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FINAL MUNITIONS AND EXPLOSIVES OF CONCERN QUALITY ASSURANCE PROJECT PLAN MOVING TARGET MORTAR RANGE SOUTH UNEXPLODED ORDNANCE SITE 7 (UXO 7) REMEDIAL INVESTIGATION NAS OCEANA VA

11/1/2013

CH2M HILL

Worksheet #1—Title and Approval Page

Final

Munitions and Explosives of Concern Quality Assurance Project Plan

Moving Target Mortar Range-South (UXO 07) Dam Neck Annex Remedial Investigation

Naval Air Station Oceana Virginia Beach, Virginia

Contract Task Order WE69

November 2013

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

NAVFAC CLEAN 8012 Program
Contract N62470-11-D-8012

Prepared by

CH2MHILL®

Virginia Beach, Virginia

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Executive Summary

This Munitions and Explosives of Concern (MEC) Quality Assurance Project Plan (QAPP) supports the Remedial Investigation (RI) activities being performed at the Moving Target Mortar Range-South (MTMR-S), unexploded ordnance (UXO) 07, at Dam Neck Annex (DNA) of Naval Air Station (NAS) Oceana, Virginia Beach, Virginia, and serves as a guideline for the field activities and data quality assessment. CH2M HILL prepared this document under the Department of the Navy (Navy) Comprehensive Long-term Environmental Action – Navy (CLEAN) 8012 Contract N62470-11-D-8012, Contract Task Order WE69, for submittal to Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic and the Virginia Department of Environmental Quality (VDEQ). VDEQ is the lead regulatory agency. This MEC-QAPP will help ensure that RI data collected or compiled are scientifically sound, of known and documented quality, and suitable for intended uses.

The goal of this RI is to define the nature and extent of MEC at the MTMR-S. The MTMR-S is a Munitions Response Site (MRS) encompassing approximately 41 acres. The areas to be investigated during the RI field activities include the Historical Range Location (approximately 21 acres) and areas adjacent to the MTMR-S (approximately 20 acres) (**Figure 8**).

The objectives of the RI are to:

- Determine the nature and extent of MEC at the site.
- Perform an explosive safety hazard assessment for MEC using the Munitions and Explosives of Concern Hazard Assessment (MEC HA) guidance.
- Determine whether further action is warranted.

These objectives will be accomplished in two phases, as follows:

1. Digital Geophysical Mapping (DGM) Survey: Conduct a DGM survey at the following areas within and adjacent to the MTMR-S to achieve characterization of the extent of the impacted areas:
   a) Firing line area and proposed building locations in undeveloped areas
   b) Wetlands and undeveloped area between the firing line and suspected impact area
   c) Suspected impact area in the undeveloped areas to the north and south of the helicopter pad
   d) Grassy dune areas between the site and
   e) Beach area between grassy dunes and the Atlantic Ocean
2. Intrusive Investigation: Reacquire and excavate a statistically significant quantity of DGM anomalies identified during the RI DGM survey. The selected anomalies (randomly chosen from the geophysical anomalies identified by a geophysicist as potentially representing MEC) will be intrusively investigated to locate the source of each anomaly (that is, MEC, material potentially presenting an explosive hazard [MPPEH], or non-munitions-related debris). This work will be performed under a Naval Ordnance Safety and Security Activity (NOSSA)-endorsed and Department of Defense Explosives Safety Board (DDESB)-approved Explosives Safety Submission (ESS).

The RI objectives were developed from the Expanded Site Inspection (SI) conducted at the site in 2012 and subsequent NAS Oceana Partnering Team scoping session (Worksheet #9). MD consisting of four 81-mm mortars was discovered at four locations in the southeast corner of the Historical Range Location. Although no actual MEC item was found during the Expanded SI, the presence of MD suggests that MEC is potentially present at the site and an RI was recommended. MC analyzed for MEC were not detected in the two subsurface soil samples collected at the same depth and location as MD items. In addition, MC analyzed for small arms ammunition (metals) were detected in 23 surface soil samples; however, based on the results of the risk screenings, the small arms ammunition MC at the site do not pose unacceptable risks to human health or the environment. Therefore,

no further investigation of MC from either MEC or small arms ammunition is necessary. The NAS Oceana Partnering Team agreed during the November 2012 scoping session meeting to proceed to an RI for MEC, and that MC sampling during the RI is not necessary based on the Expanded SI findings.

This MEC-QAPP is intended to be the primary work plan for the activities being performed at the MTMR-S and serves as a guideline for the field activities and data quality assessment. The Health and Safety Plan (HASP), which provides an interface with CH2M HILL's overall health and safety (H&S) program, is being prepared as a separate document. The HASP will be appended to the Accident Prevention Plan (APP). The Geophysical Investigation Plan (GIP) is provided as **Appendix A**; standard operating procedures (SOPs) are provided as **Appendix B**; and responses to the NAS Oceana Partnering Team (consisting of representatives from NAVFAC and VDEQ) on the draft of this MEC-QAPP are provided in **Appendix C**.

This document is being developed in general accordance with the following guidance documents:

- *United States Environmental Protection Agency Guidance for Quality Assurance Project Plans, Quality Assurance Management System* (USEPA, 2002)
- *Uniform Federal Policy for Quality Assurance Project Plans* (USEPA, 2005)

This document consists of 37 worksheets, which are based on the September 2009 MEC Uniform Federal Policy (UFP)-QAPP format (Navy, 2009). Worksheets that are not applicable to MEC/MPPEH characterization (for example, worksheets specific to sampling and chemical analysis) have been designated as "Not Applicable." All tables are embedded within the worksheets, and figures are included at the end of each worksheet, where applicable.

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6 Future Projects within the MTMR-S Area
7 Conceptual Site Model for MEC Exposure
8 RI Areas to be Investigated

Abbreviations and Acronyms

°F	degree Fahrenheit
3R	Recognize, Retreat, Report
AM	Activity Manager
APP	Accident Prevention Plan
AQM	Activity Quality Manager
bgs	below ground surface
CA	corrective action
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLEAN	Comprehensive Long-term Environmental Action – Navy
CSM	conceptual site model
DNA	Dam Neck Annex
DDESB	Department of Defense Explosives Safety Board
DFOW	definable feature of work
DGM	digital geophysical mapping
ECP	entry control point
ESS	Explosives Safety Submission
EZ	exclusion zone
FP	Follow-up Phase
FS	Feasibility Study
FTL	Field Team Leader
GIP	Geophysical Investigation Plan
GIS	Geographic Information System
GPS	global positioning system
GSV	Geophysical System Verification
H&S	health and safety
HASP	Health and Safety Plan
IP	Initial Phase
IVS	Instrument Verification Strip
LCDR	Lieutenant Commander
MC	munitions constituents
MD	munitions debris
MDAS	Material Documented as Safe
MEC	munitions and explosives of concern
MEC HA	Munitions and Explosives of Concern Hazard Assessment
MIA	Mortar Impact Area
mm	millimeter
MPPEH	material potentially presenting an explosive hazard
MQO	measurement quality objective
MR	munitions response
MRM	Munitions Response Manager
MRP	Munitions Response Program

MRS	Munitions Response Site
MRSIMS	Munitions Response Site Information Management System
MTMR-S	Moving Target/Mortar Range-South
N/A	not applicable
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NG	nitroglycerin
NIRIS	Navy Installation Restoration Information Solution
NOSSA	Naval Ordnance Safety and Security Activity
NTR	Navy Technical Representative
OIC	Officer in Charge
ORR	Operational Readiness Review
PA	Preliminary Assessment
PAL	project action limit
PM	Project Manager
POC	point of contact
PP	Preparatory Phase
PQO	project quality objective
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	Remedial Investigation
RPM	Remedial Project Manager
RTK	real-time kinematic
SI	Site Inspection
SOP	standard operating procedure
SSC	Site Safety Coordinator
STC	Senior Technical Consultant
SUXOS	Senior Unexploded Ordnance Supervisor
TBD	to be determined
TM	Technical Memorandum
TNT	trinitrotoluene
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency
UXO	unexploded ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
VDEQ	Virginia Department of Environmental Quality
VMRC	Virginia Marine Resources Commission

Worksheet #2—QAPP Identifying Information

Site Name/Number: Moving Target Mortar Range-South (MTMR-S), Dam Neck Annex (DNA), Naval Air Station (NAS) Oceana/UXO 07

Operable Unit: Not Applicable

Contractor Name: CH2M HILL

Contract Number: N62470-11-D-8012, Contract Task Order WE69

Contract Title: Comprehensive Long-term Environmental Action – Navy 8012 (CLEAN)

1. **This Munitions and Explosives of Concern (MEC) Quality Assurance Project Plan (QAPP) was prepared in accordance with the requirements of the following United States Environmental Protection Agency (USEPA) documents:**
   - *Uniform Federal Policy for Quality Assurance Project Plans* (USEPA, 2005)
   - *United States Environmental Protection Agency Guidance for Quality Assurance Project Plans, EPA QA/G-5, Quality Assurance Management System* (USEPA, 2002)
   - *United States Environmental Protection Agency Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006)
2. **Identify regulatory program:**
   - Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
3. **This <u>project-specific</u> MEC-QAPP is for the Remedial Investigation (RI) activities at the DNA MTMR-S.**
4. **List dates of scoping sessions that were held:**

Scoping Session	Date
Naval Air Station Oceana Partnering Meeting	11/15/2012

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

Title	Author/Date
Draft Final Geophysical Investigation Plan, Site Inspection Munitions Response Program Site in Virginia, Fleet Combat Training Center, Dam Neck Annex, Virginia Beach, Virginia	CH2M HILL/March 2010
Draft Tier II Sampling and Analysis Plan, Dam Neck Annex Mortar Ranges (Moving Target Mortar Range-South and Mortar Impact Area, Expanded Site Inspection, Naval Air Station Oceana, Virginia Beach, Virginia	CH2M HILL/May 2012a
Technical Management Plan, Expanded Site Inspection for Dam Neck Annex: Moving Target/Mortar Range-South and Mortar Impact Area, Naval Air Station Oceana, Virginia Beach, Virginia	CH2M HILL/May 2012b
Munitions and Explosives of Concern Quality Assurance Project Plan for Expanded Site Inspection for Dam Neck Annex: Moving Target/Mortar Range-South and Mortar Impact Area, Naval Air Station Oceana, Virginia Beach, Virginia	CH2M HILL/May 2012c
Technical Memorandum, Site Preparation Activities at the Dive Bombing Targets-NALF Fentress and the Moving Target/Mortar Range, South-Dam Neck Annex, Naval Air Station Oceana, Virginia	CH2M HILL/February 2013a

Worksheet #2—QAPP Identifying Information (continued)

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

- Lead organization: Department of the Navy (Navy) Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic
- Installation: NAS Oceana
- Lead Regulatory Agency: Virginia Department of Environmental Quality (VDEQ)

7. Lead organization:

- NAVFAC Navy Technical Representative (NTR) (Krista Parra),
- NAVFAC Munitions Response Program (MRP) Quality Assurance Officer (QAO) (Mike Green)
- DNA Officer in Charge (OIC) (Lieutenant Commander [LCDR] Brian Morgan)

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

The worksheets that are not applicable to this MEC format of the Uniform Federal Policy (UFP)-QAPP are as follows: **Worksheets #15, #19-#20, #23-28,** and **#30**. These worksheets pertain to samples that are collected and sent to an analytical laboratory. Because this phase of the project does not involve collecting samples from the site, there is no information to enter into these worksheets. These worksheets are designated as "Not Applicable" in the document.

UFP-QAPP Worksheet #	Required Information	Included or Excluded
	A. Project Management	
	Documentation	
1	Title and Approval Page	Included
2	Table of Contents QAPP Identifying Information	Included
3	Distribution List	Included
4	Project Personnel Sign-off Sheet	Included
	Project Organization	
5	Project Organizational Chart	Included
6	Communication Pathways	Included
7	Personnel Responsibilities and Qualifications Table	Included
8	Special Personnel Training Requirements Table	Included
	Project Planning/Problem Definition	
9	Project Planning Session Documentation (including Data Needs tables) Project Scoping Session Participants Sheet	Included
10	Problem Definition, Site History, and Background. Site Maps (historical and present)	Included
11	Site-Specific Project Quality Objectives (PQOs)	Included
12	Measurement Performance Criteria Table	Included
13	Sources of Secondary Use Data and Information Secondary Use of Data Criteria and Limitations Table	Included
14	Summary of Project Tasks	Included
15	Reference Limits and Evaluation Table	Excluded
16	Project Schedule/Timeline Table	Included

Worksheet #2—QAPP Identifying Information (continued)

UFP-QAPP Worksheet #	Required Information	Included or Excluded
B. Measurement Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale	Included
18	Sampling Locations and Methods/Standard Operating Procedure (SOP) Requirements Table Sample Location Map(s)	Included
19	Analytical Methods/SOP Requirements Table	Excluded
20	Field Quality Control (QC) Sample Summary Table	Excluded
21	Project Sampling SOPs References Table Sampling SOPs	Included
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	Included
Analytical Tasks		
23	Analytical SOPs Analytical SOP References Table	Excluded
24	Analytical Instrument Calibration Table	Excluded
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Excluded
Sample Collection		
26	Sample Handling System, Documentation Collection, Tracking, Archiving and Disposal Sample Handling Flow Diagram	Excluded
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain-of-Custody Form and Seal	Excluded
QC Samples		
28	QC Samples Table Screening/Confirmatory Analysis Decision Tree	Excluded
Data Management Tasks		
29	Project Documents and Records Table	Included
30	Analytical Services Table Analytical and Data Management SOPs	Excluded
C. Assessment Oversight		
31	Planned Project Assessments Table Audit Checklists	Included
32	Assessment Findings and Corrective Action (CA) Responses Table	Included
33	Quality Assurance (QA) Management Reports Table	Included
D. Data Review		
34	Verification (Step I) Process Table	Included
35	Validation (Steps IIa and IIb) Process Table	Included
36	Validation (Steps IIa and IIb) Summary Table	Included
37	Usability Assessment	Included

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Worksheet #3—Distribution List

Name of QAPP Recipients	Title/Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address
Krista Parra	Navy Technical Representative (NTR)	NAVFAC Mid-Atlantic	(757) 341-0395	krista.parra@navy.mil
Mike Green	MRP Quality Assurance Officer (QAO)	NAVFAC Atlantic	(757) 322-8108	mike.green@navy.mil
Steve Mihalko	Remedial Project Manager (RPM)	VDEQ	(804) 698-4202	stephen.mihalko@deq.virginia.gov
Stephen Falatko	Munitions Response Manager (MRM)	CH2M HILL	(703) 376-5099	stephen.falatko@ch2m.com
Joe Kenderdine	Project Manager (PM)	CH2M HILL	(703) 376-5156	joseph.kenderdine@ch2m.com
Tim Garretson	Munitions Response (MR) Senior Technical Consultant (STC)	CH2M HILL	(904) 374-5633	timothy.garretson@ch2m.com
Tamir Klaff	MR Senior Geophysicist	CH2M HILL	(202) 596-1199	tamir.klaff@ch2m.com
Nelson Figeac	Unexploded Ordnance Safety Officer (UXOSO) / Unexploded Ordnance Quality Control Specialist (UXOQCS) for unexploded ordnance (UXO)-related activities; Field Team Leader (FTL)/Site Safety Coordinator (SSC) for non-UXO related activities	CH2M HILL	(757) 288-0374	nelson.figeac@ch2m.com
Ted Dingle	Senior Unexploded Ordnance Supervisor (SUXOS)	CH2M HILL	(757) 955-0591	theodore.dingle@ch2m.com

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Worksheet #4—Project Personnel Sign-Off Sheet

Name	Title/Role	Telephone Number (optional)	Signature/E-mail Receipt	Date MEC-QAPP Read
Krista Parra	NAVFAC NTR	(757) 341-0395		
Steve Mihalko	VDEQ RPM	(804) 698-4202		
Stephen Falatko	CH2M HILL/MRM	(703) 376-5099		
Joe Kenderdine	CH2M HILL/PM	(703) 376-5156		
John Tomik	CH2M HILL/Activity Quality Manager (AQM)	(757) 671-6259		
George DeMetropolis	CH2M HILL/MR Safety and Quality Manager	(619) 564-9627		
Tim Garretson	CH2M HILL/MR STC	(904) 374-5633		
Tamir Klaff	CH2M HILL/MR Senior Geophysicist	(202) 596-1199		
Nelson Figeac	CH2M HILL/UXOSO and UXOQCS	(757) 288-0374		
Ted Dingle	CH2M HILL/SUXOS	(757) 955-0591		
Mark Orman	CH2M HILL/Health and Safety (H&S) Manager	(414) 712-4138		

Organization: Subcontractors

Name	Title/Role	Telephone Number (optional)	Signature/E-mail Receipt	Date MEC-QAPP Read
Michael Surveying & Mapping PC	Professional Land Surveyor Subcontractor/PM	(757) 873-1762		
NAEVA Geophysics, Inc.	Digital Geophysical Mapping (DGM) Subcontractor/PM	(434) 978-3187		
To be determined (TBD)	Utility Locator Subcontractor/PM	TBD		
USA Environmental, Inc.	MEC Subcontractor/PM	(757) 689-4818		

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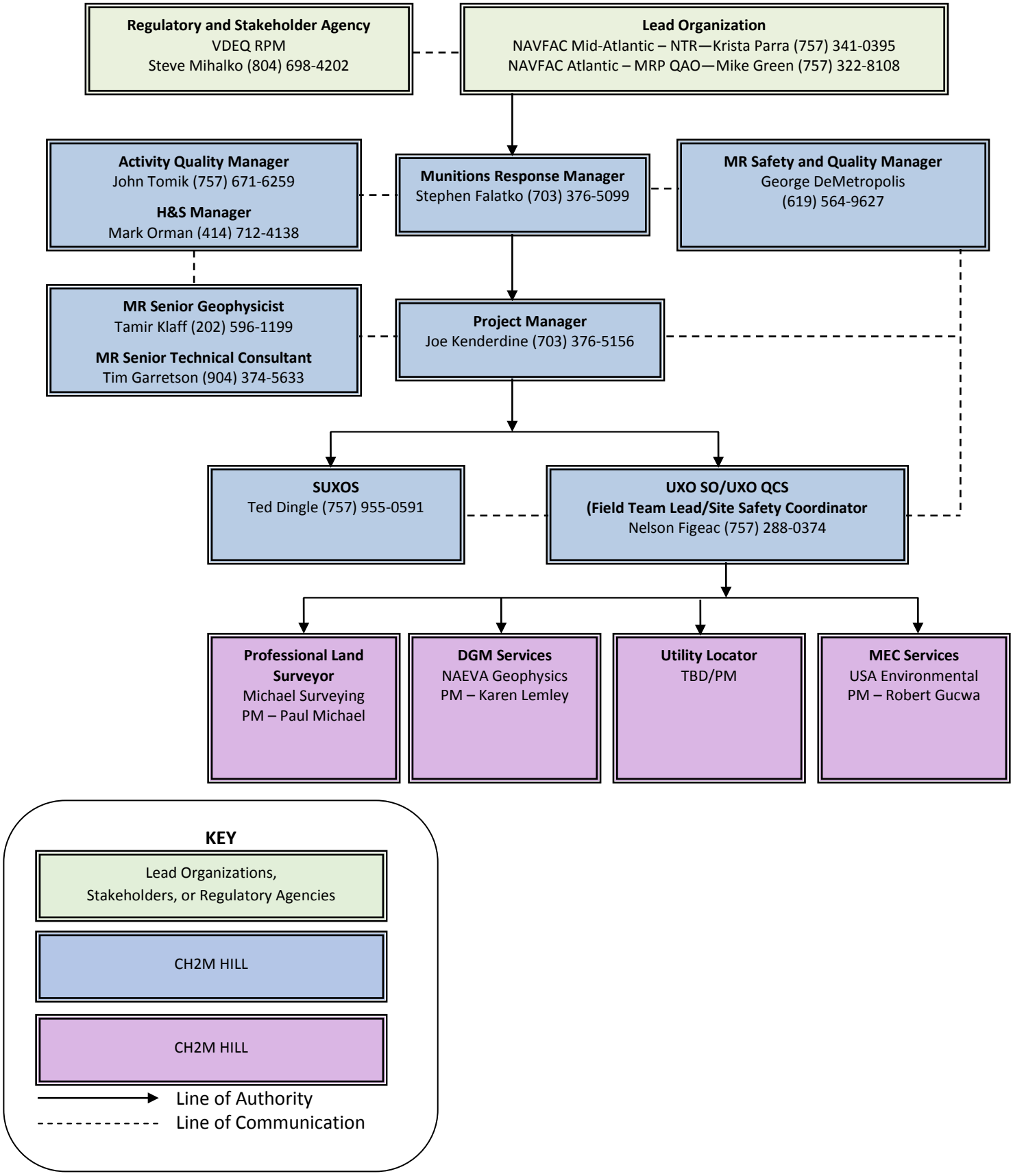
Worksheet #5—Project Organizational Chart



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Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Telephone Number and/or Email	Procedure
Communication with Navy (lead agency)	NAVFAC NTR for NAS Oceana	Krista Parra	(757) 341-0395 krista.parra@navy.mil	Primary point of contact (POC) for Navy, stakeholder and agency managers; can delegate communication to other internal or external POCs. Any issue that may affect project work should be reported to NAVFAC NTR immediately.
Communication with DNA	DNA OIC	LCDR Brian Morgan	(757) 492-6305 brian.c.morgan@navy.mil	Primary POC for DNA; will be provided with daily reports of all field activities. If field issues occur that affect the mission of the facility, the NTR and OIC or his delegated personnel should be notified immediately.
Communication with VDEQ (regulatory agency)	RPM - VDEQ	Steve Mihalko	(804) 698-4202 stephen.mihalko@deq.virginia.gov	Primary POC for VDEQ; can delegate communication to other internal or external POCs. Upon notification of field changes, VDEQ will have 24 hours to approve or comment on the field changes.
Communication regarding overall project status and implementation and primary POC with Navy NTR and VDEQ	MRM - CH2M HILL	Steve Falatko	(703) 376-5099 stephen.falatko@ch2m.com	MRP POC for CH2M HILL; can delegate communication to other contract staff as appropriate. Issues reported to the Navy NTR immediately and followed up in writing within 2 business days.
Management of MRP Implementation	PM – CH2M HILL	Joe Kenderdine	(703) 376-5156 joseph.kenderdine@ch2m.com	Primary POC for MR field and project-specific activities; timing dependent on nature of communication and predefined schedules as applicable and as requested by stakeholder agencies.
Technical communications for project implementation and data interpretation	AQM - CH2M HILL	John Tomik	(757) 671-6259 john.tomik@ch2m.com	Contact AQM regarding questions/issues encountered in the field, input on data interpretation, as needed. AQM will have 24 hours to respond to technical field questions as necessary. Responses will be communicated to the PM via email or phone.
Communications regarding project management and implementation of all project phases, and primary POC with Navy RPM	PM - CH2M HILL	Joe Kenderdine	(703) 376-5156 joseph.kenderdine@ch2m.com	Forwards all information and materials about the project to Navy RPM on a daily basis. Oversees the overall project status. Is informed of project status by CH2M HILL field personnel. If field changes occur during field activities, works with the Navy RPM to communicate field changes to the NAS Oceana MRP Team via email within 24 hours.

Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Telephone Number and/or Email	Procedure
MEC-QAPP implementation in the field	SUXOS - CH2M HILL	Ted Dingle	(757) 955-0591 theodore.dingle@ch2m.com	Facilitates CH2M HILL's internal communication (PM to field team members). Coordinates schedules and field activities with MEC and DGM subcontractors. Communicates with subcontractors by phone, followed up with e-mail to document decisions and actions. Documents deviations from the WP in the field logbook and notifies PM immediately. Executes deviations only after PM approval. Implements project H&S requirements. Provides daily progress reports/updates to the CH2M HILL PM by phone or email.
Field CA	UXOQCS/UXOSO - CH2M HILL	Nelson Figeac	(757) 288-0374 nelson.figeac@ch2m.com	The need for CA for field and analytical issues will be decided by the UXOQCS/UXOSO and MR Safety and Quality Manager. The MR Safety and Quality Manager will oversee that QAPP requirements are met by the field staff. The UXOQCS/UXOSO will notify the PM of any needed field CAs. The PM will have 24 hours to respond to the request for field CA.
Health and Safety	UXOSO/UXOQCS for UXO related activities; FTL/SSC for non-UXO related activities - CH2M HILL	Nelson Figeac	(757) 288-0374 nelson.figeac@ch2m.com	Responsible for the adherence of team members to the site safety requirements described in the Health and Safety Plan (HASP). Reports H&S incidents and near-misses to PM immediately by phone.
Technical communications for MEC-QAPP implementation, data interpretation	MR Senior Geophysicist - CH2M HILL	Tamir Klaff	(202) 596-1199 tamir.klaff@ch2m.com	Contact MR Senior Geophysicist regarding questions/issues encountered in the field, input on data interpretation, as needed. MR Senior Geophysicist will have 24 hours to respond to technical field questions as necessary. Responses will be communicated to the PM via email or phone.
Field and Data Collection CAs	MR Senior Geophysicist - CH2M HILL	Tamir Klaff	(202) 596-1199 tamir.klaff@ch2m.com	Any CAs for field and data collection issues will be developed by the SUXOS and/or the MR Senior Geophysicist and reported to the PM within 24 hours.
MR-related CAs	MR Safety and Quality Manager - CH2M HILL	George DeMetropolis	(619) 564-9627 george.demetropolis@ch2m.com	Any MR-related CAs for field and data collection issues will be developed by the SUXOS, UXOQCS/UXOSO and/or the MR Safety and Quality Manager and reported to the PM within 24 hours.

Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Telephone Number and/or Email	Procedure
Technical communications for project implementation, and data interpretation	AQM - CH2M HILL	John Tomik	(757) 671-6259 john.tomik@ch2m.com	Contact AQM regarding questions/issues encountered in the field, input on data interpretation, as needed. AQM will have 24 hours to respond to technical field questions as necessary. Responses will be communicated to the PM via email or phone.
Implementation of MEC-related portions of the MEC-QAPP	MEC Subcontractor – USA Environmental	Robert Gucwa	(757) 689-4818 rgucwa@usatampa.com	Plans, coordinates, and supervises all explosives operations; supervises all personnel inside the exclusion zones (EZs).
MEC-related QC provisions CAs	UXOQCS/UXOSO - CH2M HILL	Nelson Figeac	(757) 288-0374 nelson.figeac@ch2m.com	Any MR-related CAs for field and data collection issues will be developed by the SUXOS, UXOQCS/UXOSO and/or the MR Safety and Quality Manager and reported to the PM within 24 hours.

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Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Krista Parra	NTR	NAVFAC Mid-Atlantic	Provides project oversight and direction, assists with coordination of project activities between CH2M HILL and installation operations personnel, provides technical review of deliverables, and serves as primary regulatory interface for the Navy and the project team.
LCDR Brian Morgan	Officer In Charge	DNA	Assists with coordination of project activities between CH2M HILL and installation operations personnel.
Mike Green	MRP QAO	NAVFAC Atlantic	Provides quality review of MRP-related projects and activities for NAVFAC, including review of MEC-QAPP documents.
Steve Mihalko	RPM	VDEQ	Provides regulatory review of project documents and activities for the Commonwealth of Virginia.
Steve Falatko	MRM	CH2M HILL	Responsible for CH2M HILL MRP project implementation at NAS Oceana.
Joe Kenderdine	PM	CH2M HILL	Manages project, oversees all project activities, and is responsible for all aspects of the work performed under this MEC-QAPP. Directs and oversees staff.
John Tomik	AQM	CH2M HILL	Provides program-level review of MEC-QAPP. Provides oversight and approval for all technical issues related to the project.
George DeMetropolis	MR Safety and Quality Manager	CH2M HILL	Provides approval for all MRP-related issues for the project. Implements CH2M HILL's standard munitions QC procedures and conducts audits to confirm that QC protocols are being followed.
Tim Garretson	MR STC	CH2M HILL	Technical lead for MRP conformance to approved processes and procedures. Provides oversight and review of MR-related activities.
Tamir Klaff	MR Senior Geophysicist	CH2M HILL	Provides oversight and review of all DGM-related activities.
Mark Orman	H&S Manager	CH2M HILL	Develops and approves project HASP.
Nelson Figeac	UXOQCS/UXOSO (FTL/SSC)	CH2M HILL	Provides technical oversight and support for MEC-QAPP revisions and field work implementation. Supervises and coordinates all field activities. Implements the MEC-related QC provisions of the project. Implements the HASP, including MEC-related and general safety components. Will act as the FTL and SSC for non-UXO related tasks.
Ted Dingle	SUXOS	CH2M HILL	Implements approved MEC-QAPP. Plans, coordinates, and supervises all explosives operations. Coordinates all aspects of QC and H&S with the UXOQCS/UXOSO.
Paul Michael	PM	Professional Land Surveyor Subcontractor (Michael Surveying & Mapping)	Implements approved MEC-QAPP for land surveying (if necessary).

Worksheet #7—Personnel Responsibilities and Qualifications Table (continued)

Name	Title/Role	Organizational Affiliation	Responsibilities
Karen Lemley	PM	DGM Services Subcontractor (NAEVA Geophysics)	Implements approved MEC-QAPP for DGM.
TBD	PM	Utility Locator Subcontractor (TBD)	Implements approved MEC-QAPP for utility locating before MEC clearing (if necessary).
Robert Gucwa	PM	MEC Services Subcontractor (USA Environmental)	Implements approved MEC-QAPP for surface removal of MEC/MPPEH, intrusive investigation of DGM-identified anomalies, and MEC/MPPEH Management and Disposal.

Worksheet #8—Special Personnel Training Requirements Table

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates
Remedial Investigation	Hazardous waste operations and emergency response 40-hour training or 8-hour annual refresher, as appropriate	Registered training organization	Agency- and contractor-specific	FTL and SSC; Navy and regulatory agency representatives	FTL and SSC from CH2M HILL; UXO personnel; onsite visitors from Navy and regulatory agencies	Contractor, Navy, or regulatory agency human resources department
Fieldwork	MEC Awareness Training†	CH2M HILL UXO Technician	Before mobilization	All non-UXO technicians who will work at the site	FTL and SSC from CH2M HILL Field team members from subcontractor	Project folder
Fieldwork	Migratory Bird Protection Awareness Training	CH2M HILL UXO Tech	Before mobilization	CH2M HILL UXO technicians who will work at the site	SUXOS, UXOQCS/UXOSO from CH2M HILL	Project folder

Note:

† MEC Awareness training for non-UXO technicians is often referred to as Recognize, Retreat, Report training, also known as “3R” training. This training is intended to make the trainees aware of the potential presence of MEC, ways to recognize potential MEC, and what to do if potential MEC is observed. This training DOES NOT enable the trainee to identify the type of MEC or handle the potential MEC item.

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Worksheet #9—Project Scoping Session Participants Sheet

Project Name: RI for Moving Target/Mortar Range - South Projected Date(s) of Sampling: November 2013 **PM:** Joe Kenderdine/CH2M HILL	**Site Name:** Moving Target/Mortar Range - South **Site Location:** DNA, NAS Oceana, Virginia Beach, Virginia

Date of Session: November 15, 2012
Scoping Session Purpose: Obtain NAS Oceana Partnering Team consensus on the RI approach

Name	Title	Affiliation	Phone #	E-mail Address
Krista Parra	Navy NTR	NAVFAC Mid-Atlantic	(757) 341-0395	krista.parra@navy.mil
Steve Mihalko	RPM	VDEQ	(804) 698-4202	stephen.mihalko@deq.virginia.gov
Laura Cook	Activity Manager (AM)	CH2M HILL	(757) 671-6214	laura.cook@ch2m.com
Steve Falatko	MRM	CH2M HILL	(703) 376-5099	stephen.falatko@ch2m.com
Joe Kenderdine	PM	CH2M HILL	(703) 376-5156	joseph.kenderdine@ch2m.com

Comments/Decisions

The Team reviewed the findings and recommendations of the Expanded Site Inspection (SI) conducted at the MTMR-S. Findings of the Expanded SI indicated the presence of munitions debris (MD) in the southeast corner of the MTMR-S, as well as detections of small arms ammunition munitions constituents (MC) in surface soil. MC analyzed for MEC were not detected in the subsurface soil samples collected at the same depth and location as the MD items. Since the results of the risk screenings concluded that the MTMR-S does not pose unacceptable risk to human health or the environment for small arms ammunition MC, it was recommended that no further investigation of the MC, from either MEC or small arms ammunition, is necessary.

The Team then discussed the RI proposed for the DNA MTMR-S, which included a review of the area to be investigated, the RI approach, and RI schedule.

Action Items

CH2M HILL: Proceed to an RI for MEC, and that MC sampling during the RI is not necessary based on the Expanded SI findings.

Consensus Decision

The team agreed with the RI approach presented in the *Technical Memorandum, Expanded Site Inspection Results and Proposed Remedial Investigation Approach for the Moving Target Mortar Range – South, Dam Neck Annex – Naval Air Station Oceana, Virginia* (CH2M HILL, 2012d).

In addition, the Team agreed that during the RI, new building construction in previously undeveloped land at the MTMR-S will be investigated 100 percent and that new building construction on previously developed land will not be investigated.

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Worksheet #10—Problem Definition Overview

This worksheet provides a summary of the background information and key elements of the conceptual site model (CSM) for the MTMR-S (investigation history, physical setting, release history, and the potential exposure pathways and receptors of the MTMR-S), followed by the environmental questions to be answered during the RI field activities.

Site Background and History

NAS Oceana is located along the Atlantic Ocean, within the southeastern portion of the city of Virginia Beach, Virginia (**Figure 1**). The installation encompasses just over 5,300 acres, as well as approximately 3,600 acres in restrictive easements. In addition, NAS Oceana maintains control over several annex properties and outlying fields in the surrounding Virginia and North Carolina area. The mission of the facility is to support the Navy's Atlantic and Pacific fleet forces of strike-fighter aircraft and joint and interagency operations (Malcolm-Pirnie, 2008).
DNA is located approximately 5 miles southeast of NAS Oceana, in Virginia Beach, Virginia, and covers approximately 1,400 acres (**Figure 1**). The mission of this installation is to provide force-level engineering solutions, mission-critical and associated testing, and training technologies for the maritime, joint, special warfare, and information operations domains (Malcolm-Pirnie, 2008).

The MTMR-S is a Munitions Response Site (MRS) located in the southeastern portion of DNA, east of the Regulus Avenue and Bullpup Street intersection, and comprises 41 acres (**Figure 2**). Approximately 10 percent of the eastern portion of the site is developed and covered by parking lots and buildings. The remainder of the site is undeveloped and heavily wooded. Additionally, a portion of the site is within a Dune Management Area and is protected pursuant to the Coastal Primary Sand Dune Protection Act. This program is administered by the Virginia Marine Resources Commission (VMRC).

The MTMR-S range was used as a small arms firing range and moving target mortar range in the 1940s and 1950s. Based on the range boundaries and period of use, probable munitions used at the MTMR-S include .30- and .50-caliber small arms projectiles and practice 60-millimeter (mm) and 81-mm mortars. Only practice mortars are believed to have been used based on the distance between the probable firing point and impact area.

Investigation History

2008 Preliminary Assessment

A Preliminary Assessment (PA) was conducted by Malcolm Pirnie in 2008. The MTMR-S was inspected during the PA field activities to identify possible MEC and any sources of MC-related contamination at the site. Based on a review of historical documents and information obtained during the PA, the MTMR-S was a suspected MEC area.

2010 Site Inspection

An SI was conducted by CH2M HILL in 2010 to evaluate the potential presence or suggested absence of MEC at the MTMR-S. A visual survey of the accessible areas at the firing point and impact area (mortar ranges) was performed to confirm the findings of the PA and seek evidence of any MEC or MD. No surface MEC items were found in the portion of each former range east of Regulus Avenue (suspected target/impact area).
As part of the SI, a limited DGM survey was completed at the suspected target and impact area (the area east of Regulus Avenue) at MTMR-S in March 2010 using an EM61-MK2 metal detector coupled with a real-time kinematic (RTK) global positioning system (GPS) (CH2M HILL, 2010). The DGM survey identified the presence of 35 'Priority 1' geophysical anomalies within the MTMR-S (**Figure 3**)(CH2M HILL, 2012d). 'Priority 1' anomalies are those determined to be the most likely to represent subsurface MEC (60-mm or 81-mm mortars in the top 2 feet) if present at the site; however, non-munitions-related metallic items can create similar responses in the geophysical data. Because an EM61-MK2 survey cannot determine the source of a subsurface anomaly, intrusive investigations were needed to determine whether MEC was present in the subsurface.

Worksheet #10—Problem Definition Overview (continued)

2012 Expanded Site Inspection

In June 2012, an Expanded SI was conducted at the MTMR-S that included an intrusive investigation and surface and subsurface soil sampling (CH2M HILL, 2012d). Specifically, positions of the 'Priority 1' anomalies identified during the SI were excavated during the intrusive investigation, and surface and subsurface soil samples were collected at the MTMR-S to determine the presence or absence of MC associated with a release from MEC and from small arms ammunition items. During the Expanded SI:

- MD consisting of four 81-mm mortars, all of which were classified as Material Documented as Safe (MDAS), was discovered at four anomaly locations in the southeast corner of the MTMR-S.
- MC analyzed for MEC (trinitrotoluene [TNT], nitroglycerin [NG[, and hexahydro-1,3,5-trinitro-1,3,5-triazine [RDX]) were not detected in the two subsurface soil samples collected at the same depth and location as MD items I-004 and I-0041 (**Figure 4 and Figure 5**).
- MC analyzed for small arms ammunition (metals) were detected in 23 surface soil samples; however, based on the results of the risk screenings, the small arms ammunition MC at the site do not pose unacceptable risks to human health or the environment.

Although no actual MEC item was found during the Expanded SI, the presence of MD suggests that MEC is potentially present at the site.

Based on the results of the Expanded SI, the following actions were recommended:

- Conduct an RI at this site due to the presence of MD.
- No further investigation of MC from either MEC or small arms ammunition is necessary.

Release History

Based on findings of the Expanded SI, the MTMR-S contains MEC and MC as a result of the historical range operations at the site. Although MC is present at the site, conservative risk screenings conducted during the Expanded SI indicate that it does not pose unacceptable risk to human health or the environment for small arms ammunition MC (CH2M HILL, 2012d). The MTMR-S was used primarily during the 1940s and 1950s for military training purposes (such as firing ranges and target areas). A moving target machine gun range was present in the southeastern portion of DNA, as observed on 1942 and 1943 maps. The firing point was located 575 feet west of the moving target tracks, and the firing direction was east towards the Atlantic Ocean. Reportedly, the range was later replaced by a mortar range.

During the Expanded SI conducted in 2012, MD consisting of four 81-mm mortars, all of which were classified as MDAS, was discovered at four anomaly locations in the southeast corner of the MTMR-S, providing evidence that former activities may have resulted in MEC being released into the environment.

Physical Setting

Geology

The MTMR-S is located within the Atlantic Coastal Plain physiographic province, which is underlain with unconsolidated sediments generally of Quaternary ages. These surficial deposits include undivided sand, clay, gravel, and peat, which were deposited in marine, fluvial, aeolian, and lacustrine environments (Malcolm Pirnie, 2008).

Hydrology

The site-specific hydrogeology of MTMR-S is currently unknown. However, the following basewide hydrology is presented to provide a framework for site-specific hydrologic information.

Worksheet #10—Problem Definition Overview (continued)

NAS Oceana and DNA lie within the boundaries of three drainage basins: the Chesapeake Bay watershed in the north, the Southern Watersheds Area in the south, and Owls Creek watershed in the east. The Southern Watersheds Area is a collective of the North Landing River, Northwest River, and Back Bay watersheds. Surface waters drain into the Chesapeake Bay via Great Neck, Wolfsnare, and London Bridge creeks; to the Southern Watersheds Area via West Neck Creek; and to Owls Creek watershed via Owls Creek and its tributaries (Geo-Marine, 2006).

Surface waters at NAS Oceana consist of several small ponds, wetlands, and an extensive network of artificial drainage channels and channeled stream courses. The stations ponds are not naturally occurring, but were formed as a result of borrow pit excavations (Geo-Marine, 2001).

Surface waters that occur on DNA include approximately 51 acres of Redwing Lake in the northern portion of the installation, Sadler Pond in the central portion, and several small ponds such as Lotus Pond and Lilly Pond and areas of open water that are associated with the extensive marsh system. Lake Tecumseh, also known as Brinson Lake Inlet, forms the southern boundary of DNA. Redwing Lake and Lake Tecumseh are connected through an open drainage channel and are connected to Back Bay. Surface waters on DNA are joined to offbase water bodies by a number of drainage canals. Surface water flows from DNA to the south into Black Gut, Back Bay, North Bay, and Shipps Bay (Malcolm Pirnie, 2008).

Ecological Setting

As stated previously, a portion of the MRS is located within a Dune Management Area that is protected pursuant to the Coastal Primary Sand Dune Protection Act under administration of the VMRC. VMRC and the City of Virginia Beach Wetlands Board will be notified about intrusive activities prior to performing MR activities. The western portion of the site contains freshwater emergent and forested/shrub wetlands.

Because the site is within a Dune Management Area, habitat disturbance will be minimized during the MR activities. Accessible areas will be considered those that can be traversed without damaging or removing vegetation.

To date, no cultural resources have been identified on the MTMR-S. The MTMR-S overlaps a portion of the Interdunal Swale, Dune, and Freshwater Marsh Special Interest Area and supports two state-rare plant species: the white-top fleabane (*Erigeron vernus*) and fasciculate beakrush (*Rhynchospora fascicularis var.fascicularis*).

DNA has been documented to support endangered and special-status species including the loggerhead turtle (*Caretta caretta*), piping plover (*Charadrius melodus*), and the northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*).

Prior to conducting the MR actions, the area will be surveyed for threatened and endangered species (flora and fauna), cultural resources, and other sensitive environments. If a habitat for a threatened or endangered species, cultural environment, or sensitive environment is encountered, the work in the area will be adjusted to minimize the impacts to that area.

Adjustments may include, but are not limited to, working outside of known time periods when threatened and endangered species are known to be in that location and limited or restricted vegetation clearance. In addition, public concerns are aired through public outreach events and are given consideration prior to and throughout the MR activities.

Climate and Weather

The climate of Virginia Beach is classified as humid subtropical. Winters are very mild, and snowfall is light. Summers are hot and humid with warm evenings. The mean annual temperature is 59.6 degrees Fahrenheit (°F)

Worksheet #10—Problem Definition Overview (continued)

(15.3 degrees Celsius [°C]), with an average annual snowfall of 8.1 inches (210 mm), although snowfall averages are lower to the south away from the Chesapeake Bay. Average annual rainfall is 45 inches (1,100 mm). The wettest seasons are the spring and summer, although rainfall is fairly constant all year round. The highest recorded temperature was 105°F (41°C) in July 2010, and the lowest recorded temperature was 4°F (−16 °C) in January 1985 (http://www.noaa.gov/).

Cultural Resources

There are no cultural resources located within the MTMR-S (Malcolm Pirnie, 2008).

Current and Future Land Use

MTMR-S currently consists of developed and undeveloped areas. Undeveloped and moderately wooded areas are located on the western and southern portion of the site. Currently, the DNA helicopter pad and supporting facilities are located on the northeastern portion of the site.

The MTMR-S is not surrounded by a gate or fencing, but is within the confines of DNA and general public access is restricted; however, Navy and Department of Defense personnel have access to the MTMR-S. Future proposed construction projects in and adjacent to MTMR-S include a Helo-Pad, Drop Pad, Ready Service Lockers, a Target Maintenance Building, a Range Launch Site, and Center of Gravity Building, as shown on **Figure 6**.

MEC Conceptual Site Model

The CSM provides a description of the sources of MEC, pathways that could result in exposure to explosive hazards, and the receptors and activities that currently occur on the site or could occur in the future. The source of MEC items identified at the MTMR-S is attributed to historical site use associated with releases of small arms ammunitions and mortars during target and firing practice, respectively. Based on the June 2012 Expanded SI, the MD was located less than 24 inches below ground surface (bgs).

Potential Receptors and Exposure Pathways

The following sections provide a general description of the human and ecological receptors that are currently present or may be present at the MTMR-S, and their potential exposure routes to MEC in soil, as summarized in the CSM (**Figure 7**).

Human Receptors and Exposure Routes

Based on current and potential future uses of the MTMR-S, potential human receptors include current/future Navy personnel, authorized visitors, contractors, and adult and adolescent trespassers (Malcolm Pirnie, 2008).

The primary exposure routes for MEC to Navy personnel, authorized visitors, and contractors include direct exposure to MEC in surface and/or subsurface soil during construction or other intrusive activities. The primary exposure routes for MEC to trespassers include contact with MEC on the ground surface (Malcolm Pirnie, 2008). Although these exposure routes are considered to be complete, MEC was not identified on the surface during the June 2012 Expanded SI; however, MD was observed within 24 inches bgs.

Ecological Receptors and Exposure Routes

Based on current and potential future uses of the MTMR-S, ecological receptors include plant and animal biota. Receptor fauna that could be affected include common mammals, birds, reptiles, fish, amphibians, and invertebrates (Malcolm Pirnie, 2008).

Ecological receptors may come into direct contact with MEC in the surface or subsurface soil via feeding or burrowing activities that result in disturbance of soils (Malcolm Pirnie, 2008). Although these exposure routes are considered to be complete, MEC was not identified on the surface during the June 2012 Expanded SI; however, MD was observed within 24 inches bgs.

Worksheet #10—Problem Definition Overview (continued)

General Remedial Investigation Approach

The RI approach includes surface MEC/MPPEH removal, a DGM survey, intrusive investigation of identified geophysical anomalies, and a Munitions and Explosives of Concern Hazard Assessment (MEC HA).

A DGM survey will be conducted in the areas within and adjacent to the MTMR-S as follows and as shown on **Figure 8**:

a) Firing line area and proposed building locations in undeveloped areas (full coverage of accessible areas for DGM grids [approximately 1.1 acres])

b) Wetlands and undeveloped area between the firing line and suspected impact area (30 meters [100 feet] transect spacing and approximately 3,730 meters [12,230 feet] total transect length)

c) Suspected impact area in the undeveloped areas to the north and south of the helicopter pad (5 meters [16 feet] transect spacing and approximately 1510 meters [4,940 feet] total transect length)

d) Grassy dune areas between the site and beach (full coverage of accessible areas for DGM grids limited to open, non-vegetated areas to minimize dune habitat disturbance [approximately 10.0 acres])

e) Beach area between grassy dunes and the Atlantic Ocean (12 meters [40 feet] transect spacing and approximately 2700 meters [8,870 feet] total transect length)

Following the DGM survey, a statistically significant subset of the geophysical anomalies identified in the DGM surveys will be randomly selected for intrusive investigation. The Estimating a Proportion statistical method, described as follows, will be used to determine the quantity of anomalies to be investigated to obtain a 95 percent confidence (with a ± 5 percent sampling error) in the distribution of the different types of sources of anomalies within each area. The selected anomalies (randomly chosen from the geophysical anomalies identified by a geophysicist as potentially representing MEC) will be intrusively investigated to locate the source of each anomaly (that is, MEC, MPPEH, or non-munitions-related debris). This work will be performed under a Naval Ordnance Safety and Security Activity (NOSSA)-endorsed and Department of Defense Explosives Safety Board (DDESB)-approved Explosives Safety Submission (ESS).

Currently, CERCLA has no special provisions for dealing with explosive hazards. The *Munitions and Explosives of Concern Hazard Assessment (MEC HA) Methodology* (USEPA, 2010) will be used for assessing potential explosive hazards to human receptors at the site. The MEC HA is intended to fit into military MRP activities and the regulatory structure of the CERCLA process.

The results of the RI DGM survey and intrusive investigation will be compiled with the results of the DGM survey and intrusive investigation conducted during the SI and Expanded SI, to evaluate the nature and vertical/horizontal extent of MEC within and adjacent to the MTMR-S. Results of the RI and MEC HA will be used to decide whether further action is warranted.

MEC and Environmental Questions to be Answered

The goal of the study is to identify whether MEC are present within and adjacent to the MTMR-S. The environmental questions to be answered during the RI are:

- What is the nature and extent of MEC?
- What are the explosive safety hazards posed by any MEC potentially present at the site?
- Are remedial actions necessary and critical?

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Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

Who will use the data?

The data will be used by the Navy and VDEQ to make decisions about the path forward for the MTMR-S. CH2M HILL will use the data to prepare an RI report.

What are the project action limits (PALs)? (Specified detailed list should be provided in Worksheet #15)

The goal of the study is to identify whether MEC items are present in soil in and around the MTMR-S. The principal questions to be answered by the study are:

- Is MEC present in soil in and around the MTMR-S?
- If MEC is present, what is the general nature and extent of the contamination in soil in and around the MTMR-S?
- Is an explosive hazard posed to human receptors from MEC in soil at the site?

What will the data be used for?

Data collected during the RI will be used to evaluate the nature and extent of MEC/MPPEH and to assist with future decision-making processes with regards to the MTMR-S. Specific data uses are outlined as follows.

DGM data collected will be used to:

- Identify geophysical anomalies that represent potential subsurface MEC/MPPEH.
- Evaluate the lateral extent of distribution of geophysical anomalies at the site.
- Assist in planning the MEC/MPPEH intrusive investigation.

Data collected during the intrusive investigation will be used to:

- Determine the nature (that is, source) of the geophysical anomalies.
- Evaluate the horizontal and vertical (within 24 inches bgs) extent of the anomaly sources (and thereby MEC/MPPEH) at the site.
- Prepare the MEC HA that will be included in the RI report.

With regard to the MEC HA, the information will be used to assess the three components of the MEC HA: severity, accessibility, and sensitivity. Each of these three components is assessed by input factors as follows:

- **Severity** (potential consequences of the effect, such as injury or death, on a human receptor should an MEC item function as designed). This component is based on two input factors: (1) Energetic Material Type and (2) Location of Additional Human Receptors (that is, in addition to the “initiating human”).
- **Accessibility** (the likelihood that a human receptor will be able to come in contact with a MEC item). This component is defined based on site accessibility, potential contact hours, amount of MEC, minimum MEC depth relative to the maximum receptor intrusive depth, and migration potential.
- **Sensitivity** (the likelihood that a MEC item will function as designed if a human receptor interacts with it). This component is based on classification and size of the MEC.

