Quality Assurance Project Plan
Superfund Response Actions
Former Fort Ord, California

Volume II
Munitions Response

Appendix B
Advanced Geophysical Classification for Munitions Response
Quality Assurance Project Plan

Worldwide Environmental Remediation Services Contract
Contract No. W912DY-10-D-0027
Task Order No. CM01

Prepared for:
United States Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814

Prepared for KEMRON Environmental Services, Inc. by:
Gilbane
1655 Grant Street, Floor 12
Concord, CA 94520

August 2016

TABLE OF CONTENTS

TABLE OF CONTENTS i
LIST OF FIGURES i
LIST OF APPENDICES ii
ABBREVIATIONS AND ACRONYMS iii
EXECUTIVE SUMMARY vi
1.0 PROJECT MANAGEMENT 10
1.1 Title and Approval Page (QAPP Worksheets #1 & 2) 10
1.2 Project Organization and QAPP Distribution (QAPP Worksheets #3 & 5) 14
1.3 Personnel Qualifications and Sign-off Sheet (QAPP Worksheets #4, 7, & 8) 15
1.4 Communication Pathways (QAPP Worksheet #6) 19
1.5 Project Planning Session Summary (QAPP Worksheet #9) 20
2.0 PROJECT QUALITY OBJECTIVES 21
2.1 Conceptual Site Model (QAPP Worksheet #10) 21
2.2 Project/Data Quality Objectives (QAPP Worksheet #11) 28
2.3 Measurement Performance Criteria (QAPP Worksheet #12) 34
2.4 Project Tasks & Schedule (QAPP Worksheets #14 & 16 [Uniform Federal Policy (UFP)-QAPP Manual Section 2.8.1]) 36
3.0 SAMPLE DESIGN 37
3.1 Sampling Design and Rationale (QAPP Worksheet #17) 37
3.2 Standard Operating Procedures References Table (QAPP Worksheet #21) 50
3.3 Equipment Testing, Inspection and Quality Control (QAPP Worksheet #22) 51
4.0 DATA MANAGEMENT AND DATA REVIEW 60
4.1 Project Documents and Records (QAPP Worksheet #29) 60
4.2 Assessments and Corrective Action (QAPP Worksheets #31, 32, & 33) 66
4.3 Data Verification, Validation, and Usability Inputs (QAPP Worksheet #34) 79
4.4 Data Verification and Validation Procedures (QAPP Worksheet #35) 81
4.5 Data Validation Procedures (QAPP Worksheet #36) 84
4.6 Data Usability Assessment (QAPP Worksheet #37) 86
5.0 REFERENCES 88

LIST OF FIGURES

Figure 1-1 Organizational Structure
Figure 2-1 Site Locations
Figure 2-2 Impact Area Ranges
Figure 2-3 Impact Area Conceptual Site Model
Figure 3-1 Advanced Geophysical Classification Decision Tree

LIST OF APPENDICES

Appendix A	Project Schedule
Appendix B	Standard Operating Procedures
Appendix C	Blind Seed Firewall Plan
Appendix D	Draft Advanced Geophysical Classification Validation Plan
Appendix E	Responses to Comments

ABBREVIATIONS AND ACRONYMS

ACC	Air Combat Command
A-E	Architect Engineer
A/E/C	Architecture, Engineering, and Construction
ANSI/ASQ	American National Standards Institute/American Society for Quality
APP	Accident Prevention Plan
Army	U.S. Department of the Army
BCT	Base Realignment and Closure (BRAC) Cleanup Team
BLM	Bureau of Land Management
BRAC	Base Realignment and Closure
CA	corrective action
CAP	corrective action plan
CAR	corrective action report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CQA	Certified Quality Auditor
CQCSM	Contractor Quality Control Systems Manager
CSDGM	Content Standard for Digital Geospatial Media
CSM	conceptual site model
DDESB	Department of Defense Explosives Safety Board
DFW	definable feature of work
DGM	digital geophysical mapping
DMM	discarded military munitions
DoD	Department of Defense
DQI	data quality indicator
DQO	data quality objective
EM	engineer manual
EMI	electromagnetic induction
EPA	Environmental Protection Agency
ESRI	Environmental System Research Institute
ESTCP	Environmental Security Technology Certification Program
FFA	Federal Facility Agreement
FGDC	Federal Geographic Data Committee
FP	Follow-Up Phase
FS	feasibility study
AGCMR-QAPP	Advanced Geophysical Classification for Munitions Response Quality Assurance Project Plan
GIS	geographic information system
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDF5	Hierarchical Data Format version 5
HMP	Habitat Management Plan

IDQTF	Intergovernmental Data Quality Task Force
IMU	inertial management unit
IP	Initial Phase
ISO	industry standard object
ISO 80	schedule 80 small industry standard object
IVS	instrument verification strip
LUCs	land use controls
MAJCOM	Major Command Manager
MEC	munitions and explosives of concern
MMRP	Military Munitions Response Program
MPC	measurement performance criteria
MPS	MEC Procedures Supplement
MR	munitions response
MRA	munitions response area
MRS	munitions response site
MQO	measurement quality objectives
NCR	Non-Conformance Report
NSSDA	National Standard for Spatial Data Accuracy
OESS	Ordnance and Explosives Safety Specialist
OPTEMA	One-Pass Time-domain Electromagnetic Induction Array
PDF	portable document format
PE	Professional Engineer
PMP	Project Management Professional
PP	Preparatory Phase
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	Remedial Action
RCA	root cause analysis
RD	remedial design
RI	remedial investigation
ROD	Record of Decision
RTK	real-time kinematic
SDSFIE	Spatial Data Standards for Facilities, Infrastructure, and Environment
SOP	standard operating procedure
SSWP	site-specific work plan
SUXOS	Senior Unexploded Ordnance Supervisor
TEMTADS	Time-domain Electromagnetic Multi-sensor Towed Array Detection System 2x2
TOI	target of interest
TP-18	Technical Publication – 18
UFP	Uniform Federal Policy
USACE	United States Army Corps of Engineers

UXA	UX-Analyze Advanced
UXO	unexploded ordnance
UXOSO	Unexploded Ordnance Safety Officer
UXOQCS	Unexploded Ordnance Quality Control Specialist

EXECUTIVE SUMMARY

This Advanced Geophysical Classification for Munitions Response - Quality Assurance Project Plan (AGCMR-QAPP) has been prepared in support of the U.S. Army Corp of Engineers (USACE), Sacramento District, under the Worldwide Environmental Remediation Services Contract, contract number W912DY-10-D-0027, delivery order CM01, for the continuation of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Action (RA) at Former Fort Ord in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP Manual (Intergovernmental Data Quality Task Force [IDQTF], March 2005), *Optimized UFP-QAPP Worksheets* (IDQTF, March 2012), and the Interim Guidance Document 14-01, *Technical Guidance for Military Munitions Response Actions,* Engineer Manual (EM) 200-1-15 (USACE, October 2013). The munitions and explosives of concern (MEC) remedial action in the Impact Area Munitions Response Area (MRA) is being conducted in accordance with the *Final Track 3 Record of Decision (ROD), Impact Area Munitions Response Area, Track 3 Munitions Response Site, Former Fort Ord, California* (U.S. Department of the Army [Army], 2008) and *Final Work Plan, Remedial Design/Remedial Action (RD/RA), Track 3 Impact Area Munitions Response Area, Former Fort Ord, California* (USACE, 2009).

This AGCMR-QAPP is based on the 28 optimized worksheets that accompany the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP; IDQTF, 2012) and is intended to be the primary work plan for MEC removal utilizing advanced electromagnetic induction (EMI) geophysical classification to support remedial action objectives. The included worksheets will serve as a guideline for project activities and data quality assessment. This AGCMR-QAPP addresses the quality assurance (QA) and quality control (QC) elements of the American National Standard, ANSI/ASQ E4-2004 and meets the requirements of EPA/QA G-5. Modifications have been made to the standard worksheets based on the munitions response (MR) advanced geophysical classification format designed specifically for advanced EMI MR classification projects, as described in *Uniform Federal Policy for Quality Assurance Project Plans Template: Geophysical Classification for Munitions Response, Revised Beta Draft* (IDQTF, 2015). Worksheets deemed not applicable to this advanced geophysical classification-optimized QAPP format have been either modified to meet the intent of the worksheet or excluded.

This document is divided into the following four major sections:

- Project Management describes the project management approach, including the purpose and structure of the AGCMR-QAPP and the project team organization
- Project Quality Objectives defines the conceptual site model, project objectives and background, data quality objectives, and documentation requirements
- Sample Design explains the sampling approach
- Data Management and Data Review describes assessment and oversight procedures to verify and validate data quality

This AGCMR-QAPP contains a series of worksheets that are for both general and specific information pertaining to the MEC remediation activities to be completed in the Impact Area MRA and planned MEC remediation activities anticipated to be conducted in Bureau of Land Management (BLM) Area B (based on the Track 2 Remedial Investigation (RI)/Feasibility Study (FS) and Proposed Plan for BLM Area B and MRS-16). It describes the planning, implementation, acquisition, and assessment of advanced geophysical classification data using effective methodologies and thorough QC activities that KEMRON Environmental Services (KEMRON), directed by the USACE, may use during MEC RAs at the Former Fort Ord, California. This AGCMR-QAPP includes information for data management, data analysis and QC activities in support of MEC response actions and is intended for use by field operators, supervisors, data managers and other technical experts responsible for implementing and coordinating advanced geophysical classification activities for the project.

