ☐UTM ☐State Plane NAD _____ ☐Local ☐Other _____ **Unit of Measure:** ☐ meters☐ feet

Sketch of Survey Area: **Approx. Scale:** _____ **North Arrow:**

_____

Terrain:

☐Level ☐Moderate Slope ☐Steep

☐Rolling ☐Ruts ☐Gullies

☐Rocky ☐Swampy ☐Dangerous

Tree Cover: **Tree Height:** ____

☐None ☐Light ☐Medium ☐Thick

Brush:

☐None ☐Light ☐Medium ☐Thick

Weather:

☐Sunny ☐Cloudy ☐Drizzle

☐Rain ☐Thunderstorms ☐Hail

☐Fog ☐Humid ☐Snow

Grid Corner Coordinates:

UTM/State Plane/Local

SW _____, _____

NW _____, _____

NE _____, _____

SE _____, _____

Battery Voltage: Start _____ End _____

Personnel Metal Check? ____

Sensor Height: _____

Repeat Line? _____

Raw Data File Name: _____ **Repeat Data File Name:** _____

Geophysical Instrumentation: _____ **Serial Number:** _____

Base Station: _____ **Serial Number:** _____

Navigation Method: _____ **Serial Number:** _____

Additional Comments: _____

Attachment 5: Example DGM Checklists

Checklist for Out of Box Equipment Tests

Project Name: _____

Project Location: _____

Contractor Point of Contact: _____

Equipment Source: _____

Equipment Serial Numbers: _____

_____

Reviewer's Name and Title: _____

Date of Review: _____

	Y	N	N/A
1. Has the equipment been inventoried and inspected for damage or wear?	____	____	____
2. When the cable shake test was performed were there spikes in the data? (Replace any faulty components if necessary, and repeat)	____	____	____
3. When the instrument was nulled did it exhibit unacceptable drift?	____	____	____
4. Did the system produce the expected response during the static/spike test?	____	____	____
5. Did the system produce the expected response over the IVS?	____	____	____

Checklist for Daily IVS Checks

Project Name: _____
Project Location: _____
Date: _____
Team: _____

IVS Test AM (example T1IVS081616AM)
File Name: _____Battery Start: _____ _____Battery End: _____ _____
Line 0: Background (1 min.) (Includes cable shake and personnel check. If these fail, start a new file after issue has been dealt with)
Line 1: Spike (1 min.) CH1: _____ CH2: _____ CH3: _____ CH4: _____
Line 2: Run IVS out.
Line 3: Run IVS back
Line 4: Background Line

IVS Test PM (example T1IVS081616PM)
File Name: _____Battery Start: _____ _____Battery End: _____ _____
Line 0: Background (1 min.)
Line 1: Spike (1 min.) CH1: _____ CH2: _____ CH3: _____ CH4: _____
Line 2: Run IVS out
Line 3: Run IVS back
Line 4: Background Line

Standard Operating Procedures for DGM Data Processing

(DGM – 002)

1. Purpose

The purpose of this standard operating procedure (SOP) is to provide procedures and technical guidance on processing DGM data.

2. Equipment

This SOP is applicable for the data from Geonics EM61-MK2 and Leica Differential Global Positioning System (DGPS) and Robotic Total Station (RTS) systems.

The EM61-MK2 is a high-resolution time-domain electromagnetic instrument designed to detect shallow ferrous and non-ferrous metallic objects. The Standard EM61-MK2 system consists of two coils, a digital data recorder, batteries and processing electronics. The EM61-MK2's transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects. Each of the two spatially separated receiver coils measures these eddy currents. The EM61-MK2 measures the eddy currents at four distinct time intervals in the bottom coil or at three intervals on the bottom and one on the top coil. For this work, the top coil will not be used. The secondary EM fields will be measured at 216, 366, 660 and 1266 microseconds after the transmitter current has turned off with the lower coil. These time gates are typically referred to a Channels 1-4 respectively. The secondary voltages induced in the coil are measured in millivolts (mV). The data is collected into Geonics' EM61MK2, Geomar's Nav61MK2 or Multi61 program.

Leica GPS 1200 series and VIVA RTK-DGPS systems provide sub-centimeter accuracy and can be combined with DGM data in real-time. The reported accuracy for real-time corrections is 8mm + 1 ppm (horz.), and 15mm + 1ppm (vertical).

The Leica TPS1200 RTS precision angle-measurement system uses a visible red laser, has auto-lock capability, and measures to prisms and reflective tape. The range is 3 km to a single prism and the accuracy is 1 mm + 1.5 ppm.

3. Software

Data will be interpreted using a combination of Geonics, Geomar and Geosoft Oasis Montaj (or equivalent) software to provide coordinate location information for each target. The version for each software package will be the most current, unless otherwise communicated to the client.

4. DGM Data Processing Procedures

The following are the standard procedures for DGM data processing.

4.1 Initial Data Processing

Depending on site conditions, navigation of the system is accomplished through either Fiducial (FID) method, GPS method, or RTS method. The various processing steps for each type of positioning are detailed below.

4.1.1 The FID method is used in wooded areas where GPS/RTS positioning is unavailable. This method uses painted ropes and/or flags positioned across each grid for the placement of fiducial marks within the recorded data. Local coordinates are warped to geodetic using reference locations (stakes) surveyed in by licensed surveyors on evenly spaced centers. Geonics DAT61MK2 will be used to perform initial processing of fiducially positioned data. The data acquisition program EM61MK2, operating on the Allegro in the field, saves readings in a raw (binary) files format which are given the extension name R61. DAT61MK2 is used to convert the binary files to ASCII format with the extension name M61. The data processor will follow the DAT61 manual to correct the positions of the fiducial data before importing the M61 or XYZ file into Geosoft Oasis Montaj for further processing.

4.1.2 The second method of navigation is GPS. The base station is setup on a control point and corrections are sent via radio link to the rover receiver. The rover GPS antenna is mounted over the center of the EM61-MK2 coil and provides real time positional tracking capabilities that are streamed into the same .R61 file as the EM61-MK2 data. The GPS data quality will be reviewed by the data processor in Geomar TrackMaker software or Geonics DAT61MK2 software to ensure that an acceptable number of data points have the quality indicators to demonstrate the required accuracy necessary to meet the project objectives. For data with GPS positioning TrackMaker or DAT61MK2 will only be used to convert the binary data to ASCII format to be imported into Geosoft Oasis Montaj.

4.1.3 The third method of navigation is RTS. The RTS uses known points, typically the surveyed grid corners, to provide geodetic locations based on reflection time calculations for calibrated lasers and a prism located above the DGM coil. The positional data recorded by the RTS is merged with the EM61 data in post processing. Geodetic locations can also be reacquired using the RTS. The post processing steps for RTS data are not included in this SOP, but will be provided for review if the system is used to position data at this site.

4.2 Initial Production Quality Check

Before post processing can begin on a production dataset the data processor will confirm that all MPC outlined in the Work Plan have been met. The daily QC tests to include the IVS and static/spike must meet the metrics outlined in the Work Plan and IVS Report. Additionally, all field documentation must be reviewed for accuracy and completeness.

4.3 Post Data Processing

Oasis Montaj will be used to process and analyze the DGM data. Processing steps will include leveling the data to remove any time based drift, correcting the position for latency or lag introduced by the electronics and, when necessary, removing any coherent noise (e.g. 60 Hz filter). The goal of these initial steps is to correct the position of the data bring the background amplitude down to zero. After the position and amplitude of the data has been corrected the data will be gridded in order to generate color-coded maps for each survey grid or transect. Prior to selecting targets the data will be analyzed with the Geosoft quality control tools to insure that all MPC, such as Coverage and Along-Line Spacing, have been met. If the processor identifies and failures or gaps in the data he/she will instruct the field teams to recollect the data necessary to meet all project MPC. Maps will be produced and provided with the grid packages for all QC tools used to assess the data.

4.4 Target Selection

Potential target locations will be selected using a combination of two target selection methods: automatic and manual. The automatic method utilizes the target selection algorithm within the Geosoft Oasis Montaj software (e.g. Blakely Test). This procedure selects anomaly locations based solely on the signal intensity based on a generated grid of the data. The second method (herein referred to as "manual") utilizes a data interpreter, who manually selects potential target locations using data characteristics such as the signal intensity from the coil and different time gates, anomaly footprint, anomaly shape and trend, track line characteristics (i.e., spatial sample density), terrain, previous intrusive information, and comments entered by the data acquisition crew regarding geology, terrain, weather, etc. In all cases the un-filtered data will be reviewed to insure the initial processing steps did not mask the presence of additional anomalies. The specific target selection method and thresholds will be defined in the IVS Report.

5. Documentation and Data Transfer

Raw data will be transferred from the geophysical data logger a minimum of once daily. The raw data shall be backed up on a local hard drive as well as on the project server or SharePoint on a daily basis. A copy of the field notebook and/or digitized field notes to include file names and content as well as all raw data, shall accompany the processed data for submittal. Any scripts used for data processing will be provided to QA along with the data deliverables. All data processing steps performed in addition to the provided scripts will be documented by the data processor and delivered with the data submittal. The complete data trail will be represented on the server and/or SharePoint so that changes made by the data processor and/or the QC geophysicist can be tracked. Datasets along with all quality control results and target selections will be tracked in an Access Database to be provided with each submittal.

6. Quality Control

In addition to the quality checks performed by the data processor, the QC geophysicist or designee will review a minimum of 10% of the data to insure that it meets all project requirements. The QC geophysicist will be responsible for insuring that all seed items were detected in accordance with the metrics defined in the Work Plan and/or the IVS report. All non-conformances will be reported and followed by a root-cause analysis.

Bay West

Standard Operating Procedure

Sample Custody

CORP-ENV-004-1510208

Revised: December 12, 2012

Review and Approval:

Developed by: _____ Date: 12-12-2012
Signature
QA/QC Manager
Title

Reviewed by: _____ Date: 12-12-2012
Signature
QA/QC Manager
Title

Approved by: _____ Date: 12-12-2012
Signature
Vice President of Operations
Title

Questions and requests for information regarding this SOP should be directed to the Vice President of Operations or the QA/QC Manager. This SOP cannot be edited, changed, or revised without the approval of the individuals listed above, and all edits, changes, and revisions must be routed through the Document Management Coordinator.

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1.0 INTRODUCTION

1.1 Purpose

Due to the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are provided to the client or possibly introduced as evidence in legal proceedings. To maintain and document sample possession, sample custody procedures are followed. All paperwork associated with the sample custody procedures will be retained in Bay West, Inc. (Bay West) files unless the client requests that it be transferred to them for use in legal proceedings or at the completion of the contract.

2.0 DEFINITIONS

Sample - A material to be analyzed that is contained in single or multiple containers representing a unique location and possessing a unique sample identification number.

Sample Custody - A sample is under custody if:

1. It is in your possession;
2. It is in your view, after being in your possession;
3. It was in your possession and then locked up to prevent tampering; and/or
4. It is in a designated and identified secure area.

Chain-of-Custody Record - Form used to document the transfer of custody of samples from one individual to another.

Custody Seal - A custody seal is a tape-like seal that is part of the chain-of-custody process and is used to detect tampering with samples after they have been packed for shipping.

Sample Label - Adhesive label placed on sample containers to designate a sample identification number and other sampling information.

Sample Tag - Tag attached with string to a sample container to designate a sample identification number and other sampling information. Tags may be used when it is difficult to physically place adhesive labels on the container (e.g., in the case of small air sampling tubes).

3.0 RESPONSIBILITIES

Sampler - The Sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

Site Supervisor - The Site Supervisor is responsible for ensuring that strict Chain-of-Custody procedures are maintained during all sampling events. The site supervisor is also responsible for coordinating with the subcontractor laboratory to ensure that adequate information is recorded on custody records.

4.0 REQUIRED EQUIPMENT

This section provides a list of equipment to be used but does not necessarily include all equipment such as sample containers and personal protection equipment. The following is a general list of equipment that should be obtained in the office prior to initiating field work:

- Chain-of-Custody Records (applicable Bay West forms);
- Custody seals;
- Sample labels or tags; and
- Clear Tape.

5.0 PROCEDURES

5.1 Chain-of-Custody Record

This procedure establishes a method for maintaining custody of samples through use of a Chain-of-Custody Record. This procedure will be followed for all samples collected or split samples accepted.

Field Custody

1. Collect only the number of samples needed to represent the media being sampled. To the extent possible, determine the quantity and types of samples and sample locations prior to the actual fieldwork. As few people as possible should handle samples.
2. The field sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
3. Sample labels or tags shall be completed for each sample, using waterproof ink.

Transfer of Custody and Shipment

1. Samples are accompanied by a Chain-of-Custody Record (see Figure 1 for example of Chain-of-Custody Record). When transferring the possession of

samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst in the appropriate laboratory.

- The date/time will be the same for both signatures when custody is transferred directly to another person. When samples are shipped via common carrier (e.g. Federal Express), the date/time will not be the same for both signatures. Common carriers are not required to sign the form; however, the airbill tracking number should be recorded on the Chain-of Custody.
- In all cases, it must be readily apparent that the person who initially received custody is the same person who relinquished custody to the next custodian.
- If samples are left unattended or a person refuses to sign, this must be documented and explained on the Chain-of-Custody Record.

2. Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate custody record accompanying each cooler or shipment unit. When shipping multiple coolers containing samples from the same project, indicate on the Chain-of-Custody that the Cooler/Record is 1 of 2 or 1 of 3, etc. to reflect the total number of coolers and Chain-of-Custody records shipped.
3. All shipments will be accompanied by the Chain-of-Custody Record identifying its contents. The original record will accompany the shipment, and the copies will be retained by the site supervisor and, if applicable, distributed to the appropriate sample coordinators. Freight bills will also be retained by the site supervisor as part of the permanent documentation.

Procedure for Completing Bay West Chain-of-Custody Record
(Refer to attached Figure 1)

1. Record project number.
2. Record sampler for the project.
3. Record the name and address of the laboratory (include both the Bay West Project Manager and the laboratory Project Manager name) to which samples are being shipped.
4. Record the unique Chain-of-Custody record number for each Chain-of-Custody used in shipping for the day. (Note: not all CoCs have record numbers)
5. Enter the project name/location code or number.
6. Record overnight courier's sample airbill tracking number on the Chain-of-Custody.
7. Note sample type (matrix) and matrix code. Include the matrix code on the Chain-of-Custody Record.
8. Record sample identification number.

9. Enter date of sample collection.
10. Enter time of sample collection in 24-hour time format.
11. List parameters for analysis and the number of containers submitted for each analysis.
12. Enter MS/MSD (matrix spike/matrix spike duplicate) if sample is for laboratory quality control, or other remarks (e.g. sample depth).
13. Record the type of the preservative used to preserve the sample. Use the remarks column if no space identification dedicated to preservative.
14. All samplers must sign in the space provided.
15. The originator verifies (checks) the information entered on the Chain-of-Custody and then signs the "Relinquished by" box, prints his/her name, and enters the current date and time (24-hour). Edits to the Chain-of-Custody should be made by drawing a single line through the incorrect information, recording the correct information, and initialing and dating next to the change.
16. Upon completion of the custody record form, the top two copies (usually white and yellow) shall be sent with the samples to the laboratory; the bottom copy (usually pink) is retained for the project files. Additional copies will be retained for the project file or distributed as required to the appropriate sample coordinators. In all cases, the original (top) copy is sent to the laboratory.
17. The laboratory sample custodian receiving the samples checks the sample label information against the custody record form. He or she also checks sample condition and notes anything unusual under "Description/Comments" on the custody record form. The laboratory custodian receiving custody signs in the adjacent "Received by" box and keeps the appropriate copy. The original copy is returned to Bay West.

NOTE: Different clients, have different *styles* of Chain-of-Custody records. In all cases, the above listed information must be included on all Chain-of-Custodies.

Bay West

18. Figure 1
EXAMPLE PACE Chain-of-Custody Record

Pace Analytical™
www.pacelabs.com

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

616700

Page: of

Required Client Information: **Section A**

Company
Address
Phone | Fax

Required Client Information: **Section B**

Report To:
Copy To:
Invoice To:
P.O.
Project Name:
Project Number:

Client Information (Check quote/contract):
Requested Due Date: *TAT:

* Turn around times less than 14 days subject to laboratory and contractual obligations and may result in a Rush Turnaround Surcharge.
Turn Around Time (TAT) in calendar days.

To Be Completed by Pace Analytical and Client **Section C**

Quote Reference:
Project Manager:
Project #:
Profile #:
Requested Analysis:

Section D **Required** Client Information:

SAMPLE ID
One character per box.
(A–Z, 0–9 / .–)
Sample IDs MUST BE UNIQUE

Valid Matrix Codes

MATRIX	CODE
WATER	WT
SOIL	SL
OIL	OL
WIPE	WP
AIR	AR
TISSUE	TS
OTHER	OT

ITEM #	SAMPLE ID	MATRIX CODE	DATE COLLECTED mm / dd / yy	TIME COLLECTED hh: mm a/p	# Containers	Preservatives: Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Remarks / Lab ID
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														

SHIPMENT METHOD	AIRBILL NO.	SHIPPING DATE	NO. OF COOLERS	NO.	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME

SAMPLE CONDITION

Temp in °C	
Received on Ice	Y/N
Sealed Cooler	Y/N
Samples Intact	Y/N

SAMPLE NOTES

Additional Comments:

SAMPLER NAME AND SIGNATURE
PRINT Name of SAMPLER:
SIGNATURE of SAMPLER: DATE Signed: (MM / DD / YY)

ORIGINAL

SEE REVERSE SIDE FOR INSTRUCTIONS

Form COC01 Rev 0601

NOTE: This SOP is current as of the date printed on the bottom. Bay West personnel may produce paper copies of this procedure printed from the controlled-document electronic file located on the Intranet. However, it is their responsibility to ensure that they are trained and utilize the current version of this procedure.

Sample Labels and Tags

Sample labels or tags will be utilized for all samples collected or accepted for Bay West projects.

1. Place adhesive labels directly on the sample containers. Place clear tape over the label to protect from moisture.
2. Sample tags will be securely attached to the sample bottle. On 80 oz. amber bottles, the tag string may be looped through the rink style handle and tied. On all other containers, it is recommended that the string be looped around the neck of the bottle, then twisted and re-looped around the neck until the slack in the string is removed.
3. One label or tag will be completed for each sample container collected. Each label or tag will be completed as follows; labels are completed with the equivalent information:
   - Record the Project Code (i.e., project name or task number);
   - Enter the Station Number if applicable;
   - Record the date to indicate the month, day, year of sample collection;
   - Enter the time (24-hour) of sample collection;
   - Record the sample location;
   - Samplers must sign/initial in the space provided; and
   - Under "remarks" add additional, relevant information, including any preservative.

5.2 Custody Seals

Custody seals must be placed on the shipping containers prior to shipment. The seal should be signed and dated by a field team member.

Custody seals may also be placed on individual sample bottles, depending on project requirements. Check with the project manager or refer to EPA regional guidelines for direction.

5.3 Sample Shipping

Bay West's Standard Operating Procedure: Packaging and Shipping of Environmental Samples (CORP-ENV-006-1510206) establishes a uniform method for packaging and shipping low-level environmental samples.

Every effort should be made to ship samples on the day they are collected. In the event samples will not be shipped on the day of collection, proper preservation techniques must be maintained until the samples reach the laboratory. Sample bottles will not be

open to test for preservation (e.g. pH) as this may compromise the sample. However, maintaining the samples at proper temperature, 4°C ± 2°C, is critical to sample integrity. Sufficient ice should be on hand to maintain proper temperatures during and after sampling. Samples held for shipment the next day must be checked for proper temperatures prior to shipping. This check should be noted in the log book.

It is inadvisable to hold samples for more than one day prior to shipping to the lab. All samples have holding times associated with their individual analysis and delaying shipping may compromise the lab's ability to meet the holding time requirements. These requirements may be found in the project Field Sampling Plan or the QAPP.

If samples are shipped on a Friday for Saturday lab delivery, the laboratory must notifed in advance of their arrival. A phone call should be placed to: the lab's Project Manager, the Bay West Project Manager and/or the Project Chemist.

If particular questions arise regarding the shipping of a certain sample, the lab's Project Manager is an *excellent* resource on proper shipping technique.

6.0 DOCUMENTATION

All notes/comments associated with the sample custody will be recorded in a project specific field notebook in accordance with the Bay West SOP for Sample Custody.

7.0 PROCEDURE PERFORMANCE EXPECTATIONS

7.1 Restrictions/Limitations

For EPA Contract Laboratory Program (CLP) sampling events, combined chain-of-custody/traffic report forms or other EPA-specific records may be utilized. Refer to regional guidelines for completing these forms.

8.0 REFERENCES

U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.

U.S. Environmental Protection Agency, *Sampler's Guide to the Contract Laboratory Program*, EPA/540/P-90/006, December 1990.

American Society for Testing and Materials, *Standard Guide for Chain-of-Custody Procedures*, ASTM D4840-99, 2010.

Bay West

Customer-Focused Environmental & Industrial Solutions

Standard Operating Procedure

Manual Sediment Sampling

CORP-ENV-019-1707046

Revised: January 2014

Review and Approval:

Developed by: _____ Date: January 27, 2014

QA/QC Manager

Title

Reviewed by: _____ Date: January 27,2014

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Approved by: _____ Date: January 27, 2014

Vice President of Operations

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Questions and requests for information regarding this Standard Operating Procedure (SOP) should be directed to the Vice President of Operations or the QA/QC Manager. This document cannot be edited, changed, or revised without the approval of the individuals listed above, and all edits, changes, and revisions must be routed through the Document Management Coordinator.

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1.0 INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) provides a standardized method for collecting manual sediment samples at suspected hazardous waste sites. This SOP must be used by samplers trained in sample collection, sample handling and sample custody. Deviations from the procedures outlined in this document must be approved by the Field Supervisor and/or the Project Manager prior to initiation of the sampling activity.

This SOP is applicable to the collection of representative sediment samples. Analysis of sediment may be biological, chemical, or physical in nature and may be used to determine the following:

- Toxicity;
- Biological availability and effects of contaminants;
- Benthic biota;
- Extent and magnitude of contamination;
- Contaminant migration pathway and potential source;
- Fate of contaminants; and
- Grain size distribution.

1.2 Scope

The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. For the purposes of this procedure, sediments are mineral and organic particulate matter transported by fluid flows which are eventually deposited as a layer of solid particles on the bed or bottom of a body of water. The water may be static, as in lakes, ponds, and impoundments; or flowing, as in rivers and streams. The Bay West, Inc. SOP, *Water Hazards*, CORP-H&S-019-62590 (Bay West, 2003) should be reviewed prior to sampling.

2.0 DEFINITIONS

Sediment – particulate matter transported by fluid flow which is eventually deposited as a layer of solid particles on the bed or bottom of a body of water.

Dredge – a mechanical device used to bring sediment to the surface.

Coring Device – a tubular device used to collect an undisturbed column of sediment.

3.0 RESPONSIBILITIES

3.1 Sampler

The sampler is responsible for the collection of representative samples, correct sample labeling, and the recording of the sampling data as specified in this SOP.

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3.2 Field Supervisor

The Field Supervisor is responsible for overseeing the sediment sampling activities. The Field Supervisor responsible for checking all work performed by the sampling team and verifying that the work satisfies the specific tasks outlined by this SOP and the project Work Plan, Quality Assurance Project Plan (QAPP) and/or the Field Sampling Plan (FSP). It is the responsibility of the Field Supervisor to communicate with the sampling team regarding specific collection objectives and anticipated situations that require any deviation from the Work Plan. It is also the responsibility of the Field Supervisor to communicate the need for any deviations from the Project Plan with the Project Manager. The Field Supervisor will ensure that every team member has the appropriate training to execute the sampling event and all sampling activities are performed safely and in accordance with the site-specific Site Safety and Health Plan (SSHP).

3.3 Project Manager

The Project Manager is responsible for the overall success of the field program and will ensure the maintenance of logbooks and forms and assessing and approving techniques not specifically described in this SOP. Direct contact with the client will be administered by the Project Manager.

4.0 REQUIRED EQUIPMENT

This section provides a list of commonly used equipment for sediment sampling. It is not comprehensive as additional equipment may be necessary depending on site conditions or the client's needs.

4.1 Sampling Devices

- Ponar® dredge – used for collecting sediment samples in hard bottoms such as sand, gravel, and clay. Designed for severe environmental conditions, including salt water use.
- Ekman® bottom sampler – used for collecting sediment samples in soft, finely divided bottoms. Does not work well in bottoms that are vegetated or have coarse debris. An extension handle is available to aid sampling in shallow water.
- Sediment coring sampler – this type of sampler has a removable inner sleeve made of Teflon® or acetate. Remove sediment core intact for geological testing and environmental sub-sampling.
- VOC sampling coring device – used for collecting sediment samples designated for volatile organic compounds (VOCs) analysis or toxicity testing. An EnCore® or a TerraCore® sampler may be used, or a liner sleeve may be sent to the lab for subsampling.
- Polycarbonate and/or metal core tubes and caps.
- Nylon rope or steel cable – for raising and lowering the dredge.
- Sample collection containers – Laboratory supplied 4-oz., 8-oz., and/or one-liter wide mouth amber glass jars with Teflon lined lids. Samples designated for VOC analysis or toxicity testing must be submitted in a sealable sampler, a pre-preserved vial or the Teflon® sleeve used for collection.

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- Gloves – for personal protection and to prevent cross-contamination of samples. Disposable powderless gloves as specified in the SSHP should be used for sampling.
- Field clothing and personal protective equipment and safety supplies – as specified in the SSHP. Personal floatation devices (PFDs) must be worn for all work performed from a boat.
- Sampling flags – Used for identifying sediment sampling locations in very shallow water. Buoys with anchors may be required in deeper water.
- Field notebook – a bound book used to record progress of sampling effort and record any problems and field observations during sampling.
- Permanent marking pen – used to mark sample bottle labels, sediment boring tubes and for documentation in the of field logbooks.
- Stainless steel spoon – or equivalent. Used for homogenizing sediment samples that will not be used for VOCs analysis or toxicity testing.
- Stainless steel bowls – or equivalent. Used for compositing samples that will not be used for VOCs analysis or toxicity testing. Must have sufficient capacity to contain a full dredge sample.
- Sample collection containers – including laboratory-supplied 4-ounce, 8-ounce, and/or one-liter wide-mouth amber glass jars with Teflon-lined lids.
- Freshwater washdown – for decontaminating non-disposal sampling equipment.
- Core tube rack – for storing cores upright until they are processed for sampling.
- Personal flotation devices and safety equipment and supplies.
- Boat operation equipment.
- Power source.
- Miter box and saw.
- Tool box with wrenches.

5.0 PROCEDURES

A new pair of gloves and eye protection must be worn at each sampling location. Splash protection may be required if stated in the SSHP. Each sampling location (GPS coordinates or equivalent) must be recorded on the site diagram prior to collecting the sample. All sampling equipment must be decontaminated prior to use.

5.1 Sediment Collection with a Dredge

Measure and record the water depth. The dredge samplers consist of spring-loaded semi-cylindrical jaws that close either when they encounter the sediment while being lowered down through the water or are actuated by a messenger weight that is dropped along a line to the sampler. In either case, the jaws close and remove a portion of the sediment ranging in depth up to approximately eight inches with depth being dependent on the physical characteristics of the sediment and the size and weight of the sampler.

Some precautions must be taken when using a dredge-type of sampler. First, once the jaws of the sampler have been spread and set, care must be taken when handling the device not to accidentally trip the triggering device, which could result in injury. Secondly, the quality of the samples is largely dependent on the speed at which the sampler is lowered to the sediment and

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the speed at which it is withdrawn from the sediment. Allowing the sampler to fall to the sediment quickly can result in significant shock waves that can blow soft/loose sediment from the sample location. Withdrawing the sampler back up through the water too quickly can result in turbulence in the water above the sampler that can wash the sediments out of the sampler. Also, sediments containing coarse gravel, wood, and other debris can limit the sampling effectiveness by preventing complete closure of the sampler jaws.

Attach a sturdy nylon rope or steel cable to the ring provided on top of the dredge. Arrange the dredge with jaws in the open position, setting the tripping device so that the sampler remains open when lifted from the top. If the dredge is so equipped, place the spring loaded pin into the aligned holes in the trip bar. Slowly lower the sampler to a point approximately two inches above the sediment. Drop the sampler to the sediment. With automatic samplers, the jaws of the sampler will close as the line slackens. If the sampler uses a messenger weight, once the line slackens, re-tension the line slightly, and send the messenger down the line to trip the sampler. Some samplers have a spring loaded pin; by pulling up sharply on the line, dredge is closed. Slowly raise the dredge to the surface and slowly decant any free liquid through the screens on top of the dredge. Care should be taken to retain the fine sediment fraction during this operation.

Open the dredge and transfer the sediment to a stainless steel bowl or other compositing container. If necessary, repeat the collection procedure until sufficient material has been collected. Homogenize the sample by mixing with a stainless steel spoon or equivalent, and then transfer the sample to a laboratory supplied glass jar. When splitting sediment samples, continuous mixing may be required to maintain homogeneity, and to avoid the settling of larger sediment fractions in the bottom of the compositing bowl. Affix a sample ID label to each container and copy the information to the Field Data Sheet.

5.2 Collection with a Coring Device

Sediment designated for VOC analysis or toxicity testing must be collected with a sampling system consisting of a tube sampler, removable Teflon® or acetate tube liner, eggshell core catcher, nosecone, extensions, and a "T" handle or drive hammer. The use of additional extensions can increase the depth of water from which sediment can be collected from 24 inches to 10 feet or more, but sample handling and manipulation become more difficult as the depth of water increases.

To collect the sample using the tube liner sampler, press down on the sampling device until the desired depth is achieved. After reaching the desired depth, rotate the sampler to shear off the bottom of the sediment core. Slowly withdraw the sampler from the sediment, and decant the surface water, using care to retain the fine sediment fraction. Unscrew the nosecone and remove the eggshell core catcher. Slide the liner/core out of the sampler tube. If there is headspace in the upper end of the sediment core, use a hacksaw to shear off the tubing at the sediment surface. Cap both ends of the tube. To minimize the potential for volatilization of certain compounds of interest, samples designated for VOC analysis or toxicity testing must not have any space present between the sediment core and the end of the cap on the liner sleeve.

If the drive hammer is used, insert the tapered handle (drive head) through the top of the sampler. Drive the sampler into the sediment to the desired depth, and rotate the sampler to shear off the bottom of the sediment core. Slowly withdraw the sampler from the sediment, and decant the surface water, using care to retain the fine sediment fraction. Unscrew the nosecone and remove the eggshell core catcher. Slide the liner/core out of the sampler tube. If there is

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headspace in the upper end of the sediment core, use a hacksaw to shear off the liner tubing at the sediment surface. Cap both ends of the tube.

Secure the caps on both ends of the core with tape, and use a waterproof pen to indicate the orientation of the sediment core. Cores should be stored upright until they are processed for sampling. Affix a sample identification label to the core and copy the information to the Field Data Sheet. Immediately place the sample on ice for transport to the analytical laboratory.

5.3 Collection of VOC samples using a Coring Device and an EnCore® or TerraCore® Sampler

VOC samples are collected from the recovered core by subsampling with an EnCore® or TerraCore® Sampler. If the sediment is sufficiently cohesive, split the core lengthwise with a sharp blade and collect a sample using the EnCore® or TerraCore® Sampler. Follow the manufacturer's instructions for sealing the sampling device or place the sample aliquot into a pre-weighed, pre-preserved vial. Place the sampler or vial in a zipper-top bag and place the sample in a chilled cooler. Non-cohesive sediment samples may need to be transferred directly into pre-weighed vials supplied by the laboratory.

5.4 Decontamination Procedures

The objectives of decontamination are to prevent the introduction of contaminants into samples from sampling equipment or other samples. Disposable sampling equipment will be used whenever possible. Samplers will change sample gloves and discard all disposable sampling equipment after each sample is collected to minimize the potential for media cross-contamination. Disposable sampling equipment includes sample gloves, acetate core tubes, polyethylene scoops, and plastic bags.

Non-disposable sampling equipment such as dredges and metal coring tubes will be decontaminated in accordance with the Bay West SOP *Field Equipment Decontamination* SOP CORP-ENV-002-1578775, October 5, 2012.

6.0 DOCUMENTATION

The sampler is responsible for complete documentation of the sampling event. It is critical that this information is accurate and the necessary information is communicated to the laboratory.

6.1 Field Logbook

The field logbook will contain all of the information collected during the sampling event. This includes, but is not limited to: arrival and departure times of <u>all</u> people on site, tailgate meetings, equipment checks and calibrations, weather conditions, a record of all measurements taken, sample names and times, deliveries and pickups of equipment/samples, and descriptions of any deviations to the Sampling Plan and the reason for the deviation.

Some projects may require site specific forms to be filled out. As with the logbook, all forms should be filled out legibly with errors crossed out with a single line, initialed and dated. Forms should be kept in a 3-ring binder, if possible, to avoid misplacement or loss. Documentation regarding field documentation can be found in the Bay West SOP *Field Documentation* CORP-ENV-010-1578753 (Bay West, 2012).

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6.2 Sample Labeling

Correct sample labeling is critical to proper sample identification and accurate log-in at the lab. Sample labes will be provided with the sample bottles from the lab. Be sure you have a sufficient supply. The required information for the sample label will be spelled out in the Work Plan/QAPP.

In general, the sample label will require:

1. Project / Site name;
2. Sample name formatted as required (refer to the Work Plan/QAPP);
3. Date and time sampled;
4. Requested analyses;
5. Any preservatives used inside the sample bottle;
6. Sampler's initials;

After the sample label is applied, the bottle should be wrapped with packing tape to minimize the chance of the label separating from the bottle. All samples must be stored on wet ice at 4°C ± 2°C in a secured cooler. Samples designated for VOC analysis or toxicity testing must be kept away from direct sunlight and immediately chilled to 4°C ± 2°C. Ship samples under chain-of-custody (CoC), protected with suitable resilient packing material to reduce shock, vibration, and disturbance.

6.3 Chain of Custody

The information on the CoC should match the bottle label EXACTLY. Double check to see that this is the case. Samples must be kept secure until delivered to the lab or picked up by a courier/overnight shipper. The cooler must be sealed with strapping tape and custody seals applied on opposite corners. Follow procedures in Bay West SOPs Sample Custody, CORP-ENV-004-1510208 (12-12- 2012) and *Packaging and Shipping of Environmental Samples*, CORP-ENV-006-1510206 (02-10- 2012).

7.0 PROCEDURE PERFORMANCE EXPECTATIONS

The number and type of quality control samples described in the SAP will be collected at the required frequency.

7.1 Duplicate Samples

Duplicate samples are used to measure sampling and laboratory precision. For analyses other than VOCs, the sediment must be thoroughly mixed before being placed in the sample jars. VOC samples should be collected as close together as possible from the sediment or from the core sampler and are considered replicates. These samples are handled with a minimum of disturbance to avoid loss of volatile compounds.

7.2 Matrix Spike Samples

Matrix spike/matrix spike duplicate (MS/MSD) samples measure the ability of the extraction procedures to remove analytes of concern from the matrix in addition to measuring analytical precision. In general, matrix spike samples require triple sample volume for analysis. Mix the

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sample thoroughly (except for VOCs) prior to filling the three sample jars. Note on the CoC which sample was selected for a MS/MSD.

7.3 Sample Preservation and Handling

Sample preservation procedures are used to maintain the original character of analytes during storage and shipment. Regardless of the nature of the sample, absolute stability for all constituents cannot be achieved. Preservation techniques, such as pH control and refrigeration, may retard physiochemical and biochemical changes. As a general rule, analyzing the sample as soon as possible is the best way to minimize physiochemical and biochemical changes.

All samples will be placed in the appropriate sample container and refrigerated (on ice or ice substitute in a cooler) immediately upon sample collection. All sample containers will be placed into individual re-sealable plastic zip-top bags or laboratory courier. The samples will be transferred to the contract laboratory via commercial express delivery service. The contract laboratory will meet all specified holding times and should make every effort to prepare and analyze the samples immediately after they are received. Chemical preservation, sample container type, and temperature requirements for the analyses to be performed are provided in the site-specific Work Plan and/or QAPP.

Samples will remain in the possession of the sampling personnel until they are shipped to the laboratory. Immediately after collection, and during shipment to the analytical laboratory, samples will be stored in coolers on ice. Ice packaged in plastic storage bags will maintain the temperature in the shipping containers at 4°C ± 2°C. A temperature blank and trip blank will be included in each cooler containing samples for volatiles analysis. Ice will be replenished as necessary to ensure adequate cooling of samples during storage and shipping.