Each input factor has two or more categories and each category is associated with a numeric score reflecting the relative contributions of the different input factors to the MEC HA. The sum of the input factor scores places the site within one of four Hazard Levels. The resulting baseline Hazard Level reflects the interaction between the current human activities in the MRS and the types, amounts, and conditions of MEC items with the MRS as determined by the RI. The MEC HA score should not be interpreted as a quantitative measure of explosive hazard.

Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

Each of the four Hazard Levels reflects attributes that describe groups of MRSs and site conditions ranging from the highest to the lowest.

What types of data are needed?

- Project Information (such as personnel, teams, instrument model numbers, transect/grid identification numbers, and locations)
- Field Notes (such as safety meetings, logbooks, photographs, and field requests to management)
- DGM and UXO Team notes (such as transect/grid information, files, personnel, methods, instruments, coordinates, and descriptions of items found)
- DGM data from the transects/grids surveyed (suspected impact area in the undeveloped areas to the north and south of the helicopter pad; beach area between grassy dunes and the Atlantic Ocean; wetlands and undeveloped area between the firing line and suspected impact area; firing line area and proposed building locations in the undeveloped areas; grassy dune area between the site and beach)
- DGM Data Processing Notes and Delivery Data (such as file names, processing performed, QC of data, and delivery dates)
- Verification that geophysical equipment is operating in accordance with the Geophysical Investigation Plan (GIP) (**Appendix A**)
- Results from the intrusive investigation of DGM-identified anomalies - Identification of quantities and types of MEC by a qualified UXO technician
- MEC HA specific information, which includes:
  - Type (general category, such as mortar, projectile, and so forth)
  - Size
  - Mark/Model
  - Energetic Material Type
  - Fuze (Yes or No), Type, Condition
  - MEC Depth
- All QC procedures (such as QC on notes, processing, data, and comparison of DGM results to intrusive results and field activities)

How "good" do the data need to be to support the environmental decision?

Sufficient definitive data with adequate QC is required to demonstrate that the MEC investigation has been performed and was effective. Sufficiency of data will be judged based on compliance with the contract and the approved MEC-QAPP. Data quality will be judged based on compliance with performance criteria for geophysical detection, reacquisition, and intrusive operations, as specified in **Worksheet #12** of this MEC-QAPP.

An extensive program of QC/QA is defined in **Worksheets #34, #35**, and **#36**.

How much data are needed?

A statistically significant quantity of identified anomalies from the total site DGM survey that represent potential subsurface MEC is needed. Data collected from excavated locations will allow the Navy and VDEQ to identify the nature of MEC in the subsurface, which will be used to evaluate remedial alternatives to mitigate or control the unacceptable hazards.

Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

Where, when, and how should the data be collected/generated?

- The DGM data will be collected from the following areas :
  a) Firing line area and proposed building locations in undeveloped areas (full coverage of accessible areas for DGM grids)
  b) Wetlands and undeveloped area between the firing line and suspected impact area (30 meters [100 feet] transect spacing)
  c) Suspected impact area in the undeveloped areas to the north and south of the helicopter pad (5 meters [16 feet] transect spacing)
  d) Grassy dune areas between the site and beach (full coverage of accessible areas for DGM grids limited to open, non-vegetated areas to minimize dune habitat disturbance [approximately 2.2 acres])
  e) Beach area between grassy dunes and the Atlantic Ocean (5 meters [16 feet] transect spacing)
- The schedule is identified on QAPP **Worksheet #16**. The field event is planned to commence in November 2013. Site preparation activities including vegetation reduction and land surveying of the DGM transects/grids and site boundary were completed from April 1 through 5, 2013.
- Data will be collected in accordance with the procedures outlined in this MEC-QAPP.

Who will collect and generate the data?

CH2M HILL's geophysical subcontractor personnel will perform the DGM survey. UXO personnel from CH2M HILL's MEC contractor, USA Environmental, Inc., will reacquire the positions of selected anomalies using length measurements from surveyed transect/grid stakes or GPS (as applicable) and perform the intrusive investigation of each anomaly source. The results of each excavation will be recorded in paper or digital logbooks.

How will the data be archived?

All files will be made available for QC verification during the project to verify that the field procedures are properly implemented. All data files, hard copies, and field notes will be maintained for the duration of the project. Electronic data will be stored on the local CH2M HILL server and will be uploaded into the NAVFAC munitions database and subsequently uploaded into the Navy Installation Restoration Information Solution (NIRIS).

The data will be archived in accordance with Navy guidance. At the end of the project, archived data will be returned to the Navy.

PQOs listed in the form of if/then qualitative and quantitative statements.

The level of data to be collected during this initial investigation of the site does not allow for a quantitative risk-based decision. Therefore, specific "quantitative" PQOs are not currently developed. Data from this investigation may be used during future project activities to further develop PQOs for any additional investigations or activities.

General "qualitative" PQOs are provided as follows, in the form of if/then statements, to summarize the objectives of this investigation.

DGM survey

1. **IF** the geophysical data in a particular area identify no locations with geophysical anomalies, **THEN** it will be concluded that MEC are not present in the subsurface of that survey area.
2. **IF** the geophysical data in a particular area identify locations with geophysical anomalies in the subsurface of the survey area, **THEN** selected anomalies (randomly chosen from the geophysical anomalies identified by a geophysicist as potentially representing MEC) will be reacquired and excavated.

Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

Intrusive Investigation

1. **IF** a 1-meter lateral radius from an anomaly location is searched and a geophysical anomaly cannot be reacquired, **THEN** the identified anomaly will be classified as a 'no-find'.
2. **IF** an anomaly is identified and a geophysical signal is still detected after excavation reaches a depth of 24 inches bgs, **THEN** it will be assumed that a potential MEC item may be present below 24 inches.
3. **IF** an item is identified as non-munitions related scrap or other refuse, and removal of the item would take a considerable effort (more than 10 minutes) to remove, **THEN** the item will be recorded as "left in place" in field logs and annotated as such in the database.
4. **IF** an item is not encountered in the first 24 inches bgs AND a geophysical anomaly is still indicated by a geophysical instrument, **THEN** the anomaly will be recorded in field notes as "left in place" and reported as "deeper than 24 inches bgs" in the database.

Once the intrusive investigation is complete, if MEC items are found and the exposure pathways to human receptors are complete, then the explosive hazards to human receptors will be evaluated in the qualitative MEC hazard evaluation, which will be prepared as part of the RI Report. The decision rules for the qualitative MEC hazard evaluation findings are:

1. **IF** the qualitative MEC hazard evaluation concludes that an unacceptable explosive hazard is present at the site, **THEN** further action will be required and remedial alternatives will be developed in a Feasibility Study (FS).

2. **IF** the MEC hazard evaluation concludes that no explosive hazard is present at the site, **THEN** no further action with institutional controls is required.

Data collected during the RI and historical data will be evaluated, and decisions on whether hazard posed by MEC is acceptable or unacceptable will be made by considering all lines of evidence. The results will be used to identify whether an explosive hazard exists at the MTMR-S.

Worksheet #12-1—Measurement Performance Criteria Table – Environmental Restoration

Definable Feature of Work (DFOW) Data Type	Geophysical Anomaly Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency
Analog instrument functional test	Accuracy and Sensitivity	Confirmation of analog system (used by UXO Technicians for pinpointing anomaly source during intrusive investigation) detection capabilities	Items are detected in the expected location in the Instrument Verification Strip (IVS).	Daily (before and at the completion of instrument use)
General EM61-MK2 DGM Systems Functioning	Completeness	Confirmation of sufficient equipment warm-up	Minimum of 10 minutes before EM61-MK2 use	Daily, before instrument use
	Accuracy	Confirmation of DGM system dynamic positioning accuracy	Positional error of IVS seed items not to exceed 50 centimeters (20 inches) during daily IVS survey	Daily (before and at the completion of DGM survey activities)
	Repeatability	Confirmation of consistency of DGM system response	Response to standardized item in the "Static Background and Static Spike" test will not vary by more than ±20 percent. Additionally, the "Repeat Data" test will be qualitatively analyzed for consistency of system response.	Daily (before and at the completion of DGM survey activities)
EM61-MK2 DGM Data Collection	Coverage	Confirmation of downline DGM data density	At least 98 percent of possible sensor readings are captured along each transect/survey line at 20 centimeters (8 inches) or less, and no data gaps of 60 centimeters (2 feet) or greater exist.	At the completion of each DGM survey
	Coverage	Confirmation of DGM survey coverage (transect spacing)	Survey lines/transects are spaced in accordance with plan (depends on area) (±20 percent), except where trees or other obstructions prohibit such spacing.	At the completion of transect layout (to confirm spacing) and DGM survey (to confirm coverage)
	Accuracy	Confirmation of DGM anomaly positioning accuracy	A selected anomaly must be within 1 meter (3.3 feet) of each QC seed item or the lack of a selected anomaly can be adequately explained.	Each occurrence

Worksheet #12-1—Measurement Performance Criteria Table (continued)

DFOW Data Type	Geophysical Anomaly Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency
Intrusive Operations Anomaly Resolution Data	Accuracy	QC to sample identification of munitions-related anomaly sources	Type, condition, and fuzing state (no fuze, unarmed fuze, armed fuze) of munitions-related items correctly identified.	Each occurrence
	Accuracy	QC review of identification of blind seed item location	100 percent of all blind seeds installed by the UXOQCS are removed and their location identified to within 1 meter (3.3 feet).	At the completion of the surveyed area that contained a blind seed item
	Completeness	QC audit of anomaly identification data; QC of excavation following to ensure removal of targets to specific depth	At least 10 percent of investigated anomalies ≤ to 24 inches bgs are investigated by UXOQCS to confirm removal of source of anomaly. Anomalies ≥ 24 inches bgs will not be resolved.	Daily and weekly
	Completeness	QC audit of anomaly identification forms (Daily Transect Tracking Logs – electronic)	Anomaly identification forms (electronic) completely and correctly filled out for each anomaly	Daily
	Completeness	QC audit of MEC accountability	100 percent of MEC items logged are verified as blown-in-place or otherwise disposed of.	Weekly

Worksheet #12-2—Definable Features of Work Auditing Procedure

DFOW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Pre-mobilization Activities	Document Management and Control	Verify appropriate measures are in place to manage and control project documents	Preparatory Phase (PP)	Once	Appropriate measures are in place to manage and control project documents.	Do not proceed with field activities until criterion is passed.
	Data Management	Verify appropriate measures are in place to manage and control project data	PP	Once	Appropriate measures are in place to manage and control project data.	Do not proceed with field activities until criterion is passed.
	Subcontractor Procurement	Ensure procurement of subcontractors and verify qualifications, training, licenses	PP/Initial Phase (IP)	Once	Subcontractors' qualifications, training, and licenses are up to date and acceptable.	Ensure subcontractor provides qualifications, training, and licenses or change subcontractor.
	MEC-QAPP	Verify the MEC-QAPP has been developed and approved	PP/IP	Once	MEC-QAPP has been prepared and approved, all parties agree to the technical and operational approach.	Do not proceed with field activities until criterion is passed.
Mobilization/ Site Preparation	Onsite Document Review	Verify Project Plans are approved and review with project team and get appropriate signatures	PP/IP	Once	Document is approved and has been reviewed and acknowledged by appropriate project team members.	Personnel who are not familiar with the Project Plans may not proceed with field activities until criteria are passed.
	Establish Communication and Logistics	Verify functionality of communications equipment and logistical support is coordinated	PP/IP	Once	Communications and other logistical support are coordinated.	Do not proceed with field activities until criterion is passed.
	Local Agencies and Emergency Services Notification	Verify local agencies and emergency services have been notified of site activities if required by contract	PP/IP	Once	Emergency services and local agencies are aware of site activities.	Do not proceed with field activities until criterion is passed.
	Verify site specific training	Verify all site specific training has been performed and acknowledged	PP/IP	Once	Site specific training is performed and acknowledged.	Do not proceed with field activities until criterion is passed.
	Site Boundary	Verify boundary matches project plans/statement of work	PP/IP	Once	Boundary is correct	Stop activities until boundary is verified and matches statement of work coverage

Worksheet #12-2—Definable Features of Work Auditing Procedure (continued)

DFOW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Utility Clearance	Work Method	Verify Independent third-party utility clearance was conducted in conjunction with Miss Utility of Virginia	PP/IP	Once	Independent third-party utility clearance or Miss Utility of Virginia not conducted.	Stop activity until full compliance can be assured.
Surface MEC/MPPEH Removal	Work Method	Verify operations are conducted in accordance with the MEC-QAPP, SOPs, and Accident Prevention Plan (APP).	PP/IP/ Follow-up Phase (FP)	Daily	MEC and surface debris, greater than 2" x 2", is inspected and removed.	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary.
Instrument Verification Strip	Work Method	Verify measurement quality objectives (MQOs) established in Geophysical System Verification (GSV) Plan have been accomplished.	PP/IP	Once	MQOs identified in GSV Plan have been achieved.	Continue with instrument verification strip (IVS) until MQOs are achieved. If concurrence is not met CA Request issued by field staff to MR Senior Geophysicist.
DGM Survey	Equipment Testing	Check results of QC tests performed as specified in the GIP	FP	Each occurrence	QC tests must pass standards defined in the GIP.	If a QC test does not pass, data must be recollected or a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
	Work Method	Verify DGM Survey conducted in accordance with the GIP.	IF/FP	Daily	DGM Survey conducted in accordance with the GIP.	Stop activity until full compliance can be ensured and any activities not performed within compliance are re-evaluated and re-performed if necessary.
		Confirm that DGM survey MQOs established during GSV are being met.	FP	Each Occurrence	DGM survey MQOs are being met.	If the MQOs are not being met, data must be recollected or a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.

Worksheet #12-2—Definable Features of Work Auditing Procedure (continued)

DFOW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Anomaly Reacquisition	Equipment Testing	Verify equipment testing has been performed and equipment is functional.	IP/FP	Once/ Daily/As Required	Equipment passed functionality test as required by this MEC-QAPP.	Repair or replace instrument.
	Work Method	Verify work methods are established and communicated.	IP/FP	Daily	Work methods are established and communicated and being performed in accordance with this MEC-QAPP and SOPs.	Stop activities until the MEC-QAPP and SOPs can be followed and any activities not performed within compliance are re-evaluated and re-performed, if necessary
Intrusive investigation of DGM-identified anomalies	Equipment Testing	Verify equipment tested in accordance with the MEC-QAPP.	IP/FP	Daily	Equipment testing performed and tests passed.	Repair or replace instrument.
Intrusive investigation of DGM-identified anomalies (cont.)	Work Method	Verify operations are conducted in accordance with the ESS, MEC-QAPP, MEC Removal SOPs, and the HASP: – Survey – DGM Anomaly Investigation – Ammunition and Explosives Transportation – Explosives Storage and Accountability – Disposal/Demolition Operations – Scrap Inspection Operations	IP/FP	Daily	Work performed in accordance with the MEC-QAPP, referenced MEC SOPs, and the HASP.	Stop activity until full compliance can be confirmed and any activities not performed within compliance are re-evaluated and re-performed if necessary.
	Work Method	DGM Identified targets cleared using EM61-MK2.	FP	Daily	Removal of anomaly source verified with EM61-MK2.	Stop activity until full compliance can be confirmed and any activities not performed within compliance are re-evaluated and re-performed if necessary.

Worksheet #12-2—Definable Features of Work Auditing Procedure (continued)

DFOW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Anomaly Source Removal Verification	Work Method	UXOQCS will verify 10 percent of anomalies have been cleared.	FP	Daily	Anomaly signature, metal 2-inch x 2-inch or greater, MPPEH, MEC left within area or anomaly location	Stop activity until full compliance can be confirmed and any activities not performed within compliance are re-evaluated and re-performed if necessary.
	Data Management	Verify that all specifications of the discovered items (anomaly source identification, nomenclature or description, depth, weight, quantity, orientation and azimuth [directional MEC only], filler, and disposition) have been recorded using the digital handheld field device and uploaded into the project database.	IP/FP	Daily	Documentation of recovered investigations findings is accurate.	Receive proper or complete recovered investigation findings from investigation team leader and refresh documentation requirements to responsible parties.
		Verify that the anomaly source recovered during intrusive excavations is appropriate to the amplitude of the initial anomaly detected during the DGM.	IP/FP	Daily	Recovered anomaly source is appropriate to the amplitude of the initial anomaly detected during the DGM.	Return to the location of the source of the anomaly excavation to determine if additional anomalies are present. If anomalies being recovered continue to be inappropriate for the amplitude as detected during the DGM, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
Demilitarization of MEC/MPPEH	Final inspection of MEC/MPPEH	UXOQCS conducts final inspection of MEC/MPPEH.	FP	Each occur-rence	All crevices and aspects of the item can be visually inspected to verify free of explosive material.	MEC/MPPEH item is re-processed by detonation or any other demilitarization method outlined within the ESS.

Worksheet #12-2—Definable Features of Work Auditing Procedure (continued)

DFOW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Material Transportation	MDAS Packaging and Labeling	Inspection of MDAS packaging and labeling	FP	Each occur-rence	Labeling and packing of MDAS conforms to *Ammunition and Explosives Safety Ashore* (Naval Sea Systems Command Ordnance, 2011. Publication 5, Volume 1, 7th Rev. Change 10).	MDAS will not be shipped until it conforms to OP5.
Demobilization	Demobilize from the site	Verify equipment and personnel have been demobilized from the site and the site is returned to pre-mobilization condition.	FP	Once	All personnel and equipment have been demobilized and the site is in pre-mobilization condition.	Restore site to pre-mobilization condition, package and ship all equipment offsite, demobilize crew

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Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
Preliminary Assessment (PA) Report	Final Preliminary Assessment – Naval Air Station Oceana, Dam Neck Annex and Naval Auxiliary Landing Field Fentress, Virginia	Malcolm Pirnie, 2008	Information from this report will be used to define the potential MEC that may have been used at the MTMR-S.	Limited historical records were available/identified during the PA.
SI Report	Final Site Inspection Report, Munitions Response Program, Munitions Response Sites at Dam Neck Annex and Naval Auxiliary Landing Field Fentress, Naval Air Station Oceana, Virginia Beach, Virginia	CH2M HILL, 2011	Information from this report will be used to determine the probable types of munitions used at the MTMR-S, and results of the DGM will be used to locate potential MEC in the subsurface.	None
Expanded SI Technical Memorandum	Technical Memorandum, Expanded SI Inspection Results and Proposed Remedial Investigation Approach for the Moving Target Mortar Range – South, Dam Neck Annex – Naval Air Station Oceana, Virginia	CH2M HILL, 2012d	The presence of MD during the 2012 intrusive investigation provides evidence that MEC is present in the subsurface. Soil sampling results and the risk screenings indicate that the MTMR-S site does not pose unacceptable human health or ecological risks for small arms ammunition MC. The results will be used to determine the nature and extent of MEC.	None
ESS	Amendment 01 - Explosives Safety Submission for Dam Neck Annex Moving Target/Mortar Range-South, Naval Air Station Oceana, Virginia Beach, Virginia	CH2M HILL, 2013b	The ESS will be used during the MR activities at the MTMR-S.	None

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Worksheet #14—Summary of Project Tasks

Activities to be performed at the MTMR-S have been divided into DFOWs and the tasks to be completed are outlined in the following table and summarized in **Worksheet #17**. Procedures for these tasks, including QC checks, recording and correcting data, data processing, data management, and information management will be performed in general accordance with the SOPs listed as follows and presented in **Attachment B**.

DFOW	Tasks	SOP
Pre-mobilization Activities	• RI MEC-QAPP development and approval • Geographic Information System (GIS) setup • Subcontractor procurement • Document management and control • Data management • Comprehensive work approval process	SOPs will be provided by subcontractors (vegetation clearing [if required], MEC, and DGM) upon procurement
Mobilization/Site Preparation	• Utility clearance – flag and spray paint detected underground utilities • Mobilize crew and equipment • Onsite document review • Communications and logistics establishment • Local agencies and emergency services notification, if required • Site-specific training • Emplacement of blind QC seeds in DGM survey area • Establish EZs, Entry Control Points (ECPs), and rally points • MPPEH will be managed in accordance with the ESS • Site layout - flagging site boundary and transect/grid stake placement	SOPs will be provided by MEC subcontractor upon procurement
Anomaly Avoidance	• Equipment testing and setup. • Survey (border, transects/grids, DGM, and DGM target reacquisition) confirmation • Site visits	MRP-SOP-0001 Munitions Response Program, SOP, Surface Munitions and MEC & Subsurface Anomaly Avoidance
Surface MEC/MPPEH Removal	Surface debris removal/reduction Equipment maintenance	SOPs will be provided by surface debris removal/ reduction subcontractor upon procurement.
DGM Survey	• Equipment setup and testing • DGM survey	SOPs will be provided by DGM survey subcontractor upon procurement
DGM Data Processing	• Pre- and Post-data processing • Data block submittals	No SOP. The GIP will be followed
Anomaly Reacquisition	• Equipment testing and setup • Survey confirmation	SOPs will be provided by MEC subcontractor upon procurement
Intrusive investigation of DGM-identified anomalies and removal verification	• Team separation • Equipment testing and setup • Anomaly investigation • Record recovered items • Anomaly source removal verification • Notification and guard recovered MEC/MPPEH for further disposition by Navy	ESS SOPs will be provided by MEC subcontractor upon procurement

Worksheet #14—Summary of Project Tasks (continued)

DFOW	Tasks	SOP
MEC/MPPEH Management and Disposal	• MEC/MPPEH accountability and transfer to Navy • MPPEH processing • Disposal of MDAS	ESS SOPs will be provided by MEC Subcontractor upon procurement
Demobilization	• Demobilize crew and equipment	--
Final Report and Closeout	• Preparation of After Action Report • Preparation of RI Report • Data archiving • Procurement closeout	--

Pre-Mobilization Activities

Before mobilization to the site occurs, planning activities will be performed to enhance timely project execution. This MEC-QAPP has been developed to provide detail for how the project will be performed and the quality standards to which it will be compared. Before mobilization to the site occurs, this plan will be reviewed and approved by CH2M HILL, the Navy, and regulators to ensure that the scope is executed, and H&S protocols are adhered to as outlined herein. Additionally, coordination will take place to ensure GIS information and equipment are available and updated for project activities, document and data management procedures are in place, and all subcontractors have been procured. Subcontractor qualifications, certifications, and licenses will be reviewed before subcontractor selection.

A pre-investigation meeting will be held in advance of the proposed mobilization date for field activities with the Navy that will also serve as the pre-construction and mutual understanding meeting. At the meeting, CH2M HILL will present an overview of the intrusive investigation and discuss project scope, schedule, H&S concerns, QC procedures, and any site logistical issues to develop a mutual understanding of project details.

Mobilization/Site Preparation

Utility Clearance

Miss Utility and NAS Oceana public works department personnel will be contacted prior to beginning work to mark out utilities. A utility locator will be subcontracted to identify and mark out subsurface utilities. Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of field personnel and the protection of the Base infrastructure.

Mobilization

Mobilization consists of transporting personnel and equipment to the work site and establishing temporary facilities and site controls, consisting of portable sanitary facilities, a decontamination area, and site refuge area. General mobilization activities are listed as follows:

- Identify/procure, package, ship, and inventory project equipment.
- Notify local agencies, including police, hospital, and fire department (onsite and offsite), as appropriate, of the site activities and ensure that they are appropriately equipped to respond to site emergencies.
- Finalize operating schedules.
- Organize support facilities.
- Establish a project command post in an area that is convenient to intrusive activities, but outside the EZs.

Worksheet #14—Summary of Project Tasks (continued)

- Assemble and transport the work force.
- Test and inspect equipment during mobilization and continue daily throughout the duration project to ensure proper functionality and prevent damage. Repair or replace as necessary to ensure quality performance.
- Establish onsite communications (for example, mobile phones or two-way radios) between team members.
- Conduct site-specific training on the MEC-QAPP, HASP, and MEC procedures and hazards, including "3R training" (recognize, retreat, report). Minimum training requirements are listed in **Worksheet #8.**
- Verify that all onsite personnel review this MEC-QAPP and all applicable SOPs and appendices.
- Verify that all forms and project documentation are in order and project team members understand their responsibilities with regard to completion of project reporting requirements.
- Inform Base and security personnel of site activities and duration of work.

During mobilization, a kickoff and site safety meeting will be conducted. This meeting will include a review of the MEC-QAPP and acknowledgment of the HASP by all site personnel. Additionally, a morning safety meeting will be conducted each day to review the tasks to be performed that day and any potential hazards. Additional meetings will be conducted as needed as new personnel, visitors, and/or subcontractors arrive at the site.

Site Preparation and EZs

Site preparation activities include establishing boundaries; vegetation removal, if required; and EZs. Anomaly avoidance techniques will be implemented by a UXO escort to avoid any potential surface or subsurface MEC; surface MEC avoidance will be performed during vegetation removal operations. If MEC or MPPEH is identified during site preparations, the item will be disposed of in accordance with the ESS.

Establish Exclusion Zones

EZs and ECPs will be required and enforced throughout implementation of the RI field activities, in accordance with the ESS (CH2M HILL, 2013b). While an EZ is in effect, access to these areas will be limited to essential personnel and authorized visitors. Non-essential personnel will be prohibited from entering established EZs. Signs and/or barriers will be located at ECPs to the EZ.

Geophysical Control Points

Permanent geophysical control points were previously established near the subject project area. The control points are permanent in nature and set at locations that can be expected to remain undisturbed. The horizontal control on the permanent control points are based on the Virginia State Plane Coordinates, South Zone (North American Datum of 1983).

Transect and Grid Layout

DGM will be performed along transects/grids at the MTMR-S, as shown by **Figure 8**. The ends of each transect will be marked with non-metallic stakes along the transect center line, to be no taller than 45 centimeters (18 inches) and driven to a depth of 15 centimeters (6 inches). The beginning transect end-stake will be marked with the transect identification and the letter A. The end transect end-stake will be marked with the transect identification and the letter Z. The intermediate transect stakes will begin with B and increase. The stake spacing will be decreased, as needed, in order to maintain unobstructed line-of-sight from one stake to the next along each transect. For example, stakes will be placed at turning points along transects where transects may bend around trees or other immovable obstructions.

The DGM survey of each grid will be accomplished by collecting data at regularly spaced, overlapping parallel lines. It is anticipated that the grids will be 30 meters by 30 meters (100 feet by 100 feet), but the grid size may vary dependent on field conditions.

Worksheet #14—Summary of Project Tasks (continued)

Blind Seed Location Survey

As provided in Section 3.4.2 of the GIP (**Appendix A**), one QC seed per 3,050 linear meters (10,000 linear feet) of the transects and one QC seed per 0.75 acres of the grids, will be placed throughout the non-mapped portion of the site. Therefore, at least 31 QC seeds will be placed along the proposed 93,720 meters (28,566 linear feet) of transects, one QC seed will be placed in the proposed 0.25 acre grid near the proposed buildings in the vicinity of the ready service locker area, and two QC seeds will be place in the proposed 0.85 acre grid near the former firing line. The QC seeds will be consistent with the GIP specifications. The UXOQCS will plant and collect the location of the seeds in anomaly avoidance mode with a Land Surveyor. The accuracy of the seed location survey will be within 15 centimeters (6 inches).

Anomaly Avoidance

Anomaly avoidance techniques will be implemented by a CH2M HILL UXO technician to avoid any potential contact with surface or subsurface MEC/MPPEH by non UXO-qualified personnel (such as vegetation reduction, survey, DGM and sampling crews). Subsurface anomaly avoidance will be performed during intrusive sampling operations. If a MEC item or MPPEH is recovered during site preparations, the item will be disposed of in accordance with the ESS.

Surface MEC/MPPEH Removal

DGM survey effectiveness is limited in the dune areas due to surface debris and will require surface MEC/MPPEH removal. The areal extent of the dune areas is shown on **Figure 8**. Surface debris, to the extent practicable, will be inspected and removed prior to the DGM survey task.

Specifically, the surface MEC/MPPEH removal will include a visual clearance of MEC, MPPEH, and MD from a specified geographic surface by qualified UXO technicians. The surface MEC/MPPEH removal may also be aided by handheld detectors in vegetated areas where visibility of the surface is reduced and will be conducted in advance of DGM surveys to reduce the number of resultant target anomalies. MEC and MPPEH items that are deemed unacceptable to move will be flagged for subsequent disposal operations. MEC, MPPEH, and MD items that are acceptable to move will be collected and placed in a designated location at the MTMR-S to await further evaluation and processing.

DGM Survey

The DGM survey will be conducted using an EM61-MK2 metal detector with GPS positioning. The DGM team will demonstrate system performance by executing the IVS and equipment testing and setup. The DGM team will then collect geophysical data from the following areas using the transect spacing and grid coverage noted as follows to locate geophysical anomalies that may represent subsurface MEC/MPPEH (**Figure 8**):

a) Suspected impact area in the undeveloped areas to the north and south of the helicopter pad (5 meters [16 feet] transect spacing)

b) Beach area between grassy dunes and the Atlantic Ocean (5 meters [16 feet] transect spacing)

c) Wetlands and undeveloped area between the firing line and suspected impact area (30 meters [100 feet] transect spacing)

d) Firing line area and proposed building locations in undeveloped areas (full coverage in accessible areas for DGM survey)

e) Grassy dune areas between the site and beach (DGM survey limited to open, non-vegetated areas to minimize dune habitat disturbance [approximately 2.2 acres])

Worksheet #14—Summary of Project Tasks (continued)

As discussed in Section 3.1.2 of the GIP (included in **Appendix A**), the MQO for transect lane spacing is to maintain appropriate lane spacing to ensure appropriate coverage of the area. The intended lane spacing for transects will range from 5 meters (16 feet) to 30 meters (100 feet), with a ±20 percent leeway allowance, with the exception of locations where vegetation (that cannot be cut) or terrain cause greater deviation. In full coverage areas the intended lane spacing is 0.75m (2.5 feet). The DGM subcontractor SOP describes the procedures to be used to acquire geophysical data by using electromagnetic detectors with GPS positioning.

After an analysis of the geophysical data, the DGM subcontractor will process and interpret the data and select geophysical anomalies; the CH2M HILL project MR Senior Geophysicist will provide QC review of the data and perform statistical selection of the geophysical anomalies to be intrusively investigated.

DGM Data Processing

DGM data processing details and deliverable requirements are presented in the GIP (**Appendix A**).

Anomaly Reacquisition

The selected anomalies will be reacquired and intrusively investigated in accordance with Section 6.1.3 of the ESS (CH2M HILL, 2013b). Each anomaly location will be flagged using a polyvinyl chloride flag with the unique anomaly identifier recorded in indelible ink. The flag will be placed 1 foot north of the actual reacquired anomaly location.

Intrusive Investigation of DGM Identified Anomalies and Removal Verification

MEC removal operations will be performed via hand excavation to identify the source of individual anomalies to a maximum depth of 24 inches bgs. Handheld metal detectors (such as a Schonstedt GA-52Cx or White's XLT) may be used by UXO technicians to assist in pinpointing the source(s) of anomalies; however, final confirmation of a cleared hole will be performed with an EM61-MK2 by a UXO technician with a QC check by the UXOQCS.

Details associated with this operation are included in the SOPs presented in **Appendix B**. The SOPs will be provided by the subcontractors once procured. The following basic techniques will be used for anomaly excavation:

- The UXO technician will investigate within a 1-meter radius, to a maximum depth of 24 inches bgs, of the flagged anomaly using an appropriate geophysical instrument for pinpointing assistance.
- Until identified otherwise, the source of the anomaly is assumed to be MEC. Excavation will be initiated adjacent to the subsurface item. The excavation will continue until the excavated area has reached a depth below the top of the item as determined by frequent inspection with an appropriate geophysical instrument.
- Using progressively smaller and more-delicate tools to remove the soil carefully, the excavation team will expand the sidewall to expose the metallic item for inspection and identification without moving or disturbing the item.
- Once the item is exposed for inspection, the excavation team will determine if it is MEC and/or MPPEH.
- Recovered MEC and MPPEH will be assessed and their explosives safety status documented in accordance with the ESS (CH2M HILL, 2013b).
- If the item is not MEC, it will be removed and the area will be rechecked with an EM61-MK2 to ensure that a MEC item was not hidden beneath the removed item. The excavation team will then annotate the results of the excavation on the dig sheet and move on to the next marked DGM anomaly.
- Anomaly locations inspected, along with results of the inspection, will be documented by the MEC subcontractor and provided to the CH2M HILL SUXOS.

Worksheet #14—Summary of Project Tasks (continued)

Detailed information on the intrusive investigation process will be in the MEC Subcontractor's SOP, which will be submitted after the subcontractor has been procured.

For each anomaly location inspected, QC inspections of the intrusive investigation will proceed as follows:

- After the dig team intrusively investigates an anomaly location, the hole is to be left open to the depth investigated and the polyvinyl chloride flag placed in the hole or bent after the investigation is completed.
- The UXOQCS will inspect the intrusively investigated anomaly locations using an EM61-MK2 to determine whether all detectable metallic items within a 1-meter radius of the hole and within the 24-inch excavation depth have been identified and investigated. If the source of the anomaly is below 24 inches bgs, the source of the anomaly will remain in place.
- All holes related to intrusive investigations will be filled back to original grade or covered before departing the project site each day following QC verification.
- Anomaly locations inspected, along with results of the inspection and CAs planned (in the event that the UXOQCS decides that inspection results require a change in intrusive team procedures or a re-performance of any work), will be documented and provided to CH2M HILL SUXOS.
- Additional QC analysis of intrusive results in comparison with the original amplitude of geophysical anomalies will be performed by the CH2M HILL MR Senior Geophysicist. Anomaly locations that are determined to need re-investigation through this process will be re-inspected.

MEC/MPPEH Management and Disposal

All explosive operations will follow the procedures outlined in Technical Memorandum (TM) 60A-1-1-31 (Army, 1989). Demolition operations will be performed daily, or the MEC will be properly secured until operations can be conducted. Demolition operations will be performed within the MRS. Recovered MEC and MPPEH will be evaluated by the SUXOS and UXOSO and classified as either acceptable to move or unacceptable to move. Recovered MEC/MPPEH classified as unacceptable to move will be blown-in-place. If MEC/MPPEH is acceptable to move, it may be carried by hand within the MRS for demolition. If the MEC/MPPEH item cannot be disposed on the day of discovery, the item will be flagged, secured, and continually guarded until such time as demolition operations occur. Base security will also be notified.

All recovered MEC and MPPEH will be destroyed onsite by detonating the items with donor explosives, in accordance with the ESS.

An MEC/MPPEH holding area will be established. MEC/MPPEH will be managed in accordance with Section 6.3 of the ESS.

Demolition Team

The Demolition Team will be composed of a minimum of three UXO-qualified individuals and will be responsible for identifying demolition locations, developing site security controls and engineering controls for the demolition events, and delivering and guarding any explosives delivered to the site. The Demolition Team Supervisor will coordinate with the UXOSO, who is not a member of the Demolition Team. The Demolition Team Supervisor will inspect each post-detonation location after a minimum of 5 minutes have passed to confirm a complete detonation, assess fire hazards, assess the response, and recover potential remaining explosives that were not consumed in the explosion.

Demolition Operations

Before demolition operations begin, the SUXOS will notify and coordinate with local emergency services to reduce public exposure, maintain safety, and keep the public informed. The emergency contacts and phone numbers are provided in the HASP.

Worksheet #14—Summary of Project Tasks (continued)

All nonessential personnel to the operations will be evacuated to a distance greater than the established minimum fragmentation distance for the MEC being detonated. Before priming of demolition charges, all avenues of entry will be physically blocked and positive control will be maintained. ECPs will be established in accordance with the ESS (CH2M HILL, 2013b). Radio communications will be maintained among all concerned parties. Avenues of ingress will not be opened without the express permission of the Demolition Team Supervisor.

While preparing MEC for detonation, the Demolition Team Supervisor will ensure that the number of personnel onsite is kept to the minimum required to safely accomplish the disposal mission. The MEC disposal process will be performed in accordance with demolition practices outlined in TM 60A-1-1-31.

During demolition operations, the Demolition Team Supervisor will control and be responsible for explosive disposal operations to ensure the following:

- The area is clear and remains clear of unauthorized personnel.
- The UXOSO will have sole custody of and maintain the firing device, and will not delegate or authorize connection to the firing device or initiation of the pyrotechnic chain until the maximum fragmentation distance is secured for horizontal and vertical fragmentation distances. Only the UXOSO may give permission to the Demolition Team Supervisor to prime a detonation and ignite or fire a detonation.
- The Demolition Team Supervisor will confirm by verbal communication and document the time of communication approval from the UXOSO to authorize a detonation.
- Preparatory activities for demolition are summarized as follows and detailed in the applicable SOPs listed in **Worksheet #21b**:
  - Review of the DDESB-approved ESS for conformance to plan criteria.
  - CH2M HILL will notify the Navy NTR prior to conducting demolition activities.
  - Identify MEC or MPPEH item and applicable technical publication or ORDATA II Database (http://ordatamines.maic.jmu.edu) for functioning, hazards, safeties, warnings, and/or notes.
  - Identify MEC or MPPEH item and applicable technical publication or ORDATA II Database (http://ordatamines.maic.jmu.edu) for functioning, hazards, safeties, warnings, and/or notes.
  - Document (demo/safety logbooks) Demolition Team Supervisor and UXOSO review of commercial explosives manufacturer's: safety notes, warnings instructions, and Material Safety Data Sheets for explosives and, as applicable, initiation or firing device or systems manufacture's guidelines.
  - Review POC list, emergency upwind rally points and evacuation points, location and directions to hospital; ensure that detonation and safety support vehicles have directions and map to the hospital with communications; and ensure demolition vehicle has two 20-pound BC-rated fire extinguishers.
  - Ensure emergency response equipment identified within HASP is on hand.
  - Ensure two means of communication are available.
  - Designate essential personnel to be involved in the operation.
  - Acquire protective work materials and implement approved engineering controls.

Following the completion of demolition activities, CH2M HILL will notify and provide a summary of the demolition activities and outcome to the Navy NTR.

Worksheet #14—Summary of Project Tasks (continued)

Unintentional Detonation

These emergency procedures provide a plan in the event of an explosive emergency and provide procedures to be followed to limit the extent of injury and damage until qualified professionals can arrive to provide assistance.

After an explosion occurs, additional explosions may occur. Therefore, the response to unintentional detonations should involve a minimal number of personnel. Emergency steps are as follows:

- Contact emergency services
- Minimal number of personnel (one person if possible) provides first aid
- Additional personnel withdraw to safe rally point
- One UXO-qualified person meets first responders and escorts them to the explosion site

MEC Data Reporting

The collection of accurate and detailed data is essential to documenting MEC-related discoveries and resulting disposition of MEC for future reference. Digital tracking forms for MEC and MPPEH will be used to list data for each MEC/MPPEH item encountered. The tracking form will be filled out with the following information:

- **Unique identity number**—Also to be incorporated in photographs of the item (by using a dry erase board, for example)
- **Location**—Northing and easting coordinates
- **Depth to Item**—If the item is partially buried, depth to the center of the mass of the item (recorded in inches)
- **Orientation**—Geographical direction (N, S, E, W) the item is pointing, unless vertical
- **Type and Nomenclature**—Type of ordnance and nomenclature, as specifically as possible; to also be incorporated in photographs of the item (by using a dry erase board, for example)
- **Filler**—Type of filler, such as none, inert, high explosive, white phosphorus, illumination, incendiary, chemical, or smoke
- **Fuze**—Type of fuze, such as none, filler plug, inert, point detonating, powder train, or base detonating
- **Date and Time Found**—Date when the MEC/MPPEH item was found and approximate time it was found
- **Team or Individual**—Team number or individual's name that found the MEC/MPPEH/ item
- **Disposal**—Disposal status
- **Date Disposed**—Date when the MEC/MPPEH item was disposed
- **Photo identification**—Photo number(s) from camera or identification number if included in photo
- **Comments**—Any noteworthy comments

MDAS Management

Before release of the material for disposal, material will be inspected in the containers to ensure that it is free of explosives. DD Form 1348-1A will be used as 100 percent inspection/100 percent re-inspection documentation. All DD Form 1348-1A documentation will clearly show the following information in typed or printed letters:

- Name of SUXOS and the government representative (or designee)
- Organization
- Two signatures from UXO Technician III's not in the same chain of command (such as SUXOS and the UXOSO, SUXOS, and a government representative)

Worksheet #14—Summary of Project Tasks (continued)

- Contractor's office
- Field office phone number(s) of the persons certifying and verifying the MDAS
- Basic material content (type of metal [steel, mixed])
- Estimated weight
- Unique identification of each sealed container
- Location where MDAS was obtained
- Seal identification, if different from the unique identification of the sealed container

CH2M HILL will coordinate with the NTR to maintain the chain of custody and final disposition of the certified and verified materials. The certified and verified materials will be released to an approved processing facility for disposal. If the chain of custody is broken, the affected MDAS will undergo a second 100 percent inspection, a second 100 percent re-inspection, and be documented to verify its explosive safety status (identified as either MDAS or other debris).

Disposal of MDAS

MDAS will be accumulated in appropriately sized containers, characterized, transported, and disposed of in accordance with the ESS (CH2M HILL, 2013b).

Demobilization

Full demobilization of equipment and personnel will occur when site activities are complete and appropriate QA/QC checks have been performed.

Final Report and Closeout

After Action Report

An After Action Report will be prepared for the MTMR-S when it is determined that MR actions are complete. The After Action Report will be prepared in accordance with NOSSA Instruction 8020.15D (NOSSA, 2013) to document the results of the MEC intrusive investigations. The report will provide a summary of all MEC found during the investigation, summarize all the MEC removal activities, and provide an evaluation of the selected removal methods and their relative effectiveness.

RI Report

The RI report will be prepared and will include a summary of previous SI and a site history; a physical features description; a summary of completed field activities, including DGM and anomaly investigation results; an evaluation of site characterization data, including nature and extent of MEC; a MEC HA; and revised MRS prioritization protocol. The RI report will also identify and describe any additional MR actions.

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Worksheet #15a—Reference Limits and Evaluation Table (Environmental Response)

Matrix:

Analytical Group:

Concentration Level:

Analyte	Chemical Abstract Service Number	Tap Water Regional Screening Levels	Maximum Contaminant Levels	Project Quantitation Limit Goal	Laboratory-Specific Limits	
					Quantitation Limits	Method Detection Limits

Not Applicable

Worksheet #15b—Reference Limits and Evaluation Table (Munitions Response)

As discussed in **Worksheet #11**, data collected during this investigation will be used to evaluate removal alternatives in an FS. Therefore, due to the nature of this investigation, there are no traditional reference or action limits that can be established for this phase of the RI.

MEC Item	PAL	PAL Reference	Project Quantitation Limit Goal	Validated Detection Limits for Specific Munitions Detection System

Not Applicable

Worksheet #16—Project Schedule / Timeline Table

Activities	Organization	Dates		Deliverable	Deliverable Due Date
		Anticipated Date of Initiation	Anticipated Date of Completion		
MEC-QAPP					
Draft MEC-QAPP	CH2M HILL	03/04/2013	07/31/2013	Draft QAPP	07/31/2013
Navy MR Review	NAVFAC	08/01/2013	08/07/2013	Comments on Draft MEC-QAPP	
Draft Final MEC-QAPP	CH2M HILL	08/08/2013	08/15/2013	Draft Final MEC-QAPP	08/15/2013
Partnering Team Review	NAVFAC and VDEQ	08/15/2013	10/14/2013	Comments on Draft Final MEC-QAPP	
Final MEC-QAPP	CH2M HILL	10/15/2013	11/01/2013	Final MEC-QAPP	11/01/2013
Amend Existing ESS					
Draft ESS	CH2M HILL	02/07/2013	02/27/2013	Draft ESS	02/27/2013
NAVFAC Review	NAVFAC	02/28/2013	03/15/2013	Comments on Draft ESS	
NOSSA Review	NOSSA	03/18/2013	04/10/2013	Comments on Draft ESS	
Submit Final ESS/NOSSA Endorsement	NOSSA	04/11/2013	06/25/2013	Final ESS	06/25/2013
Receive DDESB Acceptance of ESS	DDESB	07/25/2013	07/25/2013		
ESS Correction 1					
Draft ESS Correction 1	CH2M HILL	10/01/2013	10/07/2013	Draft ESS Correction 1	10/07/2013
NAVFAC Review	NAVFAC	10/08/2013	10/11/2013	Comments on Draft ESS	
NOSSA Review	NOSSA	10/14/2013	10/25/2013	Comments on Draft ESS	
NOSSA Endorsement	NOSSA	10/28/2013	10/30/2013	Final ESS Correction 1	10/30/2013

Worksheet #16—Project Schedule / Timeline Table (continued)

Activities	Organization	Dates		Deliverable	Deliverable Due Date
		Anticipated Date of Initiation	Anticipated Date of Completion		
Field Investigation					
DGM Subcontractor Procurement	CH2M HILL	09/16/2013	10/25/2013		
MEC Service Subcontractor Procurement	CH2M HILL	09/16/2013	11/01/2013		
Field Investigation – surface MEC/MPPEH removal	CH2M HILL	11/18/2013	11/22/2013		
Field Investigation – DGM Survey	CH2M HILL and DGM subcontractor	12/02/2013	12/13/2013		
Field Investigation – Intrusive Investigation and MEC/MPPEH Management	CH2M HILL and MEC Service subcontractor	02/17/2014	03/07/2014		
RI Report					
RI Report	CH2M HILL	03/10/2014	10/21/2014		10/21/2014

Worksheet #17—Sampling Design and Rationale

This worksheet describes the MEC sampling design and rationale that will be used to select the DGM geophysical anomalies for intrusive investigation. This process will be performed to meet the requirements and objectives of the intrusive investigation as they are defined in **Worksheet #11**. The DFOWs for the RI at the MTMR-S are presented in **Worksheet #14**, and the location where any additional supporting documentation for the DFOWs is listed in the following table.

DFOW	SOP	Supporting Document(s)
Pre-Mobilization Activities	-	MEC-QAPP
Mobilization/Site Preparation	-	MEC-QAPP, ESS
Anomaly Avoidance	CH2M HILL MR-001 Anomaly Avoidance SOP	MEC-QAPP
Surface MEC/MPPEH Removal	SOPs will be provided by MEC removal subcontractor upon procurement	MEC-QAPP
DGM Survey	SOPs will be provided by DGM survey subcontractor upon procurement	MEC-QAPP, GIP, GSV
DGM Data Processing	GIP is provided in Appendix A	MEC-QAPP, GIP
Anomaly Reacquisition	SOPs will be provided by DGM subcontractor upon procurement	MEC-QAPP, ESS
Intrusive investigation of DGM identified anomalies and removal verification	SOPs will be provided by MEC subcontractor upon procurement	MEC-QAPP, ESS
MEC/MPPEH Management and Disposal	SOPs will be provided by MEC subcontractor upon procurement	MEC-QAPP, ESS
Demobilization	-	MEC-QAPP
Final Report and Closeout	-	MEC-QAPP

Statistical Anomaly Selection

Not all of the geophysical anomalies identified during the DGM survey will represent MEC. Furthermore, it is not possible to investigate every anomaly located in the 41 acres within and adjacent to the MTMR-S. As such, a statistically significant subset of the geophysical anomalies identified in the DGM surveys will be randomly selected for intrusive investigation at and adjacent to the MTMR-S. The Estimating a Proportion statistical method, described as follows, will be used to determine the quantity of anomalies to be investigated within each unique population (that is, the firing line, impact area, interdunal area, beach) to obtain a 95 percent confidence (with a ± 5 percent sampling error) in the distribution of the different types of sources of anomalies.

When a population size is large (for example: [n] np ≥ 5 and n(1-p) ≥ 5) or unknown, the necessary sample size of DGM anomalies to be intrusively investigated can be calculated using the following statistical sample size formulas:

$$n_0 = \frac{Z_\alpha^2 pq}{e^2}$$

Where:

Z_α = desired confidence level
p = proportion of DGM anomalies classified as munitions-related
q = proportion of DGM anomalies classified as non-munitions-related (q = 1-p)
e = acceptable margin of error for proportion being estimated
n_0 = statistical sample size for a large population

Worksheet #17—Sampling Design and Rationale (continued)

When the population size is known, the following finite population correction can be used to reduce the number of anomalies required to obtain the same confidence level:

$$n_1 = \frac{n_0}{1+\left(\frac{n_0}{N}\right)}$$

Where:

n_1 = adjusted statistical sample size for a finite population
n_0 = statistical sample size for a large population
N = size of the population (number of DGM anomalies)

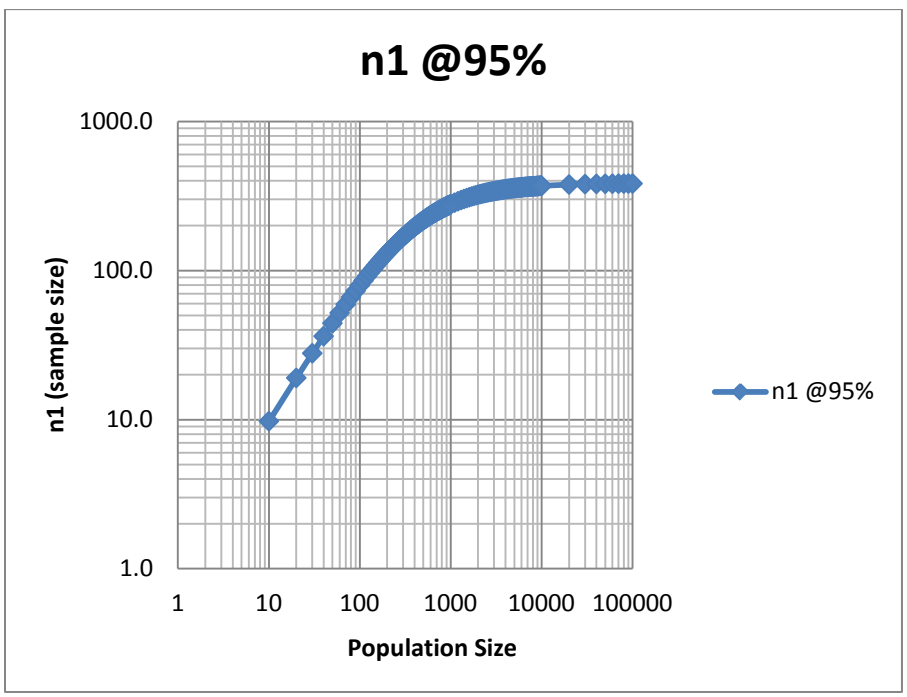
When estimating the variance of proportional variables (that is, munitions-related or non-munitions-related), it is most conservative to estimate a population proportion of 50 percent (p=0.5); the result is that variance (pq) is maximized, and therefore the required sample size is also maximized.

