APPENDIX F – STANDARD OPERATING PROCEDURES

APPENDIX F-1

GEOPHYSICAL INSTRUMENT STANDARD OPERATING PROCEDURES

Operational Use of the G-856 Magnetometer and Operational Use of the G-858/822 Magnetometer

WSI *POLICY AND PROCEDURE MANUAL*		
SUBJECT: Operational use of G-856 Magnetometer		**No**. Op.001.G856.mag
EFFECTIVE DATE: February 27, 2008		**SUPERSEDES:**
SECTION: Geophysics Group		**DEPARTMENT**: OU 1494
NAME/TITLE: J. Williams/Sr. Technical Manager		
SIGNATURE:	John A Williams Jr	**DATE APPROVED:** March 10, 2008

1. PURPOSE

This procedure outlines the technical requirements and operational use of the G-856 Magnetometer for use in geophysical surveys.

2. APPLICABILITY AND SCOPE

The requirements of this procedure are applicable to all project activities which include the use of the G-856 Magnetometer. The instrument is utilized as a magnetic basestation to collect magnetic data used to diurnally correct the G-858 magnetometer data.

3. REFERENCES

   3.1. G-856 Magnetometer Operating Manual, Geometrics, Inc.

4. DEFINITIONS

   4.1. Central Equipment Stores (CES) - WESTON's central equipment storage location in West Chester, PA. This group is responsible for securing, maintaining, and distributing equipment.

   4.2. G-856 Magnetometer components:

      4.2.1. One proton-precession magnetometer

      4.2.2. One Geometrics data logging console

      4.2.3. Aluminum pieces to assemble data collection staff

      4.2.4. Optional external battery

      4.2.5. Download Cable

5. SET-UP AND OPERATION

This section outlines the steps for setting up the G-856 Magnetometer system in the field for the acquisition of monitoring daily magnetometer data.

5.1. Assemble G-856 Magnetometer according to operating manuals.

5.2. It is not necessary to perform a warm-up of the G-856.

5.3. Set-up the specific data collection software on the data collection console

5.3.1. Synchronize the G-856 and G-858 clocks within 1 second.

5.3.2. Set the appropriate data collection rate (sampling rate, i.e. 1 reading every 20 seconds is sufficient for collecting diurnal data).

5.3.3. Erase any previous data on the instrument in order to ensure enough room from the current data.

5.3.4. Start logging data on the G-858 console.

5.4. At the end of the day stop data collection and download data utilizing MagMap2000 software from Geometrics.

Applicable References:

Geometrics, 2000. Total *Field Magnetometer Performance Published Specifications and What They Mean*: Technical Report TR-120, Geometrics, San Jose, CA.

Geometrics, 2001. *G-856 Magmapper Operation Manual*.

Smith, K., 1997. *Cesium Optically Pumped Magnetometers*: Technical Report M-TR91, Geometrics, San Jose, CA.

USAESCH (U.S. Army Engineering Support Center, Huntsville). 2003. *Munitions Response Data Item Descriptions (DIDs)*. Revised 1 December 2003.

Project Specific Work Plan - Data Quality Objectives (DQO) with established metrics

Review/Revision Date:	J. Williams - 03/10/08
Original Prepared By/Date:	M. Saunders – 03/03/2008
Revision #1 –	

<table>
<tr><td colspan="4">WSI
POLICY AND PROCEDURE MANUAL</td></tr>
<tr><td colspan="3">SUBJECT: Operational use of G-858 Magnetometer</td><td>No. Op.001.G858.mag</td></tr>
<tr><td colspan="2">EFFECTIVE DATE: February 27, 2008</td><td colspan="2">SUPERSEDES:</td></tr>
<tr><td colspan="2">SECTION: Geophysics Group</td><td colspan="2">DEPARTMENT: OU 1494</td></tr>
<tr><td colspan="4">NAME/TITLE: J. Williams/Sr. Technical Manager</td></tr>
<tr><td>SIGNATURE:</td><td>John A Williams Jr</td><td colspan="2">DATE APPROVED: March 10, 2008</td></tr>
</table>

1. PURPOSE

This procedure outlines the technical requirements and operational use of the G-858 Magnetometer for use in geophysical surveys.

2. APPLICABILITY AND SCOPE

The requirements of this procedure are applicable to all project activities which include the use of the G-858 Magnetometer. The instrument is utilized to collect magnetic data from the subsurface up to a depth of four feet (unofficial estimate). The data generated are collected concurrently with a navigational system (RTK or total station) and stored on a Geometrics field computer.

3. REFERENCES

3.1. G-858 Magnetometer Operating Manual, Geometrics, Inc.

4. DEFINITIONS

4.1. Central Equipment Stores (CES) - WESTON's central equipment storage location in West Chester, PA. This group is responsible for securing, maintaining, and distributing equipment.

4.2. G-858 Magnetometer components:

4.2.1. Two Cesium magnetometer sensors

4.2.2. One Geometrics data logging console

4.2.3. Aluminum pieces to assemble data collection staff

4.2.4. Battery pack

4.2.5. Navigational mount

5. SET-UP AND OPERATION

This section outlines the steps for setting up the G-858 Magnetometer system in the field for the acquisition of geophysical data using a Global Positioning System (GPS). Be sure to follow all operating manuals for set-up and operation.

5.1. Assemble G-858 Magnetometer according to operating manuals.

5.2. Interface the G-858 Magnetometer with a navigational system for precise location data. Connect serial cable from navigational system into the RS-232 Port.

5.3. Perform 10-15 minute warm-up of G-858 Magnetometer according to ambient temperature. Check the magnetometer system settings to ensure "RF 1 & 2 and Bright 1 & 2 are reading within specified limits as per the values below:

RF should be below 60% - Optimum is 35%

Brightness should ALWAYS be 50% +/- 2%

COLD should always be 50% +/- 2%

Signal usually is about 25% but is dependent on the environment.

5.4. Measure distance between top and bottom sensors from center to center of each sensor (typically 1 meter, but project dependent). A pin flag affixed to the bottom sensor at the instrument height (determined from the height optimization test) allows the operator to maintain a constant height by using the pin flag as a guide.

5.5. Set-up the specific data collection software on the data collection console

5.5.1. Set the appropriate data collection rate (sampling rate, i.e. 10 Hz for MEC mapping).

5.5.2. The G-858 Magnetometer utilizes "Datasets" to store data. There are only five Datasets available.

5.5.2.1. Collect all QC data in Dataset 1.

5.5.2.2. Collect all Survey files in Datasets 2-5

5.5.3. Adjust line increments and stations start as needed per survey file.

5.6. Perform Pre-survey QC function tests (see separate QC SOP) which usually consists of a 2-3 minute Static Test (remain stationary with no object – record readings), Static Spike (remain stationary with a metallic object [i.e. 5-6 inch ½ diameter rebar] beneath coil – record readings), and 0.5-1 minute Cable Vibration

Test (remain stationary with no object moving cables – record readings). Note any spikes or abrupt changes in data.

5.7. Perform Latency Test – Magnetometer data does not exhibit latency effects as other instruments, but it is suggested that several latency test be run early in your project to verify and document this result.

5.8. If all QC data is verified, collect data, according to operating manual.

5.8.1. If a Geophysical Prove-out survey is required, data acquisition will be performed following the guidance established in the Site Specific GPO Work Plan.

5.8.2. For production surveys, data acquisition will be performed following the guidance established in the Site Specific Geophysical Investigation Plan (GIP).

Applicable References:

Geometrics, 2000. Total *Field Magnetometer Performance Published Specifications and What They Mean*: Technical Report TR-120, Geometrics, San Jose, CA.

Geometrics, 2001. *G-858 Magmapper Operation Manual*.

Smith, K., 1997. *Cesium Optically Pumped Magnetometers*: Technical Report M-TR91, Geometrics, San Jose, CA.

USAESCH (U.S. Army Engineering Support Center, Huntsville). 2003. *Munitions Response Data Item Descriptions (DIDs)*. Revised 1 December 2003.

Project Specific Work Plan - Data Quality Objectives (DQO) with established metrics

Review/Revision Date:	J. Williams – 03/10/08
Original Prepared By/Date:	M. Saunders – 03/03/2008
Revision #1 –	

APPENDIX F

Analog Locator Operations and Analog Locator Operator Checkout

<table>
<tr><td colspan="4">WSI
POLICY AND PROCEDURE MANUAL</td></tr>
<tr><td colspan="3">SUBJECT: Analog Locator Operations</td><td>No. Op.001.Analog Locator Operations.su</td></tr>
<tr><td colspan="2">EFFECTIVE DATE: February 29, 2008</td><td colspan="2">SUPERSEDES:</td></tr>
<tr><td colspan="2">SECTION: UXO Service Line</td><td colspan="2">DEPARTMENT:</td></tr>
<tr><td colspan="4">NAME/TITLE: J. Williams/Sr. Technical Manager</td></tr>
<tr><td>SIGNATURE:</td><td></td><td colspan="2">DATE APPROVED: February 5, 2008</td></tr>
</table>

1. PURPOSE

This procedure outlines the requirements for analog locator operations.

2. APPLICABILITY AND SCOPE

The analog locator will be used during the following operations:

- Analog Locator Daily QC Checkout
- Analog Surveys ("mag and dig")
- Near-Surface Anomaly Detection
- Backhoe Excavations
- Final 10% Analog Locator QC Surveys

The following section provides descriptions of these operations.

3. OPERATIONS

Analog Locator Daily QC Checkout

The UXO Technicians will conduct a daily instrument standardization check by placing the instrument over a standard item prior to commencing daily field activities. The standard item will be buried with the item description, depth and orientation annotated on a wooden stake marking where the item is located. The standard item will remain in the same location until the block of grids has been completely investigated.

An Analog Locator Checkout and Return Form will be filled out daily by equipment operators to record the results of the analog locator QC checkout and document the condition of the equipment.

Analog Locator Surveys

Analog locator surveys (i.e., "mag and dig") will be performed in areas that cannot be surveyed using the digital techniques. "Mag and dig" sweeps are particularly effective in areas where vegetation and terrain limit the use of larger digital systems. The "mag and dig" approach will also be used in areas where metallic fragments and debris make digital discrimination from MEC ineffective.

UXO Technicians will use the procedure described in Section 4.0 of this SOP to conduct analog locator surveys. The location of any MEC items that are located by using this method will be recorded with a GPS (or other survey method if under vegetation canopy) and all collected field data will be recorded in personal digital assistant's (PDAs).

Near-Surface Anomaly Detection

Near-surface anomalies are those subsurface anomalies that can be excavated using hand tools. Throughout the excavation, the UXO Technician will use a magnetometer to check and verify the location of the anomaly.

Backhoe Excavations

Some anomalies are more deeply buried and require excavation using heavy equipment (i.e., backhoe). Prior to the arrival of the heavy equipment, the UXO Team Leader will ensure that a cleared entrance and egress path is available for the heavy equipment. Once on-site, the heavy equipment will be used to excavate the earth overburden from the suspect anomaly. The distance to the anomaly will be checked with the magnetometer during the excavation.

Final 10% Analog Locator QC Surveys

Quality control surveys will be performed after intrusive operations have been completed. A 10 percent QC survey will be performed by the UXOQCS using the analog instrument for all grids originally surveyed digitally. The discovery of any UXO or UXO-like item sufficient in size to represent a 37mm projectile or larger will constitute a failure of the grid (area) being investigated. Results of the 10 percent analog locator QC survey will be documented by the UXOQCS in the daily quality control (QC) report.

4.0 ANALOG LOCATOR SURVEY PROCEDURE

The following procedure will be used by equipment operators to conduct "mag and dig" operations with a handheld analog locator:

- The UXO Team Leader will direct personnel to establish individual search lanes approximately 3 feet wide and to begin searching each lane using a handheld analog locator.

- The equipment operator will start at one end of each lane and move forward toward the opposing baseline.

- During the forward movement, the UXO Technician will move the magnetometer back and forth in a sweeping motion from one side of the lane to the other. Both forward movement and the swing of the analog locator are performed at a pace that ensures that the entire lane is searched and that the instrument is able to appropriately respond to subsurface anomalies.

- Whenever a subsurface anomaly or metallic surface object is encountered, the technician will halt and investigate the anomaly or place a flag for later investigation. Throughout this operation, the UXO Team Leader will closely monitor individual performance to ensure these procedures are being performed with due diligence and attention to detail.

6.0 ANALOG LOCATOR QUALITY CONTROL REPORTS

The quality control reports and forms used to document the QC activities listed in this policy and procedure manual are as follows.

Review/Revision Date:	L. Temple - 01/22/08
Original Prepared By/Date:	S. Young – 01/14/2008
Revision #1 –	

FIELD SUPERVISOR REVIEW SHEET

I have read the Project Work Plan and Standard Operating Procedure (SOP) UXO Technicians Analog Locator QC Checkout. I understand it. To the best of my knowledge the processes described in the Work Plan and this SOP can be done in a safe, healthful, and environmentally sound manner. I have made sure all persons assigned to this process are qualified, have read and understand the requirements of the Work Plan and SOP, and have signed the worker's statement for this process. If necessary, I will conduct an annual review of the Work Plan and SOP. If deviations from this SOP are necessary, I will ensure that project activities are stopped until the SOP is revised and approved. If unexpected safety, health, or environmental hazards are found, I will ensure that project activities are stopped until the hazards have been eliminated.

SUPERVISOR'S NAME	SIGNATURE/DATE

FIELD TEAM REVIEW SHEET

Each field team member shall sign this section after site-specific training is completed and before being permitted to work on-site.

I have read the Project Work Plan and Standard Operating Procedure for UXO Technicians Analog Locator QC Checkout. I have received the hazard control briefing. I understand them. I will follow the Work Plan and SOP unless I identify a hazard not addressed in it or encounter an operation I do not understand. If that occurs, I will stop site activities and notify my immediate supervisor of the problem.

WORKER'S NAME (Print)	SIGNATURE/DATE	SUPERVISOR'S NAME	SIGNATURE/DATE

WESTON SOLUTIONS

ANALOG LOCATOR CHECKOUT AND RETURN PROCEDURE

Month ____________________________

Instrument____________________________

Serial No. ____________________________

Work Site ____________________________

Operator's Signature	Comments	Date		CHECKOUT PROCEDURE	Check case for damage; open case	Check instrument for damage	Open battery compartment	Install batteries	Audio switch in "A" position	Power up; adjust sensitivity control	Set volume control	Verify digital display	Report to test grid	Test grid results; Pass/Fail	RETURN PROCEDURE	Clean instrument	Open battery compartment	Remove and store batteries	Close battery compartment	Return instrument to storage case	Return case to storage area	
		1																				
		2																				
		3																				
		4																				
		5																				
		6																				
		7																				
		8																				
		9																				
		10																				
		11																				
		12																				
		13																				
		14																				
		15																				
		16																				
		17																				
		18																				
		19																				
		20																				
		21																				
		22																				
		23																				
		24																				
		25																				
		26																				
		27																				
		28																				
		29																				
		30																				
		31																				

WSI *POLICY AND PROCEDURE MANUAL*		
SUBJECT: Analog Locator Operator Checkout		**No**. Op.001.Analog Operator Checkout.su
EFFECTIVE DATE: February 29, 2008		**SUPERSEDES:**
SECTION: UXO Service Line		**DEPARTMENT**:
NAME/TITLE: J. Williams/Sr. Technical Manager		
SIGNATURE:		**DATE APPROVED:** February 5, 2008

1. PURPOSE

This procedure outlines the requirements for analog locator operator checkout.

2. APPLICABILITY AND SCOPE

The Geophysical Test Plot will be used as the analog locator operator checkout area. The Geophysical Test Plot Plan identifies the approximate number and type of items buried in the test plot. Equipment operators must successfully locate the required number of targets prior to commencing field data collection.

3. TEST OPERATIONS AND REPORTING

Prior to collection of field data, each equipment operator will be certified in the established test plot. To achieve certification, each operator must demonstrate the ability to locate 85% of target items. The UXO Technician Analog Locator Qualification Form will be used to record the results of the test and will serve as a record of the individual's analog locator qualification history.

Failure to locate 85% of the items will require a root cause analysis. After corrective action, operators may be reprocessed through the test plot to demonstrate their ability to reach the required levels of detection.

Upon successful completion of the test, certification of the operators/equipment will be recorded by the UXOQCS on the Analog Locator Qualification Form and documented in the daily quality control (QC) report on the day that certification occurs.