8.0 REFERENCES

2003 Bay West SOP, Water Hazards, CORP-H&S-019-62590, April 18, 2003

2012 Bay West SOP, Field Equipment Decontamination, CORP-ENV-002-1578775, October 5, 2012

2012 Bay West SOP, Packaging and Shipping of Environmental Samples, CORP-ENV-006-1510206, February 10, 2012

2012 Bay West SOP, Sample Custody, CORP-ENV-004-1510208, December 12, 2012.

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Bay West

Standard Operating Procedure

SOIL SAMPLING

CORP-ENV-016-1624811

Revised: April 10, 2013

Review and Approval:

Developed by: _____
Signature
QA/QC Manager _____ Date: April 10, 2013
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Reviewed by: _____
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Approved by: _____
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Vice President of Operations _____ Date: April 10, 2013
Title

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1.0 INTRODUCTION

1.1 Purpose

The objective of this standard operating procedure (SOP) is to define the techniques and requirements for collecting soil samples from both the surface soil and the unconsolidated zone. Techniques include the use of hand trowels, hand augers, Shelby tubes, split- spoon, and macro-core samplers.

Analytical procedures are often targeted as the main source of error in data analysis, but generally only represent a minimal contribution to the total error. Field errors are often the major source of error. Potential sources of field error are: sample collection, sample handling, transport, preparation, preservation, and sample identification. Some of these restrictions and/or limitations are discussed in detail in **Section 7.1**. The sampling portion of any data collection effort has historically been the most difficult to assess when assessing project data quality. Through the correct and consistent application of this SOP, Bay West field staff will generate samples which are both representative of the targeted sample location, and comparable to another data set assuming similar samples and sample conditions.

1.2 Scope

The scope of this SOP covers all aspects of soil sampling including but not limited to: surface soils, subsurface soils accessible from an excavation, stockpiles and samples collected from subsurface exploration devices such as a drill rig. Sediment sampling is not part of this SOP.

2.0 DEFINITIONS

Surface soils or surficial zone – The layer of soil that comprises the top 10–12 inches of soil. This soil may be disturbed soil, that may be found in an industrial area that receives a great deal of traffic or undisturbed soil, such as forest soils that are fairly compact.

Unconsolidated zone – The layer of soil below the surficial zone but above bedrock that exists in a relatively loose state.

Hand trowel – a small, stainless steel device that is operated with one hand to scoop surface soil into a sampling container. A small shovel may also be used to collect surface soil samples.

Hand auger – A stainless steel cylinder (bucket or tube) approximately 3–4-inches in diameter and one foot long, open at both ends with the bottom edge designed to twist into the soil and cut out a soil core. The bucket or tube collects the soil sample. The auger has a T-shaped handle (for hand operation) attached to the top of the bucket by extendable stainless steel rod(s). A slide hammer can be attached, in place of the T- handle to drive a tube sampler.

Shelby tube – A cylindrical sampling device generally made of steel, which is driven into the subsurface soil through the hollow-stem auger or hand auger device with a slide hammer. The tube, once retrieved, may be capped and the undisturbed soil sample extruded in the laboratory prior to analysis.

Split-spoon - A cylindrical sampling device generally made of carbon steel, which fits into a hollow stem auger. The split spoon is hinged lengthwise, which allows the sample to be retrieved by opening (“splitting”) the spoon.

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Macro-core – A piston rod sampling device, typically 4 or 5-feet long, generally made of carbon steel, which fits onto hollow push rods. A push probe rig pushes the sampler to the desired sample depth then extension rods are lowered through the hollow push rods to release a stop-pin which allows the sampler to be filled when the sampler is advanced at the desired sampling interval.

Subsurface soil – The soil which exists deeper than approximately 1 foot (30 cm) from the surface, but above bedrock or any other consolidated material.

Grab sample – A discrete portion or aliquot taken from a specific location at a given point in time. Grab samples are not composited.

Liner – A cylindrical sampling device generally made of plastic, brass, stainless steel, or Teflon, that is placed inside a split-spoon, macro-core or hand auger bucket to collect soil samples.

Sample syringe – Cut or open-end syringe used to core a measured quantity of soil that can be extruded into a sample jar that contains sodium bisulfate or methanol preservative.

EnCore® sampler – A coring device that allows a specific quantity of soil to be collected (e.g., 5-grams and 25-grams). This device has a tight fitting cap that seals with an O-ring. Samples collected in this manner may be frozen prior to shipment to the lab.

Composite sample – Two or more grab sub-samples taken from a specific media and site at a specific point in time. The sub-samples are collected and mixed, and then a single average sample is taken from the mixture.

Auger flight – A steel section (typically 5-feet long) attached to an auger to extend the auger as coring depth increases.

3.0 RESPONSIBILITIES

Sampler – The Sampler is responsible for the sampling, collection, labeling, analysis and recording of data as specified in this SOP.

Site Supervisor – The Site Supervisor is responsible for making sure that field personnel are trained in the use of the sampling procedure and the required equipment, and for making sure that soil samples are collected in accordance with the approved procedure and any other SOPs pertaining to specific media sampling.

Project Manager – The Project Manager is responsible for maintaining logbooks and forms and for approving techniques not specifically described in this SOP and documenting these techniques.

4.0 REQUIRED EQUIPMENT

This section provides a list of equipment that is generally used to collect soil samples but does not necessarily include all possible types of soil sampling equipment. Bay West SOPs, including specified equipment and associated forms, shall be obtained and followed for classification and description of unconsolidated material, decontamination, sampling, packaging and shipping. Specific SOPs are listed below:

- *Classification and Description of Soil, Sediment, and Rock* (SOP# CORP-ENV-007-1577802, current version) – Provides procedures for the classification and description of soil, unconsolidated material (sediment) and rock samples collected during field operations at sites where environmental investigations are performed;
- *Field Equipment Decontamination* (SOP# CORP-ENV-002-1578775, current version) – Presents procedures for decontamination of field sampling equipment. All equipment will be decontaminated between sampling locations to prevent cross contamination of samples;
- *Packaging and Shipping of Environmental Samples* (SOP# CORP-ENV-006-1510206, current version) – Establishes packaging and shipping requirements and guidelines for environmental sample shipping; and
- *Sample Custody* (SOP# CORP-ENV-004-1510208, current version) – Presents sample custody procedures to maintain and document sample possession that are traceable from the time the samples are collected until their analysis is complete. The data generated may be introduced as evidence in legal proceedings.

The following subsections identify the types of equipment used for a specific sampling method. Prior to initiating field work it will be necessary to determine the type of equipment that will be needed to complete the sampling. The selection and restrictions/limitations of equipment and sample methods are discussed in greater detail in **Section 7.1**. In addition to the SOPs identified above and the equipment specified in the following sections, the sampler will also obtain the following materials before initiating field work:

- Site-specific plans;
- Field log book;
- Indelible black ink pens and markers;
- Labels and appropriate forms/documentation for sample shipment;
- Clear, waterproof tape;
- Laboratory prepared sample containers;
- Preservatives;
- Insulated coolers(s) and waterproof sealing tape;
- Ice bags or “blue ice”;
- Latex, nitrile, or other appropriate soil sampling gloves as specified in the site-specific safety and health plan (SSHP);
- Plastic zip-top bags;
- Packing material such as bubble wrap for packing the sample containers in the coolers;
- Stainless steel and/or Teflon-lined spatulas and pans, trays, or bowls;
- Plastic sheeting; and
- Personal protective equipment (PPE) and clothing as specified in the site-specific plans.

NOTE: This SOP is current as of the date printed on the bottom. Bay West personnel may produce paper copies of this procedure printed from the controlled-document electronic file located on the Intranet. However, it is their responsibility to ensure that they are trained and utilize the current version of this procedure.

4.1 Manual (Hand) Sampling

- Hand trowel or a small shovel;
- Hand auger: flighted, bucket, or tube-type auger as required by the site-specific plans;
- Extension rods, as needed; and
- Wrench(es), pliers, tool kit.

4.2 Split-Spoon and Shelby Tube Sampling

- Drill rig equipped with a 140-lb drop hammer and sufficient hollow-stem augers to drill to the depths required by the site-specific plans;
- Sufficient numbers of split-spoon or Shelby tube samplers so that at least one is always decontaminated and available for sampling. Three split-spoon or Shelby tube samplers are generally the minimum necessary (Shelby tubes are usually used only once);
- Split-spoon liners, as appropriate;
- Wrench(es), hammer, tool kit; and
- Basket or spring retainers may be needed for split-spoon sampling in loose, sandy soils.

Note: Shelby tubes may not retain the sample in loose, sandy soils.

4.3 Macro-core Sampling

- Push-probe rig with sufficient push rods to probe the depths required by site-specific plans;
- Sufficient number of macro-core liners for the planned number of sampling intervals; and
- Hook-blade knife to cut the liners.

5.0 PROCEDURES

5.1 Preparation

The following general steps will be followed in preparing to collect soil samples:

1. Don the appropriate PPE as dictated by the SSHP.
2. The collection points shall be specified in the site-specific plan, located on a site map, and referenced in the field logbook.
3. Processes for verifying depth of sampling must be specified in the site-specific plans.
4. Clear away vegetation and debris from the surface at the sampling location.
5. Prepare an area next to the sample collection location for laying out cuttings by placing plastic sheeting on the ground or over a work area, if necessary.
6. Set up a decontamination line, if decontamination is required.

5.2 Collection

The following general steps will be followed when collecting all surface or subsurface soil samples:

1. VOC samples or samples degraded by aeration shall be collected first and with the least disturbance possible. These samples shall be collected as grab samples using an EnCore® sampler, a Terra Core® sampler or a cut syringe sampling device. Immediately after sample collection, the EnCore® sampler will be sealed and placed into the foil bag it came with. If a Terra Core® sampler or a cut syringe sampling device is used, the soil will immediately be extruded into a 40 ml VOA vial containing the appropriate preservative. The vial will be sealed and the level of the liquid preservative will be noted and it should be sufficient to completely cover the soil aliquot. If not, another sample should be collected. VOA sample preservation is detailed in **Section 7.1.5**. Soil aliquots for the remaining analyses should be thoroughly homogenized prior to sample collection. (Reference EPA Method 5035 from EPA SW-846, *Test Methods for Evaluating Solid Waste*).
2. Sampling information shall be recorded in the field logbook and on any associated forms. Describe the soil sample, according to Bay West *Classification and Description of Soil, Sediment and Rock* (SOP# CORP-ENV-007-1577802, current version), in the field logbook or on the soil boring log form.
3. Specific sampling devices to be used shall be identified in the site-specific field sampling plans.
4. Care must be taken to prevent cross-contamination and misidentification of samples.
5. Processes for verifying depth of sampling must be specified in the site-specific plans.
6. When all sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.
7. Complete the field logbook entry and other appropriate forms, being sure to record all relevant information before moving to the next location and/or leaving the site.
8. Decontaminate all equipment according to Bay West *Field Equipment Decontamination* (SOP# CORP-ENV-002-1578775, current version) before proceeding to the next sample location.
9. Properly package all samples for shipment and complete all necessary sample shipment documentation. Transfer custody of samples to the appropriate personnel. See Bay West *Packaging and Shipping of Environmental Samples* and *Sample Custody* (SOP# CORP-ENV-006-1510206, current version, and SOP# CORP- ENV-004-1510208, current version, respectively).

NOTE: This SOP is current as of the date printed on the bottom. Bay West personnel may produce paper copies of this procedure printed from the controlled-document electronic file located on the Intranet. However, it is their responsibility to ensure that they are trained and utilize the current version of this procedure.

5.3 Manual (Hand) Augering

The following steps will be followed when collecting hand-augured samples:

1. Auger to the depth required for sampling. Place cuttings on plastic sheeting or as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.
2. Throughout the augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.
3. Cease augering when the top of the specified sampling depth has been reached. If required, remove auger from the hole and decontaminate, or use a fresh auger. Then obtain the sample.
4. Collect a grab sample for VOC analyses (or samples that may be degraded by aeration) immediately and place in a pre-preserved sample container using a cut syringe or filling and sealing an EnCore® sampler. VOA sample preservation is detailed in **Section 7.1.5**. Soil aliquots for the remaining analyses should be thoroughly homogenized prior to sample collection.
5. Label the sample container with the appropriate information. Secure the label, covering it with a piece of clear tape.
6. Remaining sample will be homogenized for other analyses. The sample will be thoroughly mixed in a stainless steel bowl and small rocks and twigs will be removed prior to placing the sample in the appropriate container(s). Label container(s) as required.
7. Wipe exterior of containers clean with a Kimwipe® or paper towel.
8. Place containers in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler (4°C ± 2°C).
9. Proceed with further sampling, as required by the site-specific plans.

5.4 Manual (Hand) Augering Using a Tube Sampler with Liner

The following steps will be followed when collecting hand-augured samples using a tube sampler with liner:

1. Auger to the depth required for sampling. Place cuttings on the plastic sheeting as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.
2. Throughout augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.
3. Cease augering when the top of the specified sampling depth has been reached.
4. Remove the auger from the hole and decontaminate.
5. Prepare a decontaminated tube sampler by installing a clean liner in the auger tube.
6. Use the slide hammer to advance and retrieve the sampler. Remove the liner from the tube and immediately cover ends with Teflon tape and cap the ends of the tube. Seal the caps with waterproof tape.
7. Label the sealed liners as required in the site-specific plans. Mark the top and bottom of the sample on the outside of the liner. Indicate boring/well number and depth on outside of liner.

8. Wipe outside of sealed liners clean with a Kimwipe® or paper towel.
9. Place sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler (4°C ± 2°C).
10. Proceed with further sampling, as required by the site-specific plans.

5.5 Split-Spoon Sampling

The following steps will be followed when collecting split-spoon samples:

1. Remove any pavement and sub-base material from an area of twice the bit diameter, if necessary.
2. The drilling rig will be decontaminated at a separate location prior to drilling, per Bay West SOP or the site-specific decontamination procedures.
3. Attach to the drill rig the hollow-stem auger with the cutting head, plug and center rod(s).
4. Begin drilling and proceed to the first designated sample depth, adding auger flight(s) as necessary.
5. Remove the plug and center rods.
6. Install a decontaminated split-spoon on the center rod(s) and insert it into the hollow- stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.
7. Mark the center rod in 6-inch increments for 24-inches from the top of the auger flight(s).
8. Drive the spoon using the hammer. Use a full 30-inch drop for the hammer as specified by the American Society for Testing and Materials (ASTM) Method D-1586. Record the number of blows required to drive the spoon through each 6-inch increment.
9. Cease driving when the full-length of the spoon has been driven or upon refusal.
10. Refusal occurs when little (<1-inch) or no progress is made for 50 blows of the hammer.
11. Pull the spoon free by using upswings of the hammer to loosen the sampler. Pull out the center rod and spoon.
12. Unscrew the split-spoon assembly from the center rod and place it on the plastic sheeting.
13. Remove the drive shoe and head assembly. If necessary, tap the split-spoon assembly with a hammer to loosen threaded couplings.
14. With the drive shoe and head assembly off, open (split) the spoon, being careful not to disturb the sample.
15. Label sample containers with appropriate information. Secure the label, covering it with a piece of clear tape.
16. If VOC analyses or analyses that may be degraded by aeration are to be conducted on the soil sample, collect a grab sample for the analyses immediately and place in a pre-preserved sample container using a cut syringe or filling and sealing an EnCore® sampler. VOA sample preservation is detailed in **Section 7.1.5**. Soil aliquots for the remaining analyses should be thoroughly homogenized prior to sample collection.

17. Record the sample identification number, depth from which the sample was taken, and the analyses to be performed on the samples in the field logbook and on the appropriate forms.
18. Remaining soil samples should be homogenized prior to placing samples in appropriate containers. Label containers as required.
19. Wipe outside of sample containers clean with a Kimwipe® or paper towel.
20. Place sample containers in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler (4°C ± 2°C).
21. Continue to advance the hollow stem augers to the next sampling point. Collect samples as outlined above.
22. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.

5.6 Split-Spoon Sampling Using Liners

The following steps will be followed when collecting samples with lined split spoons:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
2. The drilling rig will be decontaminated at a separate location prior to drilling.
3. Attach the hollow-stem auger with the cutting head and center rod(s).
4. Begin drilling and proceed to the first designated sample depth, adding auger flight(s) as necessary.
5. Remove the plug and center rods.
6. Install a clean liner in the split-spoon barrel.
7. Install a decontaminated split-spoon on the center rod(s) and insert into the hollow- stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.
8. Mark the center rod in 6-inch increments for 24-inches from the top of the auger flight(s).
9. Drive the spoon using the hammer. Use a full 30-inch drop for the hammer as specified by ASTM Method D-1586. Record the number of blows required to drive the spoon through each 6-inch increment.
10. Cease driving when the full-length of the spoon has been driven or upon refusal. Refusal occurs when little (<1-inch) or no progress is made after 50 blows of the hammer.
11. Pull the spoon or tube free by using upswings of the hammer to loosen the sampler.
12. Pull out the center rod and spoon.
13. Unscrew the split-spoon assembly from the center rod and place it on the plastic sheeting.
14. Remove the drive shoe and head assembly. If necessary, tap the split-spoon assembly with a hammer to loosen threaded couplings.

15. With the drive shoe and head assembly off, open (split) the spoon and remove the liner without disturbing the sample.
16. Wipe the outside of the sealed liners clean with a Kimwipe® or paper towel.
17. Mark the top of the core and the sample depth using a marker on the outside of the plastic liner.
18. Collect a grab sample for VOC analyses (or samples that may be degraded by aeration), if required, immediately and place in a pre-preserved sample container using a cut syringe or filling and sealing an EnCore® sampler.
19. Pack samples in a chilled cooler. Collect headspace and other samples as required by the site-specific plans. VOA sample preservation is detailed in **Section 7.1.5**. Soil aliquots for the remaining analyses should be thoroughly homogenized prior to sample collection.
20. In the field logbook and on the boring log, describe sample lithology by observing cuttings and the bottom end of the sample in the liner.
21. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.
22. When sampling is complete, remove the drilling rig to the heavy equipment decontamination site.

5.7 Macro-core Sampling

The following steps will be followed when collecting samples with lined split spoons:

1. Plastic liner and solid drive point is placed in macro-core.
2. Macro-core is placed on the end of the push rods and driven to the desired sampling depth.
3. Extension rods are lowered through the hollow push rods to release a stop-pin in the drive point which allows the sampler to be filled when the sampler is advanced.
4. The macro-core is advanced through the desired sample interval.
5. The macro-core is retrieved by pulling the push rods.
6. The macro-core is opened and the plastic liner, filled with the soil sample, is removed.
7. Wipe the outside of the sealed liners clean with a Kimwipe® or paper towel.
8. Mark the top of the core and the sample depth using a marker on the outside of the plastic liner.
9. Immediately collect VOC samples by cutting the plastic liner and using a coring device as previously described to collect the sample. Pack samples in a chilled cooler. Collect headspace and other samples as required by the site-specific plans. VOA sample preservation is detailed in **Section 7.1.5**. Soil aliquots for the remaining analyses should be thoroughly homogenized prior to sample collection.
10. In the field logbook and on the boring log, describe sample by observing cuttings and the bottom end of the sample in the liner.
11. Continue to advance the cleaned and relined macro-core to the next sampling point.

12. Collect samples as outlined above. When sampling is complete, push rods need to be decontaminated before reuse or leaving the site.

5.8 Shelby Tube Sampling

The following steps will be followed when collecting samples using the Shelby tube:

1. Remove any pavement and sub-base material from an area of twice the bit diameter, if necessary.
2. The drilling rig will be decontaminated at a separate location prior to drilling.
3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s).
4. Begin drilling and proceed to the first designated sample depth, adding auger flight(s) as necessary.
5. Slightly raise the auger flight(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods.
7. Attach a head assembly to a decontaminated Shelby tube. Attach the Shelby tube assembly to the center rods.
8. Lower the Shelby tube and center rods into the hollow-seam augers and seat it at the bottom. Be sure to leave 30 inches or more of center rod above the lowest point to the hydraulic piston's extension.
9. Use the rig's hydraulic drive to push the Shelby tube into undisturbed soil. The tube should be pushed with a steady force.
10. When the Shelby tube has been advanced to its full-length or to refusal, back off the hydraulic pistons. Attach a hoisting plug to the upper end of the center rod, twist to break off the sample, and pull the apparatus out of the hole with the rig winch.
11. Retrieve the Shelby tube to the surface, detach it from the center rod, and remove the head assembly.
12. Since the typical intent of Shelby tube sampling is for engineering purposes and undisturbed sample is required, the tube ends should be sealed immediately, the top and bottom ends of the tube marked, and the tube should be transported to the laboratory in an upright position. Indicate boring/well number and depth on outside of liner.
13. Wipe the outside of the sealed tubes clean with a Kimwipe® or paper towel.
14. Place sealed tubes in zip-top plastic bags and seal bags. Pack samples in a chilled cooler (4°C ± 2°C).
15. Continue to advance the hollow stem augers to the next sampling point. Collect samples as outlined above.
16. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.

6.0 DOCUMENTATION

Individuals performing the work will record their observations in a commercially available, bound field logbook and the boring log forms. Editing of field logbook data is not allowed. The source of the reference material or field charts used must be recorded in the field logbook. If a log book is used to record the sample description, the readings must be transferred within 24 hours to a boring log form. The following is a general summary of the information to be documented:

- List of all personnel present:
- Field conditions including:
    - Air temperature;
    - Wind speed/direction;
    - Precipitation/moisture at the time of sampling event;
    - Ambient odors;
    - Airborne dust;
    - Description of any exceptions to this SOP; and for each sample location
    - Sample Name used to identify the sample;
    - Sample method and equipment used;
    - Date and time of sample collection;
    - A list of all samples sent to each laboratory; and
    - Complete a boring log form for all soil borings.

7.0 PROCEDURE PERFORMANCE EXPECTATIONS

7.1 Restrictions/Limitations

Only qualified persons trained in performing the requirements and the duties described in the SOP shall conduct the work. The Project Manager or QA/QC Manager will have the authority to decide whether or not an individual is qualified.

7.1.1 Selection and Limitations of Sampling Equipment

Choosing the proper sampling tool depends on the nature of the soil to be sampled and the goals of the project. Scoops, trowels and triers are used for surface grab samples (0 to 0.5 feet below grade) whereas the hand auger can be used to depths as great as 12 feet. The auger will produce a composite sample of the penetrated section.

The Shelby tube will collect a sample with the least amount of disturbance; however, this method precludes logging of the sample and is difficult to use in very well-compacted sediments. Using a continuous split-spoon sampling device or push probe macro-core is a rapid method of obtaining relatively undisturbed samples; however, depth of sampling is dependent upon sediment cohesiveness. Insufficient cohesiveness will result in poor sample recovery and borehole collapse. Split-spoons or macro-cores are both good general purpose sampling devices.

7.1.2 Removal of Extraneous Material

If indicated in the project planning documents, extraneous material is removed at the time of sample collection. If rocks, debris, root, twigs, etc. are not removed in the field, there may be greater chance for inconsistent sub-sampling in the laboratory and/or submitting insufficient sample volume. In some cases this material may have to be saved and analyzed separately depending on the project requirements.

Obtaining an aliquot from a sample container is referred to as laboratory subsampling and is performed by laboratory personnel during sample preparation steps. Current SW-846 and other standard reference methods provide little or no guidance on subsampling within their preparatory methods and laboratory staff commonly overlooks these critical procedures. Furthermore, it is common for many analytical methods to require only a fraction (1 to 30-grams for soils) of the submitted sample to be subjected to the actual analysis. Because only a fraction of the submitted sample is actually involved in the evaluation of the sampling location, it is important that the entire sample be truly representative. Adequate sample homogenation prior to laboratory submittal will increase the degree of sample representativeness.

7.1.3 Sample Homogenizing

Proper homogenizing technique is critical to accurately assessing the condition of a site, and to generating QC data that reflects the quality of the environmental data produced. Depending on site characteristics and the extent of contamination, the project plans may address homogenizing techniques directly. The generation of field control samples (e.g., replicate samples) will provide a mechanism for evaluating matrix heterogeneity and the sampling and handling techniques of the field personnel. As always homogenization techniques should not be used for VOC analysis or other parameters that require undisturbed sample collection.

Obtaining samples in a soil or sediment matrix requires homogenization of the sample aliquot prior to filling sample containers (with exception of VOC type parameters). Before sample mixing is performed, instructions on the removal of extraneous sample materials (grass or materials in “root zone,” leaves, sticks, rocks, etc.) should be reviewed. Moisture content, sediments, and waste materials may inhibit the ability to achieve complete mixing prior to filling sample containers. However, it is extremely important that solid samples be mixed as thoroughly as possible to ensure that the sample is as representative as possible of the sample location.

Homogenization procedures may be accomplished by several methods. The method best suited for the media will depend on the physical characteristics of the solid material (e.g., heterogeneity of media, maximum particle size present, moisture content, etc.). In general, homogenization is accomplished by filling a properly decontaminated container with the sample and mixing it with a decontaminated implement. The container should be large enough to hold the sample volume and accommodate the procedures without spilling. In most cases, the method of choice for mixing is referred to as cone and quartering and can be performed in a bowl or tray of an appropriate material (depending on the analytical parameters to be performed). If the solid medium is not amenable to cone and quartering techniques due to the high moisture content or high cohesiveness of the waste, alternative procedures may need to be pursued, i.e., kneading, particle size reduction, or particle size separation devices (i.e., sieves). Additional procedures will likely require expansion of the field decontamination scope.

7.1.4 Compositing Samples

There are various types of composite sampling techniques available. The technique of compositing discrete samples is typically employed when the site under investigation is quite large to improve the precision (lower the variance) of the estimated average contaminant concentrations, especially when contamination exhibits a short-range heterogeneity, and to decrease the probability of making a wrong decision based on limited data. Discussion between project planners and data users should be done to determine the appropriateness of applying compositing schemes to meet project objectives. Composite sampling is not specific to one matrix. Rather it can be utilized for solid, semisolid, liquid, and air matrices.

Composite samples consist of a series of discrete grab samples that are mixed together to characterize the average composition of a given material. The discrete samples used to make up a composite sample are typically of equal volume. Discrete samples must be collected in an identical fashion. Likewise, the number of grab samples forming a composite should remain consistent (i.e., a number and pattern for collection of grab samples within a grid should be selected and, for a given grid size, should not be changed). Homogenizing techniques must be used on each individual discrete sample, and the resultant composite sample.

If a contaminant is detected in a composite sample, each discrete grab sample that made up the composite should be analyzed individually to determine actual distribution of the contamination. Therefore the discrete samples should be initially submitted to the laboratory with the composites on "hold" for storage and potential analysis.

Potential analytical problems associated with compositing is when the sample matrix is not amenable to mixing techniques, which resulting in a non-homogeneous sample mixture compromising the representativeness of the composite results.

Areal Composite – Areal composite samples are samples collected from individual grab samples collected in an area or on a cross-sectional basis. Areal composites are made up of equal volumes of grab samples where all grabs are collected in an identical manner. Areal composite sampling is typically used for estimating average contaminant concentrations in surface soils or sediments. This is especially useful when contaminants are present in a nugget form (i.e., TNT chunks, lead shot, etc.), exhibiting large differences in concentration in a small area (short-range heterogeneity). Grid sizes should be kept moderate (<5 to 10-feet) in diameter, if project objectives and intended use of the data are to maintain aspects of a "discrete" sample while providing better overall coverage.

Vertical Composite – Vertical composite samples are also collected from individual grab samples but taken from a vertical cross section. Vertical composites are also made up of equal volumes of grab samples where all grab samples are collected in an identical manner. Vertical profiles of soil borehole or sediment columns are examples of vertical compositing.

7.1.5 VOC Sample Preservation

Preservation of VOC samples in the field is critical to successful soil sampling. Generally, there are four methods to accomplish proper preservation: Using a sealing device, e.g., an EnCore® sampler or using one of three liquid preservation methods as provided by the laboratory. All four techniques can be successfully used, but they all have their drawbacks. The EnCore® sampler is probably the easiest technique to use in the field. EnCore® samples come in two sizes: 5 gram and 25 gram. The site-specific sampling and analysis plan (SAP) will specify which one to use. Two of the specific EnCore® samplers should be collected for each sampling location. The sampler is pressed into the soil until the small O-ring is observed in the tool window, the open end of the sampler is cleaned of any soil adhering to the sealing surface and the cap is then locked into place. The drawbacks are these samplers are expensive and are one time use only. The lab needs to extrude the sample upon receipt (with 48 hours) and place the soil into a preservative, an extra step on their part and a (small) potential step to spill or contaminate the sample.

The three field liquid preservation methods consist of the lab providing either: three 40 ml *low level* VOA vials for each sample to be collected (sodium bisulfate and methanol preservatives), three 40 ml *low level* VOA vials for each sample to be collected (deionized water and methanol preservatives), or two 40 ml *medium level* VOA vials for each sample to be collected (methanol preservative only). The preservation method depends on the concentration range of the analytes to be determined and will be specified in the site-specific SAP.

The first field liquid preservation method (low level) requires two vials containing ~5 ml of sodium bisulfate ($NaHSO_4$) solution and a small stir bar and one vial containing ~5 ml of lab grade methanol. All of the vials are pre-weighed by the lab before shipment. The sampler uses a coring device, such as a Terra Core® or a cut syringe, to place approximately 5 grams of soil into each vial. Be certain the threads of the vial are free of soil before sealing the vial. It is not critical to know the exact mass of the soil added to the vial as the lab will weigh the vial prior to analysis. It is critical the liquid in the vial covers the top of the soil aliquot for proper preservation.

The second field liquid preservation method (low level) requires two vials containing ~5 ml of deionized water and one vial containing ~5 ml lab grade methanol. All of the vials are pre-weighed by the lab before shipment. The sampler uses a coring device, such as a Terra Core® or a cut syringe, to place approximately 5 grams of soil into each vial. Be certain the threads of the vial are free of soil before sealing the vial. It is not critical to know the exact mass of the soil added to the vial as the lab will weigh the vial prior to analysis. It is critical the liquid in the vial covers the top of the soil aliquot for proper preservation.

The third field liquid preservation method requires two vials containing ~10 ml of lab grade methanol. All of the vials are pre-weighed by the lab before shipment. The sampler uses a coring device, such as a Terra Core® or a cut syringe (calibrated to collected 5 grams of soil), to place approximately 5 grams of soil into each vial. Be certain the threads of the vial are free of soil before sealing the vial. Clean the treads, if necessary. It is not critical to know the exact mass of the soil added to the vial as the lab will weigh the vial prior to analysis. It is critical the liquid in the vial covers the top of the soil aliquot for proper preservation. Swirl the vial to ensure thorough mixing of the soil and liquid.

Drawbacks to the field liquid preservation techniques are: spillage of the preservative, which renders the vials useless as the tare weight is lost, adding too much soil to the vial so the preservative does not cover all of the soil in the vial, and limited shelf life of the pre- preserved vials. Laboratories usually prefer one of the field liquid preservation methods because, after weighing the vial, the sample can often be placed directly on the instrument auto sampler for analysis. In addition, if no other sample jars are required for this particular sampling location, a small 250 ml sample jar without preservative will need to be sent to the lab in addition to the liquid preserved vials for a percent moisture determination. Some laboratories may send a different number of vials according to their lab SOP. These differences will be detailed in the site-specific SAP.

When performed properly, all four of these techniques will produce a valid, preserved soil sample. These soil sampling techniques are described in detail in EPA Method 5035, *Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples*, as referenced below.

8.0 REFERENCES

American Society for Testing and Materials, *Penetration Test and Split Barrel Sampling of Soils, Standard Method D-1586-84*, 1984.

U.S. Department of Energy, *Hazardous Waste Remedial Actions Program, Quality Control Requirements for Field Methods, DOE/HWP-69/R1*, July 1990.

U.S. Department of Energy, *Hazardous Waste Remedial Actions Programs, Standard Operating Procedures for Site Characterizations, DOE/HWP-100*, July 1990.

U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste, SW-846 Method 5035, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples*. Final Update IV, Revision 6, February 2007.

SITE SPECIFIC STANDARD OPERATING PROCEDURE ANALOG OPERATIONS

This Site-Specific Standard Operating Procedure (SSSOP) has been developed specifically for the Strother Field FUDS Disposal Area MRS RI and describes analog operations. This SSSOP is not intended for personnel untrained in unexploded ordnance (UXO) procedures.

The Senior UXO Supervisor (SUXOS) may modify these procedures as necessary with the approval of the UXO Safety Officer/Quality Control Specialist (UXOSO/QCS).

Analog operations are used to remove subsurface MEC in areas inaccessible to geophysics.

1.0 EQUIPMENT

Each situation will dictate the needed equipment, so the team may omit certain items from this list or use equipment not listed here.

- Analog Detector (White, Schonstedt, etc.) with instruction manual;
- Bucket or other container;
- Camera;
- Communications device (radio, cellular phone);
- Digging tools;
- Drinking water;
- Eyewash;
- Fire extinguisher;
- First aid kit;
- Flashlight;
- Hand trowel;
- Pin flags;
- Global Positioning System (GPS);
- Line/rope;
- Stakes;
- Digging tools (shovel, pick, digging bar); and
- Earth Moving Machinery (EMM).

1.1 Metal detectors

Handheld detectors authorized for this project include but are not limited to Whites Spectra VX3, Whites XLT, Whites DFX, Schonstedt GA-52cx and Magnetic Locator ML-3L. Other detectors may be used. All detectors are checked at the ITS to ensure they can meet project objectives.

Either magnetometers or electromagnetic detectors are suitable for the munitions anticipated at the MRS which are ferrous. Check metal detectors prior to field used to ensure they meet the project objective of identifying subsurface munitions and munitions burial pits.

1.2 Function check and inspect equipment

Set up metal detectors in accordance with the manufacturer's instructions. For electromagnetic detectors, there is normally a UXO program available. If no UXO program is available, set it up to detect a target that simulates an ordnance item expected on the project. Ordnance items may contain many types of metal, but steel is the most common.

Check metal detectors at the instrument test strip (ITS) as outlined in the Uniform Federal Program-Quality Assurance Project Plan (UFP-QAPP). The ITS will have metallic seed items buried at various depths and orientations. This is a go/no go test. If the detector fails, check for obvious defects, change batteries, and rerun the check. If the detector fails again, reject it and replace it with a different detector. Document instrument checks in the team logbook.

Check all other equipment for suitability of use (i.e. cracked shovel handles, loose pick heads).

2.0 SAFETY

2.1 Exclusion zones

Establish an exclusion zone (EZ) before beginning any operations having potential contact with munitions and explosives of concern (MEC). Refer to the explosives site plan (ESP) for the current EZ to be engaged at the munitions response site (MRS), because exclusion zone distances may be amended from time to time. Mark the EZ with signs, caution tape, or other visible means; zone to prevent entry of nonessential personnel. Monitor the EZ, including the airspace above it, for unauthorized entry, and stop analog work when nonessential personnel enter the area.

2.2 MEC and General Safety

UXO team members must follow all general Corps of Engineers and UXO safety precautions. The Accident Prevention Plan (APP) contains specific precautions. These are some major items.

- Ensure communications with emergency services before starting UXO operations;
- Be aware of any ordnance item that may contain a cocked striker;
- Consider all ordnance armed unless proven otherwise;
- Remove soil from an anomaly carefully;
- Begin excavation from the side of the anomaly and work in;
- Do not move any item unless positively identified as acceptable to move from a safety standpoint;
- The SUXOS and UXOSO must evaluate MEC to determine if it is acceptable to move from a safety standpoint;
- Do not disassemble any ordnance item;
- Do not intentionally activate any munitions components (i.e. impellers, arming vanes etc.);
- Never rely on color coding for positive identification of an ordnance item; and
- Stop excavating and move upwind if any chemical ordnance or industrial chemicals are suspected. Contact the SUXOS.

3.0 ANALOG SEARCH PROCEDURES

Search areas should be defined and identified by the SUXOS as outlined in the work plan. Search grids will divide the work area into manageable sections and help with data collection. Grid size is typically 200 foot by 200 foot, but will be optimized for field conditions. Grids may be surveyed with the GPS or measuring tapes. Grids need not be measured to exact standards, provided all area within the digital geophysical mapping (DGM) inaccessible areas are addressed. Mark grid corners clearly with stakes, flagging, paint, or other means.