Several terminology conventions are used throughout this AGCMR-QAPP, including the following:

- *Advanced EMI sensors* are geophysical instruments that utilize transmit and receive coils oriented in three dimensions and placed in multiple locations relative to the center of the sensor array. By analyzing this detailed EMI data with specialized geophysical classifiers, the physical properties of an anomaly source (such as size, aspect ratio, wall thickness, and symmetry) can be estimated, allowing the project team to make informed decisions about whether an item should be excavated or can be safely left in place. Advanced EMI sensors include the Geometrics MetalMapper, the Time-domain Electromagnetic Multi-sensor Towed Array Detection System 2x2 (TEMTADS), the Man-Portable Vector EMI Sensor (MPV), and the One-Pass Time-Domain ElectroMagnetic Induction Array (OPTEMA), among others. Each of these advanced geophysical classification systems is based on similar sensor coils deployed in different configurations, and any one or a combination of them, may be used for advanced geophysical classification work at the former Fort Ord, with approval from the project team.
- A *detection survey* is a dynamic digital geophysical mapping (DGM) survey, where sensor data is recorded digitally for later processing, analysis, and target anomaly selection. Detection surveys may utilize traditional geophysical sensors, such as the Geonics EM61-MK2A EMI detector and the Geometrics G-858 gradiometer, or they may utilize advanced EMI sensors.
- A *classification survey* is a survey consisting of cued (static) advanced EMI sensor measurements acquired over anomalies previously identified during a detection survey. The static measurement allows the advanced EMI sensor to acquire detailed EMI data after measuring the response of a buried metallic item at numerous positions and from multiple angles and orientations around the item. This provides the level of detail required for confident classification of the item.

Depending on site-specific conditions and the goals and objectives of each individual activity, advanced geophysical classification may not be the most efficient technique or the best choice to meet individual project objectives. Advanced geophysical classification is an additional tool to be utilized in specific situations, but it will not replace standard MEC removal methods.

Crosswalk: Uniform Federal Policy (UFP)-QAPP to 2106-G-05

Optimized UFP-QAPP Worksheets		**2106-G-05 QAPP Guidance Section**	
		Project Management	
1 & 2	Title and Approval Page	2.2.1	Title, Version, and Approval/Sign-Off
3 & 5	Project Organization and QAPP Distribution	2.2.3	Distribution List
		2.2.4	Project Organization and Schedule
4, 7 & 8	Personnel Qualifications and Sign-off Sheet	2.2.1	Title, Version, and Approval/Sign-Off
		2.2.7	Special Training Requirements and Certification
6	Communication Pathways	2.2.4	Project Organization and Schedule
9	Project Planning Session Summary	2.2.5	Project Background, Overview, and Intended Use of Data
		Project Quality Objectives	
10	Conceptual Site Model	2.2.5	Project Background, Overview, and Intended Use of Data
11	Project/Data Quality Objectives	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
12	Measurement Performance Criteria	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
14 & 16	Project Tasks & Schedule	2.2.4	Project Organization and Schedule
		Sample Design	
17	Sampling Design and Rationale	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
21	Field Standard Operating Procedures (SOPs)	2.3.2	Sampling Procedures and Requirements
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
		Data Management and Data Review	
29	Project Documents and Records	2.2.8	Documentation and Records Requirements
31, 32 & 33	Assessments and Corrective Action	2.4	Assessments and Data Review (Check)
		2.5.5	Reports to Management
34	Data Verification and Validation Inputs	2.5.1	Data Verification and Validation Targets and Methods
35	Data Verification Procedures	2.5.1	Data Verification and Validation Targets and Methods
36	Data Validation Procedures	2.5.1	Data Verification and Validation Targets and Methods
37	Data Usability Assessment	2.5.2	Quantitative and Qualitative Evaluations of Usability
		2.5.3	Potential Limitations on Data Interpretation
		2.5.4	Reconciliation with Project Requirements

1.0 PROJECT MANAGEMENT

1.1 Title and Approval Page (QAPP Worksheets #1 & 2)

Site Name: Track 3 Impact Area Munitions Response Area
Site Location: Former Fort Ord, California
Document Title: Final, Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume II, Munitions Response, Appendix B, Advanced Geophysical Classification for Munitions Response Quality Assurance Project Plan
Contract Number: W912DY-10-D-0027

REVIEW SIGNATURES

Investigative Organization

Digitally signed by Andy Gascho
Date: 2016.08.02 14:56:23 -06'00'

Date: 08/02/16

Andy Gascho
Gilbane Project Geophysicist

Margaret M. Sheatzley
Digitally signed by Margaret M. Sheatzley
DN: cn=Margaret M. Sheatzley, o=KEMRON, ou=Fort Ord, email=msheatzley@kemron.com, c=US
Date: 2016.08.02 14:06:10 -07'00'

Date: 08/02/16

Maggie Sheatzley
KEMRON Technical Editor

Erin K. Caruso
Digitally signed by Erin K. Caruso
DN: C=US, E=ecaruso@gilbaneco.com, O=Gilbane, OU=Federal Services, CN=Erin K. Caruso
Reason: I am approving this document
Date: 2016.08.02 14:40:50-07'00'

Date: 08/02/16

Erin Caruso, PE, PMP
Gilbane Deputy Project Manager

Steve Crane
Digitally signed by Steve Crane
DN: cn=Steve Crane, o=KEMRON, ou, email=scrane@kemron.com, c=US
Date: 2016.08.02 15:34:14 -07'00'

Date: 08/02/16

Steve Crane
KEMRON Project Manager

Contracting Organization

EISEN.DAVID.E.1231985146 Digitally signed by EISEN.DAVID.E.1231985146 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=EISEN.DAVID.E.1231985146 Date: 2016.08.02 14:26:45 -07'00' Date: 08/02/16

David Eisen
USACE Project Manager

MEEK.SHAWN.MICHAEL.1115801739 Digitally signed by MEEK.SHAWN.MICHAEL.1115801739 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MEEK.SHAWN.MICHAEL.1115801739 Date: 2016.08.02 15:14:10 -07'00' Date: 08/02/16

Shawn Meek
USACE Ordnance and Explosives Safety Specialist

JACKSON.JOHN.MICHAEL.1396427903 Digitally signed by JACKSON.JOHN.MICHAEL.1396427903 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=JACKSON.JOHN.MICHAEL.1396427903 Date: 2016.08.02 16:58:47 -07'00' Date: 08/02/16

John Jackson
USACE Quality Assurance Geophysicist

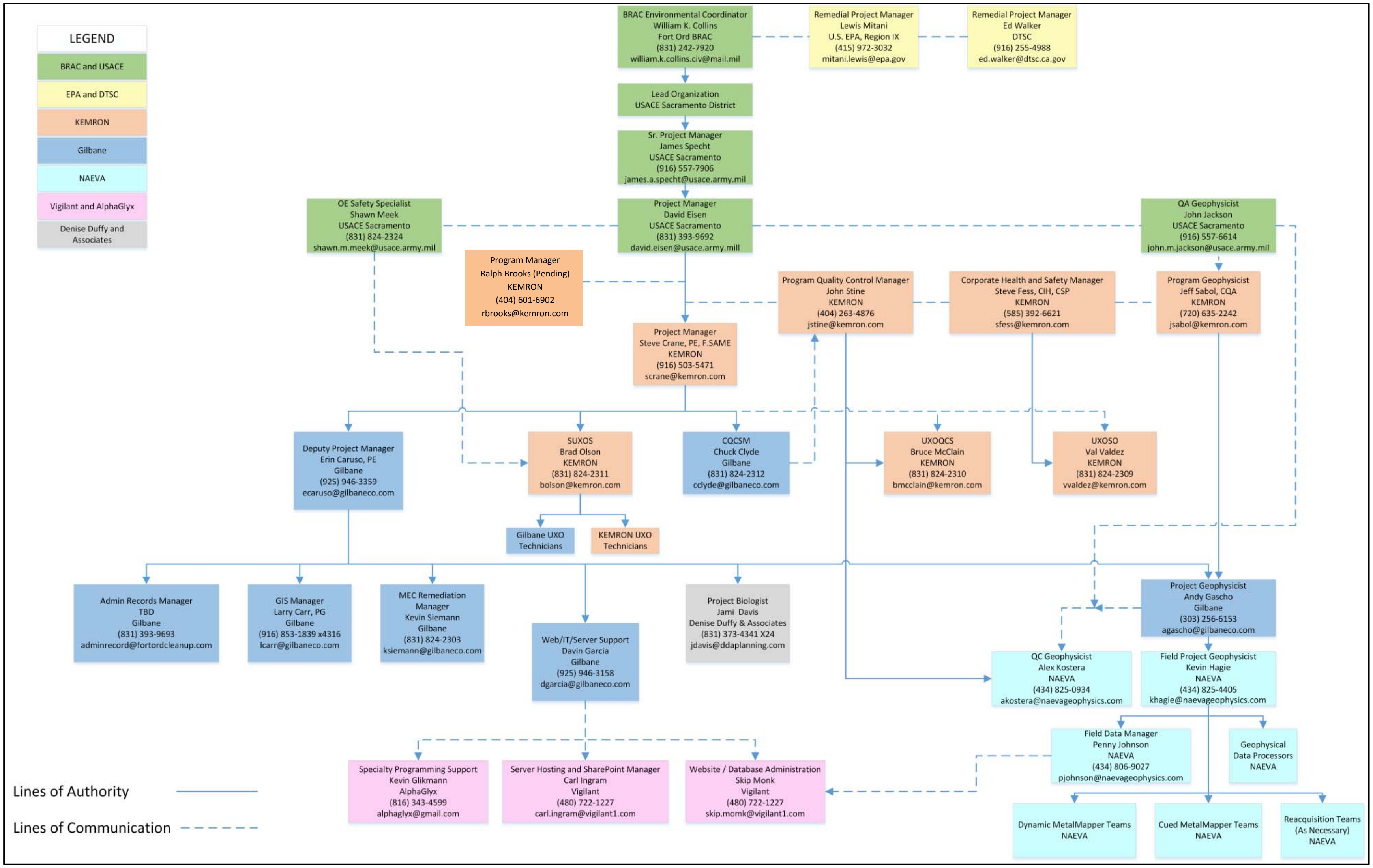
Plans and reports from previous investigations relevant to this project