Review/Revision Date:	L. Temple - 01/22/08
Original Prepared By/Date:	S. Young – 01/14/2008
Revision #1 –	

Attachment A

ANALOG LOCATOR QUALIFICATION FORM

Name:	Member ID:	Team #	Date:

Analog Locator Unit Serial Numbers:

1.

2.

Item No.	Target Located?		Location of Target		Radial Error of Target Location (in)	Comments
	Yes	No	Northing (ft)	Easting (ft)		

UXOQCS Name:	Signature:	Date:

APPENDIX F-2

STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE G-1

FIELD DOCUMENTATION

1. SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes procedures for proper field documentation. When samples are collected for chemical or physical characteristics analysis, field surveys or measurements are performed, or oversight of field activities is undertaken, field documentation must be completed. The field logbook serves as a permanent and traceable record of all field activities related to a project and will become a part of the project files. The information presented in this SOP focuses on the completion of field logbooks and/or field forms for documenting field activities conducted by WESTON.

All data collection will be documented in either a bound field logbook or on appropriate field forms. Field logbooks will be assigned to individual field personnel for daily entries. Notes in the bound field logbooks will be made legibly, written in black or blue ink, and be as detailed and descriptive as possible so that a particular situation may be recalled without reliance on the collector's memory. No blank pages or sections of pages will be allowed. If a page is not completely filled in, a line will be drawn through the blank portion and initialed by the person keeping the log. There should be no erasure or deletions from the field notes. At the end of each day, the logbook will be signed and dated.

2. EQUIPMENT

Field logbooks
Field forms

3. RELATED PROCEDURES

None

4. PROCEDURES

4.1 FIELD LOGBOOK

The field logbook is the primary means of documenting field activities. It must be completed concurrent with field activities and present a thorough but concise summary of the activities conducted. The field logbook should enable the field activities to be reconstructed without relying on the field member's memory. Refer to the Logbook Operating Practices provided at the end of this SOP for detailed descriptions of field logbook entry procedures. Logbooks should be kept in the field member's possession or in a secure place during field work. General provisions for field logbooks include:

- Project name/location and sequential logbook number should appear on the cover.
- Contact information should be recorded inside the front cover in case the logbook is misplaced.
- Write legibly and use a black or blue ink pen for all logbook entries.
- Corrections should be made by crossing out the data with a single strike mark, which will be initialed and dated by the person making the correction. Ensure that the original entry being struck out is still readable.
- Each page of the logbook should be sequentially numbered, dated, and signed by the field team member.
- Time should be recorded in military time (24-hour clock).
- For field sampling or data collection events documented in the logbook, entries should include but not be limited to:
  - Name of author, date, and time of entry.
  - Name, company/agency affiliation, and responsibility of field team members.
  - Names, titles, and arrival/departure times of any site visitors.
  - Weather (e.g., temperature, cloud cover, humidity, wind).
  - Health and safety briefings, personal protection equipment (PPE) level, or changes or issues encountered.
  - Calibration of field equipment.

- Description of task.
- Sample or data collection method.
- Number and volume of sample(s) taken.
- Date and time of collection.
- Sample identification number(s).
- Information concerning sampling changes, scheduling modifications, and change orders.
- Details of sampling locations and visual observations of matrix sampled (e.g., soil description, odors, discolorations).
- Site sketch of sample locations.
- Sample preservation.
- Sample matrix.
- Sample analysis to be performed.
- Field observations.
- Any field measurements made.
- Decontamination procedures.
- Documentation for investigation derived wastes (IDW) (e.g., contents and approximate volume of waste, disposal method).
- Documentation of any scope of work changes required by field conditions.
- Description of photographs taken.

▪ For oversight activities of consultants and contractors, entries should include, but not be limited to:

- Name of author, date, and time of entry.
- Name, company/agency affiliation, and responsibility of field team members.
- Oversight location and task.
- Names, titles, and arrival/departure times of any site visitors.

- Weather (e.g., temperature, cloud cover, humidity, wind).
- Arrival and departure times of oversight staff.
- Observations of ongoing activities.
- Compliance with or deviation from approved plans.
- Details of sampling locations and visual observations of matrix sampled (e.g., soil description, odors, discolorations).
- Details of any split samples collected, including location, matrix, field sample IDs.
- Description of photographs taken.

4.2 FIELD FORMS

Various field data collection forms may be used to streamline the documentation of field data. Field forms may also be customized for large data collection efforts. If field data are recorded on a field form, this data entry should be documented in the daily field logbook entry. Field form data entry should be executed with the same quality standards as field logbook data entry. Entries should be neatly written in black or blue ink and corrections made with single line strike-out and initials. Original field forms should be submitted daily to the Task Manager and be incorporated into the project file.

Examples of field forms that may be used for documenting field activities are summarized in the following sections and included in the Sample Forms section at the end of this SOP.

4.2.1 Soil Boring Log

A Soil Boring Log for Direct Push Technology (e.g., Geoprobe) or hollow-stem auger split spoon sampling (see Sample Forms section) may be completed when WESTON installs or oversees the installation of a soil boring. Information documented on the Soil Boring Log will include:

- Sample depths.
- Penetration/recoveries.
- Analytical sample IDs.
- Blow counts (if applicable).

- Soil classification and lithological description.
- Material origin (natural or fill).
- Observed product, odor, or sheen.
- Instrument readings.

4.2.2 Well Construction Log

In the event that a borehole is completed as a groundwater monitoring well or piezometer, details of the construction may be documented in a Well Construction Log (see Sample Forms section). Information documented on the Well Construction Log includes:

- Total well depth.
- Well diameter.
- Well construction materials.
- Screen interval.
- Construction details.
- Graphic depiction of well construction.

4.2.3 Well Development

Development of a newly installed monitoring well or redevelopment of an existing monitoring well may be documented on a Well Development Form (see Sample Forms section). Information documented on the Well Development Form includes:

- Well ID and construction details.
- Purge rates.
- Headspace readings.
- Turbidity readings.
- Field notes or observations.

4.2.4 Low Flow Groundwater Sampling Record

Low flow groundwater sampling will be documented on a Low Flow Groundwater Sampling Record (see Sample Forms section). Information documented on the sampling record includes:

- Well ID and construction details.
- Times, purge rates, and parameter readings during purging.
- Final parameter values.
- Well condition survey.
- Additional field notes or observations.

4.2.5 Test Pit Log

A Test Pit Log (see Sample Forms section) may be used to record samples collected from test pits, the nature of the soil within the test pit, water entry zones, and types of material observed.

Logbook Operating Practices

Procedure

- Logbooks are permanently bound, all pages numbered.
- Entries should begin on page 1.
- Use only blue or black ink (waterproof).
- Sign entries at the end of the day, or before someone else writes in the logbook.
- If a complete page is not used, draw a line diagonally across the blank portion of the page and initial and date the bottom line.
- If a line on the page is not completely filled, draw a horizontal line through the blank portion.
- Ensure that the logbook clearly shows the sequence of the day's events.
- Do not write in the margins or between written lines, and do not leave blank pages to fill in later.
- If an error is made, draw a single line through the error and initial it.
- Maintain control of the logbook and keep in a secure location.

General Information

- Date on every page.
- Team members and initials listed at beginning of day.
- Other personnel and affiliation (e.g. OSC-Smith, OSC-Jones).
- Written legibly.
- Signatures of author at bottom of every page.
- Signatures when change of recorder.
- Corrections are single lined and corrections are initialed.
- Team members' site entries and exits are documented.
- Chargeable off-site activities are documented.
- Note End of Logbook on last page ("End of Logbook").
- Late entries noted appropriately.

Field Logbooks

- General information.
- Name, location of site, and work order number.
- Name of the Site Manager or Field Team Leader.
- Names and responsibilities of all field team members using the logbook (or involved with activities for which entries are being made).
- Weather conditions.
- Objective narratives written.
- Field observations.
- Names of any site visitors, including entities that they represent.

Sampling

- Time collected.
- Grab/composite.
- Sample location.
- Type of analysis.
- Shipping information.
- Number and types of collected samples.
- Sample location with an emphasis on any changes to documentation in governing documents (i.e., Work Plan, QAPP). This may include measurements from reference points or sketches of sample locations with respect to local features.
- Sample identification numbers, including any applicable cross-references to split samples or samples collected by another entity.
- A description of sampling methodology, or reference to any governing document (i.e., Work Plan, QAPP).
- Summary of equipment preparation and decontamination procedures.
- Sample description including depth, color, texture, moisture content, and evidence of waste material or staining.
- Air monitoring (field screening) results.
- Types of laboratory analyses requested.

Photo Logs

- Camera and PDA (IDs).
- Date of pictures.
- Time of pictures.
- Directions of photos.
- Description of photos.
- Photographer/witness.

Safety

- All safety, accident, and/or incident reports.
- Real-time personnel air monitoring results, if applicable, or if not documented in the HASP.
- Heat/cold stress monitoring data, if applicable.
- Level of protection for tasks.
- Reasons for upgrades or downgrades in personal protective equipment.
- Health and safety inspections, checklists (drilling safety guide), meetings/briefings.
- Equipment make, model, and serial number for monitoring instruments
- Calibration records for monitoring instruments.
- Site safety meeting (time/topics).
- Site objectives/ plan of activities.
- Chemical/physical hazards.
- Personnel attending.
- Special personnel information (allergies, etc.).

Equipment

- Equipment type (make and model).
- Serial nos.
- Calibration records.
- Background readings and locations.
- Monitoring readings and locations.
- Sampler(s) initials.

Contractor Oversight Activities

- Progress and activities performed by contractors including operating times.
- Deviations of contractor activities with respect to project governing documents (i.e., specifications).
- Contractor sampling results and disposition of contingent soil materials/stockpiles.
- Excavation specifications and locations of contractor confirmation samples.
- General site housekeeping and safety issues by site contractors.
- Equipment and personnel on-site.
- Duration of equipment use vs. standby.
- Inventory of shipments received (or verification of items on packing slip).
- Document inspection of disposal trucks arriving at site (e.g., visual observation of clean tankers or truck trailers, etc.).

SAMPLE FORMS

See Appendix I of the RI Work Plan

STANDARD OPERATING PROCEDURE G-3

FIELD SAMPLE NUMBERING

1. SCOPE AND APPLICATION

The objective of this Standard Operating Procedure (SOP) is to define the method for assigning field sample identifiers (IDs), which will be used on sample containers, field logbooks, and/or field data collection sheets. The purpose of the field sample IDs is to provide additional information about the sample to end users of the data. It is expected that this approach will add supplemental value for users who are evaluating data in tabular form, without the benefit of any other spatial reference.

Sample labels are required to properly identify samples and evidence. All samples must be properly labeled with the label affixed to the container prior to transportation to the laboratory.

In order to provide additional information in the sample ID, a set of requirements and guidance has been prepared to assist the data users in the execution of a scheme for building intelligence into the sample nomenclature. A field sample ID protocol has been implemented since the inception of the sampling program in June 1999. The mechanisms for recording the field sample ID are the Sample Attribute Form, the field logbook or data collection sheet, the sample container label, and the chain-of-custody forms.

Over time, edits, deletions, and additions have been made to the field sample ID to respond to feedback and comments provided by the client and the field teams. The original field sample ID had a simple format indicating date of sample collection, sampling team, and sample sequence. The original field sample ID was deemed inadequate for present and future needs, and the ID was modified to incorporate additional sample attribute information. The new field sample ID includes site, location, quality control (QC) type, and depth or date of sample collection. From a data management perspective, the key requirement for the field sample ID is that it represents a unique name. The field sample ID and its corresponding attribute information will be captured electronically and linked within the project database.

Information on sample labels should be limited to the following:

- **Field Sample ID—**Each sample, including field control samples, collected for a project should be assigned a unique character name (see below).
- **Samplers—**Each sampler's name and signature or initials.
- **Preservative—**Whether a preservative is used and the type of preservative.
- **Analysis—**The type of analysis requested.
- **Date/Time—**The date and time the sample was taken.
- **Type of Sample—**The sample identified as either discrete or composite.

2. EQUIPMENT

Sample labels
Pen with indelible ink
Sample Attribute Forms

3. RELATED PROCEDURES

G-1 Field Documentation
G-8 Sample Chain-of-Custody

4. PROCEDURE

4.1 FIELD SAMPLE ID

The environmental and associated QC samples collected during the field investigation will be labeled with a sample ID number. The sample numbers will be recorded in the site logbook, the chain-of-custody, and the shipment documents in accordance with relevant SOPs.

The sample ID will be composed of three components:

[_ _] [_ _] [_ _]
1 2 3

Component 1 – Defines the site location using a predetermined identifier:

FIGR01 = FIG Ricochet Area MRS (FTIG-003-R-01)

Component 2 – Defines the sample matrix and sample number:

SS## = surface soil sample

SB1## = subsurface soil sample 6 to 12 in

SB2## = subsurface soil sample 12 to 18 in

SB3## = subsurface soil sample 18 to 24 in

SD## = sediment sample

Component 3 – Defines the QA sample type:

00 = Background Sample

01 = Environmental Sample

02 = Duplicate sample

03 = Temperature blank

04 = Matrix spike

05 = Matrix spike duplicate

An example of typical sample ID nomenclature is FIGR01-SS01-01. The "FIGR01" indicates a sample collected from the Ricochet Area MRS. The "SS" indicates the sample is a surface soil sample (0 to 6 in bgs) at location number 01. The "01" indicates that the sample is an environmental sample.

STANDARD OPERATING PROCEDURE G-4

QUALITY ASSURANCE/QUALITY CONTROL SAMPLING

1. SCOPE AND APPLICATION

Quality assurance/quality control (QA/QC) measures are those activities undertaken to demonstrate the accuracy (how close to the true value the results are) and precision (how reproducible the results are) in monitoring. QA generally refers to a broad plan for maintaining quality in all aspects of a program. QC consists of the steps taken to determine the validity of specific sampling and analytical procedures. Quality assessment is the assessment of the overall precision and accuracy of the data, after it is analyzed.

2. EQUIPMENT

American Society for Testing and Materials (ASTM) Type II reagent-grade water

3. RELATED PROCEDURES

SOP G-1	Field Documentation
SOP G-3	Field Sample Numbering
SOP G-8	Sample Chain-of-Custody

4. PROCEDURES

4.1 FIELD DUPLICATES

For each sampling round, one duplicate sample is collected for every 10 routine samples. These duplicate samples are taken immediately following the collection of the samples. They are intended to duplicate the routine sample collected. Soil duplicates from split-spoons will be collected by splitting the soil in the spoon lengthwise and dividing the soil into the standard and duplicate containers. Soil and sediment field duplicate samples for organics other than volatiles are thoroughly homogenized and then transferred into their appropriate sample containers before shipment to the analytical laboratory. A note needs to be made in the appropriate field logbook indicating that a duplicate sample was collected, and describing how it was collected. Duplicates will be handled in the same manner as all other samples.

SOP G-3, Field Sample Numbering, identifies the numbering scheme.

4.2 EQUIPMENT BLANKS

Equipment blank samples are collected daily and analyzed to determine the effectiveness of decontamination practices. Equipment blanks (also called rinse or rinsate blanks) are collected at a frequency of 5 to 10% of samples. If fewer than 20 samples are collected in a day, 1 equipment blank sample will be collected. Equipment blank samples are collected as follows:

- Sample bottles for equipment blanks are of the same type as routine sample bottles and will be prepared prior to sampling.
- Pour ASTM Type II reagent-grade water over and/or into the decontaminated sampling equipment. Then pour the water from the sampling equipment into the equipment blank sample jars.
- After all bottles are filled, label the sampling equipment with the associated routine sample ID number and use that sampling equipment to collect the environmental sample at that particular sampling location.
- Note in the field logbook that an equipment blank was collected for that particular sampling location.

Once collected, handle equipment blank samples in the same manner as routine samples.

4.3 TRIP BLANKS

The purpose of a trip blank sample is to determine whether factors during transport may have affected the sample quality of volatile organic compounds (VOCs).

A trip blank prepared in the laboratory or field consists of two VOC sample bottles filled with ASTM Type II reagent-grade water. Trip blanks will be obtained the morning prior to sampling and will accompany the associated routine sample bottles in the same cooler. When the day of sampling is completed, the trip blanks will be handled in the same manner as routine samples and returned to the laboratory. Trip blanks will be collected at a frequency of 1 per day of VOC sample shipment. A note should be made in the field logbook that a trip blank accompanied the particular samples.