- Lay ropes or lines at approximately five-foot intervals to establish search lanes; the lanes may be adjusted to accommodate a smaller or larger search pattern;
- Guide on the lines while walking forward slowly down the search lane, sweeping the head of the metal detector smoothly from side to side;
- Ensure the detector head exceeds the width of the search lane to slightly overlap the adjacent lane;
- The detector head must be parallel to the ground surface;
- Keep the head close to the ground;
- Keep the detector head at a constant height throughout the sweep;
- Do not be deceived by a dull or low volume signal from a metal detector; deep targets do not necessarily produce a loud or sharp signal;
- Define the extent of an anomaly using the metal detector;
- Using a shovel, trowel, or other suitable tool, remove soil in small amounts from the side of the anomaly and work inward toward the anomaly;
- Be cautious when using a pick or digging bar. Never use these tools in close proximity to suspected MEC;
- Dig a hole large enough to enable you to identify the item;
- When the item is visible, carefully inspect it to identify it as MEC, munitions debris, or other debris, as described in **Section 6.0**;
- A UXO Technician I may make an initial inspection of material potentially presenting an explosive hazard (MPPEH), but inspection must be verified by a UXO Technician II or higher;
- Leave MEC or any item that cannot be positively identified in place to be evaluated by the SUXOS and UXOSO/QCS;
- Remove munitions debris and other debris and place in a designated container, normally a bucket;
- Recheck the excavation with the metal detector and continue clearing the anomaly if necessary;
- Have a second party verify that the anomaly is resolved;
- Do not backfill excavation until the SUXOS approves backfilling. This will normally occur after all quality control actions have been completed.
    - The best practice is to finish QC actions before the end of the day so that all excavations are backfilled before departing the work area; and
- Continue the process until the assigned area is complete.

4.0 EARTH MOVING MACHINERY

4.1 Manual Excavation

The UXO Team may use EMM to assist in manual excavation of anomalies. A UXO Technician on the ground will guide excavation. Once the EMM is within 12 inches of the suspected MEC, complete an excavation manually (shovels, trowels, etc.).

4.2 Mechanized MEC Operations

4.2.1 Explosives Safety

Excavation with shielded EMM is authorized when investigating anomalies, particularly for suspected munitions debris burial pits. Protective measures are as follows:

- No shielding for fragmentation is required. However, ensure that the EMM operator is protected by the windshield of the EMM or other equivalent shielding;
- Provide blast protection to personnel to the K24 overpressure distance of 5 feet. This may be reduced to 3 feet if double hearing protection of 9 dB or better is worn;
- Remove all nonessential personnel to the K40 overpressure distance of 9 feet.

The preceding may change if the ESP is amended; always refer to the ESP for current and more detailed explosives safety information.

The munition with the greatest fragmentation distance is the 4-pound incendiary AN-M50X-A1 round as of plan preparation. As work progresses, be observant for any other munitions that may drive an amendment to the ESP.

5.0 DOCUMENTATION

- Record a GPS point feature of MEC; munitions debris (MD) such as expended rocket motors, inert warheads, fragments; and range related debris such as target material;
- Where MD is spread over an extended area, create a polygon feature around it rather than recording each item as a point feature;
- Photograph the recovered item. Include a whiteboard in the photograph showing grid number, the date, a ruler or permanent markings as a size reference in inches or centimeters (gloves, pens, knives, etc. are unacceptable as size references), the standard item nomenclature (2.36-inch rocket m6A3, etc.), and any other descriptive information that may be helpful;
- Fill-in required information in the grid sheet (attached). Approximate the location of the MEC/MD on the grid sheet, as it will be more accurately recorded by GPS; and
- At the end of the workday, turn in documentation to the SUXOS or designee.

6.0 MPPEH INSPECTION

Inspection of MPPEH must take place in the MRS with an exclusion zone engaged. MPPEH procedures are more fully described in a separate SSSOP.

- After initial inspection of MPPEH by a UXO Technician II, the UXO Technician III must perform a second independent inspection;
- If any doubt exists as to whether the item is safe from explosive standpoint, do not remove it from the MRS. The item may need to be guarded or disposed of in accordance with MEC disposal procedures;
- Mark MEC for disposal and notify the SUXOS;
- After the second inspection, document the material as material documented as safe (MDAS) in the team leader's logbook; and
- Turn the MDAS over to the SUXOS for final disposition.

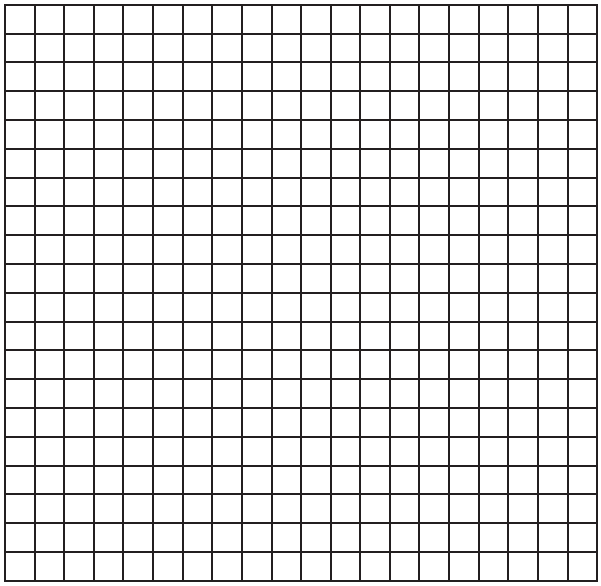
Attachments

Bay West

GRID SHEET

Project
Site: _____ Grid #_____ Date_____

Team_____ UXO Team Leader _____



SW corner

Date	Digs	MEC	MD	OD	Other	% of Grid Complete

MEC or Other Significant Items

1._____

2._____

3._____

4._____

5._____

6._____

Bay West **GRID SHEET**

Project
Site: _____ Grid #_____ Date_____

Team_____ UXO Team Leader _____

Notes:

Three Phase Quality Control Checklist

Analog Operations

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	Yes No N/A	Comments
1.	APP, QAPP	Communications available and checked		
2.	APP	Daily safety meeting conducted by SUXOS/UXOSO		
3.	Analog Operations SOP	Instrument operator manuals are on-site and detectors operated on the required programs/settings		
4.	QAPP WS#12 and #22	Metal detectors checked before use each day and documented		
5.	QAPP WS#17	DGM inaccessible areas designated for analog geophysics and clearly marked		
6.	ESP	Exclusion zone engaged and non-essential personnel removed		
7.	ESP	Intrusive Teams maintain the TSD		
8.	Analog Operations SOP	Suitable control/sweep lanes used		
9.	APP Analog	UXO Technicians are excavating safely		

Analog Operations

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	Yes No N/A	Comments
	Operations SOP			
10.	ESP	MPPEH positively identified before movement and those unsafe and/or unidentifiable for avoidance and disposal		
11.	ESP	SUXOS and UXOSO determine if MEC is acceptable to move and document status in their logbooks		
12.	Analog Operations SOP	Excavation holes are rechecked following anomaly removal to ensure that the anomaly is properly resolved		
13.	Best practice	Team Leaders observe each worker and randomly inspect sweep lanes		
14.	Analog Operations SOP	MEC is documented on a photograph with site name, date, GPS coordinate, standard item nomenclature, and description on a whiteboard		

Analog Operations

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

6.1	**Punch List**

Conducted By: _____

Acknowledged By:_____

STANDARD OPERATING PROCEDURE
Anomaly Avoidance

This Site-Specific Standard Operating Procedure (SOP) was developed specifically for the Disposal Area MRS RI at the Strother Field FUDS. This SOP is not intended for personnel untrained in unexploded ordnance (UXO) procedures.

There may be soil sampling conducted during the RI. This SOP outlines procedures to follow to protect personnel from MEC hazards during soil sampling. Use this SOP in conjunction with the Soil Sampling SOP. Soil samples may be collected from an excavator bucket, using mechanized equipment such as a drill rig or push probe, or they may be manually collected. Coordinate with your sampler. Intrusive procedures are not a component of this task and are not outlined in this SOP. If it is necessary to remove an anomaly, refer to the Intrusive SOP.

1.0 EQUIPMENT

- Analog metal detector;
- Camera;
- Communications device (radio, cellular phone);
- Digging tools;
- Drinking water;
- Eyewash;
- Fire extinguisher
- First aid kit;
- Flashlight;
- Hand trowel;
- Pin flags; and
- Global Positioning System (GPS); and

2.0 SAFETY

- All non-UXO personnel must be escorted by a UXO qualified person within the MRS.
- Do not handle MEC while performing anomaly avoidance and UXO escort. Report any MEC to the SUXOS who will apply standard MEC encounter procedures as outlined in other SOPs.
- If an anomaly is encountered, move the sampling location or perform intrusive investigation as outlined in other SOPs.
- Observe safety precautions outlined in the APP when working around heavy equipment, drill rigs, etc.
- Observe excavation safety precautions outlined in the APP when working in excavations. Benching and sloping is required.

3.0 ANOMALY DETECTION

Ascertain the detection depth of the analog instrument at the ITS. The soil sampler will identify the sample location. Monitor the soil sample location with the detector prior to intrusive operations. If the sample location is clear of anomalies be sampler may perform intrusive operations. Once the depth of detection is reached, the soil sampler must stop intrusive

operations and the location must be monitored with the detector. This procedure continues until the sample depth is reached.

Within burial pits that have been identified as non-munitions burial pits, anomaly avoidance may be terminated after reaching 2 feet beyond the last detected anomaly.

If burial pits are determined to be munitions related, anomaly avoidance must continue while advancing the drill rig or sample equipment in 1 foot increments.

4.0 ANOMALY AVOIDANCE

If an anomaly is detected at a sample location, the normal procedure is to revise the sample location.

5.0 ANOMALY CLEARANCE

Anomaly clearance is not normally within the scope of anomaly avoidance operations. However, because a complete UXO Team will be at the MRS, intrusive operations may be conducted to clear the anomaly location prior to sampling. Refer to the Intrusive SOP.

6.0 ALTERNATE PROCEDURES

Using a drill rig may be problematic, particularly within deep burial pits. Consider using an excavator or backhoe to excavate to the sample depth and then take the sample from the excavator bucket.

If shielded EMM is available, consider using mechanized MEC procedures as outlined in the Intrusive SOP to reach the appropriate depth.

SITE SPECIFIC STANDARD OPERATING PROCEDURE
MEC DIPSOSAL

This Site-Specific Standard Operating Procedure (SSSOP) has been developed specifically for the Strother Field FUDS Disposal Area MRS RI. This SSSOP is to be used only by personnel who have received training in the use of explosives and the disposal of munitions and explosives of concern (MEC). This SOP is not intended as an instruction manual for personnel untrained in the use of explosives. This SOP must be used in conjunction with the approved project Explosives Site Plan (ESP) because it contains site-specific information. This SSSOP is not intended as a checklist; however, it may be printed to check off items if desired.

1.0 PUBLICATIONS

The minimum required publications are listed below. The latest editions of these are provided on the “Disk of Required Publications” supplied with the work plan.

- Buried Explosion Module (BEM) v 6.3.2, 16 Apr 13
- Department of Defense Explosives Safety Board (DDESB) Technical Paper (TP)-15, Approved Protective Construction, Rev 3, May 10 with approval memo, 17 May 10
- DDESB TP-16, Methodologies for Calculating Primary Fragment Characteristics, Rev 4, 2 Aug 12 with addendum 4 dated 7 Mar 16.
- Department of Defense Explosives Safety Board Munitions Fragmentation Database, 21 Aug 14
- Engineer Manual 385-1-1, Safety and Health Requirements Manual, 30 Nov 14
- Engineer Manual 385-1-97, Explosives Safety and Health Requirements Manual, Change 1 with Errata 1-6, 17 May 13
- Engineer Pamphlet 1110-1-17, Establishing a Temporary Open Burn and Open Detonation Site For Conventional Ordnance and Explosives Projects, 16 Jul 99
- Explosives Site Plan, Remedial Investigation/Feasibility Study, Strother Field Formerly Used Defense Site, Disposal Area Munitions Response Site, October 2015. DDESB approved in December 2015.
- Military Remote Hardened Firing Device (MHRFD) Operations and Maintenance Manual and Quick Reference Guide
- Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives (OE) Sites, 28 Aug 98

2.0 EQUIPMENT

Suggested equipment for disposal operations is listed below. This list may be supplemented with additional items if necessary, and unnecessary items may be omitted.

- Blasting caps/detonators
- Blasting crimpers
- Cobra fuse assemblies
- Cutting pliers
- Demolition charges or perforators
- Detonating cord
- Detonator assembly
- Electrician’s Tape or Suitable Substitute
- Fire extinguisher
- First aid kit
- Fuse igniter
- Radio transceivers
- Knife
- Lightning detector
- Matches
- MHRFD
- Plastic bags
- Shock tube cutter

- Signaling device (vehicle horn, bullhorn, siren, etc.)
- Smokeless powder
- Watch

3.0 ISSUE OF EXPLOSIVES

Obtain explosives from the Bay West magazine as outlined in the Explosives Management Plan SSSOP.

4.0 FIRING SYSTEMS

Detonating

Primary: General Dynamics MHRFD

Secondary: Shock tube non-electric initiation

Burning

Time fuse

Fuse lighters

5.0 DETONATORS

Primary: Detonators with shock tube leads
Secondary: Cobra cap and fuse assemblies with nonelectric blasting caps
Depending upon availability, other types of detonators may be used.

6.0 DONOR CHARGES

Detonating

19 to 32 gram jet perforators
Detonating cord
Depending upon availability, other types of donor charges may be used.

Burning

Smokeless powder

7.0 PLACEMENT OF CHARGES

Thoroughly evaluate the MEC item and study available technical data. Place the charge where it will be most effective. Keep the following in mind:

- Place the charge on the thinnest portion of the part of the case containing explosives unless otherwise specified in technical data.
- Use sufficient donor charge to detonate the MEC item.
- Ensure continuity of explosives to the MEC item.
- With certain sensitively fuzed items, it is necessary to place the charge as close as possible without touching the MEC.
- Use the proper stand-off when using perforators/shaped charges. Generally, the stand-off for commercial perforators/shaped charges is pre-assembled, and it can be placed directly onto the MEC

item. If you are concerned about moving the MEC item, construct a stand-off and place it one times the charge diameter from the MEC item.

8.0 TEAM COMPOSITION

The Senior UXO Supervisor (SUXOS) will plan, supervise, and coordinate all explosive operations. The SUXOS may designate a demolition supervisor (DS).

The demolition team will consist of at least two people qualified in accordance with (IAW) DDESB TP-18, one of which must be a UXO Technician III (UXOT III) or higher level UXO technician.

Personnel who are not involved in setting up and firing the shot will control access to the exclusion zone or perform other duties assigned by the SUXOS or DS.

The UXO Safety Officer (UXOSO) will monitor operations to ensure safety.

9.0 NOTIFICATIONS

The SUXOS or designee must notify via telephone, radio, or in person:

- USACE Ordnance and Explosives Safety Specialist: John Kochefko 402-995-2281
- USACE Project Manager: Kurt Baer 816-389-3922
- Bay West Project Manager: Marie Swiech-Laflamme 609-638-2919
- Strother Field Commission: Shawn McGrew 620-221-9280
- Local responders

10.0 PRE OPERATIONAL BRIEFING

The SUXOS or DS will give a preoperational briefing to the UXO team. A safety briefing guide is provided as **Attachment 1**.

11.0 WEATHER

Check weather with Strother Field airport forecaster, or alternatively, consult a reputable internet weather site. Disposal operations must not be conducted when lightning storms are in the vicinity.

12.0 SAFETY

Safety Signals

Give safety signals with a vehicle horn, siren, bullhorn, whistle, or similar means. They must be audible at the most distant point of the exclusion zone (EZ). Use the following safety signals:

- Warning Signal - One minute series of long audible signals 5 minutes prior to the blast signal
- Blast Signal - A series of short audible signals 1 minute prior to the shot
- All Clear - A prolonged audible signal following the inspection of the blast area

Safety Precautions

- Do not hurry. Hurrying causes misfires and accidents.
- Take prompt action to correct any hazardous situation.

- Wait one hour (60 minutes) before approaching a misfire.[1]
- Cease all demolition operations until any hazardous situation is corrected.
- The person priming the shots will have control of the firing device.
- No smoking or possession of lighters, matches, etc., is permitted during disposal operations, except in designated areas.
- Clear the area surrounding the shot of combustibles such as dry grass and vegetation.
- Maintain the Minimum Separation Distances (MSD) as outlined in the approved ESP.
- Do not attempt to fight a fire involving explosives.
- The MSD for an intentional detonation is the greater of the Maximum Fragment Distance (MFD) or the K328 overpressure distance as specified in the ESP.
- When disposing of munitions containing shaped charges, ensure that the donor charge is placed in a manner that will prevent formation of a jet.
- Ensure that the type of munition filler is known before detonating. Do not detonate a munition that is suspected to contain chemical or biological warfare material.
- Place donor charges carefully to prevent accidental initiation of MEC.
- Lightning is a hazard to all field activities. Lightning strikes, even at distant locations, may cause extremely high local earth currents. Effects of remote lightning strikes are multiplied by their proximity to conducting elements such as those found in buildings, fences, railroads, bridges, streams, and underground cables or conduits. Suspend all field activities when an electrical storm approaches to within 5 miles of the project location.
- If necessary, use engineering controls to reduce shock, blast overpressure, and fragmentation.
- During open detonation operations, locate personnel away from lifting lugs, strong backs, base plates, etc.
- Check communications with all personnel before initiating demo shot/burn.
- Monitor the exclusion zone and cease operations immediately if there are any incursions.
- Once the shot has been fired maintain silence for at least 30 seconds so that any unsuspected large fragments can be heard.
- Once disposal operations are completed, conduct a thorough search of the immediate area to ensure that a complete disposal was accomplished.
- Police the range thoroughly after detonation to ensure all explosives have been destroyed.

Exclusion Zone

Exclusion zones are covered in the ESP. The minimum separation distances (MSD) are not stated here because the ESP may be amended during the project. Maintain an exclusion zone equal to or greater than the hazardous fragment distance (HFD) for the munition being destroyed during set up of engineering controls and set up of the demo shots. The MSD for intentional detonations is the greater of the maximum fragment distance-horizontal or the K328 overpressure distance. . The maximum fragment distance-vertical is used as the distance for aircraft clearance.

Control access to the Exclusion Zone through signs, guards, roadblocks, etc.

You may reduce exclusion zones by using earth tamp as an engineering control. Calculate earth tamp with the DDESB Buried Explosion Module (BEM), TP-16 Rev 4. You may contact the UXO Technical manager for assistance.

Rounds may be consolidated for disposal IAW the DDESB-approved “Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives (OE) Sites,” August 1998, with a terminology update March 2000.

[1] Per direction of USACE we must follow procedures in Engineer Manual 385-1-1.

If a munition other than the Munition with the Greatest Fragmentation Distance as specified in the ESP exists, refer to the current DDESB Munitions Fragmentation Data Base or calculate the appropriate MSD with the generic equation calculator or using the standard overpressure formula. Contact Bay West's UXO Technical Manager for assistance, if needed.

13.0 SET-UP OF AND FIRING OF SHOTS

Refer to technical manual (TM) 60 A-1-1-31 and MHRFD operations and maintenance manual and quick reference guide for set up and firing procedures.

14.0 BURNING

Construct a burning vessel from available materials such as 55 gallon drums. Use available material such as wood to fuel the burn.

Ignite the burn using bags of smokeless powder and a combustible liquid having a flashpoint greater than 100°F (preferably diesel fuel). Because rolls of time fuze are no longer available, use the cobra fuze assemblies. Cut off the detonator and to store it until you can dispose of it properly.

15.0 POST DETONATION PROCEDURES

- Listen to determine when all fragmentation has fallen.
- Observe the area for fires or adverse conditions.
- Send two people downrange to check the shot.
- Ensure no undetonated rounds or donor charges have been kicked out.
- Police the range thoroughly for any remaining explosives.
- Inspect any resulting munitions debris using standard inspection procedures.
- Fill in shot hole.
- Return unused explosives to storage.
- Fill out the explosives use record and the inventory record and file in the Daily Quality Control report (DQCR).
- Enter the type and quantity of explosive used and the items destroyed in the DQCR.
- Declare area clear.
- Notify all parties who received pre-blast notification that the operation has been completed.
- Return to normal operations.

16.0 POST BURN PROCEDURES

- Look and listen to determine when all burning has ceased.
- Observe the area for fires or adverse conditions.
- Wait at least 30 minutes
- Send two people downrange to check the shot.
- Ensure no unburned rounds have been kicked out.
- Police the range thoroughly for any remaining explosives.
- Inspect any resulting munitions debris using standard inspection procedures.
- Return unused explosives to storage.
- Fill out the explosives use record and the inventory record and file in the Daily Quality Control report (DQCR).
- Enter the type and quantity of explosive used and the items destroyed in the DQCR.
- Declare area clear.
- Notify all parties who received pre-burn notification that the operation is complete.
- Return to normal operations.

Attachment 1

Demolition Safety Guide

SUXOS:	DEMO SUP:	UXOSO:
SITE:	DATE:	TIME:
EXCLUSION ZONES: HFD:_____ MFD-H_____MFD-V_____	FIRING SYSTEM:	NO. OF SHOTS/BURNS:
COMMS CHECK:	ROAD BARRIERS:	NO. OF PERSONNEL:
WEATHER: 850-882-4800		

NOTIFICATIONS
☐ U.S. Army Corps of Engineers (USACE) Ordnance and Explosives Safety Specialist: To Be Determined ☐ Bay West LLC (Bay West) Project Manager: 530-207-6180 ☐ Joint Test and Training Operations Control Center (JTTOCC): 850-882.5800

EXPLOSIVES DRAW		
CAPS:	DET CORD:	COBRA ASSY:
NONEL:	PERF:	FUSE LIGHTER:

WARNING SIGNALS					
5 MINUTE WARNING		1 MINUTE WARNING		ALL CLEAR	

POST BLAST / POST BURN
START 30 MINUTE POST BURN WAIT TIME:
CHECK SHOT / BURN

MEC OR MPPEH ITEMS DESTROYED OR VENTED	
ITEM	QUANTITY

Three Phase Quality Control Checklist

MEC Disposal

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	Yes No N/A	Comments
1.	APP	Communications available and checked.		
2.	MEC Disposal SOP	All required publications on site		
3.	MEC Disposal SOP	All necessary equipment on site		
4.	ESP	Exclusion zone established.		
5.	ESP	Nonessential personnel removed from exclusion zone.		
6.	MEC Disposal SOP	All personnel have read MHRFD operations and maintenance manual and quick reference guide.		
7.	Best Practice	All items in the demolition kit are functional.		

Three Phase Quality Control Checklist

MEC Disposal

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	Yes No N/A	Comments
8.	MEC Disposal SOP	The SUXOS/UXOQCS/ Demo Supervisor have conducted a demolition operational and safety briefing		
9.	EMP[2]	Magazine data cards and explosives use records are updated for each explosives receipt, issue, or expenditure.		
10.	EMP	Explosive materials are properly secured and transported.		
11.	MEC Disposal SOP	Post shot, the range is inspected for kick-outs and frag policed and inspected.		

Punch List	

[2] Explosives Management Plan (EMP)

Three Phase Quality Control Checklist

MEC Disposal

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Punch List	

Conducted By: _____

Acknowledged by: _____

SITE SPECIFIC STANDARD OPERATING PROCEDURE INTRUSIVE OPERATIONS

This Site-Specific Standard Operating Procedure (SSSOP) has been developed specifically for the Disposal Area MRS RI at the Strother Field FUDS and describes intrusive operation procedures for digital geophysical mapping (DGM)-selected anomalies. It is intended for personnel trained in unexploded ordnance (UXO) procedures in accordance with Department of Defense Explosives Safety Board (DDESB) Technical Paper 18.

The Senior UXO Supervisor (SUXOS) may modify these procedures as necessary with the approval of the UXO Safety Officer/Quality Control Specialist (UXOSO/QCS) as long as the modifications do not contradict the Accident Prevention Plan.

1.0 EQUIPMENT

Each situation will dictate the needed equipment so that the team may omit certain items from this list or use equipment not listed here.

- Personal protective equipment (boots, safety glasses, gloves, etc.);
- Analog or digital detector (White, Schonstedt, etc.) with instruction manual;
- EM61 MK2 geophysical detector;
- Bucket or other container;
- Camera;
- White board with ruler;
- Dig list provided by SUXOS;
- Communications device (radio, cellular phone);
- Drinking water;
- Eyewash;
- Fire extinguisher;
- First aid kit;
- Flashlight;
- Hand trowel;
- Pin flags;
- Global Positioning System (GPS) rover unit;
- Digging tools (shovel, pick, digging bar); and
- Earth-moving machinery (EMM).

1.1 Metal Detectors

There is no need to specify a particular metal detector for this project. Metal detectors will be checked prior to field used to ensure that they meet project objectives as outlined in the Work Plan.

1.2 Function Check and Inspection of Equipment

Set up metal detectors in accordance with the manufacturer’s instructions. There is normally a UXO program available. If no UXO program is available, set it up to detect a target that simulates an ordnance item expected on the project. Ordnance items may contain many types of metal, but steel is the most common.

Check metal detectors against a known target that simulates project objectives. This is typically and instrument test strip (ITS) emplaced by the UXO Quality Control Specialist (UXOQCS). The ITS will have metallic seed items buried at various depths and orientations. Additionally, the UXOQCS will vary the position of some seed items to preclude memorization of their position. This is a go/no go test. If the detector fails, check for obvious defects, change batteries, and rerun the check. If the detector fails again, reject it and replace it with an operational detector. Document instrument checks in the team logbook.

Check the GPS Rover against a known position before use each day. This will normally be the location of the RTK GPS base station. The GPS coordinate must be within 4.00 inches of the known position.

When used, an EM61 MK2 detector should be checked as outlined in the Work Plan. Your geophysicist will help you with the setup, operation, and testing.

Check all other equipment for suitability of use, e.g., cracked shovel handles, loose pick heads, etc.

2.0 SAFETY

2.1 Exclusion Zones

Establish an exclusion zone (EZ) before beginning any operations having potential contact with munitions and explosives of concern (MEC). Refer to the explosives site plan (ESP) for the EZ to be engaged at each munitions response site (MRS). Mark the EZ with signs, caution tape or other visible means to prevent entry of nonessential personnel. Monitor the EZ including the airspace above it for unauthorized entry and stop intrusive work when nonessential personnel enter the area.

2.2 MEC and General Safety

UXO team members must follow all applicable U.S. Corps of Engineers and UXO safety precautions and regulations. The Accident Prevention Plan contains specific precautions. These are some major items:

- Check with UXOSO and make sure the utility locate is complete.
- Ensure communications with emergency services before starting UXO operations.
- Any ordnance item may contain a cocked striker.
- Consider all ordnance armed unless proven otherwise.
- Remove soil from an anomaly carefully.
- Begin excavation from the side of the anomaly and work inward.
- Do not move any item unless positively identified as acceptable to move from a safety standpoint.
- The SUXOS and UXOSO must evaluate MEC to determine if it is acceptable to move from a safety standpoint.
- Do not jar, jolt, or disassemble any ordnance item.
- Do not intentionally activate any munitions components, e.g., impellers, arming vanes etc.
- Never rely on color coding for positive identification of an ordnance item.

- Stop excavating and move upwind if any chemical ordnance or industrial chemicals are suspected; contact the SUXOS.

3.0 ANOMALY REACQUISITION

The UXO Team investigating the anomaly may perform the reacquisition or a dedicated team may require the DGM selected anomalies. Use the following procedures to reacquire target anomalies:

- Mark a vinyl (not metal) pin flag with the target anomaly number.
- Navigate to the first target anomaly using the GPS Rover.
- Level the rover unit and mark the precise location of the anomaly.
- Secure the vinyl pin flag to the anomaly location.
- If necessary because of site conditions, mark the anomaly location using paint.

4.0 INTRUSIVE PROCEDURES

- Navigate to the anomaly flag.
- Ensure the anomaly number corresponds to the dig sheet.
- Using a metal detector, search for target anomalies within 3.3 feet (this is an initial value and subject to change during the course of the project) of the anomaly flag.
- Upon locating an anomaly, use the metal detector to define the anomaly center.
- Begin excavating to the side of the anomaly and work inward.
- Remove the soil in small increments avoiding contact with the anomaly.
- Place spoils a sufficient distance away from the excavation so that they do not create a safety issue or impede progress.
- Be cautious when using a pick or digging bar. Never use these tools in close proximity to a suspected MEC.
- Dig a hole large enough to enable you to identify the item.
- Complete the excavation using hand tools such as a trowel or knife.
- When the item is visible, carefully inspect it to identify it as MEC, munitions debris, or other debris.
- A UXO Technician I may make an initial inspection of material potentially possessing an explosive hazard (MPPEH), but the inspection must be verified by a UXO Technician II or higher.
- Leave MEC in place to be evaluated by the SUXOS and UXOQCS.
- Leave any item that cannot be positively identified in place for further evaluation.
- Remove munitions debris and other debris and place in a designated container, normally a bucket.
- Check the excavation with a metal detector and continue the process until no anomaly is found.
- As described in the Work Plan, use the EM61 MK2 detector to verify resolution of the anomaly:
    - Move the EM61 over the anomaly location, observe and record the meter readings.

  - An anomaly is considered resolved when its response amplitude is below an established threshold value.
  - This search radius may change during the course of the project so check with the SUXOS for the latest information.
- You must document each anomaly separately; see **Section 5.0**. A second person, ideally the UXO Team Leader, must then repeat the anomaly resolution verification procedures as an independent quality control test.
- If the anomaly is a utility, document it and move on.
- Do not backfill excavation until the SUXOS approves backfilling. This will normally occur after all quality control actions have been completed, but as soon as possible to avoid slip, trip, and fall hazards. If the spoils are still hot due to small pieces of metal (rust/wire, etc.) and the SUXOS approves backfilling, document that the hole was cleared, but the spoils were still hot and fill the hole.
- Continue the process until all anomalies within the search radius have been resolved as discussed in the sub-bullets above.

5.0 EARTH MOVING MACHINERY

EMM may be used if necessary as an aid to manual excavation.

5.1 Aid to Manual Excavation

The UXO Team may use earth moving machinery (EMM) to assist in manual excavation of anomalies. A UXO Technician on the ground must guide excavation. Once the EMM is within 12 inches of the suspected MEC, complete the excavation manually (shovels, trowels, etc.).

5.2 Mechanized MEC Procedures

5.2.1 Explosives Safety

Excavation with shielded EMM is authorized when investigating anomalies, particularly for suspected munitions debris burial pits. Protective measures are as follows:

- No shielding for fragmentation is required. However, ensure that the EMM operator is protected by the windshield of the EMM or other equivalent shielding;
- Provide blast protection to personnel to the K24 overpressure distance of 5 feet. This may be reduced to 3 feet if double hearing protection of 9 dB or better is worn;
- Remove all nonessential personnel to the K40 overpressure distance of 9 feet.

NOTE
The preceding may change if the ESP is amended; always refer to the ESP for current and more detailed explosives safety information.

The munition with the greatest fragmentation distance is the 4-pound incendiary AN-M50X-A1 as of plan preparation. As work progresses, be observant for any other munitions that may drive an amendment to the ESP.

6.0 DOCUMENTATION

- Photograph the recovered item. Include a whiteboard in the photograph showing the anomaly number, the date, a ruler or permanent markings as a size reference in inches or centimeters (gloves, hats, shoes, socks, spoons, pens, knives, etc. are unacceptable as size references), the standard item nomenclature, and any other descriptive information that may be helpful.
- Fill in required information in the dig sheet.
- If you find additional anomalies within the search radius, add another line to the dig sheet and repeat the anomaly number with an alphanumeric suffix. For example, if anomaly B-1 has two additional anomalies you would add lines and fill in the information for anomaly B-1a, B-1b, etc.
- At the end of the workday, turn in documentation to the SUXOS or designee.

7.0 MPPEH INSPECTION

Inspection of MPPEH must take place in the MRS with an exclusion zone engaged. MPPEH procedures are more fully described in a separate SSSOP.

- After initial inspection of MPPEH by a UXO Technician II, the UXO Technician III must perform a second independent inspection.
- If any doubt exists as to whether the item is safe from explosives standpoint, do not remove it from the MRS. The item may need to be guarded or disposed of in accordance with MEC disposal procedures.
- Mark MEC for disposal and notify the SUXOS.
- After the second inspection, document the material as material documented as safe (MDAS) in the team leader's logbook.
- Turn the MDAS over to the SUXOS for final disposition.

Three Phase Quality Control Checklist

Intrusive Investigation

Team Information		
Team:	Project:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	Yes No N/A	Comments
1.	Work Plan, APP	Communications available and checked		
2.	APP	Daily safety meeting conducted by UXOSO		
3.	APP	Team Leaders observe each worker for proper procedures and safety		
4.	QAPP WS #22	Positioning system (GPS) checked before use each day, and documented		
5.	QAPP WS#12 and #22	Detection instruments checked each day		
6.	QAPP WS#17	Dig sheet provided to UXO Team		
7.	ESP	Exclusion zone engaged before intrusive operations begin, and nonessential personnel removed		
8.	ESP	Teams maintain the TSD		

Three Phase Quality Control Checklist
Intrusive Investigation

Team Information		
Team:	Project:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	Yes No N/A	Comments
9.	QAPP	Anomalies reacquired with GPS		
10.	APP Intrusive SOP	UXO Teams practice safe digging procedures		
11.	QAPP WS#17 Intrusive SOP	UXO Teams fill out dig sheets accurately		
12.	QAPP WS#17 Intrusive SOP	All anomalies within a 3.3 feet radius of the anomaly location are investigated		
13.	QAPP WS#17	All dig locations rechecked for proper resolution and verified		
14.	Intrusive SOP	MEC is documented on a photograph with site name, date, GPS coordinate, standard item nomenclature and description on a whiteboard		

Three Phase Quality Control Checklist

Intrusive Investigation

Team Information		
Team:	Project:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	**Y**es **N**o **N/A**	Comments
15.	Intrusive SOP	SUXOS and UXOSO/QCS determine if MEC is acceptable to move and document status in their logbooks		

Punch List	

Conducted By: _____

Three Phase Quality Control Checklist

Intrusive Investigation

Team Information		
Team:	Project:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Acknowledged By: _____

STANDARD OPERATING PROCEDURE
SURFACE CLEARANCE

This Standard Operating Procedure (SOP) was developed specifically for the Strother Field FUDS Disposal Area MRS RI. This SOP is not intended for personnel untrained in unexploded ordnance (UXO) procedures.

The surface clearance is intended to:

- Remove MEC from the ground surface; and
- Remove metallic debris prior to digital geophysical mapping.

1.0 EQUIPMENT

Each situation will dictate the needed equipment so the team may omit certain items from this list or use equipment not listed here.

- Analog Detector (White, Schonstedt, etc.) with instruction manual;
- Bucket or other container;
- Camera;
- Communications device (radio, cellular phone);
- Digging tools;
- Drinking water;
- Eyewash;
- Fire extinguisher
- First aid kit;
- Flashlight;
- Hand trowel;
- Pin flags;
- Line/rope;
- Global Positioning System (GPS); and
- Digging tools (shovel, pick, digging bar).

1.1 Metal detectors

Handheld detectors authorized for this project include but are not limited to Whites Spectra VX3, Whites XLT, Whites DFX, Schonstedt GA-52cx and Magnetic Locator ML-3L. Other detectors may be used. All detectors are checked at the ITS to ensure they meet project objectives.

Check metal detectors prior to field used to ensure they meet project objectives, as outlined in the Work Plan.

1.2 Function check and inspect equipment

Set up metal detectors in accordance with the manufacturer's instructions. For electromagnetic detectors, there is normally a UXO program available. If no UXO program is available, set it up to detect a target that simulates an ordnance item expected on the project. Ordnance items may contain many types of metal, but steel is the most common.

Check metal detectors at the instrument test strip (ITS), as outlined in the Work Plan. The ITS will have metallic seed items buried at various depths and orientations. This is a go/no go test. If the detector fails, check for obvious defects, change batteries, and rerun the check. If the detector fails again, reject it and replace it with a different detector. Document instrument checks in the team logbook.

Check all other equipment for suitability of use (i.e. cracked shovel handles, loose pick heads).

2.0 SAFETY

2.1 Exclusion zones

Establish an exclusion zone (EZ) before beginning any operations having potential contact with munitions and explosives of concern (MEC). Refer to the explosives site plan (ESP) for the EZ to be engaged at the munitions response site (MRS), because the ESP will always have the most current exclusion zones. Mark the EZ with signs, caution tape, or other visible means; zone to prevent entry of nonessential personnel. Monitor the EZ, including the airspace above it, for unauthorized entry, and stop analog work when nonessential personnel enter the area.