Using a z-statistic for a 95 percent confidence level (Z_α=1.96) and a margin of error of 5 percent (e=0.05), the solution for n_0 becomes:

$$n_0 = \frac{Z_\alpha^2 pq}{e^2} = \frac{1.96_\alpha^2(0.5)(0.5)}{0.05^2} = 384$$

This formula calculates that a maximum of 384 randomly selected DGM anomalies need to be classified to determine with 95 percent confidence and ± 5 percent sampling error the proportion of munitions-related to non-munitions-related DGM anomalies in a large or unknown population.

Based on the number of anomalies identified in the DGM surveys, the finite population correction, as shown in the following example, will be used to decide if the quantity of anomalies to be intrusively investigated may be reduced while maintaining 95 percent confidence in the distribution of the different types of sources of anomalies.



Worksheet #17—Sampling Design and Rationale (continued)

For the purpose of illustration, the finite population correction for a total population of 5,000 anomalies is solved as follows. Note that this is an example only, and the actually quantity of anomalies selected for intrusive investigation will be determined after the completion of the DGM surveys.

$$n_1 = \frac{n_0}{1+\left(\frac{n_0}{N}\right)} = \frac{384}{1+\frac{384}{5000}} = 356.6$$

In this example, if 5,000 anomalies are identified along the transects within the MTMR-S, intrusive investigation of 357 randomly selected anomalies would allow one to determine with 95 percent confidence and ± 5 percent sampling error if munitions-related items are present among the geophysical anomalies identified along those transects.

After conducting the Estimating a Proportion statistical analysis, a random number selector will be applied to the target list to select the anomalies for intrusive investigation.

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Worksheet #18—Sampling Locations and Methods and Standard Operating Procedure Requirements Table

Data collection activities performed at the site will include DGM transect surveys with the specified transect spacing associated with the areas below that are within and adjacent to the MTMR-S, as shown on **Figure 8**.

Location	Exclusion Areas	Matrix	Depth relative to Ground Surface	Survey Methodology	Degree of Investigation or Coverage	SOP Reference
41 acres within and adjacent to the MTMR-S, that include the: a) Firing line area and proposed building locations in undeveloped areas (100 percent coverage for DGM survey) b) Wetlands and undeveloped area between the firing line and suspected impact area (30 meters [100 feet] transect spacing) c) Suspected impact area in the undeveloped areas to the north and south of the helicopter pad (5 meters [16 feet] transect spacing) d) Grassy dune areas between the site and beach (DGM survey limited to open, non-vegetated areas to minimize dune habitat disturbance [approximately 2.2 acres]) e) Beach area between grassy dunes and the Atlantic Ocean (5 meters [16 feet] transect spacing)	None	Soil	Unknown	Geonics EM61-MK2	A statistically significant quantity of anomalies will be re-acquired for intrusive investigation.	SOPs for Geophysical Mapping, Geonics EM61 – MK2 (Appendix B)

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Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference	Containers	Sample Volume	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time (Preparation/ Analysis)

Not Applicable

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Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of Matrix Spike/ Matrix Spike Duplicate	No. of Field Blanks	No. of Equip. Blanks	No. of Volatile Organic Analyte Trip Blanks	No. of Proficiency Test Samples	Total No. of Samples to Lab

Not Applicable

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Worksheet #21—Project Sampling SOP References Table (Munitions Response)

Reference Number	Title, Revision Number and / or Date	Originating Organization	Equipment Type	Modified for Project Work?	Comments
ES-P02-05-02-P	Operational Readiness Review (ORR)	CH2M HILL	ORR Form	No	
MRP-SOP-0001	Surface Munitions and Explosives of Concern (MEC) & Subsurface Anomaly Avoidance	CH2M HILL	Schonstedt GA-52Cx	No	
EM61-MK2	Standard Operating Procedures for Geophysical Mapping, Geonics EM61 – MK2	NAEVA Geophysics	Geonics EM61 – MK2	No	
OPS-03	Demolition/Disposal Operations	USA-E	None	No	
OPS-04	DGM Anomaly Investigations	USA-E	Schonstedt GA-52Cx	No	
OPS-05	Digital Geophysical Mapping	USA-E	Geonics EM61-MK2	No	
OPS-13	MPPEH Management	USA-E	None	No	
OPS-14	MEC Analog Detection and Removal Actions	USA-E	Schonstedt GA-52Cx	No	
OPS-17	MEC Surface Sweeps	USA-E	Schonstedt GA-52Cx	No	
None	EM61-MK2 Setup and Use For Reacquire and Post Intrusive Checks	USA-E	Geonics EM61-MK2	No	

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

See also **Worksheet #12-1.**

Field Equipment	Activity[1]	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference	Comments
EM61-MK2	Verification	At the beginning of each work day when used. (Some tests are also run at the end of the day.) DGM system is warmed up before use and QC tests are run to ensure stability and functionality.	System passes QC test measures	Inspect/repair equipment until functioning properly.	Equipment operator	EM61-MK2 and OPS-05	MR Senior Geophysicist to confirm test performed through data collection notes and data evaluation.
Schonstedt or White's XLT (or equivalent)	Verification	At the beginning of each work day when used	System responds to items in Equipment Check Area	Inspect/repair equipment until functioning properly.	Equipment operator	MRP-SOP-0001, OPS-04, OPS-14, and OPS-17	UXOQCS verifies daily equipment check of handheld magnetometers.

[1] Activities may include: calibration, verification, testing, and/or maintenance.

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Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work (Y/N)

Not Applicable

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Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference

Not Applicable

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference

Not Applicable

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Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
SAMPLE RECEIPT AND ANALYSIS
SAMPLE ARCHIVING
SAMPLE DISPOSAL

Not Applicable

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Worksheet #27—Sample Custody Requirements Table

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):
Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):
Sample Identification Procedures:
Chain-of-custody Procedures:

Not Applicable

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Worksheet #28—Laboratory QC Samples Table

Matrix:

Analytical Group:

Analytical Method/SOP Reference:

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank						
Laboratory Control Standard						
Internal Standards						
System Monitoring Compounds/Surrogates						

Not Applicable

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Worksheet #29—Project Documents and Records Table

Document/ Report/Form	Generator	DFOW	Frequency of Completion	Location/Where Maintained
Field Notebook	CH2M HILL FTL	All fieldwork	Daily	CH2M HILL local server, hard copy onsite then in project file
Work Plans (MEC-QAPP)	CH2M HILL	Pre-mobilization activities	Once prior to beginning fieldwork	CH2M HILL local server, hard copy onsite then in project file
CA Forms	CH2M HILL	All fieldwork	As necessary	CH2M HILL local server and project file
Digital handheld field devices (for example, PDAs)	CH2M HILL, DGM Subcontractor, and MEC Subcontractor	DGM survey, anomaly reacquisition, intrusive investigation of DGM- identified anomalies, and anomaly verification	Daily	CH2M HILL local server, hard copy onsite (digital handheld field device and hand written), and then in project file
Equipment/Instrument Check Logs	CH2M HILL, MEC and Reacquisition Subcontractors	Anomaly Reacquisition/Intrusive investigation of DGM identified anomalies/Anomaly Source Removal Verification	As required by this MEC-QAPP	CH2M HILL local server, hard copy onsite then in project file
Daily QC Reports (PP, IP, and FP)	CH2M HILL	All fieldwork	Daily	CH2M HILL local server, hard copy onsite then in project file
Field Photograph Log	CH2M HILL	All fieldwork	Daily/As necessary	CH2M HILL local server
Daily Project Reports	CH2M HILL	All fieldwork	Daily	CH2M HILL local server, hard copy onsite then in project file
Daily H&S Documents	CH2M HILL	All fieldwork	Daily	CH2M HILL local server, hard copy onsite then in project file
Training Records	CH2M HILL and Subcontractors	All fieldwork	Prior to mobilization to the site	Hard copy onsite and with Human Resources
Meeting Agendas, Minutes, Presentation, and so forth	CH2M HILL	All DFOWs	As necessary	CH2M HILL local server
RI Report	CH2M HILL	Final report	Once upon completion of site activities	CH2M HILL local server

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Worksheet #30—Analytical Services Table

Matrix	Analytical Group	Sample Locations/ Identification Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization	Backup Laboratory / Organization

Not Applicable

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Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Geophysical Data Quality Assessment	Daily during DGM survey	External	NAEVA Geophysics	DGM Subcontractor QA Manager, Karen Lemley	PM/CH2M HILL, MR Senior Geophysicist/ CH2M HILL	MR Senior Geophysicist/ CH2M HILL	PM/CH2M HILL
Field Performance Audit to verify removal of excavated anomaly sources	Once at the end of the intrusive investigation	Internal	CH2M HILL	SUXOS and/or MR Senior Geophysicist	MEC Subcontractor, DGM Subcontractor	UXOQCS/CH2M HILL	PM/CH2M HILL
Field Performance Audit	Once during field event	Internal	CH2M HILL	SUXOS and/or MR Senior Geophysicist	MEC Subcontractor, DGM Subcontractor	FTL/CH2M HILL	PM/CH2M HILL
Data storage and transfer system check	Prior to initial data collection and once weekly	Internal	CH2M HILL	MR Senior Geophysicist	FTL	FTL/CH2M HILL	PM/CH2M HILL

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Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response	Timeframe for Response
Field Performance Audit	Checklist and Written Audit Report	CH2M HILL PM	Within 1 week of audit	Memorandum	CH2M HILL SUXOS CH2M HILL MR Senior Geophysicist	Within 1 week of receipt of CA Form

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Worksheet #32-1—Corrective Action Form

Person initiating CA _____ Date _____

Description of problem and when identified (Submit a drawing/sketch if necessary): _____

_____

_____

_____

Cause of problem, if known or suspected: _____

_____

_____

Resolution/Sequence of CA: (including date implemented, action planned and personnel/data affected) _____

_____

_____

_____

_____

_____

_____

_____

CA implemented by: _____ Date: _____

CA initially approved by: _____ Date: _____

Follow-up date: _____

Final CA approved by: _____ Date: _____

Information copies to:

_____

_____

_____

_____

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Worksheet #32-2—Field Performance Audit Checklist

Project Responsibilities

Project No.: _____ Date: _____

Project Location: _____ Signature: _____

Team Members

Yes No 1) Is the approved work plan being followed?

Comments _____

_____

Yes No 2) Was a briefing held for project participants?

Comments _____

_____

Yes No 3) Were additional instructions given to project participants?

Comments _____

_____

DGM Operations

Yes No 1) Are routine inspections and QC checks of the equipment being performed as outlined in this MEC-QAPP?

Comments _____

_____

Yes No 2) Is the proposed location of transect lines clearly communicated with DGM Survey Team?

Comments _____

_____

Yes No 3) Is data collection being performed as required by the MEC-QAPP?

Comments _____

_____

Yes No 4) Are data stored properly and uploaded for transfer in a timely manner?

Comments _____

_____

Yes No 5) Are photographs taken and documented?

Comments _____

_____

Worksheet #32-2—Field Performance Audit Checklist (continued)

Document/Data Control

Yes No 1) Are all work plan documents available onsite for review?

Comments _____

_____

Yes No 2) Are daily reports and other documentation completed as required by the MEC-QAPP?

Comments _____

_____

Yes No 3) Are equipment QC data and collected field data properly transferred for review?

Comments _____

_____

Worksheet #33—QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date	Person Responsible for Report Preparation	Report Recipient(s)
Daily QC Report	Daily	Following day	UXOQCS for UXO related activities; FTL for non-UXO related activities	Navy
QC Meeting Minutes	Post Meeting	Within 7 days	UXOQCS for UXO related activities; FTL for non-UXO related activities	Navy
Preparatory Inspection Forms	Once for each applicable DFOW (prior to start of task)	With daily reports the following day after meeting	UXOQCS for UXO related activities; FTL for non-UXO related activities	Navy
Initial Inspection Forms	Once for each applicable DFOW (prior to start of task)	With daily reports the following day after meeting	UXOQCS for UXO related activities; FTL for non-UXO related activities	Navy
Follow-Up Inspection Forms	Once for each applicable DFOW (document in daily reports)	Document in daily reporting	UXOQCS for UXO related activities; FTL for non-UXO related activities	Navy
RI Report	Post-field event	See Worksheet #16	PM/CH2M HILL	Stakeholders, see Worksheet #4

The RI report will include the following:

- Executive Summary
- Introduction: Describe the objectives and scope of the RI, as well as the organization of the RI report.
- Environmental Setting: Describe the current and historical land uses associated with DNA and the MTMR-S, discuss previous investigations conducted at the site, and summarize the physical characteristics of the site, such as climate, geology, hydrology, and ecology.
- RI Activities: Provide details of the data gathering methods and approaches used during the field activities.
- Investigation Findings: Present the analytical data pertaining to each media type, DGM and intrusive results, and assesses the nature and extent of MEC at the site.
- MEC Hazard Assessment (MEC HA)
- Conclusions and Recommendations: Summarize the results of the RI and the potential MEC hazard, as well as provide recommendations for additional activities at the site.

Supplemental information, such as figures, tables, survey data, DGM data, intrusive anomaly data, and the MEC HA supporting calculations, will be included as appendices to the report.

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Worksheet #34—Verification (Step I) Process Table

A preparatory phase inspection will be performed prior to beginning each DFOW to review applicable specifications and verify the necessary resources, conditions and controls are in place and compliant before the start of work activities. An initial phase inspection will be performed at the beginning of each DFOW to observe/review the application of procedures to ensure their adequacy, ensure adequate resources are applied to the activity and that a clear understanding exists as to the QC requirements of the DFOW. The responsible person will inspect the relevant items from the checklist in the SOP, as appropriate.

DFOW	Verification Description	Verification Documentation	Responsible for Verification (name, organization)
Pre-mobilization Activities	Prior to mobilization to the site, verify – project personnel have proper training and required certification to perform site activities and achieve project MQOs. – site access has been approved for project personnel, including subcontractor and that appropriate security measures are in place for personnel and equipment.	QC Forms	PM/CH2M HILL, UXOQCS/CH2M HILL
Mobilization/ Site Preparation	Prior to mobilization to the site, verify on site personnel – have reviewed the approved ESS, MEC-QAPP, and applicable SOPs, and – understand the project objectives, procedures, and MQOs.	QC Forms	PM/CH2M HILL, UXOQCS/CH2M HILL
Anomaly Avoidance	Prior to any site activities, verify that project personnel – are familiar with MRP-SOP-0001 (MEC Surface and Subsurface Anomaly Avoidance), and – have completed "3R" training.	QC Forms / Munitions Response Site Information Management System (MRSIMS)	UXOQCS/CH2M HILL
Surface MEC/MPPEH Removal	Prior to surface MEC/MPPEH removal activities, verify that surface MEC/MPPEH Removal personnel – are familiar with applicable SOPs and will remove surface debris and/or MEC/MPPEH in accordance with the approved MEC-QAPP.	QC Forms / MRSIMS	UXOQCS/CH2M HILL
DGM Survey	Prior to DGM survey activities, verify that DGM personnel – are familiar with the geophysical survey methods for the GSV and DGM survey, including navigation and data collection procedures detailed in the GIP and appropriate SOPs and – will conduct DGM survey activities in accordance with the approved MEC-QAPP.	QC Forms / MRSIMS	MR Senior Geophysicist/ CH2M HILL
DGM Data Processing	Prior to DGM data processing, verify – data collection is complete, data have been recorded accurately, and data transfer procedures are adequate, and – DGM data processors are familiar with the methods and procedures detailed in the GIP and will process and interpret DGM data in accordance with the approved MEC-QAPP.	QC Forms / MRSIMS	MR Senior Geophysicist/ CH2M HILL
Anomaly Reacquisition	Prior to anomaly reacquisition, verify reacquisition personnel – are familiar with applicable SOPs and will reacquire selected anomalies in accordance with the approved MEC-QAPP.	QC Forms/MRSIMS	MR Senior Geophysicist/ CH2M HILL UXOQCS/CH2M HILL

Worksheet #34—Verification (Step I) Process Table (continued)

DFOW	Verification Description	Verification Documentation	Responsible for Verification (name, organization)
Intrusive investigation of DGM-identified anomalies and removal verification	Prior to intrusive operations, verify intrusive investigation personnel – are familiar with the procedures detailed in the ESS and applicable SOPs and – will conduct intrusive operations in accordance with the approved ESS and MEC-QAPP.	QC Forms	MR Senior Geophysicist/ CH2M HILL UXOQCS/CH2M HILL
MEC/MPPEH Management and Disposal	Prior to MEC/MPPEH management and disposal operations, verify that UXO personnel – are familiar with the procedures detailed in the ESS and applicable SOPs and – will conduct MEC/MPPEH management and disposal operations in accordance with the approved ESS and MEC-QAPP.	QC Forms	UXOQCS/CH2M HILL
Demobilization	Prior to demobilization, verify – on-site activities are complete and – the site has been restored to preexisting conditions.	QC Forms	PM/CH2M HILL, UXOQCS/CH2M HILL
Final Report and Closeout	Not applicable (N/A)		

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

Follow-up inspections are conducted to ensure that procedures are being correctly performed, no changed conditions exist which may affect the quality of work and lessons learned are being captured and applied.

Definable Feature of Work	Frequency of Inspection	Validation Description/Documentation	Validation Documentation	Responsible for Validation (name, organization)
Pre-mobilization Activities	N/A	No Follow-up required for this DFOW	N/A	N/A
Mobilization/Site Preparation	N/A	No Follow-up required for this DFOW	N/A	N/A
Anomaly Avoidance	Minimum of one team per day	Inspection to validate that MRP-SOP-0001 (MEC Surface and Subsurface Anomaly Avoidance), is being followed	QC Forms	UXOQCS/CH2M HILL
Surface MEC/MPPEH Removal	Minimum of one team per day	Inspection of surface MEC/MPPEH removal activities and results to validate the ESS and applicable SOPs are being followed	QC Forms/MRSIMS	MR Senior Geophysicist/UXOQCS/CH2M HILL
DGM Survey	Minimum of one team per day	Inspection to confirm – Part 1 of the GSV Process (IVS) has been conducted in accordance with the GSV Plan, and – the results of the IVS survey indicate the DGM system will meet the project MQOs. Inspection of DGM activity records to validate – subcontractor-provided SOPs and the GIP are being followed, – survey coverage is in accordance with approved project plans, and – data MQOs are being achieved.	QC Forms/MRSIMS	MR Senior Geophysicist/CH2M HILL
DGM Data Processing	Per data set	Inspection of DGM data processing to validate – data processing procedures detailed in the GIP are being followed and – data and interpretation results are usable.	QC Forms/MRSIMS	MR Senior Geophysicist/CH2M HILL
Anomaly Reacquisition	Minimum of one team per day	Inspection of anomaly reacquisition activities and results to validate – applicable SOPs are being followed and – selected anomalies are reacquired within acceptable limits of positional accuracy.	QC Forms/MRSIMS	MR Senior Geophysicist/CH2M HILL and UXOQCS/CH2M HILL

Worksheet #35—Validation (Steps IIa and IIb) Process Table (continued)

Definable Feature of Work	Frequency of Inspection	Validation Description/Documentation	Validation Documentation	Responsible for Validation (name, organization)
Intrusive investigation of DGM-identified anomalies and removal verification	Minimum of one team per day	Inspection of intrusive investigation activities and results to validate – the ESS and applicable SOPs are being followed and – anomaly sources are resolved in accordance with the approved ESS and MEC-QAPP.	QC Forms/MRSIMS	MR Senior Geophysicist/CH2M HILL and UXOQCS/CH2M HILL
MEC/MPPEH Management and Disposal	Weekly and per demolition event	Inspection of MEC/MPPEH Management and disposal activities and records to validate – the ESS and applicable SOPs are being followed and – all MEC/MPPEH items are tracked and disposed of in accordance with the approved ESS and MEC-QAPP.	QC Forms	UXOQCS/CH2M HILL
Demobilization	N/A	Inspection of demobilization activities and records to verify – all equipment and personnel have been removed from the site and – the site has been restored to pre-existing conditions.	QC Forms	PM/CH2M HILL, UXOQCS/CH2M HILL
Final Report and Closeout	N/A	No Follow-up required for this DFOW		

Worksheet #36—Geophysical Data Validation (Steps IIa and IIb) Summary Table

Verification and validation of RI data will involve the following five-step process to ensure data quality:

- Step 1 will consist of a review of preparatory QC activities, including verification of personnel training and qualifications and initial IVS demonstration activities
- Step 2 will consist of a review of initial and follow-up phases of QC inspections and certification
- Step 3 will consist of a review of DGM data acquisition, processing, and interpretation, including associated documentation
- Step 4 will consist of a review of MEC clearance operations, including review of follow-up QC checklists and compliance with the surveillance requirements of the MEC-QAPP
- Step 5 will consist of a review of intrusive investigation results to validate the completion of RI field activities and the appropriate handling of recovered MEC and MPPEH items

The five steps will be documented and reviewed by the PM, MR Senior Geophysicist, and UXOQCS before submission to the Navy. Upon Navy approval, the package will be provided to the regulatory agencies and stakeholders, as required. The following sections describe each process step. Additional details are included in the GIP and GSV Plan (Appendix A).

Step 1: Pre-operational Team Training and Site Preparation

Step 1 consists of verification of personnel training and qualifications and demonstration of DGM system performance at the IVS. Surveillance checks will verify completion and documentation of mandatory pre-operational preparation, including training, personnel qualifications, equipment status, and accurate SOPs for project activities. This process will document that the pre-operational actions in the SOPs have been met and that project personnel are qualified and prepared to conduct DGM surveys and intrusive investigations. A checklist of any identified deficiencies will be provided to the PM, MR Senior Geophysicist, and UXOQCS. A record of the completed checklists will be maintained in the project QC file as discussed in scoping sessions and the ORR.

Step 2: QC Inspection and Surveillance

Step 2 consists of documentation that QC inspection and surveillance activities are conducted in accordance with contract specifications and approved SOPs. This process will verify that the geophysical survey, intrusive investigation, and MEC/MPPEH handling protocols are followed. The following activities are included in the Step 2 inspection:

a. Verify that personnel performing geophysical and intrusive MEC work are properly trained, including required certification of UXO Technicians, prior to initiating RI fieldwork

b. Verify that the construction of the IVS, including a background DGM survey of the IVS location and the placement of IVS seed items, is in compliance with the requirements of the GSV Plan to allow appropriate demonstration of DGM system performance

c. Verify that DGM system (personnel and equipment) performance has been demonstrated at the IVS in accordance with the GSV Plan before initiating the RI DGM survey

d. Verify that the DGM survey team has conducted the DGM survey in accordance with the GIP and appropriate SOP

e. Review DGM results to verify that the geophysical survey is complete and has been conducted in accordance with the GIP

f. Verify that the analysis of DGM data and selection of anomalies for intrusive investigation has been conducted and documented in accordance with the GIP

Worksheet #36—Geophysical Data Validation (Steps IIa and IIb) Summary Table (continued)

g. Verify that intrusive investigations have been conducted in accordance with the ESS and appropriate SOPs

h. Verify that intrusive investigations have been completed, and that all recovered MEC and MPPEH items have been properly identified and managed for treatment and disposal

i. A record of the completed activities will be maintained in the project QC file and reported in the RI Report and periodic progress reports. Steps 3 – 5, described below, address specific Step 2 activities.

Step 3: Inspection of DGM Data Acquisition and Analysis

Step 3 consists of the independent verification of the geophysical data for Step 2 (b through f). The MR Senior Geophysicist will verify that the DGM data were correctly acquired, processed and interpreted. This QC is in addition to the 100-percent QA performed by the Navy's QAO, as necessary. This combined effort will begin during the initial IVS survey and will continue throughout the duration of RI DGM activities. DGM system performance will be demonstrated through the IVS survey before commencing RI DGM survey operations and will continue throughout DGM activities through the blind seeding portion of the GSV. An IVS Letter Report will be prepared immediately following the initial IVS survey to present the IVS survey results. The DGM system (personnel and equipment) will meet the MQOs described in the GIP (**Appendix A**) throughout RI DGM activities.

Step 4: Inspection of Intrusive Investigation Operations

Step 4 consists of documentation of QC surveillance operations to address Step 2 (g). An SOP-specific compliance check, along with review of appropriate QC surveillance forms, will document that the intrusive investigation is conducted in accordance with the ESS and appropriate SOPs. A copy of each QC surveillance report will be stored in the project QC file and included in periodic progress reports.

Step 5: Final Inspection of Intrusive Investigation Results

Step 5 consists of a review of intrusive investigation results to address Step 2(h). This step will verify that DGM anomaly sources have been located and removed and that recovered MEC and MPPEH items have been handled in accordance with the ESS and appropriate SOPs. During intrusive investigation, excessive "no contact" findings will trigger the generation of a Root Cause Analysis to determine if a quality issue exists with either the geophysical data used for anomaly selection or the intrusive investigation process. As part of the root cause analysis, the project team will determine the extent of data affected by the quality issue and provide planned CAs and/or recommendations, if necessary. After CAs have been implemented, any portions of the site affected by the quality issue will be re-worked.

Worksheet #37—Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

- If all QC criteria are met, then the data are usable.
- If QC criteria are not met, then data are suspect and cannot be used until confirmed.

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

- If significant inconsistency in data is determined the data will be evaluated to assess impact on decision-making.
- If significant deviations are noted between QC of equipment, background information, and field data, the cause will be further evaluated to assess impact on decision making.

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

- Graphical representations and site representative figures will be produced to reflect the areas which are most likely to contain MEC and which do not.
- The RI report will identify any data usability limitations and make recommendations for future investigations, if necessary.
- A data quality evaluation section will be included as part of the RI report to summarize the results of the data collection and interpretation.
- The RI report will identify any data usability limitations and make recommendations for CA if necessary.

Identify the personnel responsible for performing the usability assessment.

- The PM, MR Senior Geophysicist, and other team members will be responsible for collecting and compiling the data. The data will then be presented to the Navy and VDEQ, who will evaluate the data usability according to project objectives.

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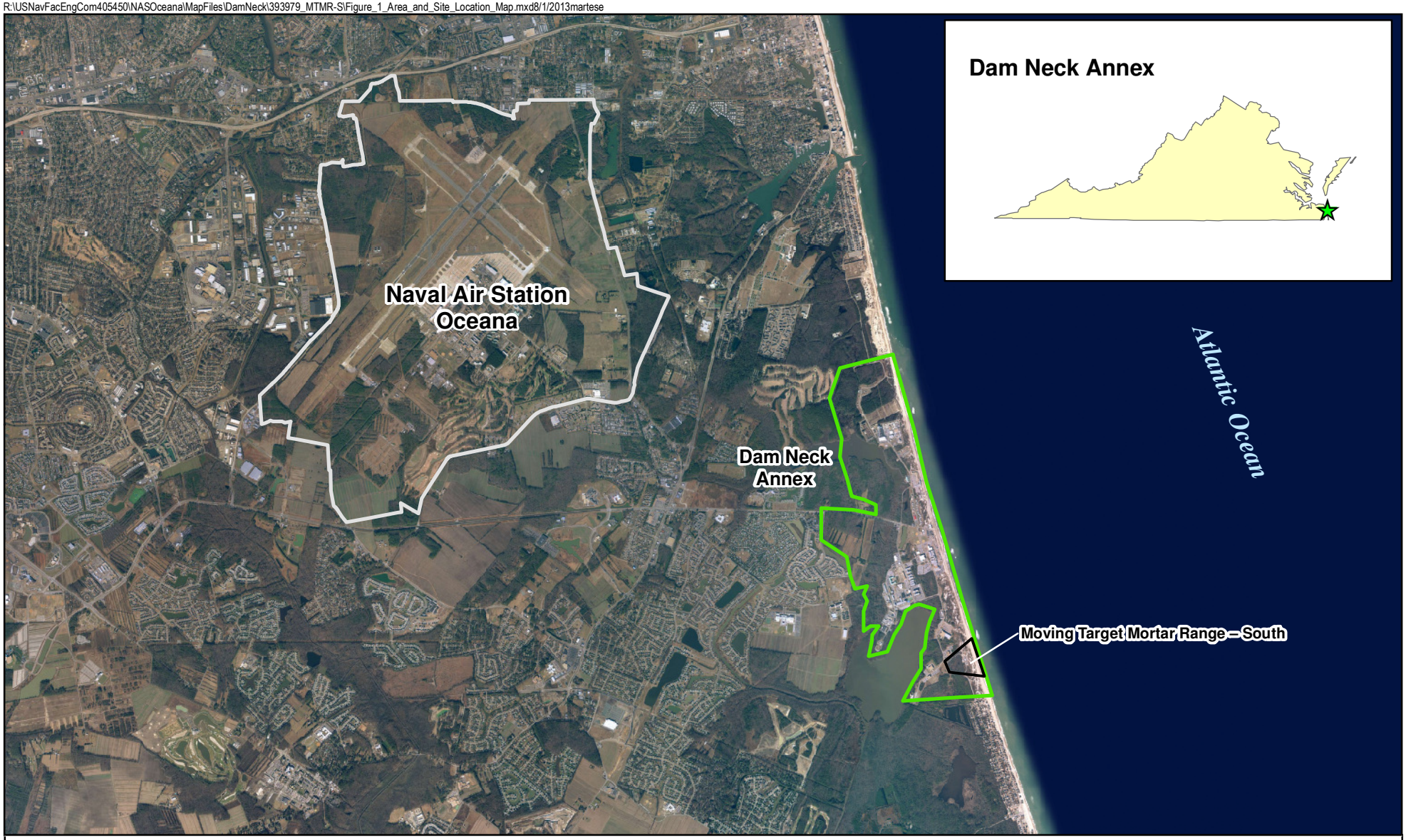
Figures

R:\USNavFacEngCom405450\NASOceana\MapFiles\DamNeck\393979_MTMR-S\Figure_1_Area_and_Site_Location_Map.mxd8/1/2013martese



Legend

- MRS Site
- NAS Oceana Boundary
- Dam Neck Annex Boundary

N
W E
S

0 0.6 1.2 Miles

Figure 1
Area and Site Location Map for the MTMR-S
Dam Neck Annex - Naval Air Station Oceana
Virginia Beach, Virginia

CH2MHILL

R:\USNavFacEngCom405450\NASOceana\MapFiles\DamNeck\393979_MTMR-S\Figure 2 - Moving Target_Mortar Range - South Boundary.mxd7/31/2013martese

Legend

- Installation Boundary
- MRS Boundary
- Historical Range Location

N
W E
S

0 500 1,000
Feet

Figure 2
Moving Target/Mortar Range – South Boundary
Dam Neck Annex - Naval Air Station Oceana
Virginia Beach, Virginia

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R:\USNavFacEngCom405450\NASOceana\MapFiles\DamNeck\393979_MTMR-S\Figure 3 - Priority1 DGM Geophysical Anomalies 2010.mxd7/31/2013martese

Legend

- Priority 1 Anomalies
- Installation Boundary
- MRS Boundary
- Historical Range Location

N
W E
S

0 300 600 Feet

Figure 3
Priority 1 DGM Geophysical Anomalies – Site Inspection, March 2010
Dam Neck Annex - Naval Air Station Oceana
Virginia Beach, Virginia

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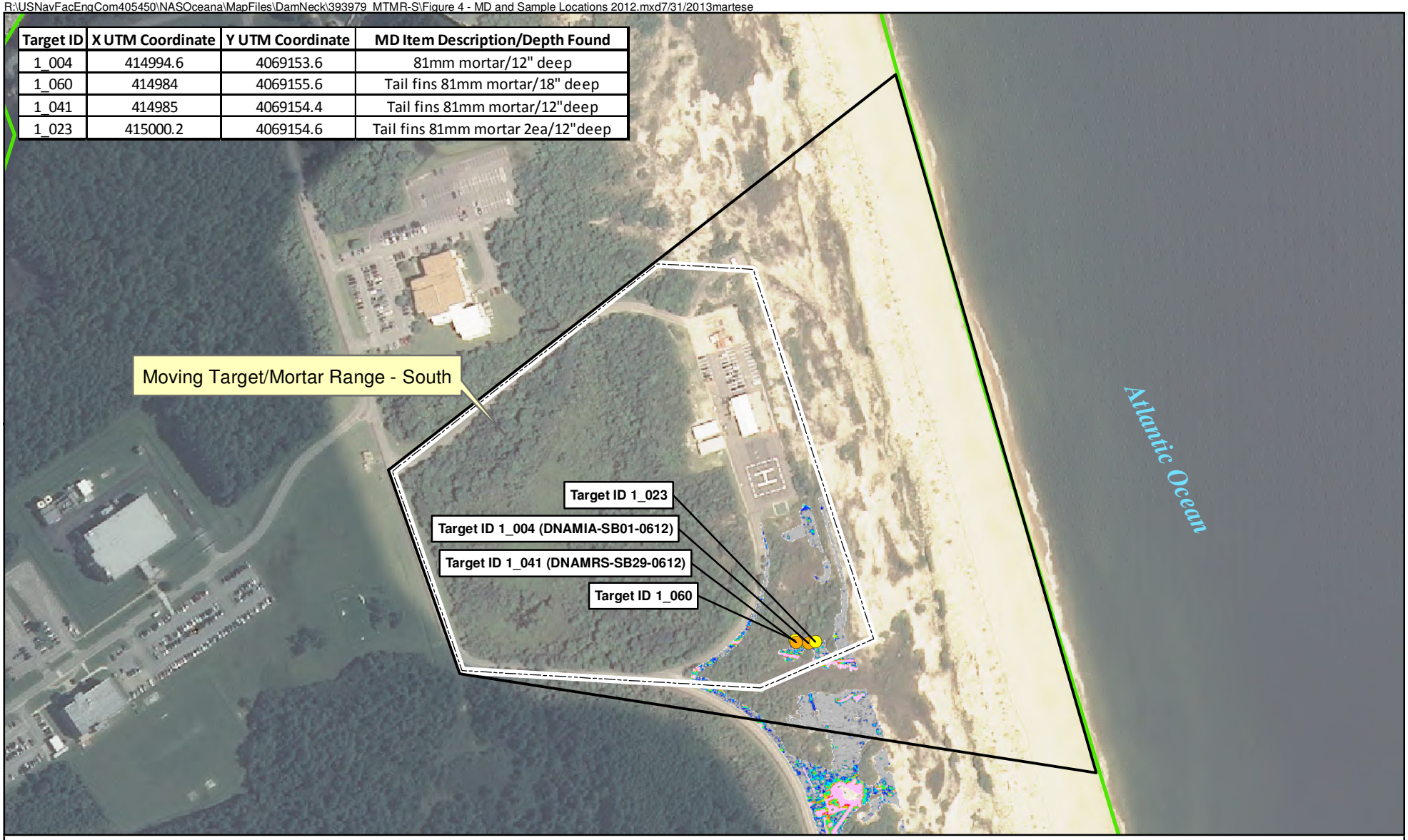
R:\USNavFacEngCom405450\NASOceana\MapFiles\DamNeck\393979_MTMR-S\Figure 4 - MD and Sample Locations 2012.mxd7/31/2013martese

Target ID	X UTM Coordinate	Y UTM Coordinate	MD Item Description/Depth Found
1_004	414994.6	4069153.6	81mm mortar/12" deep
1_060	414984	4069155.6	Tail fins 81mm mortar/18" deep
1_041	414985	4069154.4	Tail fins 81mm mortar/12"deep
1_023	415000.2	4069154.6	Tail fins 81mm mortar 2ea/12"deep



Legend

- Munitions Debris Location
- Munitions Debris and Subsurface Soil Location
- Installation Boundary
- Historical Range Location
- MRS Boundary

N
W E
S

0 175 350
Feet

Figure 4
Munitions Debris and Subsurface Soil Sample Locations
Expanded Site Inspection, June 2012
Dam Neck Annex – Naval Air Station Oceana
Virginia Beach, Virginia

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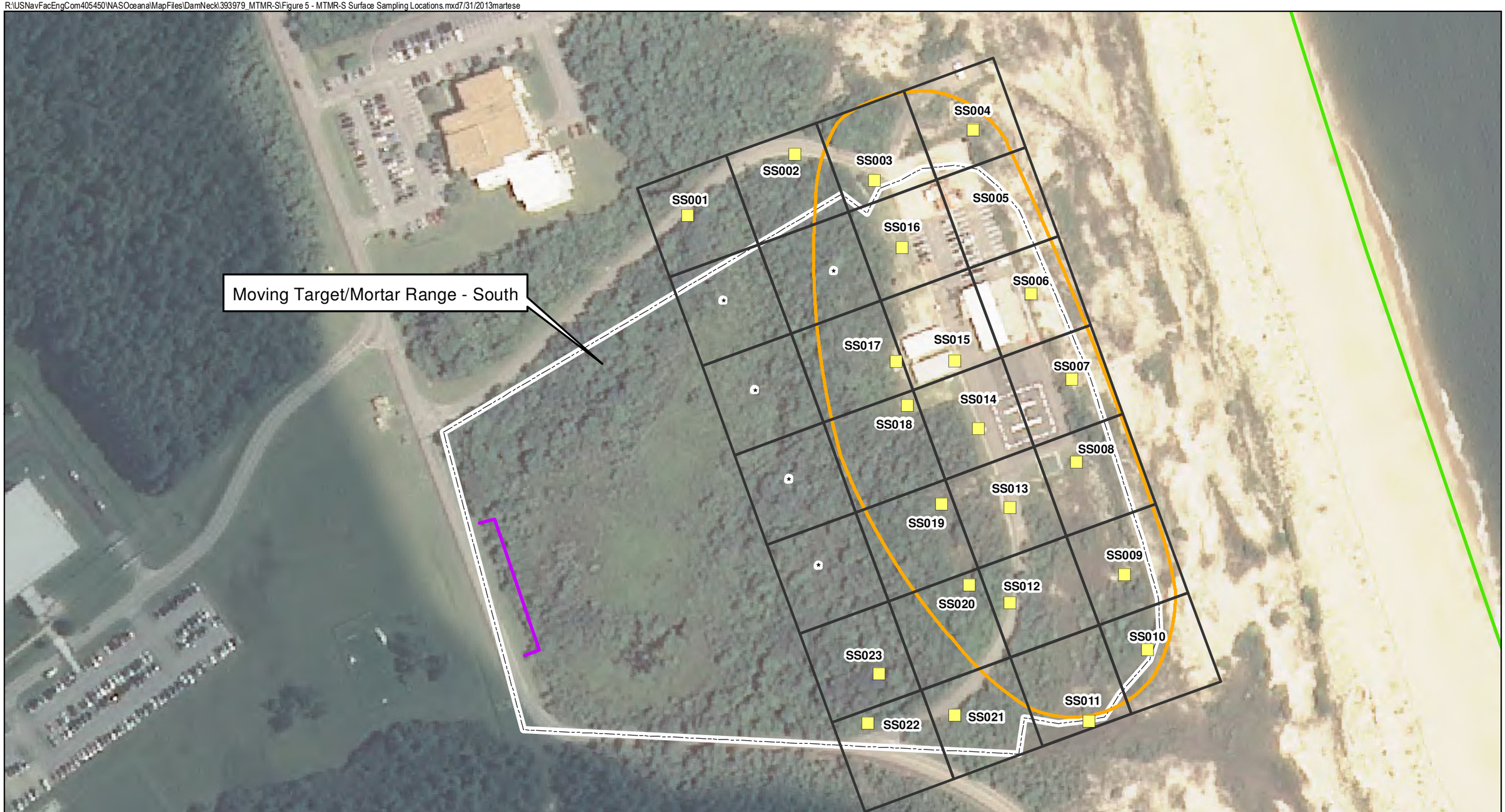
R:\USNavFacEngCom405450\NASOceana\MapFiles\DamNeck\393979_MTMR-S\Figure 5 - MTMR-S Surface Sampling Locations.mxd7/31/2013martese



Legend

- Sample Locations
- Probable Gun Turrets and Structures (1945)
- Target Track (1945)
- Installation Boundary
- Historical Range Location
- Grid

*Not sampled due to presence of heavy brush or standing water

N
W E
S

0 75 150
Feet

Figure 5
MTMR-S Surface Soil Sampling Locations - Expanded Site Inspection, June 2012
Dam Neck Annex - Naval Air Station Oceana
Virginia Beach, Virginia

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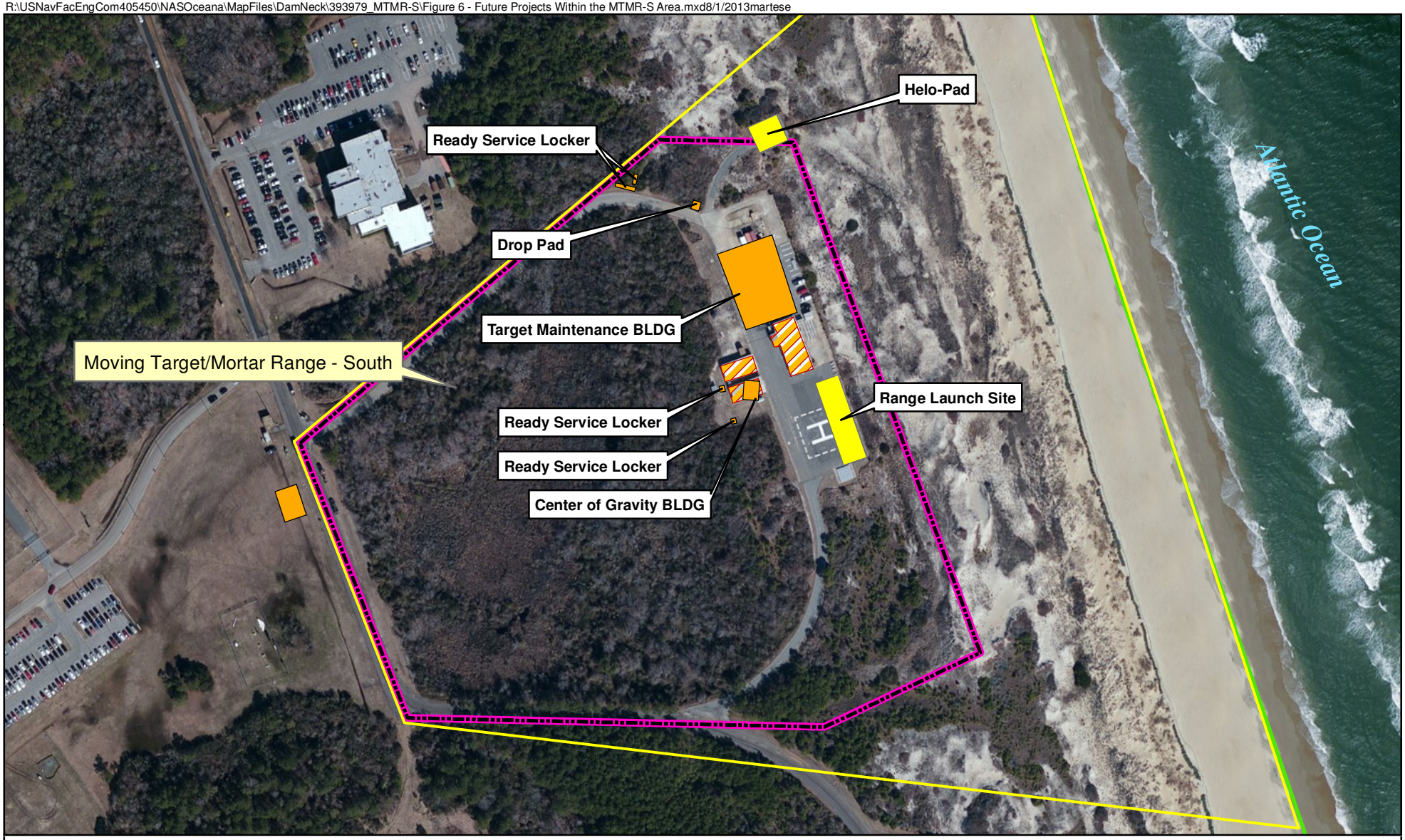
R:\USNavFacEngCom405450\NASOceana\MapFiles\DamNeck\393979_MTMR-S\Figure 6 - Future Projects Within the MTMR-S Area.mxd8/1/2013martese



Legend
- Demo
- New Construction
- New Pavement/Slab
- Concrete Pad - Reuse
- Installation Boundary
- Historical Range Location
- MRS Boundary

N
W E
S

0 125 250
Feet

Figure 6
Future Projects Within the MTMR-S Area
Dam Neck Annex - Naval Air Station Oceana
Virginia Beach, Virginia

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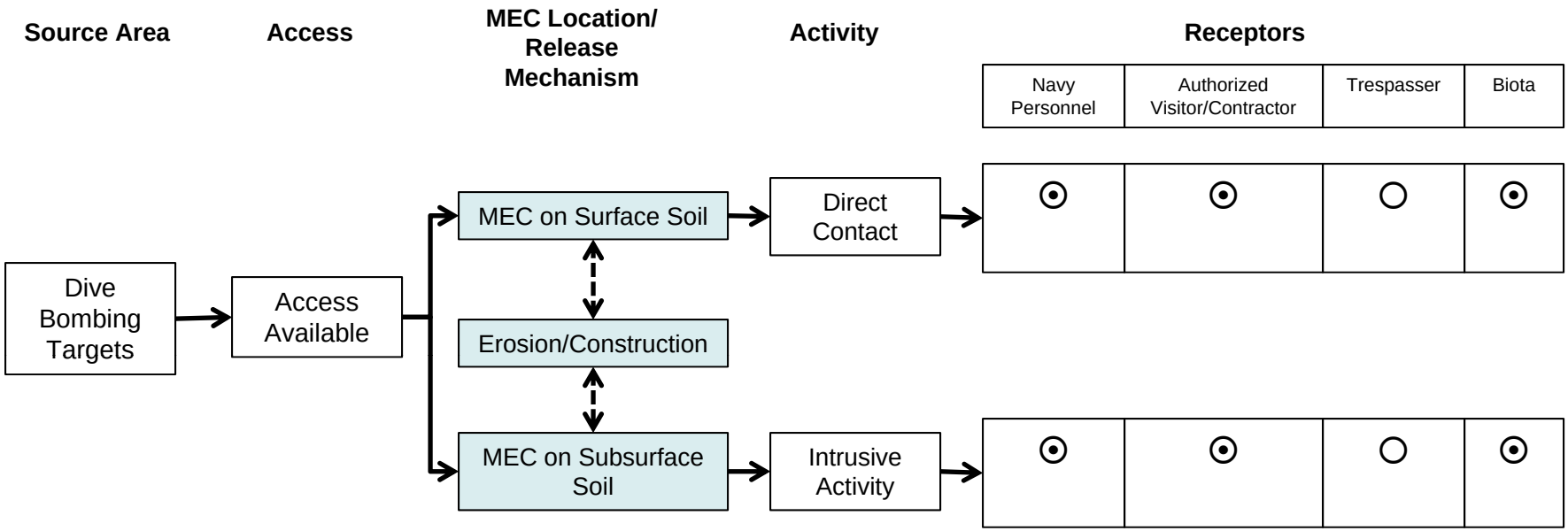
Conceptual Site Model for MEC Exposure

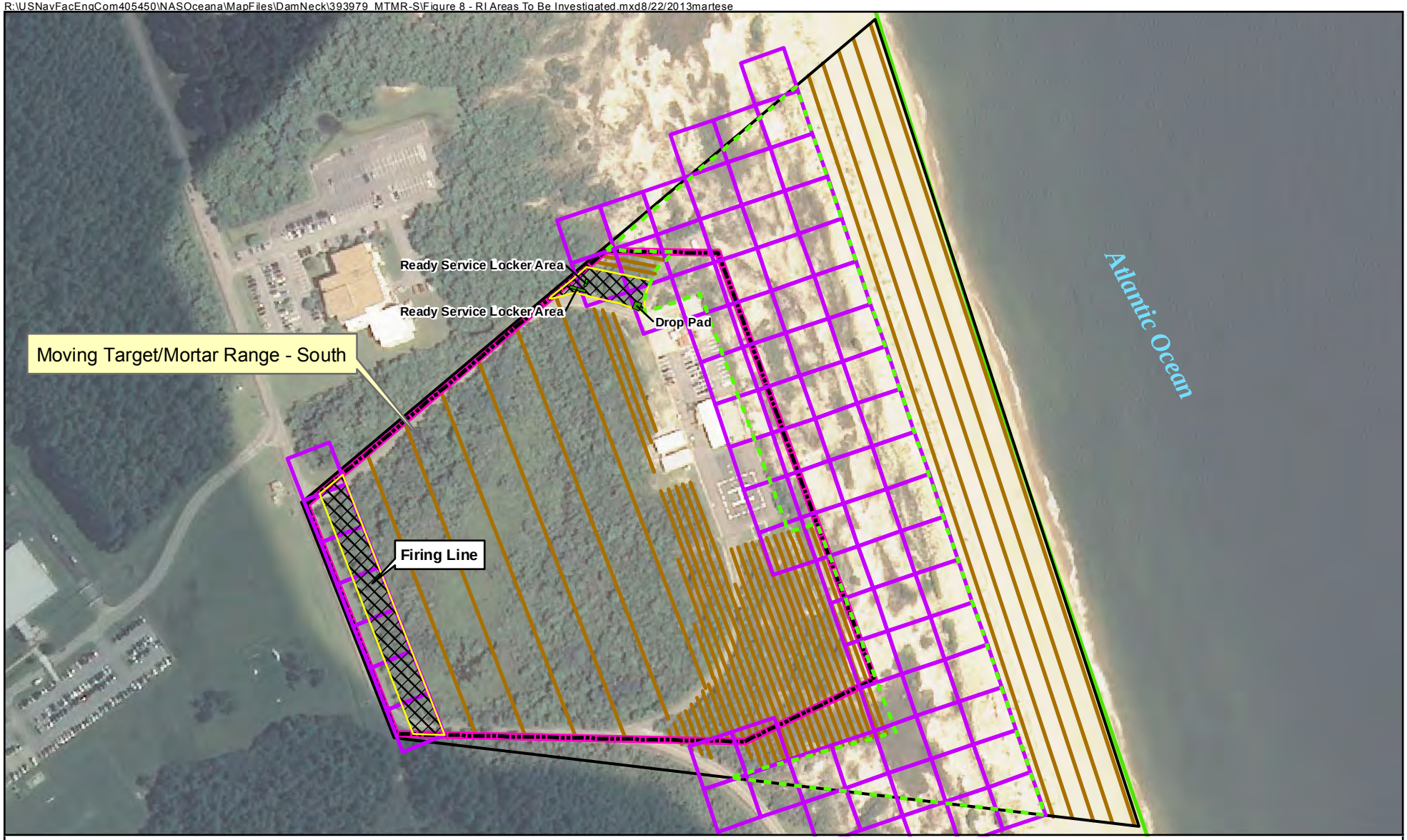


⊙ - Potentially Complete Pathway
○ - Incomplete Pathway

Source: Figure 5.10-4 (Malcolm Pirnie, 2008)

Figure 7
Conceptual Site Model for MEC Exposure
Moving Target/Mortar Range - South Remedial Investigation
Dam Neck Annex – Naval Air Station Oceana
Virginia Beach, Virginia

R:\USNavFacEngCom405450\NASOceana\MapFiles\DamNeck\393979_MTMR-S\Figure 8 - RI Areas To Be Investigated.mxd8/22/2013martese



Legend

- Transect
- Full coverage of accessible areas for DGM grids
- Dune Area (full coverage of accessible areas for DGM grids)
- Installation Boundary
- Historical Range Location
- MRS Boundary
- Buildings
- Grid 30mx30m

N
W E
S

0 50 100
Meters

Figure 8
RI Areas to be Investigated
Moving Target/Mortar Range–South
Dam Neck Annex - Naval Air Station Oceana
Virginia Beach, Virginia

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Appendix A
Geophysical Investigation Plan

Final

Geophysical Investigation Plan
Moving Target Mortar Range-South (UXO 07)
Dam Neck Annex
Remedial Investigation

Naval Air Station Oceana
Virginia Beach, Virginia

Contract Task Order WE69

September 2013

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

NAVFAC CLEAN 8012 Program
Contract N62470-11-D-8012

Prepared by

CH2MHILL

Virginia Beach, Virginia

Approved By:

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Date: 2013.09.06 11:18:20 -04'00'

Steve Falatko
CH2M HILL – Munitions Response Manager

Date

Approved By:

Tamir L. Klaff

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Tamir Klaff
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Date

Approved By:

John Tomik

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Date: 2013.09.06 10:51:03 -04'00'

John Tomik
CH2M HILL – Activity Quality Manager

Date

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Geophysical System Verification Plan

Acronyms and Abbreviations

3R	Recognize, Retreat, and Report
bgs	below ground surface
cm	centimeter(s)
DGM	digital geophysical mapping
DNA	Dam Neck Annex
ft	foot or feet
FTL	Field Team Leader
GIP	Geophysical Investigation Plan
GPS	global positioning system
GSV	geophysical system verification
ID	identification
in	inch(es)
ISO	industry standard object
m	meter(s)
MEC	munitions and explosives of concern
MEC-QAPP	Munitions and Explosives of Concern-Quality Assurance Project Plan
mm	millimeter
MPC	measurement performance criterion
MPPEH	material potentially presenting an explosive hazard
MQO	measurement quality objective
MRP	Munitions Response Program
MTMR-S	Moving Target/Mortar Range - South
mV	millivolt
NAS	Naval Air Station
nT	nanoTesla
PA	Preliminary Assessment
PDF	portable document format
QC	quality control
RI	Remedial Investigation
RTK	real-time kinematic
SI	Site Inspection
UTM	universal transverse Mercator
UXO	unexploded ordnance

SECTION 1

Geophysical Operations Overview

This Geophysical Investigation Plan (GIP) provides details of the equipment, approach, methods, operational procedures, and quality control (QC) methods to be used in performing the geophysical investigation at the Moving Target/Mortar Range-South (MTMR-S), Unexploded Ordnance (UXO) 07, at Dam Neck Annex (DNA) of Naval Air Station (NAS) Oceana, Virginia Beach, Virginia. DNA is located approximately 5 miles southeast of NAS Oceana, in Virginia Beach, Virginia, and covers approximately 1,400 acres. The mission of this installation is to provide force-level engineering solutions, mission-critical and associated testing, and training technologies for the maritime, joint, special warfare, and information operations domains. Background information on the MTMR-S can be found in Worksheet 10 of the Munitions and Explosives of Concern (MEC) Quality Assurance Project Plan (MEC-QAPP).