4.4 MS/MSD SAMPLES

Matrix spike/matrix spike duplicate (MS/MSD) samples are collected for the laboratory to perform internal QC checks. MS/MSD sampling involves collection of triple the volume of a routine surface water or groundwater sample. No additional volume is required for soil. MS/MSD samples are collected at a rate of 1 for every 20 samples. They are collected as separate samples immediately after the collection of the routine samples for the same parameter. The sample collection procedure is as follows:

- Additional bottles will be prepared the first day so the sampling teams will be ready to sample. For example, a routine sample for polychlorinated biphenyls (PCBs) requires two 1-liter amber glass bottles. An MS/MSD sample for PCBs requires six 1-liter amber glass bottles.

- Note in the field logbook that an MS/MSD sample was collected at that particular location. Once collected, handle samples in the same manner as routine samples.

The MS/MSD samples are identified using the standard nomenclature as outlined in SOP G-3, with the designation of MS/MSD on the chain-of-custody form and on the sample containers. Chain-of-custody procedures are presented in SOP G-8.

STANDARD OPERATING PROCEDURE G-6

DECONTAMINATION

1. SCOPE AND APPLICATION

All personnel or equipment involved in intrusive sampling or entering an area during intrusive sampling must be thoroughly decontaminated prior to sampling and prior to leaving the site to minimize the spread of contamination and prevent adverse health effects. This Standard Operating Procedure (SOP) describes the normal decontamination of sampling and site equipment. To minimize the possibility of cross-contamination of samples (contamination of a sample by chemicals picked up at another area and transferred to an analytical sample by sampling or drilling equipment), proper decontamination procedures must be followed consistently.

Generally, solvents are used to remove organic compounds, such as volatile organic compounds (VOCs) and polychlorinated biphenyls (PCBs); nitric acid is used to remove residual metals; and detergent wash and/or steam cleaning are used to remove gross contamination and soil. All material and equipment should arrive intact and in clean condition. Recommended procedures for equipment decontamination during drilling, test pit operations, sampling, and other field investigation procedures are described in the following sections.

2. EQUIPMENT

Plastic sheeting, buckets, etc. to collect wash water and rinsates
Approved potable water
Deionized (DI) water
Medical-grade isopropanol or equivalent
Reagent grade 0.10N nitric acid
Non-phosphate laboratory detergent (Liquinox)
Aluminum foil or clean plastic sheeting
Pressure spraying, rinse bottles, brushes

Plastic garbage bags

0.01N hydrogen chloride (HCl)

3. RELATED PROCEDURES

G-7 Management of Investigation Derived Waste (IDW)

4. PROCEDURE

4.1 SAMPLE BOTTLES

At the completion of each sampling activity, the exterior surfaces of the sample bottles must be decontaminated as follows:

- Be sure the bottle lids are on tight.
- Wipe the outside of the bottle with a paper towel to remove gross contamination.

4.2 SOIL SAMPLING EQUIPMENT

Sampling equipment that will be used includes materials such as stainless steel bowls, trowels, scoops, and split-spoons. Equipment to be used during sampling will be decontaminated at a centralized decontamination area site at which the equipment is being used. All sampling equipment will be decontaminated after use to prevent cross-contamination between sampling points. Decontaminated equipment will then be wrapped in aluminum foil with the shiny side facing out. No sampling debris will be left on any site.

The procedure for decontaminating sampling equipment is as follows:

- Place dirty equipment on a plastic ground sheet at the head of the decontamination line.
- Rinse equipment with potable water to remove surface dirt and mud if necessary.
- Scrub equipment with a bristle brush using a non-phosphate detergent (e.g., Liquinox) and potable water. To clean the inside of a bailer, use a bottlebrush pulled through the bailer with a polypropylene cord.
- Rinse off soap with potable water.

- Using a squirt bottle, rinse with 10% ultrapure nitric acid (use 1% nitric acid for metallic sampling materials) if equipment will be used for the collection of metals samples. Collect nitric acid rinsate in a tub or bucket.

- Rinse with American Society for Testing and Materials (ASTM) Type II reagent-grade water.

- For equipment used to collect samples analyzed for organics, rinse with medical-grade isopropanol or equivalent. Collect solvent rinsate in a tub or bucket separate from the nitric acid rinsate.

- Rinse with ASTM Type II reagent-grade water.

- Allow equipment to air dry.

- Wrap equipment with aluminum foil (shiny side facing out).

- Sampling equipment used to collect samples for organic analyses will not be allowed to contact any type of plastic after decontamination.

- Equipment that can not be washed and rinsed (e.g., PID) should be covered with a plastic bag while sampling, with only the probe tip exposed.

At the end of the decontamination procedures, the proper disposal of the decontamination liquids will include the following steps:

- Discharge potable water in the decontamination area.

- Rinse soapy washtub in the decontamination area only.

- Dilute the detergent wash water and discharge it in the decontamination area.

- Overturn tubs to allow them to drain.

- Rinse tub bottoms and stack tubs for future use.

- The isopropanol, nitric acid, and DI rinse should be placed in a designated 55-gallon drum or other designated container for future characterization and disposal.

4.3 DRILLING EQUIPMENT

Drilling rigs will arrive on-site in clean condition and will be inspected by a WESTON geologist. After arrival at the site, all equipment, tools, and tool storage areas that will be used in the drilling, sampling, and completion of the soil borings and monitor wells will be steam cleaned before initiating drilling at any site to remove road dirt. The frequency and procedures for decontamination of drilling equipment are as follows:

- The drill rig and all equipment will be steam cleaned when they are moved to new sites, or more often if required by WESTON.

- The drill rig (i.e., deck derrick and undercarriage) will not be steam cleaned between soil borings and wells at the same site unless gross contamination is present on the rig that could fall off and enter subsequent boreholes. It is very important during this initial decontamination of the rig to check the threads of the drilling rods and drilling bits for grease, and to remove it (with a wire brush and Liquinox detergent) if it is present. The only allowable "lubricant" on the threads is Teflon tape.

- The surfaces of the drilling equipment, including drill rods, augers, bits, and associated tools (including any tape measures), will be decontaminated at a central site-specific decontamination area using the following procedures:

  – Remove gross amounts of mud/soil using a shovel, wire brush, or other tools.

  – Transport drill rig and tools to site decontamination area.

  – Steam clean the equipment thoroughly, using a brush to remove any particulate matter or surface film. If the equipment is still not clean, proceed to the following steps. Otherwise allow the equipment to air dry.

  – If necessary, use a brush and a phosphate-free detergent/potable water solution to scrub the drilling tools that may enter a subsequent borehole. Use a brush to remove any clinging soil or surface film. If the soil/mud on the tools can be easily removed by steam cleaning, this step can be skipped.

  – Rinse the equipment thoroughly with potable water and allow it to air dry.

  – Drill rods and manmade well construction materials will be decontaminated on a steel rack (one set per rig on-site), provided by the driller, that keeps the piping 2 or 3 feet above the ground. Precautions should then be taken, by using plastic sheeting, to ensure that decontaminated casing, augers, and other equipment do not come into contact with the ground and that the storage areas on the drill rig or tender are clean.

- At the decontamination site, it may be necessary to fill out properly a Hot Work Permit, depending on the type of steam generator present.

- During split-spoon sampling, subcontractor personnel may be required to help decontaminate the used split-spoons by performing the initial gross cleaning of the split-spoon using a Liquinox (or equivalent) solution and scrub brushes. WESTON personnel will supervise the initial cleaning and then complete the balance of the decontamination procedures. If, because of sample preparation or description activities, the on-site WESTON personnel are unable to complete the decontamination in a timely manner and subcontractor personnel are waiting for split-spoons, standby charges will not be incurred. It will be the responsibility of the subcontractor personnel to complete the split-spoon decontamination, including solvent rinse, under WESTON supervision.

4.4 BACKHOE

If a backhoe is being used to excavate test pits in contaminated soil, or if analytical soil samples are to be collected from test pits, the following decontamination procedures should be followed:

- Prior to excavation of any test pit and between test pits, steam clean the backhoe bucket and arm using a non-phosphate detergent (i.e., Liquinox/potable water solution).
- Rinse the detergent solution from the backhoe bucket and arm by steam cleaning with potable water.

4.5 FIELD PARAMETER EQUIPMENT

- Water level indicators and transducers used for measurement of water in wells and in surface waters will be decontaminated after each use by flushing with ASTM Type II reagent-grade water prior to and after each use. If floating product or high levels of organic contamination are evident, or known to exist in a well, the full sampling decontamination procedure outlined in Subsection 4.2 will be employed.
- Water quality instrument probes will be flushed with ASTM Type II reagent-grade water between measurements. No solvents will be used to clean these probes.
- Turbidimeter sample vials will be wiped dry after being filled with a sample and prior to insertion into the turbidimeter. After the measurement is taken, the sample vial and the turbidimeter will be flushed with ASTM Type II reagent-grade water.

4.6 SUBMERSIBLE PUMP

All submersible pumps used for sampling or for well development will be decontaminated after use to prevent cross-contamination between wells. The procedure for decontaminating submersible pumps is as follows:

- Scrub pump and cord in a tub of Liquinox and potable water.
- Pump (or recirculate) at least 20 gallons of the soapy water through the pump.

- Rinse with potable water.
- Pump (or recirculate) at least 20 gallons of rinse water through the pump.
- Rinse with DI water.
- Place pump in a decontaminated, plastic garbage can, or wrap it in clean plastic.

After decontamination, the proper disposal of the decontamination liquids includes the following steps:

- Drain wash water and rinse in decontamination area.
- Rinse decontamination containers with potable water.
- Allow containers to dry overnight.

5. PRECAUTIONS

- Dispose of all wash water, rinse water, rinsates, and other sampling wastes (e.g., tubing, plastic sheeting) in properly marked, sealable containers, or as directed.
- Once a piece of equipment has been decontaminated, be careful to keep it in such condition until needed.
- Follow the health and safety plan in regard to personal protective equipment (PPE), especially with regard to eye protection and gloves.

6. BIBLIOGRAPHY

ASTM Standard D5088. 2008. "Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites." ASTM International, West Conshohocken, PA. 2008, DOI: 10.1520/D5088-02R08. www.astm.org. (Accessed 24 February 2010).

STANDARD OPERATING PROCEDURE G-7

MANAGEMENT OF INVESTIGATION DERIVED WASTE (IDW)

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to describe the requirements for investigation derived waste (IDW) management. The requirements of these procedures are applicable to management for wastes generated as a result of field sampling and characterization activities and not yet characterized by laboratory analysis as hazardous or non-hazardous wastes. The goal of IDW management is to minimize the amount of waste generated while following applicable regulations. Field personnel should review and understand all applicable federal, state, and local regulations regarding IDW. Regulations may prohibit disposal of certain IDW on-site.

Prior to commencing sampling of remediation, the Field Team Leader will select an area, preferably secure, for IDW storage in consultation with the On-Site Manager.

Any container used for IDW will be U.S Department of Transportation (DOT) approved. Drums will not be stacked on top of each other and will be stored in rows not larger than two drums wide, with labels facing outward for identification. Decontamination fluids and other low-volume fluids may be temporarily stored and transported in 5-gallon buckets with lids.

Different residual materials (e.g., soil and water) will not be drummed together, but will be placed in separate drums. Field screening will be used to drum materials with similar levels of contamination together, if possible.

2. EQUIPMENT

Wrangler type boxes
DOT-approved drums or other containers
Funnels
5-gallon buckets

Photoionization detector (PID) or other appropriate instrumentation

Labeling material

3. RELATED PROCEDURES

SOP G-6	Decontamination
SOP A-1	Calibration and Use of Air Monitoring Instruments

4. IDW MANAGEMENT

All soil cuttings IDW must be placed in drums or other appropriate containers. As existing site information has shown the groundwater to be non-hazardous, the purge water from monitoring wells will be discharged into the ground next to the well to allow infiltration. As necessary, IDW-filled drums will be transported to the secure staging area at the site in accordance with applicable DOT and U.S. Environmental Protection Agency (EPA) regulations.

The IDW-filled drums must be sampled to determine whether they contain materials classified as Resource Conservation and Recovery Act (RCRA) hazardous wastes. IDW-filled drums containing RCRA hazardous wastes must be shipped off-site within 90 days.

The EPA *Guide to Management of Investigation-Derived Wastes* (January 1992) will be used to assist in management of IDW where necessary.

4.1 SOIL

Soil cuttings and excess samples must be drummed. They will be placed in DOT-approved drums and will be sealed and labeled in accordance with labeling practice.

4.2 LIQUIDS

Residual liquid such as water from well sampling and development will be poured on the ground next to the well. Decontamination water must be containerized. It will be placed in a temporary holding tank or DOT-approved drums or containers as appropriate. Drums will be sealed and labeled in accordance with labeling procedures. Decontamination solvents and test kit solvents will be segregated from aqueous material and allowed to evaporate as much as possible before being containerized in solvent-specified drums. Liquids drums will contain removable bungs. Funnels will be used to prevent spillage when adding liquids to the drums.

4.3 PERSONAL PROTECTIVE EQUIPMENT (PPE) AND OTHER DISPOSABLES

Project-specific provisions should be made prior to disposal of IDW. Do not assume bagged waste can be disposed of in any dumpster. All non-contaminated disposable wastes such as bags, washed gloves, and material scrap, will be kept separate from other wastes. This material will be bagged or otherwise contained and disposed of in the Field Office dumpster or other appropriate and approved location.

Contaminated disposable wastes may include disposable PPE and contaminated equipment. This material will be placed in wrangler-type boxes unless field screening results of soil and/or waste residuals indicate non-elevated results.

5. DISPOSAL OPTIONS

Wastes that have been drummed based on field criteria may be sampled for laboratory analysis to determine the appropriate type of disposal facility. The number of samples collected will depend on the homogeneity of the drummed material, the nature of the source areas, and the requirements of the disposal facility.

IDW characterized or listed as hazardous waste will be managed and disposed of in a manner consistent with local and state guidance, and federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and/or RCRA or Toxic Substances Control Act (TSCA) guidelines.

IDW determined to be non-hazardous waste will be managed and disposed of in accordance with state and/or local guidelines.

5.1 LABELING

Pending a determination of whether the IDW is hazardous or non-hazardous, containers will be labeled on the side using a weather-resistant paint pen. The following information will be included:

- Investigation Derived Waste (IDW)
- Sampling location identification.
- Sampling area designation.
- Point of contact with phone number.
- Type of material.
  - OB—Overburden soil and cuttings.
  - SD—Sediment.
  - GW—Groundwater from wells.
  - DW—Decontamination water.
  - DS—Disposables.
  - SV—Decontamination solvents.
- Water content.
  - SAT—Saturated.
  - UNSAT—Unsaturated.
- For drums containing liquids, indicate the approximate fill line on the outside of the drum. Do not fill more than two-thirds full with liquids.
- Range of field screening results and instrument type.
- Date the drum was filled and sealed.

Only IDW pending analysis may be labeled. Any wastes known to be RCRA or TSCA wastes based on knowledge of the waste material must be managed as RCRA or TSCA at the point of generation. Upon receipt of analytical results for those IDW containers, the respective containers must immediately be managed appropriately.

6. BIBLIOGRAPHY

EPA (U.S. Environmental Protection Agency). 1992. *Guide to Management of Investigation-Derived Wastes*. January 1992.

STANDARD OPERATING PROCEDURE G-8

SAMPLE CHAIN-OF-CUSTODY

1. SCOPE AND APPLICATION

Chain-of-custody (COC) records provide documentation of the handling of each sample. Sample custody will be initiated by WESTON upon collection of samples and maintained until samples are relinquished to the shipping carrier for delivery to the laboratory. COC forms will be placed in waterproof plastic bags and taped to the inside lid of the cooler. The cooler will be sealed with COC seals. COC forms will be used for recording pertinent information about the types and numbers of samples collected and shipped for analysis. Sample identification numbers will be included on the COC form to ensure that no error in identification is made during shipment.

2. EQUIPMENT

COC forms
Waterproof plastic resealable bags
COC seals
Labels
Pen
Markers
Tape
Scissors

3. RELATED PROCEDURES

SOP G-1	Field Documentation
SOP G-3	Field Sample Numbering
SOP G-9	Sample Packing and Shipping

4. DOCUMENTATION

4.1 CHAIN-OF-CUSTODY RECORDS

COC procedures provide documentation of the handling of each sample. COC procedures are implemented so that a record of sample collection, transfer of samples between personnel, sample shipping, and receipt by the laboratory that will analyze the sample is maintained. The COC record serves as a legal record of possession of the sample. The COC record is initiated with the acquisition of the sample. The COC record remains with the sample at all times and bears the name of the person (field investigator) assuming responsibility for the samples. The field investigator is tasked with ensuring secure and appropriate handling of the bottles and samples. To simplify the COC record and eliminate potential litigation problems, as few people as possible should handle the sample or physical evidence during the investigation. A sample is considered to be under custody if one or more of the following criteria are met:

- The sample is in the sampler’s possession.
- The sample is in the sampler’s view after being in possession.
- The sample was in the sampler’s possession and then was locked up to prevent tampering.
- The sample is in a designated secure area.