2.2 MEC and General Safety

UXO team members must follow all general Corps of Engineers and UXO safety precautions. The Accident Prevention Plan (APP) contains specific precautions. These are some major items.

- Ensure communications with emergency services before starting UXO operations;
- Be aware of any ordnance item that may contain a cocked striker;
- Consider all ordnance armed unless proven otherwise;
- Remove soil or vegetation from an anomaly carefully;
- Begin from the side of the anomaly and work in;
- Do not move any item unless positively identified as acceptable to move from a safety standpoint;
- The SUXOS and UXOSO must evaluate MEC to determine if it is acceptable to move from a safety standpoint;
- Do not disassemble any ordnance item;
- Do not intentionally activate any munitions components (i.e. impellers, arming vanes etc.);
- Never rely on color coding for positive identification of an ordnance item; and
- Stop work and move upwind if any chemical ordnance or industrial chemicals are suspected. Contact the SUXOS.

3.0 SEARCH PROCEDURES

3.1 Site Layout

The SUXOS is responsible for identifying the search area.

Use the GPS to lay out the MRS boundaries. Mark the boundaries with stakes, flagging, paint, or other highly visible markers.

Search grids will divide the work area into manageable sections and help with data collection. Grid size is typically 200 foot by 200 foot, but will be optimized for field conditions. Grids may be surveyed with the GPS or measuring tapes. Grids need not be measured to exact standards provided all area within the site boundary is covered. Mark grid corners clearly with stakes, flagging, paint, or other highly visible means.

3.2 Visual Sweep

Visual methods may be used where the ground surface is visible. Use metal detectors to search within duff and vegetation. Remove anomalies within the duff and vegetation down to the mineral surface of the ground. Items that protrude from the ground surface must be investigated and removed if possible.

General instructions for conducting a surface clearance through visual means are as follows:

- The team lines up at close intervals; spacing depends upon the site conditions such as vegetation and terrain. The intervals between sweepers should be close enough to see the ground surface and identify objects throughout the search area.
- The team walks forward, observing the ground surface for MEC and/or other metallic objects.
- Be observant of changes in vegetation or topography that may indicate a burial pit.
- The speed should be slow enough to ensure a thorough search.
- On the initial sweep, the first person in line guides on the grid line.
- The last person in line places a pin flag or survey tape along the route at close intervals. This serves as a record of the area swept and a guide for the return sweep.
- On the return sweep, the first person in line follows the line marked on the previous sweep. Recover the flags for later use.
- Guidance by GPS may be used instead of flags or tape.
- The team should maintain line spacing by moving at a uniform speed.
- Due to terrain or other conditions, the lines may not be straight. This is not important as long as the entire sweep area is searched.
- The team leader follows the sweep line to spot check the team's work. The team leader may delegate the spot check to any team member.
- The team continues sweeping back and forth until the assigned area is completely searched.
- The team may remove soil from a partially buried item.
- Characterize and recover encountered items as described in **Sections 5 and 6** of this SOP.

3.3 Detector Aided Sweep

Use the following procedures to supplement the visual sweep in areas where the ground surface is obscured:

- Allow enough space between detectors to avoid interference with each other.
- The detector head must be parallel to the ground surface. Keep the head close to the ground.
- The detector head must be kept at a constant height throughout the sweep.

- Define the extent of the anomaly using the metal detector.
- Using gloved hand, rake, or other suitable tool, remove soil or duff in small amounts from the side of the anomaly and work inward toward the anomaly.
- Once the anomaly is uncovered, characterize and recover it as described in **Section 6.0** of this SOP.
- Recheck the area with the metal detector and continue clearing the anomaly if necessary.
- Backfill any excavation after completing documentation unless otherwise instructed.
- Continue the process until the assigned area is complete.

4.0 EARTH MOVING MACHINERY

The UXO Team may use earth moving machinery (EMM) to assist in manual excavation of any item that is protruding from the ground surface. A UXO Technician on the ground will guide excavation. Once the EMM is within 12 inches of the suspected MEC, complete an excavation manually (shovels, trowels, etc.).

5.0 DOCUMENTATION

- Record a GPS point feature at locations of MEC; and suspected munitions burial pits, and range related debris;
- Where munitions debris (MD) is spread over an extended area, create a polygon feature around it rather than recording each item as a point feature;
- Photograph the recovered item. Include a whiteboard in the photograph showing the grid number, the date, a ruler or permanent markings as a size reference in inches or centimeters (gloves, pens, knives, etc. are unacceptable as size references), the standard item nomenclature, and any other descriptive information that may be helpful;
- Fill-in required information in the grid sheet (attached). Approximate the location of the MEC/MD on the grid sheet, as it will be more accurately recorded by GPS; and
- At the end of the workday, turn in documentation to the SUXOS or designee.

6.0 MPPEH INSPECTION

Inspection of material potentially possessing an explosive hazard (MPPEH) must take place in the MRS with an EZ engaged. MPPEH procedures are more fully described in a separate SOP.

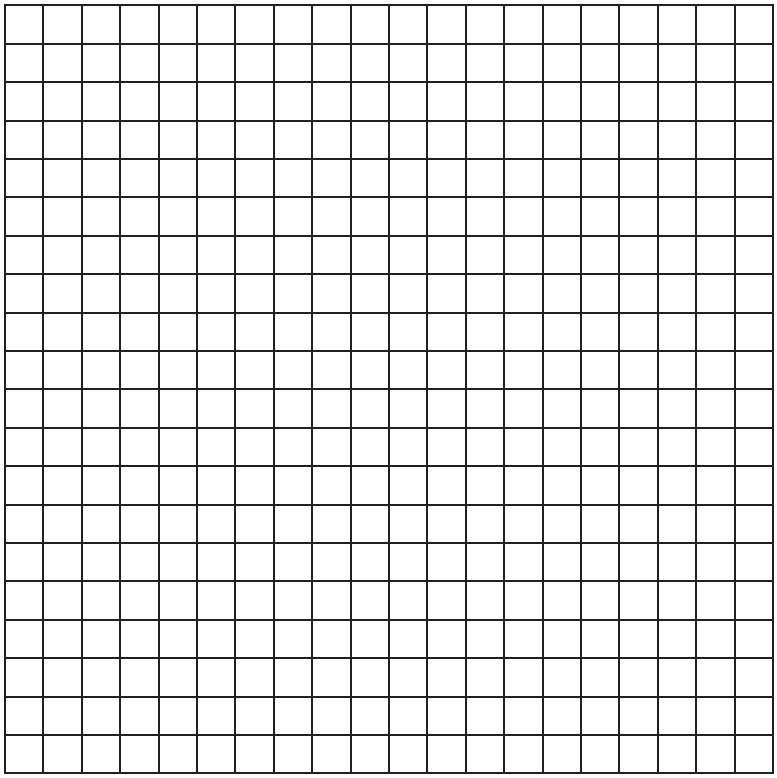
- After initial inspection of MPPEH by a UXO Technician II, the UXO Technician III must perform a second independent inspection;
- If any doubt exists as to whether the item is safe from explosive standpoint, do not remove it from the MRS. The item may need to be guarded or disposed of in accordance with MEC disposal procedures;
- Mark MEC for disposal and notify the SUXOS;
- After the second inspection, document the material as material documented as safe (MDAS) in the team leader’s logbook; and
- Turn the MDAS over to the SUXOS for final disposition.

Attachments

GRID SHEET

Project: _____ Grid #_____ Date_____

Team_____ UXO Team Leader _____



SW corner

Date	Digs	MEC	MD	OD	Other	% of Grid Complete

MEC or Other Significant Items

1._____

2._____

3._____

4._____

5._____

GRID SHEET

Project: _____ Grid #_____ Date_____

Team_____ UXO Team Leader _____

Notes

Three Phase Quality Control Checklist

Surface Clearance

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (Highlight or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	Yes No N/A	Comments
1.	APP, QAPP	Communications available and checked		
2.	APP	Daily safety meeting conducted by SUXOS/UXOSO/TIII		
3.	Surface Clearance SOP	Area requiring surface clearance is clearly marked		
4.	Surface Clearance SOP	The surface clearance addresses the complete area within the MRS boundary		
5.	Surface Clearance SOP	Grid size and shape optimized for field condition		
6.	Surface Clearance SOP	Suitable control/sweep lanes used		
7.	ESP	Appropriate exclusion zone engaged		
8.	ESP	MPPEH are positively identified before movement, and those unsafe and/or unidentifiable for avoidance and disposal		

Three Phase Quality Control Checklist

Surface Clearance

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (Highlight or Circle) Preparatory (P); Initial (I); Follow-up (F)		

9.	ESP	SUXOS and UXOSO determine if MEC is acceptable to move		
10.	MPPEH Inspection SOP	Munitions and other debris properly inspected, segregated, and removed from the work zone		
11.	Surface clearance SOP	Team Leaders observe each worker and randomly inspect sweep lanes		
12.	Surface clearance SOP	MEC is documented on a photograph with site name, date, standard item nomenclature, GPS coordinate, and description on a whiteboard		

Punch List	

Three Phase Quality Control Checklist

Surface Clearance

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (Highlight or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Conducted By: _____

Acknowledged By:_____

STANDARD OPERATING PROCEDURE
VEGETATION REMOVAL

This Site-Specific Standard Operating Procedure (SSSOP) has been developed specifically for the Disposal Area MRS RI at the Strother Field FUDS and describes procedures for vegetation removal. Vegetation removal will be required in areas where vegetation is presenting an impediment to digital geophysical mapping or analog searches.

1.0 EQUIPMENT

The following is a list of suggested equipment. Not all equipment may be necessary and equipment not listed here may be used.

- Communications equipment;
- Chainsaw;
- Brush cutter with various cutting heads;
- Hand tools (machetes, axes, loppers);
- Sharpening stone or file;
- Fire extinguisher;
- First aid kit;
- Fuel;
- Rakes and shovels;
- Spill kit;
- Drop cloths;
- Personnel Protective Equipment
  - Kevlar chaps;
  - Hard hat;
  - Hearing protection;
  - Gloves;
  - Face shield;
  - Safety glasses;
  - Safety toe boots; and
  - Analog metal detector.

2.0 SAFETY

Safety precautions are detailed in the Accident Prevention Plan (APP). The following are presented here for emphasis:

- Vegetation removal is taking place in an area where munitions and explosives of concern (MEC) may exist. Be alert for MEC;
- Use analog detector to search the area ahead of the brush cutting to help avoid contact with MEC;
- Be alert for wildlife with in the vegetation, especially snakes;
- Use only sharp cutting tools. Sharpen or replace dull cutting tools;
- Refuel power equipment on a drop cloth to prevent spilling fuel to the environment;
- Inspect and use PPE;
- Cut vegetation close to the ground and ensure a clean cut parallel to the ground surface with no sharp points; and
- Ensure that cut vegetation will not present a tripping hazard.

3.0 CUTTING

Brush cutting will be limited to that necessary to conduct DGM or analog investigations. Inspect DGM and analog investigation areas to determine brush cutting requirements. Most likely, only undergrowth will need to be trimmed to allow passage of personnel with their equipment. If necessary to cut trees, only trees less than 4 inches diameter at 5 feet above the ground may be cut.

Perform MEC avoidance procedures in front of the brush cutting operation. A UXO qualified person must search the area and identify any material potentially presenting an explosive hazard (MPPEH). Inspect the MPPEH as outlined in the appropriate SSSOP and dispose of MEC. If UXO qualified personnel are performing the brush cutting, they may perform MEC avoidance as they progress.

Cut vegetation evenly and parallel with the ground surface to preclude creating a stabbing hazard. Cut the vegetation close enough to the ground that it does not present a tripping hazard. Cut in a systematic manner and remove cut brush and trees from the work area as work proceeds.

4.0 INSPECTION

Visually inspect the cut brush to ensure personnel may pass through safely. There should be no branches or vines that may snag equipment. The cut vegetation should not present a potential tripping hazard. The must be no cut vegetation that will present a stabbing hazard to personnel in case of a fall. The DGM operator should be consulted during the final inspection.

ATTACHMENTS

Three Phase Inspection Checklist

Three Phase Quality Control Checklist

Vegetation Removal

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	Yes No N/A	Comments
1.	APP	Communications available and checked		
2.	APP	Daily safety meeting conducted by SUXOS/ UXOSO		
3.	Veg Removal SOP APP	A UXO qualified person precedes vegetation removal to check for MEC		
4.	Veg Removal SOP APP	Personnel are using the correct PPE		
5.	Veg Removal SOP APP	Vegetation is cut parallel to the ground surface so as not to pose a stabbing hazard		
6.	Veg Removal SOP APP	No tripping hazards exist after vegetation is cut		
7.	Veg Removal SOP	Vines and undergrowth are cleared sufficiently to allow passage of DGM or analog investigation teams		

Three Phase Quality Control Checklist

Vegetation Removal

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

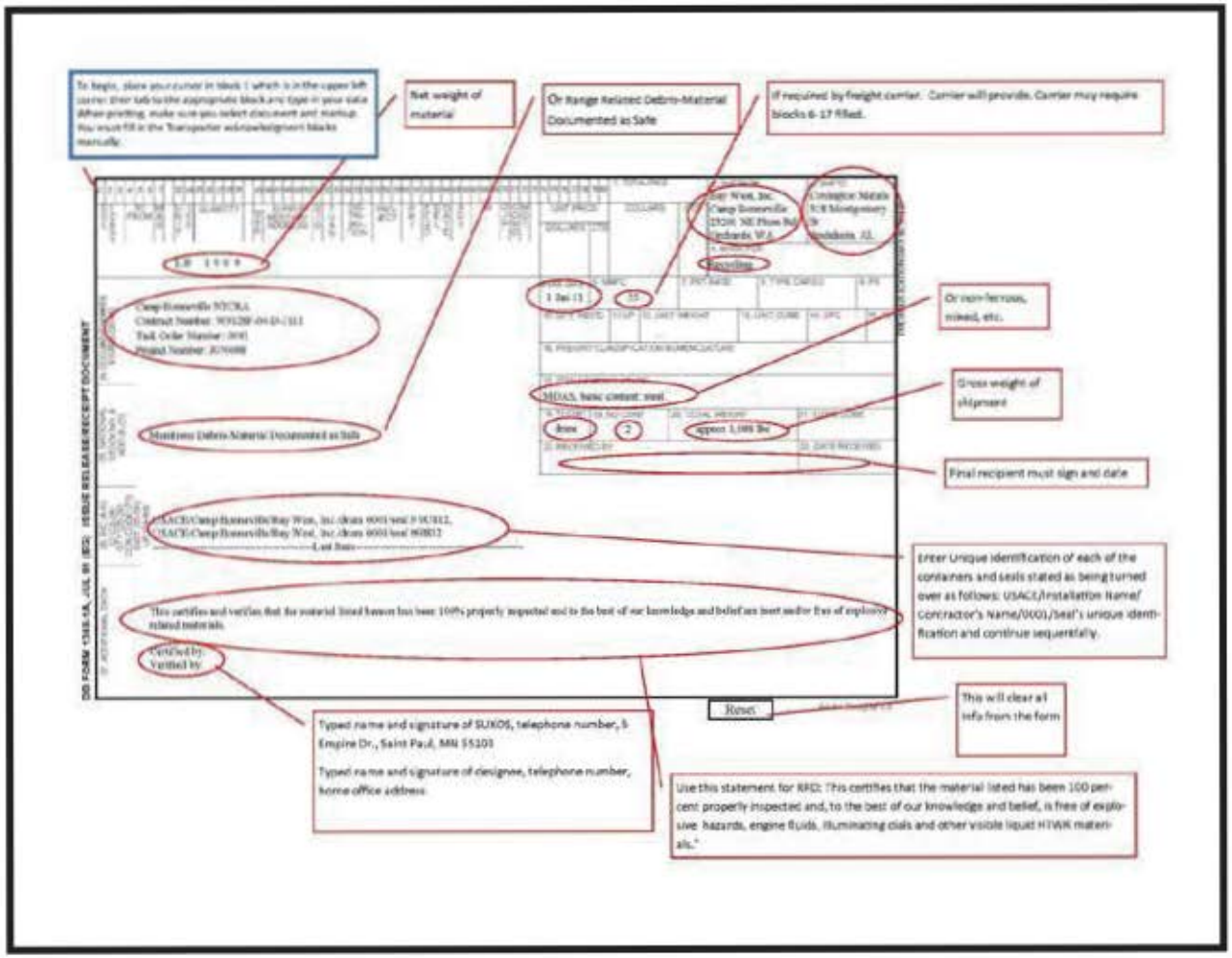
Item	Ref.	Inspection Point	Yes No N/A	Comments
8.	Veg Removal SOP	Trees greater in diameter than 6 inches at 5 feet above the ground surface are not cut		

Punch List	

Conducted By: _____

Acknowledged By: _____

Forms


Net weight of material
Or Range Related Debris-Material Documented as Safe
If required by freight carrier. Carrier will provide. Carrier may require blocks 6-17 filled.
Or non-ferrous, mixed, etc.
Gross weight of shipment
Final recipient must sign and date
Enter Unique identification of each of the containers and seals stated as being turned over as follows: USACE/Installation Name/ contractor's Name/0001/Seal's unique identification and continue sequentially.
This will clear all info from the form
Typed name and signature of SUXOS, telephone number, 5 Empire Dr., Saint Paul, MN 55101
Typed name and signature of designee, telephone number, home office address
Use this statement for RFD: "This certifies that the material listed has been 100 percent properly inspected and, to the best of our knowledge and belief, is free of explosive hazards, engine fluids, illuminating oils and other visible liquid HTWR materials."
Reset

Bay West, Inc.
Munitions Debris Demilitarization Certification and Manifest

18000

GENERAL

1. Generator's Name and Mailing Address – Generator is the installation	1a. Generator's Phone #
2. Generator's Project Location –	2a. Project Phone #
3. Transporter 1 Name and Mailing Address –	3a. Transporter 1 phone #
4. Transporter 2 Name and Mailing Address	4a. Transporter 2 phone # ( )
Qualified Recycler (QR) Name and Mailing Address – Timberline Environmental Services,	5a. QR phone #
	5b. QR Identification #

Inspection/Certification/Demil

6. Security Seal #s	7. Gross Wt. Lbs	8. Tare Wt. Lbs/Kgs	9. Net Wt. Lbs/Kgs	10. Weight Ticket #

11. Description	12. Material	13. Quantity	14. Units (Wt., Vol)
Munitions Debris Material Documented As Safe (MDAS)	Scrap Metal		

INERT CERTIFICATION

Each item of Material Potentially Presenting An Explosive Hazard (MPPEH) has been inspected and is Material Documented As Safe (MDAS).

15. Inspector 1		
Printed/Typed Name	Signature	Month Day Year
16. Inspector 2		
Printed/Typed Name	Signature	Month Day Year

DEMILITERIZATION CERTIFICATION

I certify that each item or items listed hereon were demilitarized in accordance with DoD 4160.21-M-1 and other applicable regulations.

17. Demil Certified By:		
Printed/Typed Name	Signature	Month Day Year
18. Demil Verified By:		
Printed/Typed Name	Signature	Month Day Year

TRANSPORTER

19. Transporter 1 Acknowledgement of Receipt of Materials		
Printed/Typed Name	Signature	Month Day Year
20. Transporter 2 Acknowledgement of Receipt of Materials		
Printed/Typed Name	Signature	Month Day Year

QUALIFIED RECYCLER

21. Discrepancy Indication Space

22. Qualified Recycler Acknowledgement of Receipt of Materials		
Printed/Typed Name	Signature	Month Day Year

23. Qualified Recycler Certification of Consumption	25. Final Disposition of Material	
Printed/Typed Name	Signature	Month Day Year

Bay West

Customer-Focused Environmental & Industrial Solutions

Standard Operating Procedure

Surface Water Sampling

CORP-ENV-021-1791417

Revised: March 2016

Review and Approval:

Developed by: Eric Malarek Date: March 08, 2016

Eric Malarek, QA Program Chemist

Reviewed by: Date: March 08, 2016

Brad Kulberg, QA/QC Manager

Approved by: Date: March 8, 2016

Ed Bacig, Vice President of Operations

Questions and requests for information regarding this Standard Operating Procedure (SOP) should be directed to the Vice President of Operations or the QA/QC Manager. This document cannot be edited, changed, or revised without the approval of the individuals listed above, and all edits, changes, and revisions must be routed through the Document Management Coordinator.

NOTE: *This SOP is current as of the date printed on the bottom. Bay West personnel may produce paper copies of this procedure printed from the controlled document electronic file located on the Intranet. However, it is their responsibility to ensure that they are trained and utilize the current version of this procedure.*

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NOTE: *This SOP is current as of the date printed on the bottom. Bay West personnel may produce paper copies of this procedure printed from the controlled document electronic file located on the Intranet. However, it is their responsibility to ensure that they are trained and utilize the current version of this procedure.*

1.0 INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) is to define the techniques and requirements for collecting surface water samples from ponds, lakes, streams and rivers for various analyses. Sampling situations vary widely, and, therefore, no universal sampling procedure can be recommended. Sampling of both aqueous and non-aqueous liquids is generally accomplished through the use of one of the following samplers or techniques:

- Direct Method
- Dip Sampler
- Discrete depth sampler (e.g. Kemmerer or Van Dorn sampler)
- Electric pumps
- Stormwater collection devices

Use of these sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

Analytical procedures are often targeted as the main source of error in data analysis, but generally only represent a minimal contribution to the total error. Field errors are often the major source of error. Potential sources of field error are: sample collection, handling, transport, preparation, preservation, and identification/labeling. Some of these restrictions and/or limitations are discussed in detail in **Section 7.1**. The sampling portion of any data collection effort has historically been the most difficult to assess when assessing project data quality. Through the correct and consistent application of this SOP, Bay West field staff will generate samples which are both representative of the targeted sample location, and comparable to another data set assuming similar samples and sampling conditions.

1.2 Scope

This SOP covers common aspects of surface water sampling from sample collection, documentation, transport, and submittal to the project laboratory for analysis. Site specific sampling information will be presented in the Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP), which includes the Field Sampling Plan.

2.0 DEFINITIONS

Analyte – A chemical substance that's presence and concentration is determined by an analytical procedure

Direct Method – The technique of submerging the sample bottle directly in the media to be sampled.

Field Parameters – The UFP-QAPP may require field parameters to be collected prior to sample collection. These parameters will be presented in the UFP-QAPP and generally include: pH, Dissolved Oxygen (DO), Specific Conductivity, Temperature, Oxidation/Reduction Potential (ORP) and Turbidity. These measurements should be taken at the same location and depth as the field sample.

3.0 RESPONSIBILITIES

Field Sampler – The Field Sampler is responsible for the sampling, collection, labeling, field analysis and recording of data as specified in this SOP.

Site Supervisor – The Site Supervisor is responsible for making sure that field personnel are trained in the use of the sampling procedure and the required equipment, and for making sure that wipe samples are collected in accordance with the approved procedure and any other SOPs pertaining to specific media being sampled.

Project Manager – The Project Manager is responsible for maintaining logbooks and forms and for approving techniques not specifically described in this SOP and documenting these techniques.

4.0 REQUIRED EQUIPMENT

This section provides a list of equipment that is generally used to collect surface water samples but does not necessarily include all possible types of surface water sampling equipment. Bay West SOPs, including specified equipment and associated forms, shall be obtained and followed for: sample measurements collected in the field, decontamination, packaging and shipping. Specific SOPs are listed below:

- *Packaging and Shipping of Environmental Samples* (SOP# CORP-ENV-006-1510206, current version) – Establishes packaging and shipping requirements and guidelines for environmental sample shipping; and
- *Sample Custody* (SOP# CORP-ENV-004-1510208, current version) – Presents sample custody procedures to maintain and document sample possession that are traceable from the time the samples are collected until their analysis is complete. The data generated may be introduced as evidence in legal proceedings.
- *Field Equipment Decontamination* (SOP# CORP-ENV-002-1578775, current version) – Presents decontamination procedures to avoid cross contamination in the field. All decontamination procedures should be documented in the field log book.
- *Surface Water Sampling* – This SOP.

The following subsections identify the types of equipment used for surface water sampling. Prior to initiating fieldwork, it will be necessary to determine the type of equipment that will be needed to complete the surface water sampling. The selection and restrictions/limitations of equipment and sample methods are discussed in greater detail in **Section 7.1**. In addition to the SOPs identified above and the equipment specified in the following sections, the sampler will also obtain the following materials before initiating fieldwork:

- Site-specific plans;
- Field log book;
- Indelible black ink pens and markers;
- Labels and appropriate forms/documentation for sample shipment;
- Clear, waterproof tape;
- Laboratory prepared sample containers;
- Insulated cooler(s) and waterproof sealing tape;
- Wet Ice and zip-top bags;

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- Latex, nitrile, or other appropriate sampling gloves as specified in the Site-specific Safety and Health Plan (SSHP);
- Packing material (bubble wrap) for packing the sample containers in the cooler(s); and
- Personal protective equipment (PPE) and clothing as specified in the SSHP.

4.1 Surface Water Sampling

The following elements are required for Surface Water Sampling:

1. Sample containers (provided by the laboratory). Some bottles may contain a preservative consisting of an acid or base as prescribed by the analytical method.
2. Bottle order form (indicating which bottles are used for each analysis and preservative, if any, in the bottle), Chain of Custody forms, and sample labels.
3. Sampling Device(s):

Table 1. Surface Water Sampling Devices

Technique	Primary Use	Potential Pitfalls
Direct Grab Method	Sampling at or near the water's surface.	Bottle requires decontamination after filling. Preservative may be lost as the water fills the bottle.
Dip Pond Sampler	Sampling at or near the water's surface. Long handle can extend the sampler's reach into a difficult to reach area.	Non-disposable sampler requires decontamination after filling. May need to dip the sampler several times to acquire sufficient sample volume.
Discrete Depth Sampler	Sampling at depth. Expensive.	Sampler limited with one time volume collected. Release mechanism can be recalcitrant at times. Requires decontamination.
Electric Pumps	Sampling at depth. Can withdraw large quantities of water quickly.	Requires power source and dedicated tubing. Requires decontamination.
Stormwater Collection Devices	Sampling stormwater. Designed not to collect rainfall, only run off.	Placement and securing device may be tricky. Many different types to choose from.

5.0 PROCEDURES

1. Determine the depth of the water the sample will be collected from. Consult the UFP-QAPP for guidance.
2. Collect any Field Parameters as required by the UFP-QAPP.
3. Determine the proper type of sampling method/device depending on depth and volume of sample required.
4. Wearing a clean pair of sampling gloves, dip the sample bottle, sampler, or place the other sampling device as necessary into the surface water to be sampled.
5. Determine that the sampling device is at the appropriate depth for depth sample collection (**this is critical**).
6. If the sampling is occurring in a moving body of water, i.e. a stream or river, samples should be collected from the most downstream location first, working upstream. This will prevent disturbed sediment from entering the samples from upstream locations.
7. If entering the water body, always do so with as little bottom disturbance as possible and wait for the water around the planned sampling area to return to its undisturbed state (clarity) before sampling.
8. Open/fill the sampling device. Be certain devices deployed at depth (e.g. Kemmerer or Van Dorn sampler) did not prematurely open prior to reaching the sampling depth.
9. Care should be taken filling bottles from a sampling device as not to displace any preservative placed in the bottle by the lab.
10. VOA vials should be completely filled without any air bubbles in the vial. Other bottles should only be filled to shoulder of the container, not to the brim.
11. Wipe the sample bottle dry. If oily water was collected and is present on the outside of the bottle, decontaminate the bottle with a detergent and potable water rinse. Do not rinse the bottle in the water body just sampled.
12. Complete the sample label with a waterproof marker (e.g. Sharpie®) and the Chain of Custody form with a black, ballpoint pen (do not use markers). Ensure all samples are properly labeled and match the Chain of Custody form *exactly*.
13. Dispose of sampling gloves after each sample. Repeat steps 1 through 13 for all remaining samples. Different analytical parameters may require different sample bottles for each sample location.

6.0 DOCUMENTATION

Individuals performing the work will record their observations in a bound field logbook. If an edit of field logbook data is required, the incorrect information will be struck out with a single line, initialed and dated. The correct information will be written next to the error. The source of the reference material or field charts used must be recorded in the field logbook. The following is a general summary of the information to be documented:

- List of all personnel present:
- Field conditions, including:
    - Air temperature;
    - Wind speed/direction;
    - Precipitation/moisture at the time of sampling event;

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- Ambient odors;
- Airborne dust;
- Field Parameters;
- Description of any exceptions to this SOP;

And for each sample location:

- Sample Name used to identify the sample;
- Sample method and equipment used;
- Date and time of sample collection; and
- A list of all samples sent to each laboratory.

7.0 PROCEDURE PERFORMANCE EXPECTATIONS

7.1 Restrictions/Limitations

Only qualified persons trained in performing the requirements and the duties described in the SOP shall conduct the work. The Project Manager or QA/QC Manager will have the authority to decide whether or not an individual is qualified.

7.1.1 Selection and Limitations of Sample Locations

Not all planned sample locations may be accessible to field samplers. Water flow, underwater obstructions and safety considerations may prevent sampling at one or more locations.

If possible, an alternate location should be chosen for sample collection. Any changes in sampling location as specified in the UFP-QAPP should be thoroughly documented in the filed logbook and accompanied with digital images.

Safety Note: *Surface water sampling can sometimes require the use of boats for access into or across bodies of water. Observe all boating safety considerations in the project health and safety plan (SSHP) including donning of proper life jackets. If sampling from a bank, do not overreach; use a Dip Pond Sampler whenever possible and do not attempt to remove the container from the clamp while still in contact or close proximity to the water body. Do not wade into a water body unless the depth is well known, currents are flowing at a safe speed, appropriate personnel have determined it is safe, and a spotter is available.*

7.1.2 Selection and Limitations of Sample Collection

Due to the lack of depth of the water in some locations, the Direct Method of sampling collection may not be possible. Utilizing the Dip Pond Sampler method may be used but care must be taken to collect representative samples, especially when the sample volume is limited.

When using a depth sampler (e.g. a Kemmerer or a Van Dorn sampler), and additional sample volume is required after the first aliquot is collected, care must be taken to lower the sampler to the same depth as before. Care should also be taken to not disturb the bottom of the water body. This step will help ensure a representative sample is collected.

7.1.3 Sample Preservation

Preservation of samples in the field is critical to the analysis of any samples. Correct sample preservation techniques will be presented in the UFP-QAPP for each parameter collected. At a minimum, all samples should be stored in an insulated cooler on ice to achieve the <6°C

required temperature for preservation and maintained at this temperature until laboratory receipt.

8.0 REFERENCES

USEPA Region 9 Laboratory, 1999. Field Sampling Guidance Document #1225, Surface Water Sampling, September.

Standard Operating Procedures for DGM Target Reacquisition (DGM – 003)

1. Purpose

The purpose of this standard operating procedure (SOP) is to provide procedures and technical guidance on performing target reacquisition for targets selected from DGM data.

2. Equipment

This SOP is applicable for the Geonics EM61-MK2 and Leica Differential Global Positioning System (DGPS) and Robotic Total Station (RTS) systems.

The EM61-MK2 is a high-resolution time-domain electromagnetic instrument designed to detect shallow ferrous and non-ferrous metallic objects. The Standard EM61-MK2 system consists of two coils, a digital data recorder, batteries and processing electronics. The EM61-MK2's transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects.

Each of the two spatially separated receiver coils measures these eddy currents. The EM61-MK2 measures the eddy currents at four distinct time intervals in the bottom coil or at three intervals on the bottom and one on the top coil. For this work, the top coil will not be used. The secondary EM fields will be measured at 216, 366, 660 and 1266 microseconds after the transmitter current has turned off with the lower coil. These time gates are typically referred to as Channels 1-4 respectively.

The secondary voltages induced in the coil are measured in millivolts (mV). The data is collected into Geonics' EM61MK2 or Geomar's Nav61MK2 program and temporarily stored in an Allegro CX prior to downloading to a laptop computer.

Leica GPS 1200 series and VIVA RTK-DGPS systems provide sub-centimeter accuracy and can be combined with DGM data in real-time. The reported accuracy for real-time corrections is 8mm + 1 ppm (horz.), and 15mm + 1ppm (vertical).

The Leica TPS1200 RTS precision angle-measurement system uses a visible red laser, has auto-lock capability, and measures to prisms and reflective tape. The range is 3 km to a single prism and the accuracy is 1 mm + 1.5 ppm.

3. Target Reacquisition Procedures

The following are the standard procedures for reacquiring targets selected from DGM data.

3.1 Instrument Standardization

All instruments will be assembled and calibrated (where required) as specified in their User Manuals and in accordance with the Tetra Tech Instrument Calibration and Maintenance Procedure. Additionally, each instrument will be field tested daily to ensure that the instrument is operating properly and capable of meeting the project MPC detailed in Worksheet #12.

If at any time it is determined that a piece of equipment requires maintenance or calibration it will be removed from production until necessary maintenance or calibration has been performed and the geophysical system has been verified to meet the criteria. Equipment set-up, calibration, and Quality Control checks will be the same as those performed for data acquisition with the exception that the dynamic QC tests (such as the IVS) will not be performed since digital geophysical data will not be recorded during this phase of the investigation.

3.2 Navigation

Targets will re reacquired using the same positioning system that was used for data acquisition.

3.2.1 The FID method is used in wooded areas where GPS/RTS positioning is unavailable. Targets will be reacquired using local coordinates. Tapes will be pulled from the southwest grid corner in the northing and easting direction to locate the target.

3.2.2 The second method of navigation is GPS. The base station is setup is the same as that detailed in Attachment 3 of the Data Acquisition SOP. The rover GPS antenna will be used to reacquire the target location.

3.2.3 The third method of navigation is RTS. The RTS uses known points, typically the surveyed grid corners, to provide geodetic locations based on calculated reflection time between the gun and the prism. Work instructions for setting up the RTS will be provided for review if this method is used.

3.3 Target Refinement

The EM61 will not be used to refine the reacquired target location. The operator will place the flag in the ground within 6inches of the coordinates on the dig sheet.

4. Documentation

When GPS is used the reacquired target location will be stored so that offsets can be calculated and tracked. All data will be tracked in the project Access Database.

5. Quality Control

Quality control activities are discussed in the Work Plan and in the Geophysical Verification Plan. The geophysical system must meet the defined MPCs at the frequency defined in the Work Plan in order for the data to be considered usable. All non-conformances must be reported and followed by a root-cause analysis.

Bay West

Standard Operating Procedure

Classification and Description of Soil, Sediment, and Rock

CORP-ENV-007-1577802

Revised: October 2, 2012

Review and Approval:

Developed by: _____ Date: October 2, 2012
Signature

Manager, Environmental Division
Title

Reviewed by: _____ Date: October 2, 2012
Signature

QA/QC Manager
Title

Approved by: _____ Date: October 2, 2012
Signature

Vice President of Operations
Title

Questions and requests for information regarding this SOP should be directed to the Vice President of Operations or the QA/QC Manager. This SOP cannot be edited, changed, or revised without the approval of the individuals listed above, and all edits, changes, and revisions must be routed through the Document Management Coordinator.

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1.0 INTRODUCTION

This Standard Operating Procedure (SOP) describes the classification and description of unconsolidated material (soil, sediment) and rock samples collected during field operations performed by Bay West, Inc. (Bay West).

1.1 Purpose

The installation of monitoring wells, piezometers, boreholes, and test pit excavations are standard practice at many sites requiring environmental investigations. These activities require that a trained geologist or other earth scientist provide descriptions of subsurface material encountered. The purpose of this SOP is to serve as a guide for recording basic classification and descriptive information with emphasis on soil, sediment, or rock properties that affect ground water flow and contaminant transport. In order to make descriptions as uniform and consistent as possible, this SOP provides a list of references to be used in the field and a sequence for recording information on a standardized log form.

1.2 Scope

This SOP is applicable to all sites requiring a subsurface investigation, including sediment locations, by Bay West.

2.0 DEFINITIONS

The following definitions correspond to the list of descriptors outlined in **Section 5.2.1**. The definitions are provided to aid the field geologist in identifying the types of information and tools that are used to accurately describe a sample and record the description on soil boring log and coring log forms (**Attachment A**). Descriptive criteria and terminology presented are for visual classification and manual tests. Similar soils, sediment, or rocks may be grouped together; for example, identify one sample and describe it completely. Then identify others samples as similar based on performing only a few of the identification and description procedures. Descriptive information should be evaluated and reported on every sample.