Title	Company	Date
Final Record of Decision, Impact Area Munitions Response Area, Track 3 Munitions Response Site, Former Fort Ord, California (OE-0647)	US Department of the Army (Army)	2008
Programmatic Biological Opinion for Cleanup and Property Transfer Actions Conducted at the Former Fort Ord, Monterey County, California (8-8-09-F-74)	US Department of the Interior – Fish and Wildlife Service	2015
Biological Opinion for the Former Fort Ord Vegetation Clearance Activities and Transfer of Parcel E29b.3.1 (8-8-11-F-39)	US Department of the Interior – Fish and Wildlife Service	2011
Final, Track 2, Remedial Investigation/Feasibility Study, BLM Area B and MRS-16, Former Fort Ord, California (OE-0802D, Revision 2)	Gilbane	2015
Munitions and Explosives of Concern Procedures Supplement, Former Fort Ord, California (OE-0858)	KEMRON	2015
Quality Assurance Project Plan, Former Fort Ord, California; Volume II, Appendix A, Munitions and Explosives of Concern Remedial Action (OE-0861)	KEMRON	2015
Site-Specific Work Plan, Munitions and Explosives of Concern Remedial Action, MRS-BLM Unit 23 and in Support of Units 11 and 12 Prescribed Burns (Includes Portions of 5A, 9, 25, 28, and 31), Former Fort Ord, California	KEMRON	2015
Final Track 3 Impact Area Munitions Area Munitions Remedial Investigation/Feasibility Study Report, Former Fort Ord, California (OE-0596R)	MACTEC/Shaw	2007
Final Site-Specific Work Plan, Munitions and Explosives of Concern Remedial Action, Non-Burn Areas, Former Fort Ord, California (OE-0685D)	Shaw	2010
Final Work Plan, MRS-BLM Burn Units 01-05 Munitions and Explosives of Concern Removal, Former Fort Ord, California, Revision 0 (OE-0626L)	Shaw E&I	2008
Final Work Plan, Remedial Design/Remedial Action (RD/RA), Track 3 Impact Area Munitions Response Area, Munitions and Explosives of Concern Removal, Former Fort Ord, California (OE-0660K)	USACE	2009
Installation-Wide Multispecies Habitat Management Plan for Former Fort Ord, California (BW-1787)	USACE	1997

Title	Company	Date
Penetration of Projectiles into the Ground, An Analysis of UXO Clearance Depths at Fort Ord	USACE	1997

1.2 Project Organization and QAPP Distribution (QAPP Worksheets #3 & 5)

Figure 1-1. Organizational Structure



1.3 Personnel Qualifications and Sign-off Sheet (QAPP Worksheets #4, 7, & 8)

ORGANIZATION: KEMRON

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Ralph Brooks (Pending)	Program Manager			
John Stine	Program Quality Control Manager	Senior NCO Academy U.S. Navy EOD School, Munitions Disposal Specialist U.S. Air Force Munitions Maintenance Specialist Master EOD Technician Master EOD Training Instructor, USAF Department of Defense Explosives Safety Board (DDESB) TP-18-Qualified Senior Unexploded Ordnance Supervisor (SUXOS) 39 years of unexploded ordnance (UXO) and MMRP experience, with 32 years of supervisory experience	USACE UXO #0539 NATO QA/QC Evaluator/Inspector/Trainer QA/QC Officer, Unit Level, USAF QA/QC Manager, Air Combat Command (ACC), Major Command Manager (MAJCOM) EOD HQ USAF Munitions Specialist Training NAVSEA Technical Instructors Course HAZWOPER	
Jeff Sabol	Program Geophysicist	BS Physics 17 years of MMRP geophysical and QC experience	American Society of Quality (ASQ) - Certified Quality Auditor (CQA) Oasis Montaj Geophysical Data Processing for UXO ESTCP Geosoft UX-Analyze Advanced Training ArcGIS HAZWOPER	

Steve Crane	Project Manager	MS Civil and Environmental Engineering 34 years of combined experience in environmental engineering, project management, program management, and business unit management Previous Project Manager (2010-2014) for the $60 million Fort Ord MEC Removal and Soil Remediation WERS task order for Gilbane	Registered Civil Engineer (Professional Engineer) [PE] USACE Architect - Engineer (A-E) Contracting Short Course, USACE-Huntsville Program for Manager Development, Univ. of North Carolina – Chapel Hill Graduate Business School	
Bradley Olson	SUXOS	DDESB TP-18-Qualified SUXOS 30 years of EOD and UXO experience	Naval EOD School USACE CQM HAZWOPER HAZWOPER Supervisor 30-Hour Construction Safety 10-Hour Construction Safety	
Bruce McClain	Unexploded Ordnance Quality Control Specialist (UXOQCS)	DDESB TP-18-Qualified UXOQCS 30 years of EOD and UXO experience	Naval EOD School USACE CQM HAZWOPER HAZWOPER Supervisor 30-Hour Construction Safety 10-Hour Construction Safety	
Val Valdez	Unexploded Ordnance Safety Officer (UXOSO)	DDESB TP-18-Qualified UXOSO 25 years of EOD and UXO experience	Naval EOD School 30 Hour Construction Safety USACE CQM 1st Aid/CPR RAD Safety HAZWOPER Supervisor	

ORGANIZATION: Gilbane

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Erin Caruso	Deputy Project Manager (Gilbane Project Manager)	MS Engineering 14 years of MMRP experience Current Project Manager (2015-present) for the Fort Ord MEC Removal and Soil Remediation WERS task order for Gilbane	PE (California) USACE CQM PMP HAZWOPER	

Kevin Siemann	MEC Remediation Manager	BS Environmental Science 16 years of experience	HAZWOPER	
Chuck Clyde	Contractor Quality Control System Manager (CQCSM)	17 years as Quality Control Manager for various DoD Projects	HAZWOPER 30-Hour Construction Safety CPR/First Aid API -650/653 Storage Tank Management Confined Space Supervisor	
Andy Gascho	Project Geophysicist	MS Geophysics 16 years of MMRP geophysics experience 4 years of advanced geophysical classification experience on 7 advanced geophysical classification projects	Oasis Montaj Geophysical Data Processing for UXO ESTCP Geosoft UX-Analyze Advanced Training HAZWOPER 30-Hour Construction Safety	
Larry Carr	GIS Manager	BS Geology 14 years of experience GIS (19 years overall experience in industry)	HAZWOPER	

ORGANIZATION: NAEVA Geophysics

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Mark Howard	Field Project Geophysicist	BS Geology 19 years of MMRP geophysics experience 4 years of advanced geophysical classification experience on 6 advanced geophysical classification projects	Professional Geologist (Pennsylvania) ESTCP Geosoft UX-Analyze Advanced Training HAZWOPER	
Alison Paski	Lead Data Processor	BS Geophysics 14 years of experience 5 years of advanced geophysical classification experience on 12 advanced geophysical classification projects	Oasis Montaj Geophysical Data Processing for UXO ESTCP Geosoft UX-Analyze Advanced Training	

Alex Kostera	QC Geophysicist	BS Geology 15 years of MMRP geophysics experience 2 years of advanced geophysical classification experience on 2 advanced geophysical classification projects	Professional Geologist (Virginia) Oasis Montaj Geophysical Data Processing for UXO HAZWOPER	
Penny Johnson	Field Data Manager	BS Geology 15 years of MMRP geophysics experience 10 years database management experience on MMRP projects	Microsoft Access Intermediate/SQL Oasis Montaj Geophysical Data Processing for UXO HAZWOPER	

ORGANIZATION: Vigilant Technologies

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Skip Munk	Database Administrator	Education: B.S., Business Accounting, University of Phoenix—Sacramento, CA (October 2008) 20 year SQL Server experience, Microsoft SQL Server and SQL Azure. Programming experience: C#, Visual Basic (VB6, VB, .Net, VBA, VB Script), xBase (dBase and FoxPro), Java, JavaScript, Delphi, and SAP ABAP. Experience developing middle tier Windows Service and Web Services using .Net framework. Web development using HTML, ASP, ASP.NET (VB.Net and C#), Java, and JavaScript. SAP applications, using ABAP, ALV Grid, and SmartForms, including BAPI concepts. Experienced with various cloud based systems.	BC400 ABAP Workbench Foundations, SAP Education - Atlanta, GA BC405 Programming ABAP Reports SAP Education—Calgary, Alberta, Canada Database Implementation with SQL Server 6.5 Microsoft Education—Honolulu, HI	

Signatures indicate personnel have read and agree to implement this AGCMR-QAPP as written.

1.4 Communication Pathways (QAPP Worksheet #6)

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, and documentation)
Regulatory agency interface	USACE	David Eisen	(831) 393-9692	USACE Fort Ord Project Manager provides routine project updates to Base Realignment and Closure (BRAC) Cleanup Team (BCT) and stakeholders, including work variances and corrective actions.
Project status reports	KEMRON	Steve Crane	(916) 853-1839	KEMRON Project Manager e-mails weekly status reports to USACE Fort Ord Project Manager for distribution to Fort Ord project delivery team.
Stop work due to safety issues	KEMRON	Val Valdez	(831) 824-2309	UXOSO informs KEMRON Project Manager and Health and Safety Manager of critical safety issues and develops report. OESS and USACE Fort Ord Project Manager informed of issue and receive report.
AGCMR-QAPP variances during project execution	Gilbane	Erin Caruso	(916) 853-1839	Gilbane Project Manager submits Field Change Request to USACE Project Manager for review and approval.
Field corrective actions	NAEVA Gilbane	Alex Kostera Chuck Clyde	(434) 825-0934 (813) 824-2312	QC Geophysicist and CQCSM prepare a Non-Conformance Report (NCR) and, as applicable, a Corrective Action Request (CAR) and Corrective Action Plan (CAP). Forms are provided to the KEMRON Program QC Manager for review and approval. KEMRON Program QC Manager then provides forms to USACE Fort Ord Project Manager for review and approval.
Blind seeding information and issues	NAEVA	Alex Kostera	(434) 825-0934	QC Geophysicist communicates directly with USACE QA Geophysicist and USACE OESS regarding blind seeding information in accordance with the Blind Seed Firewall Plan (Appendix C).
Geophysical quality control variances	NAEVA	Alex Kostera	(434) 825-0934	QC Geophysicist prepares a NCR and, as applicable, a CAR and CAP. Forms are provided to USACE QA Geophysicist, USACE OESS, and USACE Fort Ord Project Manager for review and approval.
Data verification issues (e.g., incomplete records)	Gilbane	Andy Gascho	(303) 256-6153	Gilbane Project Geophysicist prepares a NCR and, as applicable, a CAR and CAP. Forms are provided to USACE QA Geophysicist, USACE OESS, and USACE Fort Ord Project Manager for review and approval.
Data review corrective actions	NAEVA	Alex Kostera	(434) 825-0934	QC Geophysicist prepares a NCR and, as applicable, a CAR and CAP. Forms are provided to USACE QA Geophysicist, USACE OESS, and USACE Fort Ord Project Manager for review and approval.