4.1.1 Transfer of Custody and Shipment

All sample sets should be accompanied by a COC record (Figure 1). This form records each sample and the individuals responsible for sample collection, transfer, shipment, and receipt by the laboratory. The form must also contain pertinent information about the sampling location, date, and times, signature of sampling technician, types and numbers of samples collected and shipped for analysis in each lot and the project name.

Samples shall be accompanied by an approved and completed COC form during each step of custody, transfer, and shipment. When physical possession of samples is transferred, both the individual relinquishing the samples and the individual receiving the samples should sign, date, and note the time that he/she received the samples on the COC record. This COC record

Figure 1 Example Chain-of-Custody Form

Chain of Custody Record

WESTON SOLUTIONS
Restoring Resource Efficiency

Client ____________
Site Name ____________
W.O. ____________
Laboratory ____________

Contact Name ____________
Contact Phone No. ____________
Turn-around-Time ____________
Sampler ____________

Analysis Requested by Group by Container
(number listed for total containers per analysis group)

Preservative

Lab Batch Number:

Lab ID	Sample ID	Matrix QC MS	Matrix QC MSD	Matrix QC DUP	Total Num of Containers	Matrix	Date Collected	Sample Time	App.IX VOA	Total PCBs by Aroclors	Homologs	Congeners		Herbicide	Dioxin/Furan	Appx. IX Metals	CN	Sulfide	TOC	Grain Size	Method TO-4 (Air)				

Field Remarks/Comments

Lab Use Only

Temp of Cooler when Received, C^{o}

1	2	3	4

COC Tape was present on outer package	Y	N
COC Tape was unbroken on outer package	Y	N
COC Tape was present on sample	Y	N
COC Tape was unbroken on sample	Y	N
Received in good condition	Y	N
Labels Indicate Properly Preserved	Y	N
Received within Holding Time	Y	N

Relinquished by	Received by	Date	Time	Relinquished by	Received by	Date	Time

Page 1 of 1

documents transfer of custody of samples from the field investigator to another person, other laboratories, or other organizational units.

Samples sent off-site for analysis must be properly packaged for shipment, and delivered or shipped to the designated laboratory for analyses. Shipping containers must be secured by using nylon strapping tape and custody seals (see Section 4.2). The custody seals must be placed on the container so that it cannot be opened without breaking the seals. The seal must be signed and dated by the field investigator.

When previously collected samples are split with a facility, state regulatory agency, or other government agency, the agency representative must sign the COC record, if present. All samples should be accompanied by a COC record. The original of the COC record will be placed in a plastic bag taped to the inside lid of the secured shipping container and transmitted to the laboratory along with the samples. One copy of the record will be retained by the field investigator or project leader. This copy will become a part of the project file. If sent by mail, the package should be registered with return receipt requested. If sent by common carrier, an air bill should be used. Receipts from post offices and air bills should be retained. The air bill number or registered mail serial number should be recorded in the remarks section of the COC record.

4.2 CHAIN-OF-CUSTODY SEALS

The COC seal is an adhesive seal placed in areas such that if a sealed container is opened, the seal would be broken (Figure 2). The COC seal ensures that no sample tampering occurred between the field and the laboratory analysis.

These signed and dated seals will be placed at the junction between the lid and the jar and on the cooler by the person responsible for packaging. If the coolers or jars are opened before receipt at the laboratory, the seals will not be intact. If the COC seals are not intact, the Laboratory Project Manager will notify the WESTON Analytical Manager within 24 hours of receipt of the container. The WESTON Analytical Manager will then follow the corrective action procedures.

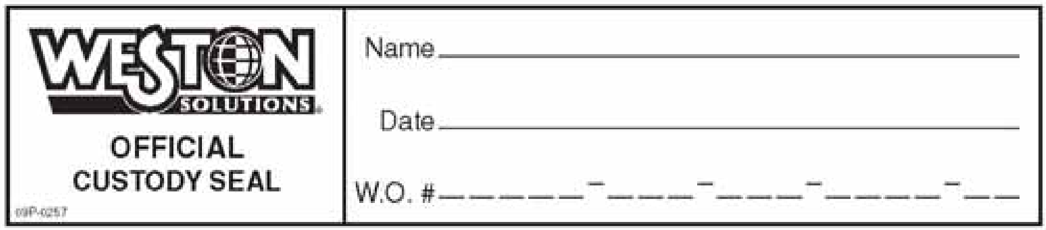


Figure 2 Chain-of-Custody Seal

4.3 SAMPLE LABELS

Every sample container will receive a label. Labels (Figure 3) will be completed using waterproof ink and will include the following information:

- Project name.
- Unique sample number.
- Sampling date and time.
- Initials of sampler.
- Sample media (soil, groundwater, etc.).
- Sample collection method (grab or filtered/unfiltered for groundwater).
- Analysis requested/chemical analysis parameters (analytes and EPA SW-846 method number).
- Method of sample preservation/conditioning.
- Remarks (such as photoionization detector readings) are useful.

PROJECT NAME	
SAMPLE ID	SAMPLE DATE
SAMPLED BY	SAMPLE TIME
SAMPLE MEDIA	REMARKS
PRESERVATIVE	____GRAB ____ COMPOSITE
ANALYSIS REQUESTED	

Figure 3 Jar/Bottle Label

4.4 POTENTIAL PROBLEMS

Although most sample labels are made with water-resistant paper and are filled out using waterproof ink, inclement weather and general field conditions can affect the legibility of sample labels. It is recommended that, after sample labels are filled out and affixed to the sample container, the container be placed in a plastic resealable bag. This will preserve the label, keep it from becoming illegible, and if the label falls off, the identification of the sample will still be known. In addition to label protection, COC and analysis request forms should also be protected when samples are shipped in iced coolers. Typically, these forms should be placed inside a plastic resealable bag or similar waterproof protection and taped to the inside lid of the secured shipping container with the samples.

5. CORRECTIONS

If an error is made, a single line should be drawn through the entry, and the entry initialed and dated. The erroneous information should not be obliterated. Any errors found in documentation should be corrected by the person who made the entry.

STANDARD OPERATING PROCEDURE G-9

SAMPLE PACKING AND SHIPPING

1. SCOPE AND APPLICATION

This section describes procedures for properly packaging and shipping environmental and/or hazardous material samples. The procedures described in this section are performed after samples have been collected and placed in the proper containers and correctly preserved. The person overseeing sample shipping is required to have current certification in the Shipping and Transporting Dangerous Goods Course.

2. EQUIPMENT

Chain-of-custody
Custody seals
Fiber strapping tape
Ice
Waterproof cooler
Plastic resealable bags
Paper towels
Bubble wrap, vermiculite, "peanuts" or other inert packing material
Air bills
Up arrows
Dangerous Goods Shipping Paperwork (if applicable)

3. RELATED PROCEDURES

SOP G-8 Sample Chain-of-Custody

4. PROCEDURE

4.1 ENVIRONMENTAL SAMPLES

Environmental samples are defined as those samples collected from environmental matrices (that are known or expected to be non-contaminated) such as soil, groundwater, or sediments that are being shipped for further testing. Environmental samples should be packaged for shipment as follows (refer to WESTON's *Manual of Procedures for Shipping and Transporting Dangerous Goods* (WESTON, 2009) for additional information as necessary):

1. The sample container is checked to determine if it is adequately identified, and sample labels are compared to chain-of-custody.

2. All bottles are checked to ensure that the contents are secured.

3. A waterproof cooler (such as a Coleman or other sturdy cooler comprised of metal or equivalent strength material) is typically used as a shipping container. In preparation for shipping samples, if the cooler has a drain plug, the drain plug is taped shut from the outside. Approximately 3 inches of inert packing material, such as bubble wrap, asbestos-free vermiculite, perlite, or styrofoam beads or "peanuts," is placed in the bottom of the container. Vermiculite is not to be used when analyzing for trace metals.

4. The bottles are placed upright in the cooler in such a way that they do not touch and will not touch during shipment. Bubble wrap or cardboard separators may be placed between the bottles at the discretion of the shipper.

5. All samples should be shipped to the laboratory on ice and chilled to 4 °C, except for the geotechnical and other samples that do not require shipment with ice. A temperature blank should be placed in the cooler so that it can be easily found by the laboratory when the cooler is first opened upon receipt.

6. Additional inert packing material is placed in the cooler to partially cover the sample bottles (more than halfway), to ensure they do not shift during transport. If samples are required to be shipped to the laboratory with ice, ice must be double bagged and placed around, among, and on top of the sample bottles. The cooler should then be filled with ice or inert packing material to prevent shifting and breakage of the contents.

7. The paperwork going to the laboratory is placed inside a plastic bag. The bag is sealed and taped to the inside of the cooler lid. The chain-of-custody form is included in the paperwork sent to the laboratory. The air bill must be filled out before the samples are handed over to the carrier. The contract laboratory should be notified by telephone of the shipment along with the estimated time of arrival. If another sample is being sent to another laboratory for analysis (such as dioxin), or if the shipper suspects that the sample

contains any other substance that would require laboratory personnel to take additional safety precautions, the individual laboratory must be notified. Also, be sure to discuss with the appropriate laboratory whether samples will be accepted by the laboratory on Saturday. If the laboratory isn't open on Saturdays, one either couldn't sample on Friday or would have to drive the samples to the laboratory so that they were received by the laboratory before closing.

8. The cooler is closed and taped shut with strapping tape (filament-type).

9. Custody seals are placed on the cooler. Additional seals may be used if the sampler or shipper thinks more seals are necessary.

10. The cooler is handed over to the overnight carrier. A standard air bill is necessary for shipping environmental samples. The shipper should be aware of carrier weight or other policy limitations. "Environmental Samples" may be included on the air bill to indicate the nature of the goods. Be sure to affix "Saturday Delivery" stickers on the cooler and select the "Saturday Delivery" check box on the carrier air bill.

4.2 HAZARDOUS SAMPLES

Hazardous samples are defined as those that are known to or suspected to contain contaminated materials and typically include, but are not limited to, oils (liquid nonaqueous phase liquid (LNAPL) and dense nonaqueous phase liquid (DNAPL)), sludges, discarded products, source area samples, and waste profile samples. Hazardous samples must be packaged according to International Air Transport Association (IATA) regulations for air transportation and/or U.S. Department of Transportation (DOT) regulations for ground carrier shipments. Personnel with required duties pertaining to the shipment of hazardous samples and/or other dangerous goods including packaging and/or paperwork preparation will have completed required training as specified by IATA/DOT regulations. At a minimum, employees will have completed WESTON's Function-Specific Shipping and Transporting Dangerous Goods training course with required refresher training every 2 years.

In accordance with current IATA and DOT regulations, WESTON has prepared a *Manual of Procedures for Shipping and Transporting Dangerous Goods* to instruct employees on the shipment of routine hazardous samples and dangerous goods. Only those employees that have completed the aforementioned training course are qualified to prepare shipments of dangerous goods in accordance with the provisions provided in the *Manual of Procedures for Shipping and Transporting Dangerous Goods*. For shipments not considered to be routine and not covered by the manual, a Dangerous Goods Shipping Advisor within WESTON will be contacted for assistance. Dangerous Goods Shipping Advisors have completed initial (24-hour) and refresher training (16-hour) at IATA- and DOT-endorsed training facilities.

Sample shipments that may contain hazardous constituents must be evaluated and comply with instructions within WESTON's *Manual of Procedures for Shipping and Transporting Dangerous Goods*.

5. BIBLIOGRAPHY

CFR (Code of Federal Regulations) . 49 CFR, Subtitle B, Other Regulations Relating to Transportation, Chapter I, Pipeline and Hazardous Materials Safety Administration, Department of Transportation, Parts 100–185.

IATA (International Air Transport Association). 2009. *Dangerous Goods Regulations*. 50th Edition. Effective from 1 January 2009 through 31 December 2009.

WESTON (Weston Solutions, Inc.). 2009. *Manual of Procedures for Shipping and Transporting Dangerous Goods*.

STANDARD OPERATING PROCEDURE G-10

SURVEYING

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide technical guidance for the surveying of environmental sampling locations. Sampling locations/stations covered in this operating practice include wells, piezometers, soil borings, test pits, surface soil and sediment stations, and staff gauges.

This operating practice, however, can also be referenced for surveying other data points, as necessary. The objective of this operating practice is to identify the specific data and reporting requirements for the measuring of coordinates and elevations for environmental sampling locations.

The objective of a sample location surveying effort is to provide accurate and well documented coordinate and elevation information that is referenced to an appropriate benchmark. It is equally important that the calculated coordinate and elevation information is reported in a pre-established format to facilitate the timely uploading of this information into a project's locational database. An increasing number of environmental projects have begun to use integrated geological, hydrological, analytical, and geographical databases to effectively manage, analyze, and report the large amounts of technical information. The link between the project's technical databases and the locational database provides a system for the generation of accurate data presentations (including two-dimensional (2-D) and three-dimensional (3-D) maps and cross-sections). Thus, when planning for a survey effort, or preparing a survey Request for Proposal (RFP), the scope of work (SOW) should include a detailed explanation of the deliverable format for the survey information.

2. EQUIPMENT

Surveying equipment
Calculator
Knife or small saw to notch top of casing survey point

Radio (optional)

3. RELATED PROCEDURES

SOP GW-6 Water Level and Well Depth Measurements

4. PROCEDURE

All surveying activities shall be performed under the direct supervision of a certified land surveyor. Locations and elevations surveyed shall be measured as the distance in feet from a reference location(s), which is tied to the applicable state plane coordinate system (SPCS). The surveys shall be third order Class II control surveys in accordance with the *Standards and Specifications for Geodetic Control Networks* (Federal Geodetic Control Committee, 1984). Horizontal precision shall be to the nearest foot. In the SPCS, the x-coordinate is the east-west axis, and the y-coordinate is the north-south axis. All x,y values shall be positive. Elevations shall be surveyed to a precision of $\pm$0.01 foot and referenced to the National Geodetic Vertical Datum of 1929 (NGVD of 1929) or North American Vertical Datum, 1988 Adjustment (NAVD 88) depending on project requirements. These surveys should be connected by third order leveling to the NGVD of 1929 or NAVD 1988 in accordance with the *Standards and Specifications for Geodetic Control Networks*.

4.1 SURVEYING DRILLING/SAMPLING LOCATIONS

The surveyor will survey the location (referenced to the applicable coordinate system) and ground elevations of soil borings, test pits, and surface soil sampling points. Wells and piezometers will require the following survey measurements:

- Adjacent ground surface elevation.
- Adjacent concrete pad surface elevation (center of pad).
- Top of inner casing elevation.
- State plane coordinate location of inner casing.

In most instances, wells and piezometers will have a locking cap, and will be opened and re-locked by the surveyor using keys supplied by WESTON. Elevations for both the natural ground surface (not the concrete well pad) and inner well casings will be surveyed from pre-established reference points. Either a notch of the casing rim or an arrow point painted on the inside well casing, just below the rim, will designate a casing reference point. If no reference point is observed, the surveyor will establish a reference point. Well locations will be surveyed from the inner casing reference point.

For borings, soil samples, and test pits, the reference elevation equals the ground surface elevation.

The surveyor shall provide only the state plane coordinates for surface water/sediment sampling points; no elevation control is required. The top of each staff gage will be surveyed for state plane coordinate and elevation information.

4.2 ELECTRONIC DELIVERABLE

The survey information for each sample location shall be delivered on computer compact disk (CD) along with a hard copy. The electronic information can be in the form of either Microsoft Excel spreadsheet files or standard ASCII data files. CAD drawing (DWG-type) files may also be required.

Each electronic file MUST contain the following fields or entries for each drilling/sampling location surveyed:

- Client name.
- Site name.
- Site number (NA if not applicable).
- Location ID number.
- Location type (e.g., piezometer, soil boring, test pit).
- Northing (state plane coordinate in feet).
- Easting (state plane coordinate in feet).
- Ground surface elevation (excluding surface water/sediment sampling locations).
- Concrete pad surface elevation (excluding surface water/sediment sampling locations).
- Top of inner casing elevation (for wells and piezometers only).
- Reference elevation (see below for definitions).