2.1 Descriptors for Soil and Sediment

<u>Naming Soils and Sediments</u>. Use field equipment, reference charts, and American Society for Testing and Materials (ASTM) Standards presented in **Attachments B**, **C**, and **D** to name soils and sediments.

<u>Texture</u>. In examining soils and sediments, the texture shall refer to:

- Particle size, distribution, and range – provide percentage estimates (see the USCS in Attachment C).
- Angularity – angular, subangular, subrounded, rounded (see Attachment C and Table 1 and Figure 3 of Attachment D).
- Shape – flat, elongated.

Color. Color may be determined using the Munsell color chart. If the Munsell Color Chart is used, list the Munsell number that corresponds to the color. If the soil/sediment is mottled, list individual color names and provide an overall best color name. Accurate comparison is obtained by holding the sample directly behind the apertures separating the closest matching color chips (Munsell 1994).

Structure. There are several different sedimentary structures. Criteria for describing structure can be found in Table 7 of **Attachment D** and include stratified, laminated, fissured, slickensided, blocky, lensed, and homogeneous. Additional structure names are bedding, cross bedding, laminations, and burrows. Structures should only be included in the description if found in the samples.

Consistency. For intact fine-grained samples, describe the consistency in accordance with the clay consistency scale in **Attachment C** or Table 5 of **Attachment D**. Both tables present a scale from very soft to hard using a thumb penetration test. **Attachment C** also correlates the sample to the blow counts used in collecting hollow-stem auger samples.

Cementation. In some cases the sample may be cemented and should be described as weak, moderate, or strong cementation as described in Table 6 of **Attachment D**.

Moisture condition. Moisture condition refers to the amount of water within the sample. The soil/sediment should be described as dry, moist, or wet.

Odor. The purpose of many environmental investigations is to determine the nature and extent of contamination. Therefore, when dealing with potentially contaminated material, smelling for unusual odors is strongly prohibited. However, if an odor is apparent it should be noted on the soil boring log form. Possible descriptors are organic (decaying vegetation) or unusual odors (i.e., petroleum, chemical).

Evidence of Contamination. Examine the sample and note any obvious signs of contamination (e.g., streaking, free product, or discoloration). Note observations in the field book along with any readings from the photoionization or flame ionization detector (PID/FID). In addition, record PID/FID readings on the soil boring log form.

Other. Secondary features affecting porosity and permeability such as bioturbation are particularly important and should be described if observed. Particular attention is to be given to recording exact locations of water tables, perched saturated zones, and description of contaminants that may be visible (i.e., non-aqueous phase liquid).

2.2 Descriptors for Rock

Rock name. In naming sedimentary, igneous, and metamorphic rock, use field equipment to examine the specimen for mineralogy and use the appropriate classification charts. The first page of the American Geological Institute (AGI) Data Sheets for sedimentary, igneous, and metamorphic rock is included in **Attachment** E.

Use a simple descriptive name, sufficient to provide others with possible properties of the rock type. State the name and capitalize the first letter. If available, the name may include the stratigraphic unit name and/or geological age.

Lithology (composition/grain size/texture/color). Provide the following lithologic information:

- The mineralogical description (composition) of the rock;
- Grain shape and size or sizes;
- Porosity;
- Texture (vesicular, porphyritic, schistose);
- Contacts. Note any significant change in lithology (such as gradational contacts within sediments or sharp contacts such as sediments over rocks). Note if the contacts are erosional, gradational, or sharp and the depth below the ground surface; and
- Color. Color may be determined using the Munsell color chart and listing the Munsell number that corresponds to the color. Provide the wet color of fresh and weathered surfaces.

Discontinuities. These include shears, joints, fractures, cavities, secondary mineralization, or contacts. The rock types that may be encountered during drilling may have fractures or joints present within them. Note any observed fractures and describe the density of fractures. If cavities or vugs are present, note the density of the voids and estimate the size of the voids. If fractures or cavities contain evidence of secondary minerals such as zeolites, clays, or iron oxides, then describe the mineral fill.

Odor. The purpose of many environmental investigations is to determine the nature and extent of contamination. Therefore, when dealing with potentially contaminated material, smelling for unusual odors is strongly prohibited. However, if an odor is apparent it should be noted on the core log form. Possible descriptors are earthy or unusual odors (i.e., petroleum, chemical).

Evidence of Contamination. Examine the sample and note any obvious signs of contamination such as streaking, free product, or discoloration. Note these observations in the field book along with any readings from PID/FID. In addition, record PID/FID readings on the core log form.

Other. Secondary features affecting porosity and permeability such as fractures (joints or faults) or cavities should be described if observed. Particular attention is to be given to recording exact locations of water tables, perched saturated zones, and description of contaminants that may be visible (i.e., non-aqueous phase liquid). Also note coring loss/recovery, weathering/alteration, secondary mineralization, degree of induration, degree of vitrification for volcanic rocks, and hardness. Provide a description of thickness of bedding, banding, or foliation if present. Include an exact measurement of apparent bed thickness when logging core to supplement terminology such as “thin” or “thick.”

3.0 RESPONSIBILITIES

Field Geologist/Site Supervisor – The Field Geologist/Site Supervisor performing the classification and description of soil, sediment and rock samples is responsible for making a consistent and uniform log and for turning in field forms and logbooks to the Project Manager (PM).

Project Manager (PM) – The PM is responsible for maintaining logbooks and forms and for approving techniques of the classification and description of soil, sediment, and rock samples not specifically described in this SOP.

4.0 REQUIRED EQUIPMENT

The classification and description of soil, sediment, and rock samples requires a minor amount of field equipment for the geologist. This section provides a list of equipment to be used but does not include equipment such as drill rigs, PID/FID, sampling equipment, and personal protection equipment. The following is a general list of equipment that may be used:

- Field logbook;
- Soil boring log and coring log Forms (Attachment A);
- Clipboard;
- Plastic sheeting;
- Sampling trays;
- Waterproof pens;
- 10x magnifying hand lens;
- Reference manuals and field charts. These may include:
  - Standard Abbreviations and Sample Graphics (Attachment B);
  - Geotechnical Gauge (A black and white copy is included in Attachment C for reference. Use the original chart for field comparison);
  - Munsell Soil Color Chart (Munsell 1994);
  - ASTM Designation: D 2488-93, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM 1993). A copy is included in Attachment D;
  - AGI Data Sheets for Geology in the Field, Laboratory, and the Office (AGI 1982). A copy of the first page of the field classification for Igneous, Sedimentary, and Metamorphic Rocks is included in Attachment E for reference. Use the original AGI Data Sheets for field comparison;
  - U.S. Department of Interior (DOI), Engineering Geology Field Manual Second Edition, Volume I (DOI 1998); and
  - Dictionary of Geologic Terms (AGI 1984).

5.0 PROCEDURES

The descriptive protocol presented here must be followed in making basic observations. Any further descriptions must follow a protocol that is published and generally recognized by the geologic community as a standard reference. However, if the user has expertise in a particular field of petrology or soil science that allows for descriptions of certain geologic sections beyond the basic level required by this SOP, descriptions may be expanded. This should be done only with approval of the PM.

This SOP is a guide for recording visual observations of samples in the field aided by a 10x hand lens and other simple tools. Field descriptions should be supplemented by petrographic analysis and sieve analysis when the PM needs data on numerical grain-size distributions, secondary porosity development, or other data that can be collected by these methods.

5.1 Field Preparation

This section provides a list of materials and equipment to be used, but does not necessarily include all equipment such as sample equipment, sample containers, and personal protection equipment. Obtain the following materials in the office prior to initiating field work:

- Obtain field logbook;
- Obtain soil boring and/or coring log form;
- Coordinate schedules/actions with PM;
- Obtain necessary field equipment (i.e., hand lens);
- Obtain Bay West reference field charts (i.e., Abbreviations and Sample Graphics, Geotechnical Gauge, Munsell Soil Color Chart, AGI Data Sheets, Engineering Geology Field Manual; Dictionary of Geologic Terms);
- Review field support documents (i.e., sampling plan, health and safety plan); and
- Review applicable geologic reference such as U.S. Department of Agriculture Soil Conservation Survey Soil Surveys and/or geologic maps and logs from previous site investigations.

5.2 Field Activities

This section provides field classification procedures for providing descriptions of soil, sediment and rock along with definitions of descriptors.

5.2.1 Procedures for Classification and Description of Soil, Sediment, and Rock

This section presents a list of descriptors to be used in the classification and description of soil, sediment, and rock. The descriptors are further defined in **Sections 2.1** and **2.2**. Similar samples may be grouped together; for example, one sample should be identified and described completely, with the others identified as similar based on performing only a few of the identification and description procedures. Descriptive information should be evaluated and reported on every sample (DOI 1998).

It is often more practical to use abbreviations for often-repeated terminology when recording descriptions. For the terms given in this SOP and Attachments, or the associated charts to be used for description in the field, use only the designated abbreviations (see **Attachment B** for examples obtained from **Attachments C** and **D**). Other abbreviations are allowed. However, the abbreviation must be defined and recorded on the soil boring and/or coring log form the first time it is used and must be recorded at least once for every soil boring and/or coring log form. Field geologists are cautioned to limit the use of abbreviations to avoid producing a log that is excessively cryptic.

5.2.1.1 Description of Soil and Sediment

Soil and Sediment comprises a significant portion of the sections of interest at Bay West sites. The shallow subsurface is very important to the hydrologic investigation, as this is the portion of the geologic section where infiltration first occurs. Much of the contamination at sites being investigated is surface contamination, and therefore lies on, or within, the upper portion of the surficial material.

Descriptors for soil and sediment shall be recorded in the sequence outlined below. Each description shall be separated by a comma. Interpretive comments shall be recorded separately in the field log book.

- Name (sand, silt, clay, etc.) (Local name if available).
- Texture (particle size, particle size range, angularity, shape).
- Color.
- Structure.
- Consistency.
- Cementation.
- Moisture condition.
- Odor ("smelling" the sample is not recommended. However, if an odor is apparent, it should be noted on the log form).
- Evidence of Contamination.
- Other (i.e., water level, roots, burrows, caving of trench or bore hole, composition of samples, HCL reaction).

Attachment F includes an example of a completed soil boring Form using this SOP to classify and describe soil and sediment samples.

5.2.1.2 Description of Rock

Sedimentary rocks consist of lithified detrital sediments such as sandstone and shale, chemically precipitated sediments such as limestone and gypsum, and biogenic material such as coal. Igneous rocks, volcanic and plutonic, and metamorphic rocks are not as commonly observed at work sites, but they may be found interspersed in the sedimentary section as ash layers and as bedrock. Where they form bedrock, the development of fractures and vugs is important to their hydrologic properties. If the

logger is unsure of the name of the rock because of difficulty in determining mineralogy, the name shall be accompanied by a question mark. The first page of the AGI Data Sheet classification scheme for naming sedimentary, igneous, and metamorphic rocks is included in Attachment E. The actual AGI Data Sheets (AGI 1982) or the Engineering Geology Field Manual (DOI 1998) should be used in the field to name rocks.

Descriptors for rock shall be recorded in the sequence outlined below. Each description shall be separated by a comma. Interpretive comments shall be recorded separately in the field log book.

- Rock name (local name if available);
- Lithology (composition/grain size/texture/color);
- Discontinuities;
- Odor;
- Evidence of contamination; and
- Other (i.e., coring loss/recovery, water level, weathering/alteration, secondary mineralization, bedding/foliation/flow texture, degree of induration, hardness).

Attachment F includes an example of a completed core log form using this SOP to classify and describe rock cores.

6.0 DOCUMENTATION

Individuals classifying and describing soil, sediment, and rock samples will record their observations in a commercially available, bound field logbook (e.g., Lietz books) and/or on individual soil boring and/or coring log forms. When using a bound field logbook, record the same data required on the soil boring and/or coring log form. Data from the field logbook must be transcribed to the soil boring and/or coring log form if filling in the form in the field is not feasible. However, the data must reflect the same information that is recorded in the field logbook. Any editing of field logbook data requires the erroneous information to be crossed out with a single line as not to obscure the initial entry, and the entry initialed and dated by the Field Geologist. The correct information will be entered immediately adjacent to the previous entry. In addition, if data are transcribed to the soil boring and/or coring log form, it should be done within one day of the original data recording. All blanks in the soil boring and/or coring log form must be filled out. Enter “NA” if an item is not applicable. The source of the reference material or field charts used must be recorded on the log form or in the field logbook

In addition to the information on the soil boring and/or coring log form, the Field Geologist shall fill in appropriate information into the logbook as described in the sampling plan and other pertinent information such as rig shut down, rig problems, failures to recover cores, etc.

7.0 PROCEDURE PERFORMANCE EXPECTATIONS

7.1 Restrictions/Limitations

Only geologists or similarly qualified persons trained in the description of soil, sediment, and rock are qualified to perform the duties described in the SOP. The PM will have the authority to decide whether or not an individual is qualified for this task.

8.0 REFERENCES

American Geological Institute (AGI). (1984). *Dictionary of Geological Terms* (3rd Ed.). Anchor Press: New York, NY.

American Society for Testing and Materials (ASTM 1993). *Standard Practice for Description and Identification of Soils* (Visual-Manual Procedure), ASTM Designation: D 2488-93, November.

Dietrich, R. V., Dutro, J. T., & Foose, R. M. (1982). *American Geological Institute (AGI) Data Sheets for Geology in the Field, Laboratory, and Office* (2nd Ed.). American Geological Institute: Falls Church, VA.

DOI 1998, *Engineering Geology Field Manual (*2nd Ed.) Volume 1, Reprinted 2001.

Munsell Color, 1994 Revised Edition, *Munsell Soil Color Charts*: New Windsor, NY.

9.0 APPENDICES

Note: These Appendices are for informational purposes. Other equivalent charts or logs may be used. All materials used must be referenced accordingly.

ATTACHMENT A Bay West, Inc. Soil Boring Log and Coring Log Forms

ATTACHMENT B Standard Abbreviations and Sample Graphics for Soil, Sediment and Rock

ATTACHMENT C Geotechnical Gauge

ATTACHMENT D ASTM Designation: D2488-93

ATTACHMENT E First Page of the AGI Data Sheets on Sedimentary, Igneous and Metamorphic Rocks

ATTACHMENT F Example Completed Soil Boring Log and Completed Coring Log

ATTACHMENT A

Soil Boring Log and Coring Log Forms

Bay West

Project Name: _____
Project Number: _____
Driller: _____
Geologist: _____

Soil Boring No.: _____
Well No.: _____
Total Depth: _____
Drilling Method: _____
Sampling Method: _____
Grade Elevation: _____
Date Started/Completed: _____

Depth	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace PID/FID/ TLV
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
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20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

Bay West

Project Name: _____
Project Number: _____
Driller: _____
Geologist: _____

Rock Core No.: _____
Well No.: _____
Total Depth: _____
Drilling Method: _____
Sampling Method: _____
Grade Elevation: _____
Date Started/Completed: _____

Depth	Description - Remarks	Graphic Section	Munsell Color	Recovery/ loss (in.)	Headspace PID/FID/ TLV
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
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ATTACHMENT B

Standard Abbreviations and Sample Graphics for Sediment and Rock

Bay West

Project Name: Standard Abbreviations and Sample Graphics
Project Number:
Driller:
Geologist:

Soil Boring No.:
Well No.:
Total Depth:
Drilling Method:
Sampling Method:
Grade Elevation:
Date Started/Completed:

Depth	Description - Remarks (symbols)	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace PID/FID/ TLV
	Cobbles and Boulders							
1	Well graded gravel (GW)							
2	Poorly graded gravel (GP)							
3	Sandy well graded gravel [s(GW)]							
4	Silty gravel (GM)							
5	Clayey gravel (GC)							
6	Gravelly poorly graded sand [g(SP)]							
7	Well graded sand (SW)							
8	Poorly graded sand (SP)							
9	Silty sand (SM)							
10	Clayey sand (SC)							
11	Silt (ML)							
12	Sandy silt (ML/SM)							
13	Clayey silt (ML/CL)							
14	Lean clay (CL)							
15	Sandy clay (CL/SC)							
16	Silty clay (CL/ML)							
17	Organic silt (OL)							
18	Inorganic silt (MH)							
19	Fat clay (CH)							
20	Organic clay (OH)							
21	Peat (PT)							
22								
23								
24								
25								
26								
27								
28								

Notes: (1) trace <5%; few = 15-25%; little = 15-25%; some 30-45%; mostly 50-100%.
(3) Use a borderline symbol "/" when the percentage of both soil types are estimated to be between 45 and 55%.
(2) Prefix/Suffix can be used when the complete description is referenced. If a prefix/suffix is used the soil classification symbols to enclosed in parenthesis.
Prefix: s=sandy; g=gravelly. Suffixes: s=with sand; g=with gravel; c=with cobbles; b=with boulders. Examples: Sandy lean clay = s(CL);
Poorly graded sand with silt and gravel = (SP-SM)g; poorly graded gravel with sand, cobbles, and boulders = (GP)scb; gravelly silt with sand and cobbles = g(ML)sc

Bay West

Project Name: Sample Graphics
Project Number:
Driller:
Geologist:

Rock Core No.:
Well No.:
Total Depth:
Drilling Method:
Sampling Method:
Grade Elevation:
Date Started/Completed:

Depth	Description - Remarks	Graphic Section	Munsell Color	Recovery/ loss (in.)	Headspace PID/FID/ TLV
	Limestone				
1	Sandstone				
2	Siltstone				
3	Conglomerate				
4	Shale or Mudstone				
5	Basalt				
6	Granite				
7	Gneiss				
8					
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29					
30					

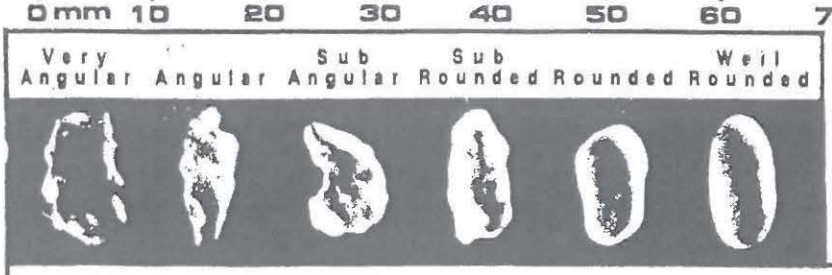
ATTACHMENT C

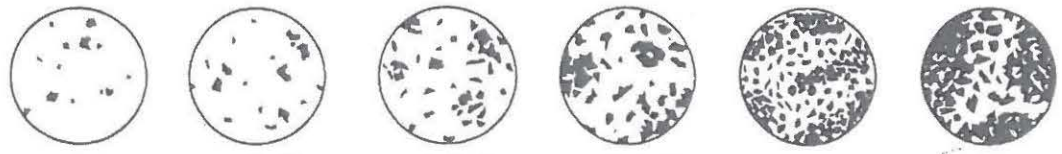
Geotechnical Gauge

Geotechnical Gauge

Manuf. by:
W.F. McCollough
3101 Elkridge Ct.
Beltsville, MD 20705

0 mm 10 20 30 40 50 60 70 80 90 100 110





MAJOR DIVISIONS			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL - GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES.	Light Brown
				GP	POORLY - GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES.	
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES.	Yellowish Orange
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES.	
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL - GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES.	Greenish Gray
				SP	POORLY - GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES.	
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY - SANDS, SAND - SILT MIXTURES.	
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES.	
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLERTHAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY.	Olive Gray
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.	
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY.	
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS.	Light Gray
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.	
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS.	
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS.	Dark Gray

CLAY

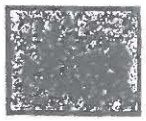
CLAY CONSISTENCY	THUMB PENETRATION	SPT, N BLOWS/FT.	Undrained Shear Strength c (PSF) TORVANE	Unconfined Compressive Strength q_u Pocket Penetrometer
VERY SOFT	Easily penetrated several inches by thumb. Exudes between thumb and finger's when squeezed in hand.	< 2	250	500
SOFT	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 - 4	250 - 500	500 - 1000
MEDIUM STIFF	Can be penetrated over 1/4 " by thumb with moderate effort. Molded by strong finger pressure.	4 - 8	500 - 1000	1000 - 2000
STIFF	Indented about 1/4" by thumb but penetrated only with great effort.	8 - 15	1000 - 2000	2000 - 4000
VERY STIFF	Readily indented by thumbnail.	15 - 30	2000 - 4000	4000 - 8000
HARD	Indented with difficulty by thumbnail.	> 30	> 4000	> 8000

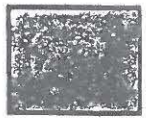
SAND

SOILTYPE	SPT, N Blows/ft.	Relative Density,%	FIELD TEST
VERY LOOSE SAND	4	0 - 15	Easily penetrated with 1/2" reinforcing rod pushed by hand.
LOOSE SAND	4 - 10	15 - 35	Easily penetrated with 1/2" reinforcing rod pushed by hand.
MEDIUM DENSE SAND	10 - 30	35 - 65	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
DENSE SAND	30 - 50	65 - 85	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
VERY DENSE SAND	50	85 - 100	Penetrated only a few inches with 1/2" reinforcing rod driven with 5-lb hammer.

Unified Soil Classification System (USCS)

	MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS	> 300	> 11.8	-
COBBLES	75 - 300	2.9 - 11.8	-
GRAVEL:			
COARSE	75 - 19	2.9 - .75	-
FINE	19 - 4.8	.75 - .19	3/4" - No. 4
SAND:			
COARSE	4.8 - 2.0	.19 - .08	No. 4 - No. 10
MEDIUM	2.0 - .43	.08 - .02	No. 10 - No. 40
FINE	.43 - .08	.02 - .003	No. 40 - No. 200
FINES:			
SILTS	< .08	< .003	< No. 200
CLAYS	< .08	< .003	< No. 200





ATTACHMENT D

ASTM Designation: D2488-93

AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 Race St. Philadelphia, Pa 19103
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If not listed in the current combined index, will appear in the next edition.

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (See Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.5 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions:*

3.1.1 Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:

Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1.2 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.1.3 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.1.4 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.5 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

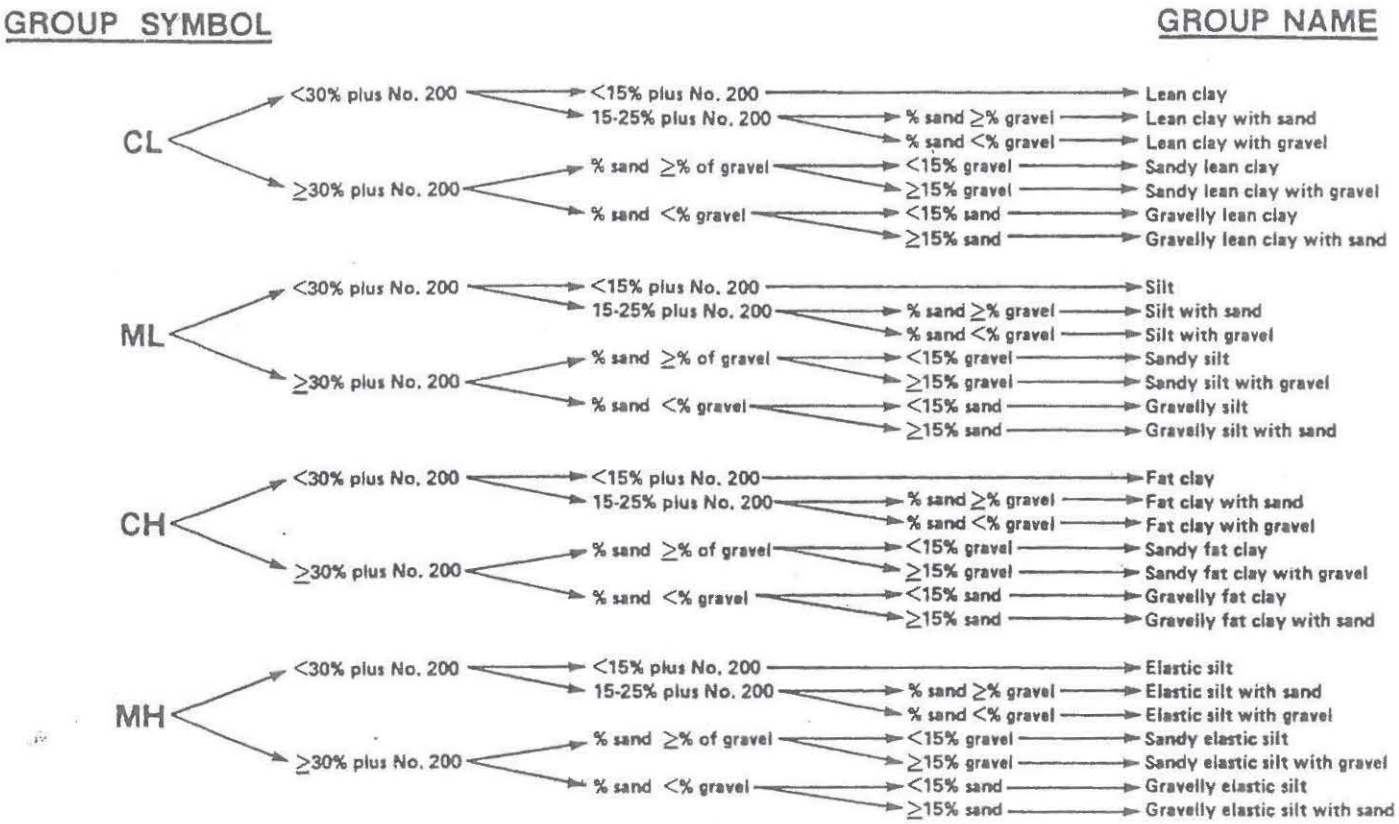
3.1.1.6 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.1.7 *sand*—particles of rock that will pass a No. 4

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved Sept. 15, 1993. Published November 1993. Originally published as D 2488 – 66 T. Last previous edition D 2488 – 90.

[2] *Annual Book of ASTM Standards*, Vol 04.08.



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)

(4.75-mm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.

fine—passes a No. 40 (425-μm) sieve and is retained on a No. 200 (75-μm) sieve.

3.1.1.8 *silt*—soil passing a No. 200 (75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

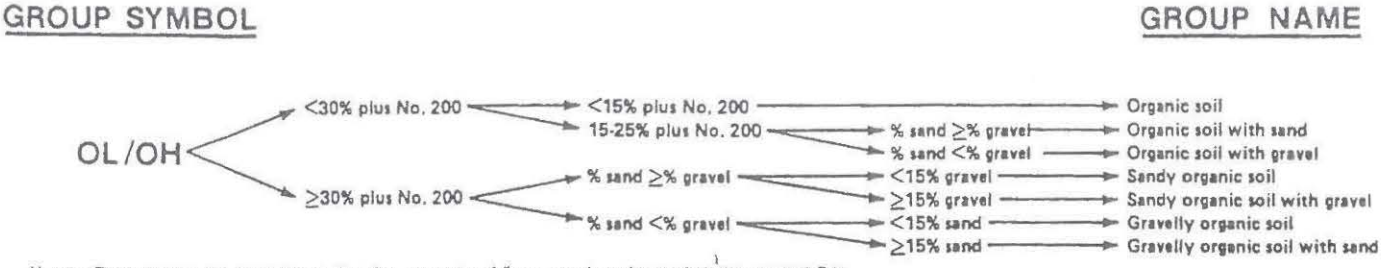
4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Figs. 1a and 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

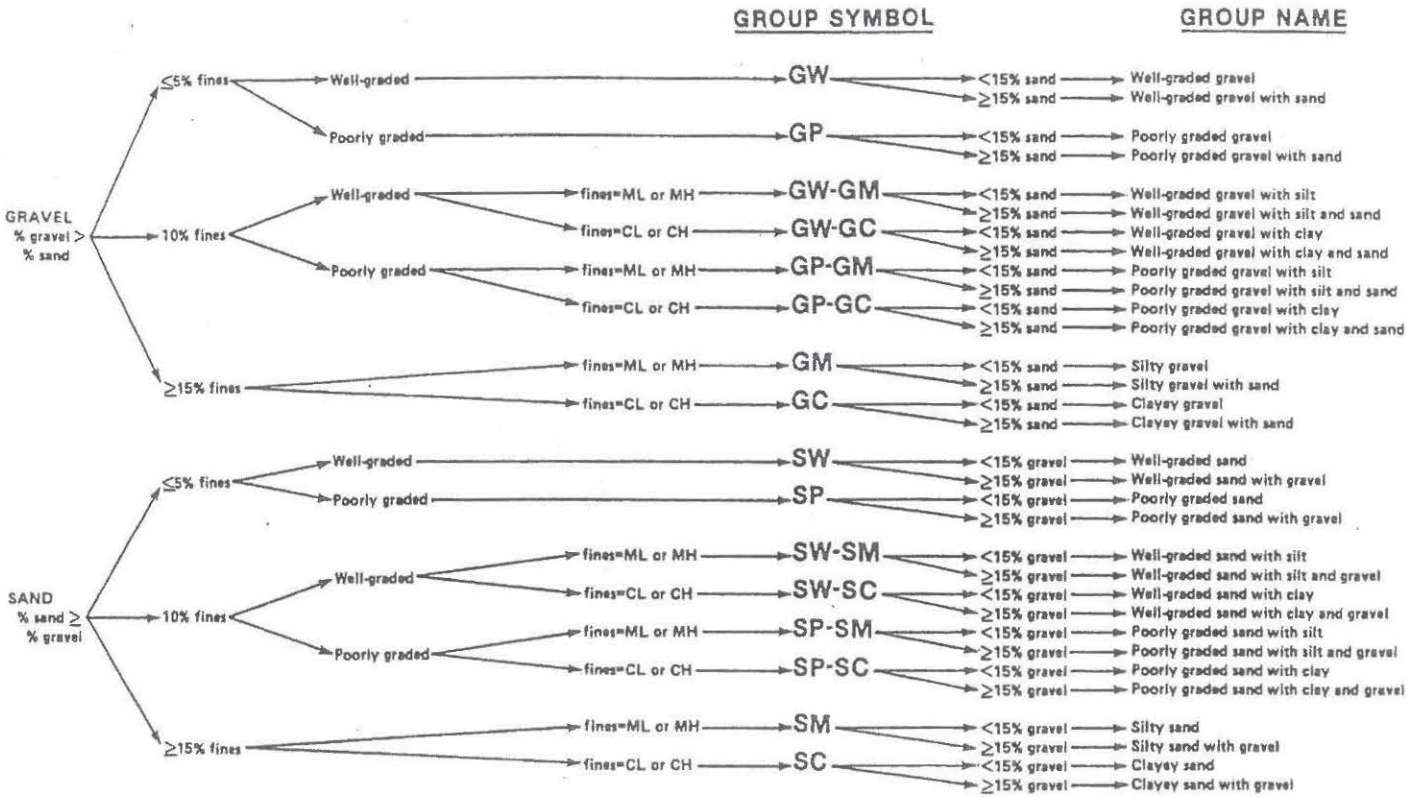
NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols*.

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

6. Apparatus

6.1 *Required Apparatus:*

6.1.1 *Pocket Knife or Small Spatula.*

6.2 *Useful Auxiliary Apparatus:*

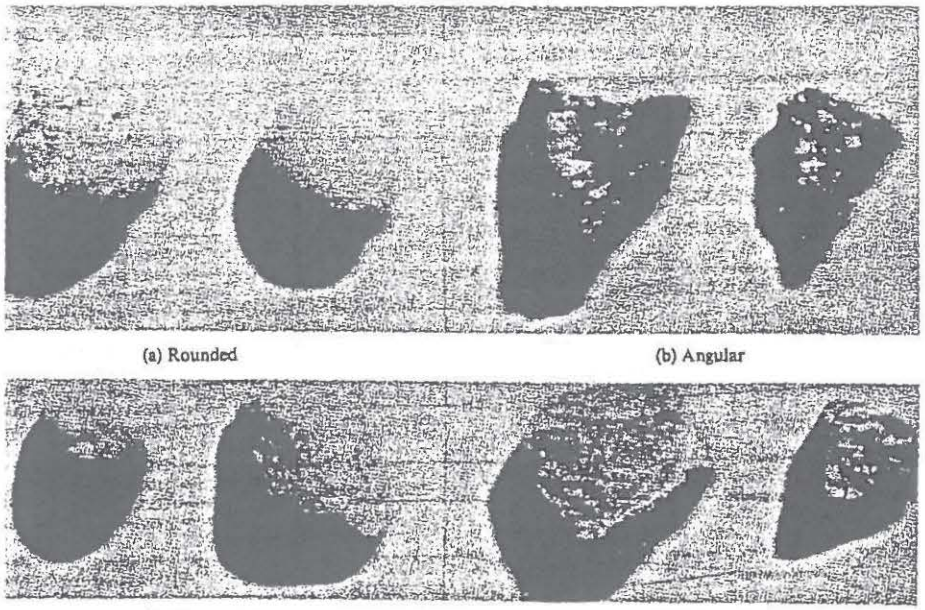
6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens.*

7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.



(a) Rounded (b) Angular

(c) Subrounded (d) Subangular

FIG. 3 Typical Angularity of Bulky Grains

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 5—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 6—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (3/8 in.)	200 g (0.5 lb)
19.0 mm (3/4 in.)	1.0 kg (2.2 lb)
38.1 mm (1 1/2 in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 7—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

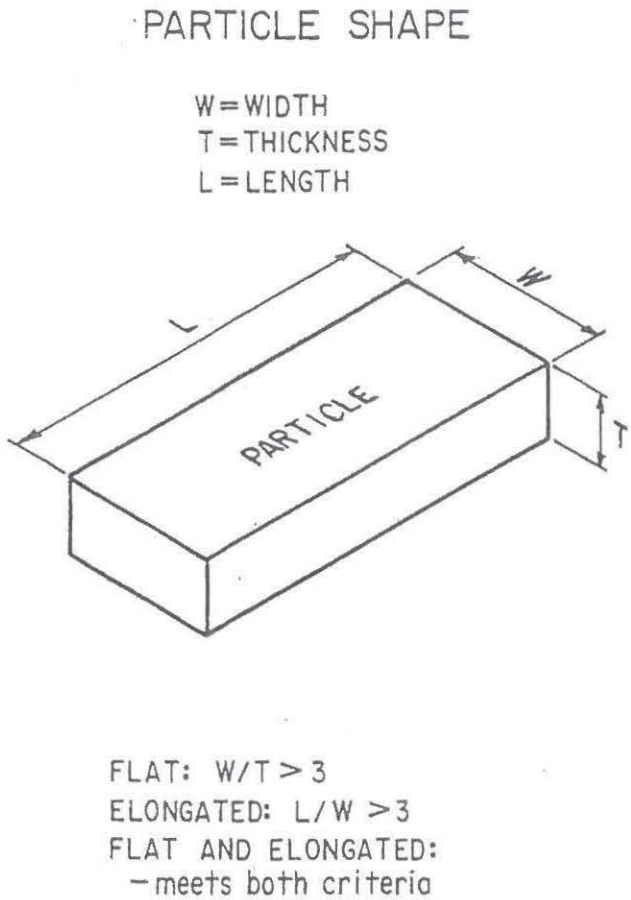


FIG. 4 Criteria for Particle Shape

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpre-

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

tation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 8—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 9—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength:*

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 10—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy:*

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness:*

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils:*

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 11—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils:*

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 12—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils (Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 13—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 14—Other examples of soil descriptions and identification are given in Appendixes X1 and X2.

NOTE 15—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %
Few—5 to 10 %
Little—15 to 25 %
Some—30 to 45 %
Mostly—50 to 100 %

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size; coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the

percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:
s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

X6. RATIONALE

Changes in this version from the previous version, D 2488 – 90, include the addition of X5 on Abbreviated Soil Classification Symbols.