1.5 Project Planning Session Summary (QAPP Worksheet #9)

Project meetings will be held as needed to discuss planning and scheduling, logistics and may include operational discussions as they relate to project decisions, deliverables, QC issues or concerns, corrective actions and data presentation to support decision making. Meeting attendees will be based on the topic(s) of discussion and may include subject matter experts. Project meeting agendas will be drafted by KEMRON and will be approved by USACE prior to dissemination to meeting attendees. Meeting minutes will be generated by KEMRON and once reviewed and approved by USACE will be maintained by KEMRON. If conducted, external Project Planning Sessions will be included in future versions of this AGCMR-QAPP. Meeting minutes will contain a list of all participants, meeting agendas, detailed description of discussions, and action items.

2.0 PROJECT QUALITY OBJECTIVES

2.1 Conceptual Site Model (QAPP Worksheet #10)

This worksheet presents a concise summary of the conceptual site model (CSM) as it relates to advanced geophysical classification activities at the Former Fort Ord. The CSM is a working, iterative model that depicts the current understanding of site conditions to assist in the communication of available information and the development of data quality objectives (DQOs).

A key component of the CSM for advanced EMI geophysical classification projects is a geographical information system (GIS) to maintain and manage project and geospatial data. New data derived from the advanced geophysical classification activities will be assimilated into the existing Fort Ord GIS and MMRP database.

BACKGROUND AND HISTORY

The former Fort Ord is adjacent to Monterey Bay in northwestern Monterey County, California, approximately 80 miles south of San Francisco (Figure 2-1 – Site Location Map). The former Army post consists of approximately 28,000 acres adjacent to the cities of Seaside, Sand City, Monterey, and Del Rey Oaks to the south and Marina to the north. Laguna Seca Recreation Area and Toro Regional Park border the former Fort Ord to the south and southeast, respectively. Land use east of the former Fort Ord is primarily agricultural.

The military conducted munitions-related activities (e.g., live-fire training) on the facility and as a result MEC including UXO and discarded military munitions (DMM) may be present in parts of former Fort Ord. The ROD (Army, 2008) for the Track 3 Impact Area Munitions Response Area (Impact Area MRA) addresses MEC that are known or suspected to be present in the Impact Area MRA. The Impact Area MRA is undeveloped, contains several rare, threatened and endangered species and is designated as a habitat reserve. The Impact Area MRA is part of the Fort Ord National Monument and will be managed by BLM once the remedial action is completed. The Impact Area MRA is a complex of numerous former military ranges (Figure 2-2 – Impact Area Ranges) with a variety of historical uses, designs and characteristics. The selected remedy includes vegetation clearance (including prescribed burning); technology-aided surface removal; digital geophysical surveys; subsurface MEC removal in selected areas; and land use controls (LUCs). Access to the Impact Area MRA is currently restricted to authorized personnel only. Remedial action activities have been ongoing in the Impact Area MRA since 2008.

BLM Area B is undeveloped, contains several rare, threatened and endangered species and is designated as a habitat reserve. BLM Area B is a part of the Fort Ord National Monument and is currently open to public recreation. The RI/FS for Track 2, BLM-Area B and MRS-16 was approved as Final (Revision 2) in May 2015. This RI/FS identified Alternative 3, Technology-Aided Surface MEC Remediation, with Subsurface MEC Remediation in Selected Areas, and LUCs as the preferred remedial alternative for BLM Area B sub-areas B-2A and B-3; and Alternative 2, LUCs for MRS-16 and the remainder of BLM Area B. In accordance with the Federal Facility Agreement (FFA), following the Proposed Plan (PP) and public meeting for the

PP, the Army will prepare a ROD for BLM Area B and MRS-16. A portion of BLM Area B has been transferred to BLM.

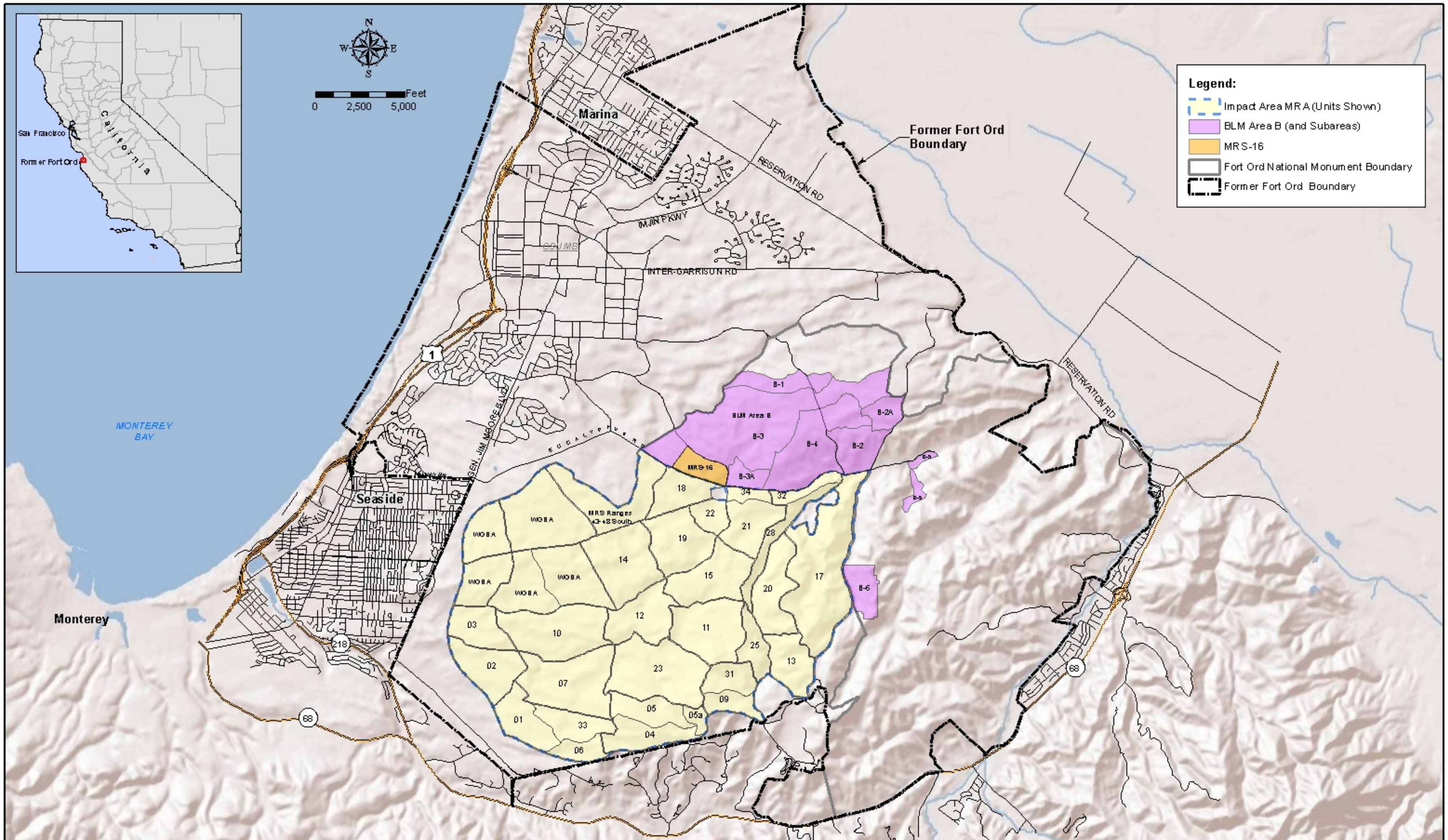
PHYSIOGRAPHY AND TOPOGRAPHY

Elevations at Fort Ord range from sea level to over 900 feet above mean sea level at Wildcat Ridge. Runoff is minimal due to the high rate of surface water infiltration into the permeable dune sand; consequently, well-developed natural drainages are mostly absent in this area. Small erosional gullies may be present where roads are carved into slopes but generally end with leveling of the topography. Closed drainage depressions typical of dune topography are common.

VEGETATION AND SENSITIVE HABITATS

The dominant plant community is central maritime chaparral, with some areas of grasslands, coastal scrub, and oak woodland. Vegetation clearance, if required, will be described in the Site-Specific Work Plan (SSWP) for a specific response area.

The Impact Area MRA, BLM Area B, and MRS-16 are currently designated as habitat reserve under the *Installation-Wide Multispecies Habitat Management Plan (HMP) for Former Fort Ord* (USACE, 1997A), which describes special land restrictions and habitat management requirements within habitat reserve areas. Habitat reserve areas support special status plant and animal species that require implementation of mitigation measures during remedial action activities identified in the HMP to ensure compliance with the Endangered Species Act and to minimize potential adverse impacts to listed species.