All fields must be filled out. If a particular field is not applicable, such as top of inner casing elevation for a soil boring location, then “NA” should be placed in that particular field.

4.3 SURVEYOR NOTES

One copy of all field notes collected during the performance of the survey effort plus any survey data reduction notes shall be delivered to WESTON, along with the survey electronic deliverable, and shall be maintained in the project file.

All topographic survey efforts conducted under contract will be certified by a surveyor with a current surveyor's license in Virginia.

The topographic survey will be completed as near to the time of field work completion as possible. Survey field data (as corrected), including loop closures and other statistical data in accordance with the Standards and Specifications referenced above, will be provided. Closure will be within the horizontal and vertical limits given above. These data will be clearly listed in tabular form: the coordinates (and system) and elevation (ground surface and top of well), as appropriate, for all borings, wells, and reference marks. All permanent and semipermanent reference marks used for horizontal a``````````````````````````nd vertical control (e.g., benchmarks, caps, plates, chiseled cuts, rail spikes) will be described in terms of their name, character, physical location, and reference value. These field data will become part of the project records.

5. BIBLIOGRAPHY

Federal Geodetic Control Committee. 1984. *Standards and Specifications for Geodetic Control Networks.*

STANDARD OPERATING PROCEDURE G-11

MEC ANOMALY AVOIDANCE

1. SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to provide guidance and general reference information for the avoidance of potential Munitions and Explosives of Concern (MEC) during performance of intrusive (e.g., soil boring, well installation, test pit) and vegetative clearing activities. This SOW pertains only to anomaly avoidance activities. If an anomaly is detected, it must be avoided, including relocation of proposed activities.

WESTON shall provide all labor, materials, and equipment necessary to perform anomaly avoidance support for performance of the required site activities in accordance with EP 75-1-2 (USACE, 2004). WESTON shall furnish the required unexploded ordnance (UXO)-qualified personnel, equipment, instruments, and transportation, as necessary, to accomplish the required services and furnish to the government reports and other data, together with supporting material developed while providing MEC support services. For anomaly avoidance on a Hazardous Toxic and Radiological Waste (HTRW) site with known or suspected MEC, the contractor shall provide a UXO team consisting of a minimum of two personnel, one of whom must be a UXO Technician II. This individual will be the UXO team leader. The UXO team must be on-site during all sampling activities. The most successful geophysical detection systems for MEC rely on one of two technologies, magnetometry or electromagnetics. Magnetometers are limited to detecting ferrous items. Electromagnetic detectors can detect any conductive metal.

Once a sampling location has been selected, an anomaly avoidance/clearance sweep will be performed prior to any intrusive activities. MEC anomaly avoidance support will be provided by two UXO Technicians to prevent accidental exposure to potential MEC while acquiring samples. The UXO Technicians will accompany all sampling personnel while working within the sampling area to identify potential subsurface anomalies in the sampling areas. Anomaly avoidance consists of the following activities for purposes of “clearing” a sample location:

- The desired sampling locations will be identified by the field team leader. The UXO Technicians will then conduct a sweep of the selected sample location with a hand-held magnetometer and an all metals detector.

- Once an area has been determined to be free of anomalies, the survey marker will be placed while a UXO Technician observes the activity.

- Should the desired area not be free of magnetic anomalies, another location will be chosen. The new location will be directly adjacent to the area that could not be cleared.

The sweeps of the sample location will be performed utilizing equipment such as the:

- Schonstedt Ordnance Locator – Uses passive vertical magnetic fluxgate gradiometer detection technology to identify ferrous materials.

- Vallon All-Metals Ordnance Locator – Uses digital magnetic pulse induction technology to identify both ferrous and non-ferrous metals.

During the implementation of anomaly avoidance procedures, WESTON shall provide adequate professional supervision and quality control to ensure the quality, safety, and completeness of the work. UXO personnel using personal protective equipment (PPE) will be knowledgeable of the limitations of the selected PPE as well as the reduced performance levels the equipment might impose on them when they are conducting assigned tasks.

No single detection system can effectively detect all types of military munitions at all locations and depths. There are many cases where UXO can penetrate deeper than geophysical instruments can currently reliably detect. On such sites, it is possible that undetected UXO remains deeper than it can be detected from the existing ground surface.

2. EQUIPMENT

Field logbook

Flagging

Obtain utility clearance and/or excavation permits

Fluxgate magnetometers

Frequency-domain electromagnetics (e.g., Schonstedt Ordnance Locater)

Time-domain conductivity electromagnetics (e.g., Vallon All-Metals Ordnance Locator)

3. RELATED PROCEDURES

SOP G-1 Field Documentation

4. PROCEDURE

4.1 GENERAL PROCEDURE

USACE has set forth personnel standards applicable to all UXO personnel working for USACE. These qualifications and standards, which detail the educational, experience, and training requirements for UXO personnel, are available in EP 1110-1-18 (USACE, 2000) and ER 385-1-95 (USACE, 2003 and 2004). WESTON personnel shall be in compliance with these requirements prior to conducting MEC support activities.

The UXO-qualified personnel shall precede the escorted personnel and visually search the surface of the proposed pathway for items of concern. The UXO-qualified personnel shall communicate visual observations to escorted personnel and avoid contact with any discovered MEC or MEC-related items by leading the group around them. The UXO-qualified personnel shall place flagging adjacent to any discovered MEC for subsequent visual reference.

An access survey must precede any type of investigation activity or ingress/egress within an area with known or suspected MEC. The UXO team shall locate an access route and investigation site that is free of anomalies, using an appropriate geophysical detection instrument. The access route shall be at least twice as wide as the widest vehicle that will use the route. If anomalies or surface MEC are encountered, they shall be marked with flagging, and the access route or investigation area shall be relocated to avoid contact. The boundary of each access route and investigation site shall be marked using survey flagging and pin flags.

The UXO team shall establish a system of flagging colors that will distinguish anomalies, surface MEC, and route boundaries from each other as well as from any utility markings at the site. No personnel shall be allowed outside of the surveyed areas.

4.1.1 Surface Soil Sampling

Surface soil samples are normally collected at depths from 0 to 6 inches below ground surface. The UXO team must conduct an access survey of the routes to and from the proposed investigation site as well as an area around the investigation site. The UXO team must visually survey the surface of each proposed surface soil sampling site for any indication of MEC. In addition, the UXO team must conduct a survey of the proposed sampling locations using geophysical instruments capable of detecting the smallest known or anticipated MEC to a depth of 1 foot below ground surface. If anomalies are detected at a proposed sampling location or too many anomalies are detected in a general area of interest, the HTRW personnel will select an alternate location for collection of surface soil samples. Any anomalies detected shall be prominently marked with survey flagging or pin flags for avoidance during surface soil sampling activities.

4.1.2 Subsurface Soil Sampling

Subsurface soil sampling is defined as the collection of samples below a nominal depth of approximately 6 inches from a split-spoon, Shelby tube, or bucket auger soil sampler using drilling techniques. The UXO team must conduct an access survey of the routes to and from the proposed investigation site as well as an area around the investigation site, as described above.

If the subsurface sampling depth is greater than the geophysical instrumentation detection capabilities, the UXO team must incrementally complete the geophysical survey following the procedures established in EP 75-1-2 (USACE, 2004). If an anomaly is detected at a proposed sampling location, the hole must be backfilled in accordance with site-specific procedures, and the sampling team must select a new sampling location. Any anomalies detected shall be prominently marked with survey flagging or pin flags for avoidance. Following collection of the soil sample, the sampling location must be backfilled in accordance with site-specific procedures.

4.2 GENERAL CONSIDERATIONS

During a comprehensive review of archival records, no evidence of the potential existence of recovered chemical warfare material (RCWM) or agent breakdown products byproducts was discovered. In the event that RCWM or munitions with unknown fillers are encountered, all work shall immediately cease, and project personnel shall be evacuated along cleared paths upwind from the discovery. A team consisting of a minimum of two personnel shall immediately secure the area to prevent unauthorized access.

Since the purpose of MEC support during HTRW activities is anomaly avoidance, the UXO team is not tasked to perform MEC disposition. MEC disposition will not be covered in the planning documents for the project; therefore, the UXO team is not capable or equipped to perform MEC disposition. In the event that MEC is encountered that cannot be avoided or, based on its fuzing or current condition, presents an imminent hazard requiring immediate attention, the UXO team shall notify the local Point of Contact (POC). The UXO team shall not destroy any of the MEC encountered. The local POC will notify the appropriate authority of the MEC discovery, and the UXO team will safeguard the site pending arrival of the appropriate authority.

All mishaps associated with execution of project activities shall be investigated and analyzed. Information reflected on the report forms provides the basis to investigate the accident, analyze the cause, and identify what corrective actions may be implemented to prevent similar occurrences. All mishaps shall be reported in accordance with USACE Supplement 1 to AR 385-40 (USACE, 1993) and EM 385-1-1 (USACE, 2008). Any mishap shall be reported on ENG Form 3394, Accident Investigation Report.

For anomaly avoidance, the senior UXO-qualified person on-site is responsible for mishap reporting. For contracts under the supervision of the district, mishaps shall be reported to the district safety office. USACE district personnel will report through Command channels to the Headquarters, U.S. Army Corps of Engineers Safety and Occupational Health Office.

5. BIBLIOGRAPHY

USACE (U.S. Army Corps of Engineers). 1993. Supplement 1 to AR 385-40, Accident Reporting and Records. Change 1, April 1993 (Supplement 1 to AR 385-40, March 1990). http://140.194.76.129/publications/ (Accessed 24 February 2010)

USACE (U.S. Army Corps of Engineers). 2000. EP 1110-1-18, Military Munitions Response Process. April 2000 and Errata December 2007 http://140.194.76.129/publications/ (Accessed 24 February 2010)

USACE (U.S. Army Corps of Engineers). 2003. EP 385-1-95b, Explosives Safety Submission. March 2003 and Errata December 2007. http://140.194.76.129/publications/ (Accessed 24 February 2010)

USACE (U.S. Army Corps of Engineers). 2004. EP 385-1-95a, Basic Safety Concepts and Considerations for Munitions and Explosives of Concern (MEC) Response Action Operations. August 2004 and Errata September 2006 and January and December 2007. http://140.194.76.129/publications/ (Accessed 24 February 2010)

USACE (U.S. Army Corps of Engineers). 2004. EP 75-1-2, Munitions and Explosives of Concern (MEC) Support During Hazardous, Toxic, and Radioactive Waste (HTRW) and Construction Activities. August 2004 and Errata December 2007. http://140.194.76.129/publications/ (Accessed 24 February 2010)

USACE (U.S. Army Corps of Engineers). 2008. EM 385-1-1, Safety and Health Requirements Manual. September 2008. http://140.194.76.129/publications/ (Accessed 24 February 2010)

STANDARD OPERATING PROCEDURE SS-2

SEDIMENT SAMPLING

1. SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) presents instructions for collecting representative sediment samples from shore areas or surface water bodies. Sediment can be considered as any material that is submerged/saturated (at least temporarily) or suspended in any surface water body. This includes sludges, lake bottom sediments, perennial and intermittent stream sediments, and marine sediments. Sampling devices to be used are based on the following categories according to applicability: (1) surface sediments (scoop or bedload sampler), (2) subsurface sediments/shallow water (corer/tube sampler), and (3) surface sediments/deep water (Ponar sampler).

2. EQUIPMENT

Personal protective equipment (see Accident Prevention Plan)
Flame ionization detector/photoionization detector (FID/PID)
Decontamination items
Visqueen
Rinse bottles
Trash bags
Paper towels
Field logbook
Work plan
Folding ruler marked in tenths of an inch
Tape measure
Grain size chart
Munsell color chart
Appropriate sampling device
Stainless steel trowels

Stainless steel bowls

Plastic resealable bags (1 quart + 1 gallon size)

Sharpies or other permanent marker

Flagging

Mean Streak or other paint markers

3. RELATED PROCEDURES

SOP G-1	Field Documentation
SOP G-3	Field Sample Numbering
SOP G-4	Quality Assurance/Quality Control Sampling
SOP G-6	Decontamination
SOP G-8	Sample Chain-of-Custody
SOP G-10	Surveying
SOP A-1	Calibration and Use of Air Monitoring Instruments

4. PROCEDURE

4.1 SAMPLE LOCATIONS

Depositional patterns should be considered in regard to the sample objectives when deciding the sediment sample locations. These patterns differ between standing and flowing bodies of water. Generally, for flowing water (e.g., stream or river beds), the depositional areas are normally found inside bends and downstream of islands or obstructions. Areas directly downstream from the joining of two streams should be avoided because the flows may not immediately mix. For standing water bodies, the center of the mass or a discharge point should be sampled for sediments. Selection of sample locations should be made based on the investigation objectives.

4.2 SAMPLE TYPES

The type of sample should be designated when selecting a sampling method. Sediment samples can either be discrete (grab) or composite samples.

4.3 SAMPLER SELECTION

The choice of samplers is dictated by sampling objectives (i.e., surficial versus subsurface samples) and site constraints based on water depth. Each sampling technique presents various advantages and disadvantages for its application. For example, sample disturbance, sample volume, chemical/physical reactivity between potential contaminants and sampling tool materials, and ease of decontamination vary from technique to technique.

4.4 SAMPLING OVERVIEW

Presented below are sampling instructions for the most common techniques for collecting sediment and sludge samples. Prior to sample collection, water body characteristics (e.g., size, depth, flow) should be recorded in the field logbook. Sampling should proceed from downstream locations to upstream locations so that disturbance from sampling does not affect sampling quality. Additionally, if surface water samples will be collected at the same locations as sediment samples, the water samples must be collected first. In collecting sediment samples from any source, care must be taken to minimize disturbance and sample washing as it is retrieved through the liquid column. Sediment fines may be carried out of the sample during collection if the liquid above is flowing or deep. This may result in collection of a non-representative sample due to the loss of contaminants associated with these fines.

While a sediment sample is usually expected to be a solid matrix, the sampler should not place the sample in the bottle and decant the excess liquid. If the sample is collected properly, any liquid in the bottle is representative of sediment conditions. If liquid flow and depth are minimal and sediment is easy to reach, a trowel or scoop may be used to collect the sediment sample; however, when the liquid above the sediment collection point is either flowing or greater than 6 inches in depth, a corer or other device that eliminates sample washing must be used to collect the sample to minimize washing the sediment as it is retrieved. It may be necessary to decant standing water from the top of the core. This should be done carefully and prior to transfer to the sample bottle. A decontaminated trowel should be utilized to transfer the sample from the corer directly into the bottle. After collection, the sampling device should be decontaminated before collecting the next sample.

In some instances, the dimensions of the surface water dictate that a barge or boat must be used. Generally, trowels or scoops cannot be used in an offshore situation. Instead, corers or dredges are a more efficient means for sample collection. The barge or boat should be positioned upstream (if there is flowing water) of the desired sample location. As the corer or dredge is lowered, it may be carried slightly downstream, depending upon the force of the flow. Upon retrieval, the contents of the corer or dredge should be transferred directly into the sample bottle using a decontaminated trowel. Both the corer or dredge and the trowel should be decontaminated before collecting the next sample.

4.5 SCOOP OR TROWEL

4.5.1 Applicability

The scoop or trowel method is a very accurate procedure for collecting representative surface sediment samples. This method can be used in many sampling situations, but is limited to sampling exposed sediments or sediments in surface waters less than 6 inches deep. The scoop or trowel sampler is not effective for sampling in waters more than 6 inches deep.

4.5.2 Method Summary and Equipment

The simplest, most direct method of collecting sediment samples is with the use of a stainless steel scoop or trowel. A stainless steel scoop or trowel is used to collect the sample, and a stainless steel bowl is used to homogenize the sample when applicable to the subsequent analysis.

4.5.3 Sampling Procedure

- Place plastic sheeting on the ground around the sampling location to prevent cross-contamination.
- Sketch the sample area or note recognizable features for future reference.
- Insert scoop or trowel into material and remove sample.
- Begin sampling with the acquisition of any grab volatile organic compound (VOC) samples, conducting the sampling with as little disturbance as possible to the media.

- If homogenization of the sample location is appropriate for the remaining analytical parameters, or if compositing of different locations is desired, the sample is transferred to the stainless steel bowl for mixing.

- Transfer sample into an appropriate sample bottle with a stainless steel spoon or equivalent.