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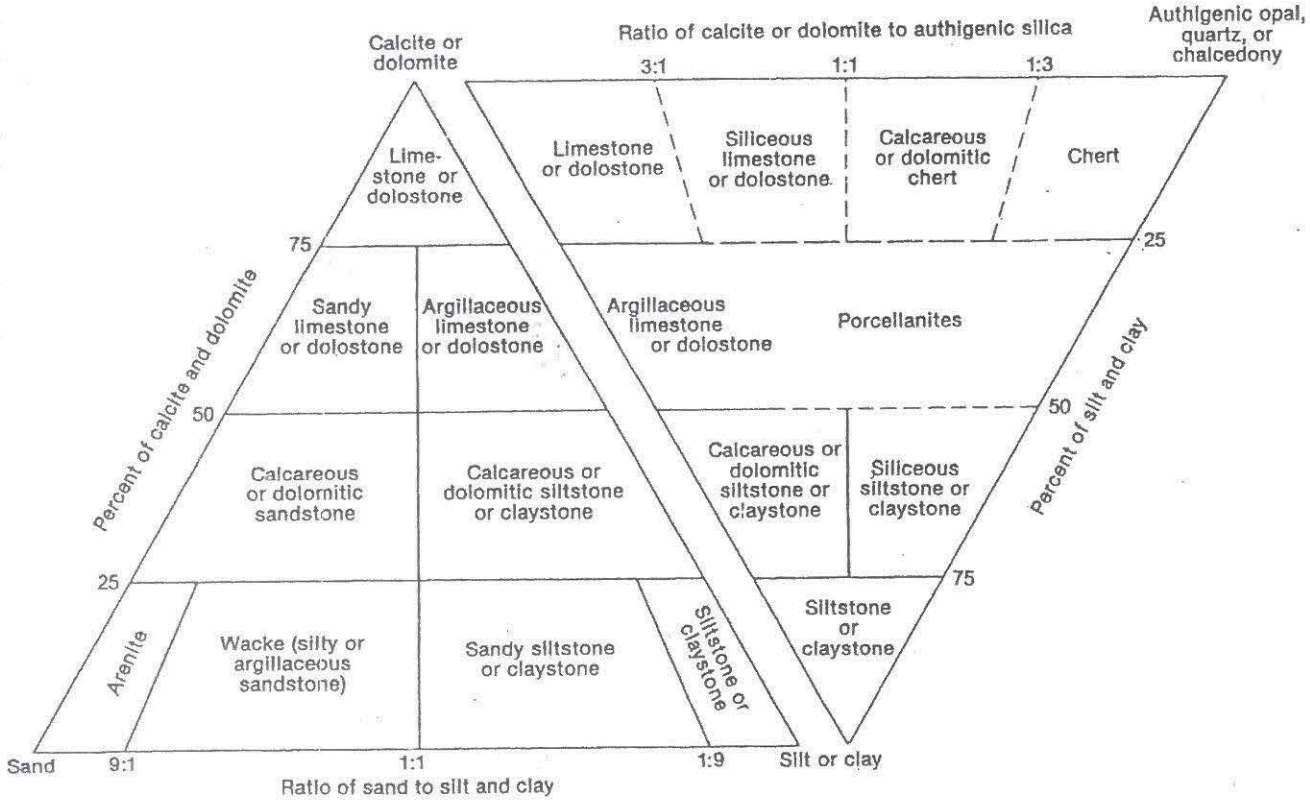
This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.

ATTACHMENT E

First Page of the AGI Data Sheets on Sedimentary, Igneous, and Metamorphic Rocks

Names for Sedimentary Rocks

Condensed by R.R. Compton from *Manual of Field Geology*, John Wiley and Sons, New York, 1956



Rock Names for Mixtures of Sedimentary Materials. The sand, silt, and clay do not include detrital grains of calcite or dolomite. Mainly after C.M. Gilbert (*in* Williams, Turner, and Gilbert, 1954, *Petrography:* San Francisco, W.H. Freeman and Co., p. 270.)

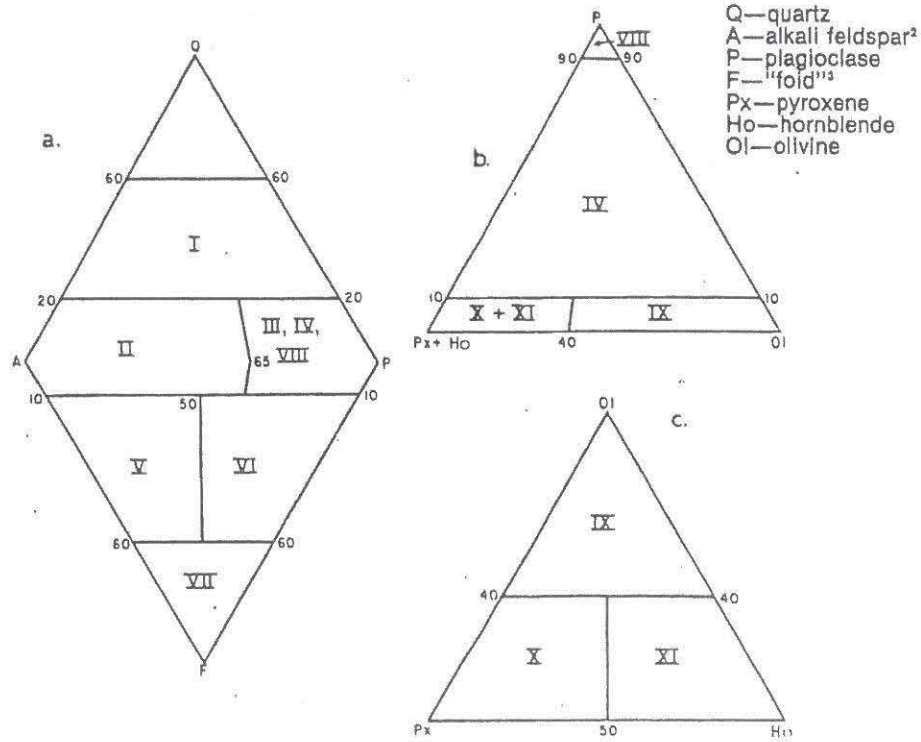
Arenite: relatively well sorted sandstone.
Wacke: sandstone so poorly sorted as to include more than 20 percent of silt or clay.
Graywacke: strongly indurated dark-colored wacke.
Shale: siltstone (silty shale) or claystone (clay shale) with prominent bedding cleavage (fissility).
Mudstone: mixture of silt and clay with blocky or spheroidal fracture.
Argillite: highly indurated (generally recrystallized) claystones or siltstones that break into hard, angular fragments.

AGI-DS-65

Field Classification For Igneous Rocks

IUGS Preliminary classification for plutonic rocks[1]

THE PHANERITES[1]



a. General classification.
b. Ultramafic and gabbroic rocks, and anorthosites.
c. Ultramafic rocks.
I, granitoids; II, syenitoids; III, dioritoids; IV, gabbroids; V, foid syenitoids; VI, foid dioritoids and gabbroids; VII, foidolites; VIII, anorthosites; IX, peridotites; X, pyroxenites; XI, hornblendites; II—IV, qualifier "foid-bearing" if foids are present; IX—XI, ultramafic rocks.

In order to plot a rock's composition in the appropriate triangle on "a", the three components alkali feldspar (A), plagioclase feldspar (P), and quartz (Q) *or* the foid minerals (F) are equated to 100 percent—*i.e.*, the other components are subtracted from the total mode and the remaining QAP or FAP percentages are normalized to 100 percent. . . *etc.* (for "b" and "c").

Diagrams for the general nomenclature are presented on Data Sheet 48. Additional diagrams outlining suggested use of prefixes leuco- and mela- and giving nomenclature for less common phanerites such as carbonatites and lamprophyres may be found in the following references:

Dietrich, R.V. and Skinner, B.J., 1979, Rocks and Rock Minerals: Wiley, N.Y., 369p.

IUGS Subcommission on the Systematics of Igneous Rocks, 1973, Classification and nomenclature of plutonic rocks: Geotimes, v. 18, n. 10 (Oct.), p. 26-30.

Streckeisen, A., 1976, To each plutonic rock its proper name: Earth Science Rev., v. 12, p. 1-33.

1. In the IUGS scheme, "plutonic rock", which refers to phaneritic rocks, is not assumed to require an igneous origin.

2. Alkali feldspar includes potassium feldspars, perthite (including its plagioclase component), and anorthoclase.

3. "foid" includes the feldspathoids—leucite and pseudoleucite, nepheline, sodalite, nosean, hauyne, cancrinite, analcime, *etc.*

Descriptive Classification of Metamorphic Rocks*

by Robert R. Compton, Stanford University

In this binomial system for naming metamorphic rocks, the main rock name is based on the texture of the rock, and the principal or more significant minerals are added as modifying nouns, as in biotite-quartz schist or andalusite-cordierite hornfels. The names are meant to be applied on a descriptive basis; a schistose rock, for example, should not be called a hornfels just because it is found in a contact aureole.

TEXTURES

Schistose—grains platy or elongate and oriented parallel or subparallel. *Foliated* (lepidoblastic) if fabric is planar, *lineated* (nematoblastic) if linear.

Granoblastic—grains approximately equidimensional; platy and linear grains oriented randomly or so subordinate that foliation is not developed.

Hornfelsic—grains irregular and interincluded but generally microscopic; recognized in field by unusual toughness, ring to hammer blow, and hackly fracture at all angles. Under hand lens, freshly broken surfaces show a sugary coating that will not rub off (formed by rending of interlocking grains).

Semischistose (gneissic)—platy or linear grains subparallel but so subordinate or so unevenly distributed that rock has only a crude foliation; especially common in metamorphosed granular rocks, such as sandstones and igneous rocks.

Cataclastic—clastic textures resulting from breaking and grinding with little if any recrystallization; characterized by angular, lensoid, or rounded fragments (*porphyroclasts*) in a fine-grained and commonly streaked or layered groundmass. *Mortar structure* applies to nonoriented arrangements, and *phacoidal, flaser,* and *augen structure* apply to lenticular arrangements.

ROCK NAMES

SCHISTOSE ROCKS

Schist—grains can be seen without using a microscope.

Phyllite—all (or almost all) grains of groundmass are microscopic, but cleavage surfaces have sheen caused by reflections from platy or linear minerals; commonly corrugated.

Slate—grains are microscopic; very cleavable; surfaces dull; tougher than shale and cleavage commonly oblique to bedding.

Phyllonite—appearance like phyllite but formed by cataclasis (see mylonite) and recrystallization commonly of coarser-grained rocks, as indicated by relict rock slices, slip folds, and porphyroclasts.

GRANOBLASTIC ROCKS

Granulite or **granofels**—granoblastic rocks, irrespective of mineral composition; because *granulite* can connote special compositions and conditions of origin, *granofels* may be preferred.

Quartzite, marble, and amphibolite—compositional names that generally connote granoblastic texture; exceptions should be modified for clarity, as *schistose quartzite* or *plagioclase hornblende schist.*

Tactite (skarn)—heterogeneous calc-silicate granulites and related metasomatic rocks of typically uneven grain.

HORNFELSIC ROCKS

All called *hornfels*, or, if relict features are clear, hornfelsic may be used with the original rock name (as *hornfelsic andesite*).

SEMISCHISTOSE (GNEISSIC) ROCKS

Semischist—fine-grained (typically less than 1/4 mm) so that individual platy or lineate grains are indistinct; relict features often common.

Gneiss—generally coarser than 1/2 mm with small aggregates of platy or lineate grains forming separate lenses, blades, or streaks in otherwise granoblastic rock. Platy or lineate structures may be distributed evenly through the rock or may be concentrated locally so that some layers or lenses are granoblastic or schistose (*banded gneiss*).

*Modified after Data Sheet 27,1965, which was condensed from *Manual of field geology,* John Wiley & Sons, New York, 1962

AGI-DS-rmf-82

CATACLASTIC ROCKS

Where original nature of rock is still apparent, rock name can be modified by suitable adjectives (as *cataclastic granite, flaser gabbro, phacoidal rhyolite*).

Mylonite—crushing so thorough that rock is largely aphanitic and commonly dark-colored; may be layered and crudely foliated but not schistose like phyllonite; porphyroclasts commonly rounded or lenticular.

Ultramylonite, pseudotachylyte—Aphanitic to nearly vitreous-appearing dark rock commonly injected as dikes into adjoining rocks.

RELICT AND SPECIAL TEXTURES AND STRUCTURES

If textures of low-grade metamorphic rocks are dominantly relict, original rock names may be modified (as *massive metabasalt, semischistose meta-andesite*). If hydrothermal alteration has produced prominent new minerals, names such as *chloritized diorite* and *sericitized granite* can be used.

Strongly metasomatized rocks with coarse or unusual textures may require special names such as *greisen, quartz-schorl rock*, and *corundum-mica rock*.

Migmatite—a composite rock composed of igneous or igneous-appearing and/or metamorphic materials that are generally distinguishable megascopically.

ATTACHMENT F

Example of Completed Soil Boring Log and Completed Coring Log

Bay West

Project Name: Zurn Lake
Project Number: J8675309
Driller: Jeremy Brandt-NTS
Geologist: Scott Zurn

Soil Boring No.: GP-6
Well No.:
Total Depth: 24 ft bgs
Drilling Method: Geoprobe
Sampling Method: 4 ft Macro Core
Grade Elevation:
Date Started/Completed: 1610 8-19-02 / 1815 8-19-02

Depth	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace PID/FID/TLV
	Sandy silt s(ML), fine to medium grained sand, black, trace fine gravel, dry. Grass surface, topsoil.		5YR2.5/1	s(ML)		24	2	0
1	Sandy silt s(ML), fine to medium grained sand, reddish brown, trace fine gravel, moist.		5YR5/3				3	
2	No Recovery.					NR	8	NR
3								
4	Sandy silt s(ML), fine to medium grained sand, reddish brown, some fine to coarse gravel, moist		5YR5/3		GP-6 4'-6'	24	5	0
W.L. 5	to wet, no odor.							
6	Same As Above (SAA).		5YR5/3			8	8	0
7								
8	SAA.		5YR5/3			24	10	0
9								
10	SAA.		5YR5/3			14	9	0
11								
12	Silty sand and gravel (SM/GW), fine to medium grained sand and fine to coarse angular gravel,		7.5YR5/3	SM/GW		24	25	0
13	brown, wet, no odor.							
14	No Recovery (pushed a rock)					NR	40	NR
15	Sandy silt (ML), fine grained sand,							
16	reddish brown, few gravel, wet.		5YR5/3	ML		24	20	0
	Poorly graded sand (SP), medium grained sand, rounded,		7.5YR3/4	SP				
17	dark brown, wet, no odor.							
18	Poorly graded sand (SP), very fine to fine grained sand, rounded to sub rounded, brown, wet.		7.5YR5/3			14	22	0
19								
20	SAA		7.5YR5/3			24	20	0
21								
22	Well graded sand (SW) fine to coarse grained sand, rounded, dark brown, wet, no odor.		7.5YR3/4	SP	GP-6 22'-24'	18	30	0
23								
24	-End of boring at 24 ft bgs due to refusal. Set temporary PVC well screen at 0' to 11.5' bgs. Initial							
25	water level measurement was 5.5 ft bgs. Collected grain size analysis from 8-12 ft bgs.							
26								
27								
28								
29								
30								

Bay West

Project Name: Zurn Lake
Project Number: J8675309
Driller: Rocky Balboa
Geologist: Scott Zurn

Rock Core No.: C1
Well No.:
Total Depth: 14
Drilling Method: Core
Sampling Method: C
Grade Elevation: 800 feet ASL
Date Started/Completed: 0800 11-14-02 / 1600 11-15-02

Depth	Description - Remarks	Graphic Section	Munsell Color	Recovery/ loss (in.)	Headspace PID/FID/ TLV
	See Soil Boring Log B1 for Soil Classification				
1					
2					
3					
4					
5					
6					
7 WL					
8	Fossiliferous Limestone, Platteville Formation light brown, wet.		7.5YR6/3	8	45
9	Shale, Glenwood Formation weathered, olive brown, moist.		2.5Y4/3	10	0
10	Shale, Glenwood Formation olive, moist.		5Y5/4	12	0
11	SAA		5Y5/4	12	0
12	SAA		5Y5/4	12	1
13	Sandstone, St. Peter, fine to medium grained, light brown, rounded and subrounded grains, poorly cemented, wet.		7.5YR6/3	12	0
14	-End of boring at 14 ft bgs. Water level measurement 7.5 ft bgs.				
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Bay West

Standard Operating Procedure

Field Equipment Decontamination

CORP-ENV-002-1578775

Revised: October 5, 2012

Review and Approval:

Developed by: _____ Date: October 5, 2012
Signature

QA/QC Manager
Title

Reviewed by: _____ Date: October 5, 2012
Signature

QA/QC Manager
Title

Approved by: _____ Date: October 5, 2012
Signature

Vice President of Operations
Title

Questions and requests for information regarding this SOP should be directed to the Vice President of Operations or the QA/QC Manager. This SOP cannot be edited, changed, or revised without the approval of the individuals listed above, and all edits,

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changes, and revisions must be routed through the Document Management Coordinator.

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1.0 INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) provides the procedures required for decontamination of field equipment. Decontamination of field equipment is required to ensure the safety of field personnel and the integrity of field samples by preventing cross contamination. Decontamination of field equipment reduces health hazards and prevents the spread of contaminants off site.

1.2 Scope

This SOP applies to all Bay West, Inc. (Bay West) personnel involved in field investigation activities when non-disposable field equipment is used. This equipment may include heavy equipment and sampling equipment.

2.0 DEFINITIONS

Contamination – Site-specific compounds/elements that can be transferred to other locations/sites or to personnel without the proper removal at the originating site.

Cross-contamination – The transfer of contamination — via equipment or personnel that have not been properly decontaminated — to less contaminated or uncontaminated samples or areas.

Decontaminated – Free of visible contamination and ready for use; when decontamination has been completed in accordance with this SOP.

Decontamination – The process of rinsing, scrubbing, or otherwise cleaning the surfaces of equipment to rid them of contaminants and to minimize the potential for cross-contamination of samples or exposure to field personnel.

Equipment Blank (EB) – A sample collected and analyzed to check decontamination techniques and the sampling equipment for residual contamination. After the sampling equipment has been decontaminated, the EB is prepared by pouring deionized water (DI water) (usually provided by the laboratory) into the sample collection equipment and rinsing all internal surfaces that contact the sample. The EB is collected into the appropriate sample bottles for laboratory analysis and labeled as an “EB.” The site-specific plans will provide the rate of collection of EBs, the method, and type of water used.

3.0 RESPONSIBILITIES

Project Manager (PM) – Has overall responsibility of the project operations and ensures that decontamination operations follow the requirements provided in this SOP and the Accident Prevention Plan/Site Safety and Health Plan (APP/SSHP). If the analytical results for a target compound/element in the EB exceed one-half of the laboratory reporting limits (RLs) for a particular analyte, the PM must document the non-conformance and initiate a corrective action.

Site Supervisor – Manages site operations under the direction of the PM and communicates the requirements of the decontamination procedures presented in this SOP and the APP/SSHP to the field personnel. The Site Supervisor may also collect and document rinsate samples to provide quantitative verification that these decontamination procedures have been correctly implemented.

Field Personnel – Personnel that may perform equipment decontamination tasks at the site (which may include the Site Supervisor) and collecting the EB samples.

4.0 REQUIRED EQUIPMENT

This section provides a general list of equipment to be used for equipment decontamination. Additional apparatus may be required for site-specific equipment such as drill rigs and earthmoving machines:

- Gloves, safety glasses, and other protective clothing as specified in the APP/SSHP;
- Plastic sheeting;
- Stiff-bristle scrub brushes;
- Drain spade (for cleaning equipment tracks);
- Plastic buckets and/or troughs;
- Nalgene and/or Teflon wash bottles;
- Detergent (phosphate-free such as Alconox®, Liquinox®);
- Appropriate decontamination rinsing solutions such as tap water, pesticide grade hexane, methanol, DI water, etc. The required solutions will be delineated in the site-specific plans;
- 55-gallon drums or other containers to retain the decontamination fluids (sample container size is dependent on equipment being decontaminated);
- Disposable wipes or rags; and
- A high-pressure pump with soap dispenser or steam-spray unit may be required for larger equipment or particularly difficult contaminants such as viscous oils or tar-like substances.

5.0 PROCEDURES

All reusable equipment (non-dedicated equipment) used to collect, handle, or measure samples will be decontaminated before coming into contact with any sample. Decontamination of equipment will occur either at the central decontamination station or at portable decontamination stations set up at the work location, sampling location, drill sites, or monitoring well locations. If small decontaminated items are not immediately used, they will be covered with either plastic or aluminum foil to ensure cleanliness. If required, the centrally located decontamination station will include a separate pad on which the heavy equipment, drill rigs, and/or other large drilling equipment, such as auger flights, can be steam cleaned and properly stored to prevent cross-contamination.

The decontamination pad will be constructed in accordance with the site-specific plans to ensure contaminated water drains into a collection system. Collected water will be pumped into 55-gallon drums or portable tanks for storage, and if necessary, sent off site under a manifest by a licensed waste hauler, if required.

Decontamination fluids, such as solvents, may need to be segregated from other investigation derived wastes. Solvent disposal alternatives will be specified in the site-specific plans.

During any decontamination activity, personnel protective clothing and equipment as specified in the APP/SSHP will be worn. These may include: gloves, boots, safety glasses, face shields, respirators and other equipment.

5.1 Sampling Equipment Decontamination

- Soap used will be a non-phosphate detergent.
- Decontaminated equipment will be thoroughly rinsed with potable water or as specified in the site-specific plans.
- Decontaminated equipment will be allowed to air dry, if time allows, before being used.
- Procedures used for decontamination will be recorded in the site logbook.
- Sampling equipment that has come into contact with oily substances will be cleaned with methanol or other approved alternative solvent to remove the oily material. This may be followed by a hexane rinse and then another methanol rinse. Specific requirements shall be followed as detailed in the site-specific plans.
- All solvents, if required, will be pesticide grade or higher purity and traceable to a specific source. The corresponding lot numbers will be recorded in the site logbook.
-

- Gloves, boots, safety glasses, face shields, and any other personnel protective clothing and equipment will be used as specified in the APP/SSHP.

5.2 Heavy Equipment Decontamination

Heavy equipment includes drill rigs and excavation equipment. The following specific steps are required when decontaminating this equipment.

Set up a decontamination pad that is large enough to fully contain the equipment to be cleaned. Use one or more layers of heavy plastic sheeting to cover the ground surface. With the equipment in place, spray areas of the equipment exposed to contaminated soils using a steam or a high-pressure sprayer. Be sure to spray down all surfaces that had the potential to contact contaminated soils.

1. Use drain spade, brushes, non-phosphate detergent and potable water or as specified in the site-specific plans to remove dirt whenever necessary.
2. If soapy water is used, rinse the equipment with clean, potable water or as specified in the site-specific plans. If using steam, the rinse step is not necessary if the steam does not contain a detergent. If the steam contains a detergent, this final clean water rinse is required.
3. Remove equipment from the decontamination pad and allow it to air dry, if time allows, before returning it to the work site.
4. Record equipment type, date, time, and method of decontamination in the appropriate logbook.
5. After decontamination activities are completed, collect all contaminated waste waters, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles (as required). All receptacles containing contaminated items must be properly labeled for disposal. Liquids and solids must be drummed separately.

5.3 Downhole Equipment Decontamination

Downhole equipment requiring decontamination includes: hollow-stem augers, drill pipes, casings, screens, etc. Follow these steps when decontaminating this equipment:

1. Set up a centralized decontamination area, if possible. This area should be set up to contain contaminated rinse waters and to minimize the spread of airborne spray. The decontamination area/pad requirements will be site-specific.
2. Set up a “clean” area upwind of the decontamination area to receive cleaned equipment for air drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed.
3. Place the object to be cleaned on plastic-covered sawhorses or other supports.

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4. Using non-phosphate detergent and potable water in the high-pressure sprayer (or steam unit), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and in gaps thoroughly. Use a brush, if necessary, to dislodge dirt.
5. If using soapy water, rinse the equipment using clean potable water or as specified in the site-specific plans. If using steam, the rinse step is not necessary if the steam does not contain a detergent. If the steam contains a detergent, this final clean water rinse is required.
6. Remove the equipment from the decontamination area and place in the clean area to air dry.
7. Record equipment type, date, time, and method of decontamination in the appropriate logbook.
8. After decontamination activities are completed, collect all contaminated waste waters, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal. Liquids and solids must be drummed separately.

5.4 Sampling Equipment Decontamination

Sampling equipment includes split spoons, spatulas, bowls, and other equipment used for sample homogenization that directly contact sample media. Follow these steps when decontaminating this equipment:

1. Set up a decontamination line on plastic sheeting. The decontamination line should progress from “dirty” to “clean” and end with an area for drying decontaminated equipment. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or the surfaces on which decontaminated equipment is to be placed.
2. Before washing, disassemble any items that might trap contaminants internally. Do not reassemble these items until decontamination is complete. Wash items thoroughly in a bucket of non-phosphate detergent and potable water or as specified in the site-specific plans. Use a stiff-bristle brush to dislodge any clinging dirt.
3. Rinse the item in potable water or as specified in the site-specific plans. Rinse water should be replaced as needed, generally when the water becomes cloudy.
4. If required by the site-specific plans, rinse the item with DI water, isopropyl alcohol, 10% nitric acid (for stainless steel, glass, plastic, and Teflon), or 1% nitric acid (for items made of low- carbon steel) followed by a distilled water rinse.
    a. **Note**: Care should be taken not to get nitric acid on skin or clothing. This step should not be used unless required by the sampling plan.

b. **Caution**: Do not allow nitric acid to contact methanol or hexane. Contain nitric acid waste separately from organic solvent waste.

5. If required by the sampling plan, rinse the item with methanol or another approved organic solvent.
6. If polar organic compounds such as pesticides, polychlorinated biphenyls (PCBs), and fuels are to be sampled, rinse the item with hexane or approved alternatives, followed by a second methanol rinse. This step should not be used unless required by the site-specific plan.
7. Triple rinse the item with water if solvents were used to clean the item, as required by the site-specific plans.
8. Shake off remaining water and allow the item to air dry completely, if time allows.
9. After drying, wrap the clean item in plastic wrap or in aluminum foil.
10. Record equipment type, date, time, and method of decontamination in the site logbook.
11. After decontamination activities are completed, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable gloves, boots, and clothing. Place contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately. (Refer to site-specific plans for waste management requirements).

5.5 Pump Decontamination

Follow these steps when decontaminating pumps:

1. Set up the decontamination area using plastic sheeting to cover the ground, tables, and other porous surfaces. Follow the site-specific plans for pump decontamination. For example, the plans may require setting up three containers in a triangle. One container at the base of the triangle would contain dilute (non-foaming) soapy water and the second container would hold potable water. The container at the apex would receive waste water. Place a container of DI water, if required, adjacent to the waste container on the same side as the potable water container.
2. The pump should be set up in the same configuration as for sampling. Submerge the pump intake (or the pump, if submersible) and all downhole-wetted parts (tubing, piping, foot valve) in the soapy water of the first container. Place the discharge outlet in the waste container above the level of the waste water. Pump soapy water through the pump assembly until it discharges to the waste container.
3. Move the pump assembly to the potable water container while leaving discharge outlet in the waste container. All downhole-wetted parts must be immersed in the

potable water rinse. Pump potable water through the pump assembly until it runs clear.

4. If required, move the pump intake to the distilled water container. Pump distilled water through the pump assembly. Usually, three pump-and-line-assembly volumes will be required to thoroughly rinse the apparatus.
5. Decontaminate the discharge outlet by hand following the steps outlined in Section 5.4.
6. Place the decontaminated pump assembly in the “clean” area and allow it to air dry, if time allows. Intake and outlet orifices should be covered with aluminum foil to prevent the entry of airborne contaminants and particles.

5.6 Waste Disposal

Refer to site-specific plans for waste disposal requirements. The following are general guidelines for disposing of wastes:

- All wash water, rinse water, and decontamination solutions that have come in contact with contaminated equipment are to be handled, packaged, labeled, marked, stored, and disposed of as a hazardous waste unless other arrangements are approved in advance.
- Small quantities of decontamination solutions may be allowed to evaporate to dryness.
- If large quantities of used decontamination solutions will be generated, it may be best to separate each type of waste in a separate container. This may permit the disposal of wash water and rinse water in a sanitary sewage treatment plant rather than as a hazardous waste.
- If an industrial waste water treatment plant is available on-site, the disposal of acid solutions and solvent-water solutions may be permitted there. The site-specific plans will indicate the proper disposal methods.
- Unless required by the site specific plans, plastic sheeting and disposable protective clothing may be treated as a solid, nonhazardous waste.

6.0 DOCUMENTATION

All notes/comments associated with the decontamination of field equipment will be recorded in a project-specific field notebook in accordance with the Bay West SOP for Field Documentation, CORP-ENV-010-1578753.

7.0 PROCEDURE PERFORMANCE EXPECTATIONS

Whenever possible, sampling is performed in a clean to dirty progression. Equipment decontamination is performed between each sample collection location. Depending on

project requirements, an EB may be collected. When possible, EBs are collected after "dirty" samples to assess the "worst case" decontamination effectiveness. Successful decontamination will result in an EB with no detections above laboratory RLs. If laboratory results for an EB exceed the RLs, the PM must document this and initiate a corrective action.

Nitric acid and polar solvent rinses are necessary only when sampling for metals or organics, respectively. These steps should not be used unless specifically required by the site-specific plans because of potential acid burns and ignitability hazards.

If the field equipment rinsed with solvents is not allowed to air dry properly before use, volatile organic residue may be detected in the samples. The occurrence of residual organic solvents is often dependent on the time of year sampling is conducted; volatilization is rapid in the summer, but slow in the winter. Approved decontamination solvents are listed in the site-specific plans.

8.0 REFERENCES

Bay West, Inc. Standard Operating Procedure for Field Documentation, CORP-ENV-010-1578753.

Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures for Site Characterization,* DOE/HWP-100, July 1990.

Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements for Field Methods,* DOE/HWP-69/RI.

American Society for Testing and Materials, *Standard Practice for Decontamination of Field Equipment at Nonradioactive Waste Sites,* ASTM 05088-90, June 29, 1990.

U.S. Environmental Protection Agency, Region II, *CERCLA Quality Assurance Manual,* Revision 1, 1989.

U.S. Environmental Protection Agency, Region IV, *Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual,* 1986.

U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods,* EPA/540/Procedures-87/001.1, 1987.

Bay West

Standard Operating Procedure

Packaging and Shipping of Environmental Samples

CORP-ENV-006-1510206

Revised: February 10, 2012

Review and Approval:

Developed by: John D. Verlan — Date: 02-15-2012

Signature

QA/QC Manager

Title

Reviewed by: John D. Verlan — Date: 02-15-2012

Signature

QA/QC Manager

Title

Approved by: [signature] — Date: 02-15-2012

Signature

Vice President of Operations

Title

Questions and requests for information regarding this SOP should be directed to the Vice President of Operations or the QA/QC Manager. This SOP cannot be edited, changed, or revised without the approval of the individuals listed above, and all edits, changes, and revisions must be routed through the Document Management Coordinator.

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to establish packaging and shipping requirements and guidelines for environmental sample shipping. Proper packaging and shipping is necessary to ensure the protection and the integrity of environmental samples shipped to the laboratory for analysis.

2.0 DEFINITIONS

Environmental Sample - Environmental Sample is any sample that has less than reportable quantities for any hazardous constituents according to Department of Transportation (DOT) regulations for promulgated in 49 CFR - Part 172.

Chain-of-Custody – Chain-of-Custody is a legal term that refers to the ability to guarantee the identity and integrity of the sample (or data) from collection through reporting of the test results.

3.0 RESPONSIBILITIES

Sampler – The sampler is required to maintain Chain-of-Custody of the samples at all times. Only people associated with the project may handle the samples. The duties of the sampler include: proper labeling of the samples, completion of the Chain-of-Custody form, proper packing of the shipping container, most often a cooler, and transportation of the shipping container to the courier meeting point or to an overnight delivery service. The Chain-of-Custody always accompanies the samples at all times.

Site Supervisor - The site supervisor is responsible for ensuring that the Chain-of-Custody is maintained, packaging and sampling procedures are conducted in accordance with this SOP and the site specific SAP. The site supervisor is also responsible for ensuring that the proper laboratory analysis of the samples is requested by Bay West.

Project Manager - The Project Manager is responsible for maintaining logbooks and forms, tracking the Chain-of-Custody and for approving and documenting techniques not specifically described in this SOP.

4.0 REQUIRED EQUIPMENT

This section provides a list of equipment to be used but does not necessarily include all equipment such as sample containers and personal protection equipment. The following is a general list of equipment that should be obtained prior to initiating field work:

- Coolers with return address labels of the Bay West office;
- Heavy-duty plastic garbage bags;
- Plastic zip-top bags, small and large;
- Clear tape;
- Fiber tape;
- Duct tape;
- Bubble wrap;
- Ice;
- Chain-of-Custody seals;
- Indelible black ink pens and markers;
- Completed Chain-of-Custody record or CLP custody records, if applicable;
- Completed Bill of Lading (if required); and
- "This End Up" and directional arrow labels;
- Saturday Delivery Labels (if required).

5.0 PROCEDURES

The following steps must be followed when packing sample bottles and jars for shipment:

1. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape. Line the cooler with a large heavy-duty plastic garbage bag;
2. Be sure the caps on all bottles are tight (will not leak). Check to see that sample labels and chain-of-custody records are completed properly <u>and they match *exactly*</u>;
3. Place all bottles in separate and appropriately-sized, plastic zip-top bags, remove air pockets and close the bags. Up to three VOA vials may be packed in one bag. Glass containers must be wrapped in bubble wrap prior to insertion into the bag. Optionally, place bagged and bubble-wrapped VOA vials in a quart/gallon metal can and then fill the can with additional bubble wrap;
4. Place a sufficient layer of bubble wrap on the bottom of the cooler and then place the bottles and cans in the bag with sufficient space to allow for the addition of more bubble wrap between the bottles and cans. It is mandatory to place glass sample bottles and jars into the cooler *vertically*. Due to the strength properties of a glass container, there is significantly less chance of breakage when the container is packed vertically rather than horizontally;

5. Put ice in large, plastic, zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place these ice bags on top of or between the samples. Several bags of ice are required for temperature control. Fill all remaining space between the bottles or cans with bubble wrap. Securely fasten the top of the large garbage bag inside the cooler with fiber or duct tape;
6. Place the completed Chain-of-Custody Record or the Contractor Laboratory Program (CLP) Traffic Report Form (if applicable) for the laboratory into a plastic zip-top bag, seal the bag, tape the bag to the inner side of the cooler's lid, and then close the cooler. The sampler keeps one copy of the Chain-of-Custody Record. Include any additional paperwork sent to notify the laboratory of project information (laboratory notification checklist) or if a sample is suspected of containing any substance for which laboratory personnel should take additional safety precautions;
7. Fiber tape or duct tape shall be wrapped around each end of the cooler two times and completed custody seals affixed to the top opposite sides of the cooler, half on the fiber tape or duct tape so that the cooler cannot be opened without breaking the seal. Complete an additional two wraps with fiber tape or duct tape; place clear tape over custody seals; and
8. The shipping container lid must be marked "THIS END UP" and arrow labels which indicate the proper upward position of the container should be affixed to the cooler. A label containing the name and address of the shipper (Bay West) shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo-only Aircraft, Flammable Solids, etc.) are not permitted to be on the outside of the container used to transport environmental samples and shall not be used. The name and address of the laboratory shall be placed on the container; or, when shipping by common courier, the airbill or the Bill of Lading shall be completed and attached to the lid of the shipping container.

6.0 DOCUMENTATION

All notes/comments associated with the packaging and shipping will be recorded in a project specific field notebook in accordance with this Bay West. A copy of the Chain-of-Custody will be sent to the Project Manager and entered into the Bay West Document Management System. The copy of the original Chain-of-Custody retained in the field will be sent to the project file.

7.0 PROCEDURE PERFORMANCE EXPECTATIONS

Each sample cooler must be packaged and preserved with sufficient ice in order for the laboratory to receive the samples intact and at the proper temperature, 4°C ± 2°C. If there are additional preservation requirements, e.g. Dry Ice, these will be presented in the site specific SAP.

Samples shall be wrapped and packaged to prevent cross contamination. Trip blank samples are provided by the laboratory for analysis to assess potential cross contamination.

Temperature Blank samples may be provided by the laboratory. These plastic bottles should remain in the bottom of the cooler. Do not wrap them in bubble wrap. If no temperature blanks are present upon receipt of the cooler(s), the lab will use an IR Temperature Gun to determine the sample's receipt temperature.

7.1 Restrictions/Limitations

Holding times for the sample analyses must not be exceeded. It is recommended that samples be packed in time to be shipped nightly for overnight delivery. If not, the samples should be shipped the next morning. Use caution when shipping samples for Saturday delivery; make arrangements by calling the laboratory before sending the samples.

8.0 REFERENCES

U.S. Environmental Protection Agency, *Sampler's Guide to the Contract Laboratory Program*, EPA 540-R-07-06, July 2007.

U.S. Environmental Protection Agency, Region IV, Field Sampling Quality Control, SESD PROC-01-R3, October 2010.