Geophysical Classification for Munitions Response
Quality Assurance Project Plan
Former Fort Ord
Monterey County, California

Figure 2-1
Site Locations

GEOLOGY AND HYDROGEOLOGY

The former Fort Ord lies within the Coast Ranges Geomorphic Province, and generally reflects the transitional condition between the mountains of the Santa Lucia Range and the Sierra de la Salinas to the south and southeast, respectively, and the lowlands of the Salinas River Valley to the north. Older, consolidated rock is exposed at the ground surface near the southern base boundary and becomes buried under a northward-thickening sequence of poorly consolidated deposits to the north. The former Fort Ord and the adjacent areas are underlain by one or more of the following units:

- Mesozoic granitic and metamorphic rocks.
- Miocene marine sedimentary rocks of the Monterey Formation.
- Upper Miocene to lower Pliocene marine sandstone of the Santa Margarita Formation (and possibly the Pancho Rico and/or Purisima Formations). Locally, these units are overlain and obscured by geologically younger sediments, including:
    - Plio-Pleistocene alluvial fan, lake, and fluvial deposits of the Paso Robles Formation
    - Pleistocene eolian and fluvial sands of the Aromas Sand
    - Pleistocene to Holocene valley fill deposits consisting of poorly consolidated gravel, sand, silt, and clay
    - Pleistocene and Holocene sand dune deposits
    - Recent beach sand
    - Recent alluvium

Geologic conditions may impact geophysical sensors through the influence of soil and rock constituents on the electromagnetic response of MEC items. High levels of electrically conductive minerals can produce complex electromagnetic signatures that interfere with the MEC detection and characterization process. Evaluation of site-specific geologic conditions is executed through (a) review of geologic and soil maps that describe the subsurface mineralogical conditions, and (b) review of the site through a site walk-over whereby geologic and soil effects can be directly verified and evaluated.

The strongest effects of the geologic conditions at the former Fort Ord are associated with the Santa Margarita Formation. This formation includes units containing significant amounts of iron matrix mineralization that manifest as magnetic concretions. These magnetic concretions are spherical, ranging from ½ to 1 ¼ inches in diameter, and are present throughout the former Fort Ord. While poorly documented throughout the site, the condition of the Santa Margarita Formation may affect the geophysical mapping process in the following three ways:

1. When exposed on the surface, magnetic concretions cause anomalies in the geophysical data.
2. When buried, the effects of concretions are anticipated to range from minor to severe, depending on the depth of burial and the concentration of items.
3. When the Santa Margarita Formation is significantly eroded, the effects of the concretions may be more severe. As the concretions are resistant to weathering, the erosion of the

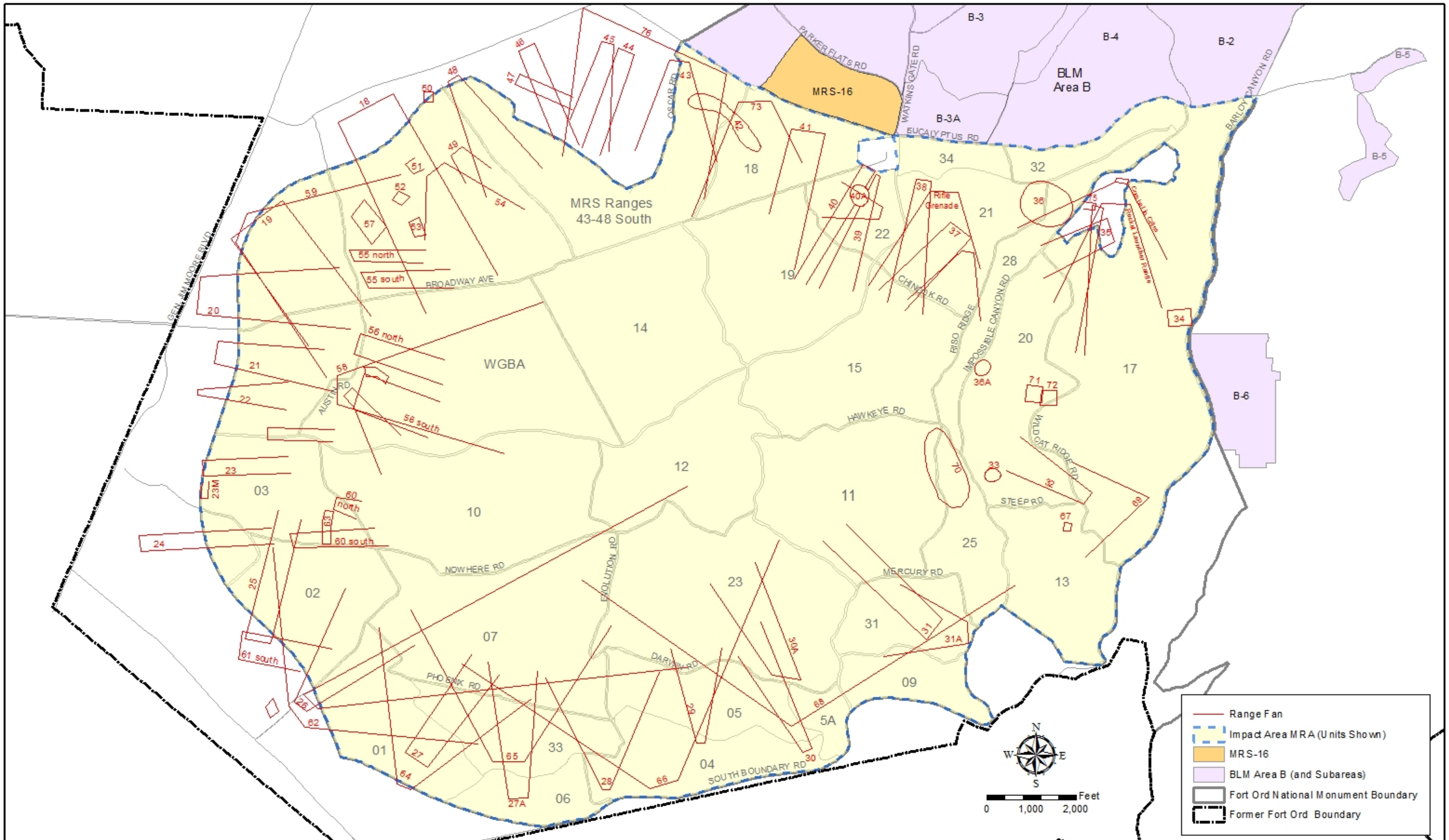
formation can leave large accumulations of these iron nodules in the remaining soil that can result in large anomalies in the data.

SOURCES OF KNOWN OR SUSPECTED MEC

Since 1917, portions of former Fort Ord were used by cavalry, field artillery, and infantry units for maneuvers, target ranges, and other purposes. From 1947 to 1974, Fort Ord was a basic training center. After 1975, the 7th Infantry Division occupied Fort Ord. Fort Ord was selected in 1991 for decommissioning, but troop reallocation was not completed until 1993, and the base was not officially closed until September 1994.

The Impact Area MRA is a complex of numerous former military ranges with a variety of historical uses, designs, and characteristics (Figure 2-2 – Impact Area Ranges). Various types of munitions have been used during the training activities historically conducted within the Impact Area MRA including artillery and mortar projectiles, rockets and guided missiles, rifle and hand grenades, practice land mines, pyrotechnics, bombs, and demolition materials. Select ranges were used for small arms training activities only, while other ranges are characterized as multi-use. In general, the firing points of the ranges were located near the perimeter of the MRA, and firing was directed toward the interior portion of the range complex. Training activities at the Impact Area MRA ceased after the closure of Fort Ord in 1994. The former ranges within the MRA contain a concentration of similar expended munitions and MEC. The Impact Area MRA is fenced, warning signs are posted, and access is controlled by the Army. The perimeter of the Impact Area MRA is patrolled to detect and prevent trespassing.

BLM Area B is generally located north-northeast of the Impact Area MRA (Figure 2-1) and is comprised of eight (8) different sub-areas based on historic training uses and the quality, types, and depth of previous munitions responses conducted in the respective areas. Investigations and MEC removal actions performed to date have identified historical use of BLM Area B and MRS-16 for various close combat and weapons training purposes, including use of machine gun, hand grenade, rifle grenade, smoke grenade, flares, 2.36 inch rocket, 37mm projectile, and mortars (60mm, 81mm, 3 inch stokes, and 4.2 inch).



Geophysical Classification for Munitions Response
Quality Assurance Project Plan
Former Fort Ord
Monterey County, California

Figure 2-2
Impact Area Ranges

G:\ArcGIS\USACE\Fort_Ord\PROJECTS\KEMRON\GCMR-QAPP\Figure_2-2_IA_Ranges.mxd 7/28/2016 [14:29 PM] AGASCHO, Gilbane