- Check that a polytetrafluoroethylene (PTFE) liner is present in the cap. Wipe away any particles clinging to the bottle threads and rim to ensure a tight seal. Secure the cap tightly.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately.

- Complete all chain-of-custody documents and field sheets, and record in the field logbook.

- Decontaminate sampling equipment after use and between sample locations.

4.6 TUBE SAMPLER

4.6.1 Applicability

Discrete sediment samples from shallow to moderately deep water can be collected efficiently. Equipment for the polycarbonate tubing sampler is portable and easy to use.

4.6.2 Method Summary and Equipment

Polycarbonate tubing samplers are a simple and direct method for obtaining sediment samples. The corer is forced into the sediment. The corer is then withdrawn using a vacuum/suction technique and the sample is collected.

4.6.3 Sampling Procedure

- Probe sample location to determine approximate sediment thickness.

- Lower the polycarbonate tubing sampler until the tube contacts the top of the sediment.

- Gradually force corer into sediment (use a hammer or slambar if necessary to obtain desired sediment depth). Maintain tension on the plunger rope as sampling apparatus and tubing is advanced into the sediment. Tension will create a vacuum between the top of the sediment and the tubing, generally increasing sediment recovery.

- Remove the sampling apparatus and tubing from the sediment. Place cap on bottom of tubing and secure. Remove the tubing from the sampling apparatus and place a top on the TOP of the tubing and secure. Record the date, time, and location of the sample in the logbook and on the top cap with a permanent marker. Properly decontaminate the sampling equipment after use and between sampling locations.

- Remove sediment core from corer and place core on a clean working surface.

- Discard top of core if any organic material (e.g., leaves) is present.

- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. If homogenization of the sample location is appropriate for the remaining analytical parameters, or if compositing of different locations is desired, the proper sample interval is sectioned from the tube and transferred to the stainless steel bowl for mixing.

- Repeat as necessary to obtain sufficient sample volume.

- Transfer sample into an appropriate sample bottle with a stainless steel spoon or equivalent.

- Remove any soil clinging to the bottle threads or rim, and secure the cap tightly.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately.

- Complete all chain-of-custody documents and field sheets, and record in the field logbook.

- Decontaminate sampling equipment after use and between sample locations.

4.7 PONAR SAMPLER

4.7.1 Scope and Applicability

Ponar samplers are capable of sampling most types of sludges and sediments from silts to granular materials in deep water. They are available in sizes from hand-operated to winch-operated. Ponars are relatively safe, easy-to-use, prevent escape of material with end plates, reduce shock waves, and have a combination of the advantages of other sampling devices. Ponar grab samplers are more applicable for a wide range of sediments and sludges because they penetrate more deeply and seal better than spring-activated types (e.g., Ekman samplers). Penetration depths will usually not exceed 6 inches. Ponar samplers are not capable of collecting undisturbed samples. For example, material in the first centimeter of sediment cannot be separated from the rest of the sample. Ponars can become buried in soft sediment. The Ponar sampler is not recommended for the acquisition of volatile organic analysis (VOA) samples.

4.7.2 Method Summary and Equipment

The Ponar grab sampler is a clamshell-type scoop activated by a counter-lever system. The shell is opened, latched in place, and slowly lowered to the bottom. When tension is released on the lowering cable, the latch releases and the lifting action of the cable on the lever system closes the clamshell.

4.7.3 Sampling Procedure

- Place plastic sheeting around the sampling location to prevent cross-contamination.
- Attach the necessary length of sample line to a decontaminated Ponar. Solid braided 5-millimeter (mm) (3/16-inch) nylon line is usually of sufficient strength; however, 20-mm (3/4 -inch) or greater nylon line allows for easier hand hoisting.
- Measure the depth to the top of the sediment with a weighted object or pole.
- Mark the distance to the top of the sediment on the sample line with a proximity mark 1 meter above the sediment. Record depth to top of sediment and depth of sediment penetration.
- Open sampler jaws until latched. From this point, support the sampler by its lift line, or the sampler will be tripped and the jaws will close.
- Tie free end of sample line to fixed support to prevent accidental loss of sampler.
- Begin lowering the sampler until the proximity mark is reached.
- Lower the sampler rapidly through last meter until contact is felt.
- Allow sample line to slack several centimeters. In strong currents, more slack may be necessary to release mechanism.
- Slowly raise dredge to clear surface.

- Drain free liquids through the screen of the sampler, being careful not to lose fine sediments.

- Place Ponar into a stainless steel or PTFE tray and open.

- Repeat until sufficient sample volume has been collected.

- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media.

- If homogenization of the sample location is appropriate for the remaining analytical parameters, or if compositing of different locations is desired, the sample is transferred to the stainless steel bowl for mixing.

- Collect a suitable aliquot with a stainless steel laboratory spoon or equivalent and place sample into appropriate sample bottle. Remove any soil clinging to the bottle threads or rim, and secure the cap tightly.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately.

- Complete all chain-of-custody documents and field sheets and record information in the field logbook.

- Decontaminate sampling equipment after use and between sample locations.

4.8 BEDLOAD SAMPLER

4.8.1 Scope and Applicability

Bedload sediment samples are typically collected during high flow conditions (storm events) from river or stream channels to capture mobilized coarse grained sediments which are migrating downstream along the top of the sediment substrate. The degree to which bedload sediment is actively migrating at a given location will vary greatly with flow, sediment, and stream morphology conditions.

4.8.2 Method Summary and Equipment

There are several models of bedload samplers available depending on collection criteria, but all are designed to sit on the bedload surface with an entrance opening oriented facing upstream, which allows the migrating bedload sediments to enter the sampler and collect in a mesh sampler bag. Sampler type (i.e., hand-held or winch lowered), entrance opening (3-inch by 3-inch or 6-inch by 6-inch), chamber expansion ratio (1.4 or 3.22), and sampler bag mesh size (0.25 mm to 2.0 mm) can all be selected based on the objectives of the sampling program. Hand-held units are oriented upstream by the sampling team while winch lowered units are equipped with fins to orient the sampler to stream flow. Samples can be collected as discreet grabs or composited from multiple locations across a stream channel.

4.8.3 Sampling Procedure

- Place plastic sheeting around the sampling location to prevent cross-contamination.
- Attach the selected sampler bag to the sampler, and the sampler to the winch cable (if applicable).
- Measure the depth to the top of the sediment with a weighted object or pole.
- Mark the distance to the top of the sediment on the winch line with a proximity mark 1 m above the sediment.
- Begin lowering the sampler until the proximity mark is reached, allowing the sampler to orient to the stream flow.
- Lower the sampler slowly through last meter, allowing it to gently rest down on the sediment surface.
- Allow sampler to rest on the bottom for 2 minutes.
- Slowly raise sampler to clear surface.
- If sufficient sample volume has been collected, proceed to sample processing. If not, return the sampler to the stream bed for additional collection time. For composite samples across a stream channel, the sampler should be deployed for an equal amount of sampling time at each composite location. Record the total sample time at each location.
- Once sufficient sample volume has been collected, remove the sampler bag from the bedload sampler, and allow free water to drain from the mesh bag.
- Empty sample bag into a stainless steel bowl and remove any organic materials such as twigs and leaves.
- Thoroughly homogenize the sample in the stainless steel bowl by mixing.

- Collect a suitable aliquot with a stainless steel laboratory spoon or equivalent and place sample into appropriate sample bottle. Remove any soil clinging to the bottle threads or rim, and secure the cap tightly.
- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately.
- Complete all chain-of-custody documents and field sheets and record information in the field logbook.
- Decontaminate sampling equipment after use and between sample locations.

4.9 SEDIMENT SAMPLING PROCEDURE IN A COBBLE SUBSTRATE

The following method will be used when the presence of a large proportion of cobbles and/or boulders precludes the use of other sediment sampling techniques:

1. Place 55-gallon drum (lid and bottom removed) onto sampling location. Push, pound, and wiggle the drum into the sediment. Remove cobbles around rim of drum as needed.
2. Remove large rocks (e.g., cobbles) from inside of drum as a 5-gallon bottomless bucket is placed inside of the drum. Push, pound, and wiggle the bucket into the sediment to partition this area from the drum.
3. Remove sediment from 0 inches to 6 inches from the entire inside of the bucket with a trowel or scoop and place into sample jars.
4. Place rubber seal in the bottom of the bucket. Pump or bail water from the bucket into a 10-micrometer (µm) filter bag. Pump/bail until water level reaches the bottom of the bucket, or until 5 gallons of water are passed through the filter bag. Remove the rubber seal from the bottom of the bucket.
5. Use a power auger to loosen the next 6-inch interval of sediment/cobbles.
6. Collect the 6-inch to 12-inch interval of sediment with trowel or scoop, and place into sample jars.
7. Repeat step 4.
8. Decontaminate the 5-gallon bucket, rubber seal, and trowel/scoop.
9. Submit all 4 samples (2 sediment, 2 filter bags) for laboratory analysis.

4.10 SAMPLE CONTAINERS AND PRESERVATION TECHNIQUES

4.10.1 Sample Containers

Refer to the Quality Assurance Project Plan (QAPP), Section 19 (WESTON, 2010) for information on the required size and type of sample containers. Samples should be collected and containerized in the order of the volatilization sensitivity of the parameters. A preferred collection order for some common parameters follows:

1. VOA.
2. Total organic carbon (TOC).
3. Extractable organics (base/neutral/acid (BNA) or semivolatile organic compound (SVOC)).
4. Total metals.
5. Phenols.
6. Cyanide.
7. Total solids.

4.10.2 Sample Preservation and Handling

Many of the chemical constituents and physiochemical parameters that are to be measured or evaluated in investigation programs are not chemically stable; therefore, sample preservation is required. Appropriate preservation techniques and sample containers that the sampler should use for each constituent or common set of parameters are specified in the QAPP, Section 19. The samples collected for VOC analysis should *never* be homogenized or composited. They should be carefully transferred directly from the sample collection device to the sample container in order to minimize contaminant loss through agitation/volatilization or adherences to another container.

4.10.3 Field Quality Control Sampling Procedures

Field quality control samples are collected by the sampling team to determine whether data are of suitable quality. They include blanks, duplicates, and/or background samples. A detailed discussion of field quality control samples is presented in SOP G-4.

4.10.4 Decontamination Procedures

All equipment that will enter the sediment must be decontaminated. Sampling equipment should be decontaminated as described in SOP G-6. Sampling equipment should be placed in plastic bags until immediately prior to use. Additional sampling devices may be needed on-site to ensure adequate drying time.

4.10.5 Documentation

Bound field logbooks should be used for the maintenance of field records. All aspects of sample collection and handling as well as visual observations shall be documented in the field logbooks as outlined in SOP G-1.

All entries in field logbooks should be legibly recorded and contain accurate and inclusive documentation of project activities.

5. BIBLIOGRAPHY

ASTM Standard D3976. 2005. "Standard Practice for Preparation of Sediment Samples for Chemical Analysis." ASTM International, West Conshohocken, PA. 2005, DOI: 10.1520/D3976-92R05. www.astm.org. (Accessed 24 February 2010).

ASTM Standard D4823. 2008. "Standard Guide for Core Sampling Submerged, Unconsolidated Sediments." ASTM International, West Conshohocken, PA. 2008, DOI: 10.1520/D4823-95R08. www.astm.org. (Accessed 24 February 2010).

EPA (U.S. Environmental Protection Agency) and U.S. Army Corps of Engineers (USACE). 1998. *Great Lakes Dredged Material Testing and Evaluation Manual.* Final Draft. Prepared by U.S. Environmental Protection Agency, Regions 2, 3, 5 and Great Lakes National Program Office and U.S. Army Corps of Engineers Great Lakes and Ohio Division.

WESTON (Weston Solutions, Inc.). 2010. *Draft Uniform Federal Policy Project-Specific Quality Assurance Project Plan (QAPP), Remedial Investigation for the Ricochet Area Munitions Response Site in State Game Lands 211, Pennsylvania.* Prepared for National Guard Bureau and Pennsylvania Army National Guard, Department of Military and Veterans Affairs, Fort Indiantown Gap Military Reservation.

STANDARD OPERATING PROCEDURE SS-3

SOIL SAMPLING

1. SCOPE AND APPLICABILITY

Instructions presented in this Standard Operating Procedure (SOP) are for collecting representative soil samples. Soil sampling can be classified into two primary types: surficial and subsurface. Instructions for sampling surficial soil included in this section utilize the spade and scoop. Instructions for sampling subsurface soil included in this section utilize the following techniques: split spoon sampler and thin-walled (Shelby) tube. There are also specific sampling protocols presented for riverbank and/or floodplain sampling using hand augering.

2. EQUIPMENT

Field logbook
Muncell color chart
Grain size card
Hand lens
Clipboard
Folding rule (in feet and tenths)
Pocket penetrometer (if required)
Indelible ink markers
Squirt bottle (with deionized water)
Plastic sheeting
Paper towels
Pens (blue or black)
Eye protection
Work gloves
Surgical gloves
Sample jars
Sample jar labels

Chain-of-custody forms

Photoionization detector (PID)

Decontamination materials

Appropriate sampling device

3. RELATED PROCEDURES

SOP G-1	Field Documentation
SOP G-3	Field Sample Numbering
SOP G-4	Quality Assurance/Quality Control Sampling
SOP G-6	Decontamination
SOP G-7	Management of Investigation Derived Waste (IDW)
SOP G-8	Sample Chain-of-Custody
SOP G-10	Surveying
SOP G-11	MEC Anomaly Avoidance
SOP GW-1	Borehole/Well Abandonment
SOP A-1	Calibration and Use of Air Monitoring Instruments

4. PROCEDURE

4.1 SAMPLING LOCATIONS

Sampling at sites is usually conducted in an attempt to discover contamination and to define its extent and variability. With such an objective, it is most logical to choose sample locations that will yield the most information about site conditions. Because of the nature of the media, soil samples can vary considerably across a site. Physical properties of the soil, including grain size and cohesiveness, may limit the depth from which samples can be collected and the method required to collect them. In most soil, hand-powered equipment can be used only to a depth of approximately 4 to 5 feet. At greater depths, soil sampling is normally performed with a drill rig or other mechanically driven device.

4.2 SAMPLE TYPES

The type of sample should be designated when selecting a sampling method. Application techniques for sample methods include discrete (grab) or composite samples. A discrete (grab) sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected immediately and at one particular point in the sample matrix. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease. Composites are samples composed of two or more specific aliquots (discrete samples) collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can, in certain instances, be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask the presence of contaminants by diluting isolated concentrations of analytes that may be present in the environmental matrix.

4.3 SAMPLE COLLECTION

Each sampling technique presents various advantages and disadvantages for its application. For example, sample disturbance, sample volume, chemical/physical reactivity between potential contaminants and sampling tool materials, and ease of decontamination vary from technique to technique. Subsurface soil conditions themselves will restrict the application of certain samples. For example, the thin-walled tube sampler is not applicable for sampling sands.

Presented below are sampling instructions for the most common techniques of collecting soil samples. Prior to sample collection, the soil sampling location and characteristics (e.g., soil type, depth) should be recorded in the field logbook. Selection of soil sampling equipment is usually based on the depth of the samples. Manual techniques are usually selected for surface or shallow subsurface soil sampling. At greater depths, mechanically driven equipment is usually required to overcome torque induced by soil resistance and depth.

4.3.1 Surficial Sampling

4.3.1.1 Spade and Scoop

The spade and scoop method is a very accurate, representative method for collecting surface and shallow subsurface soil samples. This method is usually limited to soil depths less than 1 foot.

Method Summary and Equipment

The simplest, most direct method of collecting surface soil samples is to use a spade and stainless steel scoop. A typical garden spade can be used to remove the top cover of soil to the required depth, and the smaller stainless steel scoop can be used to collect the sample.

Sampling Procedure

- Place plastic sheeting on the ground around the sampling location to prevent cross-contamination.
- Carefully remove the top layer of soil to the desired sample depth with a pre-cleaned or decontaminated spade.
- Using a pre-cleaned or decontaminated stainless steel scoop or trowel, collect the sample aliquot for volatile organic compound (VOC) analysis first (if applicable), then homogenize enough soil in a stainless steel bowl for the remaining sample containers.
- Transfer sample into the appropriate sample bottle with a stainless steel laboratory spoon or equivalent.
- Remove any soil clinging to the bottle threads or rim, and secure the cap tightly.
- Label the sample bottle with the appropriate sample label. Complete the label carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately.
- Complete all chain-of-custody documents and record in the field.
- Prepare samples for shipping.
- Decontaminate sampling equipment after use.