The following topics are covered in this GIP: safety issues; geophysical measurement quality objectives (MQOs); description of the site; anticipated MEC types, quantities, compositions, and depths; site physical conditions; adverse geophysical conditions; site utilities and manmade features that may affect the geophysical operation; data acquisition and reporting; and geophysical program QC requirements.

Digital geophysical instruments will be used during digital geophysical mapping (DGM) survey operations that record instrument response digitally, allowing for the subsequent download and interpretation of the data. DGM instruments will be operated by the DGM subcontractor.

Analog geophysical instruments used during operations such as clearing locations for emplacement of survey stakes will be analog, meaning these instruments will be used to detect metallic items in the subsurface on a real-time basis and the instrument response will not be recorded. Analog instruments generally indicate the presence of metallic items through sound or visual display. These analog instruments will be operated by an UXO Technician III or II.

1.1 Safety Issues

Project personnel are required to adhere to the project Health and Safety Plan. DGM survey effectiveness is limited in the dune areas due to surface debris and will require surface clearance prior to beginning DGM operations. MEC avoidance will be practiced during the geophysical survey. MEC avoidance will be provided by one UXO Technician III, who will also serve at the Field Team Leader (FTL). DGM survey personnel will not access areas outside of the survey area or access routes, as directed by the FTL. Personnel are prohibited from touching, handling, moving, or investigating any item that resembles MEC or material potentially presenting an explosive hazard (MPPEH). Upon encountering a potential MEC/MPPEH item, DGM personnel will retreat to a designated rally point and immediately inform the FTL. The FTL will report any MEC encounters to the Facility Fire Response and Navy Remedial Project Manager.

1.2 DGM Personnel Qualifications

DGM operations will be conducted by personnel experienced in MEC geophysical operations and led by a qualified MEC geophysicist. All non-UXO technical personnel will have 3R (Recognize, Retreat, and Report) Training. Throughout DGM operations, DGM support personnel will strictly adhere to the general practices given in this GIP and specifically in the project Health and Safety Plan.

1.3 Areas to be Investigated

The area to be investigated during the DGM survey is shown on **Figure 8** in the MEC QAPP. The DGM survey will be conducted in the following areas within and adjacent to the MTMR-S using the transect spacing and grid coverage noted:

a) Firing line area and proposed building locations in undeveloped areas (full coverage of accessible areas for DGM grids)

b) Wetlands and undeveloped area between the firing line and suspected impact area – (30 meters [m] (100 feet [ft] transect spacing)

c) Suspected impact area in the undeveloped areas to the north and south of the helicopter pad (5 m [16 ft] transect spacing)

d) Grassy dune areas between the site and beach (full coverage of accessible areas for DGM grids limited to open, non-vegetated areas to minimize dune habitat disturbance [approximately 2.2 acres])

e) Beach area between grassy dunes and the Atlantic Ocean (5 meters [16 feet] transect spacing)

SECTION 2

Background

2.1 Past, Current, and Future Site Uses

Detailed discussions of the past uses of the site are provided in Worksheet 10 of MEC-QAPP. Additional information is in the Preliminary Assessment (PA) report (Malcolm Pirnie, 2008) and Expanded Site Inspection (SI) Results Technical Memorandum (CH2M HILL, 2012).

2.2 Anticipated MEC Types, Composition, and Quantities

Refer to Expanded SI Results Technical Memorandum (CH2M HILL, 2012), and PA (Malcolm Pirnie, 2008) documents.

2.3 Anticipated Depth of MEC Items

Although 81mm mortars can penetrate 2.7 ft into sand, in reality, most will land less than 2 ft below the subsurface. During the Expanded SI, the four munitions debris items, (pieces of 81 millimeters (mm) mortars) discovered at four locations in the southeast corner of the MTMR-S were all observed within 18 inches of the ground surface (bgs).

2.4 Vegetation and Topography

Refer to Expanded SI Results Technical Memorandum (CH2M HILL, 2012), and PA (Malcolm Pirnie, 2008) documents.

2.5 Geologic Conditions

Refer to Expanded SI Results Technical Memorandum (CH2M HILL, 2012), and PA (Malcolm Pirnie, 2008) documents.

2.6 Shallow Groundwater Conditions

Refer to Expanded SI Results Technical Memorandum (CH2M HILL, 2012), and PA (Malcolm Pirnie, 2008) documents.

2.7 Adverse Geophysical Conditions

There are no known adverse geophysical conditions that might affect DGM operations.

2.8 Site Utilities

A utility locator will be subcontracted to identify and mark out subsurface utilities as necessary. Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of field personnel and the protection of the Base infrastructure.

2.9 Manmade Features Potentially Affecting Geophysical Operations

A helicopter pad and supporting facilities are located on the northeastern portion of the site and a concrete structure is located in the area of the former firing line. If ferrous metals (rebar) were used to reinforce the concrete in these areas, the DGM data collected might be affected. The impact to the DGM data would be potential masking of collocated anomalies within the subsurface, selection of anomalies associated with manmade features as targets of interest, or saturated response areas. A saturated response area is a defined

area in the DGM data where identification of individual, discrete anomalies is not possible due to a significantly elevated anomaly density.

2.10 Site-specific Dynamic Events

No site-specific dynamic events (for example, unusually strong winds or harsh weather conditions) that might affect the DGM survey operations at the site are anticipated. Although it is possible that weather conditions may impede operations at some time during the project, no significant delays or effects on geophysical instruments resulting from weather are expected.

2.11 Overall Site Accessibility and Impediments

Coordination will be required with NAS Oceana and DNA personnel because the facility is active.

Since some portions of the MTMR-S are situated on a forested-shrub wetland, some investigation areas are not accessible due to standing water (which was present during the vegetation reduction activities in April 2013).

SECTION 3

Geophysical Investigation

The geophysical system verification (GSV) process will be used to validate the DGM system to be used for the DGM surveys. The GSV Plan is provided as an Attachment to this plan.

3.1 DGM MQOs

The primary objective of the DGM activities at the site is to detect metallic items that may be MEC or MPPEH. MQOs specific to the EM61-MK2 surveys to be performed at the site are summarized in the following subsections.

3.1.1 General Geophysical Systems Functioning

DGM Systems Positioning

The MQO for DGM systems positioning is that the coordinates being obtained from the positioning systems are at a sufficient accuracy to allow for appropriate relocation of geophysical anomalies for intrusive investigation. Positioning will be accomplished using real-time kinematic (RTK) global positioning system (GPS) (approximately 2-centimeter accuracy). This MQO will be evaluated by comparing the DGM derived positions of the emplaced IVS targets with known ground truth. The measurement performance criterion (MPC) for this is that the derived positions will be within 1.0 m (3.3 ft) of the established ground truth positions.

DGM Systems Data Repeatability

The MQO for DGM systems data repeatability is that the systems respond consistently from the beginning to the end of an operation. The MPC for this is that the response to a standardized item will not vary more than ±20 percent. This will be evaluated by ensuring that, on a daily basis, the geophysical system being used passes QC Test # 5, *Static Background and Static Spike,* as outlined in Section 3.4.1. Results of QC Test # 6, *Repeat Data*, will also be qualitatively[1] reviewed for repeatability.

3.1.2 DGM Surveys

Downline Data Density

The MQO for down line (along the survey transect) data density is to have sufficient data collected along each transect to detect munitions items and to minimize potential data gaps. The measurement performance criteria are that at 98% or more of possible sensor readings are captured along each transect at distances of 0.213 m (0.7 ft) or less and that no individual data gaps greater than 0.61 m (2 ft) exist along a survey transect, unless the gap is associated with a surface obstruction. This spacing will be quantitatively evaluated in order to determine whether the DGM survey data used for anomaly selection meet this requirement.

Survey Coverage (Transect Spacing)

The MQO for lane spacing is to maintain appropriate lane spacing to ensure appropriate coverage of the area. The MPC for this is that with an intended lane spacing of 5 m (16 ft) near the undeveloped areas to the north and south of the helicopter pad, 5 m (16 ft) in the beach area between dunes and ocean, and 30 m (100 ft) in the wetlands. A ±20 percent leeway allowance for obstructions to the transect lane, with the exception of locations where vegetation (that cannot be cut) or terrain cause greater deviation.

Survey Coverage (Lane Spacing - Full Coverage)

The MQO for lane spacing refers to the ability to maintain appropriate spacing between individual survey lanes for achieving 100% coverage of accessible portions of the survey area. The MPC for this is that the lane spacing is no greater than 1 m (3.3 ft), with an intended lane spacing of 0.75 m (2.5 ft). The specified lane spacing is intended

[1] Comparisons are qualitative because sources of error, including horizontal orientation of the instrument, system bounce, item orientation, and actual item distance from system transmitter and receiver coils can cause high variability in signal response. Quantitative validation of the system response to an industry standard object (ISO) is performed during QC Test #5 (Static Background and Static Spike), described in Section 3.4.1.

to provide sufficient overlap of the sensor footprint in order to effectively achieve 100% coverage. Survey data will be evaluated for missing lines, improperly positioned lines and data gaps that are not otherwise explained (e.g., surface obstruction) in order to determine whether the DGM survey footprint has adequately achieved 100% coverage.

Positioning Precision

The MQO for horizontal positioning precision is that positioning of detected anomalies is precise (repeatable) enough to allow effective reacquisition of the anomaly. The MPC for this objective is a precision of 1 m (3.3 ft). The survey positioning precision is validated by the use of blind seeded targets (i.e. targets that are emplaced in locations that are not known by the DGM subcontractor). A blind seed is deemed to be detected if one of the set of DGM subcontractor selected targets is located within a 1 m (3.3 ft) radius of the seed. This MQO will be evaluated by verifying that all blind seeds have an anomaly location selected within this standard or can be otherwise explained.

Data Handling

The MQO for data handling is that pre-processed and final processed data must be delivered in a timely manner and in a useable format. During production surveys, the MPC for data handling will require that “draft” (raw) data packages be completed and delivered within 3 working days of data collection, and the final data packages within 5 working days of data collection. Compliance will be evaluated based on the actual delivery of data.

3.2 Geophysical Instrumentation

The following subsections detail the geophysical equipment to be used for the investigation.

3.2.1 Analog Geophysical Instruments

The analog geophysical instrument to be used during non-DGM operations where a geophysical instrument is needed to detect metallic items in real time will be a Schonstedt GA-52Cx magnetic locator. This hand-held gradiometer detects the magnetic field of ferrous objects and responds to the difference in the magnetic field between two sensors spaced approximately 50 centimeters (cm) (20 inches [in]) apart. The response is a change in the frequency of the signal emitted by the instrument’s speaker.

3.2.2 DGM Instrument and Positioning Method

The DGM instrument that has been presumptively selected based on site conditions and project objectives is the Geonics EM61-MK2. Positioning will be accomplished using RTK GPS. The DGM system will be configured in a man-portable mode (either wheel-based or “stretcher” mode, depending on ground cover).

The EM61-MK2 is a high-resolution, time-domain electromagnetic instrument designed to detect, with high spatial resolution, shallow metallic objects. The EM61-MK2’s transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects. The EM61-MK2 offers the ability to measure the eddy currents at three distinct time intervals, or four intervals if no top coil measurements are recorded. Earlier time gates provide enhanced detection of smaller metallic objects, so the four-interval method will be used for this project.

Location control for the DGM data will be performed using RTK GPS. Wooden stakes marking the transect lanes and the grid corners will be set by a Virginia licensed professional land surveyor (PLS) prior to the start of DGM. Stakes will be placed without any metal markers (e.g. rebar, hubs, nails) and will not extend more than 0.3 m (1 ft) above the ground surface. UXO personnel will conduct MEC avoidance during placement of surveyor stakes.

3.3 Data Acquisition, Processing and Reporting

3.3.1 Field Data Sheets

Field information to be recorded in the Munitions Response Program Enterprise (MRP Enterprise) system field devices will include the following:

- Site identification (ID)
- Survey Area ID (e.g., grid, grid block, transects, etc.)
- Field team leader name
- Field team members' names
- Date of data collection
- Instrument used
- Positioning method used
- Instrument serial numbers
- Geophysical data file names
- Data collection sampling rate
- Transect/grid numbers, survey direction, RTK GPS locations, start and end points
- Weather conditions
- Grid conditions
- Terrain conditions
- Cultural conditions
- Survey area sketch
- Associated QC data file names
- Field notes (other)

3.3.2 Data Processing

EM61-specific software will be used for initial data processing, and the output will be imported into Geosoft Oasis Montaj for additional processing, graphical display, anomaly selections, and QC. The types of processing that may be performed on the data include the following:

- Positional offset correction
- Sensor bias, background leveling, and/or standardization adjustment
- Sensor drift removal
- Latency or lag correction
- Geophysical noise identification and removal (spatial, temporal, motional, terrain induced)
- Contour level selection with background shading
- Digital filtering and enhancement (low pass, high pass, band pass, convolution, correlation, non-linear, etc.)

3.3.3 Interpretation/Anomaly Selection

MEC-experienced data processing geophysicists will use the following criteria, supplemented by site- and system-specific criteria established during instrument validation, for selecting and locating anomalies:

- Maximum amplitude of the response with respect to local background conditions
- Lateral extent (plan size) of the area of response
- Three-dimensional shape of the response
- Decay curve characteristics
- Location of the response with respect to the edge of the grid, unsurveyable areas, land features, cultural features, or utilities within or adjacent to the grid
- Potential distortions in the response from interference of nearby cultural features

3.3.4 Target Locations

The target analysis process culminates in the creation of digital target location sheets that contain target information location and amplitude and can be used for future investigation operations (if performed).

The data analysis process culminates in the creation of anomaly lists in MRSIMS format, an example of which is shown below. These lists can be opened using Microsoft Excel or standard text editors and include, at a minimum, the following information:

- Unique anomaly identifiers
- Survey area identifier
- Predicted location in Universal Transverse Mercator (UTM), North American Datum 1983 (NAD83) coordinates, in Easting (meters) and Northing (meters)
- Coordinates in site-specific UTM zone
- Anomaly type identifier (e.g., cultural debris, suspected utility, saturated response area, etc.)
- Response amplitude
- Unit of response (e.g., milliVolt [mV]) or nanoTeslas [nT])

Example MRSIMS Anomaly List for EM61-MK2 DGM Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	ID	GRIDCELLID	X1	Y1	X2	Y2	X3	Y3	X4	Y4	TYPE	AMPLITUDE	UNITS	s_ColLineage	s_Generation	s_GUID	s_Lineage
2	1	K2F9J1WB	258959.4	2006299.6	0	0	0	0	0	0	1	3.67	mV				
3	2	K2F9J1WB	258962.4	2006302.2	0	0	0	0	0	0	1	19.42	mV				
4	3	K2F9J1WB	258964.2	2006301.8	0	0	0	0	0	0	1	4.47	mV				

3.3.5 DGM Anomaly Maps

With each target sheet, the DGM subcontractor will also provide a DGM Anomaly map containing the following information:

- Client name
- Project name
- DGM Subcontractor
- Map creator
- Map approver
- Date map was created
- Map file name (full path and file extension)
- Scale
- Survey area identification (e.g., Transects, grids)
- Transect/grid stake locations
- Contoured data with color scale
- Anomaly locations with unique identification numbers
- North arrow, legend, title block, etc.

3.3.6 Records Management

All files will be made available for QC verification during the project to verify that the field and data processing procedures are properly implemented. All raw data files, final processed data files, hard copies, and field notes will be maintained for the duration of the project.

3.3.7 Final Reports, Maps, and Geophysical Mapping Data

No later than 3 work days after collection, the DGM subcontractor will provide each day's data for QC inspection via the Internet using a File Transfer Protocol site, electronic mail (email) attachments for small files under 5 megabytes, or digital compact disk. Such data are considered to be in raw form. These data will be corrected for sensor offsets, diurnal variations, latency, heading error (if magnetometer is used), and drift. The DGM subcontractor also will provide a digital planimetric map, in Geosoft format and coincident with the location of the geophysical survey, so that each day's geophysical data set can be registered within the original mission plan survey map.

All geophysical field data will be provided to CH2M HILL in delineated fields as x, y, z, v1, v2, and so on, where x and y are UTM grid plane coordinates in easting (meters) and northing (meters) directions and z (elevation is an optional field in feet), v1, v2, v3, and so on are the instrument readings. The last data field will be a time stamp. Each data field will be separated by a comma or tab. No individual file will be more than 100 megabytes in size and no more than 600,000 lines long. Each grid of data will be logically and sequentially named so that the file name can be easily correlated with the grid name used by other project personnel.

Within 30 days of data collection, the processed geophysical field data, all final maps, and supporting geophysical interpretations will be provided to CH2M HILL. All geophysical data will be accompanied by a report (standard report format out of MRP Enterprise) documenting the field activities associated with the data and the processing performed. Information provided by the MRP Enterprise report is summarized in **Table 1**.

All sensor data will be correlated with navigational data, based on a local "third order" (1:5,000) monument or survey marker. If a suitable point is not available, a land surveyor will establish a minimum of two new monuments or survey markers with a minimum of third-order accuracy.

3.4 DGM Systems QC

An extensive QC program will be applied to the DGM operations at the site. **Figure 1** shows an overall chart of the QC steps.

3.4.1 QC Tests

Each of the DGM systems will be field tested to confirm proper operating conditions. Several basic QC tests will be performed in addition to instrument-specific tests. A description of each basic QC test, its acceptance criteria, and its frequency is provided below and summarized in **Table 2**.

1. **Equipment Warm-up**. The EM61-MK2 system will be turned on and allowed to warm up for a minimum of 10 minutes before use. Equipment warm-up will be performed the first time an instrument is turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to cool down.

2. **Personnel Test.** This test checks the response of instruments to personnel and their clothing/proximity to the system. On a daily basis, the EM61-MK2 system being used that day will be checked for its response to the personnel operating the system. The response will be observed in the field for immediate corrective action and transmitted back to the processor, and analyzed and checked for spikes in the data that could create false anomalies. The personnel test will be conducted at the beginning of the survey operation for each work day.

3. **Vibration Test (Cable Shake).** This test checks the response of instruments to vibration. On a daily basis, the EM61-MK2 will be checked for its response to vibrations in the system's cables. The response will be observed in the field for immediate corrective action and transmitted back to the processor and analyzed and checked for spikes in the data that could create false anomalies. The vibration test will be conducted at the beginning of the survey operation for each work day.

4. **Static Background and Static Spike**. Static tests will be performed by positioning the EM61-MK2 within or near the survey boundaries in an area free of metallic contacts and collecting data for at least 3 minutes. During this time, the instrument will be held in a fixed position without a "spike" (small industry standard object [ISO]) placed on a stand at a carefully measured distance and orientation and then with a small ISO

spike (1 minute without spike, 1 minute with spike, 1 minute without spike). The purpose of the static test is to detect unusual levels of instrument or ambient noise. The purpose of the spike test is to observe that the system is responding within industry standards. The static background and static spike test will be conducted at least every 4 hours, including the beginning and end of each survey operation.

5. **Repeat Data.** This test is performed to verify repeatability of the data and will be performed after the initial survey over an area. At least 2 percent of the survey area will be resurveyed.

6. **Position Test.** Positioning accuracy of the final processed data will be demonstrated by operating the RTK GPS equipment over one or more known points. The accuracy of the data positioning will be assessed by calculating the difference between a known location over which a positioning instrument is held and the displayed position. The sensor position test will be conducted at the beginning of the survey operation for each work day. This test will not apply to DGM data collected using fiducial positioning methods.

3.4.2 QC Seed Items

At least one QC seed item, a small ISO (discussed in the GSV Plan, provided as an Attachment) will be seeded every 3,050 linear meters (10,000 linear feet) for transects, and every 0.75 acre for grids, on average, in the land-based survey areas. Therefore, at least 31 QC seeds will be installed along the proposed 93,720 meters of transects, one QC seed will be installed in the proposed 0.25 acre grid near the proposed buildings in the vicinity of the ready service locker area, and two QC seeds will be installed in the proposed 0.85 acre grid near the former firing line. The seed items will be tagged with labels identifying them as inert and providing a contract reference, a point of contact address, phone number, and a target identifier. CH2M HILL personnel will perform seeding using hand tools. The seed locations will be checked using a hand-held analog geophysical instrument to confirm that no existing anomalies are present at the seed location. Once placed, the locations of all seeded items will be surveyed using conventional survey equipment or measured distance from centerline stakes. The items will be placed at easily detectable depths (approximately 6 inches below ground surface) in order to have a high enough signal-to-noise ratio to compare to known industry standard target values. Detection of the QC seed items will be monitored by CH2M HILL and if an item is not detected, a root-cause analysis will be performed and corrective actions identified.

3.4.3 QC of DGM Data and Deliverables

The DGM subcontractor will perform QC of geophysical data and data deliverables at each step of the processing path. **Figure 2** shows the processing path and the QC steps performed. Data will not move to the next stage until they have passed the QC check. The CH2M HILL QC Geophysicist will perform a final QC check on the data before final delivery to the Navy.

QC checks to be performed on field forms, pre-processed data, and processed data can be found in **Table 1**.

3.4.4 Corrective Measures

Specific corrective measures are related to the type of geophysical equipment used; however, the following are the basic corrective measures to be followed in association with DGM surveying:

- Replacement of sensors if they fail to meet instrument check requirements.
- Resurvey of transects if seeded items are not identified (do not show in the DGM data). When there is a failure to select a seed item from the data but the item is clearly present in the DGM data, a re-analysis of the DGM data will be performed instead of a resurvey.

3.5 Analog Geophysical Systems QC

QC over the analog geophysical instruments will be accomplished through daily checks that the instruments are functioning before using them for field activities. Each instrument will be operated over a small ferrous metallic item. If the instrument is not able to detect the item, the instrument will be taken out of use until it is repaired.

Section 4

References

CH2M HILL. 2012. *Technical Memorandum, Expanded Site Inspection Results and Proposed Remedial Investigation Approach for the Moving Target Mortar Range – South, Dam Neck Annex – Naval Air Station Oceana, Virginia.* November.

Malcolm Pirnie, Inc. 2008. *Final Preliminary Assessment, Naval Air Station Oceana, Dam Neck Annex and Naval Auxiliary Landing Field Fentress, Virginia.* October.

Tables

TABLE 1
Processing Documentation Requirements
GIP for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, Virginia

Information Type	"Raw" Data Delivery Report	Final Data Delivery Report	Must be in File Headers
Site ID	X	X	X
Geophysical instrument type used	X	X	
Positioning method used	X	X	
Instrument serial numbers (geophysical and positioning)	X	X	
Coordinate system and unit of measure	X	X	
Transect/grid ID (or other identifier of surveyed area)	X	X	X
Date of data collection	X	X	X
Raw data file names associated with delivery	X	X	
Processed data file names associated with delivery	X	X	
Name of Project CH2M HILL QC Geophysicist	X	X	
Name of Site Geophysicist	X	X	
Name of data processor	X	X	
Data processing software used	X	X	
Despiking method and details	X	X	
Sensor drift removal and details	X	X	
Latency/lag correction and details	X	X	
Sensor bias, background leveling and/or standardization adjustment method and details		X	
Portable document format (PDF) document showing graphical results of each field quality control test	X	X	
Geophysical noise identification and removal (spatial, temporal, motional, terrain induced) and details		X	
Other filtering/processing performed and details		X	
Gridding method		X	
Anomaly selection and decision criteria details		X	
Geosoft ".xyz"and ".grd" files for unit of survey being delivered (e.g., transect or area agreed upon with Geophysicist)		X	
Geosoft ".grd" file for unit of survey being delivered		X	
Geosoft ".map" file for unit of survey being delivered		X	
PDF of Geosoft map for unit of survey being delivered		X	
Geosoft ".map" mosaic of all processed data to date		X	
PDF mosaic of Geosoft map of all processed data to date		X	
Other processing comments		X	
Date data processing is completed	X	X	
Data delivery date	X	X	
Scanned copy of field notes and field mobile data collection device notes (if applicable)	X		

TABLE 2
Geophysical Instrument Standardization Tests and Acceptance Criteria for DGM
GIP for Dam Neck Annex –Moving Target Mortar Range – South Remedial Investigation (RI)
Virginia Beach, Virginia

Test	Test Description	Acceptance Criteria	Power On	Beginning of Day	Beginning and End of Day	Between Survey Areas	~2% of Daily Area Surveyed
1	Equipment Warm-up	Equipment specific (minimum 10 minutes)	X				
2	Personnel Test	Personnel, clothing, etc. should not result in EM61-MK2 target picking channel data spikes >2 mV from the mean		X			
3	Vibration Test (Cable Shake)	Data profile does not exhibit EM61-MK2 target picking channel data spikes >2 mV from the mean		X			
4	Record Sensor Positions (RTK GPS)	Accuracy of positioning data at known, surveyed location is within 4 inches (10 centimeters)		X			
5	Static Background and Static Spike	±20% of standard item response, after background correction; azimuth test (G-858) results identify potentially unfavorable sensor orientations or, or if an unfavorable orientation is identified, it is noted and not used during production survey.			X	X	
6	Repeat Data	IVS seed item locations within ±0.8 ft (25 centimeters) of known, surveyed locations;			X		
		Qualitative repeatability of response amplitude					X

Figures

FIGURE 1
Overview of DGM Process QC
GIP for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, Virginia

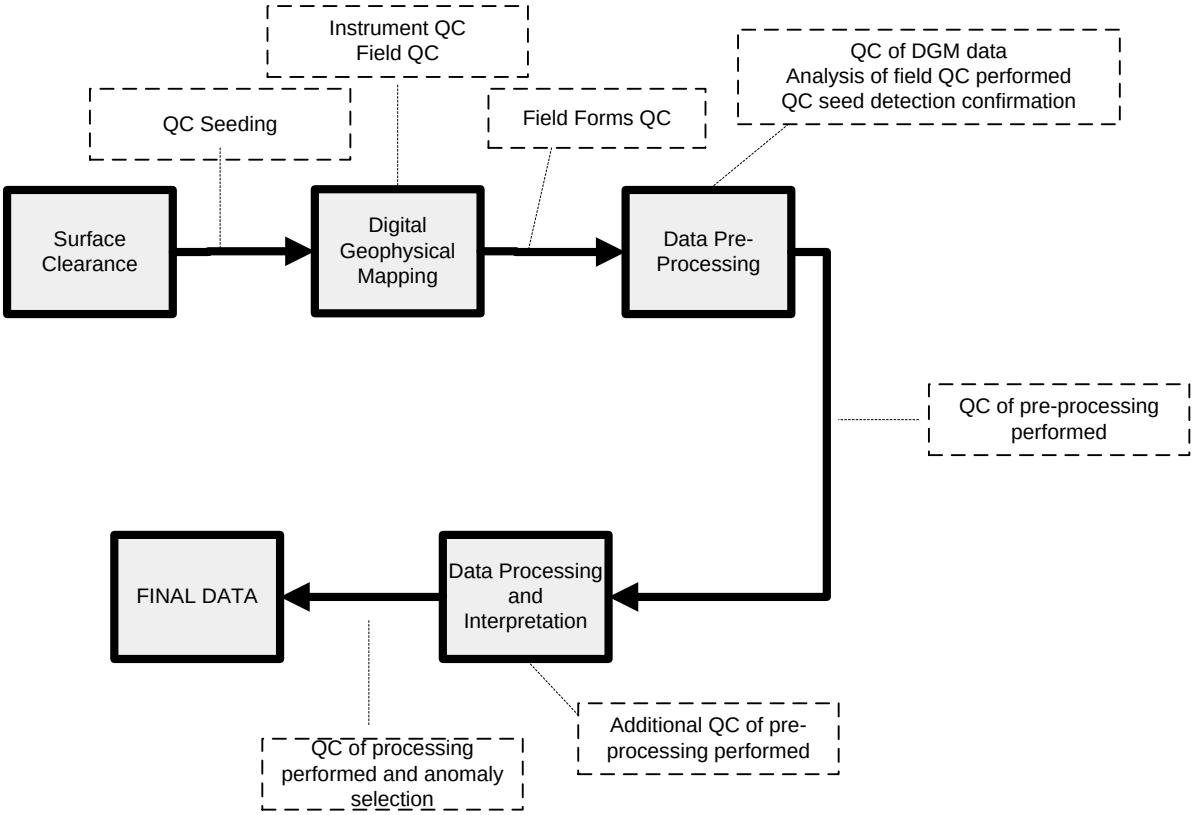
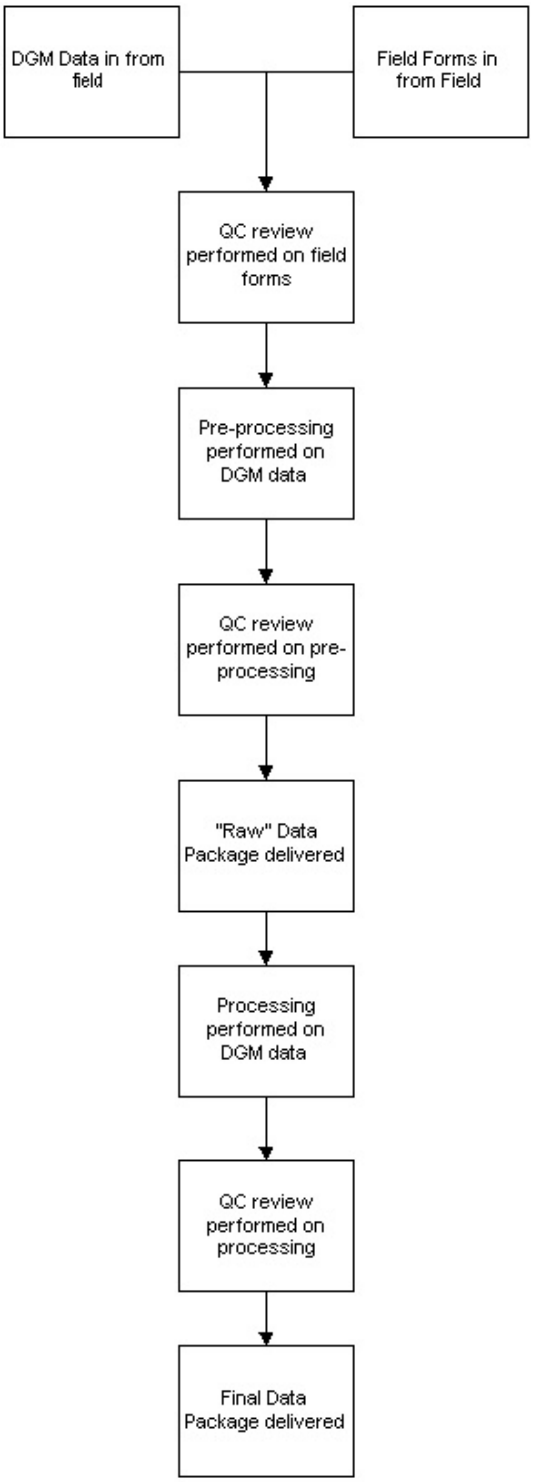


FIGURE 2
QC of DGM Data – Process Flow Path
GIP for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, Virginia



Attachment
Geophysical System Verification Plan

Final

Geophysical System Verification Plan
Moving Target Mortar Range-South (UXO 07)
Dam Neck Annex
Remedial Investigation

Naval Air Station Oceana
Virginia Beach, Virginia

Contract Task Order WE69

September 2013

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

NAVFAC CLEAN 8012 Program
Contract N62470-11-D-8012

Prepared by

CH2MHILL

Virginia Beach, Virginia

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Acronyms and Abbreviations

cm	centimeter(s)
DGM	digital geophysical mapping
ft	foot or feet
GPS	global positioning system
GSV	geophysical system verification
in	inch(es)
ISO	industry standard object
IVS	instrument verification strip
m	meter(s)
MEC	munitions and explosives of concern
MQO	measurement quality objective
NRL	Naval Research Laboratory
QC	quality control
RTK	real-time kinematic
SOP	standard operating procedure
UXO	unexploded ordnance

SECTION 1

Geophysical System Verification

Geophysical system verification (GSV) is a physics-based, presumptively selected technology process in which signal strength and sensor performance are compared to known response curves of industry standard objects (ISOs) to verify digital geophysical mapping (DGM) systems before and during site surveys. The GSV process is designed to perform initial verification of the DGM system using an instrument verification strip (IVS), followed by a blind seeding program for continued verification throughout the field operations.

1.1 IVS

The initial phase of the investigation to locate munitions and explosives of concern (MEC), material potentially presenting an explosive hazard, and non-munitions related metallic items in the subsurface at each site will be verification of the presumptively selected DGM system using an IVS.

1.1.1 Personnel and Qualifications

The following individuals will be involved in the IVS process:

- CH2M HILL Quality Control (QC) Geophysicist
- DGM subcontractor's Site Geophysicist
- DGM subcontractor's Field Geophysicist or Geophysical Technician
- DGM subcontractor's Data Processor

DGM subcontractor personnel involved in the IVS process will meet the following qualifications:

- **Site Geophysicist:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and have a minimum of 2 years of directly related geophysical experience. This individual will be capable of competently managing personnel, equipment and data on projects requiring multiple geophysical field teams and geophysical data processors and will have at least 1 year of experience in performing geophysical operations on a MEC site.
- **Field Geophysicist:** will have a degree in geophysics, geology, geological engineering, or a closely related field; a minimum of 2 years of directly related geophysical experience; and at least 1 year of experience in performing geophysical operations on a MEC site.
- **Geophysical Technician:** will have at least 6 months of experience in geophysical data collection on MEC-related projects.
- **Geophysical Data Processor:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have at least 6 months of experience in processing geophysical data related to MEC projects.

1.1.2 DGM System

The presumptively selected DGM system to be verified and used for the production surveys will consist of the Geonics EM61-MK2 time-domain electromagnetic metal detector, with positioning provided by real-time kinematic (RTK) global positioning system (GPS). The system and positioning methods are discussed in detail in the Geophysical Investigation Plan, of which this document is an attachment.

1.1.3 Location and Length of IVS

An IVS strip was established for prior work performed by CH2M HILL at the Moving Target/Mortar Range – South (MTMR-S) at Dam Neck Annex in Virginia Beach, Virginia. The following sections provide all the information needing for setting up a new IVS if the existing IVS cannot be used. The IVS establishment steps will be skipped if the existing IVS is used.

1.1.4 ISOs

The ISO items (**Figure A-1**) to be used in the IVS are 1 inch (in) (2.54 centimeters [cm]) by 4 in (10.16 cm) steel pipes (Part Number: 44615K466) from the McMaster-Carr online catalog (http://www.mcmaster.com/):

Shape:	Straight Nipple, Threaded Both Ends
Schedule:	40
Pipe Size:	1 in (1.315 in outer diameter)
Length:	4 in
Finish:	Black welded steel

Instrument response curves for this ISO have been developed by the Naval Research Laboratory (NRL). These response curves demonstrate their standard response under their best orientation and worst orientation at multiple distances from the instrument's bottom transmit/receive coil. The best orientation would be perpendicular to the EM61-MK2 instrument plane to cause the highest peak amplitude response. The worst orientation would be parallel to the instrument plane and perpendicular to the direction of travel to cause the lowest peak amplitude response (Naval Research Laboratory [NRL]/MR/6110--09-9183[1]).

1.1.5 IVS Procedures

A qualified and experienced MEC DGM operations geophysical team will employ the system to be verified over the IVS. **Figure A-2** illustrates the IVS process and the procedures to be employed during site work.

1. An IVS area will be selected with preference for the following (although none of the conditions are vital for IVS success):
   (a) Terrain, geology and vegetation similar to that of most of the project site
   (b) Geophysical noise conditions similar to those expected across the survey area
   (c) Site of sufficient size to accommodate all necessary IVS tests and equipment and for adequate spacing (at least 10 feet (ft) [3 meters (m)]) between the ISO items to avoid ambiguities in data evaluation
   (d) Readily accessible to project personnel
   (e) Proximity to the actual survey site (if not within the site)
2. A "background" DGM survey will be performed by the DGM subcontractor with the instrument to be validated over the IVS. This step will allow background geophysical conditions to be recorded, help evaluate the appropriateness of the location (for example, few existing anomalies), and verify that ISOs are not seeded near existing anomalies. The data will be post-processed (that is, filtered and positions attached to the geophysical data) and provided to the CH2M HILL QC Geophysicist for evaluation.
3. Following verification that the IVS area is clear of subsurface anomalies (or that existing anomalies can be avoided during seeding), two ISO items will be buried perpendicular to the plane of the EM61-MK2 system's transmit/receive coil (vertically) at depths of approximately 3 and 7 times their diameter (10 cm and 23 cm respectively). The approximate IVS setup will be as shown on **Figure A-3**.

   Measurements of the item depths will be to the center of mass of each item. CH2M HILL personnel will bury the ISOs to the appropriate depths for seed items. The background survey data and anomaly avoidance techniques will be used to ensure that end stakes and ISOs are not placed on top of or near existing anomalies. Personnel will emplace ISOs and record the emplacement data (depth, orientation, and azimuth).
4. Conventional Total Station survey equipment or RTK GPS will be used to record the center of each ISO location and the IVS endpoints. The holes will then be filled with soil and a polyvinyl chloride surveyor's flag or 6-inch wooden survey stake placed at each ISO location.

   A DGM survey will be performed by the DGM subcontractor over the IVS area, including the transects described in **Table A-1** and shown on **Figure A-4**. The data will be processed and interpreted by the DGM

[1] NRL. 2009. EM61-MK2 Response of Three Munitions Surrogates, NRL/MR/6110--09-9183. March 12.

subcontractor and provided to the CH2M HILL QC Geophysicist for confirmation within 12 hours of completion of the survey.

5. If the initial MQOs have not been met, the CH2M HILL QC Geophysicist will meet with the DGM subcontractor to discuss whether modifications to instrumentation or procedures can be made to the DGM system in order to meet the measurement quality objectives (MQOs).
6. If the MQOs cannot be met by the DGM subcontractor, the CH2M HILL QC Geophysicist will meet with the project team to discuss a resolution (that is, modification of an MQO) before completing the IVS process.
7. Once the surveys have been performed and the system has met the initial (or modified) MQOs, the IVS process will be complete.

1.1.6 MQOs

The testing in the IVS area will verify the ability of the system to achieve the specific MQOs outlined in **Table A-2**. The system will not be used for site surveys until it is able to meet the IVS MQOs or until the project team agrees on the reasoning behind an MQO not being met and an appropriate revised MQO has been established.

Production survey MQOs will be achieved through the ISO blind seeding program and other QC tests, as discussed in the Geophysical Investigation Plan. The IVS MQOs, measurement performance criteria, and test method to be used during the IVS process are summarized in **Table A-2** and discussed in detail in the following subsections.

General System Verification

DGM System Positioning

The MQO for DGM system positioning is that the coordinates being obtained from the positioning system are of sufficient accuracy to allow for appropriate relocation of geophysical anomalies for intrusive investigation. The measurement performance criterion for this is that the positional error at known monuments will not exceed 3.3 ft (1.0 m). This will be evaluated during the IVS process by ensuring that the anomalies representing the ISO seeds in the IVS data are positioned within this distance from the measured locations.

DGM System Munitions Detection

The MQO for munitions detection is to demonstrate that the system in use is capable of detecting munitions within industry standards. This is demonstrated through a physics-based, presumptively selected technology process in which signal strength and sensor performance are compared to validated industry values. For the EM61-MK2, this process involves demonstrating that the maximum amplitude response over a standard item falls within the sensor response curve for that item, as determined through NRL demonstration tests for that item (**Figure A-5**). Once it has been established that the system is responding comparably, a cross-correlation of industry experience with detection of munitions items can be assumed. In other words, the depths and orientations of munitions items which the EM61-MK2 has been shown to be effective at detecting under test scenarios[2] and other projects can be expected.

Because minor changes in the coil height as it passes over the item and slight variations in the path traveled down the IVS can significantly affect the amplitude response received from the instrument, the IVS results will be qualitatively evaluated. A finding that the geophysical instrument itself is responding within a specific threshold will be accomplished through the spike test results (Section 1.1.7), wherein the distance from the coil and orientation of the item can be strictly controlled.

[2] NRL/MR/6110--08-9155 (EM61-MK2 Response of Standard Munitions Items), Final Report for the Evaluation of (Unexploded Ordnance) UXO Detection Technology at the Standardized UXO Test Sites Aberdeen and Yuma Proving Grounds, Standardized UXO Technology Demonstration Site Program, SERDP, November 2007. Demonstrator scoring results: http://aec.army.mil/usaec/technology/uxo01f.html.

Data Handling

The MQO for data handling is that all data must be delivered in a timely manner and in a useable format. Because of the need for rapid feedback during IVS operations to effectively test potential DGM systems, the measurement performance criterion for data handling during IVS activities will require that initial data be completed and delivered to the CH2M HILL QC Geophysicist within 12 hours of collection. Final processed data for the IVS will be delivered to the CH2M HILL QC Geophysicist within 3 working days of collection. This will be evaluated based on the actual delivery of data during the IVS process.

1.1.7 QC

Achievement of the instrument evaluation MQOs will be verified by the CH2M HILL QC Geophysicist. The selected IVS area, the process of emplacing the IVS items, and the survey locations will be verified through observation during the IVS process. Geophysical subcontractor-provided standard operating procedures (SOPs) (to be provided as an addendum to this GSV Plan after subcontractor selection) will be reviewed to confirm that equipment and procedures are being checked according to documented SOPs. The QC tests listed in **Table A-3** and detailed in the following subsections will be performed on the geophysical system being used:

1. **Equipment Warm-up**. All geophysical equipment will be warmed up for a minimum of 10 minutes. Equipment warm-up will be performed the first time an instrument is turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to cool down.

2. **Personnel Test.** This test checks the response of instruments to personnel and their clothing/proximity to the system. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to the personnel operating the system. The response will be observed in the field for immediate corrective action and transmitted back to the processor, then analyzed and checked for spikes in the data that could create false anomalies. The personnel test will be conducted at the beginning of the survey operation for each work day.

3. **Vibration Test (Cable Shake).** This test checks the response of instruments to vibration. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to vibrations in the cables. The response will be observed in the field for immediate corrective action and transmitted back to the processor and analyzed and checked for spikes in the data that could create false anomalies. The vibration test will be conducted at the beginning of the survey operation for each work day.

4. **Static Background and Static Spike**. Static tests are performed by positioning the survey equipment within or close to the survey boundaries in an area free of metallic contacts and collecting data for a specific period, while holding the instrument in a fixed position without a “spike” (small ISO placed at an accurately measured distance and orientation from the transmitter coil, as in the example shown in **Figure A-6**) and then with a “spike.” The purpose of the static test is to identify any unusual levels of instrument or ambient noise. The static background and static spike test is conducted at the beginning and end of each survey operation. This is the test that essentially “opens” and “closes” a survey area (grid, grid block, set of transects, etc.)

   The ISO can be placed above or below the EM61-MK2 transmitter coil as long as the distance is measured from the center of mass of the item to the horizontal plane of the coil (top of coil if item placed above coil, bottom of coil if item placed below), as illustrated in **Figure A-7**.

5. **Repeat Data.** This test is performed to verify repeatability of the data and will be performed after the initial survey over an area. At least 2 percent of the survey area will be resurveyed.

6. **Position Test.** Positioning accuracy of the final processed data will be demonstrated by operating the RTK GPS equipment over one or more known points. The accuracy of the data positioning will be assessed by calculating the difference between a known location over which a positioning instrument is held and the displayed position. The sensor position test will be conducted at the beginning of the survey operation for each work day. This test will not apply to DGM data collected using fiducial positioning methods.

1.1.8 Data Analysis and Interpretation

All data collected at the IVS test strip will be post-processed and analyzed. Instrument-specific data processing SOPs will be provided as an addendum to this Plan after subcontractor selection.

1.1.9 IVS Data Evaluation

The CH2M HILL QC Geophysicist will evaluate the data provided by the geophysical subcontractor and validate for the project team whether the selected geophysical system meets the IVS MQOs.

SECTION 2

Blind Seeding

As a continuing part of the GSV process, ISOs will be used as blind QC seeds in the areas to be surveyed to provide ongoing verification that the DGM system is properly functioning and the munitions detection and positioning MQOs are continuing to be met.

2.1 Seeds Placement

Seeds will be buried vertically at a depth of approximately 6 in (15 cm) below ground surface, with the depth being measured to the center of mass of the item, as illustrated in **Figure A-7**. Depths will be recorded in field notes. The field team leader will be responsible for labeling each QC seed with a unique identifier. These seeds can either be labeled with a paint pen or with a weather-resistant label taped to or secured within the seed. The location of blind seeds will not be shared with personnel performing DGM surveys and data processing/interpretation until those tasks have been completed.

2.2 Validation

After each data set is delivered to CH2M HILL by the DGM subcontractor, the CH2M HILL QC Geophysicist will overlay the locations of the blind seeds and verify that the munitions detection and positioning MQOs are continuing to be met. Should an issue be detected (such as a data trend indicating a MQO limit is being approached) or an MQO is not met, a comprehensive root-cause analysis will be performed and a corrective action identified.