FATE AND TRANSPORT CONSIDERATIONS FOR MEC

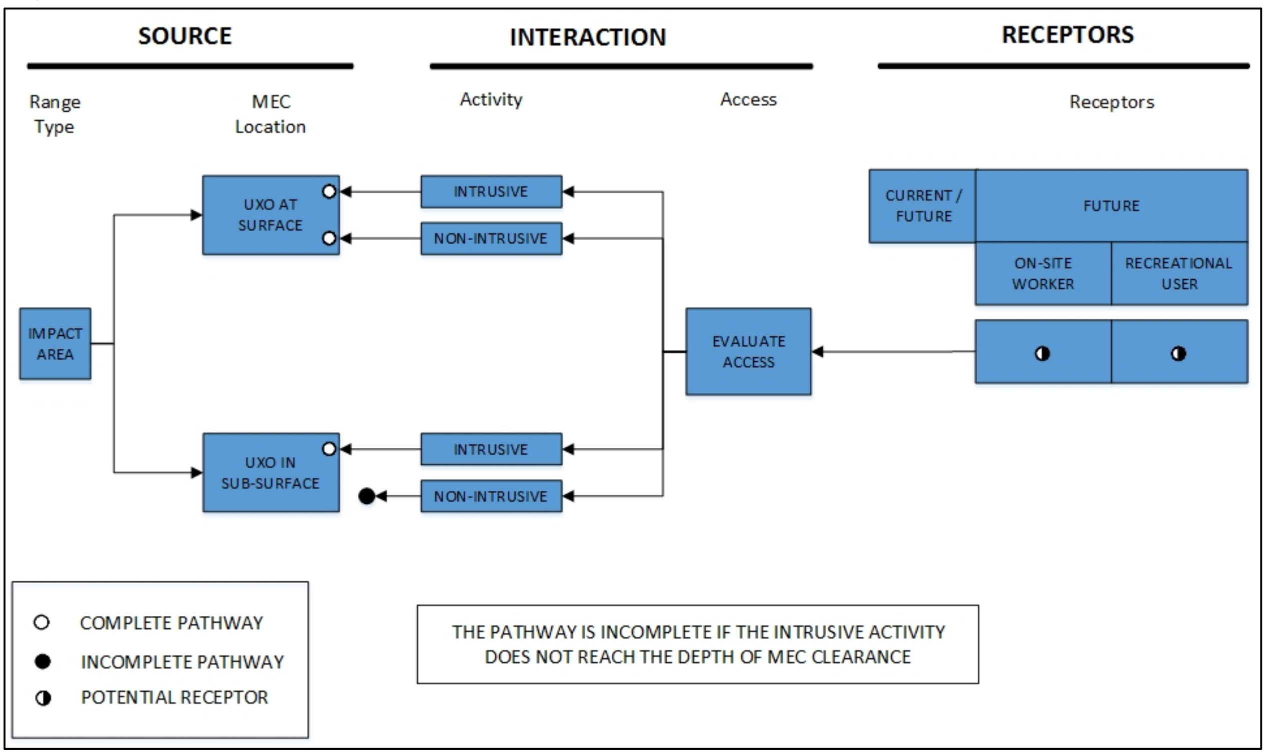
The fate and transport of MEC items within the Impact Area MRA and BLM Area B is governed by various physical factors and transport processes. Natural erosion of soil over time, due to wind, water, and other natural processes, can result in the exposure, reburial, and transport of MEC.

POTENTIAL RECEPTORS AND EXPOSURE PATHWAYS

The Impact Area MRA consists of the 6,560-acre portion of the 8,000-acre historical Impact Area that is entirely within the natural resources management area described in the *Installation-Wide Multispecies Habitat Management Plan for Former Fort Ord, California* (USACE, 1997) and is currently identified for transfer to the BLM. The Impact Area MRA is currently being used as a habitat for endangered species.

Based on the historical range uses, various types of munitions items are expected on the surface and subsurface within the Impact Area MRA. The potential future receptors for this area include habitat monitors, habitat workers, or visitors that could encounter MEC within the Impact Area MRA. In accordance with the Impact Area Track 3 ROD (signed in 2008), remedial actions have been conducted in several units within the Impact Area MRA and will continue to be implemented. The CSM for the Impact Area MRA displayed in Figure 2-3 relates to portions of the Impact Area MRA where remedial action activities have not yet been conducted.

Figure 2-3 Impact Area Conceptual Site Model



2.2 Project/Data Quality Objectives (QAPP Worksheet #11)

DQOs are qualitative and quantitative statements that outline the decision-making process and specify the data required to support project objectives. DQOs specify the level of uncertainty that will be accepted in results derived from data. The DQO process used for developing data quality criteria and performance specifications for decision making is consistent with the *Guidance on Systematic Planning Using the Data Quality Objectives Process*, Environmental Protection Agency (EPA) QA/G-4 (EPA, 2006). The DQO process consists of the following seven steps:

- Step 1: State the problem
- Step 2: Identify the goals of the project
- Step 3: Identify information inputs
- Step 4: Define the boundaries of the project
- Step 5: Develop the project data collection and analysis approach
- Step 6: Specify project-specific measurement performance criteria
- Step 7: Develop the survey design and project workflow

Step 1: State the Problem. MEC in the form of DMM and UXO are known to be present in portions of the Former Fort Ord. The Army has been conducting MEC investigations and removals in munitions response sites at the former Fort Ord using analog and digital geophysical techniques to detect subsurface metallic items. Within the Impact Area MRA, specific areas are selected for subsurface MEC removal. During traditional subsurface MEC removal utilizing digital geophysical methods, the site is geophysically mapped using EM61-MK2A EMI sensors, supplemented by analog (mag and dig) removal in highly cluttered areas. Because these technologies do not provide a validated means to discriminate between MEC and nonhazardous metallic debris, the locations of all anomalies greater than the detection threshold (specified in the SSWPs) are identified, reacquired, and excavated. Experience has shown that the majority of the cost and effort of subsurface MEC removals are associated with the excavation of non-MEC items. Recent research has resulted in the development of discrimination technologies to reduce the number of excavations of non-MEC items, thus reducing the cost of subsurface removals.

Advanced geophysical classification uses geophysical sensors to detect metal items beneath the ground surface followed by the use of advanced sensors and geophysical classifiers to estimate physical properties of the item (such as size, aspect ratio, wall thickness, and symmetry) and determine whether the item is a target of interest (TOI) or non-TOI. Using this information in a structured decision-making process, the project team will be able to make informed decisions about whether an item should be excavated or can be left in place.

Step 2: Identify the goals of the project. Depending on site-specific conditions and the goals and objectives of each individual activity, advanced geophysical classification may not be the most efficient technique or the best choice to meet individual project objectives. Advanced geophysical classification is an additional tool to be utilized in specific situations, but it will not replace standard MEC removal methods. The goal of the advanced geophysical classification work is to identify geophysical anomalies potentially representing MEC and to determine which of those anomalies require removal and which may be left in place. Advanced geophysical classification may be used to detect anomalies resulting from DMM, UXO, and other metallic debris and to classify those anomalies so that informed decisions can be made as to whether each anomaly is a TOI and should be removed or is a non-TOI and may be left in place. Geophysical detection data will be used to initially detect and document the locations of subsurface anomalies. If deemed appropriate for use at a specific site or area, geophysical data collected using advanced EMI sensors in a cued (static) mode will then be used to classify each anomaly as follows:

1. TOI (i.e., highly likely to be DMM or UXO)
2. Non-TOI (i.e., highly unlikely to be DMM or UXO)
3. Inconclusive.

Detected items classified as "TOI" and "inconclusive" will be targeted for removal. Items classified as non-TOI will be left in place. The results of geophysical detection and classification and the subsequent intrusive investigation must meet established DQOs to complete the investigation.

Step 3: Identify information inputs. The following information inputs are required for successful accomplishment of the project objectives:

- An up-to-date CSM that summarizes site conditions based on previous studies, including:
    - Remedial action objectives
    - Site history and use
    - Range boundaries
    - Types and quantities of MEC known or suspected to be present
    - Expected distribution of MEC present
    - Topography, geology, and vegetation
    - Land use considerations
    - Reasonably anticipated future uses
    - Current and future receptors
    - Exposure pathways
    - Access restrictions or other obstacles to investigation
    - Endangered species, sensitive habitats, and historic or cultural resources that could be affected by traffic or other disturbances occurring during the investigation
    - Assumptions, data gaps, and sources of uncertainty
- Detection survey DGM results, including:

  - Areas covered
  - System QC test results
  - Instrument Verification Strip (IVS) results
  - Surveyed validation seed and QC seed locations
  - Data acquisition point responses and locations
  - Data analysis results, including:
    - Anomaly locations
    - Unique anomaly identification numbers
    - Amplitude response for each anomaly
- Classification survey results, including:
  - Definition of targets of interest
  - Unique anomaly identification numbers and locations
  - System QC results
  - IVS results
  - Background data
  - Surveyed validation seed and QC seed locations and types
  - Site-specific munitions library
  - Anomaly classification results
  - Ranked dig list with stop-dig threshold
  - Classification Survey Validation Report
  - Validation results
  - Classification Survey Data Usability Evaluation
  - Updated CSM
- Intrusive investigation and MEC removal results, including:
  - Excavation results (database)
  - Photos
  - Disposal records
  - Stop-dig threshold verification
  - Comparison of excavated validation digs to predictions
  - Final Data Usability Evaluation
  - Final CSM

Step 4: Define the boundaries of the project. The boundaries of areas within each unit where subsurface MEC removal will be conducted utilizing advanced geophysical classification will be detailed in the SSWP and Technical Memorandum prepared for each activity. Spatial boundaries for each Unit are presented on Figure 2-1 (Site Location Map). The vertical extent of the activity extends from the surface to depths to be specified in the SSWP prepared for each activity.

Step 5: Develop the project data collection and analysis approach. Advanced geophysical classification work will use the results from advanced geophysical sensors (decay curves) and Geosoft's UX-Analyze Advanced (UXA) software to measure, model, and classify target anomalies detected during the geophysical detection survey. Geophysical data from advanced sensors will be interpreted with physics-based models to estimate the physical attributes of the anomalies, and classifier models will be used to evaluate the likelihood that the anomalies are intact munitions. Anomalies will be classified into one of three categories described in Step 2 above. The final product of the geophysical investigation will be a "ranked anomaly list" that classifies each anomaly, justifies the classification, and identifies whether a detected object will be removed or left in place. Anomalies on the list will be ranked in order of greatest likelihood to be a TOI to greatest likelihood to be a non-TOI, based on their confidence metrics.

The advanced geophysical classification approach also addresses concerns related to the geologic conditions described in Worksheet 10. These geologic conditions are not anticipated to adversely impact advanced geophysical classification activities for the following reasons:

- The advanced geophysical classification systems utilize electromagnetic induction sensors, which are typically less affected by geologic conditions than other geophysical sensor types.
- Advanced sensor investigations include periodic background measurements that are used to subtract the non-target component (sensor response due to the sensor system itself and the ambient environment in which the target is buried) from the overall sensor measurement, leaving only the signature of the target.