U.S. Army Corps of Engineer, EM 200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans*, February 2001.

STANDARD OPERATING PROCEDURE
INCREMENTAL SOIL SAMPLING

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) is field guidance for collecting incremental soil samples during remedial investigation (RI) activities at the Strother Field Formerly Used Defense Site Disposal Area Munitions Response Site (MRS), Kansas. The SOP assumes that sampling personnel have training and experience in soil sampling techniques.

Analysis of the incremental samples is for munitions constituents (MC), select metals and explosives associated with military munitions at the MRS, and pH (see **Section 6** of the Work Plan). Refer to **Section 6** for details of incremental soil sampling design and rationale.

2.0 EQUIPMENT

- Field logbook
- Indelible ink markers
- Scale
- Trimble GPS
- Terra Core® samplers or equivalent
- 1-2 gallon Ziploc bags or equivalent
- Disposable scoops or spoons
- Plastic sheeting/drop cloth
- Pens (blue or black)
- Eye protection
- Work gloves
- Surgical gloves
- Chain-of-custody forms
- Suitable carrying container (bucket, backpack, etc.)

3.0 PROCEDURE

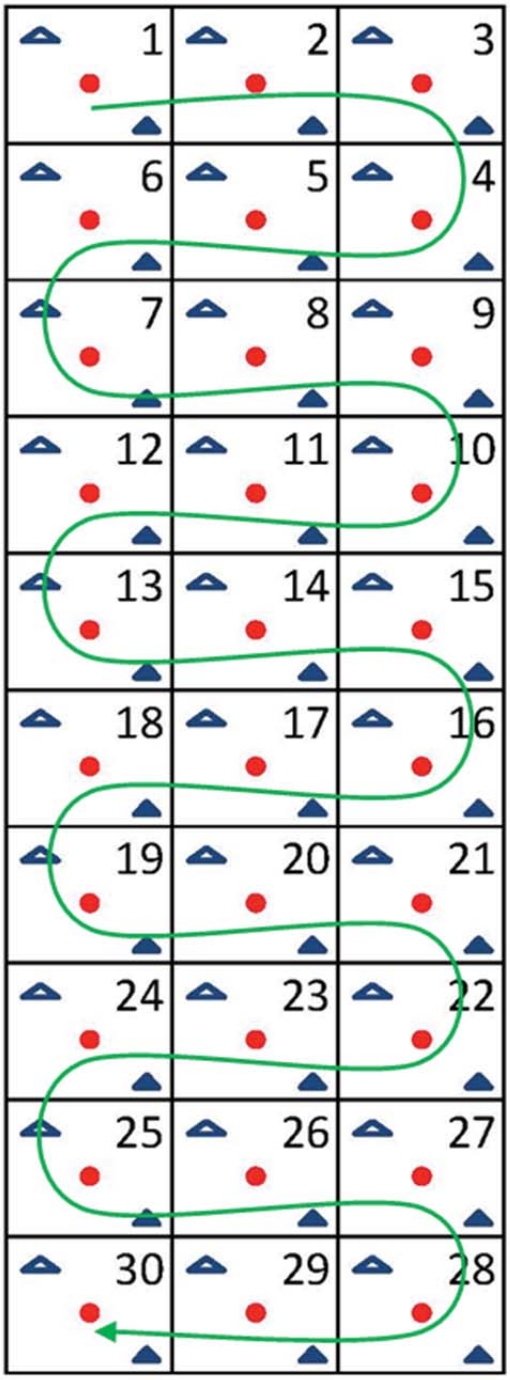
3.1 Sampling Locations

Because no potential risk from MC was identified based on the known munitions found at the MRS during the site inspection (SI) phase of investigation, environmental media samples are planned for collection during the RI in the event that a munitions and explosives of concern (MEC) burial pit is found or new, previously unidentified munitions are found with associated potential MC concerns. Therefore, sampling locations will be determined based on the results of RI MEC characterization (see **Section 6** of the Work Plan).

3.2 Sampling Scheme

See **Figure 1** for the sampling scheme including depth, increment sizes, sample weights, and collection pattern.

Figure 1: Field Sampling Scheme



● Field replicate 1 increment location
▲ Field replicate 2 increment location
△ Field replicate 3 increment location

1) Stake out areas of concern using pre-loaded submeter GPS.
2) Divide areas of concern into 0.25 or 0.50 acre decision units (DU) and mark the corners with flags, stakes, etc.
3) Using GPS, measuring tapes or any other accurate positioning method, demarcate the DUs into uniform cells and mark increment locations with flags using a systematic approach.
   a) Sampling unit design for 0.25 acres (~10,890 ft^2) and 30 increments. Increment size: 19.05 ft in a side.
   b) Sampling unit design for 0.50 acres (~ 21,780 ft^2) and 30 increments. Increment size: 26.94 ft in a side.
   c) A smaller 30 increment decision unit is acceptable when 0.25 or 0.50 acre DUs do not fill the AOC evenly.
4) Don new nitrile or vinyl gloves, and use new/ clean sampling equipment for each replicate collected within each DU.
5) Lay out drop cloth and sampling supplies.
6) Begin at Increment 1 (or other random starting location) and proceed sequentially using a serpentine pattern to traverse the DU.
7) Depth: 1-2 inches bgs
   a) Remove vegetation, debris, and top inch of soil with a clean, nonmetallic tool such as a plastic scoop or spoon.
8) Collect soil using a clean sampler (e.g., Terra Core® or other uniform collection device that is cylindrical in shape and sized appropriately to not limit sampled media based on grain size).
   a) It is not necessary to decontaminate the sampler between increments for a single replicate.
   b) A minimum of three field replicates should be collected from each DU.
9) Eject soil from sampler into Ziploc bag; ~33.3 grams/increment.
10) Weigh each core sample to ascertain the number required to make 33.3 grams. Once you know the number of cores, it is not necessary to weigh each increment.
11) Check weight of bag before completing a field replicate.
12) Mark bag with sample identification as specified in **Section 6**.
13) Record sample information in logbook (**Section 6**).
14) Preserve samples per **Appendix B (QAPP)**.
15) Ship samples per **Appendix B (QAPP)**..

4.0 DOCUMENTATION

Record the following information in the sampling logbook:

- Personnel present;
- Field conditions;
    - Air Temperature;
    - Wind speed/direction;
    - Precipitation/moisture;
    - Ambient odors;
    - Airborne dust;
    - Description of any exceptions to this SOP;
    - Sample number;
    - Sample method and equipment used;
    - Date and time of sample collection; and
    - List of samples sent to laboratory.

5.0 REFERENCES

Interstate Technology Regulatory Council (ITRC). 2012. *Incremental Sampling Methodology ISM-1*. Web-based guidance document dated February 2012. http://www.itrcweb.org/ism-1/

STANDARD OPERATING PROCEDURE
MPPEH MANAGEMENT

This Standard Operating Procedure (SOP) has been developed specifically for the Strother Field Formerly Used Defense Site (FUDS) Remedial Investigation (RI) at the Disposal Area Munitions Response Site (MRS)I. It describes procedures for the management of material potentially presenting an explosive hazard (MPPEH). It is intended for personnel trained in unexploded ordnance (UXO) procedures in accordance with (IAW) Department of Defense Explosives Safety Board (DDESB) Technical Paper 18.

The Senior UXO Supervisor (SUXOS) may modify these procedures as necessary with the approval of the UXO Safety Officer/Quality Control Specialist (UXOSO/QCS) as long as the modifications do not contradict the Accident Prevention Plan (APP).

MPPEH procedures must follow Department of Defense Instruction (DoDI) 4140.62, and Engineer Manual (EM) 385-1-97 Chapter I. MPPEH must be assessed and its explosives safety status determined and documented prior to transfer within the Department of Defense (DoD) or release from DoD control. Prior to release to the public, MPPEH must be documented by authorized and technically qualified personnel as material documented as safe (MDAS) after a 100% inspection and an independent 100% reinspection to determine that it is safe from an explosives safety perspective. This guide summarizes the procedures for managing MPPEH.

1.0 EQUIPMENT

- Personal Protective Equipment (boots, safety glasses, gloves, etc.);
- Roll-off containers;
- Communications device (radio, cellular phone);
- Drinking Water;
- Eyewash;
- Fire Extinguisher;
- First Aid Kit;
- Flashlight;
- Non sparking tools;
- Expray;
- Candle lighter;
- Logbook;
- Pens;
- Manifest; and
- 1348-1A.

2.0 SAFETY

Follow all applicable United States Army Corps of Engineers (USACE) and UXO safety precautions and regulations. The APP contains specific precautions.

3.0 INSPECTION PROCEDURES

Complete the inspections and verifications within the munitions response site (MRS).

All encountered material is initially classified as MPPEH. A UXO Technician II inspects the MPPEH when encountered and he UXO Technician III independently inspects and verifies each

item. At least one inspector must be a U.S. citizen IAW DoDI 4140.62. A UXO Technician I may tentatively identify an MPPEH item, but this must be confirmed by a UXO Technician II.

Visually inspect all items for the presence of energetic material. Use a test method, such as a flame test (EM 385-1-97) or colorimetric test (e.g., Expray™) to test any substance that you cannot positively identify as explosives. Check within targets, fencing, and other non-munition items to ensure that no munitions are concealed within them. Classify items with no explosives safety hazard as MDAS. If unable to positively assess an item as MDAS, then burn or detonate; see **Sections 4.0** and 5**.0**. Document this inspection in the team leader's logbook or on a form before removing it from the MRS.

Note that IAW EM 385-1-97, munitions and explosives of concern (MEC) may not be moved unless the risk has been evaluated by the SUXOS and UXOSO/QCS, and must be left in place until then.

MDAS includes munitions debris (MD), range related debris (RRD) or other debris (OD). In addition to explosives, inspect RRD for the presence of engine fluids, illuminating dials, and other visible liquid hazardous, toxic and radioactive waste (HTRW) materials. OD is debris that is not related to munitions or range operations such as discarded household items, fence wire, and even old cars as long as they were not used as targets.

OD will be left in-place for this RI. Store MDAS in 55-gallon drums, which are closed with tamper evident seals, until final disposition. Maintain seal integrity until final disposition. Assign a unique identifier to each container as follows: USACE/Installation/Site Name/Contractor's Name/0001/final seal number and continue sequentially.

4.0 VENTING

You may need to open the cases of some munitions to allow internal inspection and to preclude a mechanical detonation during later processing. If you suspect these munitions may contain energetic material, you must secure them in a location sited for the storage of explosives or guard them until venting. If the munitions do not contain energetic material you may keep them in any secure storage, such as your Conex, until venting.

5.0 MEC DISPOSAL

Perform all MEC and small arms ammunition disposal as outlined in Technical Manual 60A-1-1-31.

6.0 SUPERVISION BY SUXOS, UXOQCS AND UXOSO

The SUXOS is responsible for:

- Ensuring all inspections are done properly;
- Performing random inspections of inspected material;
- Certifying all MD and RRD for shipment; and
- Ensuring containers are properly sealed.

The UXOQCS is responsible for:

- Performing and documenting audits of MPPEH procedures;
- Performing random inspections of inspected material; and
- Verifying the MPPEH inspection process has been followed if the Ordnance Explosives Safety Specialist (OESS) is unavailable.

The UXOSO is responsible for:

- Ensuring all procedures are followed; and
- Ensuring all MPPEH procedures are being performed safely.

Nothing prohibits the SUXOS, UXOSO, UXOQCS from performing 100% reinspections of MDAS before signing the certification and verification forms.

7.0 DOCUMENTATION AND SHIPPING

Prepare a Department of Defense Form (DD Form) 1348-1A (it is a Department of Defense form, but it is specifically designated DD form, not DoD form; attached) to document the explosives safety status of the MDAS. A computer fillable copy of the 1348 is provided with the work plan or you may use a manual copy (Attached). The attached instructions are for manual or computer forms, but some instructions are obviously only for the computer version.

The SUXOS and OESS or UXOQCS (if delegated by the OESS) sign the form. A copy of this 1348-1A must accompany the MDAS shipment. Some method of tracking the transfer of custody must be used. Bay West has a standard manifest. Check that all job titles, signatures, weights and seal numbers on the 1348-1A and the manifest are identical. 1348s and manifests are available in DMS.

Use one of the following statements on the 1348.

For projects with RRD:

"This certifies that the material listed has been 100 percent properly inspected and, to the best of our knowledge and belief, is free of explosive hazards, engine fluids, illuminating dials and other visible liquid HTRWR materials."

For projects with only MD:

"This certifies and verifies that the material listed has been 100 percent inspected and to the best of our knowledge and belief, is inert and/or free of explosives or related materials."

Provide a copy of the 1348 to the transporter. This 1348 must accompany the shipment and the disposal facility must sign block 22 of the 1348 to acknowledge receipt. You should communicate this requirement to the processor. Also, seal one copy of the 1348 in the container, attach one to the exterior of the container, and file one suspense copy in the project record.

The disposal facility will send Bay West LLC (Bay West) the signed 1348-1a and a certificate of destruction, which is to be filed in the project record and included in the final report.

8.0 LESSONS FROM FIELD EXPERIENCE

These are practices that UXO Teams have found helpful. They are not to be construed as mandatory.

- At the grid, use buckets to segregate MDAS.
- The SUXOS and UXOQCS may receive the buckets of certified MDAS from the UXO Teams and put the material in its final containers.
- If you run out of seals, they are available from industrial suppliers such as Uline. Order them and charge them to the project.
- Have only one active container at a time, if possible. Exceptions may be multiple MRS or large containers for large MDAS items.

- Establish a log book dedicated to MDAS.
    - Record seals each time they are replaced.
    - Verify seal numbers before opening containers.
    - Record the date of each opening and closing.
- When a container is full, prepare the 1348-1a in at least 3 copies. At a minimum put:
    - 1 in container;
    - 1 on outside of container; and
    - 1 in project file.

ATTACHMENTS

Three Phase Inspection Checklist

Three Phase Quality Control Checklist
MPPEH Management

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

Item	Ref.	Inspection Point	Yes No N/A	Comments
1.	APP	Communications available and checked		
2.	APP	Daily safety meeting conducted by SUXOS/ UXOSO		
3.	Work Plan ESP	Inspection takes place within MRS		
4.	ESP	MPPEH evaluated before movement		
5.	EM 385-1-97	UXO team members conduct initial inspection and segregation of munitions and cultural debris		
6.	EM 385-1-97	UXO team leader conducts second inspection and segregation of munitions and cultural debris		
7.	DoDI 4140.62; TP -18	Inspectors are technically qualified to assess MPPEH. UXO TII or higher		
8.	DoDI 4140.62	At least one final MPPEH inspector is a U.S. Citizen		
9.	EM 385-1-97	SUXOS oversees the MPPEH inspection process		
10.	EM 385-1-97	UXOQCS conducts random inspections and observations of the MPPEH inspection		

Three Phase Quality Control Checklist
MPPEH Management

Team Information		
Team:	Location:	Date:
Personnel Present:		
Phase of Inspection (**Highlight** or Circle) Preparatory (P); Initial (I); Follow-up (F)		

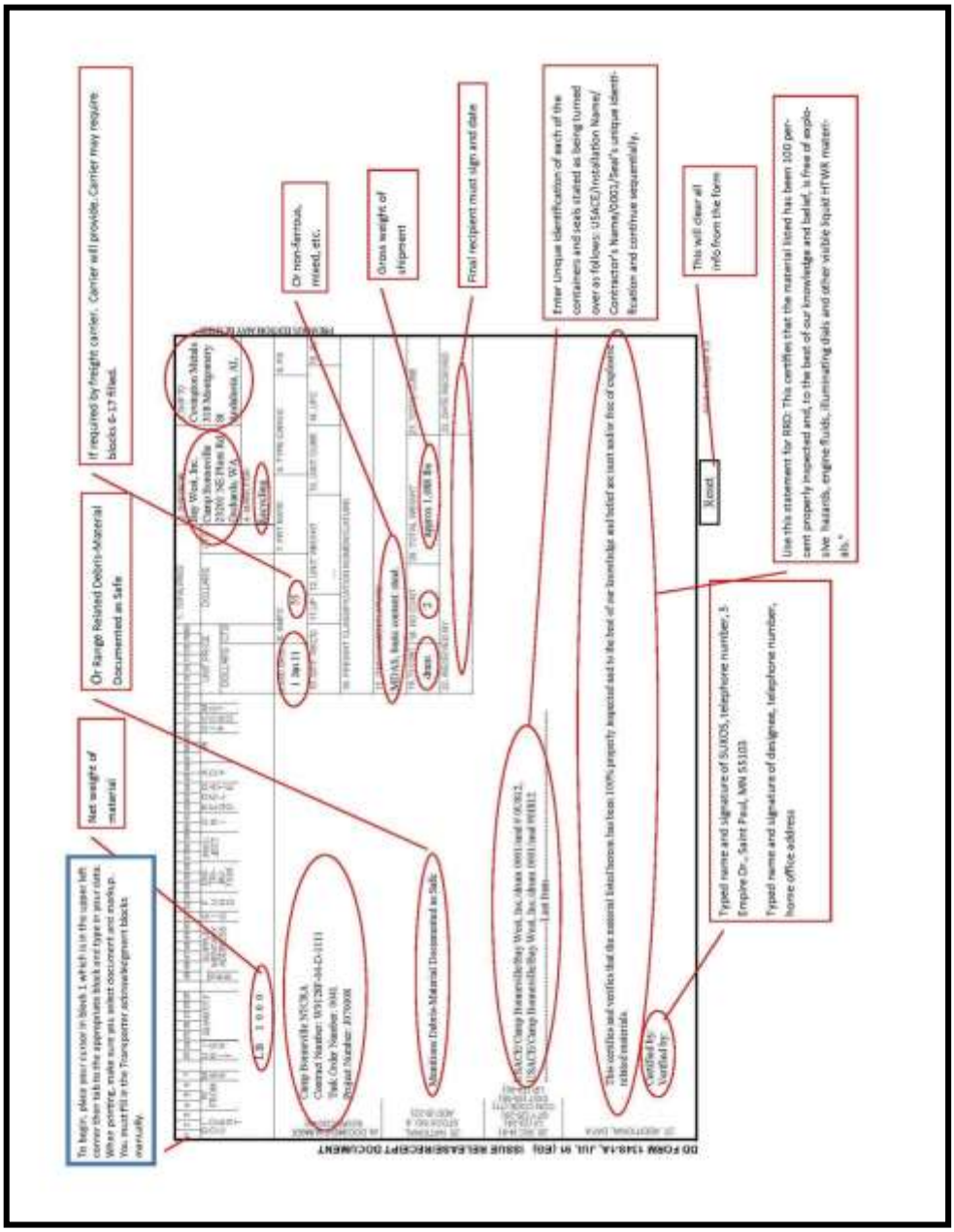
Item	Ref.	Inspection Point	Yes No N/A	Comments
		process		
11.	ESP	SUXOS and UXOSO determine if MEC is acceptable to move		
12.	EM 385-1-97	Munitions and cultural debris are properly inspected, segregated, and removed from the work zone		
13.	EM 385-1-97	MDAS is stored in containers with tamper-evident seals		
14.	ESP	MEC is marked for disposal in place or moved to a consolidation point		

Punch List	

Conducted By: _____

Acknowledged By: _____

Forms


To begin, place your cursor in block 1, which is in the upper left corner then tab to the appropriate block and type in your data. When printing, make sure you select document and markup. You must fill in the Transporter acknowledgment blocks manually.
Net weight of material
Or Range Related Debris-Material Documented as Safe
If required by freight carrier. Carrier will provide. Carrier may require blocks 6-17 filled.
Or non-ferrous, mixed, etc.
Gross weight of shipment
Final recipient must sign and date
Enter Unique identification of each of the containers and seals stated as being turned over as follows: USACE/Installation Name/ Contractor's Name/0001/Seal's unique identification and continue sequentially.
This will clear all info from the form
Use this statement for RRD: "This certifies that the material listed has been 100 percent properly inspected and, to the best of our knowledge and belief, is free of explosive hazards, engine fluids, illuminating dials and other visible liquid HTWR materials."
Typed name and signature of SUXOS, telephone number, 3. Empire Dr., Saint Paul, MN 55103
Typed name and signature of designee, telephone number, home office address
Reset
DD FORM 1348-1A, JUL 91 (ISSUE RELEASE/RECEIPT DOCUMENT)

Bay West, Inc.
Munitions Debris Demilitarization Certification and Manifest

18000

GENERAL

1. Generator's Name and Mailing Address – Generator is the installation	1a. Generator's Phone #
2. Generator's Project Location –	2a. Project Phone #
3. Transporter 1 Name and Mailing Address –	3a. Transporter 1 phone #
4. Transporter 2 Name and Mailing Address	4a. Transporter 2 phone # ( )
Qualified Recycler (QR) Name and Mailing Address – Timberline Environmental Services,	5a. QR phone #
	5b. QR Identification # | | | | | | |

Inspection/Certification/Demil

6. Security Seal #s	7. Gross Wt. Lbs	8. Tare Wt. Lbs/Kgs	9. Net Wt. Lbs/Kgs	10. Weight Ticket #

11. Description	12. Material	13. Quantity	14. Units (Wt., Vol)
Munitions Debris Material Documented As Safe (MDAS)	Scrap Metal		

INERT CERTIFICATION

Each item of Material Potentially Presenting An Explosive Hazard (MPPEH) has been inspected and is Material Documented As Safe (MDAS).

15. Inspector 1		
Printed/Typed Name	Signature	Month Day Year | | | | | |
16. Inspector 2		
Printed/Typed Name	Signature	Month Day Year | | | | | |

DEMILITERIZATION CERTIFICATION

I certify that each item or items listed hereon were demilitarized in accordance with DoD 4160.21-M-1 and other applicable regulations.

17. Demil Certified By:		
Printed/Typed Name	Signature	Month Day Year | | | | | |
18. Demil Verified By:		
Printed/Typed Name	Signature	Month Day Year | | | | | |

TRANSPORTER

19. Transporter 1 Acknowledgement of Receipt of Materials		
Printed/Typed Name	Signature	Month Day Year | | | | | |
20. Transporter 2 Acknowledgement of Receipt of Materials		
Printed/Typed Name	Signature	Month Day Year | | | | | |

QUALIFIED RECYCLER

21. Discrepancy Indication Space

22. Qualified Recycler Acknowledgement of Receipt of Materials		
Printed/Typed Name	Signature	Month Day Year | | | | | |

23. Qualified Recycler Certification of Consumption	**25. Final Disposition of Material**	
Printed/Typed Name	Signature	Month Day Year | | | | | |

Appendix E

Contractor Personnel Qualification Letters

(provided upon mobilization)

Appendix F

Correspondence

Bay West
Customer-Focused Environmental & Industrial Solutions

May 20, 2016

United States Fish and Wildlife Service
Kansas Ecological Services Office
ATTN: Jason Luginbill
2609 Anderson Avenue
Manhattan, KS 66503

RE: Remedial Investigation Activities
Strother Field FUDS, Kansas
FUDS Property/Project No.: B07KS0277/B07KS027703

Mr. Luginbill,

The U.S. Army Corps of Engineers is performing a Remedial Investigation (RI) to determine if further action is warranted under the Comprehensive Environmental Response, Compensation, and Liability Act to address potential explosive hazards and associated munition constituents risks to human and ecological receptors at the Disposal Area Munitions Response Site (MRS) located at the Strother Field Formerly Used Defense Site (FUDS) in Cowley County, Kansas. Figures depicting the FUDS in Winfield and Arkansas City, and the MRS location within the FUDS are attached for your reference.

Previous field investigations at the FUDS include the Site Inspection performed in 2009. At that time, the United States Fish and Wildlife Service (USFWS) and the Kansas Department of Wildlife, Parks and Tourism (KDWPT) were contacted regarding planned activities and the potential for encountering threatened and/or endangered species at the MRS. At that time, no objections to the planned field activities were identified by USFWS or KDWPT, no listed species were identified for the FUDS, and no other state permits were identified as relevant to the work performed.

Similar to that effort, this letter is being sent to describe the activities planned for the RI to determine if there is a change in these conditions.

To determine the nature and extent of munitions and explosives of concern (MEC) within the 28.3-acre MRS, planned field activities for RI characterization include the following:

- A surface clearance where geophysical investigations are planned;
- Digital geophysical mapping (DGM) data collection using both a towed array (3-coil electromagnetic sensor approximately 3 meters in width), and a man-portable system (single-coil electromagnetic sensor approximately 1 meter in width);
- Intrusive investigation of selected anomalies from the DGM data using hand tools to the greatest extent practical and heavy equipment if necessary (i.e., if a burial pit is found or deep contact anomalies are suspected);
- Analog detector surveys with intrusive investigation of anomalies discovered along the Posey Creek area;
- Demilitarization/demolition of any suspected MEC encountered;
- Offsite disposal of munition debris following a determination that it is safe: and,

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Customer-Focused Environmental & Industrial Solutions

- Environmental sampling of soil, surface water and sediment if a burial pit is encountered or if a different type of munition determined to be MEC is found that has not been previously identified and evaluated at the MRS.

A figure depicting the planned geophysical investigation where work will be performed is also attached to this letter for your reference, in addition to the Corps' Important Ecological Places (IEP) forms provided to assist you during your review. Please return the completed IEP checklists with your response.

Thank you for your time and assistance. If you have any questions, please feel free to contact myself via the contact information below, or Mr. Kurt Baer, Project Manager, U.S. Army Corps of Engineers, Kansas City District, kurt.h.baer@usace.army.mil or 816-389-3922.

Cordially,

Bay West LLC

Marie Swiech-Laflamme, PG
Senior Geologist/Project Manager
609-232-8026
mlaflamme@baywest.com

Att: FUDS Location Figure
MRS Location Figure
Planned Geophysical Investigation
IEP Checklist forms

CC: Kurt Baer, USACE Kansas City
Brandon Sellers, USACE Omaha

BWJ150506

Bay West LLC • Five Empire Drive • Saint Paul, MN • 55103-1856

Figure 1-1

Strother Field Location Map

Strother Field FUDS
Cowley County, Kansas
FUDS Property No. B07KS0277

Coordinate System: NAD 1983 UTM Zone 14N
Basemap: National Geographic Society, i-cubed

0 10,000 20,000 Feet
0 3,000 6,000 Meters
1 inch = 8,506 feet

Strother Field FUDS - Installation Boundary

Drawn By: S.G. Date Drawn/Revised: 5/11/2016 Project No. J150506

Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_OMAHA\Strother_Field\MapDocs\J150506 FIG 1-1 Strother Field Location Map.mxd

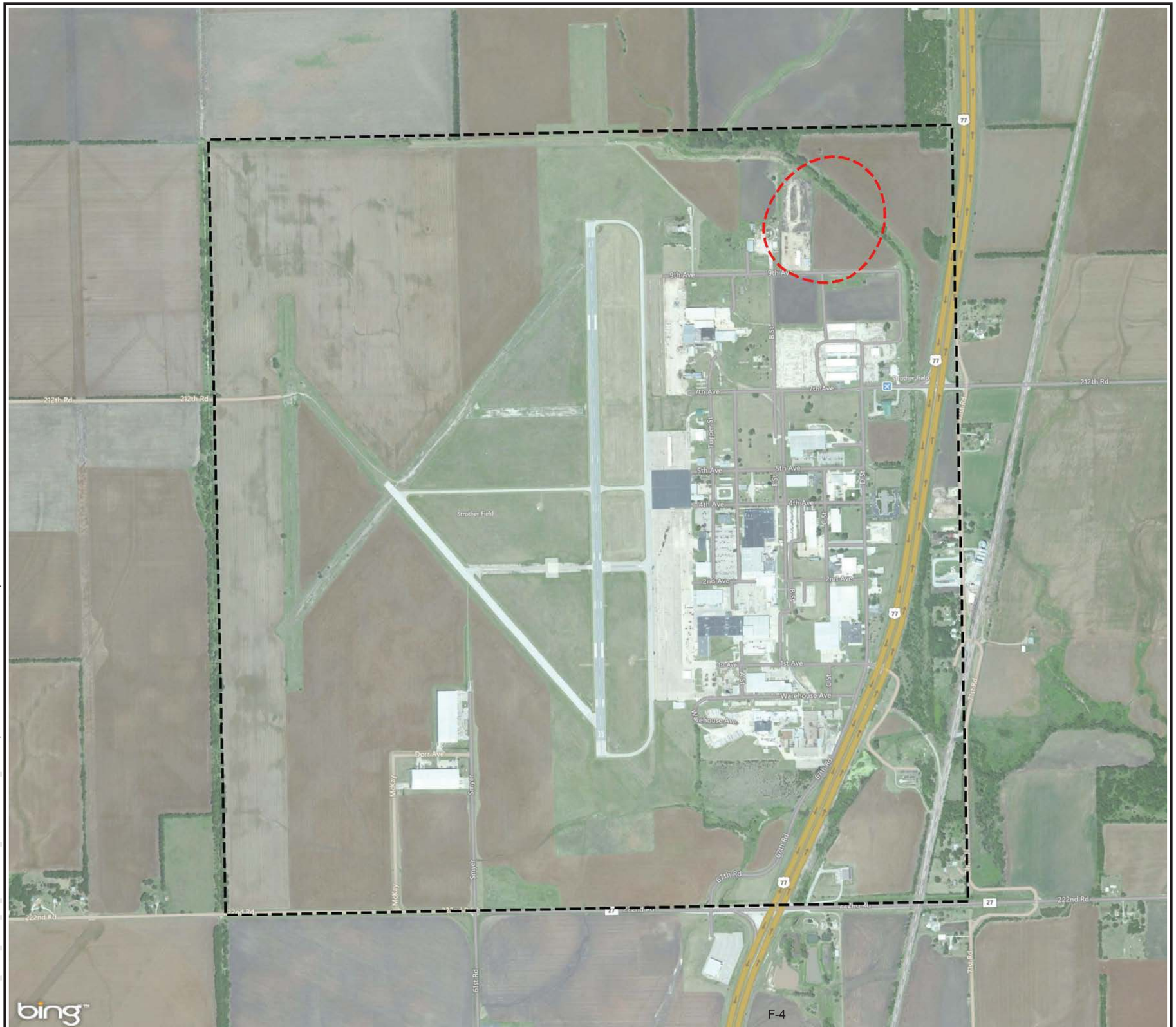
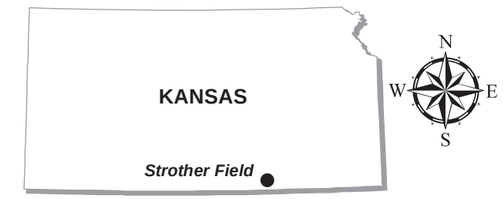


Figure 1-2

Strother Field Disposal Area MRS Location Map

Strother Field FUDS
Cowley County, Kansas
FUDS Property No. B07KS0277



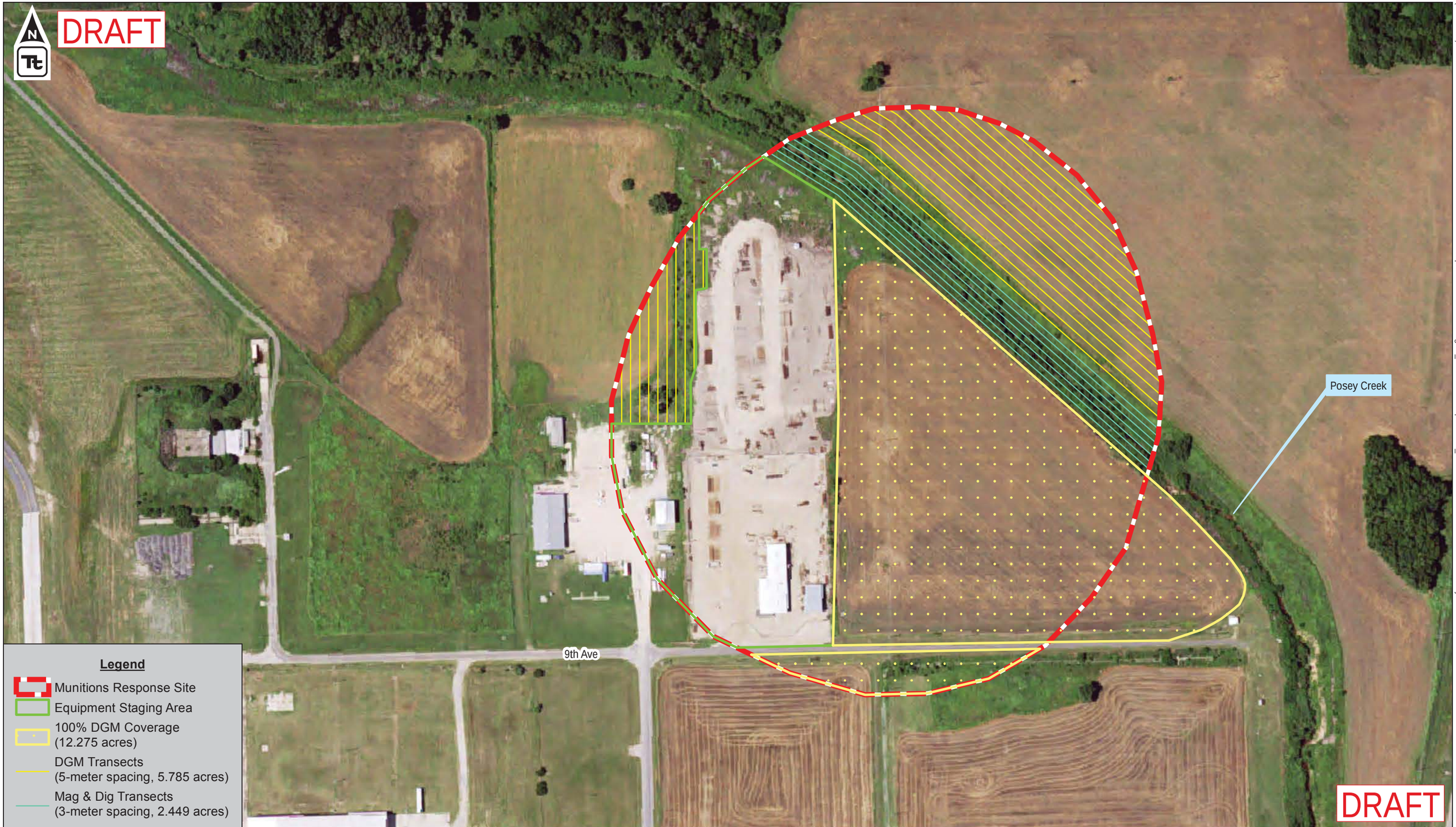
Coordinate System: NAD 1983 UTM Zone 14N
Basemap: Bing Aerial Imagery WMS

0 1,000 2,000 Feet
0 300 600 Meters
1 inch = 1,000 feet

Disposal Area MRS Boundary
Strother Field FUDS - Installation Boundary

Drawn By: S.G. Date Drawn/Revised: 12/23/2015 Project No. J150506

Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_OMAHA\Strother_Field\MapDocs\J150506 FIG 1-2 Munitions Response Site Location.mxd



1 INCH = 200 FEET (SCALE AT 17" X 11")

SCALE IN FEET

0 200 400

WGS 1984 UTM ZONE 14N METERS

NOTES:
1) Imagery from the USDA National Agriculture Imagery Program (NAIP), 1-m resolution, 2015, via the ArcGIS Image Server.

DEFINITIONS:
DGM = Digital Geophysical Mapping
MAG = Analog All-Metals Detector
MRS = Munitions Response Site

PREPARED FOR:
US Army Corps of Engineers®
Omaha District

PREPARED BY:

TITLE:
REMEDIAL INVESTIGATION GEOPHYSICAL SURVEY PLAN
STROTHER FIELD FUDS (PROPERTY NO. B07KS0277)

A REVISION

PROJECT: DISPOSAL AREA MRS

PROJECT NO.: 106-46690002

LOCATION: COWLEY COUNTY, KANSAS

DATE: 04/2016

FIGURE: Figure 1-3

(\\tts153fs1) P:\USACE Northwestern DIV\Omaha District\Strother Field Disposal Area\GIS\MXD\Fig7-4_StrotherFieldDisposalArea_MRS.mxd 2016/04/22: Tetra Tech ECI / jeff.dahoda

Checklist for Important Ecological Places (IEP)

Item	Ecological Place	Relevant for this MRS?	Comments
1	Locally important ecological place identified by the Integrated Natural Resource Management Plan, BRAC Cleanup Plan or Redevelopment Plan, or other official land management plans.		
2	Critical habitat for Federal designated endangered or threatened species.		
3	Marine Sanctuary.		
4	National Park.		
5	Designated Federal Wilderness Area.		
6	Areas identified under the Coastal Zone Management Act.		
7	Sensitive Areas identified under the national estuary program or near coastal waters program.		
8	Critical areas identified under the clean lakes program.		
9	National monument.		
10	National seashore recreational area.		
11	National lakeshore recreational area.		
12	Habitat known to be used by federal designated or proposed endangered or threatened species.		
13	National preserve.		
14	National or state wildlife refuge.		
15	Unit of coastal barrier resources system.		
16	Coastal barrier (undeveloped).		
17	Federal land designated for protection of natural ecosystems.		
18	Administratively proposed federal wilderness area.		
19	Spawning areas critical for the maintenance of fish/shellfish species within river, lake, or coastal tidal waters.		
20	Migratory pathways and feeding areas critical for maintenance of anadromous fish species within river reaches or areas in lakes or coastal tidal waters in which fish spend extended periods of time.		