SECTION 3

IVS Reporting

Results of the IVS process will be documented in a technical memorandum after the IVS process has been performed. The report will include a summary of the IVS operations, an as-built map of the IVS plot, and IVS results. Results of the blind seeding evaluation will be provided as part of the Remedial Investigation report.

Tables

TABLE A-1
IVS Transects Descriptions and Purpose
GSV Plan for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, Virginia

Transect	Description	Purpose
A	Offset by 0.75m	Demonstrate horizontal drop off of item response
B	Directly over center of strip	Verify response vs. established response curves
C	Offset by 0.37m (1/2 intended lane separation) from center of strip	Demonstrate horizontal drop off of item response
D	Offset by 0.75m (on opposite side of strip from Transect A)	Demonstrate horizontal drop off of item response
E	Offset by ~3m from strip	Measure background noise

TABLE A-2
Project Measurement Quality Objectives
GSV Plan for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, Virginia

Measurement Quality Objective	Measurement Performance Criteria	Test Method During IVS
General System Verification		
DGM System Positioning. Accurate coordinates are being obtained from DGM positioning systems.	Positional error of ISO seeds will not exceed 3.3 ft (1.0 m).	Results of IVS DGM survey vs. IVS seed locations will be evaluated to ensure compliance.
DGM System Munitions Detection. DGM system response is within industry standards for detection.	Response to ISO is comparable to published or calculated results for that item.	Results of IVS surveys over seed items in strip will be qualitatively reviewed.
	Response to standardized item will not vary more than ±20%of expected value[1] in static test.	Results of static test will be quantitatively reviewed to ensure compliance.
Data Handling		
All data must be delivered in a timely manner and in a useable format.	IVS data is completed and delivered within 12 hours.	Evaluate based on actual delivery of data.

[1] NRL/MR/6110--09-9183 (Provided as **Figure A-5**)

TABLE A-3
Geophysical Instrument Standardization Tests and Acceptance Criteria for DGM
GIP for Dam Neck Annex –Moving Target Mortar Range – South RI
Virginia Beach, Virginia

Test	Test Description	Acceptance Criteria	Power On	Beginning of Day	Beginning and End of Day	Between Survey Areas	~2% of Daily Area Surveyed
1	Equipment Warm-up	Equipment specific (minimum 10 minutes)	X				
2	Personnel Test	Personnel, clothing, etc. should not result in EM61-MK2 target picking channel data spikes >2 mV from the mean		X			
3	Vibration Test (Cable Shake)	Data profile does not exhibit EM61-MK2 target picking channel data spikes >2 mV from the mean		X			
4	Record Sensor Positions (RTK GPS)	Accuracy of positioning data at known, surveyed location is within 4 inches (10 centimeters)		X			
5	Static Background and Static Spike	±20% of standard item response, after background correction; azimuth test (G-858) results identify potentially unfavorable sensor orientations or, or if an unfavorable orientation is identified, it is noted and not used during production survey.			X	X	
6	Repeat Data	IVS seed item locations within ±0.8 feet (25 centimeters) of known, surveyed locations;			X		
		Qualitative repeatability of response amplitude					X

Figures

FIGURE A-1

Industry Standard Object

GSV Plan for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, VA

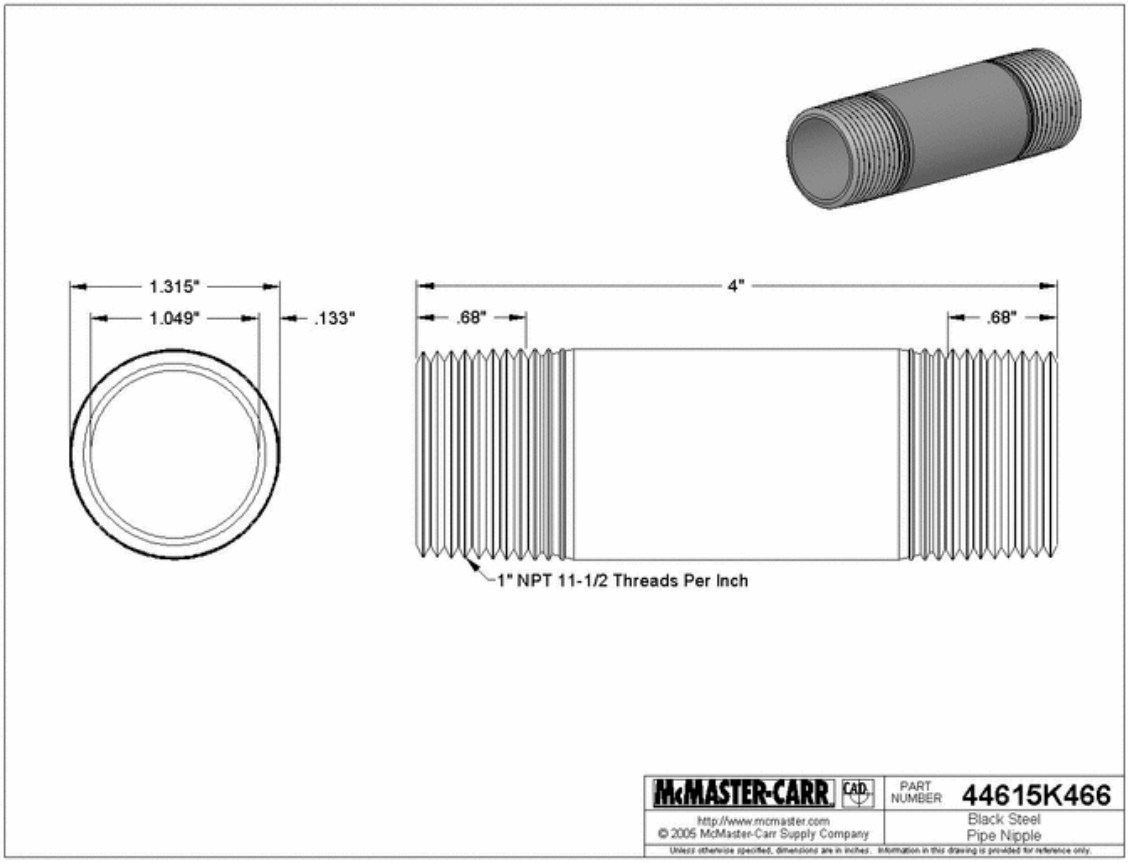


FIGURE A-2
IVS Process
GSV Plan for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, VA

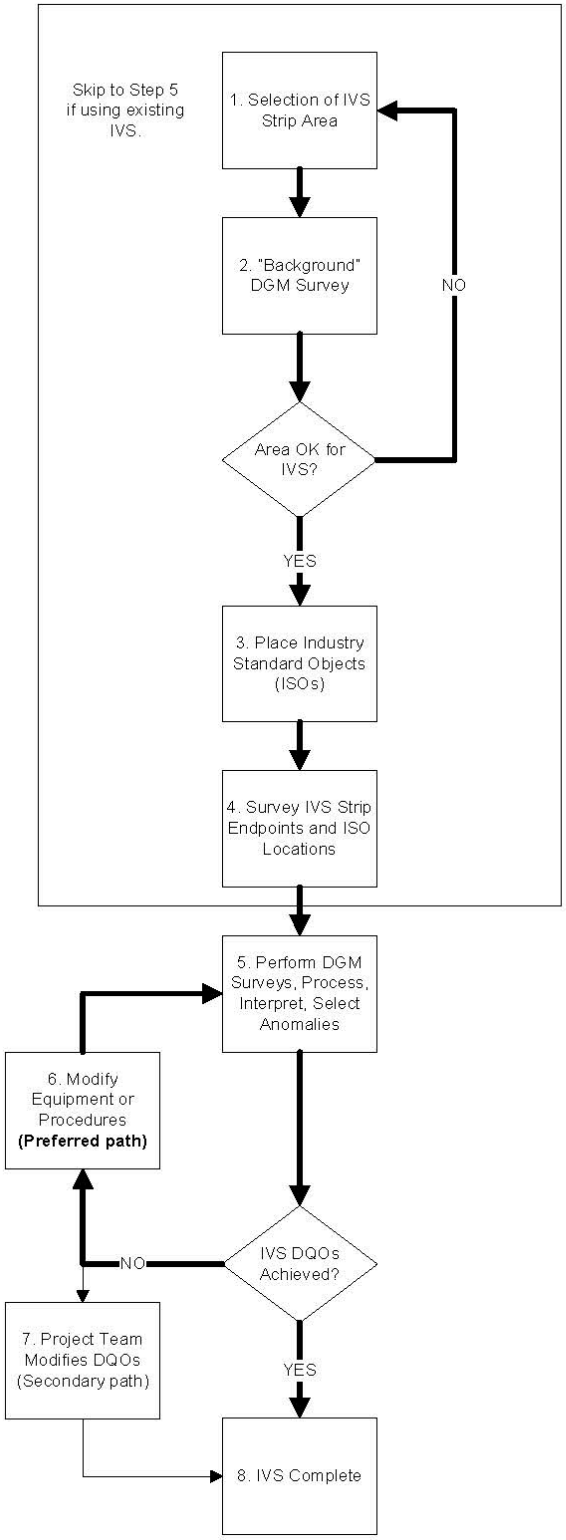


FIGURE A-3
IVS Strip
GSV Plan for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, VA

FIGURE A-4
IVS Transects
GSV Plan for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, VA

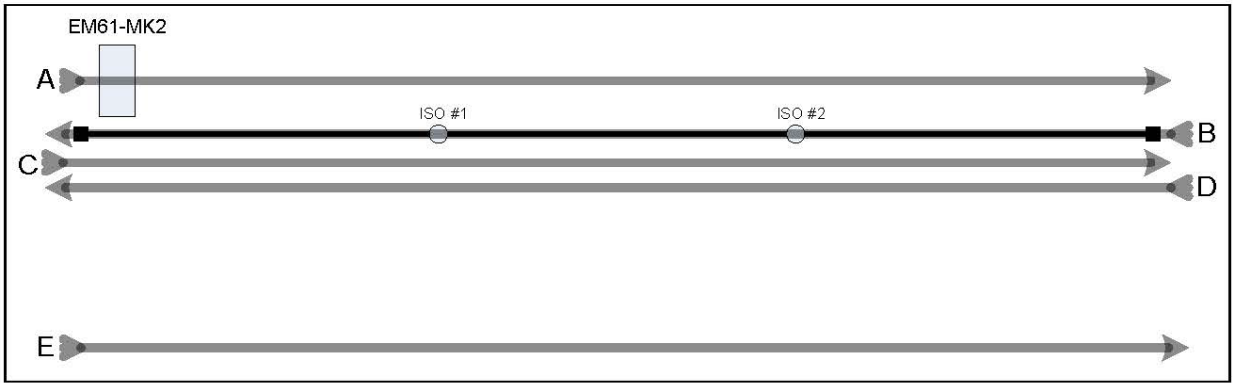
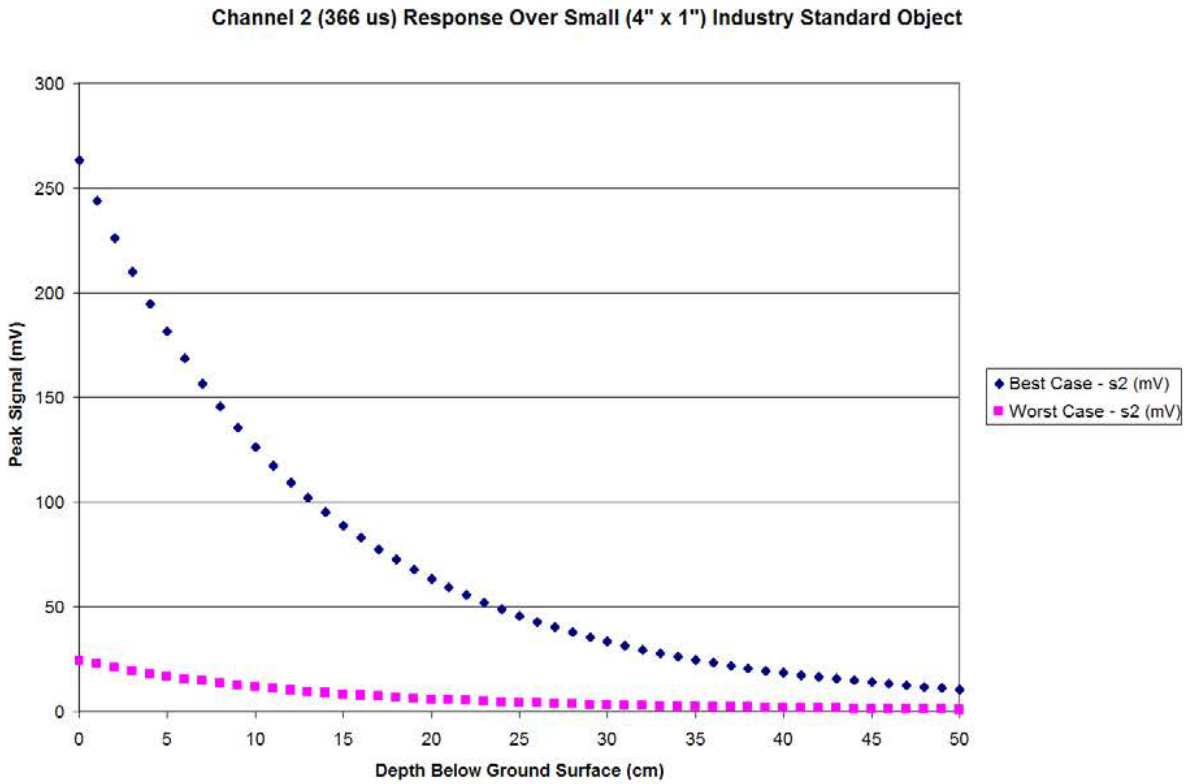


FIGURE A-5

NRL Results for Small (4 inch x 1 inch) ISO Tested under EM61-MK2 Bottom Coil

GSV Plan for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, VA



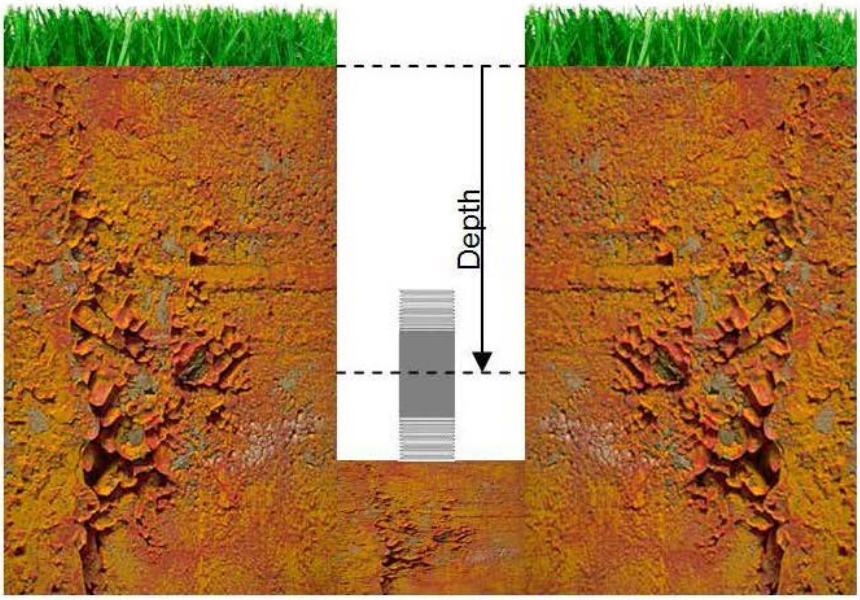
Reference: NRL/MR/6110-09-9183

FIGURE A-6
Example Spike Test Setup
GSV Plan for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, VA

FIGURE A-7

QC Seed Burial Illustration

GSV Plan for Dam Neck Annex – Moving Target/Mortar Range - South RI
Virginia Beach, VA



Appendix B
Standard Operating Procedures

NAeVA GEOPHYSICS INC.

THE LEADER IN SUBSURFACE DETECTION

Subsurface Geophysical Surveys

GPR
MAGNETICS
ELECTROMAGNETICS
SEISMICS
RESISTIVITY
UTILITY LOCATION
UXO DETECTION
BOREHOLE CAMERA
STAFF SUPPORT

Standard Operating Procedures for Geophysical Mapping

Geonics EM61 – MK2

UXO 07: Moving Target Mortar Range-South (Dam Neck Annex)
UXO 09 Dive Bombing Targets (Naval Auxiliary Landing Field Fentress)
Naval Air Station Oceana
Virginia Beach, Virginia

Contract Task Order WE60 & WE69

October 2013

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Purpose

The purpose of this Standard Operating Procedure (SOP) is to provide specific procedures for data collection, processing and equipment for the geophysical investigations at UXO 07 Moving Target Mortar Range-South (MTMR-S) at Dam Neck Annex and at UXO 09 Dive Bombing Targets (DBTs) at Naval Auxiliary Landing Field (NALF) Fentress located within Naval Air Station Oceana, Virginia Beach, Virginia.

Equipment and Theory

This SOP is applicable for the Geonics EM61-MK2 and Trimble's 5700/R7/R8 RTK (Real Time Kinematic) GPS.

The EM61-MK2 is a high-resolution time-domain electromagnetic instrument designed to detect, with high spatial resolution, shallow ferrous and non-ferrous metallic objects. In comparison with other metal detectors, especially magnetometers, it is much better suited for work in close proximity to man-made structures and in areas of dense subsurface metallic debris (i.e. impact ranges). The Standard EM61-MK2 system consists of two air-cored coils, a digital data recorder, batteries and processing electronics. The EM61-MK2's transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects. Each of the two spatially separated receiver coils measures these eddy currents. The EM61-MK2 offers the ability measure the eddy currents at three distinct time intervals in the bottom coil or four intervals if no top coil measurements are recorded (as planned for this work). Earlier time gates provide enhanced detection of smaller metallic objects. Secondary voltages induced in both coils are measured in millivolts (mV). The arrangement of coils is such that there is a vertical separation of 40 cm. Assuming accurate data positioning, target resolution of approximately 0.5 meters can be expected. The data are collected into Geomar's Nav61MK2 program and temporarily stored in an Allegro CX prior to downloading to a laptop computer.

Trimble's 5700 GPS is a 24-channel dual frequency RTK receiver that uses both L1 and L2 satellites. This system operates with a base and a rover unit; the base sends corrections to the rover via radio link, thus maintaining a 3cm horizontal accuracy and a 5cm vertical accuracy. For configuration with the EM61-MK2, the rover is set to output a GGA NMEA string at 1 Hz, which is captured into the NAV61MK2 program and on the Allegro CX.

Instrument Standardization

All instruments will be assembled and calibrated (where required) as specified in their User Manuals. Additionally, each instrument will be field tested daily to ensure that the instrument is operating properly (explained in Section 7).

Data Acquisition

Whether the survey area is established as grids or as transect lines, the EM61-MK2 is operated at a walking pace by one or two people. Data collected on wheels at a rate of one reading/10 cm or in tandem mode (the instrument is carried by two operators) readings triggered at 10 readings/second. Selection of the appropriate method is based primarily on local terrain conditions. When GPS positioning is used data are collected in automatic mode at 10 readings/second regardless of collection method.

Instrument Setup

When the instrument is operated in wheel mode, it is setup according to Geonics EM61-MK2 manual. For tandem mode, the EM61-MK2 coils are centered and suspended on two 10ft long fiberglass poles. The instrument is attached to the poles using the top coil with zip ties and webbing. The webbing wraps around the poles and is attached to the bottom coil clamps. For both modes of data collection, the cables are taped and secured to prevent them from getting tangled and possibly disturbed by movement or vegetation. If GPS is used, a tripod is attached to the top coil and the satellite antenna is fastened to the top.

Navigation

Depending on site conditions, navigation of the system is accomplished through either Fiducial (FID) method or Global Positioning System (GPS/RTK) method.

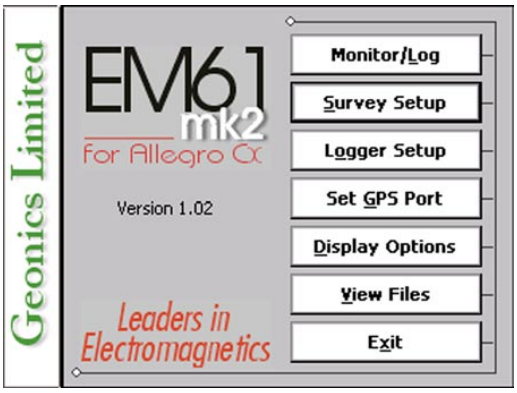
The FID method is used in wooded areas where GPS positioning is unavailable. This method uses painted ropes positioned across each grid for the placement of fiducial marks within the recorded data. Local coordinates are warped to geodetic using reference locations (stakes) surveyed in by licensed surveyors on evenly spaced centers.

The second method of navigation is GPS/RTK. The base station is setup on a control point and corrections are sent via radio link to the rover receiver. The rover GPS antenna is mounted over the center of the EM61-MK2 coil and provides real time positional tracking capabilities that is streamed into the same software program as the EM61-MK2 data.

Data collection Steps

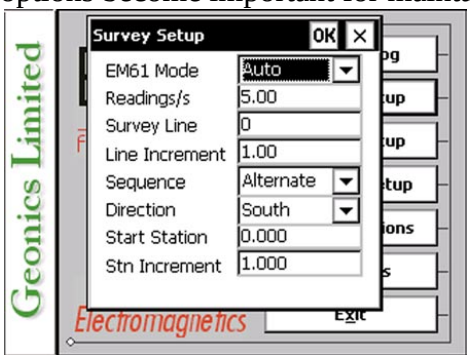
The following steps are followed to begin surveying with the **<u>EM61-MK2 with fiducial positioning</u>**:

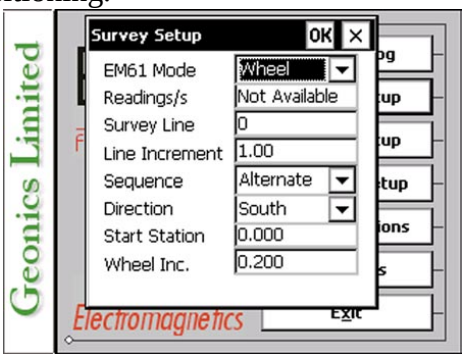
1. Turn on the EM61-MK2 by pushing in the fuse on the top of the console/electronics.
2. Allow the instrument to warm up for at least 15 minutes.
3. Turn on the Allegro CX, and open the EM61MK2 program. The screen below will be displayed.



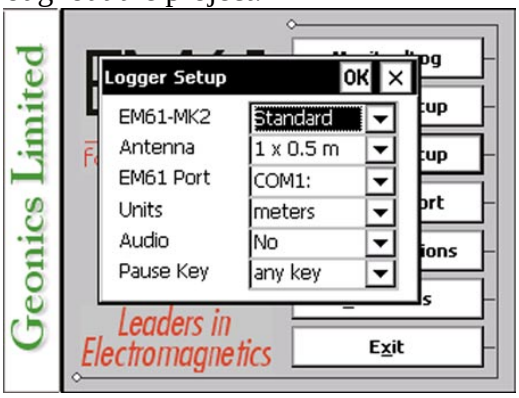
4. Click on “Survey Setup”, and specify the following options. Depending on surface conditions, the Mode is set to “Auto” and Readings/s is set to “10” or the Mode is set

to “Wheel”, Readings/s to “Not Available”, and Wheel Inc. to 0.1. The remaining options become important for maintaining positioning.



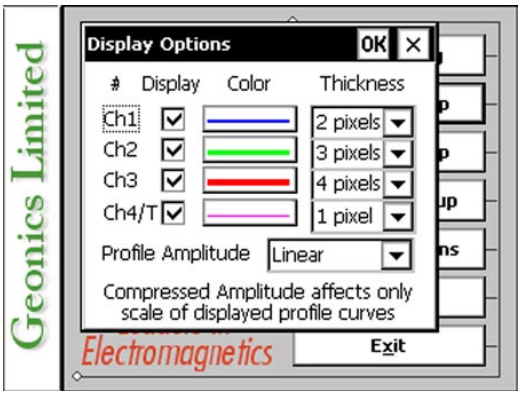


5. Click on “Logger Setup”, and specify the following options. These settings will remain as defaults throughout the project.

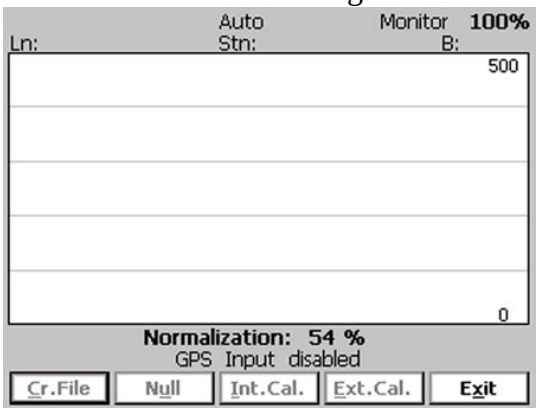


6. Click on “GPS Port Setup”, and make sure the *GPS Input* is set to “Disabled”, and all other options are grayed out.

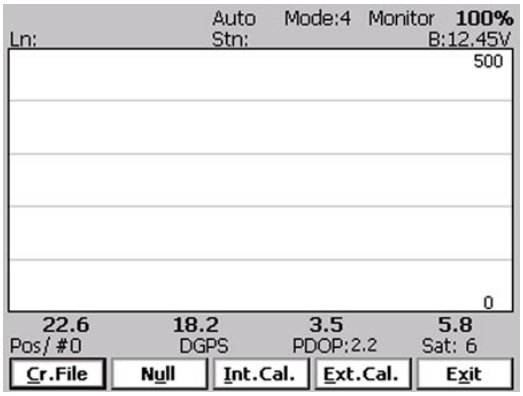
7. Click on “Display Options”, and specify the following options. These options are also operator preferences for aesthetics and do not affect the collected data.

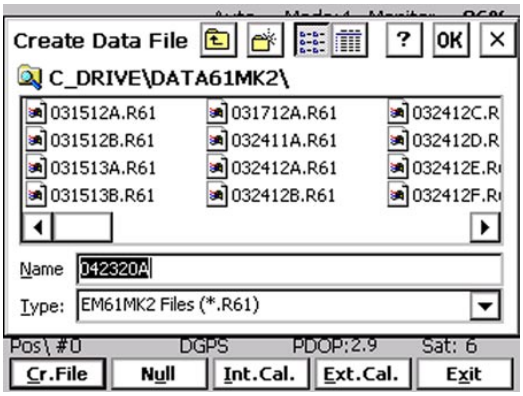


8. Once all parameters are set, click on "Monitor/Log". The screens shown below will be displayed while the instrument is normalizing.



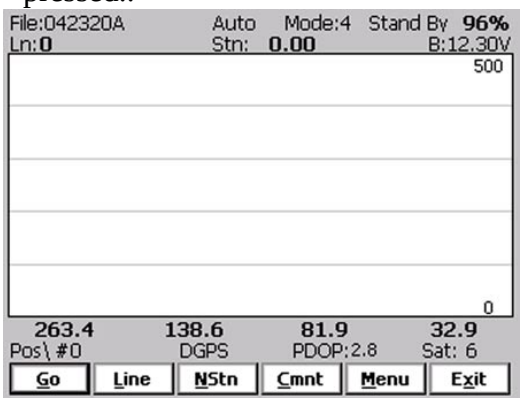
9. Once the Instrument has finished normalizing, find a quiet spot and *Null* the instrument. Then click on *Cr. File* and name and save the file.

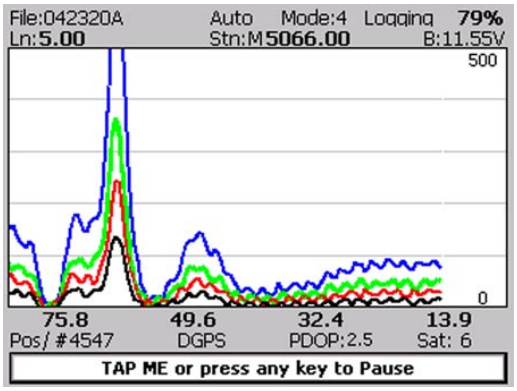




10. Line up on the grid or transect and select *Go*. The software will begin logging the readings, and a *Pause* button will appear at the bottom of the screen. As the operator crosses over each rope (reference location) the fiducial button is hit adding a marker in the data which is later used in the editing of the data to accurately position the data. At the end of the line, tap the *Pause* button or hit enter on the keypad. One thing to note is the difference between fiducial collection in tandem mode and fiduical collection in wheel mode. When data are collected in wheel mode, once the *Go*

button is pressed the instrument does not start taking readings until the wheels are turning or the instrument is moving, since the readings are triggered by the odometer in the wheels. For data collected in tandem mode, the instrument is set automatic, so as soon as the *Go* button is pressed the instrument is recording readings. The operator needs to make sure that they are ready to go prior to pressing the *Go* button. The most effective way to collect data in Tandem mode without GPS is to start behind the grid and as the center of the instrument crosses the "start" line the *Go* button is pressed..

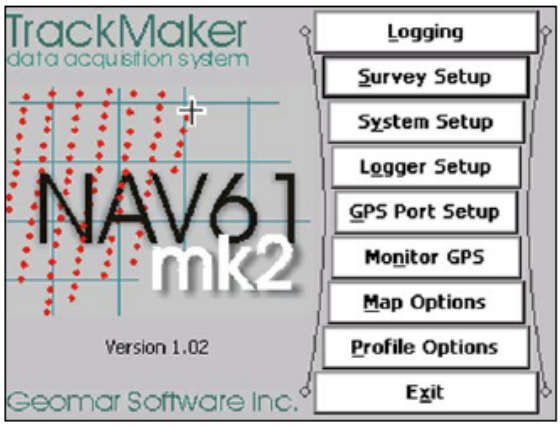




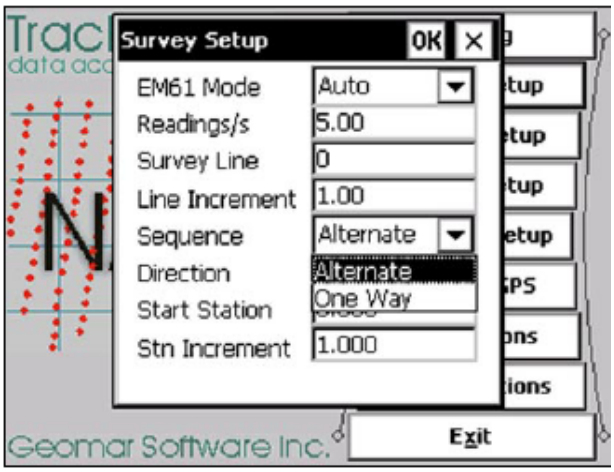
11. On the screens shown above, the EM61-MK2 data are monitored.
12. At the end of the file, select the *Exit* button. The file automatically saves at the end of every line.

The following steps are followed to begin surveying with the **EM61-MK2 with RTK GPS positioning assuming the GPS base station and GPS QC check have already been preformed**:

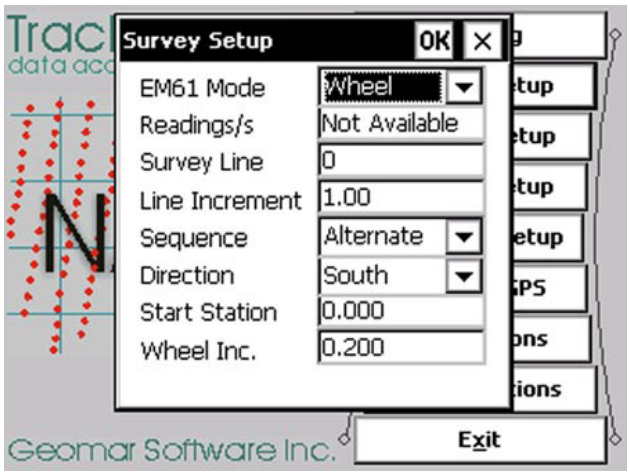
1. Turn on instrument by pushing in the fuse on the top of the console/electronics
2. Allow instrument to warm up for at least 15 minutes
3. Turn on Allegro CX and open NAV61MK2 program. The screen below will be displayed.



4. Click on "Survey Setup" and specify the below options. For this GPS/RTK Method, the Mode is set to "Auto" and Readings/s is set to "10". For Fid Method, the Mode is set to "Wheel", Readings/s is "Not Available", and Wheel Inc. now shows up instead of Stn Increment and it is set to 0.1.

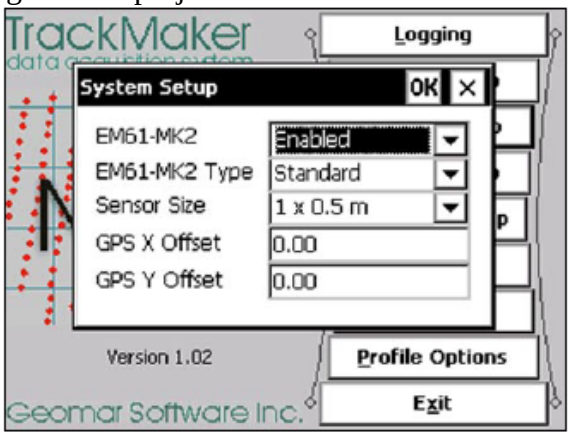


GPS/RTK Method

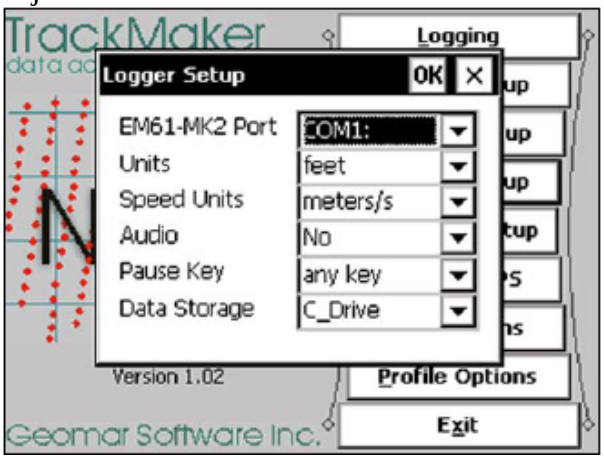


Fiducial Method

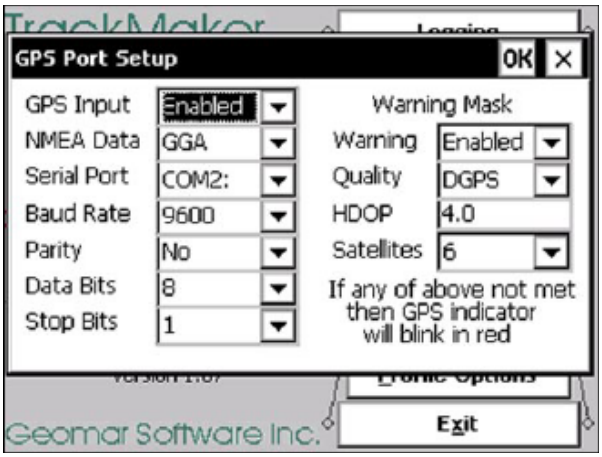
5. Click on "System Setup" and specify the below options. These setting will usually remain the same throughout the project.



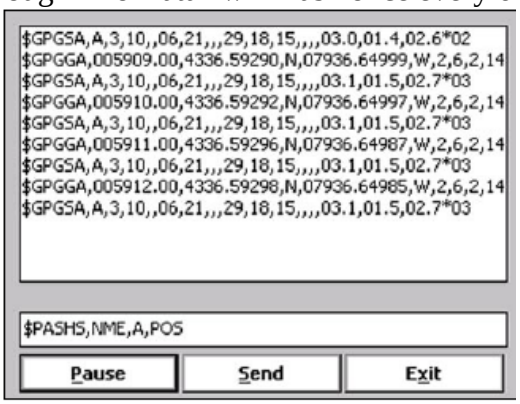
6. Click on "Logger Setup" and specify the below options. These setting will remain the same throughout the project.

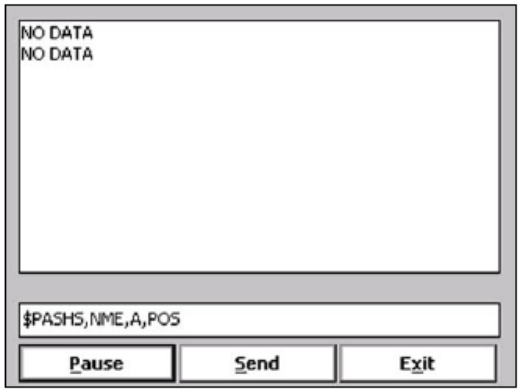


7. Click on "GPS Port Setup" and specify the below options. When using GPS the below setting will be used. On the left side of the screen is where parameters can be set for alerts to go off if the GPS string is inadequate.

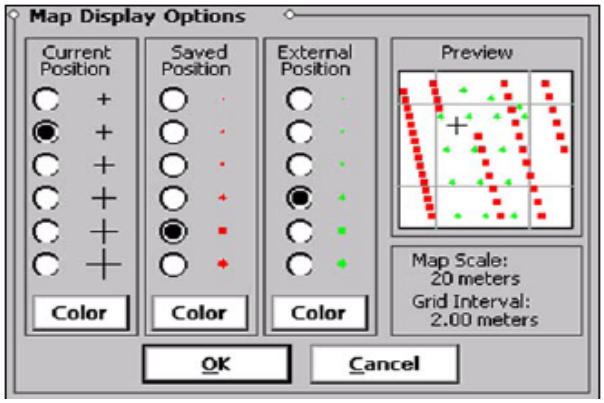


8. Click on "Monitor GPS" and the below window will open. If the NMEA string is coming in correctly, the screen will appear like the one on the left. If there is a problem with the baud rate, "No Data" will appear once a second. If there is nothing coming through "No Data" will flash once every 6 seconds.

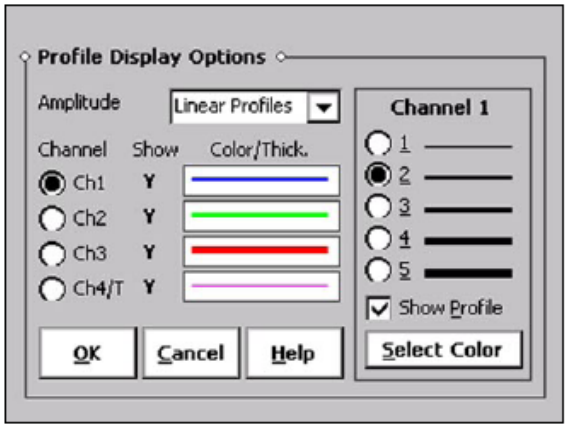




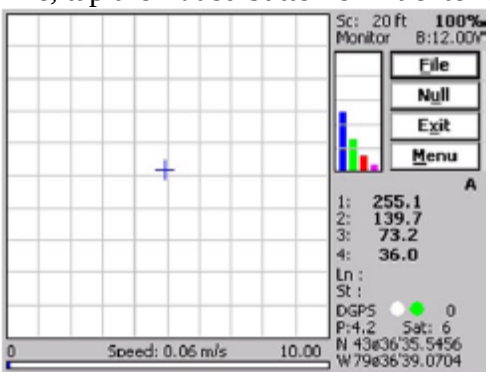
9. Click on "Map Options" and specify the below options. These are more operator preferences for aesthetics then for performance of the software.

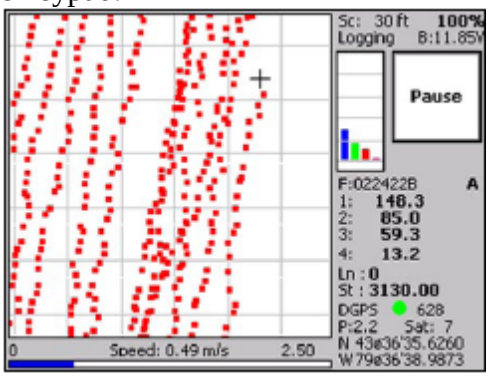


10. Click on "Profile Options" and specify the below options. These are more operator preferences for aesthetics then for performance of the software.



11. Once all the parameters are set click on the logging screen. The below screens will be displayed. Find a quiet spot and *Null* the instrument, then click on *File* and name your file and save it. Line up on the grid or transect and select *Go*. The software will start logging the readings and a large *Pause* button will appear on the screen. At the end of the line, tap the *Pause* button or hit enter on the keypad.





12. On the above screens, both the EM61-MK2 data and the GPS/RTK data are monitored, as well as the data coverage.
13. At the end of the file, the *Exit* button is selected. The file automatically saves at the end of every line.

Data Storage and Preliminary Processing

EM61-MK2 data are temporarily stored in the Allegro data logger via Geonics' EM61MK2 or Geomar's NAV61 software and then downloaded into a laptop computer for further on-site processing using Geonics' DAT61MK2 or Geomar's Trackmaker and Geosoft Oasis Montaj software.

Initial data processing is performed by the field team and includes reviewing data for integrity and general repeatability. In the case of traditional surveying methods, positional data are edited based on the known locations of fiducial marks.

Post Processing

Once the initial editing steps have been performed, the data are turned over to NAEVA's processors for advanced analysis, target selection, and preparation of deliverables. The processor will go through five steps before the final data packages are delivered.

Step 1) QC of the field forms that have been uploaded from the PDA into the database. This QC check insures that the forms are filled out correctly with the following item

- The appropriate grid block name
- Transects associated with the block
- QC test file names (Static/Spike Tests, Personnel Test, Cable Shake Test and Latency Tests)
- Block file name
- Repeat file name
- Instrument used (EM61MK2 Wheeled, EM61MK2 Tandem)
- Collection/navigation method (RTK or FID)
- Daily conditions
- Cultural features

Step 2) Preprocessing of the QC tests and block data. The QC test data are actually finalized here but the block data are preprocessed. This step is to check the data for the following:

- Data quality
- Location
- Coverage
- Line path positioning
- Down line density
- Check of QC tests

First, a folder needs to be created where the Geosoft files are to be saved. Next open Geosoft and create a new project in the folder you just made (File – Project – New). There are separate projects for the QC tests and DGM Block(s).

After the project is created, several script files can be used in Geosoft that help expedite the preprocessing/processing procedures. They are listed below with a brief description. Alternately, each step may be conducted manually.

- **QC_Static_QC1.gs, QC_Static_QC2_etc.gs and QC_IVS.gs**. These scripts are partially interactive. *_QC1.gs includes Static/Spike, Personnel and Cable Shake test lines. *_QC2.gs includes just the Static/Spike test lines and the *_IVS.gs contains the IVS test line(s). The scripts do the following:

  - Asks you to name the new Geosoft database it is about to create.
  - Asks you to locate then import the Geosoft xyz file.
  - Asks for the correct import template. For this project, there are two different import templates: GPS/RTK and FID (Locals).
  - Asks for the file name that was just imported.
  - Set X and Y as current (either in UTM or FID locals).
  - Preliminary auto levels and preliminary lag (lags IVS Test ONLY) corrects channels 1, 2, 3 & 4. The leveling gx is similar to the drift correct in Geosoft except we use a median filter. Preliminary leveling for channel 1 is Low window = 0, High window = 80 and Window length = 100. Preliminary leveling for channel 2 is Low window = 0, High window = 75 and Window length = 100. Preliminary leveling for channel 3 is Low window = 0, High window = 65 and

Window length = 100. Preliminary leveling for channel 4 is Low window = 0, High window = 60 and Window length = 100.
    - Refine the leveling in the selected targeting channel. A larger or smaller window length if needed i.e. a larger window length may be needed over very high response features. Manual leveling if needed.
    - Refine lag/latency of the data if needed (IVS test ONLY).
    - Create Geosoft maps and print as PDFs.
    - Add QC information to QC Analysis Spreadsheet.
    - Export out completed processed Geosoft xyz file with header information.

The following are for the DGM Block Data:

- **01_Setup.gs**. This script is partially interactive. It does the following:
    - Asks you to name the new Geosoft database it is about to create.
    - Asks you to locate then import the Geosoft xyz file.
    - Asks for the correct import template. For this project, there are two different import templates: GPS/RTK and FID (Locals).
    - Asks for the file name that was just imported.

  If there is more than one block xyz file then **02_Import.gs** will be needed. It goes through the same steps as the 01_Setup script except naming and creating a new database. In most cases, there is just one xyz file with an associated repeat xyz file. After all block xyz files are imported, the next script to run is:
- **03_Import_Repeat.gs**. Again this script is partially interactive and does the following:
    - Asks you to locate then import the Geosoft repeat xyz file.
    - Asks for the correct import template. For this project, there are two different import templates: GPS/RTK and FID (Locals).
    - Asks for the file name that was just imported.

  If there is more than one repeat xyz file then run this script again until all repeats are imported.
- **04_Preprocessing.gs** (different ones for GPS/RTK and FID)
    - Warp FID Locals to appropriate coordinate system (FID Locals Preprocessing)
    - Set X_UTM and Y_UTM as current.
    - Makes x_d and y_d channels by using the differences filter by 1.
    - Creates a data_density channel then runs a math expression “data_density = sqrt((x_d*x_d)+(y_d*y_d)).
    - Creates and displays a data density map showing a 1m footprint for possible gaps and flags any readings over 0.2m.
    - Creates and displays a GPS Quality map (GPS/RTK Preprocessing)
    - Preliminary auto levels and preliminary lag corrects channels 1, 2, 3 & 4. The leveling gx is similar to the drift correct in Geosoft except we use a median filter. Preliminary leveling for channel 1 is Low window = 0, High window = 80 and Window length = 100. Preliminary leveling for channel 2 is Low window = 0, High window = 75 and Window length = 100. Preliminary leveling for channel 3 is Low window = 0, High window = 65 and Window length = 100. Preliminary

leveling for channel 4 is Low window = 0, High window = 60 and Window length = 100.

- Grids raw, leveled and leveled lagged data using MinCurv or Kriging with a grid cell of 0.2 and a blanking distance of 0.6.
- Creates and displays preliminary contour maps of the selected targeting channel with line paths.
- Selects the appropriate lines and asks for the combined preprocessed xyz file name to be exported with the correct export template. Exported as a Geosoft xyz file with header information.
- Selects the appropriate lines and asks for the combined preprocessed repeat xyz file name to be exported with the correct export template. Exported as a Geosoft xyz file with header information.

To finish the preprocessing, the following steps are to be taken:

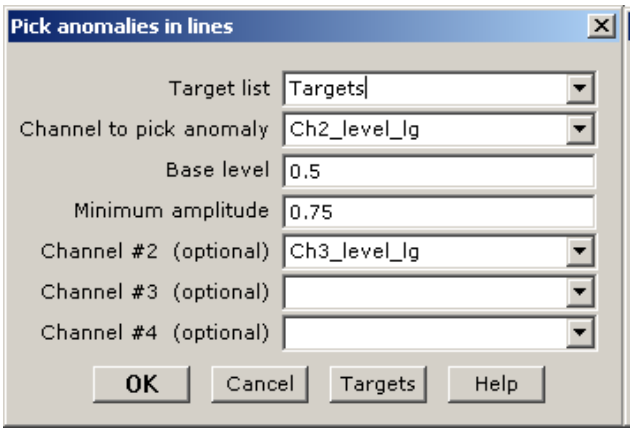
- Add appropriate culture files to the preliminary maps and any GIS/CADD information.
- Create Geosoft maps and pdf files of the preliminary repeat profiles.
- Fill out the Database (MRSIMS).

Step 3) QC of the preprocessing. The QC criteria are as follows:

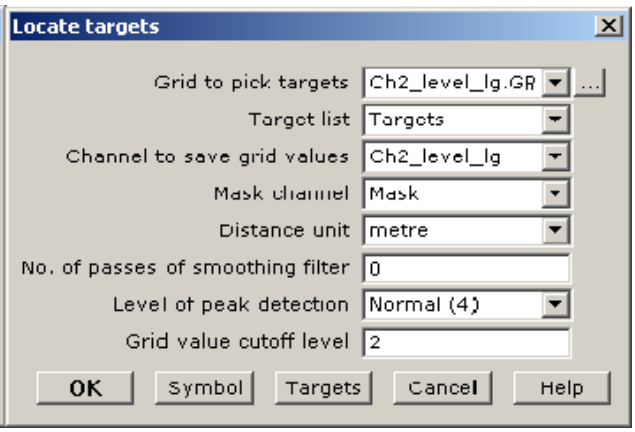
- Check Location & Coverage
- Check grid block name & corresponding grid cells
- Check that the appropriate file names are listed in the correct area in the database
- Check header information on the xyz files.
- Fill out QC of the preprocessing in the database
- Create a DGM Raw Data/Preprocessing Delivery Report
- Upload preprocessing xyz file & Raw Data Delivery Report to CH2M HILL's ftp site.

Step 4) Final processing stage. The final processor opens the Geosoft project created in Step 2 and performs the following:

- Refines the leveling in the selected targeting channel. A larger or smaller window length if needed i.e. a larger window length may be needed over very high response features. Manual leveling if needed.
- Refine lag/latency of the data if needed
- Add filters to the data if needed. Some filters you would expect to see are non-linear, low pass & high pass.
- Grid the data with MinCurv or Kriging. The parameters for both are a grid cell of 0.2 & a blanking distance of 0.6. Kriging better defines high response anomalies. MinCurv on the other hand will usually create false anomalies between lines near high response anomalies.
- Select anomalies in Geosoft's UX-Detect Module by using either "Pick Peaks Along Profile" or "Blakely Test". "Pick Peaks Along Profile" is used for transect surveys and "Blakely Test" is mainly used for 100% coverage surveys.