The presence of groundwater has minimal effect on the advanced geophysical classification system sensor and is therefore not expected to be an issue during advanced geophysical classification activities. Standard practice requires the acquisition of at least one background measurement every two hours to allow subtraction of the responses from the instrument itself and the ambient environment from the sensor measurements. In the event of changing soil moisture conditions due to precipitation, more frequent background measurements will be taken, as necessary, to accurately isolate and remove moisture-related response from the sensor measurements.

Advanced geophysical classification activities will be performed in accordance with the HMP and monitored by natural resources personnel to ensure compliance with the Endangered Species Act and to minimize potential adverse impacts to listed species.

DETECTION SURVEY

The anomaly detection survey may be conducted using standard EM61-MK2 DGM as described in the MEC-QAPP (KEMRON, 2015b) or using advanced EMI sensors. If advanced EMI sensors are used for the detection phase, the following parameters of interest, inferences, and decision rules will be utilized.

Parameters of interest from detection survey data: Anomaly measurements with an amplitude and signal to noise ratio greater than or equal to the site-specific threshold values described in the SSWP.

Type of inference: Measurements meeting the criteria noted above will be considered to be potential TOI and selected as anomalies for further evaluation during the classification phase.

Decision rules: Anomalies with response amplitudes and signal to noise ratios greater than or equal to the site-specific threshold values, as determined by test pit measurements or other site-specific methods, will be selected and placed on the cued investigation list for the classification survey. Site-specific anomaly selection threshold values will be dependent on detection goals specified in the SSWP for each project area.

CLASSIFICATION SURVEY

The characteristics of interest in the cued advanced geophysical classification sensor data are the physical characteristics intrinsic to each anomaly source that allow the classification process to determine whether the anomaly most likely represents a TOI or non-TOI. The sensor data from each measurement will be processed and analyzed to create a model of the target that best fits the measured data. In many cases, the best fit to the measured data will be a combination of multiple targets. The model (or models) will then be compared to the classification library of known MEC signatures to classify the target as one of the following:

1. TOI – Targets that are likely to be MEC items or QC or validation seed (formerly referred to as QA seed) items
2. Non-TOI – Targets that are unlikely to be MEC items or QC or validation seed items
3. Inconclusive – Targets for which the modeled response is not highly-correlated with the observed response, and the acquired data therefore does not support a confident classification decision

Parameters of interest from classification survey data: Cued measurement noise value (beta noise points), inversion fit coherence, inversion outputs of β1, β2, β3, x, y, and z, and library match confidence metrics.

Type of inference: If any of the following three criteria are met, the anomaly will be selected as a TOI:

- The polarizability matches (within specifications established on Worksheet 22) that of an item in the project-specific TOI library.

- Estimates of the size (UXA_size), shape (β1/β2/β3 ratios), symmetry (UXA_Plate_Sym or Axial_Sym), and wall thickness (UXA_Decay) calculated from the polarizability curves indicate the item is long, cylindrical, thick-walled, and of similar size to MEC items thought to exist in the site.
- There is a group of 3 or more anomalies having similar polarizabilities that, after intrusive investigation, are discovered to be TOI.

Anomalies with poor inversion fit coherence (where the modeled response is not highly-correlated with the observed response) that, after considering all available information, cannot be ruled as non-TOI will be classified as inconclusive.

Decision rules:

- If an object is classified as TOI, then the object will be excavated.
- If an object is classified as non-TOI, then the object will be left in place.
- If an object is classified as inconclusive, then the object will be excavated.

INTRUSIVE INVESTIGATION

Anomalies classified as either TOI or inconclusive will be intrusively investigated, and the sources of the anomalies will be removed. Items classified as non-TOI will be left in place. A subset of non-TOI anomalies will be identified in the final Advanced Geophysical Classification Validation Plan (the draft version of which is included in Appendix D) and intrusively investigated as validation digs to demonstrate that appropriate classification decisions were made. If an investigated anomaly from the validation list is determined to be a TOI, a root cause analysis (RCA) will be performed.

Intrusive investigation results, including precise recovery depths, will be recorded, and photographs will be taken of recovered items. Additionally, details regarding specific varieties of recovered MEC items (e.g., HE vs. practice munitions) will be recorded.

Step 6: Specify project-specific measurement performance criteria. Project-specific measurement performance criteria (MPC), the criteria that acquired data must meet to satisfy the DQO, are presented in Worksheet 12. Failure to achieve the MPC may have an impact on end uses of the data, which will be discussed in the Data Usability Evaluation Report.

Step 7: Develop the survey design and project workflow. The MPC established during Step 6 of the DQO process were used to develop the sample design, which is described in Worksheet 17. The sample design is broken down into a series of specific processes and data acquisition steps, termed definable features of work (DFW). Figure 3-1 provides an advanced geophysical classification decision tree that will be used in the execution of the sample design to evaluate the conformance of specific DFW to established MPC.

2.3 Measurement Performance Criteria (QAPP Worksheet #12)

This worksheet documents the project-specific MPC in terms of precision, bias, sensitivity, representativeness, completeness, and comparability. The MPC establish the minimum performance specifications that the geophysical survey design, including instruments and procedures, must meet to ensure acquired data will satisfy the DQO documented on Worksheet 11. In this worksheet, "detection survey" refers to dynamic surveys conducted with advanced EMI sensors.

DFW	Data Quality Indicator (DQI)	Specification	Activity Used to Assess Performance
QC seeding	Representativeness	Subsurface blind QC seed items placed at site. Subsurface QC seed items (industry standard objects [ISOs]) will be placed in the subsurface such that each data acquisition team, whether acquiring detection or cued data, can be expected to encounter between one and three seed items per day.	Comparison of actual placement data (quantity and recorded depths and orientations) to specifications in AGCMR-QAPP
Detection survey	Completeness	100% of the intended survey area is surveyed.	Verification of conformance to measurement quality objectives (MQOs) for in-line spacing and cross-line spacing (see Worksheet #22)
Detection survey	Sensitivity	The site-specific detection threshold is identified in the SSWP.	Initial and ongoing IVS surveys. Blind seed detection. Analysis of background variability across the site.
Detection survey	Accuracy/Completeness	100% of QC and validation seed items must be detected.	Review of QC and validation seed detection results per survey unit
Detection survey	Completeness/ Comparability	Complete Geosoft® databases and target lists delivered.	Data verification/data validation
Classification survey	Completeness/ Comparability	Site-specific classification library must include signatures for all TOI known or suspected to be present at the site, as listed in the CSM.	Verification of site-specific library
Classification survey	Representativeness/ Accuracy	Background data measurements will be acquired at least once every 2 hours of cued survey data acquisition. Background locations will be selected such that background data will be representative of the various subsurface conditions expected to be encountered within the survey area.	Data verification/data validation

DFW	Data Quality Indicator (DQI)	Specification	Activity Used to Assess Performance
Classification survey	Completeness	All detected anomalies classified as: 1. TOI 2. Non-TOI 3. Inconclusive	Data verification
Classification survey	Completeness	In addition to Geosoft database, inversion results delivered as png files illustrating (at a minimum) the three estimated primary axis polarizabilities, the polarizabilities of the best library match, quality indicators for measured data, quality indicators for inversion results, and quantitative classification metrics.	Data verification/data validation
Intrusive Investigation	Accuracy	All predicted non-TOI that are intrusively investigated from the validation dig list are confirmed to be non-TOI.	Visual inspection of recovered items
Intrusive Investigation	Accuracy	Recovered items from predicted TOI locations approximate the size and shape of the predicted TOI.	Visual inspection and qualitative evaluation of recovered items from the TOI digs
Intrusive Investigation	Accuracy/ Completeness	Classification survey correctly classifies 100% of all QC and validation seed items.	Review of QC and validation seed item classification results

2.4 Project Tasks & Schedule (QAPP Worksheets #14 & 16 [UFP-QAPP Manual Section 2.8.1])

A summary of the investigation tasks and schedule is provided in Appendix A. Detailed descriptions of the project tasks are provided in Worksheet 17 - Sampling Design and Rationale.

3.0 SAMPLE DESIGN

3.1 Sampling Design and Rationale (QAPP Worksheet #17)

This worksheet details the specific DFWs to be performed to meet the objectives of the investigation. Each of these work elements, the SOPs that define the methods for performing the activities, and other supporting documentation for performing the investigation are presented in the table below. The principal tasks associated with the DFWs are detailed following the table. In this worksheet, "detection survey" refers to dynamic surveys conducted with advanced EMI sensors.