4.3.2 Subsurface Sampling

4.3.2.1 Split-Spoon Sampler

The split spoon sampler is used for sampling subsurface soil in cohesive and non-cohesive type soils. It is used extensively for collecting subsurface soil samples for chemical analysis. The split spoon sampler will require a drill rig and crew for collecting samples at a depth greater than 5 feet. The split-spoon sampler will be the primary subsurface sampling device used.

Method Summary and Equipment

The split spoon sampler is typically a 2- or 3-inch-diameter, thick-walled, steel tube that is split lengthwise. If a 2-inch-diameter split spoon sampler is used, then standard penetration tests can be taken to determine the density of the soil (ASTM D1586). A cutting shoe is attached to the lower end; the upper end contains a check valve and is connected to the drill rods. When a boring is advanced to the point that a sample is to be taken, drill tools are removed, and the sampler is lowered into the hole on the bottom of the drill rods. The sampler is driven into the ground in accordance with the standard penetration test.

Sampling Procedure

- Place plastic sheeting on the ground around the sampling location to prevent cross-contamination.
- Assemble the sampler by aligning both sides of the barrel and then screwing the drive shoe on the bottom and the heavier headpiece on top.
- Place the sampler in a perpendicular position on the material to be sampled.
- Drive the tube utilizing a sledge hammer or drill rig if available. Do not drive past the bottom of the headpiece because this will result in compression of the sample.
- Record the length of the tube that penetrated the material being sampled and the number of blows required to obtain this depth. Typically, the number of blows per 6 inches of depth is recorded.
- Withdraw the sampler and open it by unscrewing the drive shoe and head, and splitting the barrel. If split samples are desired, a decontaminated stainless steel knife should be utilized to split the tube contents in half longitudinally.

- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media.
- If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of different locations is desired, the sample is transferred to the stainless steel bowl for mixing.
- Transfer sample into an appropriate sample bottle with a stainless steel laboratory spoon or equivalent.
- Remove any soil clinging to the bottle threads or rim, and secure the cap tightly.
- Label the sample bottle with the appropriate sample label. Be sure to label the bottle carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately.
- Complete all chain-of-custody documents and record in the field.
- Prepare samples for shipping.
- Decontaminate sampling equipment after use and between sampling locations.

4.3.2.2 Thin-Walled (Shelby) Tube Sampler

Applicability

Thin-walled tube samplers allow collection of undisturbed samples in cohesive type soil (i.e., clays). They are primarily used for collecting soil samples for certain geotechnical tests. Thin-walled tube samplers are not the ideal container for transporting samples to the laboratory for chemical analysis. The opportunity for describing the soil is diminished because most of the soil is concealed in the tube. The Shelby Tube will be used only in clayey material where an undisturbed sample is required, and the field crew has specifically been instructed to use a Shelby Tube sampler.

Method Summary and Equipment

The thin-walled tube sampler is designed to take undisturbed samples in cohesive type soils. The thin-walled tube sampler is available in brass, galvanized steel, plain steel, or stainless steel, and is manufactured in either 30- or 36-inch lengths. It is available in 2-, 3-, and 5-inch diameters;

however, the 3-inch diameter is the most commonly used. Thin-walled tube samplers are usually used for sampling cohesive soils for geotechnical evaluation, rather than chemical analysis.

Sampling Procedure

- Place plastic sheeting on the ground around the sampling location to prevent cross-contamination.
- Place the sampler in a perpendicular position on the material to be sampled.
- Push the tube into the soil by a continuous and rapid motion, without impact or twisting. In no instance should the tube be pushed further than the length provided for the soil sample.
- When the soil is so hard that a pushing motion will not penetrate the sample sufficiently for recovery, it may be necessary to collect a disturbed sample with the split-spoon sampler. Extremely dense and hard soil may result in damage to the thin-walled tube sampler.
- Before pulling out the tube, rotate the tube at least two revolutions to shear off the sample at the bottom. For geotechnical analysis, seal the ends of the tube with wax or rubber packers to preserve the moisture content. In such instances, the procedures and preparation for shipment should be in accordance with ASTM Method D1587. For chemical samples, seal the ends of the tube with teflon-lined plastic caps or equivalent. Seal each end cap with plastic electrical tape.
- Label the sample tube with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.
- Complete all chain-of-custody documents and record in the field.
- Prepare samples for shipping.
- Decontaminate sampling equipment after use and between sampling locations.

4.3.2.3 Hand Augering—Riverbank and Floodplain Sampling

Instructions presented in this SOP are for collecting representative soil samples at riverbank and/or floodplain locations.

Applicability

Hand augering is an accurate and efficient method for sampling soil. Soil samples are removed at discrete depths. Hand augering proves inefficient where the subsurface contains large gravel, or when the surface and subsurface are frozen.

Method Summary and Equipment

The auger is attached to an auger handle. Typically, there are three standard size augers available for use (with internal diameters of 4, 2, and 1 inch, respectively). A single auger can be used to collect a discrete sample at a specified depth or the augers can be used in succession (from highest to lowest internal diameter) to take three discrete samples at different depths (such as 0 to 6 inches, 12 to 18 inches, and 24 to 30 inches below ground surface (bgs)) at the same location.

Sampling Procedure (discrete samples/different depths)

- Place plastic sheeting on the ground around the sampling location to prevent cross-contamination.
- Attach the 4-inch internal diameter auger on the auger handle.
- Clear the area of any vegetation, if necessary.
- Begin augering at the sample location. Auger to a depth of 6 inches.
- Remove all soil from the auger and place in a clean stainless steel bowl for homogenizing. This is the first sample with a depth of 0 to 6 inches bgs.
- If it is too difficult to auger to a depth of 6 inches, remove soil sequentially until reaching the 6-inch depth.
- After collecting the first sample, use the same auger (4-inch internal diameter) to auger the soil from 6 to 12 inches bgs. Remove the auger from the auger handle and set aside. Be careful to let the soil from the 6- to 12-inch depth remain in the auger.
- Replace surgical gloves (to prevent cross-contamination) and attach a clean 2-inch internal diameter auger to the auger handle.
- Auger from 12 to 18 inches bgs. This is the second sample. Carefully place this soil in a second clean stainless steel bowl for homogenizing.

- Using the same auger, auger to a depth of 24 inches. Remove the auger from the auger handle, again keeping the soil in the auger.
- Replace surgical gloves (to prevent cross-contamination) and attach a 1-inch internal diameter auger on the auger handle and collect the third sample. The third sample is the soil at a depth of 24 to 30 inches. Place this soil in a third clean stainless steel bowl for homogenizing.
- Once the three samples have been collected, place the soil in the first two augers back in the sample location.
- Homogenize the soil in the third bowl. Use a new pair of gloves to avoid cross-contamination. Document the soil description and place soil in desired jars as necessary. Label the jars with the correct sample identifier (ID) number and other necessary information (see **SOP G-3**).
- Place the sample jars in a cooler filled with ice as soon as possible.
- Repeat this procedure for the other two soil samples. If any soil remains, place in the same sampling hole to avoid spreading possible contamination.
- Prepare samples for shipping.
- Decontaminate all sampling equipment after use and between sampling locations.

4.4 FIELD MEASUREMENT PROCEDURES

The purpose of this section is to identify methods for field screening soil. Visual assessment and instrument readings will be used to screen field samples and residual samples. Residual materials may include excess samples, cuttings, and other materials.

4.4.1 Preparation

- Review screening procedures and equipment operation manuals.
- Calibrate field screening instruments in accordance with the manufacturer's instructions and operating procedures (see SOP A-1).
- Document calibrations in the field logbook.
- Determine the ambient air temperature. If the ambient air temperature is below 15 ^{o}C, select an area where soil samples can be kept warm for head space readings.

4.4.2 Field Screening

Prior to and during collection of a soil or sediment sample, visually observe the sampling area, and sample for signs of releases that include the following:

- Surface discoloration or staining.
- Stressed or discolored vegetation.
- Physical evidence of hydrocarbons or other contamination.

Record visual observations of the sampling area in the field logbook. Include a sketch and dimensions of any area where visual signs of a release are observed.

4.4.3 Instrument Readings

Take instrument readings prior to sampling to monitor ambient air for health and safety purposes. Record this information in the field logbook.

Soil and/or sediment headspace readings are taken in the following manner:

- Place soil/sediment sample in a clean, dry, glass jar so that the jar is not more than half full. Cover the jar with aluminum foil and replace the lid.

- If the ambient temperature is low, bring the jarred samples to an area where they can be warmed.

- Gently shake the jar to aid sample volatilization.

- Remove the lid and insert the probe through the aluminum foil, but not into the sample since this will clog the instrument. Record the instrument reading of the area on the log reserved for headspace readings.

- Do not submit the jarred sample for laboratory analysis.

- Dispose of the jarred sample in accordance with residual management protocols.

4.5 SOIL SAMPLING FOR VOLATILE ORGANIC COMPOUNDS

4.5.1 $EnCore_{TM}$ Sampler

The EnCore Sampler has been approved for collection of samples, and this method is the preferred sampling method for use at the site. The EnCore Sampler (or equivalent) selects a small volume (about 5 grams) of soil that is stored in a chamber that is submitted to the analytical laboratory. *The sample must be received, prepped, and analyzed within 2 days of collection; therefore, all samples must be shipped the day they are collected.*

Two or three EnCore samplers will be required per analytical sample:

- One EnCore sampler for low-concentration analysis.
- One EnCore sampler for high-concentration analysis or low-concentration duplication.
- One EnCore sampler for repreparation.
- One volatile organic analyte (VOA) jar with Teflon cap for moisture determination.

The EnCore Sampler is a single use device. It can not be cleaned and/or reused. The following is the procedure for using the EnCore Sampler:

- Hold the coring body and push the plunger rod down until the small o-ring rests against the tabs. This will ensure that the plunger moves freely.
- Depress the locking lever on the EnCore T-Handle. Place the coring body, plunger end first, into the open end of the T-Handle, aligning the two slots on the coring body with the two locking pins in the T-Handle.
- Twist the coring body clockwise to lock the pins in the slots. Check to ensure the sampler is locked in place. The sampler is now ready for use.
- Turn the T-Handle with the T up and the coring body down. This positions the plunger bottom flush with the bottom of the coring body (ensure that the plunger bottom is in position).
- Using the T-Handle, push the sampler into the soil until the coring body is completely filled. When full, the small o-ring will be centered in the T-Handle viewing hole.
- Remove the sampler from the soil and wipe any excess soil from the exterior of the coring body.
- Place a cap on the coring body while it is still in the T-Handle. Push and twist the cap over the bottom until the grooves on the locking arms seat over the ridge on the coring body. The cap must be seated to seal the sampler.
- Remove the capped sampler by depressing the locking lever on the T-Handle while twisting and pulling the sampler from the T-Handle.

- Lock the plunger by rotating the extended plunger rod fully counter-clockwise until the wings rest firmly against the tabs.
- Attach a completed circular label from the EnCore Sampler bag to the cap on the coring body.
- Complete the outside label on the EnCore Sampler bag and add a custody seal.
- Return the full EnCore Sampler to a resealable plastic bag. Seal the bag and place on ice.

It should be noted that EnCore Samplers can be used for all soil sampling activities, i.e., surface soil, sediment, etc., by sub-sampling the sampling device (e.g., shovel, coring device, split spoon). In a soil matrix that is noncohesive, the EnCore Sampler's plunger can be retracted, filled with the required sample volume, and then capped.

5. BIBLIOGRAPHY

ASTM Standard D4700. 2006. "Standard Guide for Soil Sampling from the Vadose Zone." ASTM International, West Conshohocken, PA. 2006, DOI: 10.1520/D4700-91R06. www.astm.org. (Accessed 24 February 2010).

ASTM Standard D3550. 2007. "Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils." ASTM International, West Conshohocken, PA. 2007, DOI: 10.1520/D3550-01R07. www.astm.org. (Accessed 24 February 2010).

ASTM Standard D1452. 2009. "Standard Practice for Soil Exploration and Sampling by Auger Borings." ASTM International, West Conshohocken, PA. 2009, DOI: 10.1520/D1452-09. www.astm.org. (Accessed 24 February 2010).

ASTM Standard D1586. 2008. "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils." ASTM International, West Conshohocken, PA. 2008, DOI: 10.1520/D1586-08a. www.astm.org. (Accessed 24 February 2010).

ASTM Standard D1587. 2008. "Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes." ASTM International, West Conshohocken, PA. 2008, DOI: 10.1520/D1587-00R07E01. www.astm.org. (Accessed 24 February 2010).

STANDARD OPERATING PROCEDURE SS-4

Post-Blow-in-Place Sampling

7-Sample Wheel Approach

1. SCOPE AND APPLICABILITY

Instructions presented in this Standard Operating Procedure (SOP) are for collecting post-blow-in-place (post-BIP) soil samples. Instructions for surface soil sampling included in this section utilize the 7-Sample Wheel approach.

The purpose of this post-BIP sampling program is to collect and analyze representative post-detonation soil samples for all UXO items that are BIP to confirm that any residual detectable munitions constituents (MC) [e.g., 2,4,6-trinitrotoluene (TNT)] concentrations are within acceptable levels following high-order detonation events.

2. EQUIPMENT

Field logbook
Clipboard
Folding rule (in feet and tenths)
Paper towels
Pens (blue or black)
Eye protection
Work gloves
Surgical gloves
Sample jars
Sample jar labels
Chain-of-custody forms
Appropriate sampling device

3. RELATED PROCEDURES

SOP G-1 Field Documentation
SOP G-3 Field Sample Numbering

SOP G-4 Quality Assurance/Quality Control Sampling
SOP G-6 Decontamination (if disposable equipment is not utilized)
SOP G-7 Management of Investigation Derived Waste (IDW)
SOP G-8 Sample Chain-of-Custody
SOP G-11 MEC Anomaly Avoidance

4. PROCEDURE

4.1 SAMPLING LOCATIONS

Sampling will be conducted at locations where discovered UXO items are detonated in place (i.e., post-BIP).

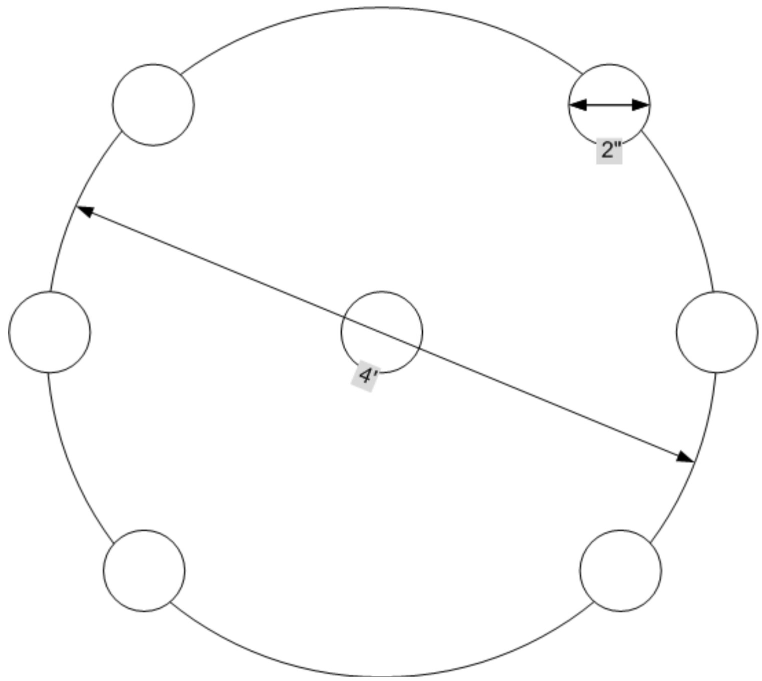
4.2 SAMPLE TYPES

Post-BIP soil samples will consist of a composite sample based on the Cold Regions Research Engineering Laboratory (CRREL) 7-Sample Wheel approach [as described in CRREL Special Report (SR) 96-15, *Assessment of Sampling Error Associated with Collection and Analysis of Soil Samples at Explosives-Contaminated Sites*]. Composite samples are composed of two or more specific aliquots [discrete (grab) samples] collected at various sampling locations as described in Subsection 4.3.

4.3 *7-SAMPLE WHEEL APPROACH*

The 7-Sample Wheel approach obtains seven grab samples within the wheel (see Figure 4-1) and combines them together. Typically the portions used to make the composite are not individually weighed; however, they should be approximately equal in weight. Each grab samples will be combined in a disposable aluminum container, all foreign matter will be logged and removed with a sterile gloved hand, and then the samples will be thoroughly homogenized to form one composite sample. The complete procedures to establish a composite sample from the seven samples are detailed on page 4 of CRREL SR 96-15. Each of the grab samples will be collected from a depth of 0 to 12 inches below ground surface (bgs) using a disposable scoop or similar equipment.