Pick Peaks Along Profile



Blakely Test

- Refine target selection. Check validity and position. Targets found to be invalid or incorrectly located are adjusted or removed. Additionally, anomalies not selected by UX-Detect, yet deemed to represent a potential UXO target, are being manually selected.
- Export out completed grid block processed Geosoft xyz file with header information.
- Split target Geosoft databases into their grid cells.
- Re-sort the target database by shortest path and if needed, add any additional four point polygon targets (Data Gap Polygons or Heavily Saturated Area Polygons) to the end of the target list. Export a Geosoft xyz file with header information.
- Create and display a colored contour Geosoft map(s) of the grid cell(s) with the following; title block, color scale, index map, legend, target locations & target numbers.
- Create a pdf of the colored contoured grid cell map(s).
- Create and display final repeat profiles with line path profiles.
- Create pdfs of the final repeat profiles.
- Fill out DGM processing form in the database (MRSIMS).
- Export out repeat processed Geosoft xyz file with header information.
- Create a final delivery package that includes the following:
  - All the Geosoft colored contour grid cell maps that are included in the grid block.
  - All the pdfs for the grid cell maps that are included in the grid block.
  - Repeat Geosoft maps with their pdfs. The repeat maps will go into the QC by block folder on the ftp site.
  - Processed Geosoft xyz files of the grid block & repeat data. The repeat xyz files will go into the QC by block folder on the ftp site.
  - Geosoft grd files for the grid block.
  - Target lists in both xls & xyz formats (the xls is in MRSIMS format).

Step 5) QC of the processed data. The QC criteria are as follows:

- Check to see if leveling and the lag is appropriate.
- Check anomaly selections on the maps, xyz file and xls file.
- Check maps title block, index map and legend (map & pdf).
- Check repeat data profiles (map & pdf).

- Check header information on xyz files.
- Check entries on the processing form in the database (MRSIMS).
- Get QC data (maps, pdf's & xyz files) for the corresponding block. Add repeat data (maps, pdf's & xyz files). Zip it. Upload to CH2M HILL ftp site.
- Fill out QC form in the database then create a "Final Data Delivery Report". Add this report to the final delivery package listed above. Zip it. Upload to CH2M HILL ftp site.

Quality Control

The following quality control (QC) procedures are performed and documented during the data collection process and reviewed by a qualified geophysicist on a daily basis.

1. Equipment Warm-up: For at least 15 minutes
2. Record Sensor Positions: Positioning accuracy of the final processed data will be demonstrated by operating the equipment over one or more known points. The accuracy of the data positioning will be assessed by calculating the difference between a known location over which a positioning instrument is held and the displayed position. The sensor position test will be conducted at the beginning of the survey operation for each workday.
3. Personnel Test: This test checks the response of instruments to personnel and their clothing/proximity to the system. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to the personnel operating the system. The response will be observed in the field for immediate corrective action and transmitted back to the processor, and analyzed and checked for spikes in the data that can possibly create false anomalies. The personnel test will be conducted at the beginning of the survey operation for each workday.
4. Cable Shake Test: On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to vibrations in the cables. The response will be observed in the field for immediate corrective action, transmitted back to the processor, analyzed, and checked for spikes in the data that can possibly create false anomalies. The vibration test will be conducted at the beginning of the survey operation for each workday.
5. Static Background and Static Spike: Static tests will be performed by positioning the survey equipment within or near the survey boundaries in an area free of metallic contacts and collecting data for a 3-minute period. During this time, the instrument will be held in a fixed position without a spike (known standard), with a spike and then without a spike. The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist. The static background and static spike test will be conducted at the beginning and end of each grid block.
6. Repeat Data: This test is performed to verify repeatability of the data and will be performed after the initial survey over an area. At least 2% of the survey lines will be repeated. Repeatability of the instrument is further evaluated in the daily collection of the IVS.

All work will follow the extensive QC program laid out in the Work Plan. In addition, the NAEVA will demonstrate the performance of each DGM system prior to its use at an Instrument Verification Strip (IVS), as described in the GSV Plan. The continued performance of each DGM system used will also be documented daily at an IVS.

MRP – SOP – 0001

MUNITIONS RESPONSE PROGRAM (MRP)

STANDARD OPERATING PROCEDURE (SOP)

SURFACE MUNITIONS AND EXPLOSIVES OF CONCERN (MEC)

& SUBSURFACE ANOMALY AVOIDANCE

1.0 OBJECTIVE:

Provide safe procedures to avoid Munitions and Explosives or Concern (MEC) during visitor/personnel escort, land survey, vegetation reduction, sediment sampling, soil boring, drilling, direct push technology-core sampling, or other environmental or construction activities conducted in an environment where the presence of MEC is suspected.

2.0 PURPOSE:

This SOP provides guidance for avoiding surface MEC (e.g., Unexploded Ordnance (UXO), Discarded Military Munitions (DMM)), Material Potentially Presenting an Explosive Hazard (MPPEH), and subsurface anomalies.

3.0 APPLICABILITY:

This SOP applies MEC avoidance procedures per Department of Army Engineering Pamphlet (EP) 75-1-2 Munitions and Explosives of Concern Support During Hazardous Toxic and Radioactive Waste (HTRW) and Construction Activities.

4.0 TECHNCIAL GUIDANCE:

This SOP lists processes and procedures that comply with the following sources:

- DOD 6055.09-M, Ammunition and Explosives Safety Standards, February 2008
- USN Environmental Restoration Program (MRP Chapter 12) August 2006
- NAVSEA OP 5Volume 1, Ammunition and Explosives Safety Ashore, July 2009;
- NOSSA Instruction 8023.11(series), Standard Operating Procedure Development
- USAF Manual 91-201, Explosive Safety Standards, November 2008
- DA Pamphlet 385-64, Ammunition and Explosives Safety Standards, October, 8, 2008
- DA Field Manual (FM) 21-16, Unexploded Ordnance (UXO) Procedures, August, 1994
- DA Engineering Manual (EM) 1110-1-4009, Military Munitions Response Actions, June, 2007
- DA Engineering Pamphlet (EP) 1110-1-18, Military Munitions Response Process, April 2006
- DA Engineering Manual (EM) 385-1-97, Explosives, Health and Safety, September 2008
- **Note: Electronic copies for the sources listed above are available via CH2M HILL SUXOS Laptop Computer**

5.0 SOP VALIDATION RECORD:

SOP Title: MEC Anomaly Avoidance.....Work Instruction Identification/ SOP: # MRP-SOP-0001

Author: K. Lombardo Date: December 1, 2009.....Revision Date: 02/16/2012

Review: G. DeMetropolis, Date: February 16, 2012 .....Approval; J. Bowles

Validation Date: December 14, 2009 .....Process Observer: Kevin Lombardo, December 14, 2009

6.0 HAZARDOUS MATERIALS:

Hazardous Chemicals: None; Product Name: N/A; Material Safety Data Sheets: N/A; Health Hazards: N/A

7.0 EMERGENCY RESPONSE INFORMATION

Work Site Name (location) address/building # Street):

_____

Nearest intersection (cross streets) or entrance gate:

_____

Safe Area Rally Point (gate/building or intersection) Note: Rally Point should be upwind of work location:

_____

UXO Qualified Technician Incident Commander: (name) _____

Personnel Injury or Medical Distress:

1. Summon Emergency Medical Services (EMS)
2. Administer Fist Aid and/or CPR
3. Notify Project Manager
4. PM implements CH2M HILL SOP 111, Incident Notification, Reporting, and Investigations.

Fire:

1. Evacuate personnel from the Munitions Response Site and Area to safe rally point
2. Notify Fire Department of "Work site Name," fire location, and personnel safe rally point
3. Obtain head count, ensuring all personnel are present and or accounted for.
4. Notify Project Manager
5. PM implements CH2M HILL SOP 111, Incident Notification, Reporting, and Investigations.

(Fire/Rescue radio call sign): _____ **Phone #** _____

Medical Services radio call sign: _____ **Phone #** _____

Range Control radio call sign: _____ **Phone #** _____

Project Manager POC: _____ **Phone #** _____

Identify local disaster warning system (radio, PA, phone, other):_____
Flag(s): _____
Warning Bells/Horns/Sirens/Lights/Strobes: _____
Public Address System: _____
Weather Radio Channel: _____
Other: _____

8.0 PERSONNEL ROLES AND RESPONSIBILITY

Note: Roles and responsibilities are dependent upon work plan direction; one or all roles and responsibilities may be applicable.

1. Project/Construction Manager (P/CM): Provides the necessary resources and personnel to safely and efficiently accomplish the scope of work. Ensures CH2M HILL unexploded ordnance (UXO) personnel shall be qualified in accordance with:
   - OPNAVINST 8020.14/MCO P8020.11 (series).
   - And are certified to perform the job assigned and that the certification is current. Contractors who perform those duties described in NAVSEA OP5, paragraph 2-3 involving ammunition and explosives shall comply with NAVMED P117 Article 15-107.
   - Prior to site operations, CH2M HILL will verify training, medical qualification statements by physicians, and conformance to substance abuse testing and reporting programs.
   - Shall confirm active explosive certification program conformance for personnel compliance to requirements for UXO personnel identified IAW DDESB Technical Paper (TP) 18, and monitors these personnel for conformance to the Bureau of Alcohol, Tobacco, Firearms, and Explosives, Safe Explosives Act 2003 Certification requirements for "Employee Possessor," and or "Responsible Person."
2. Senior UXO Supervisors or Unexploded Ordnance Technician III or II: Supervises the operational resources necessary to implement, and accomplish this procedure and requirements set forth within the Work, Health, Safety, Quality and Accident Prevention Plans. May stop work at anytime to prevent accidents, remedy unsafe conditions, stop an unsafe act, or question the safety of a process or procedure or

observe non conformance to this SOP and/or plans. Provides a Site Specific Tailgate Safety Briefing to include MEC, construction, industrial, environmental, and natural safety hazard awareness. Provides the plan of day. As applicable provides a Hazardous Materials briefing for items used, consumed, or required for this SOP. Brief personnel on communications, security, emergency/medical response, evacuation, rally points, IAW with project instructors, and plans. Also, informs personnel to prevent disclosure of classified work, site observations, or information.

3. Non-UXO Qualified Personnel are obligated to follow guidance within this SOP, Work, Health and Safety and Accident Prevention Plans.

9.0 PRE-OPERATIONAL CHECK LIST	
1. ( ) CH2M HILL Inc. Safety Risk Evaluation (SRE) and Explosives Safety Submission Determination (ESSD) (Navy Projects)	2. ( ) Project Task/Work/ Instructions
3. ( ) Work Plan/Accident Prevention Plan/ Health and Safety Plan	4. ( ) Personal Protective Equipment (PPE) IAW Safety Plan
5. ( ) Emergency P.O.C List	6. ( ) Directions and map to hospital
7. ( ) Communications (2 methods)	8. ( ) First aid/Fire Extinguisher/- (GPS/compasses optional)

10.0 ANOMALY DETECTION EQUIPMENT (as required by project instruction)
( ) Ferrous Metal Detector (Schonstedt GA 52CX or Ferex 4.021 MK 26 Mod 0 or equivalent), with extra batteries, carry case, & instruction manual (as required by project instructions)
( ) All Metals Detector (White Spectrum XLT or equivalent) with extra battery, carry case, & instruction manual (as required by project instructions)
( ) Down-hole Instrument Direct Push Technology – Schonstedt MG 230 Gradiometer maximum 2.12-inch "Outside Diameter" (OD) Probe Head - Extra batteries and instruction manual (as required by project instructions)

11.0 EXPLOSIVE ORDNANCE RECONNAISSANCE EQUIPMENT
WARNING **Direct physical contact with or movement of MEC or MPPEH is not authorized.** ( ) Tape Measure, ruler, pen/paper, item for scale perspective (e.g. dollar bill),
( ) Camera (digital), with spare batteries (as required by project instructions)
( ) Small dry erase white board and dry erase marker for photograph item number, date, time, location, and description.

12.0 GENERAL INFORMATION	
CATEGORY **Surface MEC/Anomaly Avoidance**	**DIRECTIONS** **(S)** = Safety, **(O)** = Operations, **(Q) =** Quality Control
Note: (o) PM shall obtain MISS Utilities Check and or local Dig (intrusive) permits prior to intrusive actions (such as use of direct push technology, drilling, and use of hand augers) **(WARNING)** **Fire: (s)** Do not attempt to fight a fire, evacuate area, move upwind or crosswind to safe rally point, notify fire department. **Wildlife: (s)** Aggressive/defensive – Avoid wildlife –withdraw from area **Hunters: (s)** Withdraw from area, retreat to vehicle, contact project authority **CWM: (s)** Evacuate upwind to safe rally point, mark area on map, contact PM **Severe Weather (lighting, winds, and storms): (s)** Evacuate to vehicle, follow PM guidance	
13.0 SAFETY	
Munitions Response Group Safety Manager	George DeMetropolis/SDO Telephone (Office): (619) 687 – 0120, Ext. 37239 Telephone (Cellular): (619) 564 – 9627
Safety Plan, Accident Prevention Plan and Activity Hazard Analysis	(s) All field personnel require reading, compliance, and acknowledging they understand and comprehend the safety information contained within these plans, SOP and AHA; attesting through signature and date
Visitors access to work location	(s) All visitors (contract/transient/witness) require a safety briefing, wearing of PPE IAW site specific safety plan, and conformance to UXO Technician instructions**.**
Safety Meeting:	(s) Each morning – Project Personnel shall participate in a tailgate safety briefing, discussing the operational activities (plan of the day), MEC/HTRW hazards/risks, safety controls, and emergency procedures; daily weather forecast, work activity OSHA PPE

	level, insect/poisonous plant avoidance, and heat/cold stress prevention. Personnel shall sign and date, the safety briefing acknowledgment form; confirming individual participation, understanding, and comprehension prior to operations. Personnel who do not participate in the safety briefing or, understand, or comprehend the safety briefing may not access work areas.
Safety Pre-field operations check list	(s) ( ) First Aid Kit (serviceable and supplies within shelf life) (s) ( ) Fire Extinguisher 10BC (or greater) (charged/indicator green) (s) ( ) Water (minimum 1 liter per person) (s) ( ) Cell phone/identified alternate land line location/or two/way Radio (s) ( ) Identification of wind direction, and rally points (s) ( ) PPE IAW Activity Hazard Analysis (s) ( ) Vehicles unlocked; keys in announced location (s) ( ) Insect repellant/sun screen (available)
Equipment Check-out: 1) Schonstedt – GA52CX magnetometer or equivalent 2) White's (E series) Spectrum model XLT Metal Detector or equivalent 3) Schonstedt gradiometer MG 230 for Down-hole or underwater search or equivalent 4) Forster Ferex 4.021 models K,L, & W or MK 26 MOD 0 magnetometer for down-hole or underwater search or equivalent	(o) Assemble/inspect, IAW manufacture instructions (o) Test geophysical instruments against a known source (ferrous or non-ferrous) for instrument response. (o) Source (ferrous) Schedule 40, 2-inch x 5-inch steel pipe or equivalent (q) Pass/Fail - instrument shall detect source on surface at 12-inches above item/fail non-detect - replace instrument (o) Source on surface (non-ferrous) ¾-inch x 6-inch Brass Pipe nipple (aka) couple fitting or equivalent (q) Pass/Fail - instrument shall detect source on surface at 6-inches above item/fail non-detect - replace instrument

	(q) Name of individual recording geophysical instrument source test results by instrument manufacturer with: type, model, serial number, by the date of daily equipment check. Record results for pass/fail source test with remarks. Reject and replace geophysical instrument that does not pass quality control source test.
14.0 SITE ACCESS	
WARNING: UXO Technician(s) shall not make physical contact with MEC, or commercial explosives. UXO Technicians assigned to implement this SOP shall not intentionally move MEC or explosives, incendiaries, smokes, propellants, or commercial explosives. **NOTE:** If MEC, to include Unexploded Ordnance (UXO), Discarded Military Munitions, (DMM) or Material Potentially Presenting an Explosive Hazard (MPPEH) are encountered, the UXO Technician shall respond IAW 3R training, avoid such items, and notify Project Manger IAW site-specific project instructions.	(o) Implement 3R (R, R, R) process, and procedures. (o) Recognize MEC, UXO, DMM, and or MPPEH; offset mark anomaly location with flag, ribbon, paint, stakes, other location identifier (o) Retreat from MEC location and avoid MEC location (o) Report & record MEC location in logbook and contact Project Manager IAW project instructions to request additional guidance. **Note:** MR Safety may instruct UXO Qualified Technician to perform a zero contact Explosive Ordnance Reconnaissance of the item requesting information for type by function, condition, filler, and nomenclature (if visually possible), supported by photographs of the item.
15.0 EXPLOSIVE ORDNANCE RECONNAISSANCE (EOR)	
EXPLOSIVE ORDNANCE RECONNAISSANCE Reconnaissance involving the investigation, detection, location, marking, initial identification, and reporting of suspected MPPEH in order to determine future action	
EOR Method UXO Qualified Technician is required prior to performing an Explosive Ordnance Reconnaissance to review Department of the Army, Field Manual (FM) 21-16, Unexploded Ordnance (UXO) Procedures, August 1994 – A copy can be obtained from:	(o) Use general Explosive Ordnance Disposal (EOD) safety precautions until munition type, fuzing , condition, and filler are identified (o) Upon identification, of type by function, fuzing, and condition use general EOD safety precautions for the category of munition (e.g.

WWW.UXOINFO.COM or from CH2M HILL MR Operations, Kevin Lombardo/WDC	Rocket; avoid approach to the front and rear of item, etc). (s) Approach Unexploded Ordnance (UXO) 45^0 to the rear (s) Do not cast shadows over UXO fuze (s) Remain cognizant to avoid dispensed wires, filaments, or other items that could initiate movement (s) Remain cognizant of Electromagnetic Hazardous Radiation, to Ordnance (HERO) precautions.
Information Recovery	(o) Photograph item from each vantage point. Identify each photograph with item name, view (side, front, rear, etc.), and distance from camera to item, (f-stop & shutter speed and film speed if applicable). It is required that a photograph log be kept for each item. Use a ruler in photo to demonstrate perspective of the item. (o) Close-up photograph fuze, markings, nose, tail, and or markings
16.0 PERSONNEL ESCORT	
Personnel Escort A minimum of one UXO qualified Technician(II) shall escort non-UXO qualified site personnel conducting access to a Munitions Response Area or Site The UXO qualified person shall visually search the surface of walking paths, roads, and parking areas to locate, mark, and avoid MEC during walking, driving, or setting-up equipment.	(o) Establish a wind streamer of tape/ribbon (flag) within/near the project site to observe wind direction. (o) A UXO Technician shall visually search the surface area, for MEC/HTRW to avoid such items. The UXO Technician may augment the visual search with the application of a geophysical instrument to detect surface/subsurface ferrous and or non-ferrous anomaly sources for the purpose of anomaly avoidance (o/s) When escorting non-qualified UXO personnel, a UXO Technician shall lead, and non-UXO qualified personnel shall follow along a path identified by the UXO Technician. (o) The UXO Technician shall identify surface hazards (MPPEH) and avoid such hazards. The location of a hazard requires, the UXO Technician to communicate the location to non-UXO qualified persons for avoidance around the item. (s) Communication can be by hand signals (pointing), or marking with flags, tape, ribbon, paint, stakes, or other means identified during a safety briefing.

	(s) Essential Personnel Limits - MR Escorts are a minimum of one UXO qualified Technician II or above, to no more than six (6) non-qualified persons. (s) Non UXO qualified personnel shall not approach and avoid a marked MPPEH or HTRW hazard.
17.0 MEC AVOIDANCE SUPPORT **LAND SURVEY, SEDIMENT SAMPLING, GROUNDWATER COLLECTION, ENDANGERED SPECIES SAMPLING/MONITORING**	
Applicable to Visitors, Land Survey, Sediment Sampling, Groundwater Collection, Endangered Species Sampling/Monitoring	
WARNING: Subsurface intrusive acts could initiate MEC, through physical contact, movement, or shock.	(o) A UXO Technician shall search each intrusive point from the surface with a magnetometer and or all metals detector in accordance with the instruments manufactures instructions, to locate ferrous and/or non-ferrous subsurface anomalies. Location of such subsurface anomalies requires the placement of an offset marker (pin flag a minimum of 12-inches) to the north of the greatest signal strength for the anomaly. (s) For land survey and sampling activities where detection of an anomaly occurs, an alternative location free of ferrous and non-ferrous anomalies is required to proceed with intrusive activities. (q) The UXO Technician shall note within the daily logbook the rejection of the primary location and selection of the alternative location, with a written description of direction and feet/inches for the offset location from the primary point.
NOTE: Personnel performing subsurface intrusive activities for the purpose of land survey and environmental sampling require a UXO Technician to search the subsurface with either or both (dependent on MEC site-specific history) a magnetometer and/or all metals detector to confirm the subsurface is free of ferrous and or non-ferrous anomalies. A UXO Technician shall mark the boundaries /limits for ingress/egress access from a safe area (i.e.: road) to the work activity location or provide escort to and from the work activity location.	
18.0 VEGETATION REDUCTION MEC AVOIDANCE (MANUAL/MECHANICAL)	
WARNING: DO not apply vegetation cutting	(o) A UXO Technician shall escort vegetation reduction personnel, perform a visual and/or magnetometer and/or all metals detection instrument search of surface

closer than six-inches to ground surface. Vegetation reduction actions that occur less than six-inches above ground surface, may result in movement, or shock to MEC, resulting in an unintentional detonation or functioning as designed of the item.	access routes, walking paths, and vegetation reduction locations for MEC/HTRW and or obstruction hazards. (o) The UXO Technician shall operate a magnetometer and or all metals detection instrument to locate surface anomalies with potential to be a hazard to vegetation reduction crews. (o) The UXO Technician shall perform a visual surveillance of the surface to locate surface hazards (MEC, HTRW) or obstructions to equipment, mark the location and instruct vegetation reduction crews to avoid the location. (s) The UXO Technician shall remain away from the immediate operating radius of powered equipment and remain alert for flying debris (s) The UXO Technician shall wear high visibility outerwear, use hearing, and eye protection, and avoid swing radius of powered equipment.
Warning : Personnel performing vegetation reduction activities shall not operate equipment closer than 6-inches to the ground thus, all brush cutting equipment (chain saws, weed whackers, string trimmers, brush cutters, bush hogs, hydro-ax, or debarking equipment) shall operate six-inches or greater above ground.	
19.0 MEC AVOIDANCE (DOWN HOLE)	
WARNING: When applying MEC avoidance procedures for drilling or the use of direct push technology, the steel mass of drill rigs and direct push technology DPT power plants will influence gradiometers, and magnetometer reporting instruments. Thus, drill rigs and DPT equipment shall be withdrawn a minimum of ten feet from intrusive points while performing down-hole avoidance search.	(o) Prior to drilling, the UXO Technician will conduct a visual reconnaissance of access paths and drilling area. The reconnaissance will include locating the designated sampling or drilling location(s) ensuring that the locations do not have surface MEC, or MPPEH, and magnetometers or all metal detection search do not indicate the presence of subsurface anomalies. If detection of subsurface anomalies occurs, at the sampling point, the sampling point is abandoned. Once the designated sampling point has been determined free of anomalies, an access route for the sampling crew's vehicles is searched. The access path requires twice the width of the widest vehicle and marking along the sides with flags, ribbon, engineer tape, stakes, or equivalent to define limits. (s) If an observation of MEC or MPPEH should occur, the UXO Technician shall mark the item, avoid it, and notify the PM for either military EOD or UXO Contractor

	support. (o) A UXO Technician will clear each work site for drilling/DPT and clearly mark the safe to walk, and drill or DPT, boundaries. Each drill/DPT safe area will be large enough to accommodate the drilling equipment and provide a work area for the crews. As a minimum, the safe area will be a rectangle, with a side dimension equal to twice the length of the largest vehicle or piece of equipment for use on site.
NOTE: (p) Drilling and application of DPT may require an ingress route and pad turning radius, twice the width, and length of the mechanical equipment.	
NOTE: MEC may exist within the subsurface up to 30 feet below ground surface, dependent on site-specific history. Refer to project instruction to determine maximum depth for down-hole MEC avoidance support.	
The UXO Technician is required to escort personnel and remain with personnel when sampling/drilling at an MRP or MEC/MPPEH suspect site.	(o) Soil bore holing may be by hand auger, power-auger, drilling, DPT. A UXO Technician will examine, prior to sampling/drilling, the borehole location with a down-hole gradiometer or magnetometer, a minimum of every one (1) foot, to the deepest sampling depth or a maximum of 30 feet below ground surface to ensure avoidance of anomalies, or to depth identified within the project instruction.
WARNING: Drilling equipment may produce injury from snapping cables, pinch points, chain failures or falling booms, derricks, and drill piping. Avoid the immediate operational radius of drillers when supporting efforts.	(o) Drilling down–hole monitoring requires at a minimum of one (1) foot increments of search, during the actual well drilling operation. This will require the withdrawal of the drill rod or augers from the hole and moving the drill rig a minimum of 10 feet or enough feet away from the drill-hole location to prevent the metal in the rig from influencing the magnetometer/gradiometer. (o) The UXO Technician shall perform down-hole monitoring for anomalies at each location identified within the project instruction.
20.0 QUALITY CONTROL	

The QC Manager will be responsible for ensuring this SOP is effectively implemented. Surveillances and/or inspections will be conducted to ensure SOP compliance.	(q) UXOQC personnel shall document nonconforming materials, items or activities in a NCR based on surveillances and/or inspections
21.0 ACTIVITY COMPLETION	
Completion of documentation:	( ) Project site logs to Project Manager ( ) Tail gate safety meeting log to Project Manager ( ) Equipment check-out report to Project Manager ( ) Quality control reports to Project Manager

21.0 EQUIPMENT

ITEM	QUANTITY
Cellular telephone	1
Dow-hole (only) Magnetometer/Gradiometer capable of down-hole operations to 30 feet	1 or (as required by Project instruction)
Magnetometer capable of monitoring to a depth of two-feet below ground surface for ferrous items	1 or (as required by Project instruction)
All metals detector capable of monitoring to a depth of 6-inches below ground surface for non-ferrous items	Optional
Multi colors of marking flags, ribbon, and tape	As determined by SUXOS
Batteries	Two day supply for instruments
First –aid Kit (25 person)	1 within the work area
Water	Minimum 1 liter per person in work area
Camera/Tape Measure/Ruler/Calipers/Paper Pencil	As determined by SUXOS
Hand tools, (hammer, general purpose tools, etc.)	Assorted as determined by SUXOS

MINIMUM PERSONAL PROTECTIVE EQUIPMENT: IAW with Safety Plan and AHA or a minimum of OSHA LEVEL "D"

Coveralls (or long pants, sleeved shirt)

Boots (level "D") Cover (cap, floppy, skull) Gloves (leather) Safety Eye protection (as required by AHA) Hard hats (when working in an area with a potential for head injury or heavy equipment e.g. drill rig) Because this is a possible HTRW operation, the MR Supervisor will direct the required explosive safety site PPE conditions.
SPECIAL TRAINING AND REFRESHER REQUIREMENTS: UXO Technicians will be qualified at a minimum Level II designation and be graduates of the U.S. Naval School of Explosive Ordnance Disposal or other DOD DEDSB TP 18 approved course or school/course of instruction, Hazard Waste Operations IAW 29CFR 1910.120 (e) & (f) and medical clearance physical authorization to perform work.
WAIVERS, EXEMPTIONS, SPECIFIC AUTHORIZATIONS, OR APPROVED DEVIATIONS THAT APPLY TO THIS OPERATION: None
ACTIVITY HAZARD ANLAYSIS

Safe Work Method Statement/ Job Hazard Analysis

Company Name: **CH2M HILL**	Project Name/#: SOP MRP 0001- MEC Anomaly Avoidance
Work Activity/Task: MEC Anomaly Avoidance	Principal Contractor: **CH2M HILL**
Date: December 09, 2009	Note: Sign off to be provided at Tool Box talk
Prepared by: George DeMetropolis	Supervisor: TBD by project location
Signature:	Safety Coordinator (SC): TBD by project location
All metals detection equipment, metal detection instruments, magnetometry equipment, gradiometers, and military ordnance detection equipment, plant & equipment required: - machinery: maintenance checks provided and recorded by subcontractor or operator: suitably qualified and competent, with health, safety, and environment (HS&E) training	Training Requirements 29 CFR 1910.120 (e) & (f); DDESB TP 18 minimum qualifications for Unexploded Ordnance Technicians; OPNAVINST 8020.14/MCO P8020.11 (series) and are certified to perform the job assigned and certification is current. NAVSEA OP5, paragraph 2-3 involving ammunition and explosives shall comply with NAVMED P117 Article 15-107. Prior to site operations, CH2M HILL will verify training, medical qualification statements by physicians, and conformance to substance abuse testing and reporting programs. CH2M HILL has an active explosive certification program and monitors these personnel for conformance to the Bureau of Alcohol, Tobacco, Firearms, and Explosives, Safe Explosives Act 2003 Certification requirements for "Employee Possessor," and or "Responsible Person." 3R training for non-UXO qualified Personnel. (in addition to those in project's written safety plan: - OHS Construction Induction - Waste Management for waste streams and materials

Job Step	Potential Hazard	Controls
Forms/Permits	Unknown client-specific hazards. MEC Surface/Subsurface	UXO qualified personnel, SOP MR 0001, 3Rs Training for Non-UXO qualified personnel, Metal (ferrous/nonferrous) detection equipment, DA EP 75-1-2. Well driller license, drill rig permit •Well installation or abandonment notification •Dig/drill permit obtained, where required by client facility •Water withdrawal permit obtained, where required
Site Setup	Striking underground utilities, impact with MEC	•Location of underground utilities and installations identified •Daily briefing Avoid Surface and Subsurface MEC through the use of MR SOP 0001 – MEC Anomaly Avoidance
	Striking overhead utilities	•Locate and take appropriate precautions with required distances from power lines •Lower mast and secure during travel

	Physical environmental hazards	•Use of appropriate personal protective equipment (PPE) where required. Safety boots, hard hats, safety glasses and hearing protection are mandatory. Respirators when chemical hazards exist. No loose-fitting clothing, rings, watches, etc.; long hair to be restrained close to the head.
	Dermal or inhalation exposure to contaminants	•Investigate history of area; determine nature and degree of contaminants that could be present •Conduct air monitoring for potential hazardous atmospheres as described in the project's written safety plan. •Use respirators and other PPE as prescribed in the project's written safety plan

Job Step	Potential Hazard	Controls
Site Setup (Continued)	Fire /Explosion	• No smoking around the drill rig – MR SOP-0001 MEC Anomaly Avoidance
	Struck by vehicles	•Follow traffic control plan •Wear high-visibility warning vests
	Drill rig travel	•Ensure stable ground and adequate footing for machinery. Adequate ground preparation to support loads and accommodate waste materials. •Drill rig travel will be conducted with mast secured in its lowered position •Tools and equipment secured prior to rig movement •Only personnel seated in cab are to ride on the rig vehicle •Ensure clearance of overhead power lines •Use alarm or spotter when reversing rig
	Illegal offsite impacts	• Excavation area checked for wetlands, endangered species, cultural/historic resources
	Spread of contamination from contaminated drill cuttings	•Manage cuttings in accordance with all project plans

Drilling Activities	Rotating machinery parts of drill rig MEC- surface/Subsurface – physical contact	•Daily inspection of drill rig & equipment •Ensure appropriate guards are installed or suitable barriers to forewarn personnel of dangers •Personnel clear during set up, clear of rotating parts •Loose clothing, long hair, and jewelry to be safely secured •Hands or feet should not be used to move cuttings away from auger •Rig in neutral and augers stopped rotating before cleaning •Kill switch installed, clearly identified and operational •Rig placed in neutral when operator not at controls •Pressurized lines and hoses secured from whipping hazards Advance Drill/bore hole/DPT in one foot increments applying MR SOP 0001-MEC Anomaly Avoidance Procedures
	Hoisting operations	•Ensure all personnel are clear of operation to a suitable safe distance
	Overturning of drill rig	•Establish drill pad if necessary •Drill rig level and stabilized
	Securing ropes and cables	•Ensure security to stable fixture. Do not wrap around any part of the body. •Drill rig ropes in clean, sound condition

22.0 PROCESS SUPERVISOR'S STATEMENT

I have read and understand this SOP. To the best of my knowledge, the processes described within this SOP can be done in a safe, healthful, and environmentally sound manner. I have made sure that all persons assigned to this process are qualified, have read and understand the requirements of this SOP, and have signed the workers statement for this process. I will ensure the SOP is the most recent revision. If a major change to the SOP is necessary, I will ensure that the processes are stopped until the SOP is revised and approved. If unexpected safety, health, or environmental hazards arise, I will stop activities, until hazards have been controlled, reduced, or eliminated to an acceptable risk level.

SOP MRP 0001 PROCEDURE SUPERVISOR ACKNOWLEDGEMENT

UXO Supervisor's Name (print):	Supervisor's Signature	Organization	Date

23.0 PERSONNEL STATEMENT

I have read this SOP and I have received adequate demonstration of the procedure, training to perform the process and procedure according to requirements, procedure, and guidance identified below. I agree to follow this SOP, unless I identify a hazard, work condition, or compliance issue not addressed within this SOP or encounter a situation, condition, or issue that, I cannot perform according to the SOP. If such a stoppage occurs, I will immediately notify the SUXOS, UXO Technician III, or II. Should the situation, condition, or compliance remain unresolved for greater than 24-hours, I shall contact the Munitions Response Safety Manager (619) 564-9627.

SOP MRP – 0001 - PERSONNEL STATEMENT ACKNOWLEDGEMENT

Personnel Name (print):	Personnel Signature	Organization	Date

STANDARD OPERATING PROCEDURE
OPS-03 – DEMOLITION/DISPOSAL OPERATIONS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide the minimum procedures and safety and health requirements applicable to the conduct of demolition/disposal operations on sites contaminated with unexploded ordnance (UXO) or munitions and explosives of concern (MEC).

2.0 SCOPE

This SOP applies to all USA Environmental, Inc. (USA) site personnel, including contractor and subcontractor personnel, involved in the conduct of UXO/MEC demolition/disposal operations on a UXO/MEC contaminated site. This SOP is not intended to contain all of the requirements needed to ensure complete compliance, and should be used in conjunction with approved project plans and applicable referenced regulations. Consult the documents listed in Section 12.0 of this SOP for additional compliance issues.

3.0 RESPONSIBILITIES

3.1 PROJECT MANAGER

The Project Manager (PM) will be responsible for ensuring the availability of the resources needed to implement this SOP, and will also ensure that this SOP is incorporated into plans, procedures, and training for sites where this SOP is to be implemented.

3.2 SENIOR UXO SUPERVISOR

The Senior UXO Supervisor (SUXOS) will be responsible for assuring that adequate safety measures and housekeeping are performed during all phases of site operations, to include demolition activities, and will visit site demolition locations, as deemed necessary, to ensure that demolition operations are carried out in a safe, clean, efficient, and economic manner. The demolition activities will then be conducted under the direct control of the SUXOS, who will have the responsibility of supervising all demolition operations within the area.

The SUXOS will be responsible for training all on-site UXO personnel regarding the nature of the materials handled, the hazards involved, and the precautions necessary. The SUXOS will also ensure that the Daily Operational Log, Ordnance Accountability Log, USA Demolition Shot Records, and inventory records are properly filled out and accurately depict the demolition events and demolition material consumption for each day's operations. The SUXOS will be present during all demolition operations or designate a competent, qualified person to be in charge during any absences.

3.3 UXO SAFETY OFFICER

The UXO Safety Officer (UXOSO) for the site is responsible for ensuring that all demolition operations are being conducted in a safe and healthful manner, and is required to be present during all MEC demolition operations. The UXOSO will ensure the compliance of the demolition team with the above referenced documents that are applicable to the particular task being performed.

3.4 UXO QUALITY CONTROL SPECIALIST

The UXO Quality Control Specialist (UXOQCS) is responsible for ensuring the completeness of demolition operations records and for weekly inspection of the Ordnance Accountability Log, the Daily Operational Log, the USA Demolition Shot Record, and the inventory of MEC and demolition material. The UXOQCS,

assisted by demolition team personnel, will inspect each demolition pit and an area of appropriate radius after each demolition shot, in accordance with the approved explosive siting plan, to ensure that there are no kick-outs, hazardous UXO/MEC components, or other hazardous items. In addition, the pit may be checked with a magnetometer and large metal fragments, and any hazardous debris, will be removed on a per use basis in accordance with the SOW. Any UXO/MEC discovered during the QC check will be properly disposed of using the demolition procedures in the WP. Extreme caution must be exercised when handling UXO/MEC, which has been exposed to the forces of detonation. Personnel must adhere to acceptable safe practices and procedures when determining the condition of munitions and fuzes that have not been consumed in the disposal process.

4.0 GENERAL OPERATIONAL AND SAFETY PROCEDURE

All personnel, including contractor and subcontractor personnel, involved in operations on UXO/MEC-contaminated sites will be familiar with the potential safety and health hazards associated with the conduct of demolition/disposal operations, and with the work practices and control techniques used to reduce or eliminate these hazards. During demolition operations, the general safety provisions listed below will be followed by all demolition personnel, at all times. Noncompliance with the general safety provisions listed below will result in disciplinary action, which may include termination of employment.

All safety regulations applicable to demolition range activities and demolition and MEC materials involved will be complied with.

- Demolition of any kind is prohibited without an approved siting plan.
- The quantity of MEC to be destroyed will be determined by the range limit, fragmentation and K-Factor distance calculations.
- In the event of an electrical storm, dust storm, or other hazardous meteorological conditions, immediate action will be taken to cease all demolition range operations and evacuate the area.
- In the event of a fire, which does not include explosives or energetic material, put out the fire using the firefighting equipment located at the site; if unable to do so, notify the fire department and evacuate the area. If injuries are involved, remove the victims from danger, administer first aid, and seek medical attention.
- The UXOSO is responsible for reporting all injuries and accidents that occur.
- Personnel will not tamper with any safety devices or protective equipment.
- Any defect or unusual condition noted that is not covered by this SOP will be reported immediately to the SUXOS or UXOSO for evaluation and/or correction.
- Methods of demolition will be conducted in accordance with this SOP and approved changes or revisions thereafter.
- Adequate fire protection and first aid equipment will be provided at all times.
- All personnel engaged in the destruction of MEC will wear clothing made of natural fiber, close-weave clothes, such as cotton. Synthetic material such as nylon is not authorized unless treated with anti-static material.
- Care will be taken to minimize exposure to the smallest number of personnel, for the shortest time, to the least amount of hazard, consistent with safe and efficient operations.
- Work locations will be maintained in a neat and orderly condition.
- All hand tools will be maintained in a good state of repair.
- Each heavy equipment and/or vehicle operator will have a valid operator's permit or license for the equipment being operated.

- Equipment and other lifting devices designed and used for lifting will have the load rating and date of next inspection marked on them. The load rating will not be exceeded and the equipment will not be used without a current inspection date.
- Leather or leather-palmed gloves will be worn when handling wooden boxes, munitions, or UXO/MEC.
- Lifting and carrying require care. Improper methods cause unnecessary strains. Observe the following preliminaries before attempting to lift or carry:
  - When lifting, keep your arms and back as straight as possible, bend your knees and lift with your leg muscles.
  - Be sure you have good footing and hold, and lift with a smooth, even motion.
- The demolition range will be provided with two forms of communication, capable of contacting appropriate personnel or agencies (i.e., medical response, Quick Response Force (QRF).
- Motor vehicles and material handling equipment (MHE) used for transporting MEC or demolition materials must meet the following requirements:
  - Exhaust systems will be kept in good mechanical repair at all times.
  - Lighting systems will be an integral part of the vehicle.
  - One Class 10B:C rated, portable fire extinguisher will, if possible, be mounted on the vehicle outside of the cab on the driver's side, and one Class 10B:C fire extinguisher will be mounted inside the cab.
  - Wheels of carriers must be chocked and brakes set during loading and unloading.
  - No demolition material or MEC will be loaded into or unloaded from motor vehicles while their motors are running.
- Motor vehicles and MHE used to transport demolition material and MEC will be inspected prior to use to determine that:
  - Fire extinguishers are filled and in good working order.
  - Electrical wiring is in good condition and properly attached.
  - Fuel tank and piping are secure and not leaking.
  - Brakes, steering, and safety equipment are in good condition.
  - The exhaust system is not exposed to accumulations of grease, oil, gasoline, or other fuels, and has ample clearance from fuel lines and other combustible materials.
- Employees are required to wear leather, or rubber, gloves when handling demolition materials. The type of glove worn is dependent on the type of demolition material.
- A red warning flag, such as an “Active Range Flag” or a wind sock, will be displayed at the entrance to the demolition range during demolition operations when required by local authority. If applicable, the entrance gate will be locked when demolition work is in process.
- Unless otherwise directed or authorized by the explosives siting plan, all demolition shots will be tamped with an appropriate amount of earth/dirt.
- An observer will be stationed at a location where there is a good view of the air and surface approaches to the demolition range, before material is detonated. It will be the responsibility of the observer to order the SUXOS to suspend firing if any aircraft, vehicles, or personnel are sighted approaching the general demolition area.

- Two-way radios will not be operated in close proximity of the demolition range while the pit is primed or during the priming process. Radio transmissions and explosives will be separated by a minimum of 50 ft.
- No demolition operation will be left unattended during the active portion of the operation (i.e., during the burn or once any explosives or UXO/MEC are brought to the range).
- A minimum radius (approximately 50 feet) around the demolition pit will be cleared of dry grass, leaves, and other extraneous combustible materials around the demolition pit area.
- No demolition activities will be conducted if there is less than a 2,000-ft ceiling or if wind velocity is in excess of 20 mph.
- Demolition shots must be fired during daylight hours (minimum time for sunrise and sunset is determined by the firing procedure used (i.e., electric, non-electric, shock tube 30/60/60).
- Notification of the local authorities will be made in accordance with the site requirements.
- No more than two persons will ride in a truck transporting demolition material or MEC, and no person will be allowed to ride in the trailer/bed.
- Vehicles will not be refueled when carrying demolition material or MEC, and must be 100 ft from magazines or trailers containing such items before refueling.
- All explosive vehicles will be cleaned of visible explosive and other contamination, before releasing the vehicles for other tasks.
- Prior to conducting any other task, personnel will wash their faces and hands after handling demolition material or MEC.
- Demolition pits will be spaced a safe distance apart, with no more than 10 pits prepared for a series of shots at any one time.

5.0 SPECIAL REQUIREMENTS FOR DEMOLITION ACTIVITIES

The following safety and operational requirements will be met during demolition range operations. Any deviations from this procedure will be allowed only after receipt of written approval from the PM and the client. Failure to adhere to the requirements and procedures listed in the paragraphs below could result in serious injury or death; therefore, complete compliance with these requirements and procedures will be strictly enforced.

5.1 GENERAL REQUIREMENTS

The general demolition range requirements listed below will be followed at all times:

- The CEHNC "Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Munitions and Explosives of Concern (MEC) Sites," will be followed when destroying multiple munitions by detonation on site. This document will be present on site during site operations.
- White Phosphorus and propellant will be disposed of only in an approved manner and following the guidance for maximum temperature exposure (90 degrees Fahrenheit).
- Material awaiting destruction will be stored at not less than intra-line distance, based on the largest quantity involved, from adjacent explosive materials and from explosives being destroyed. The material will be protected against accidental ignition or explosion from fragments, grass fires, burning embers, or detonating impulses originating in materials being destroyed.
- UXO/MEC or bulk explosives to be destroyed by detonation should be detonated in a pit not less than 3 ft deep and covered with earth which protrudes not less than 2 ft above existing ground level. Requirements may be found in the explosives siting plan. The components should be placed on their sides or in a position to expose the largest area to the influence of the demolition

material. The demolition material should be placed in direct contact with the item to be detonated and held in place by tape or earth packed over the demolition materials. The total quantity to be destroyed below ground at one time will not exceed the range limit.

- Detonations will be counted to ensure detonation of all pits. After each series of detonations, a search will be made of the surrounding area for UXO/MEC. Items such as lumps of explosives or unfuzed ammunition may be picked up and prepared for the next shot. Fuzed ammunition, or items that may have internally damaged components, will be detonated in place, if possible.
- Prevailing weather condition information can be obtained from the local weather service, or other acceptable source and the data logged in the Demolition Shot Log before each shot or round of shots.
- All shots will be dual primed.
- Whenever possible, during excavation of the demolition pits contour the ground so that runoff water is channeled away from the pits. If demolition operations are discontinued for more than two weeks, the pits should be backfilled until operations resume.
- Upon completion of the project, all disturbed demolition areas will be thoroughly inspected for UXO/MEC. Depending upon contract requirements, the site may have to be backfilled and leveled. If necessary, this will be coordinated with the contractor representative.
- Prior to and after each shot, the USA Demolition Shot Record is to be filled out by the SUXOS with all applicable information. This record will be kept with the Ordnance Accountability Log and reflect each shot.

5.2 ELECTRIC DETONATOR USE

The following requirements are necessary when using electric detonators and blasting circuits:

- Electric detonators and electric blasting circuits may be energized to dangerous levels from outside sources such as static electricity, induced electric currents, and radio communication equipment. Safety precautions will be taken to reduce the possibility of a premature detonation of the electric detonator and explosive charges of which they form a part. Radios will not be operated while the pit is primed or during the priming process.
- The shunt will not be removed from the leg wires of the detonator until the continuity check of the detonator is to be performed.
- When uncoiling, or straightening, the detonator leg wires, keep the explosive end of the detonator pointing away from the body and away from other personnel. When straightening the leg wires, do not hold the detonator itself; rather, hold the detonator leg wires approximately 1 in. from the detonator body. Straighten the leg wires by hand; do not throw or wave the wires through the air to loosen them.
- Prior to use, the detonators will be tested for continuity. To conduct the test, place the detonators in a pre-bored hole in the ground or place them in a sand bag, and walk facing away from the detonators and stretch the wires to their full length, being sure to not pull the detonators from the hole or sand bag. With the leg wires stretched to their fullest length, test the continuity of the detonators one at a time by un-shunting the leg wires and attaching them to the galvanometer and checking for continuity. After the test, re-shunt the wires by twisting the two ends together. Repeat this process for each detonator until all detonators have been tested. This process will be accomplished at least 50 ft from and downwind of any MEC or demolition materials and out of the demolition range personnel and vehicle traffic flow pattern. In addition, all personnel on the demolition range will be alerted prior to the test being conducted.

  NOTE: When testing the detonator, prior to connecting the detonator to the firing circuit, the leg wires of the detonator must be shunted by twisting the bare ends of the wires together

immediately after testing. The wires will remain short circuited until time to connect them to the firing line or Remote Firing Device (RFD) Receiver.

- At the power source end of the blasting circuit, the ends of the wires will be shorted or twisted together (shunted) at all times, except when actually testing the circuit or firing the charge. The connection between the detonator and the circuit firing wires must not be made, unless the power ends of the firing wires are shorted and grounded or the firing panel is off and locked.
- The firing line will be checked using pre-arranged hand signals or through the use of two-way radios, if the demolition pit is not visible from the firing point. If radios are used, communication will be accomplished a minimum of 50 ft from the demolition pit and detonators. The firing line will be checked for electrical continuity in both the open and closed positions, and will be closed/shunted after the check is completed.
- UXO/MEC to be detonated will be placed in the demolition pit and the demolition material placed/attached in such a manner as to ensure the total detonation of the UXO/MEC. Once the UXO/MEC and demolition material are in place and the shot has been tamped, the detonators will be connected to the det cord. Prior to handling any detonators that are connected to the firing line or RDF, personnel will ensure that they are grounded. The detonators will then be carried to the demolition pit with the end of the detonators pointed away from the individual. The detonators are then connected to the detonation cord, Non-El, etc., ensuring that the detonator is not covered with tamping material to allow for ease of recovery/investigation in the event of a misfire.
- Prior to making connections to the blasting machine or RFD Transmitter, the entire firing circuit will be tested for electrical continuity and ohms resistance, or transmitting power (as applicable), to ensure the blasting machine or RFD Transmitter (distance) has the capacity to initiate the shot.
- The individual assigned to make the connections at the blasting machine or panel will not complete the circuit at the blasting machine or panel, and will not give the signal for detonation, until satisfied that all personnel in the vicinity have been evacuated to a safe distance. When in use, the blasting machine, or its actuating device, will be in the blaster's possession at all times. When using the panel, the switch must be locked in the open position until ready to fire, and the single key must be in the blaster's possession.
- Prior to initiating a demolition shot(s), a warning will be given; the type and duration of such warning will be determined by the prevailing conditions at the demolition range. At a minimum, this should be an audible signal using a siren, air horn, or megaphone, which is sounded for a duration of one minute, five minutes prior to the shot and again one minute prior to the shot.

5.3 NON-EL USE (SHOCK TUBE)

The following requirements are necessary when using NON-EL (Shock Tube) systems:

- After cutting a piece of shock tube, either immediately tie a tight overhand knot in one or both cut ends or splice one exposed end and tie of the other.
- Always use a sharp knife or razor blade to cut shock tube so as to prevent the tube from being pinched or otherwise obstructed.
- Always cut shock tube squarely across and make sure the cut is clean.
- Use only the splicing tubes provided by the manufacturer to make splices.
- Every splice in the shock tube reduces the reliability of the priming system; therefore keep the number of splices to a minimum.
- Always dispose of all short, cut-off pieces in accordance with local laws as they relate to flammable material.

The shock tube system is a thin plastic tube of extruded polymer with a layer of Pentaerythritol Tetranitrate (PETN) coated on its interior surface. The PETN propagates a shock wave, which is normally contained within the plastic tubing. The shock tube offers the controlled instantaneous action of electric initiation without the risk of premature initiation of the detonator by radio transmissions, high-tension power lines, or static electricity discharge. The NON-EL system uses detonators in the bunch blocks and in the detonator assembly, which are to be handled in accordance with approved procedures.

The high reliability of the shock tube initiating system is due to the fact that all of the components are sealed and, unlike standard non-electric priming components, cannot be easily degraded by moisture. Cutting the shock tube makes the open end vulnerable to moisture and foreign contamination; therefore, care must be taken to prevent moisture and foreign matter from getting in the exposed ends of the shock tubes.

5.3.1 Shock Tube Demolition Procedures

WARNING
Although the detonation along the shock tube is normally contained within the plastic tubing, burns may occur if the shock tube is held.