21	Terrestrial areas utilized for breeding by large or dense aggregations of animals.		
22	National river reach designated as recreational.		
23	Habitat known to be used by state designated endangered or threatened species.		
24	Habitat known to be used by species under review as to its Federal endangered or threatened status.		
25	Coastal Barrier (partially developed).		
26	Federally-designated scenic or wild river.		
27	State land designated for wildlife or game management.		
28	State-designated scenic or wild river.		
29	State-designated Natural Areas.		
30	Particular areas, relatively small in size, important to maintenance of unique biotic communities.		
31	State-designated areas for protection or maintenance of aquatic life.		
32	Wetlands		
33	Fragile landscapes, land sensitive to degradation if vegetative habitat or cover diminishes.		

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Kansas Ecological Services Field Office
2609 Anderson Avenue
Manhattan, Kansas 66502

June 22, 2016

Marie Swiech-LaFlamme, PG
Geologist/Project Manager
Bay West LLC
Five Empire Drive
Saint Paul, MN 55103-1856

RE: Strother Field FUDS, Kansas FWS Tracking # 2016-CPA-0732

Dear Ms. Swiech-LaFlamme:

This is in response to your letter dated May 20, 2016, requesting comment on the proposed Remedial Investigation to determine if further action is warranted under the Comprehensive Environmental Response, Compensation and Liability Act to address potential explosive hazards and associated munition constituents risk to human and ecological receptors at the Disposal Area Munitions Site (FUDS) in Cowley County, Kansas.

Based on review of the proposed action and the land uses on site, I conclude that no federally-threatened or endangered species are likely to be present in the project area.

The Migratory Bird Treaty Act prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. Takings could result from projects in prairies, wetlands, stream and woodland habitats, and those that occur on bridges and other structures if swallow or phoebe nests are present. While the provisions of MBTA are applicable year-round, most migratory bird nesting activity in Kansas occurs during the period of April 1 to July 15. However, some migratory birds are known to nest earlier than this (e.g., hawks and owls) and some later (e.g., goldfinches). If the proposed project appears likely to result in the take of migratory birds, I recommend a field survey during the nesting season of the affected habitats and structures to determine the presence of active nests. Our office should be contacted immediately for further guidance if a field survey identifies the existence of one or more active bird nests that you believe cannot be avoided temporally or spatially by the planned activities.

While the MBTA has no provision for allowing unauthorized take, the USFWS realizes that some birds may be killed during project construction and implementation even if all reasonable measures to protect them are used. The USFWS Office of Law Enforcement carries out its mission to protect migratory birds through investigations and enforcement, as well as by fostering relationships with individuals, companies, and industries that have taken effective steps to minimize their impacts on migratory birds, and by encouraging others to enact such programs.

It is not possible to absolve individuals, companies, or agencies from liability even if they implement avian mortality avoidance or similar conservation measures. However, the Office of Law Enforcement focuses its resources on investigating and prosecuting individuals and companies that take migratory birds without regard for their actions or without following recommendations to avoid take.

Thank you for this opportunity to comment on the proposal. If we can be of any further assistance, please call Ms. Michele McNulty, of this office, at 785-539-3474 ext. 106.

Sincerely,

for Michele McNulty

Jason Luginbill
Field Supervisor

cc: KDWPT, Pratt, KS (Ecological Services)

Checklist for Important Ecological Places (IEP)

Item	Ecological Place	Relevant for this MRS?	Comments
1	Locally important ecological place identified by the Integrated Natural Resource Management Plan, BRAC Cleanup Plan or Redevelopment Plan, or other official land management plans.		
2	Critical habitat for Federal designated endangered or threatened species.		
3	Marine Sanctuary.		
4	National Park.		
5	Designated Federal Wilderness Area.		
6	Areas identified under the Coastal Zone Management Act.		
7	Sensitive Areas identified under the national estuary program or near coastal waters program.		
8	Critical areas identified under the clean lakes program.		
9	National monument.		
10	National seashore recreational area.		
11	National lakeshore recreational area.		
12	Habitat known to be used by federal designated or proposed endangered or threatened species.		
13	National preserve.		
14	National or state wildlife refuge.		
15	Unit of coastal barrier resources system.		
16	Coastal barrier (undeveloped).		
17	Federal land designated for protection of natural ecosystems.		
18	Administratively proposed federal wilderness area.		
19	Spawning areas critical for the maintenance of fish/shellfish species within river, lake, or coastal tidal waters.		
20	Migratory pathways and feeding areas critical for maintenance of anadromous fish species within river reaches or areas in lakes or coastal tidal waters in which fish spend extended periods of time.		

Checklist for Important Ecological Places (IEP)

21	Terrestrial areas utilized for breeding by large or dense aggregations of animals.		
22	National river reach designated as recreational.		
23	Habitat known to be used by state designated endangered or threatened species.		
24	Habitat known to be used by species under review as to its Federal endangered or threatened status.	✓	Northern long-eared bat, Tri-colored bat
25	Coastal Barrier (partially developed).		
26	Federally-designated scenic or wild river.		
27	State land designated for wildlife or game management.		
28	State-designated scenic or wild river.		
29	State-designated Natural Areas.		
30	Particular areas, relatively small in size, important to maintenance of unique biotic communities.		
31	State-designated areas for protection or maintenance of aquatic life.		
32	Wetlands	✓	Riparian
33	Fragile landscapes, land sensitive to degradation if vegetative habitat or cover diminishes.		

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May 20, 2016

Kansas Department of Wildlife, Parks and Tourism
Environmental Services Section
ATTN: Emma Foltz
512 SE 25th Ave.
Pratt, KS 67124

RE: Remedial Investigation Activities
Strother Field FUDS, Kansas
FUDS Property/Project No.: B07KS0277/B07KS027703

Ms. Foltz,

The U.S. Army Corps of Engineers is performing a Remedial Investigation (RI) to determine if further action is warranted under the Comprehensive Environmental Response, Compensation, and Liability Act to address potential explosive hazards and associated munition constituents risks to human and ecological receptors at the Disposal Area Munitions Response Site (MRS) located at the Strother Field Formerly Used Defense Site (FUDS) in Cowley County, Kansas. Figures depicting the FUDS in Winfield and Arkansas City, and the MRS location within the FUDS are attached for your reference.

Previous field investigations at the FUDS include the Site Inspection performed in 2009. At that time, the United States Fish and Wildlife Service (USFWS) and the Kansas Department of Wildlife, Parks and Tourism (KDWPT) were contacted regarding planned activities and the potential for encountering threatened and/or endangered species at the MRS. At that time, no objections to the planned field activities were identified by USFWS or KDWPT, no listed species were identified for the FUDS, and no other state permits were identified as relevant to the work performed.

Similar to that effort, this letter is being sent to describe the activities planned for the RI to determine if there is a change in these conditions.

To determine the nature and extent of munitions and explosives of concern (MEC) within the 28.3-acre MRS, planned field activities for RI characterization include the following:

- A surface clearance where geophysical investigations are planned;
- Digital geophysical mapping (DGM) data collection using both a towed array (3-coil electromagnetic sensor approximately 3 meters in width), and a man-portable system (single-coil electromagnetic sensor approximately 1 meter in width);
- Intrusive investigation of selected anomalies from the DGM data using hand tools to the greatest extent practical and heavy equipment if necessary (i.e., if a burial pit is found or deep contact anomalies are suspected);
- Analog detector surveys with intrusive investigation (aka, mag & dig) of anomalies discovered along the Posey Creek area;
- Demilitarization/demolition of any suspected MEC encountered;
- Offsite disposal of munition debris following a determination that it is safe: and,

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- Environmental sampling of soil, surface water and sediment if a burial pit is encountered or if a different type of munition determined to be MEC is found that has not been previously identified and evaluated at the MRS.

A figure depicting the planned geophysical investigation where work will be performed is also attached to this letter for your reference, in addition to the Corps' Important Ecological Places (IEP) forms provided to assist you during your review. Please return the completed IEP checklists with your response.

Thank you for your time and assistance. If you have any questions, please feel free to contact myself via the contact information below, or Mr. Kurt Baer, Project Manager, U.S. Army Corps of Engineers, Kansas City District, kurt.h.baer@usace.army.mil or 816-389-3922.

Cordially,

Bay West LLC

Marie Swiech-Laflamme, PG
Senior Geologist/Project Manager
609-232-8026
mlaflamme@baywest.com

Att: FUDS Location Figure
MRS Location Figure
Planned Geophysical Investigation
IEP Checklist forms

CC: Kurt Baer, USACE Kansas City
Brandon Sellers, USACE Omaha

BWJ150506

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Figure 1-1

Strother Field Location Map

Strother Field FUDS
Cowley County, Kansas
FUDS Property No. B07KS0277

Coordinate System: NAD 1983 UTM Zone 14N
Basemap: National Geographic Society, i-cubed

0 10,000 20,000 Feet
0 3,000 6,000 Meters
1 inch = 8,506 feet

Strother Field FUDS - Installation Boundary

Drawn By: S.G. Date Drawn/Revised: 5/11/2016 Project No. J150506

Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_OMAHA\Strother_Field\MapDocs\J150506 FIG 1-1 Strother Field Location Map.mxd

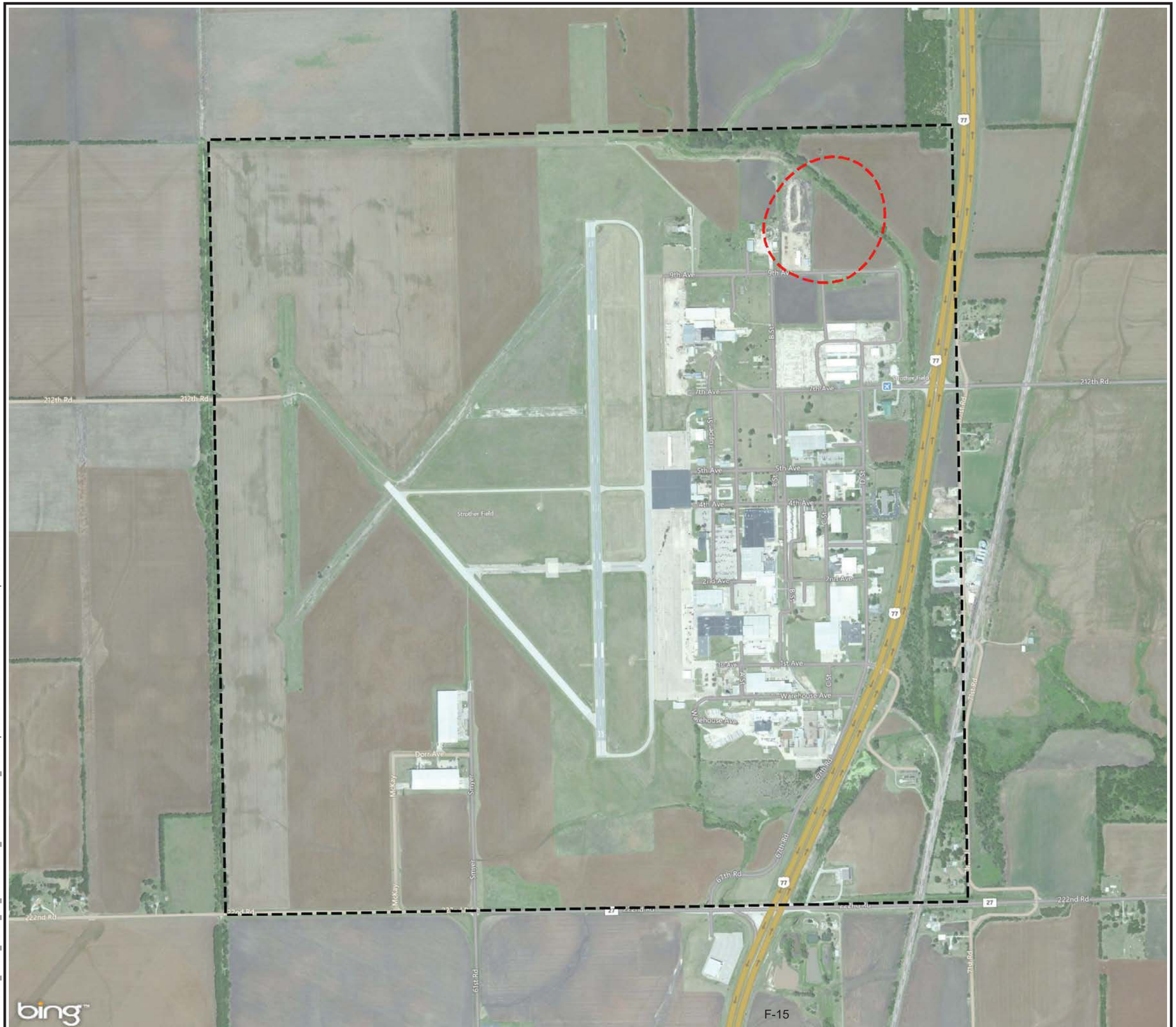
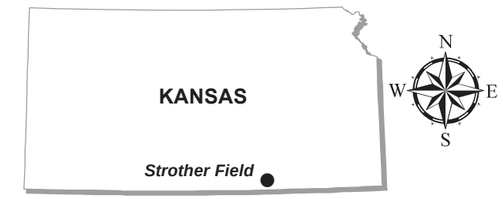


Figure 1-2

Strother Field Disposal Area MRS Location Map

Strother Field FUDS
Cowley County, Kansas
FUDS Property No. B07KS0277



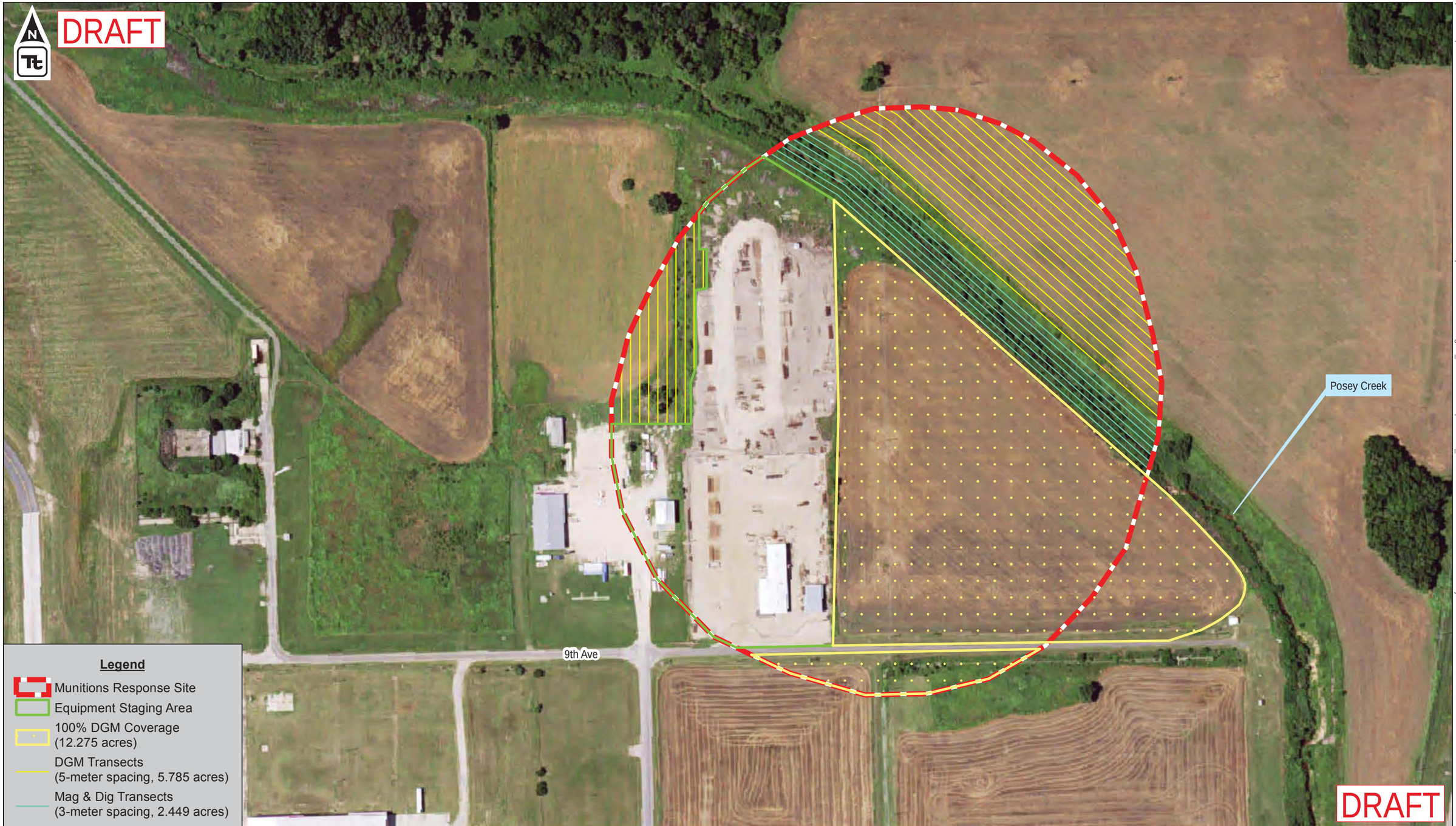
Coordinate System: NAD 1983 UTM Zone 14N
Basemap: Bing Aerial Imagery WMS

0 1,000 2,000 Feet
0 300 600 Meters
1 inch = 1,000 feet

Disposal Area MRS Boundary
Strother Field FUDS - Installation Boundary

Drawn By: S.G. Date Drawn/Revised: 12/23/2015 Project No. J150506

Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_OMAHA\Strother_Field\MapDocs\J150506 FIG 1-2 Munitions Response Site Location.mxd



1 INCH = 200 FEET (SCALE AT 17" X 11")

SCALE IN FEET

0 200 400

WGS 1984 UTM ZONE 14N METERS

NOTES:
1) Imagery from the USDA National Agriculture Imagery Program (NAIP), 1-m resolution, 2015, via the ArcGIS Image Server.

DEFINITIONS:
DGM = Digital Geophysical Mapping
MAG = Analog All-Metals Detector
MRS = Munitions Response Site

PREPARED FOR:
US Army Corps of Engineers®
Omaha District

PREPARED BY:

TITLE:
REMEDIAL INVESTIGATION GEOPHYSICAL SURVEY PLAN
STROTHER FIELD FUDS (PROPERTY NO. B07KS0277)

A
REVISION

PROJECT: DISPOSAL AREA MRS

PROJECT NO.: 106-46690002

LOCATION: COWLEY COUNTY, KANSAS

DATE: 04/2016

FIGURE: **Figure 1-3**

(\\tts153fs1) P:\USACE Northwestern DIV\Omaha District\Strother Field Disposal Area\GIS\MXD\Fig7-4_StrotherFieldDisposalArea_MRS.mxd 2016/04/22: Tetra Tech ECI / jeff.dahoda

Checklist for Important Ecological Places (IEP)

Item	Ecological Place	Relevant for this MRS?	Comments
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25	Coastal Barrier (partially developed).		
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31	State-designated areas for protection or maintenance of aquatic life.		
32	Wetlands		
33	Fragile landscapes, land sensitive to degradation if vegetative habitat or cover diminishes.		

Marie Swiech-Laflamme

From: Riedle, Daren <daren.riedle@ksoutdoors.com>
Sent: Thursday, June 02, 2016 5:29 PM
To: Marie Swiech-Laflamme
Subject: KDWPT Project Review Remedial Investigation (KDWPT# 20080636-2)

Ms. Swiech-Laflamme,

The referenced project Remedial Investigation at the Strother Field Formerly Used Defense Site was reviewed for potential impacts on crucial wildlife habitats, current State-listed Threatened and Endangered Species and Species in Need of Conservation (SINC), and Kansas Department of Wildlife, Parks and Tourism managed areas for which this agency has administrative authority.

Results of our review indicate there will be no significant impacts to crucial wildlife habitats; therefore, no special mitigation measures are recommended. The project will not impact any public recreational areas, nor could we document any potential impacts to currently-listed Threatened or Endangered species or SINC. No Department of Wildlife, Parks and Tourism permits or special authorizations will be needed if construction is started within one year, and no design changes are made in the project plans.

We provide the following general recommendations as applicable:

- **Incorporate principles of low impact development (LID), such as permeable asphalt pavement, porous concrete, swales, bioretention, or raingardens. More info. on LID:** http://www.epa.gov/owow/NPS/lid/

- **Implement and maintain standard erosion-control Best-Management-Practices during all aspects of construction by installing sediment barriers (wattles, filter logs, rock ditch checks, mulching, or any combination of these) across the entire construction area to prevent sediment and spoil from entering aquatic systems. Barriers should be maintained at high functioning capacity until construction is completed and vegetation is established. For more information go to: http://www.kdheks.gov/stormwater/#construct**

- **Reseed disturbed areas with native warm-season grasses, forbs, and trees**

Since the Department's recreational land obligations and the State's species listings periodically change, if construction has not started within one year of this date, or if design changes are made in the project plans, the project sponsor must contact this office to verify continued applicability of this assessment report. For our purposes, we consider construction started when advertisements for bids are distributed.

Consider this email our official project review. Contact me with any questions.

Daren Riedle

--
J. Daren Riedle, Ecologist
Ecological Services
Kansas Dept. of Wildlife, Parks, and Tourism
512 SE 25th Ave
Pratt, KS 67124
office: 620-672-0746
cell: 620-770-6628
fax: 620-672-2972

Bay West
Customer-Focused Environmental & Industrial Solutions

May 20, 2016

Kansas State Historical Society
ATTN: Jennie Chinn
6425 SW Sixth Avenue
Topeka, KS 66615

RE: Remedial Investigation Activities
Strother Field FUDS, Kansas
FUDS Property/Project No.: B07KS0277/B07KS027703

Ms. Chinn,

The U.S. Army Corps of Engineers is performing a Remedial Investigation (RI) to determine if further action is warranted under the Comprehensive Environmental Response, Compensation, and Liability Act to address potential explosive hazards and associated munition constituents risks to human and ecological receptors at the Disposal Area Munitions Response Site (MRS) located at the Strother Field Formerly Used Defense Site (FUDS) in Cowley County, Kansas. Figures depicting the FUDS in Winfield and Arkansas City, and the MRS location within the FUDS are attached for your reference.

Previous field investigations at the FUDS include the Site Inspection performed in 2009. At that time, inquiry with the Kansas State Historical Society was made regarding planned activities and the potential for encountering cultural resources at the MRS. At that time, no objections to the planned field activities were identified (reference: **KSR&C No. 09-02-143**).

Similar to that effort, this letter is being sent to describe the activities planned for the RI to determine if there has been any changes to the status of identified cultural resources in accordance with 36 CFR 800 for Section 106, and if RI activities may impact those resources, if present.

To determine the nature and extent of munitions and explosives of concern (MEC) within the 28.3-acre MRS, planned field activities for RI characterization include the following:

- A surface clearance where geophysical investigations are planned;
- Digital geophysical mapping (DGM) data collection using both a towed array (3-coil electromagnetic sensor approximately 3 meters in width), and a man-portable system (single-coil electromagnetic sensor approximately 1 meter in width);
- Intrusive investigation of selected anomalies from the DGM data using hand tools to the greatest extent practical and heavy equipment if necessary (i.e., if a burial pit is found or deep contact anomalies are suspected);
- Analog detector surveys with intrusive investigation of anomalies discovered along the Posey Creek area;
- Demilitarization/demolition of any suspected MEC encountered;
- Offsite disposal of munition debris following a determination that it is safe: and,
- Environmental sampling of soil, surface water and sediment if a burial pit is encountered or if a different type of munition determined to be MEC is found that has not been previously identified and evaluated at the MRS.

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A figure depicting the planned geophysical investigation where work will be performed is also attached to this letter for your reference.

Thank you for your time and assistance. If you have any questions, please feel free to contact myself via the contact information below, or Mr. Kurt Baer, Project Manager, U.S. Army Corps of Engineers, Kansas City District, kurt.h.baer@usace.army.mil or 816-389-3922.

Cordially,

Bay West LLC

Marie Swiech-Laflamme, PG
Senior Geologist/Project Manager
609-232-8026
mlaflamme@baywest.com

Att: FUDS Location Figure
MRS Location Figure
RI Geophysical Survey Plan Figure

CC: Kurt Baer, USACE Kansas City
Brandon Sellers, USACE Omaha

BWJ150506

Bay West LLC • Five Empire Drive • Saint Paul, MN • 55103-1856

Figure 1-1

Strother Field Location Map

Strother Field FUDS
Cowley County, Kansas
FUDS Property No. B07KS0277

Coordinate System: NAD 1983 UTM Zone 14N
Basemap: National Geographic Society, i-cubed

0 10,000 20,000 Feet
0 3,000 6,000 Meters
1 inch = 8,506 feet

Strother Field FUDS - Installation Boundary

Drawn By: S.G. Date Drawn/Revised: 5/11/2016 Project No. J150506

Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_OMAHA\Strother_Field\MapDocs\J150506 FIG 1-1 Strother Field Location Map.mxd

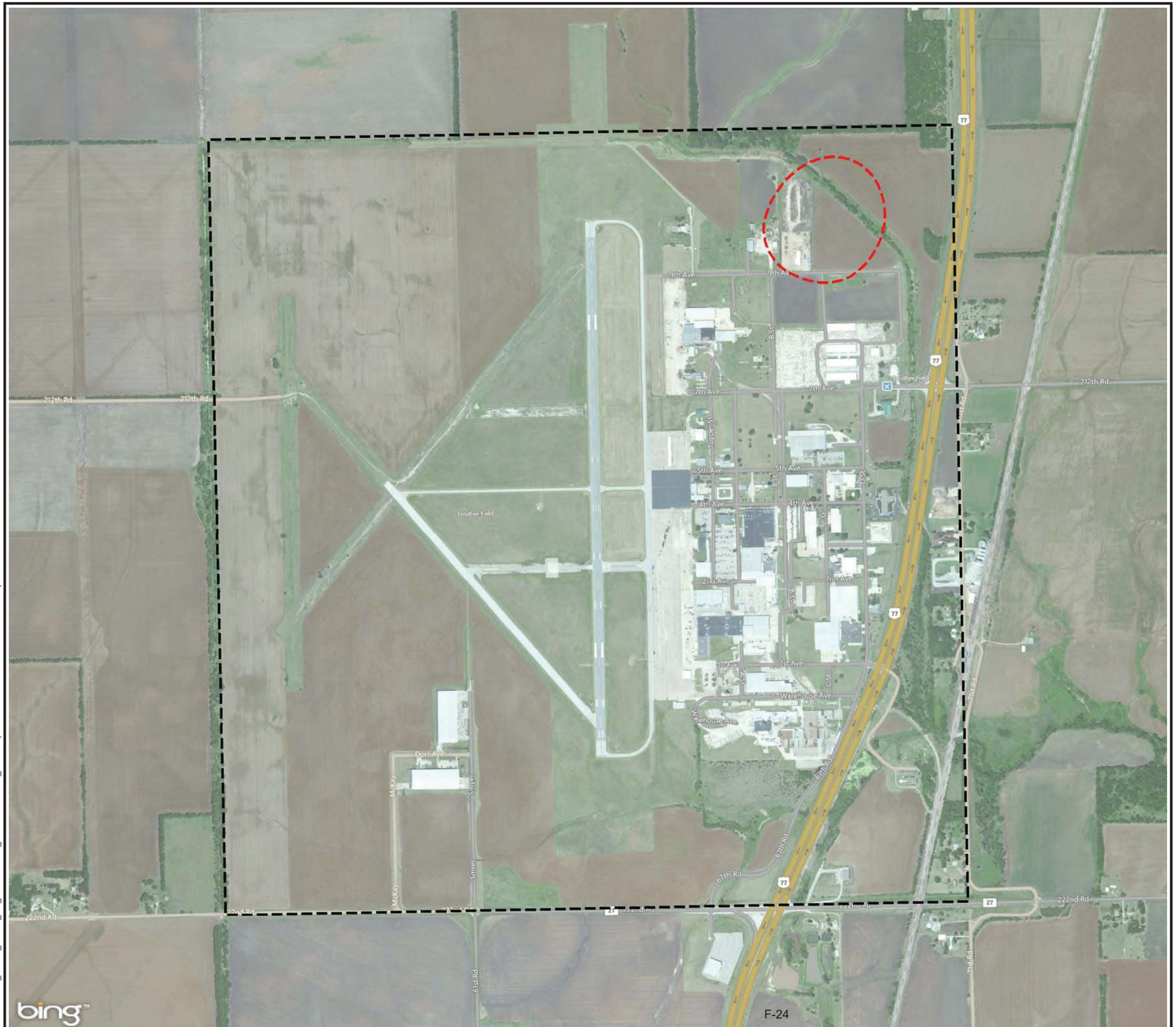
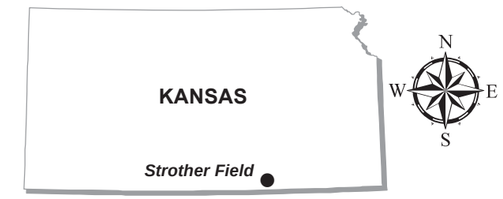


Figure 1-2

Strother Field Disposal Area MRS Location Map

Strother Field FUDS
Cowley County, Kansas
FUDS Property No. B07KS0277



Coordinate System: NAD 1983 UTM Zone 14N
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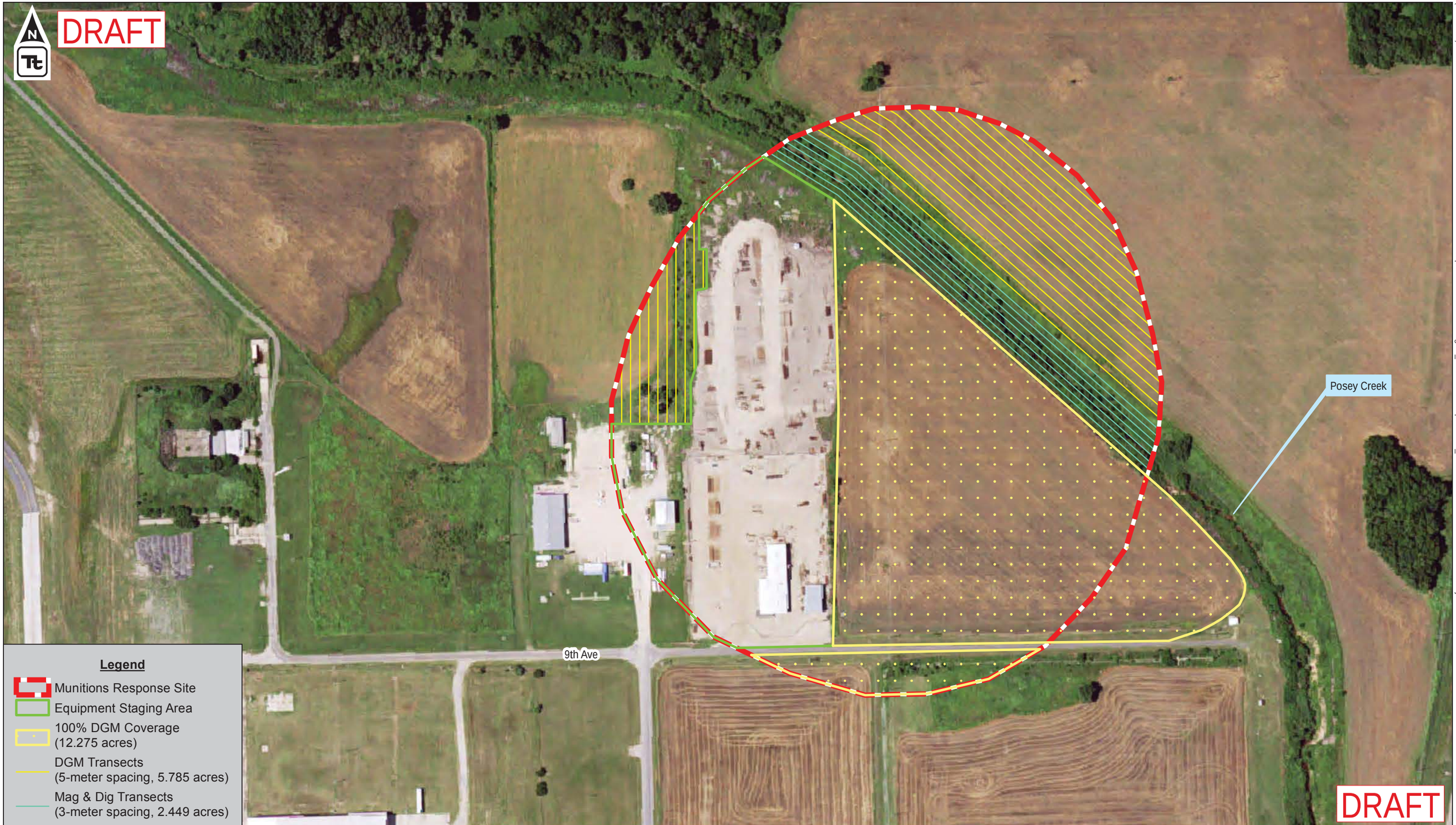
Disposal Area MRS Boundary
Strother Field FUDS - Installation Boundary

Drawn By: S.G. Date Drawn/Revised: 12/23/2015 Project No. J150506

Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_OMAHA\Strother_Field\MapDocs\J150506 FIG 1-2 Munitions Response Site Location.mxd



1 INCH = 200 FEET (SCALE AT 17" X 11")

SCALE IN FEET

0 200 400

WGS 1984 UTM ZONE 14N METERS

NOTES:
1) Imagery from the USDA National Agriculture Imagery Program (NAIP), 1-m resolution, 2015, via the ArcGIS Image Server.

DEFINITIONS:
DGM = Digital Geophysical Mapping
MAG = Analog All-Metals Detector
MRS = Munitions Response Site

PREPARED FOR:
US Army Corps of Engineers®
Omaha District

PREPARED BY:

TITLE:
REMEDIAL INVESTIGATION GEOPHYSICAL SURVEY PLAN
STROTHER FIELD FUDS (PROPERTY NO. B07KS0277)

A
REVISION

PROJECT: DISPOSAL AREA MRS

PROJECT NO.: 106-46690002

LOCATION: COWLEY COUNTY, KANSAS

DATE: 04/2016

FIGURE: **Figure 1-3**

(\\tts153fs1) P:\USACE Northwestern DIV\Omaha District\Strother Field Disposal Area\GIS\MXD\Fig7-4_StrotherFieldDisposalArea_MRS.mxd 2016/04/22: Tetra Tech ECI / jeff.dahoda

6425 SW 6th Avenue
Topeka KS 66615

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cultural_resources@kshs.org

Sam Brownback, Governor
Jennie Chinn, Executive Director

KSR&C # 16-06-023
June 3, 2016

Marie Swiech-Laflamme
Bay West

Via email

Re: Remedial Investigation – Strother Field

We have reviewed the materials received May 23, 2016 regarding the above-referenced project in accordance with 36 CFR Part 800. In reviews of this nature, the SHPO determines whether a federally funded, licensed, or permitted project will adversely affect properties that are listed or determined eligible for listing in the National Register of Historic Places. The SHPO has determined that the proposed project will not adversely affect any property listed or determined eligible for listing in the National Register. As far as this office is concerned, the project may proceed.

Thank you for giving us the opportunity to comment on this proposal. Please refer to the Kansas State Review & Compliance number (KSR&C#) listed above on any future correspondence. Please submit any comments or questions regarding this review to Patrick Zollner at 785-272-8681 ext. 217 or pzollner@kshs.org.

Sincerely,

Jennie Chinn
State Historic Preservation Officer

Patrick Zollner

Patrick Zollner
Director, Cultural Resources Division
Deputy State Historic Preservation Officer