Figure 4-1 7-Wheel Sampling Approach



Each incremental sampling location will be cleared of foreign matter (i.e., scrap metal, rocks, etc.). New scoops and gloves will be used at each sampling location. Each collected grab sample from the "wheel" will be placed along with the other grab samples in a disposable aluminum container and homogenized with a disposable scoop.

Material in the disposable aluminum container will be transferred with a new disposable scoop into the appropriate sample containers. Sample containers will be filled to the top, taking care to prevent soil from remaining in the lid threads prior to being closed to prevent potential contaminant migration to or from the sample. Sample containers will be closed as soon as they are filled, placed in an ice chest chilled to 4 degrees Celsius (°C), and processed for shipment to the laboratory. All field personnel will wear clean disposable nitrile gloves when collecting samples to avoid cross-contamination.

The sample will be thoroughly mixed using the following procedures:

- Roll the soil to the middle of the compositing container and mix.
- Quarter the sample and move to the sides of the container.
- Mix each quarter individually and roll to the middle of the compositing container.

- Mix the sample once more, composite quarter sub-samples, and place in laboratory sample container.

New disposable plastic scoops and aluminum containers will be used at each sample location.

Horizontal coordinates for each of the sampling locations will be surveyed in the field.

5. REFERENCES

ERDC (Engineer Research and Development Center)/CRREL (Cold Regions Research Engineering Laboratory) Special Report (SR) 96-15, Jenkins, Thomas F., et. al. (1996). *Assessment of Sampling Error Associated with Collection and Analysis of Soil Samples at Explosives-Contaminated Sites*. http://www.crrel.usace.army.mil/library/specialreports/SR96_15.pdf

APPENDIX F-3

STANDARD OPERATING PROCEDURE
MINIMIZING DISRUPTION OF SPECIAL PLANT AND ANIMAL SPECIES

STANDARD OPERATING PROCEDURE (SOP):

MINIMIZING DISRUPTION OF SPECIAL PLANT AND ANIMAL SPECIES

1.0 Introduction

The purpose of this SOP is to provide guidance and methodology for minimizing/eliminating the disruption to special plant AND animal species within the Ricochet Area Munitions Response Site (MRS).

2.0 Scope and Applicability

This procedure applies to all project personnel conducting activities for the Remedial Investigation of the MRS.

3.0 Species of Concern

3.1. Plant Species

Pennsylvania (PA) Threatened Species

American holly *(Ilex opaca)* – A listed threatened species. American holly is an evergreen shrub or small tree that grows to 50 ft in height. It can be easily recognized by its semi-thick, evergreen leaves with a sharp spine at the tip and additional spines along the margin. The flowers, which appear in May and June, are unisexual, so that the familiar berry-like fruit, red at maturity, can be found only on female plants. This species has been previously found within the project area along Rattling Run, Dresden Lake, and in multiple locations along Stony Creek.

PA Rare

Minniebush *(Menziesia pilosa)* – Found in dry to wet woods and stream banks; flowering in late May. This species has been previously found outside the project area along Rauch Run. However, potential forested stream bank habitat exists for this species within the project area.

Special Concern Species

Woodwardia areolata (Netted chainfern): Found in moist or wet woods and acidic bogs. This species has been previously found along Rauch Run, and potential habitat for this species exists in other locations within the project area.

3.2. Animal Species

Currently Unlisted, Proposed PA Threatened

Isopods and/or amphipods are small invertebrate species (crustaceans) that inhabit coldwater springs, seeps, on hillsides and in caves. Although these species are not listed as candidate, threatened, or endangered, they may be listed in the not so distant future. These rare invertebrate species are threatened by habitat destruction and poor water quality.

PA Candidate Species

Timber rattlesnakes occur in the forested, mountainous regions of the Commonwealth. They prefer forested areas to forage for small mammals (e.g., mice and chipmunks) and talus, south to southeastern facing rocky slopes for hibernating and other thermoregulatory activities. The timber rattlesnake is threatened by overhunting, poaching, and habitat alteration.

<u>Other Potential Special Status Species (although not listed in current Pennsylvania Natural Diversity Inventory (PNDI) request and response)</u>

A Hand-Maid Moth (*Datana ranaeceps*) – is a Special Concern Species.

photo source: Jim Vargo
http://mothphotographersgroup.msstate.edu/species.php?hodges=7911

The hand-maid moth has a wing span of 1 to 1 ½ inches with dark-brown forewings and light brown hindwings. Its distribution is largely known to occur in Pennsylvania, New Jersey, and New York but may reside in other states. Larvae are known to feed on staggerbushes (*Lyonia* spp.) as a host plant and nocturnal adults do not feed. It requires mixed hardwood forests, hardwood-pine mixes, and scrubland-grassland-woodland mixes. Information on behavior and general biology are lacking at this time.

Pine Barrens Zale (*Zale sp.1 nr.* lunifera) – is a Special Concern Species.

Source: unknown

Black Dash (*Euphyes conspicua)* – is a Special Concern Species. The Black Dash has a wingspan of 1 to 1 3/8 inches, is richly colored, has a medium-sized skipper and is best distinguished by its hindwing pattern. In both males and the dark females both above and below, there is a distinctive vaguely diamond-shape patch of yellow surrounded by the much more extensive darker background. The forewing pattern above in males is dominated by a thick, sooty-black stigma under a patch of yellow. The female’s forewing above has a bold crescent of yellow spots, some of them translucent. Its distribution is Southern Ontario, Minnesota, and eastern Nebraska around the southern periphery of the Great Lakes; southern New England south through eastern Pennsylvania, New Jersey, Maryland, and Virginia. Larval food plants consist of Tussock-Sedge (*Carex stricta*) and adults can be found nectaring on flowering plants, and common and swamp milkweeds. The habitat of the Black Dash consists of wetlands where its food plant occurs, including marshy edges, river meadows, and bogs as well as in nearby uplands with nectaring sources.

<u>Terrestrial Wildlife: State Candidates</u>

Two species of terrestrial wildlife that are State candidates include the following:

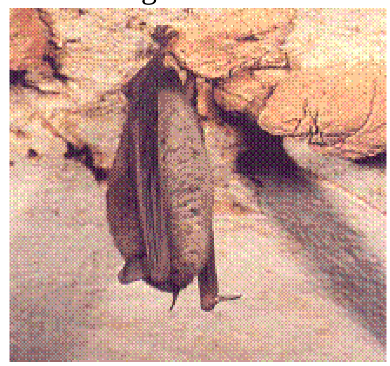


photo source: WPC 2002

Indiana bat (*Myotis sodalis*) – Pennsylvania Endangered Species. The Indiana bat is small (3 to 3.5 inches) and grayish-brown. It huddles on cave walls at densities of up to 2,700 individuals per square meter. The Indiana bat is vulnerable to human disturbance of its roosting sites, especially during its winter hibernation.

photo source: Cal Butchkowski

Allegheny woodrat (*Neotoma magister)* – is a Pennsylvania Threatened Species. The Allegheny woodrat ranges in size from 14 to 17 inches in total length (including tail). The fur is brownish-gray with slightly darker coloration in the middle of the back. The belly and paws are white and the sides are buff. The Allegheny woodrat has large ears and a furry, bi-colored tail. Its habitat includes cliff faces, in boulder piles, talus slopes, and sometimes in limestone caves. Nests composed of shredded plant fibers are found in dry cave entrances, along narrow ledges and in rock crevices. This species feeds on nuts, bark, grasses, fruits, and berries. They are nocturnal and a relatively shy species. Distribution of the Allegheny woodrat is primarily along the Appalachian Mountains from New York to Georgia and west to Indiana.

4.0 Operational Procedures

The intent of this SOP is for personnel conducting field activities to be able to

- **Recognize**,
- **Identify**, and conduct
- **Avoidance**

of all special plant and animal species that have been identified as endangered or threatened. Each phase of the Remedial Investigation (RI) field work will require separate methods and procedures to ensure the protection of special plant and animal species. Prior to any field work activities commencing, awareness training will be conducted for field staff for recognition of sensitive plant and animal species which are expected to be encountered within the site. In addition field staff will be trained in-field to identify plant species of concerns. It is acknowledged that the American Holly will be easiest plant for identification based on physical appearance year round. The Netted chainfern may not immediately be able to be recognized in early spring activities. Minniebush also falls within a late spring budding process, which will make visual recognition by the untrained eye difficult.

The first phases of field work will include mobilization, survey control installation, and installation of the geophysical verifications system. These activities will require minimal to no intrusive activity which could adversely affect plant and animal communities within State Game Land (SGL) 211. As part of in-field training the biologist will pre-survey along transect areas to identify examples of plant species of concern to show field crews. These specimens will be marked with flagging in the field and global positioning system (GPS) coordinates will be recorded. All field staff will be provided hands-on training to identify species based on examples by the field biologist. One field team member of each separate investigation team will be assigned the responsibility to identify and document occurrence of plants during field work. The over –site biologist will complete periodic (assumed to be weekly) inspections. DCNR recommends focusing on all areas within 500 ft of both banks of Stony Creek, Rauch Run, Devils'Race Course, Rattling Run and any unnamed or unmapped springs or seeps within the project area to locate specimens for training purposes.

Analog Instrument-Aided Visual Survey

An analog instrument-aided visual survey will be conducted along linear transects over a targeted 4.6% (367 acres) of the Ricochet Area MRS. Transects will be conducted at 300-ft spacing utilizing a 10-ft wide swath (based on two people with 5-ft swath width each) with a symmetric search pattern in an east-west orientation. In addition, the streams and Rail Trail within the Ricochet Area MRS will be surveyed. All subsurface anomalies identified will be intrusively investigated in real-time in order to determine the presence of munitions and explosives of concern (MEC). In areas where high cultural debris (e.g., rail spikes, tent stakes, etc.) are being identified, the unexploded ordnance (UXO) technicians will adjust the intrusive investigation as appropriate based on professional judgment. Because the team can easily go around trees and brush minimal to no cutting of trees and brush is anticipated. Minimal disturbance to plant species is expected. The locations of the American holly, Minniebush and Netted chainfern will be flagged, logged in field notes and hand held personal digital assistants (PDAs) by the designated team member during visual surveys. The oversite biologist will complete periodic inspections (assumed to be weekly) of the field activities, This will include checking on a percentage of identified plant species to verify correct species are being documented and to assist the field team with current investigation areas. These identified locations will assist future activities (e.g., Digital Geophysical Mapping (DGM) Transects or Grids) in avoiding special plants by either shifting, or specific identification or delineation may be required for work in these areas. All efforts while conducting visual surveys will be attempted to conduct no intrusive operations on anomalies within sensitive plant or animal areas. However, if a UXO item is encountered, the necessary safety and disposal precautions will be implemented. If UXO items are identified, a field biologist will survey within a 20-foot radius of the item to identify sensitive plants. If sensitive species are identified, the project team will coordinate with the PGC and DCNR for input on the most appropriate method to address protecting the plants on a case by case basis. Mitigation steps will be dictated based on type and numbers of plants, location (terrain) and access and the sensitivity of the munitions item to be detonated. For instance, if the item is safe to move, the item could be moved nearby in an area not within 30 feet of *Ilexopaca*, *Menzia piloza*, or *Woodwardia aereolata*. Transplant of plants may also be considered after consultation with DCNR It should be noted that all detonations will include the use of engineering controls (sand bag blast mitigation) to significantly reduce effects from the detonation.

Digital Geophysical Mapping Transects

Digital geophysical mapping will be conducted along linear transects over areas A-D [which equates to approximately 7.86 acres (114,128 linear ft) of the total site], which are areas that have previously been identified as having MEC present, or as having a greater potential for MEC to be present. The intent of the DGM transects is to verify the horizontal extent of MEC or munitions constituents (MC) and to determine the density within the surveyed areas. DGM transects may also be conducted in areas within the Ricochet Area MRS that have been assessed, based on the visual survey, as needing additional characterization to further assess MEC or munitions debris (MD) density. The areas selected will be prioritized based on identification of MEC during the visual survey in areas representative of both low and moderate to high MEC density as presented in the conceptual site model (CSM).

The geophysical data collected will be evaluated against anomaly selection criteria to determine which anomalies likely represent MEC and will require further intrusive investigation. This selection criterion is not a pre-set metric; rather it is determined from an iterative approach conducted during the geophysical investigation. This process consists of analyzing both the initial DGM survey data as well as data collected during the Geophysical System Verification process. This process is conducted in close cooperation with the U.S. Army Corps of Engineers (USACE) geophysicist in order to determine an agreed-upon set of anomaly selection criteria.

In addition to the above transect coverage, the length (approximately 9 miles) of the Appalachian Trail will be surveyed using DGM. For the survey of the Appalachian Trail, selection of targets will be discussed with the Appalachian Trail Conservancy, and intrusive activities, if any, will be coordinated with their concurrence.

Minimal cutting of vegetation in support of the DGM transects is expected. DGM transects locations can be adjusted to avoid high density sensitive plant and animal communities if needed. The field biologist will pre-survey transect areas to identify the presence of the above mentioned sensitive plant communities prior to DGM transect data being collected. Areas will be marked with flagging and coordinates recorded with GPS. Maps of areas of specimen locations and survey transects will be prepared and provided to field crews. If intrusive activities are required to investigate anomalies these locations will be cross checked with areas identified as having the sensitive plant communities as logged during the DGM transect collection. Locations may be modified to not impact sensitive areas. Special attention should be paid to all areas within 500 ft of both banks of Stony Creek, Rauch Run, Devils Race Course, Rattling Run, and any unnamed or unmapped springs or seeps within the project area. DCNR recommends avoiding vegetation removal or disturbance in these areas of potential habitat.

Digital Geophysical Mapping Grids

Digital geophysical mapping of grids will be conducted to quantify the types and densities of MEC within specified areas, which will be selected, based on data compiled from analog instrument-aided visual surveys and DGM transects. These grids will be located in areas that represent two distinct units, referred to as Decision Units (DU), where DU-1 represents the areas of lower MEC density, and DU-2 represents the areas of moderate to high MEC density. To provide statistically defensible data, a minimum of 4.64 acres will be surveyed (which is the remaining acreage out of the 12.5 total overall DGM coverage calculated). The size and frequency of grid placement will be based on the spatial distribution of anomaly density, and the professional judgment of the project geophysicists. In general, DU-1 will be sampled on 100-ft by 100-ft grids, and DU-2 will be sampled on 50-ft by 50-ft grids to provide a broader statistical distribution. The actual placement of grids will be determined based on real data provided by the analog instrument-assisted visual and DGM survey transects.

Again, the geophysical data collected will be evaluated against anomaly selection criteria to determine which anomalies likely represent MEC and will require further intrusive investigation. This selection criterion is not a pre-set metric; rather it is determined from an iterative approach conducted during the geophysical investigation. This process consists of analyzing both the initial DGM survey data as well as data collected during the Geophysical System Verification (GSV) process. This process is conducted in close cooperation with the USACE geophysicist in order to determine an agreed-upon set of anomaly selection criteria.

DGM grids prior to placement will be evaluated for sensitive plant and animal communities based on earlier reconnaissance and logging from Visual and DGM Transect Surveys. After a location is picked, a field biologist will survey the selected DGM grid location for sensitive plant and animal communities present within the subject grid. Areas will be marked with flagging and coordinates recorded with GPS. Maps of areas of specimen locations and grid will be prepared and provided to field crews. If required the DGM grid location may be shifted to avoid sensitive plants or animals. Minor brush and small sapling cutting may be required to get adequate coverage; however, the project team's goal is to minimize our impact on the local environment as much as possible. If subsurface anomalies are selected to be excavated during intrusive investigations, those locations will be cross checked to ensure they do not impact a local sensitive plant or animal species. These anomalies may not be dug if they are in close proximity to a sensitive plant or animal species of known location from prior reconnaissance at the site. Special attention should be paid to all areas within 500 ft of both banks of Stony Creek, Rauch Run, Devils Race Course, Rattling Run, and any unnamed or unmapped springs or seeps within the project area. DCNR recommends avoiding vegetation removal or disturbance in these areas of potential habitat.

Completion of Work

Following completion of field work WESTON will provide to DCNR location data regarding any plant species of concern found on-site during the Remedial Investigation.