5.3.2 Shock Tube Assembly

- Spool out the desired length of shock tube from firing point to demolition site and cut it off with a sharp knife or razor blade. Weight down the loose end of trunk line.
- Immediately seal off the shock tube remaining on the spool by tying a tight overhand knot in the cut-off end or use a push-over sealer.
- Using a sharp knife or razor, cut the sealed end off the detonator assembly.
- Push one of the shock tube ends to be spliced firmly into one of the pre-cut splicing tubes provided by the manufacturer at least ¼ inch. Push the other shock tube end firmly into the other end of the splicing tube at least ¼ inch. Secure splice with tape if needed.

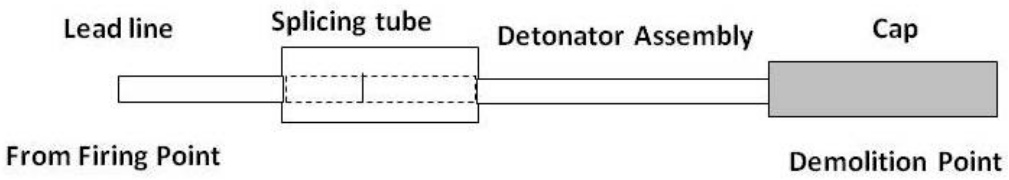


Figure 1

5.3.3 Firing Assembly Setup

1) If there are multiple items to be destroyed using bunch block(s) supplied by the manufacturer, lay out lead lines at demo site to the shot(s) and secure the bunch block with a sandbag, or some other item which will keep it from moving.

NOTE: No more than six leads may be used from any one bunch block.

2) If the detonator assembly has not been attached yet, then, using the splicing tube, splice the detonator assembly to the shock tube branch line as explained in the splicing instructions above.
3) If this is a non-tamped shot, place the detonator assembly into the demolition material. If the shot is to be tamped, then prepare the demolition material with a detonating cord lead long enough to stick out of the tamping at least 1 ft.

4) Tape the detonator assembly with cap to the detonating cord lead as shown in Figure 2.

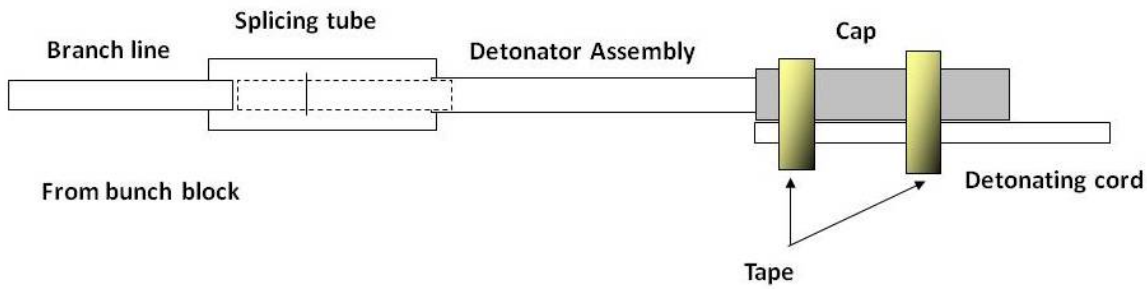


Figure 2

5) Return to the firing position.
6) Cut off the sealed end of shock tube, proceed to the directions listed in Step 7. If you are using a previously cut piece of shock tube, using a sharp knife or razor blade cut approximately 18 inches from the previously cut end, whether or not it was knotted in accordance with the above guidance.
7) Insert a primer into the firing device and connect the shock tube lead line to the firing device ensuring that the shock tube is properly seated in the firing device.
8) Take cover.
9) Signal **"Fire in the hole"** three times and initiate charge.
10) Observe a 5-minute wait time after the detonation.
11) Remain in designated safe area until Demolition Supervisor announces **"All Clear."**

5.4 DETONATING CORD USE

The following procedures are required when using detonating cord (det cord):

- Det cord should be cut using approved crimpers, and only the amount required should be removed from inventory.
- When cutting det cord, the task should be performed outside the magazine.
- For ease of inventory control, remove det cord only in 1-ft increments.
- Det cord should not be placed in clothing pockets or around the neck, arm, or waist, and should be transported to the demolition location in either an approved “day box”, original container, or a cloth satchel, depending upon the magazine location and proximity to the demolition area.
- Det cord should be placed at least 50 ft away from detonators and demolition materials until ready for use. To ensure consistent safe handling, each classification of demolition material will be separated by at least 25 ft until ready for use.
- When ready to “tie in” either the det cord to demolition materials, or det cord to detonator, the det cord will be connected to the demolition material and secured to the UXO/MEC. The cord is then strung out of the hole and secured in place with soil, or filled sandbags, being sure to leave a minimum of 6 ft of det cord exposed outside the hole.
- Once the hole is filled, make a loop in the det cord large enough to accommodate the detonator, place the detonator in the loop, and secure it with tape. The detonator’s explosive end will face down the det cord toward the demolition material or parallel to the main line.

- In all cases, ensure that there is a minimum of 6 ft of det cord extending out of the hole to allow for ease of detonator attachment and detonator inspection/replacement should a misfire occur.
- If the det cord detonators are electric, they will be checked, tied in to the firing line, and shunted prior to being taped to the loop. If the det cord detonators are non-electric, the time/safety fuse will be prepared with the igniter in place prior to taping the detonators to the det cord loop. If the det cord detonators are Non-EI, simply tape the detonators into the loop as described above.
- In the event that a time/safety fuse is used, an igniter is not available, and a field expedient initiation system is used (i.e., matches), do not split the safety fuse until the detonator is taped into the det cord loop.

5.5 TIME/SAFETY FUSE USE

The following procedures are required when using a time/safety fuse:

- Prior to each daily use, the burn rate for the time/safety fuse must be tested to ensure the accurate determination of the length of time/safety fuse needed to achieve the minimum burn time of five minutes needed to conduct demolition operations.
- To ensure both ends of the time/safety fuse are moisture free, use approved crimpers to cut 6 inches off the end of the time/safety fuse roll, and place the 6 inch piece in the time/safety fuse container.
- If quantity allows, accurately measure and cut off a 6-ft-long piece of the time/safety fuse from the roll.
- Take the 6 ft section out of the magazine, and attach a fuse igniter.
- In a safe location, removed from demolition materials and UXO/MEC, ignite the time/safety fuse, measure the burn time from the point of initiation to the "spit" at the end, and record the burn time in the SUXOS's Log.
- To measure the burn time, use a watch with a second hand or chronograph.
- To calculate the burn rate in seconds per foot, divide the total burn time (in seconds) by the length (in feet) of the test fuse.
- When using time/safety fuse for demolition operations, the minimum amount of fuse to be used for each shot will be the amount needed to permit a minimum burn time of five minutes.

5.6 DEMOLITION RANGE INSPECTION SCHEDULE

The schedule for the demolition range inspection will be followed when demolition operations are being conducted. This inspection will be conducted by the UXOSO or UXOQCS and will be documented in the Site Safety or QC Log. If any deficiencies are noted, demolition operations will be suspended and the deficiency reported to the SUXOS. Once the deficiencies are corrected, demolition operations may be resumed.

6.0 METEOROLOGICAL CONDITIONS

In order to control the effects of demolition operations and to ensure the safety of site personnel, the following meteorological limitations and requirements will apply to demolition operations:

- Demolition operations will not be conducted during electrical storms or thunderstorms.
- No demolition operations will be conducted if the surface wind speed is greater than 20 miles per hour.

- Demolition operations will not be conducted during periods of visibility of less than one mile caused by, but not limited to, dense fog, blowing snow, rain, sand storms, or dust storms.
- Demolition will not be carried out on extremely cloudy days, defined as overcast (more than 80% cloud cover) with a ceiling of less than 2,000 ft.
- Demolition operations will not be initiated until an appropriate time after sunrise, and will be secured at an appropriate time prior to sunset (see Section 4.0).

7.0 PRE-DEMOLITION/DISPOSAL PROCEDURES

7.1 PRE-DEMO/DISPOSAL OPERATIONAL BRIEFING

It is the belief of USA that the success of any operation is dependent upon a thorough brief, covering all phases of the task, which is presented to all affected personnel. The SUXOS will brief all personnel involved in range operations in the following areas:

- Type of UXO/MEC being destroyed
- Type, placement, and quantity of demolition material being used
- Method of initiation (electric, non-electric, or NON-EL)
- Means of transporting and packaging MEC
- Route to the disposal site
- Equipment being used (i.e., galvanometer, blasting machine, firing wire, etc.)
- Misfire procedures
- Post-shot clean-up of range.

7.2 PRE-DEMO/DISPOSAL SAFETY BRIEFING

The USA SUXOS, Team Leader, or UXOSO will conduct a safety brief for all personnel involved in range operations in the following areas:

- Care and handling of explosive materials
- Personal hygiene
- Two man rule, and approved exceptions
- Personnel roles and responsibilities
- Potential trip/fall hazards
- Horseplay on the range
- Stay alert for any explosive hazards on the range
- Calling a safety stop for hazardous conditions
- Location of emergency shelter (if available)
- Parking area for vehicles (vehicles must be positioned for immediate departure, with the keys in the ignition
- Location of range emergency vehicle
- Location of the assigned paramedic
- Wind direction (to assess potential toxic fumes)

- Locations of first aid kit and fire extinguisher
- Route to nearest hospital or emergency aid station
- Type of communications in event of an emergency
- Storage location of demolition materials and MEC awaiting disposal
- Demolition schedule.

7.3 TASK ASSIGNMENTS

Individuals with assigned tasks will report the completion of the task to the SUXOS. The types of tasks that may be required are:

- Contact local military authorities and fire response personnel, and get air clearance, as required.
- Contact hospital/emergency response/medevac personnel, if applicable.
- Secure all access roads to the range area.
- Visually check range for any unauthorized personnel.
- Check firing wire for continuity and shunt.
- Prepare designated pits as required.
- Check continuity of detonators.
- Check time/safety fuse and its burn rate.
- Designate a custodian of the blasting machine, fuse igniters, or Non-El initiator.
- Secure detonators in a safe location.
- Place UXO/MEC in pit, and place charge in desired location.

7.4 PREPARING EXPLOSIVE CHARGE FOR INITIATION

To prepare the explosive charge for initiation, the procedures listed below will be followed:

- Ensure firing wire is shunted.
- Connect detonator to the firing wire.
- Isolate or insulate all connections.
- Prime the demolition charge.
- Place demolition charge on UXO/MEC.
- Depart to firing point (if using non-electric firing system, obtain head count, pull igniters, and depart to designated safe area).
- Obtain a head count.
- Give one minute warning signal, using a bullhorn or siren, five minutes prior to detonation, and again at one minute prior to detonation.
- Check the firing circuit.
- Signal **“fire in the hole”** three times (or an equivalent warning), and take cover.
- If using electric firing system, connect firing wires to blasting machine, and initiate charge.
- Remove firing wires from blasting machine and shunt or turn off RFD Transmitter.

- Remain in designated safe area until SUXOS announces **"All Clear."** This will occur after a post-shot waiting period of 5 minutes and the SUXOS has inspected the pit(s).

8.0 POST DEMOLITION/DISPOSAL PROCEDURES

Do not approach a smoking hole or allow personnel out of the designated safe area until cleared to do so, and follow the procedures listed below:

- After the **"All Clear"** signal, check pit for low orders or kick outs.
- Examine pit, and remove any large fragmentation, as needed.
- Back fill hole, as necessary.
- Police all equipment.
- Notify military authorities, fire department, etc., that the operation is complete.

9.0 MISFIRE PROCEDURES

A thorough check of all equipment, firing wire, and detonators will prevent most misfires. However, if a misfire does occur, the procedures outlined below will be followed.

9.1 ELECTRIC MISFIRES

To prevent electric misfires, one technician will be responsible for all electrical wiring in the circuit. If a misfire does occur, it must be cleared with extreme caution, and the responsible technician will investigate and correct the situation, using the steps outlined below:

- Check firing line and blasting machine connections, and make a second initiation attempt.
- If unsuccessful, disconnect and connect to another blasting machine (if available), and attempt to initiate a charge.
- If unsuccessful, commence a 30-minute wait period.
- After the maximum delay predicted for any part of the shot has passed, the designated technician will proceed down range to inspect the firing system, and a safety observer must watch from a protected area.
- Disconnect and shunt the detonator wires, connect a new detonator to the firing circuit, check the replacement detonator for continuity, and prime the charge without disturbing the original detonator.
- Follow normal procedures for effecting initiation of the charge.

9.2 NON-ELECTRIC MISFIRES

Working on a non-electric misfire is the most hazardous of all operations. Occasionally, despite all painstaking efforts, a misfire will occur. Investigation and corrective action should be undertaken only by the technician who placed the charge, using the following procedure:

- If charge fails to detonate at the determined time, initiate a 60-minute wait period plus the time of the safety fuse, i.e., 5-minute safety fuse plus 60 minutes for a total of 65 minutes.
- After the wait period has expired, a designated technician will proceed down range to inspect the firing system. A safety observer must watch from a protected area.
- Prime the shot with a new non-electric firing system, and install a new fuse igniter.
- Follow normal procedures for initiation of the charge.

9.3 NON-EL MISFIRE

The use of a shock tube for blast initiation can present misfires, which require the following actions:

- If charge fails to detonate, it could be the result of the shock tube not firing. Visually inspect the shock tube; if it is not discolored (i.e., slightly black), it has not fired.
- If it has not fired, cut a 1 ft piece off the end of the tube, re-insert the tube into the firing device, and attempt to fire again.
- If the device still does not fire, wait 60 minutes and proceed down range to replace the shock tube per the instructions outlined below.
- If the tube is slightly black, then a "Black Tube" misfire has occurred, and the shock tube will have to be replaced, after observing a 60-minute wait time. When replacing the shock tube, be sure to remove the tube with the detonator in place. Without removing the detonator from the end of the tube, dispose of by demolition.

9.4 DETONATING CORD MISFIRE

USA uses det cord to tie in multiple demolition shots, and to ensure that electric detonators are not buried. Since det cord initiation will be either electrical or non-electrical, the procedures presented in Paragraphs9.1, 9.2, or 9.3, as appropriate to the type of detonator used, will be used to clear a det cord misfire. In addition, the following will be conducted:

- If there is no problem with the initiating system, wait the prescribed amount of time, and inspect the initiator to the cord connection to ensure it is properly connected. If it was a bad connection, simply attach a new initiator, and follow the appropriate procedures in Paragraph 9.0.
- If the initiator detonated and the cord did not, inspect the cord to ensure that it is det cord and not time fuze. Also, check to ensure that there is PETN in the cord at the connection to the initiator.
- It may be necessary to uncover the det cord and replace it. This must be accomplished carefully, to ensure that the demolition charge and the MEC item are not disturbed.

10.0 RECORD KEEPING REQUIREMENT

To document the demolition operations procedures and the completeness of the demolition of MEC, the following record keeping requirements will be met:

- USA (as directed) will obtain and maintain all required permits.
- The SUXOS will ensure the accurate completion of the logs, and the SUXOS and UXOQCS will monitor the entries in the log for completeness, accuracy, and compliance with meteorological conditions.
- The SUXOS will enter the appropriate data on the Ordnance Accountability Log and the Demolition Shot Record, to reflect the MEC destroyed, and will complete the appropriate information on the Explosives Accountability Log (a.k.a. the Magazine Data Card) which indicates the demolition materials used to destroy the MEC.
- The quantities of MEC recovered must also be the quantities of MEC destroyed or disposed.
- USA will retain a permanent file of all demolition records, including permits; magazine data cards; training and inspection records; waste manifests, if applicable; and operating logs.
- Copies of ATF License and any required permits must be on hand.

11.0 SAFETY AND PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

The following safety measures and personal protective equipment (PPE) will be used in preventing or reducing exposure to the hazards associated with UXO/MEC demolition/disposal operations. These requirements will be implemented unless superseded by site-specific requirements stated in the SSHP.

- Hard hats are required only when working around heavy equipment or when an overhead or head impact hazard exists.
- Steel toe/shank boots are not required during surface/subsurface location of anomalies, unless a serious toe hazard exists, whereupon a fiber safety toe will be used.
- Safety glasses will be required whenever an eye hazard exists, for example, when working around flying dirt/debris, using hand tools, etc. Safety glasses will provide protection from impact hazards and, if necessary, ultraviolet radiation (i.e., sunlight).
- Positive means will be required to secure the PPE and prevent it from falling and causing an accidental detonation.

12.0 REGULATORY REFERENCES

Applicable sections and paragraphs in the documents listed below will be used as references for the conduct of UXO demolition/disposal operations:

- USA Corporate Safety and Health Program
- OSHA General Industry Standards, 29 CFR 1910
- OSHA Construction Standards, 29 CFR 1926
- DDESB TP-16, Methodology for Calculation of Fragmentation Characteristics
- DoD 4160.21-M, Defense Reutilization and Marketing Manual
- DoD 6055.9-STD, DoD Ammunition and Explosives Safety Standards
- AR 385-64, U.S. Army Explosives Safety Program
- AR 385-10, Army Safety Program
- DA PAM 385-64, U.S. Army Explosives Safety Program
- TM 9-1300-200, Ammunition General
- TM 9-1300-214, Military Explosives
- Applicable TM 60 Series Publications
- AR 190-11, Physical Security of Arms, Ammunition, and Explosives
- ATF 5400.7, Alcohol, Tobacco, and Firearms Explosives Laws and Regulations
- DOT, 49 CFR, Parts 100 to 199, Transportation (applicable sections)
- EPA, 40 CFR Parts 260 to 299, Protection of Environment (applicable sections).
- AR 385-40 w/ USACE Supplement 1, Accident Reporting & Records
- Basic Safety Concepts and Considerations for Ordnance and Explosives Operations, EP 385-1-95a
- USACE EM 385-1-1, Safety and Health Requirements Manual

STANDARD OPERATING PROCEDURE – OPS-04
DGM ANOMALY INVESTIGATIONS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide USA Environmental, Inc. (USAE) employees and subcontractors with the minimum procedures and safety and health requirements applicable to the conduct of digital geophysical mapping (DGM) anomaly investigation operations on sites contaminated with unexploded ordnance (UXO) or munitions and explosives of concern (MEC).

2.0 SCOPE

This SOP applies to all USAE site personnel, including contractor and subcontractor personnel, involved in the conduct of DGM operations on a UXO/MEC contaminated site. The following USAE policies and procedures are not all inclusive nor are they applicable in all situations. This SOP is not a stand-alone document and is to be used together with Work Plans, other USAE SOPs, the USAE Site Safety and Health Plan (SSHP), applicable Federal, State, and local regulations, and contract restrictions and guidance. Consult the documents listed in Section 5.0 of this SOP for additional compliance issues.

3.0 INTRUSIVE INVESTIGATION OPERATIONS

All intrusive operations at MEC sites will be under the supervision of UXO qualified personnel. Non-UXO qualified personnel will not be allowed in the exclusion zone (EZ) during intrusive operations. The EZ will encompass an area large enough to protect personnel from fragmentation by an unplanned detonation. In addition, if non-UXO qualified personnel require access to the EZ, all work will stop while they are in the EZ. During operations, USAE personnel will strictly adhere to the SSHP and the following general safety practices:

- Operations will be conducted during daylight hours only.
- Access to operating areas will be limited to only those personnel necessary to accomplish the specific operation.
- UXO will only be handled by qualified UXO Technicians.
- During UXO operations the minimum separation distance (MSD) between UXO and non-UXO operations is the munition with the greatest fragmentation distance (MGFD), as stated in the Work Plan.
- During demolition operations personnel remaining on site will be limited to those personnel needed to safely and efficiently prepare the item/s for destruction.
- All personnel will attend the daily safety briefing (tailgate safety briefing) prior to entering the operating area.
- Anyone can stop operations for an unsafe act or situation.
- Safety violations and/or unsafe acts will be immediately reported to the UXO Safety Officer (UXOSO).
- Failure to comply with safety rules/procedures may result in termination of employment.

3.1 DETECTION AND REMOVAL PROCEDURES

3.1.1 GRID LAYOUT

A registered Land Surveyor will survey each of the clearance areas, accompanied by a UXO escort. Surveying activities will consist of locating clearance area boundaries, establishing permanent survey monuments, and establishing grids for geophysical investigation activities within the clearance areas.

Grids will be laid out by the survey team in the approximate size of 100 feet (ft) x 100 ft or 200 ft x 200 ft, depending on the terrain. These grids will be geophysical surveyed and the data gathered and evaluated to determine which anomalies will be selected for intrusive investigation. Dig sheets will be developed that prioritize the anomalies. These prioritized anomalies will be re-acquired to an exact location using the highly accurate Real Time Kinematic-Differential Global Positioning System (RTK-DGPS) and a Schonstedt GA-52CX magnetometer.

3.1.2 INTRUSIVE INVESTIGATION OF ANOMALIES

3.1.2.1 Intrusive Teams

Intrusive investigation teams usually consist of a Team Leader (UXO Technician III) and at least one UXO Technician II or I. During Intrusive operations UXO Technicians I will operate under the supervision of UXO Technicians II or III. Only qualified UXO technicians will perform UXO operations, which are defined as:

- MEC identification
- Access procedures such as excavation, either by hand or using heavy equipment
- Handling of MEC, explosives or explosive items
- Disposal, including movement, transportation, and final disposal of MEC

The UXO Team will be assigned a set of anomalies. Using the Dig Sheets provided, the dig team(s) will excavate each of the selected target anomalies. Site-specific conditions (e.g., a larger ordnance item found than was anticipated) may warrant modification of the EZ/MSD and removal procedures described herein. As necessary, any changes will be prepared and submitted separately for approval prior to initiation of further activities on site.

3.1.2.2 Manual Excavations

Excavations for individual anomalies will be conducted using Schonstedt GA-52CX (ferrous metal) and/or White's XLT or Minelab's Explorer II (all metals) detector to assist the team in determining the location and orientation of the target item. The personnel excavating an anomaly shall initially remove no more than a 6-inch layer of soil at the location of the anomaly. A visual and electronic search of the excavation shall then be made. This process shall be repeated until the audible signal from the magnetometer indicates the object is close to the surface. Once this determination has been made, soil will be removed by hand until the source of the anomaly is located. Excavations on individual anomalies greater than 4 ft below the ground surface (bgs) will not be made without prior approval of the U.S. Army Corps of Engineers (USACE) OE Safety Specialist.

3.1.2.3 Mechanical Handling Equipment

Mechanical handling equipment (MHE) may be used to excavate large anomalies (e.g., pits) or those deeper than 4 ft bgs if required (e.g., to confirm the anomaly is not a MEC). Any decision to use mechanized equipment to excavate these anomalies will be made by the Senior UXO Supervisor

(SUXOS) and the USACE OE Safety Specialist. Excavations will proceed slowly to ensure the MHE does not broach the item. If the excavated material is considered to be an MEC, it shall be uncovered sufficiently by hand to obtain a positive identification of the item. If the item is identified as UXO/MEC, a determination will subsequently be made as to whether it is fuzed or not.

While excavating with MHE, a UXO technician will be stationed in a position that is out of the reach of the excavation equipment but affords a view of the excavation site. This observer will ensure that the next lift is visually free of UXO. The excavated material will be placed onto the ground within a screening area that has been surface swept and the boundaries recorded. The soil spoils will be spread across the screening area using the excavator bucket. The excavated material will be screened for range related debris, material potentially presenting an explosive hazard (MPPEH), munitions debris (MD), and UXO/MEC items. UXO technicians will recover all pieces of munitions debris or range related debris and any ordnance items. After screening, the soil spoils will be stockpiled to the side of the screening area.

3.1.2.4 Disposal Pits

Excavations for disposal pits using MHE will be performed in a similar manner as specified in Section 3.1.3.2. However, because individual anomalies cannot be discerned within the disposal pits, material from the disposal pit will be excavated carefully in 2-foot lifts.

3.2 ANOMALY EXCAVATION REPORTING

The MEC Subcontractor will excavate and identify the sources of the reacquired anomalies in the field. Data to be recorded for each item discovered during anomaly excavation will include the following (as applicable):

- Type (e.g., MD, MPPEH, MEC, and UXO)
- Description (e.g., “20mm projectile, MK105 practice bomb, 40mm hand grenade” and “base, coupling, firing device”)
- Initial Condition (e.g., expended, inert, live, and to be determined [TBD])
- Approximate length
- Approximate width
- Depth
- Approximate weight
- Approximate inclination (per Figure 1-1)
- Approximate orientation (Azimuth per Figure 1-1)
- Approximate distance from flag
- Approximate orientation from flag
- Found in a pit?
- Piece of fragmentation?
    - Initial disposition (e.g., left in place or removed to scrap pile)

- Requires demolition?

All data will be turned into the Site Geophysicist at the end of the day.

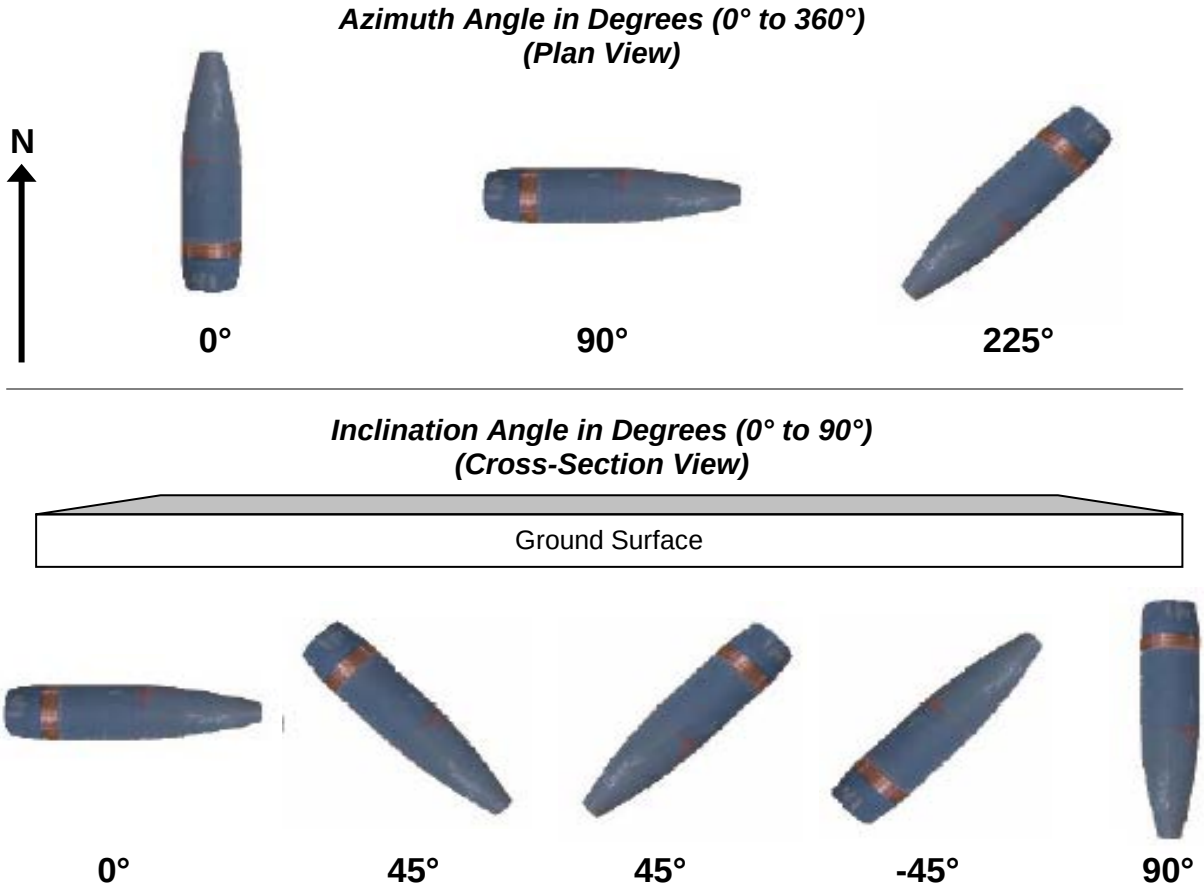


Figure 1-1: Azimuth and Inclination Examples

4.0 DISPOSAL OPERATIONS

Fuzed UXO/MEC items will be blown in place (BIP), and un-fuzed UXO/MEC items will be consolidated whenever possible in accordance with USACE Engineer Pamphlet (EP) 1110-1-17, *Establishing a Temporary Open Burn and Open Detonation Site for Conventional Ordnance and Explosives Projects*, dated 16 July 1999, Appendix D. In no case shall the SUXOS authorize or undertake destruction of UXO/MEC when there is sufficient reason to believe that the disposal action will result in personnel casualties or property damage. The USACE OE Safety Specialist will be consulted for guidance in the event that there is sufficient reason to believe that the disposal action will result in personnel casualties or property damage.

5.0 REFERENCES

- USACE Safety Considerations for UXO/MEC
- USAE Corporate Safety and Health Program (CSHP)
- OSHA, 29 CFR 1910, Occupational Safety and Health Standards

- OSHA, 29 CFR 1926, Construction Standards
- Applicable sections of EPA, 40 CFR Parts 260 to 299, Protection of Environment
- Applicable sections of DOT, 49 CFR Parts 100 to 199, Transportation
- USACE EM 385-1-1, Safety and Health Requirements Manual
- USACE ER 385-1-92, Safety and Occupational Health Document Requirements for Hazardous Waste Remedial Actions
- DOD 4145.26-M, Contractors' Safety Manual for Ammunition and Explosives
- DOD 6055.9-STD, DOD Ammunition and Explosives Safety Standards
- DOD 4160.21-M, Defense Reutilization and Marketing Manual
- DA PAM 385-64, Ammunition and Explosives Safety Standards
- AR 385-64, Ammunition and Explosives Safety Standards
- AR 200-1, Environmental Protection and Enhancement
- AR 385-10, The Army Safety Program
- AR 385-16, System Safety Engineering and Management
- AR 385-40 w/USACE supplement, Accident Reporting and Records
- TM 9-1300-200, Ammunition General
- TM 9-1300-214, Military Explosives
- TM 60 Series Publications

STANDARD OPERATING PROCEDURE AND CHECKLISTS – OPS-05
DIGITAL GEOPHYSICAL MAPPING

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1.0 CHECKLIST FOR GEOPHYSICAL TEST STRIP LOCATION AND DESIGN

Project Name: _____

Project Location: _____

USACE POC: _____

Reviewer's Name and Title: _____

Date of Review: _____

	Y	N	N/A
Objectives			
a. Have survey objectives been determined, clarified, and documented?	____	____	____
b. Has EM-1110-1-4009 been consulted to ensure that all objectives mentioned therein will be met?	____	____	____
c. Will the prove-out be available during the project for the evaluation of suspected instrument malfunctions?	____	____	____
d. Will the prove-out be available during the project for the evaluation of new equipment and operators?	____	____	____
e. Is the contractor prepared to demonstrate target reacquisition techniques in the prove-out area?	____	____	____
Site Selection			
1. Has the proposed prove-out site been evaluated for the following criteria:			
• Easy access for project personnel?	____	____	____
• Restricted access for non-project personnel?	____	____	____
2. Is the prove-out located in close proximity to the survey area?	____	____	____
3. Does the prove-out have geophysical noise conditions similar to those expected in the survey area?	____	____	____
4. Does the prove-out have terrain and vegetation conditions similar to those of the survey area?	____	____	____
5. Has a backup prove-out site been identified?	____	____	____
Site Preparation			
6. Has surface clearance been performed?	____	____	____
7. Have the following steps been executed in preparing three areas within the prove-out:			

Site Preparation (continued)	Y	N	N/A
• Geophysically map entire area prior to burial?	____	____	____
• Remove non geologic sources of anomalous response from two-thirds of the area? (optimal situation)	____	____	____

Seeding Test Strip

8. Have all available sources been consulted to determine appropriate seeded items and orientations?	____	____	____
9. Have DQO's been established and documented?	____	____	____
10. Have appropriate burial depths been determined for the seeded items?	____	____	____
11. Have the DQO's been consulted to determine the number of seeded items?	____	____	____
12. Have the seeded items been spaced a minimum of 3 meters apart?	____	____	____
13. Has a list been made to document the range of burial depths for different MEC items?	____	____	____
14. Have the following steps been taken to ensure accurate locations for the seeded items:	____	____	____
• Specify location requirements in x,y,z?	____	____	____
• Measure depth to top and center of mass of each object?	____	____	____
• Have thorough notes been taken on each item's burial?	____	____	____
• GPS or a land surveyor employed to record the position of each item?	____	____	____

Seeding Survey Areas

15. Have items been seeded near the boundaries of the survey areas?	____	____	____
16. Has a list been made of number and type of items buried, the range burial depths for different MEC items, and percentage of area seeded?	____	____	____
17. Will target threshold be reevaluated based on results of seeded items in the survey areas?	____	____	____
18. Have the positional accuracy standards used during the prove-out been applied to seeded items in the survey areas?	____	____	____

2.0 CHECKLIST FOR OUT OF BOX EQUIPMENT TESTS

Project Name: _____

Project Location: _____

USACE POC: _____

Equipment Source: _____

Equipment Serial Numbers: _____

_____

Reviewer's Name and Title: _____

Date of Review: _____

	Y	N	N/A
1. Has the equipment been inventoried and inspected for damage or wear?			
2. Has the cable shake test been performed? (Replace any faulty components if necessary)	____	____	____
3. Has the instrument (EM only) been nulled?	____	____	____
4. Has a nearby, noise-free site been selected for static background and static response tests?	____	____	____
5. Have the following instrument function tests been successfully performed:	____	____	____
• Static background test demonstrating <20% deviation in response for at least 3 minutes?	____	____	____

Background values: TG1_____, TG2_____, TG3_____, TG4_____

• Instrument response test demonstrating <20% deviation in response from test to test?	____	____	____

Response values: TG1_____, TG2_____, TG3_____, TG4_____

3.0 CHECKLIST FOR INITIAL INSTRUMENT TESTS

Project Name: _____

Project Location: _____

USACE POC: _____

Equipment Source: _____

Equipment Serial Numbers: _____

_____

Reviewer's Name and Title: _____

Date of Review: _____

	Y	N	N/A
6. Has the six-line test been utilized to evaluate the following factors:			
• Heading effects?	____	____	____
• Repeatability of the response amplitude?	____	____	____
• Positional accuracy?	____	____	____
• Latency?	____	____	____
7. If magnetics data are to be collected, have the following steps been taken in the performance of the azimuthal test:	____	____	____
• Selected an area free of geophysical noise?	____	____	____
• Fixed sensor head position?	____	____	____
• Marked four cardinal directions on ground?	____	____	____
• Collected data using a variety of sensor head orientations?	____	____	____
8. If magnetics data is to be collected, has the octant test been performed and documented?	____	____	____
9. Has the optimum sensor height for each instrument been determined?	____	____	____
10. Has the pull-away test been performed and successfully demonstrated no influence for navigational or towing equipment?	____	____	____

4.0 CHECKLIST FOR DAILY INSTRUMENT QC CHECKS

Project Name: _____

Project Location: _____

USACE POC: _____

Equipment Source: _____

Equipment Serial Numbers: _____

_____

Reviewer's Name and Title: _____

Date of Review: _____

	Y	N	N/A
1. Has the cable shake test been performed? (Replace faulty components if necessary)	____	____	____
2. Has instrument (EM only) been nulled?	____	____	____
3. Has a static background test been performed and demonstrated <20% deviation in response over at least 3 minutes:			
• Start of day?	____	____	____
Background values: TG1_____, TG2_____, TG3_____, TG4_____			
• End of day?	____	____	____
Background values: TG1_____, TG2_____, TG3_____, TG4_____			
4. Has instrument response test been performed and demonstrated <20% deviation in response from test to test:			
• Start of day?	____	____	____
Response values: TG1_____, TG2_____, TG3_____, TG4_____			
• End of day?	____	____	____
Response values: TG1_____, TG2_____, TG3_____, TG4_____			
5. Has the operator been thoroughly examined with the geophysical instrument for any sources of response that may not be readily apparent?	____	____	____
6. Has the repeat data or "clover-leaf" tests been utilized to evaluate the following factors:			
• Repeatability of response amplitude?	____	____	____
• Proper Lag Correction Applied?	____	____	____
• Positional accuracy?	____	____	____

Has there been an equipment or DQO metric failure?

Document any failure:

Document any corrective action (repair/retest)

Has corrective action solved failure?

5.0 SURVEY AREA REPORT FORM

☐ QC checked by _____ Date: _____ Date: _____

☐ QA checked by _____

Project Name: _____ _____

Project Location:

Geophysical Contractor: _____ _____

Design Center POC:

Project Geophysicist: _____ _____

Site Geophysicist:

Prove-out Area ID: _____ **Date:** _____ _____

Field Team:

Survey Type: ☐Grid ☐Meandering Path ☐Transect ☐Other _____

Coordinate System: ☐UTM ☐State Plane NAD _____ ☐Local ☐Other _____ **Unit of Measure:** ☐ meters☐ feet

Sketch of Survey Area: **Approx. Scale:** _____ **North Arrow:** _____

Terrain:

☐Level ☐Moderate Slope ☐Steep ☐Rolling ☐Ruts ☐Gullies ☐Rocky ☐Swampy ☐Dangerous

Tree Cover: **Tree Height:** ____☐None ☐Light ☐Medium ☐Thick

Brush: ☐None ☐Light ☐Medium ☐Thick

Weather: ☐Sunny ☐Cloudy ☐Drizzle ☐Rain ☐Thunderstorms ☐Hail ☐Fog ☐Humid ☐Snow

Grid Corner Coordinates: Start End File Name UTM/State Plane Local

Battery Voltage: _____ _____

SW _____, _____ _____, _____ **Static Background Value:** _____ _____ _____, _____

NW _____, _____ _____, _____

Static Response Value: _____ _____ _____, _____

NE _____, _____ _____, _____

SE _____, _____ _____, _____

Instrument Clock Drift: _____

Raw Data File Name: _____

Repeat Data File Name: _____

Geophysical Instrumentation: _____

Serial Number: _____

Sensor Separation (if applicable)**:** _____

Source (rental agency, contractor, etc.)**:** _____

Base Station: _____ **Source:** _____ **Serial Number:** _____

Navigation Method: _____ **Source:** _____ **Serial Number:** _____

Additional Comments:

_____

_____

_____

6.0 CHECKLIST FOR DATA STORAGE AND TRANSFER

Project Name: _____

Project Location: _____

USACE POC: _____

Reviewer's Name and Title: _____

Date of Review: _____

	Y	N	N/A
a. Has the transfer medium been approved by USACE?	____	____	____
b. Are all files in USACE approved formats?	____	____	____
c. Have all of the following been included in the transfer packet:			
• "Readme" file detailing contents?	____	____	____
• Raw data files?	____	____	____
• Edited data files?	____	____	____
• GPS positioning files (if separate)?	____	____	____
• Completed geophysical maps?	____	____	____
• Prioritized target lists?	____	____	____
• Data File Log / Spreadsheet of Delivered Data Files with Dates Sent?	____	____	____
d. Have the required number of copies, per USACE, been included in the transfer packet?	____	____	____

7.0 CHECKLIST FOR FIELD EDITING

Project Name: _____

Project Location: _____

USACE POC: _____

Reviewer's Name and Title: _____

Date of Review: _____

	Y	N	N/A
1. Have the following items been evaluated for correctness and edited if necessary:			
• Line numbers?	____	____	____
• Start and end points?	____	____	____
• Line direction?	____	____	____
• Fiducial locations?	____	____	____
2. Has the data been examined in profile and evaluated for geophysical noise? Enter background noise value and compare with Test Strip background:_____ vs. _____	____	____	____
3. Has the data been examined for the presence of drop-outs and spikes?	____	____	____
4. Has the presence of metal on the operator been eliminated as a possible source of geophysical noise?	____	____	____
5. Has the edited data been converted to the appropriate .xyz format?	____	____	____
6. If using magnetics, have the following steps been taken:			
• Examined base station data for any problems?	____	____	____
• Performed diurnal correction to field magnetometer data?	____	____	____
7. Has the positional data been evaluated for accuracy and completeness?	____	____	____

8.0 CHECKLIST FOR DATA PROCESSING

			FILENAMES:
Site:	_____	Raw:	_____
Location:	_____	Edited:	_____
Contractor:	_____	Processed:	_____
Sector:	_____	Contour Map:	_____
Grid:	_____	Target List:	_____
Processor(s):	_____	Target Map:	_____

	Y	N	N/A
Preprocessing			
1. Coordinate Conversion			
PROJECTED COORDINATE SYSTEM _____	____	____	____
2. Removal of Drift and Leveling	____	____	____
Record Corrections:			
3. Removal of Heading	____	____	____
Record Corrections:			
4. Lag and Offset	____	____	____
Record Corrections:			
Processing			
5. Initial Gridding	____	____	____
Record Parameters:			
6. Calculation of 3D Analytic Signal	____	____	____
7. Digital Filtering and Enhancement			
❑ Low Pass			
❑ High Pass			
❑ Non Linear	____	____	____
❑ 3x3 Convolution			
❑ Difference			
❑ Other _____			
8. Threshold Selection			
Threshold value _____	____	____	____
9. Anomaly Selection			
Number of targets _____	____	____	____

DGPS AND EM61-MK2 SOP

NMEA GGA and GSA strings are used as inputs to the Geonics EM61-MK2 data logger to position sensor data in DGM operations. For applications in wooded areas or wherever RTK DGPS does not provide sufficient coverage AND the acceptable sensor positioning accuracy is less than normal (e.g. to support reconnaissance operations), Trimble's GeoExplorer 2005 (GeoXH or equivalent) can be configured to output the required NMEA position strings. The ability to tailor the output strings in necessary, because the default output of all NMEA strings clogs up the EM61-MK2 data logger too severely.

1. Attach GeoXH, or equivalent to EM61-MK2 handle,
2. Mount external antenna over EM61-MK2 coil center,
3. Attach the serial clip to get access to the GeoXH, or equivalent, COM1 port;
4. Turn ON the GPS and once it boots, Tap START, SETTINGS, and then the CONNECTIONS tab;
5. Open *GPS CONNECT*;
6. COM2 NMEA (GPS CONNECT) should be routed to COM1 and COM3 & COM4 should be (Available). Note the very bottom message "NMEA output on COM1 at 9600-8-1-N." You're good to go;
    a. If this is not the case, tap Setup;
        i. Set NMEA Output to External – COM1:
        ii. Using the tool wrench next to the NMEA Output:
        iii. Set Port Configuration to Custom (top menu option);
        iv. Set Baud Rate to 9600;
        v. Set Data Bits to 8;
        vi. Set Stop Bits to 1; and
        vii. Set Parity to None;
        viii. Tap OK.
    b. Check that TSIP is set to Internal – COM3; and
    c. Real-Time is set to None;
    d. Tap OK;
    e. The bottom message should read "NMEA output on COM1 at 9600-8-1-N";

NOTE: GPS Connector needs to stay running, so *DO NOT tap OK*, simply tap the Windows Flag, Programs, and open GPS Controller.

7. For Surveys in wooded areas, set the precision slide all the way *left* for maximum productivity;
8. Tap the wrench to open GPS Settings;
    a. GPS Receiver Port should be set to COM3: TSIP Serial Port;
    b. The precision slider should be all the way left;
    c. Max PDOP: should be 20;
    d. Min SNR: should be 33.0 (scroll down);
    e. Min Elevation: should be 5 degrees;
    f. Velocity Filter: should be Auto;
    g. NMEA Output: Should be On;
    h. Tap the wrench next to NMEA Output:
        i. Output Interval: should be 1s;
        ii. Baud Rate: should be 9600;
        iii. Data Bits: should be 8;
        iv. Stop Bits: should be 1;
        v. Parity: should be None;

vi. Only the GGA box needs to be checked. Adding additional NMEA stings will only slow the EM61-MK2 data logger down. Scroll down to verify;
vii. Tap OK.

i. Tap OK.

9. In the upper left hand corner of the frame, open the menu and select "Real-time." On the next bar down, click on the menu and select "Summary."

   a. If everything is working correctly you should notice the following categories and their respective status:
      i. Integrated SBAS: In Use;
      ii. System: ;
      iii. Satellite ID: ;
      iv. SNR: _._ dB;
      v. Last correction: .
10. **If under "Summary" the categories above do not appear,** the settings are incorrect. Go back to the upper left hand menu (in GPS Correct) and select "Setup". Click on "Real-Time Settings" and choose:
    a. Choice 1: Integrated SBAS;
    b. Choice 2: Use uncorrected GPS;
    c. Real Time Age Limit: 4 min.
11. Verify the NMEA GGA output is being accepted by the EM61-MK2 data logger and periodically check DGPS status and number of satellites.
12. Periodically monitor GPS Controller for position accuracy, including number of satellites, PDOP, and Differential status.

Rover DGPS Equipment

1. Rover DGPS receiver with integrated and external antenna box
2. Rover Antenna telescoping range pole – in tripod box
3. Rover charger – in yellow box Rover serial cable – in yellow box (DB9 to DB9)
4. Rover Range Pole Bracket – in yellow box

Support Equipment

1. Battery chargers and data transfer link to PC – in yellow boxes
2. VAC power cable for chargers – in yellow box
3. Serial data transfer cable – in yellow box
4. Laptop PC with Trimble Geomatics Office software

Rover DGPS set up for Reacquisition:

1. Charge rover DGPS
2. Setup Telescoping Range Pole and attach Rover external antenna
3. Attach Rover bracket to range pole and Rover DGPS to bracket
4. Power ON the receiver and start TerraSync
5. Select Stakeout for Reacquisition
6. Select points from list or from map
7. Add all points, if necessary
8. Select anomaly point [e.g. A1-12842]
9. Follow rover guidance to anomaly location.
10. Extend range pole above tree canopy, if necessary
11. When delta values fall below 2m, mark location with flag labeled with the point name. Verify point reacquired with flag label
12. Measure location and accept to mark anomaly as reacquired
13. Select next point … etc.
14. When done, exit TerraSync and power down the rover DGPS
15. Remove DGPS from Range Pole
16. Store Rover
17. Store Range Pole
18. Charge Rover batteries overnight

Rover DGPS Position Reoccupation QC Test:

1. Position rover DGPS antenna over a known location
2. Verify rover position Differential
3. Record Easting (X), and Northing (Y) location
4. Compare measured location to known location
5. If location offset exceeds 2m, combined,
    a. Check satellite planning software

EM61-MK2 Setup:

1. Assemble coil assemblies
2. Attach wheels and handle (or stretcher)
3. Attach rover GPS antenna mount and mount rover GPS
4. connect upper coil to lower coil connector or attach shorting plug for bottom coil only
5. Attach battery to backpack
6. Connect coil cable to backpack
7. Connect data cable to backpack and Data Logger COM1
8. Connect GPS to EM Data Logger COM2
9. Move to an electromagnetically clean area
    a. Set the EM61-MK2 Mode Switch to:
        i. 4 – for logging four (4) bottom coil time gates
    b. Set the Master/Slave Switch to M for single sensor operation
    c. Push In the Circuit Breaker on the EM61-MK2 backpack and warm up for at least 5 minutes.
    d. Turn on Rover GPS
    e. Push the ON/OFF button to turn on the Data Logger
        i. Set Antenna Coil Size (e.g. Standard 1 x .5 m)
        ii. Set Up Logger
            1. Date
            2. Time
            3. Units (e.g. feet)
            4. COM port (e.g. COM1)
            5. Audio
            6. Pause Key: (e.g. Alt F1 or any key)
            7. Display (e.g. Text or Graphic)
        iii. Set GPS Port
            1. GPS Input: (Enabled)
            2. COM Port (COM2)
            3. Baud Rate: (9600)
            4. Parity: (No)
            5. Data Bits: 8
            6. Stop Bits: 1
            7. Can monitor GPS data in terminal mode (F3)
        iv. Set Output Port – Not used unless logging data to external PC
    f. Monitor/Null Coils – After 5 minute warm-up, null EM61-MK2 – all channels should be close to 0 +/- 1
    g. Acquire Data:
        i. Create File (F1 for default name, F3, Enter, F1 for other file name)
        ii. Survey Setup
            1. Mode: Auto
            2. Wheel Inc: N/A
            3. Reading/s: 10.00 or 16
            4. Surv Line: (e.g. 0)
            5. Line Incr: (e.g. 1 for instrument checks or 2.5 for survey)
            6. Sequence: (e.g. Alternate)
            7. Direction: (e.g. North
            8. Start Stn: (e.g. 0)
            9. Stn Incr: (e.g. Positive)
        iii. LOG DATA
            1. Wait for data display (0 to 100% internal calibration)
            2. Observe time gate values

3. Observe DGPS input (observe toggle bar and correction status for letter D, letter A is unusable GPS)
4. Enter to log data– System is ready to log data. Move to start of survey line.

h. When coil is centered over start point, press ENTER again. Display will show "logging" on the top display line. Observe coil readings. Observe Station Number (STN). Note any unusual recordings on Field Survey Sheet.

i. Walk along survey line slowly (about 2 to 3.5 miles per hour). Periodically observe Data Logger display. Note any unusual recordings, any deviations from the survey line, or any observed metal objects. Escort should log these observations and marks the outer coil edge with marking paint or plastic pin flags to insure sensor overlap on a return transect.

(If fiducial marks are available, press thumb button when coil is centered over mark for 1 second)

j. Press Pause Key (e.g. Any Key) when coil is centered over the line end to stop logging EM61-MK2 data.

(If in the Auto mode, simply continue to next line and keep moving until survey session is complete or manually set new lines with the F1 key)

k. When survey is complete, press F5 then the letter Y to exit logging. Enter a new file name to continue surveying, or return to main menu to transfer data.

l. Data Transfer using a cable:
   i. Turn OFF the Data Logger by holding the ON/OFF key
   ii. Disconnect Data Logger from EM61-MK2 backpack.
   iii. Change EM61-MK2 Backpack battery, if required
   iv. Connect Data Logger to Field Lap Top PC
   v. Power PC
   vi. Run DAT61MK2
   vii. Select "Data Transfer"
   viii. Verify serial port settings (COM1, Baud Rate: Auto)
   ix. Run the Data Logger program File Manager
      1. Upload Files.
   x. Select "List Files" and select the file names. (Check the Field Survey Form).
   xi. Select "Download" and observe PC and Data Logger to monitor data transfer status. Log any transfer problems on Field Survey Sheet.
   xii. Data Transfer using Memory Card:
      1. Exit DAT61 program to DOS c: prompt
      2. Use up arrow to find (or type) copy *.r61 d:
      3. Hit enter (files get copied from c: to Memory Card)
      4. Turn data logger OFF and eject Memory Card
      5. Insert Memory Card into PC and copy files to appropriate folder
      6. In DAT61 for Windows, convert all files from raw to ASCII (from *.r61 to *.m61)

m. Combine EM and GPS data in EM61MK2 using the "GPS Positioning" tool (or position with line and marker data).
   i. Select input file name
   ii. Enter output file name and location, enter file name on Survey Sheet.
   iii. Select the channels to position (e.g. STD D or STD 4 (all 4 bottom coil time gates))
   iv. Set the GPS Time Gap (e.g. 3 seconds)
   v. Select file format (e.g. Geosoft)
   vi. Set the GPS System (e.g. Geodetic or UTM)
   vii. Set Units to meters
   viii. Set GPS corrections to Raw GPS or Differential RTK

ix. Click “Apply” to export GPS integrated ASCII data file

n. From the File tool, select “Open XYZ File” and select the one just created. Display should show the survey tracks.

o. Data is ready for Processing and Analysis.

10. Data Management in Data Logger
    a. Once data transfer is complete and data has been positioned, exported (*.xyz file), and processed successfully, clear the data logger memory
        i. From the Main Menu, select “File Manager”
        ii. Select “Delete File”
            1. Scroll to select a file to be deleted
            2. Hit F1 key to delete
            3. Hit the “Y” key to confirm delete

File should have been removed from list

Daily EM61 Static Check

1. Setup as above
2. In a quiet area, log static EM61 background data for 1 minute (observe meter readings near 0, +/- 2-3 mV)
3. Press Enter to Pause and increment line (F1)
4. Place a “know object (e.g. a Standard Static Test Bar with steel bolt)” on the coil and log data (Enter) for 1 minute (observe meter readings #> 0, +/- 2-3 mV)
5. Press Enter to Pause, remove target, and increment line (F1)
6. Log static background data (Enter) for 1 more minute (observe meter readings near 0 +/- 2-3 mV)
7. Press Enter to Pause, and increment line
8. Log static data for 30 seconds while all system cables are shaken (observe meter readings near 0 +/- 2-3 mV – no jumps or spikes),
9. Press Enter to Pause, and increment line
10. Log static data for 30 seconds while operator kicks towards coil, twists left/right, and bends up/down (observe meter readings near 0 +/- 2-3 mV).
11. QC checks:
    a. Look for near zero readings during lines 0, 2, 3, and 4 – re-null coil or replace battery as necessary
    b. Check for consistent target readings +/-20% on line 1 from previous readings. Replace battery as necessary

Daily Latency Check

1. Setup as above
2. Find a quiet area at least 50 feet long
3. Place a known object in the center of this line (e.g. 2” Tow Ball)
4. Acquire line 0 from start (0,0) to end (0,50) directly over the object (0,25)
5. Increment the line number and acquire line 1 from end (0,50) to start (0,0) directly over the object (0,25)
6. Use this data to help determine data processing latency parameter needed to get the peak to line up in both directions.

EM Reacquisition

1. Setup as above
2. Position coil (push and pull) over flagged location in several directions while monitoring the display (e.g. SUM Channel).
3. Try to match or exceed the reported mV value on the Dig Sheet within 5 to 7m of each flag along cleared and marked transect
4. Move the flag to coil center over refined peak location
5. Log reacquired mV peak on Dig Sheet. If necessary, log refined location offset distance and direction on Dig List
6. Move to next flag

PC – Pathfinder Office, or equivalent

1. New Project
2. Enter new project name (e.g. Luis Pena)
3. Make sure Template: is using project coordinate system and units
4. Set Coordinate System correctly (e.g. US State Plane 1983, Colorado Central 0502, NAD 1983, Geoid (none) … click Finish … click Apply … click OK
5. Import points, select Custom [format] … select Name, East, North, Elevation … OK
6. Find *.csv file to load (e.g. My Documents/DRI/DRI_Sector_D.csv). Points should load and be displayed. Verify!

GPS Data Transfer from PC to Rover DGPS

1. Run Trimble Pathfinder Office, or equivalent, software on PC
2. Open Project and verify project coordinate system and units (e.g. Luis Pena, UTM, 19N, meters)
3. Import or verify target waypoints are shown
4. Connect Rover DGPS to PC (USB or Serial) a power ON Rover (machines should connect thru ActiveSync)
5. Export target waypoints to rover DGPS
6. Verify on rover DGPS:
7. Select the job
8. Select Review current job and verify points and point order. You can also map the points for the job

1. Charge all GPS and EM61-MK2 batteries overnight.

9.0 WEEKLY DGM QC REPORT:

Project Name: _____

Report Week: _____

9.1 INSTRUMENT LATENCY TEST

Metric is no zig-zag or chevron effects visible.

Describe latency correction performed _____

Document critical latency correction parameter(s) _____

Attach a representative data image map for each survey day documenting proper latency correction.

9.2 INSTRUMENT NOISE

Metric based on approved GPO results (e.g. < +/- 1.3 mV on time gate 1).

Report the weekly summary of all static background noise levels from each static test.

Report the dynamic noise levels for each survey file.

9.3 INSTRUMENT RESPONSE TEST RESULTS

Metric +/- 20 % from day to day.

Report the weekly summary of all static instrument response tests.

9.4 MAGNETOMETER HEADING CORRECTION

If used, magnetometer data will be corrected for heading errors such that there is no visible heading affects in the data displayed at the amplitude range used for detection and analysis.

Describe magnetometer heading correction performed _____

Document specific heading correction values _____

Attach a representative data image map for each survey day documenting proper heading correction.

9.5 DATA LEVELING AND/OR FILTERING

Metric is leveling and/or filtering utilities do not adversely alter the nature of the original measured response by more than 5%.

Describe data leveling and/or filtering used _____

Document critical leveling and/or filtering parameters used _____

Attach example of data profile before and after leveling and/or filtering

9.6 REOCCUPATION ACCURACY

Metric is not to exceed +/- 2m from a known location.

Describe the reoccupation point _____

Record the known location X = _____, Y = _____

Summarize the location offsets from each reoccupation test.

9.7 DATA SAMPLING DENSITY

Metric is along-track density will not exceed 0.5 feet.

Use Oasis QC tools to assess data sampling density.

Check if all data sets pass metric _____.

Attach QC maps to document any failures.

9.8 ACROSS-TRACK LINE SPACING FOR GRIDS

Metric is 90% of line spacing will not exceed 2.5 feet.

Use Oasis QC tools to assess the across-track line spacing for each grid survey.

Check if all data sets pass metric _____.

Attach QC maps to document any failures.

9.9 DYNAMIC REPEATABILITY

Dynamic DGM detection metric for grids is: Test item characteristics (peak response and size) repeatable with allowable variation of +/-25%.

Dynamic DGM detection metric for transects is: Test item in test strip anomaly characteristics (peak response and size) repeatable with allowable variation +/-25%.

Dynamic DGM positioning metric for grids is: Position offset of test item target <=35cm + ½ line spacing (e.g. <=2.4 ft for 2.5 ft line spacing) or <=50cm + ½ line spacing (e.g. <=2.9 ft for 2.5 ft line spacing) for fiducially positioned data.

Dynamic DGM positioning metric for transects is: Test item position offset <=2m.

Dynamic Analog detection repeatability metric is: Repeat a segment transect and show extra flags not greater than the greater of 20% or 8 flags, or within range of adjacent segment.

9.10 REACQUISITION ACCURACY

Metric is not to exceed 2 meters from to refined location.

Document all refined location offsets on dig list

Include updated dig list with this report

9.11 REFINED LOCATION ACCURACY

Metric is not to exceed 30 cm from refined location.

Document all discovered location offsets from refined location on Dig List

Include updated dig list with this report.

9.12 DGM FALSE NEGATIVES

Metric is no false negatives.

Document all false negative discoveries

Provide failure ID and photograph (attached to this report)

Provide failure location X = _____, Y = _____

Document corrective action taken _____

9.13 INTRUSIVE ANOMALY RESOLUTION

Metric is for all intrusive results resolved with DGM data.

UXOQCS and Project Geophysicist will initial all dig results

Each discrepancy and final resolution will be documented

Final weekly dig list is attached to this report

Site Geophysicist Signature and Date _____

UXOSO/UXOQCS Signature and Date _____

OPS 13- MPPEH MANAGEMENT

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide procedures that ensure that interior and exterior of all recovered MPPEH is inspected to determine what explosive hazard, if any exist, requiring further treatment before shipping off site for final treatment. These procedures are general in nature and may be refined with the concurrence of the Senior UXO Supervisor (SUXOS) to adapt to specific site conditions and circumstances.

2.0 SCOPE

These procedures will be conducted in accordance with the Work Plan, the Site Health and Safety Plan (SHSP) and the Explosives Safety Submission (ESS). This SOP provides the MPPEH management process that describes the inspection, storage, certification/verification procedures, and the chain of custody requirements for materials documented as safe (MDAS) slated for shipment to an authorized recycler. Specific requirements for personnel, training, equipment/material, surface search, and documentation are found in the Work Plan (WP).

3.0 INSPECTION PROCESS

All recovered MPPEH items will undergo a 100% inspection and an independent 100% re-inspection to determine and document whether it is safe (MDAS) or whether it is known to have or is suspected of having an explosive hazard [material documented as an explosive hazard (MDEH)]. The sequence of events in the inspection process is summarized in Figure 1. A Material Inspection and Release Form (Attachment 2) will be completed to document the two 100% inspections performed on all recovered materials.

A UXOTII (a UXOTI can tentatively identify items, however, a UXOTII or UXOTIII must confirm the identification) will perform a 100% inspection of each item as it is recovered and determine:

- If the item is MDAS, requiring no additional treatment prior to containerizing for off-site shipment
- If the item is MDEH that requires additional treatment (demilitarization, i.e. detonation or venting to expose a dangerous filler)
- If item is range related debris that may require draining fluids or removal of visible liquid hazardous, toxic or radiological waste (HTRW) materials.

A UXOTIII will:

- Conduct a 100% re-inspection of all recovered items to determine the proper classification as MDAS, MDEH or an item containing other dangerous fillers or HTRW constituents.
- Supervise the segregation of items by category to ensure no co-mingling of MDAS and MDEH or HTRW items.

The UXOQCS will:

- Conduct daily audits of UXO Teams performing the MPPEH inspection process and will conduct and document random sampling of all processed MDAS, MDEH and HTRW items to ensure no co-mingling occurs.

The UXOSO will:

- Ensure specific procedures and responsibilities for processing MPPEH for certification as MDAS MDEH or range-related debris outlined in the WP and this SOP are being followed
- Ensure all procedures for processing are being performed safely and consistent with applicable regulations.

The SUXOS will:

- Perform random checks to determine that the munitions debris and range-related debris are free from explosive hazards necessary to complete the appropriate Requisition and Turn-in Document, DD Form 1348-1A (see Attachment 1)
- Ensure that a DD Form 1348-1A is completed for all MDAS and range-related debris to be transferred for final disposition
- Ensure the WP, QC Plan and this SOP outline the procedures and responsibilities for processing MPPEH for final disposition as MDAS or range-related debris
- Certify all MDAS and range-related debris with one of the following statements as applicable –

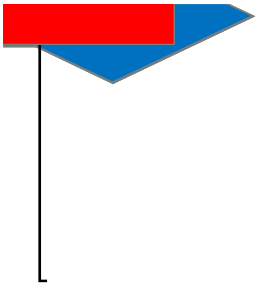
  > "This certifies that the material listed has been 100 percent properly inspected and, to the best of our knowledge and belief, are free of explosive hazards, engine fluid, illuminating dials and other visible liquid HTRW materials."[1]
  >
  > "This certifies and verifies that the material listed has been 100 percent inspected and to the best of our knowledge and belief, are inert and/or free of explosives or related materials."[2]

- Ensure that inspected debris is secured in sealed and labeled containers.

This space is intentionally left blank.

[1] This statement will be used on any ranges where range-related debris is being processed along with munitions debris

[2] This statement will be used for properties where only munitions debris is being processed



4.0 MDAS CONTAINERIZATION

MDAS is placed in closed containers that will be sequentially number and:

- Closed in such a manner that the applied seal will be broken if the container is opened
- Clearly labeled with USA Environmental, Inc., the installation/project name, the sequence number (e.g. 0001), and the container's unique seal identification, see Attachment 3 for detailed requirements for completing the label

5.0 MDAS CERTIFICATION AND VERIFICATION

The SUXOS will certify the MDAS by preparing and signing the DD Form 1348-1A for all shipments of recovered materials as discussed in Section 3 above. The designated government representative will verify the shipments if available, otherwise the shipment verification is delegated to the UXOQCS.

The 1348-1A will contain the appropriate statement as mentioned in Section 3 and prepared to provide the required information as shown in Attachment 1.

6.0 MAINTAINING THE CHAIN OF CUSTODY

The chain of custody must remain intact until the MDAS is released from DOD control that is received and signed for by the qualified receiver to further manage and process the material in accordance with DOD Instruction 4140.62. The qualified receiver will:

- Receive the unopened labeled containers
- Review and concur with the supporting documents
- Sign the 1348-1A and provide on company letterhead stating the contents of the sealed containers will not be sold, traded or otherwise given to another party prior to smelting and are only identifiable by their basic contents
- Send the supporting documentation and notification to USA that the MDAS in the sealed containers has been smelted and is only identifiable by its basic content.

If the chain of custody is broken at any time during shipment, the contents of the affected container will revert to MPPEH and will require a second 100% inspection and a 100% re-inspection, be documented as certified and verified as MDAS by qualified USA personnel.

ATTACHMENT 1.
DD FORM 1348-1A EXAMPLES

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

1 2 3 4 5 6 7 23 24 25 26 27 28 29 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

DOCUMENT | RI FROM | M&S | UNIT | QUANTITY | SER | SUPPLEMENTARY ADDRESS | SIG | FUND | DISTRIBUTION | PROJECT | PRI | REQD | DEAD DATE | ADV | RI | O/P | COND | MGT

1. TOTAL PRICE | UNIT PRICE DOLLARS | CTS | DOLLARS | CTS

2. SHIP FROM | 3. SHIP TO | 4. MARK FOR

5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS

10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE

18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE

22. RECEIVED BY | 23. DATE RECEIVED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Basic Material Content: _____

Estimate Weight (lbs): _____

Container ID No.: _____ Seal ID No.: _____

25. NATIONAL STOCK NO. & ADD (8-22)

Site Address: _____

_____

Site Telephone No.: _____

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

This certifies and verifies that the material listed has been100 percent inspected and to the best of our knowledge and belief, are inert and/or free of explosives or related materials.

27. ADDITIONAL DATA

Certify By:

_____ Date: _____
Senior UXO Supervisor / Team Leader

Verify By:

_____ Date: _____
USACE OE Safety Specialist

USA Environmental, Inc., 720 Brooker Creek Boulevard, Suite 204, Oldsmar, Florida 34677, Telephone: 813.343.6336, Fax: 813.343.637

PREVIOUS EDITION MAY BE USED

PerFORM (DLA)

Reset

DD Form 1348-1A: FOR USE FOR PROPERTIES WHERE ONLY MUNITIONS DEBRIS IS BEING PROCESSED

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

1 2 3 4 5 6 7 23 24 25 26 27 28 29 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

DOCUMENT | FROM | M&S | UNIT | QUANTITY | SER | SUPPLEMENTARY ADDRESS | SIG | FUND | DISTRIBUTION | PROJECT | PRI | REQD | DDATE | ADV | RI | O/P | COND | MGT

1. TOTAL PRICE | 2. SHIP FROM | 3. SHIP TO

UNIT PRICE: DOLLARS | CTS | DOLLARS | CTS

4. MARK FOR

5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS

10. QTY. REC'D | 11.UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE

18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE

22. RECEIVED BY | 23. DATE RECEIVED

24. DOCUMENT NUMBER & SUFFIX (30-44)

25. NATIONAL STOCK NO. & ADD (8-22)

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

27. ADDITIONAL DATA

Basic Material Content: _____

Estimate Weight (lbs): _____

Container ID No.: _____ Seal ID No.: _____

Site Address: _____

_____

Site Telephone No.: _____

This certifies that the material listed has been 100 percent properly inspected and, to the best of our knowledge and belief, are free of explosive hazards, engine fluids, illuminating dials and other visible liquid HTWR materials.

Certify By:

_____ Date: _____
Senior UXO Supervisor / Team Leader

Verify By:

_____ Date: _____
USACE OE Safety Specialist

USA Environmental, Inc., 720 Brooker Creek Boulevard, Suite 204, Oldsmar, Florida 34677, Telephone: 813.343.6336, Fax: 813.343.637

PREVIOUS EDITION MAY BE USED

PerFORM (DLA)

Reset

DD Form 1348-1A: FOR USE WHERE RANGE-RELATED DEBRIS IS PROCESSED WITH MUNITIONS DEBRIS

ATTACHMENT 2.
MATERIAL INSPECTION AND RELEASE FORM

USA 100% MATERIAL INSPECTION AND RELEASE FORM

Project:							Document Date:
Location:							Document Number:
Container Number:	Seal #:	Initials 1st:	Initials 2nd:	Reseal #:	Initials 1st:	Initials 2nd:	Comments:

The above listed containers have received two separate 100% inspections to ensure proper classification of material.
A copy of this form is to accompany the listed containers to final disposition and be retained for a period of 3 years.
This form is used to document the inspections performed by two UXO qualified personnel, one of whom must be a Technician III or higher.
This form is not to be used in place of other required documents for the transportation and/or accountibilty of material.

Name of First 100% Inspector:	Title:	Date:
Name of Second 100% Re-Inspector:	Title:	Date:

ATTACHMENT 3.
NON-HAZARDOUS WASTE (CONTAINER LABEL)

NON-HAZARDOUS WASTE

Solid Waste Excluded From Regulation Under 40 CFR 261.4 (b)

SHIPPER: USA Environmental, Inc.

PROJECT ADDRESS / LOCATION:

CITY, STATE, ZIP:

PROJECT CONTACT AND TELEPHONE NUMBER:

USACE IDENTIFIER / INSTALLATION NAME OR CONTRACT #:

UNIQUE CONTAINER # (i.e., 0001 of 0001): of

UNIQUE SEAL IDENTIFICATION #:

Date:	Seal Number:	1st Initials:	2nd Initials:	Comments:

☐ **DD Form 1348-1A** ☐ **100% Material Inspection and Release Form**

NOTE: See DD Form 1348-1A For Additional Information.
Check box(s) if DD Form 1348-1A and/or the 100% Inspection Form will accompany this shipment.

CONTACT INFORMATION: **USA Environmental, Inc.**
720 Brooker Creek Blvd., Suite 204
Oldsmar, FL. 34677
(813) 343-6336

CONTAINER LABEL

STANDARD OPERATING PROCEDURE – OPS-14
MEC ANALOG DETECTION AND REMOVAL ACTIONS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide all USA Environmental, Inc. (USAE) employees and subcontractors with the minimum procedures and safety and health requirements applicable to the conduct of analog detection and removal actions (mag and dig) at sites potentially containing unexploded ordnance (UXO) and/or munitions and explosives of concern (MEC).

2.0 SCOPE

This SOP applies to all USAE site personnel, including contractor and subcontractor personnel, involved in the conduct of analog detection and removal actions (mag and dig) on a UXO/MEC contaminated site. The following USAE policies and procedures are not all inclusive nor are they applicable in all situations. This SOP is not a stand-alone document and is to be used together with Work Plans, other USAE SOPs, the USAE Site Safety and Health Plan (SSHP), applicable Federal, State, and local regulations, and contract restrictions and guidance. Consult the documents listed in Section 7.0 of this SOP for additional compliance issues.

3.0 RESPONSIBILITIES

3.1 PROJECT MANAGER

The Project Manager is responsible for ensuring availability of resources to safely and effectively implement this SOP.

3.2 SITE MANAGER

The Site Manager is responsible for incorporating this SOP in plans, procedures, and training. In addition, he is responsible for oversight and supervision of field personnel, and ensuring compliance with this SOP.

3.3 UXO SAFETY OFFICER

The UXO Safety Officer (UXOSO) ensures that all mag and dig activities are conducted in a safe manner, in accordance with the approved Work Plan, the SSHP, this SOP, and all applicable regulatory guidance. The UXOSO's duties shall include, but are not limited to: analyzing UXO explosives operational risk, hazards, and safety requirements; establishing and ensuring compliance with all site-specific safety requirements for UXO and explosives operations; enforcing personnel limits and safety exclusion zones (EZ) for UXO clearance operations; and all activities associated with UXO and explosives transportation, storage, and destruction.

3.4 UXO QUALITY CONTROL SPECIALIST

The UXO Quality Control Specialist (UXOQCS) ensures compliance with the project Quality Control (QC) Plan and performs analog QC checks of completed grids in accordance with the Work Plan.

4.0 OPERATIONS

4.1 ANALOG DETECTION AND REMOVAL ACTIONS

All analog detection and removal (mag and dig) activities at MEC sites will be under the supervision of UXO qualified personnel. Non-UXO qualified personnel will not be allowed in the EZ during intrusive operations. If access is required by non-UXO qualified personnel, all work will stop while they are in the EZ. During operations, USAE personnel will strictly adhere to the SSHP and the following general safety practices:

- Operations will be conducted during daylight hours only.
- Access to operating areas will be limited to only those personnel necessary to accomplish the specific operation.
- UXO will only be handled by qualified UXO Technicians.
- During UXO operations the minimum separation distance (MSD) between UXO and non-UXO operations is fragmentation distance of the munition with the greatest fragmentation distance (MGFD), as stated in the Work Plan.
- During demolition operations personnel remaining on site will be limited to those personnel needed to safely and efficiently prepare the item/s for destruction.).
- All personnel will attend the daily safety briefing (tailgate safety briefing) prior to entering the operating area.
- Anyone can stop operations for an unsafe act or situation.
- Safety violations and/or unsafe acts will be immediately reported to the UXOSO.
- Failure to comply with safety rules/procedures may result in termination of employment.

4.2 GRID LAYOUT

A registered land surveyor will survey each of the clearance areas, accompanied by a UXO escort. Surveying activities will consist of locating clearance area boundaries, establishing permanent survey monuments, and establishing grids for geophysical investigation activities within the clearance areas.

Depending on the method selected and approved by the customer, the site layout and search grids will be established using a Global Positioning System (GPS), licensed surveyor, or compass and measuring tape. Survey crews will be escorted in the field by a UXO Technician II or above who will provide UXO avoidance including checking the intended survey stake locations with a magnetometer prior to driving stakes into the ground. This will prevent driving stakes into buried MEC.

4.3 ANALOG SWEEP PROCEDURES

Intrusive investigation team(s) will consist of a Team Leader (UXO Technician III) and UXO Technicians II/I. During intrusive operations UXO Technicians I will operate under the supervision of UXO Technicians II or III. UXO operations will only be performed by qualified UXO Technicians, which are defined as:

- MEC identification
- Access procedures such as excavation, either by hand or using heavy equipment
- Handling of MEC/UXO, explosives, or explosive items
- Disposal, including movement, transportation, and final disposal of MEC

Analog detector sweeps (i.e., mag and dig) are particularly effective in areas where vegetation and terrain limit the use of larger digital systems. Also, mag and dig approaches should be used when there is insufficient difference between UXO at the site and other metallic fragments and debris, such that digital discrimination is ineffective or cost prohibitive.

Initially, individual search lanes will be established approximately 5 feet (ft) wide. Each lane will be surveyed using a Schonstedt GA-52CX and/or White's XLT magnetometer. The operation will begin at one end of each lane and move in a forward direction toward the opposing baseline. During the forward movement the technician moves the magnetometer back and forth from one side of the lane to the other. Both forward movement and the swing of the magnetometer are performed at a pace that ensures the entire lane is searched and that the instrument is able to appropriately respond to subsurface anomalies. When a subsurface anomaly or metallic surface object is encountered, the UXO Technician halts and investigates the anomaly at that time. Throughout this operation the team leader closely monitors the team's individual performance to ensure these procedures are being performed correctly.

4.4 SURFACE UXO

Upon encountering a surface MEC it will be identified by two UXO Technicians and marked in accordance with the approved Work Plan for future disposition. If detonation cannot be arranged the same day as the MEC is identified, a guard will be posted during the non-working hours to ensure the item is not disturbed.

4.5 SUBSURFACE ANOMALIES

4.5.1 MANUAL EXCAVATIONS

Subsurface anomalies will be investigated by UXO-qualified personnel as they are identified during the sweep. All identified anomalies within the grid will be intrusively investigated. Excavations for individual anomalies will be conducted using the Schonstedt GA-52CX and/or White's XLT magnetometers to assist the team in determining the location and orientation of the target item. The UXO Technicians excavating anomalies shall initially remove no more than a 6-inch layer of soil along side the location of the anomaly, being careful not to impact the anomalous feature. The UXO Technician will conduct a visual and electronic search of the excavation to further pin point the anomaly source as needed. This process shall be repeated until the audible signal from the magnetometer indicates the object is close to the surface. Once this determination has been made, soil will be removed by hand until the source of the anomaly is located. Excavations on individual anomalies greater than 4 ft below the ground surface (bgs) will not be made without prior approval of the U.S. Army Corps of Engineers (USACE) OE Safety Specialist.

4.5.2 MECHANICAL HANDLING EQUIPMENT

Mechanical Handling Equipment (MHE) may be used to excavate large anomalies (e.g., pits) or those deeper than 4 ft bgs if required (e.g., to confirm the anomaly is not a MEC). Any decision to use MHE to excavate these anomalies will be made by the SUXOS and the USACE OE Safety Specialist (see SOP OPS-06, Excavation and Trenching for detailed MHE procedures). The excavation will proceed slowly to ensure the item is not broached by the MHE. If the excavated material is considered to be a MEC, it shall be uncovered sufficiently by hand to obtain a positive identification of the item. If the item is identified as UXO/MEC, a determination will subsequently be made as to whether it is fuzed or not.

While excavating with MHE, a UXO Technician will be stationed in a position that is out of the reach of the excavation equipment but affords a view of the excavation site. This observer will ensure that the next lift is visually free of UXO. The excavated material will be placed onto the ground within a screening area that has been surface swept and the boundaries recorded. The soil spoils will be spread across the screening area using the excavator bucket. The excavated material will be screened for range related debris, munitions debris, and UXO/MEC items. UXO technicians will recover all pieces of munitions debris or range related debris and any ordnance items. After screening, the soil spoils will be stockpiled to the side of the screening area.

5.0 RECORD KEEPING

The team leader will maintain a field logbook, which at a minimum will contain a record of the following:

- Weather
- Instrument details and serial number
- Team Personnel
- Grids worked
- Start and stop times
- MEC/UXO items encountered

The data to be recorded for each item discovered during anomaly excavation will include the following (as applicable):

- Type (e.g., MD, MPPEH, UXO, and non-MEC Scrap)
- Description (e.g., “projo, 20-mm, practice, MK105” and “base, coupling, firing device”)
- Initial Condition (e.g., expended, inert, live, and to be determined [TBD])
- Approximate length
- Approximate width
- Depth
- Approximate weight
- Found in a pit?
- Piece of frag?
- Initial disposition (e.g., left in place and removed to scrap pile)
- Requires demolition?

All data will be turned into the Site Geophysicist at the end of the day.

6.0 DISPOSAL OPERATIONS

Fuzed UXO/MEC items will be blown in place (BIP), and un-fuzed UXO/MEC items will be consolidated whenever possible in accordance with USACE Engineer Pamphlet 1110-1-17, Establishing a Temporary Open Burn and Open Detonation Site for Conventional Ordnance and Explosives Projects, dated 16 July 1999, Appendix D. In no case shall the SUXOS authorize or undertake destruction of UXO/MEC when there is sufficient reason to believe that the disposal action will result in personnel casualties or property damage. The USACE OE Safety Specialist will be consulted for guidance in the event that there is sufficient reason to believe that the disposal action will result in personnel casualties or property damage.

7.0 REFERENCES

- USACE Safety Considerations for UXO

- USAE Corporate Safety and Health Program (CSHP)
- OSHA, 29 CFR 1910, Occupational Safety and Health Standards
- OSHA, 29 CFR 1926, Construction Standards
- Applicable sections of EPA, 40 CFR Parts 260 to 299, Protection of Environment
- Applicable sections of DOT, 49 CFR Parts 100 to 199, Transportation
- USACE EM 385-1-1, Safety and Health Requirements Manual
- USACE ER 385-1-92, Safety and Occupational Health Document Requirements for Hazardous Waste Remedial Actions
- DOD 4145.26-M, Contractors' Safety Manual for Ammunition and Explosives
- DOD 6055.9-STD, DOD Ammunition and Explosives Safety Standards
- DOD 4160.21-M, Defense Reutilization and Marketing Manual
- DA PAM 385-64, Ammunition and Explosives Safety Standards
- AR 385-64, Ammunition and Explosives Safety Standards
- AR 200-1, Environmental Protection and Enhancement
- AR 385-10, The Army Safety Program
- AR 385-16, System Safety Engineering and Management
- AR 385-40 w/USACE supplement, Accident Reporting and Records
- TM 9-1300-200, Ammunition General
- TM 9-1300-214, Military Explosives
- TM 60 Series Publications

STANDARD OPERATING PROCEDURE
OPS-17 – MEC SURFACE SWEEPS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide all USA Environmental, Inc. (USA) employees and subcontractors with the minimum procedures and safety and health requirements applicable to perform surface sweep operations at sites potentially containing unexploded ordnance (UXO) and/or munitions and explosives of concern (MEC).

2.0 SCOPE

This SOP applies to all USA site personnel, including contractor and subcontractor personnel, involved in the conduct surface sweep operations on a UXO/MEC contaminated site. The following USA policies and procedures are not all inclusive nor are they applicable in all situations. This SOP is not a stand-alone document and is to be used together with Work Plans, other USA SOPs, the USA Site Safety and Health Plan (SSHP), applicable Federal, State, and local regulations, and contract restrictions and guidance. Consult the documents listed in Section 5.0 of this SOP for additional compliance issues.

3.0 SURFACE SWEEP OPERATIONS

All surface sweep operations at MEC sites will be performed under the direct supervision of fully qualified UXO qualified personnel. USA personnel will strictly adhere to the SSHP and the following general safety practices:

- Operations will be conducted during daylight hours only.
- Access to operating areas will be limited to only those personnel necessary to accomplish the specific operation.
- UXO will only be handled by qualified UXO Technicians.
- During UXO operations the minimum separation distance (MSD) between UXO and non-UXO operations is fragmentation distance of the munition with the greatest fragmentation distance (MGFD), as stated in the Work Plan.
- During demolition operations personnel remaining on site will be limited to those personnel needed to safely and efficiently prepare the item/s for destruction.
- All personnel will attend the daily safety briefing (tailgate safety briefing) prior to entering the operating area.
- Anyone can stop operations for an unsafe act or situation.
- Safety violations and/or unsafe acts will be immediately reported to the UXO Safety Officer (UXOSO).
- Failure to comply with safety rules/procedures may result in termination of employment.

3.1 PERSONNEL QUALIFICATIONS

All personnel involved in MEC Surface sweep operations will meet the training and experience requirement of Department of Defense Explosives Safety Board Technical Paper 18 (DDESB TP 18) for the position assigned. UXO–Sweep personnel, as defined by DDESB TP 18, are provided job and site specific training that includes, but not limited to:

- Explosive safety

- MEC recognition
- Proper use of personnel protective equipment.

UXO-Sweep personnel may perform the following MEC surface sweep tasks:

- Visual and/or detector-aided search activities
- Remove non-hazardous munitions debris and range-related debris that a fully qualified UXO Technician (UXOTII and above) has inspected and determined to be safe for handling.

3.2 SITE LAYOUT PROCEDURES

Depending on the method selected and approved by the customer, the site layout and search grids will be established using a Global Positioning System (GPS), licensed surveyor, or compass and measuring tape. Survey crews will be escorted in the field by a UXO Technician II who will provide UXO avoidance including checking the intended survey stake locations with a magnetometer prior to driving stakes into the ground, which will prevent driving stakes into buried MEC. The site layout procedures are as follows:

- Identify and mark the operating area boundaries:
  - The boundary will be marked with survey wooden stakes, with black and yellow survey tape, approximately every 200 meters. The stakes should be visible from one to the next. Therefore depending on the terrain, it may be necessary to place them closer together.
- Identify and mark search grids:
  - Search grids will vary in size depending on the site and the number of personnel to be used in sweeping. The grid width should be in multiples of 5 ft as the typical individual can cover a 5-ft wide lane with a magnetometer. For example, a 30-ft wide grid would accommodate six sweepers on line.
  - Grid boundaries will be marked with survey wooden stakes, with orange survey tape, and temporary survey lanes with white pin flags or twine/string.
- Establish and, mark if required, search lanes:
  - A typical search lane will be a width of approximately 5 ft. The lanes may or may not be established prior to sweeping. If temporary lanes are marked prior to sweeping it will be done by a UXO technician to ensure safety.
  - For wide area surface clearances, sweep lane boundaries may be marked while sweeping. For example, the sweep line would begin sweeping with a grid boundary on one side and place pin flags on the opposite side of the line as they sweep. This would provide a boundary for the return sweep and ensure 100% coverage.

3.3 SWEEP PROCEDURES

Sweep teams will consist of UXO technicians or a combination of non-UXO (General Laborers) and UXO personnel. Sweeps may be for surface (visible) or sub-surface (buried) MEC. Regardless of the type of clearance, MEC operations will only be performed by qualified UXO Technicians.

- MEC operations are defined as:
  - MEC identification
  - Access procedures such as excavation, either by hand or using heavy equipment
  - Handling of UXOs, explosives, or explosive items
  - Disposal, including movement, transportation, and final disposal of MEC

3.3.1 Flags and Markers

USA uses a system of colored flags/flagging and markers to identify MEC, scrap metal, sweep lanes, and site, zone, and grid boundaries. Table 1 lists the types of markers used.

Table 1: Marking Material

Type Marker	Flag/Flagging Color	Item/Area Marked
Stake	Black and Yellow	Site boundary
Stake	Red and Orange	Zone boundary
Stake	Orange	Grid boundary
Pin Flag	White	Temporary Boundary
Pin Flag	Red	MEC
Pin Flag	Yellow	Subsurface Anomaly
Pin Flag	Blue	MEC Scrap
Pin Flag	Green	Non-MEC Scrap

3.3.2 Surface Sweep

The purpose of a surface sweep of a grid is two fold: first to locate, mark, and record the location of the surface MEC contamination contained in each grid; and second to consolidate the scrap metal contamination within each grid. The typical span of control for a UXO Technician is three to five sweepers. This ensures positive control and safety.

3.3.2.1 Sweep Team Structure

The sweep team will consist of either all UXO Technicians or a mix of UXO and Non-UXO personnel. The following is an example and composition of a typical Sweep Team:

- One UXO Technician III, who directs and supervises all team activities, confirms the identification of all MEC encountered, and maintains the sweep team journal.
- One UXO Technician II who assists the UXO Technician III, identifies all MEC encountered, and records the location of the items located.
- Five sweepers (either UXO Technicians or General Laborers) who visually search the area for MEC. These personnel perform their duties under the direction and supervision of the UXO Technician III.

3.3.2.2 Surface Sweep Team Procedures

All sweep operations will be performed under the direct supervision of a qualified UXO Technician III. The UXO Technician III will assemble the sweepers into a sweep line and direct their movement across the survey grid.

- Sweepers will be spaced approximately 5 ft apart and, at the direction of the UXO Technician III, move through the grid on line abreast.
  - When an item is encountered, the individual will call out "hold the line", and hold up his/her hand. The line will stop and the UXO Technician II will inspect the object to determine if it is MEC or scrap and mark the item with the appropriate colored Pin Flag. The line will not move again until directed by the UXO Technician III.

- As the team moves forward the sweeper at the edge of the grid will use the grid stakes as one sweep lane boundary, the sweeper on the opposite end of the line will mark the limit of the sweep lane with White Pin Flags. These flags become the guide for the return sweep and define the limits of the previously cleared lane.
- This procedure is continued until the grid is completely swept.

- The UXO Technician III will follow behind the sweep line insuring that proper spacing is maintained, inspect and verify the identification of the flagged items, and record data on the type, nomenclature, and location of the contamination.
- Upon completion of the grid sweep the sweep team will recover and stockpile metal scrap at a central location. Under the direct supervision of the UXO Technician III, the scrap will be stockpiled in a central location in the grid. Items marked with Red Pin Flags will be left in place for the Disposal Team.

UNDER NO CIRCUMSTANCES WILL GENERAL LABORERS HANDLE OR MOVE MEC/UXO CONTAMINATION.

3.3.3 Magnetometer Assisted Surface Sweep

Magnetometer assisted surface sweep procedures are basically the same as surface sweeps. In addition to identifying surface contamination, magnetometers are used to locate buried MEC that may be concealed by brush or heavy grasses. Instructions on the use and calibration of magnetometers are in the USA magnetometer SOP. The purpose of a magnetometer assisted-surface sweep of a grid is to first locate, mark, and record the location of the surface and buried MEC contamination contained in each grid; and second to consolidate the scrap metal contamination within each grid. The typical span of control for a UXO Technician is three to five magnetometer operators. This ensures positive control and safety.

3.3.3.1 Magnetometer Assisted Surface Sweep Team Structure

The sweep team will consist of either all UXO Technicians or a mix of UXO and Non-UXO personnel. The following is the structure and composition of a typical Sweep Team:

- One UXO Technician III, who directs and supervises all team activities, confirms the identification of all MEC encountered, and maintains the sweep team journal.
- Two UXO Technicians II who assist the UXO Technician III, identify all MEC encountered, excavate and identify buried contacts, and record the location of the items located/detected.
- Five Magnetometer Operators (either UXO Technicians or trained General Laborers) who visually and electronically search the area for MEC. These personnel perform their duties under the direction and supervision of the UXO Technician III.

3.3.3.2 Magnetometer Assisted Surface Sweep Team Procedures

All sweep operations will be performed under the direct supervision of a qualified UXO Technician III. The UXO Technician III will assemble the Magnetometer Operators into a sweep line and direct their movement across the survey grid. Procedures will be the same as detailed in Section 3.3.2.2 with the exception that the Magnetometer Operators will utilize the magnetometer to assist in searching in heavy brush and grass.

4.0 DISPOSAL OPERATIONS

Disposal operations consist of actions taken at the site to remove the scrap and dispose of the MEC/UXO and explosive contamination. Demolition and transportation of MEC and explosives will be in accordance with USA's Demolition Operations and Explosive Transportation SOPs.

The use of standard Explosive Ordnance Disposal (EOD) procedures for detonating or disposing of MEC will constitute the principle control measure for ensuring safety during demolition operations. These procedures, contained in EOD technical manuals, are designed to limit fragments and harmful blast to the immediate vicinity of the disposal operation. These procedures involve the use of controls such as pits, earth cover (tamping), barricades, sandbags, and/or blast mats, and are tailored to the type of munition, its orientation, and net explosive weight (NEW). In addition, the following measures will be taken:

- All MEC/UXO will be accounted for and identified by nomenclature, if possible. As a minimum, UXO identification will be by type, by function, and filler.
- Coordination will be made with the Federal Aviation Administration to ensure air space clearance prior to the start of operations.
- MEC/UXO that is safe to move may be consolidated at each site to reduce the number of demolition shots and conserve explosives.
- Munitions debris (e.g., inert ordnance, expended munitions, mortar fins) will be removed to the appropriate reutilization office. Should the reutilization office not be established for the receipt of scrap, the contractor will dispose of the scrap through a local scrap dealer at no cost to the Government. All material will be accounted for through appropriate documentation, as required by the Government and/or scrap dealer.
- Avenues of approach to each disposal site will be controlled to prevent unauthorized access.
- Prior to the start of disposal activities, the Senior UXO Supervisor (SUXOS) and UXOSO will verify that the area around the operating site is clear of all nonessential personnel and that other UXO Technicians III have been notified. Prior to priming of demolition charges, all avenues of ingress will be physically blocked by UXO personnel. Radio communications will be maintained among all concerned parties. Avenues of ingress will not be opened without the express permission of the SUXOS. A constant state of vigilance will be maintained by all personnel to detect any intrusion into the fragmentation zone.

Minimum distances of 1,250 ft (non-fragmenting), 2,500 ft (fragmenting), and 4,000 ft (bombs and projectiles greater than 5 inches in diameter) will be established and maintained around the operating site. Depending on the type of munition being destroyed, the fragmentation distance may be increased or decreased based on data obtained from Technical Manual 60A-1-1-4. Personnel remaining on site will be limited to those personnel needed to safely and efficiently prepare the item/s for destruction.

4.1.1 Disposal Team Structure

The Disposal Team will consist of:

- One UXO Technician III will direct and supervise all team activities, maintain the Site Explosive Log Book, and inspect the scrap for hazardous material.
- Two UXO Technicians II will assist the UXO Technician III and perform disposal operations.

4.1.2 Disposal Team Procedures

The Disposal Team will remove the scrap from each survey grid and transport it to a designated central collection point. During this removal, the UXO Technician III will perform a through examination of the scrap to ensure that it is free of hazardous material. All MEC containing hazardous material will be disposed of in-situ whenever possible. The preferred method is detonation in place; however, items that are safe to be moved may be consolidated to reduce the number of shots. If MEC cannot be disposed in place or moved, the SUXOS will request EOD support.

5.0 REFERENCES

- USACE Safety Considerations for UXOs
- USA Corporate Safety and Health Program (CSHP)
- OSHA, 29 CFR 1910, Occupational Safety and Health Standards
- OSHA, 29 CFR 1926, Construction Standards
- Applicable sections of EPA, 40 CFR Parts 260 to 299, Protection of Environment
- Applicable sections of DOT, 49 CFR Parts 100 to 199, Transportation
- USACE EM 385-1-1, Safety and Health Requirements Manual
- USACE ER 385-1-92, Safety and Occupational Health Document Requirements for Hazardous Waste Remedial Actions
- DDESB TB 18, Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel
- DOD 4145.26-M, Contractors' Safety Manual for Ammunition and Explosives
- DOD 6055.09-M, DOD Ammunition and Explosives Safety Standards
- DOD 4160.21-M, Defense Reutilization and Marketing Manual
- DA PAM 385-64, Ammunition and Explosives Safety Standards
- AR 385-64, Ammunition and Explosives Safety Standards
- AR 200-1, Environmental Protection and Enhancement
- AR 385-10, The Army Safety Program
- AR 385-16, System Safety Engineering and Management
- AR 385-40 w/USACE supplement, Accident Reporting and Records
- TM 9-1300-200, Ammunition General
- TM 9-1300-214, Military Explosives
- TM 60 Series Publications

STANDARD OPERATING PROCEDURE
EM61-MK2 SET UP AND USE FOR REACQUIRE AND POST INTRUSIVE CHECKS

1.0 Equipment

- 1.1 EM61 Coil Assembly
- 1.2 EM61 Wheel Assemblies
- 1.3 EM61-MK2 Handle Assembly
- 1.4 GPS Tripod (if needed)
- 1.5 Custom Lower Coil GPS Tripod Mounts (if needed)
- 1.6 EM61-MK2 Back Pack
- 1.7 EM61-MK2 Cables
  - 1.7.1 Lower coil to Upper coil cable And Shorting Plug
  - 1.7.2 Lower coil to Back Pack cable
  - 1.7.3 Back Pack to Data Logger cable
  - 1.7.4 Data Logger to PC cable and PCMCIA Memory Card
  - 1.7.5 Battery Chargers & cables
    - 1.7.5.1 Back Pack Battery Charger & cable
    - 1.7.5.2 Data Logger Battery Charger & cable
    - 1.7.5.3 Power Inverter to charge from vehicle
- 1.8 EM61-MK2 Static Check Bar with Spike Target
- 1.9 EM61-MK2 Operating Manuals
  - 1.9.1 EM61-MK2 Operating Manual
  - 1.9.2 DAT61MK2 Computer Program Manual
  - 1.9.3 EM61-MK2 Software
    - 1.9.3.1 Data Logger Software
      - 1.9.3.1.1 EM61MK2A V1.37
    - 1.9.3.2 PC Software
      - 1.9.3.2.1 DAT61MK2 for Windows V1.35
      - 1.9.3.2.2 Backup Data Logger software
- 1.10 Tape Measures & Line Markers (line, flags, spray paint, or cones)
- 1.11 Log Book or PDA

2.0 Charge all batteries

- 2.1 EM61-MK2 Back Pack Batteries – up to 14 hours for fully discharged battery
- 2.2 EM61-MK2 Data Logger Batteries – up to 14 hours for fully discharged battery
- 2.3 PDA Batteries

3.0 Set Up EM61-MK2

- 3.1 Assemble coil, wheel, and handle assemblies
- 3.2 Connect wheel encoder cable to lower coil – tape it in place with electrical tape (do not use duct tape)
- 3.3 Connect lower to upper coil or install shorting plug to bottom coil (usually use bottom coil only with shorting plug)
- 3.4 Connect lower coil to backpack
- 3.5 Set a freshly charged battery into the backpack
- 3.6 Connect backpack to Data Logger COM1 port
- 3.7 Adjust backpack shoulder and waist straps for good fit
- 3.8 Tape cables to handle, leaving enough slack for turning

4.0 EM61-MK2 Operation

4.1 Set the EM61-MK2 Mode Switch to:
- 4.1.1 4 – for logging four (4) bottom coil time gates
- 4.1.2 D – for logging three (3) bottom coil time gates and one (1) top coil time gate – typically not used

4.2 Set the Master/Slave Switch to M for single sensor operation

4.3 Push In the Circuit Breaker on the EM61-MK2 backpack and warm up for at least 5 minutes – backpack sensor noise should start and LED should be on.

4.4 Push the ON/OFF button to turn on the Data Logger
- 4.4.1 Set Antenna Coil Size (e.g. Standard 1 x .5 m)
- 4.4.2 Set Up Logger
  - 4.4.2.1 Date
  - 4.4.2.2 Time
  - 4.4.2.3 Units (e.g. feet)
  - 4.4.2.4 COM port (e.g. COM1)
  - 4.4.2.5 Audio
  - 4.4.2.6 Pause Key: (e.g. Alt F1 or any key)
  - 4.4.2.7 Display (e.g. Text or Graphic)

4.5 Monitor/Null Coil – After 5 minute warm-up, null EM61-MK2 – all channels should be close to 0 +/- 1

4.6 Static Check:
- 4.6.1 Look for a “quiet area” where the EM61-MK2 data doesn’t change more than 3mV on channel 1
- 4.6.2 Null coil = all channels should be 0 +/-1mV
- 4.6.3 Observe all 4 channels for about 1 minute. Values should not change by more than +/- 2.5 mV
- 4.6.4 Place Static Check Bar with Spike Target (screw or bolt) on coil. Mark location so you can put it in the same place, same orientation each morning. Write the spike responses for all 4 channels in the log book and observe that they stay constant for about 1 minute.
- 4.6.5 Remove static check bar and observe that all 4 channels return to 0 +/- 2.5mV for about 1 minute.
- 4.6.6 Sensor is ready for reacq. Note that you may need to null the coil periodically. Write spike response values for all 4 channels on the static check bar to compare to next day’s check. Daily responses for each channel should not vary by more than +/- 20%. If they do, check the location and orientation of the Static Check Bar.

4.7 If refining, move to first marked flag and push/pull the EM61-MK2 over the flag in at least 2 different directions while observing the displayed values. Center the coil over the peak response and log peak response and any location offset (e.g. 6” NE) in logbook or PDA. Move flag to center of coil for intrusive team. Continue to next flag.

4.8 To check intrusive holes or spoils piles, push/pull the EM61-MK2 over the hole or spoils pile in at least 2 different directions while observing the displayed values. Insure that the EM61-MK2 values confirm that the project background value (e.g. <2.5mV on the EM61-MK2 channel, or channels, used to select anomalies) is not exceeded. Log peak response in logbook or PDA. Holes or spoils piles with signatures above the project background requirements will need to be reinvestigated.

5.0 EM61-MK2 Training/Certification

5.1 All personnel using the EM61-MK2 for confirming anomaly resolution will demonstrate that they can follow this SOP at a local test strip with at least one inert seed item buried horizontal at a depth 11 times its diameter. The UXOQC and team leaders will document each operator’s performance at this test strip located in a clean (metal free) area that is convenient to the work site in their log books to insure each operator is fully trained and certified.

Appendix C
Responses to Partnering Team Comments

VDEQ Risk Assessor
MEC-QAPP Review

Reviewer: Kyle Newman
Document: Draft MTMR-S RI MEC-QAPP
Date: 17-Sep-13

Responding Firm: CH2M HILL
Date: 21-Oct-13

Comment Number	Worksheet and/or Section	Comment	Response
1	general	While the SI found no evidence of a release of munitions constituents (MC), without knowing the full nature and extent of any MEC contamination there is a great deal of uncertainty associated with this conclusion. Standard practice at MMRP sites is to obtain a sample from underneath any recovered items that appear to be compromised with exposed explosives. VDEQ acknowledges the conclusions of the SI that there has been no evidence of an MC release, but feels that if the RI identifies any areas of dense MEC or MD (e.g. an obvious target area or burial pit) a contingency plan should be included in the RI Work Plan that allows for limited sampling for MC. This would prevent the Navy from having to remobilize resources to obtain the additional data and allow for greater confidence in those data compared to if the Navy revisited the site at a later date.	Agree. A Tier II sampling plan (UFP-SAP) will be developed to address the sample collection approach for unexpected findings. This plan will be submitted to DEQ for input and review. Prior to preparing the plan, a scoping session will be held to develop the sampling approach to analyze soil samples for high explosives.