DFW	Associated Activities (Referenced SOPs are provided in Appendix B)	Supporting Document(s)
Pre-Mobilization Activities	Prepare AGCMR-QAPP Prepare Blind Seed Firewall Plan Prepare draft Advanced Geophysical Classification Validation Plan	AGCMR-QAPP Blind Seed Firewall Plan Advanced Geophysical Classification Data Validation Plan
Mobilization and Site Preparation	Mobilize staff Mobilize equipment Kickoff/Safety Meeting Habitat conservation training for project personnel, including minimization measures outlined in the project-specific habitat checklist Place subsurface QC seed items (KEMRON) and validation seed items (USACE) with UXO/anomaly avoidance and survey locations Establish IVS	AGCMR-QAPP SOP AGCMR-02 SOP AGCMR-03 HMP
Detection Survey	Assemble advanced EMI sensor system for detection survey and verify operation Perform initial dynamic IVS survey and prepare IVS Memorandum Perform advanced EMI sensor detection survey	AGCMR-QAPP SOP AGCMR-01 SOP AGCMR-02 SOP AGCMR-05 SOP AGCMR-06

DFW	Associated Activities (Referenced SOPs are provided in Appendix B)	Supporting Document(s)
Detection Survey Data Verification	Verify quality of detection survey data prior to data analysis and target selection (daily)	AGCMR-QAPP SOP AGCMR-06
Detection Survey Data Processing, Analysis and Target Selection	Process detection survey data Select target anomalies and generate the classification investigation list for the classification survey GIS incorporation	AGCMR-QAPP SOP AGCMR-06
Detection Survey Quality Control	Validate data that has undergone data verification (weekly) Validate data that has undergone analysis and target selection process (weekly, or other predefined scheduled frequency)	AGCMR-QAPP SOP AGCMR-06
Classification Survey	Assemble advanced EMI sensor system for classification survey and verify operation Perform initial cued IVS survey and prepare IVS Memorandum Perform test pit measurements to populate classification library with site-specific TOI signatures, if necessary Establish background measurement locations Perform advanced EMI sensor classification survey	AGCMR-QAPP SOP AGCMR-01 SOP AGCMR-02 SOP AGCMR-04 SOP AGCMR-07 SOP AGCMR-08
Classification Survey Data Verification	Verify quality of classification survey data prior to inversion and classification (daily)	AGCMR-QAPP SOP AGCMR-08
Classification Survey Data Processing, Analysis and Classification	Process classification survey data – background corrections and inversions Add site-specific signatures to classification library, if necessary Classify anomalies and generate TOI/non-TOI classification spreadsheet, ranked dig lists GIS incorporation Finalize Advanced Geophysical Classification Validation Plan	AGCMR-QAPP SOP AGCMR-08

DFW	Associated Activities (Referenced SOPs are provided in Appendix B)	Supporting Document(s)
Classification Survey Quality Control	Validate data that has undergone data verification (weekly) Validate completeness of the classification library Validate data that has undergone classification and ranking process (weekly, or other predefined scheduled frequency)	AGCMR-QAPP SOP AGCMR-08
Intrusive Investigation	Reacquire and flag anomalies selected for intrusive investigation Investigate anomalies and remove identified anomaly sources	AGCMR-QAPP SOP AGCMR-09
Demobilization	Demobilize personnel and equipment	AGCMR-QAPP
Reporting	Prepare final Advanced Geophysical Classification Technical Memorandum/Data Usability Report	AGCMR-QAPP Advanced Geophysical Classification Data Validation Plan

Pre-Mobilization Activities

Prepare AGCMR-QAPP

The AGCMR-QAPP will be prepared in accordance with Guidance on QAPP, Final Draft. (EPA, 2012), UFP for QAPP, Part 2a (Revised): Optimized UFP-QAPP Worksheets (IDQTF, 2012), and UFP for QAPP Template: Geophysical Classification for MR, Revised Beta Draft (IDQTF, 2015). The AGCMR-QAPP and a detailed Site-Specific Work Plan will be provided for regulatory review prior to commencement of advanced geophysical classification field activities.

Prepare Blind Seed Firewall Plan

A Blind Seed Firewall Plan is provided in Appendix C detailing the project team's approach to limiting distribution of the QC seed information (i.e., types, depths and locations of QC seed items placed at the site).

Prepare Draft Advanced Geophysical Classification Validation Plan

A draft Advanced Geophysical Classification Validation Plan, designed to provide assurance that TOI are correctly classified and that no TOI have been classified as non-TOI, is provided in Appendix D. The plan details the approach to validation, including validation of appropriate anomaly selection methods and thresholds for library matching, cluster analysis and feature analysis. The document will be finalized after completion and delivery of the final classification results to USACE and prior to performance of validation digs.

Mobilization and Site Preparation

A mobilization period will include mobilizing staff and securing and deploying equipment. Mobilization activities will include general activities, site-specific training, and a kickoff and safety meeting. During field work activities, all environmental protection measures described in the MEC Procedures Supplement (MPS) [KEMRON 2015a] will be implemented and followed.

General Activities

The general activities to be performed as part of mobilization include the following:

- Identify/procure, package, ship, and inventory project equipment
- Finalize operating schedules
- Assemble and transport the work force
- Test and inspect equipment (See Worksheet 22 for details)
- Conduct site-specific training on the AGCMR-QAPP, MEC procedures and hazards, and habitat conservation for all project personnel
- Verify that all forms and project documentation are in order and KEMRON Team members understand their responsibilities with regard to completion of project reporting requirements, including appropriate nomenclature, terminology, and avoidance of unprofessional language in project documents and reporting forms.

Kickoff/Safety Meeting

During mobilization, a kickoff and site safety meeting will be conducted. This meeting will include a review of this AGCMR-QAPP and review and acknowledgment of the Accident Prevention Plan (APP) by all site personnel. Additional training topics to be discussed include the environmental protection measures described in the MPS (KEMRON 2015a) and the minimization measures outlined in the project-specific habitat checklist. Additional meetings will occur as needed, as new personnel, visitors, and/or subcontractors arrive at the site.

Place Subsurface QC and Validation Seeds

The QC Geophysicist will place subsurface QC seed items across the investigation area in accordance with SOP AGCMR-03 (Appendix B) prior to onset of the advanced EMI sensor survey. The seed item frequency is designed to demonstrate the quality of each production unit, generally assumed to be one day of advanced EMI sensor data acquisition. While encountering at least one seed item every day of the survey cannot be guaranteed, QC seed items will be placed such that each data acquisition team, whether acquiring detection or cued data, should encounter between one and three seed items per day, on average. The QC seed items will be ISOs that will be placed up to the maximum target depth for the investigation. Specific seed item information and burial depths will be detailed in the SSWP. The QC seed item information will be documented and provided to USACE as a separate database in accordance with the Blind Seed Firewall Plan (Appendix C).

Validation seeding will be conducted by USACE. Validation seeding details, including types of seed items, quantities, and burial locations, depths, and orientations will not be known to the contractor.

Establish IVS

In order to test the advanced EMI sensor system and verify that it is functioning properly, an initial IVS survey will be performed as described in SOP AGCMR-02 (Appendix B). The IVS will be constructed at a location convenient for daily access and will include two ISO and one 'blank' location, where nothing is buried. One ISO will be buried horizontally, perpendicular to the transect, and one will be buried vertically, at depths described in the SSWP. IVS item locations will be recorded with real-time kinematic (RTK) global positioning system (GPS), and depths and orientations will be measured as accurately as possible.

Detection Survey

Assemble Advanced EMI Sensor for Detection Survey and Verify Operation

The advanced EMI sensor system will be assembled and tested in accordance with SOP AGCMR-01 (Appendix B).

Perform initial dynamic IVS survey and prepare IVS Memorandum

After assembly of the advanced EMI sensor system for dynamic detection surveys, the IVS strip will be used to perform an initial dynamic IVS survey for each system in accordance with SOP AGCMR-02 (Appendix B) to verify proper assembly and functionality.

After performance of the initial dynamic IVS, an IVS Memorandum will be prepared detailing the dynamic IVS survey operation and results, including documentation of compliance with the dynamic IVS MQOs provided in Worksheet 22. The IVS Memorandum will be provided to the project team for review and concurrence within 3 working days of completion of the initial IVS survey. If the initial IVS results meet the dynamic IVS MQOs, the Gilbane Project Geophysicist may elect to begin the detection survey prior to project team review of the IVS Memorandum.

Perform dynamic detection survey

The dynamic detection survey will be performed in accordance with SOP AGCMR-05 (Appendix B).

Data Verification

Data verification will be conducted each day of data acquisition to demonstrate that project MQOs have been achieved and will be documented in a weekly QC report. Detection survey data verification procedures are conducted both in the field during data acquisition activities and remotely during data processing activities. Field verification of data quality will be conducted in accordance with SOP AGCMR-05, Section 3.4. Data processing verification of data quality will be conducted in accordance with SOP AGCMR-06, Section 3.1.1.

Quality control of advanced geophysical detection data and processing will be conducted by NAEVA Geophysicists experienced in advanced geophysical classification work. Every week, data that has undergone quality verification by the data processor will be provided to the QC Geophysicist for validation prior to data processing. The QC Geophysicist will validate the data quality by monitoring the data for agreement with the MQOs in Worksheet 22 and return the data to the data processor within one week for completion of data processing and target identification.

Data Processing, Analysis and Target identification

Process dynamic detection survey data, identify anomalies with response values and signal to noise ratios greater than the values described in the SSWP, and generate the cued investigation list for the classification survey.

Data processing and classification will be performed in accordance with SOP AGCMR-06.

Classification Survey

Assemble Advanced EMI Sensor for Classification Survey and Verify Operation

The advanced EMI sensor system will be assembled and tested in accordance with SOP AGCMR-01 (Appendix B).

Perform Initial Cued IVS Survey and Prepare IVS Memorandum

After assembly of the advanced EMI sensor system for classification surveys, the IVS strip will be used to perform an initial cued IVS survey for each system in accordance with SOP AGCMR-02 (Appendix B) to verify proper assembly and functionality.

After performance of the initial cued IVS, an IVS Memorandum will be prepared detailing the cued IVS survey and results, including documentation of compliance with the cued IVS MQOs provided in Worksheet 22. The IVS Memorandum will be provided to the project team for review and concurrence within 3 working days of completion of the initial IVS survey. If the initial IVS results meet the cued IVS MQOs, the Gilbane Project Geophysicist may elect to begin the classification survey prior to project team review of the IVS Memorandum.

Perform Test Pit Measurements

The library of advanced geophysical classification munitions data will be based on the munitions classification library developed and maintained by the DoD. The DoD munitions classification library was developed by acquiring advanced EMI sensor data over sample munitions items in a controlled environment. The data were then inverted to determine the primary axis polarizabilities for each sample munitions item. The DoD munitions classification library contains signature polarizabilities in both Hierarchical Data Format version 5 (HDF5) and Geosoft Oasis Montaj formats and allows classification comparisons for data acquired by various advanced EMI sensors (TEMTADS, MetalMapper, OPTEMA, and MPV) utilizing a variety of data acquisition parameters to meet specific project needs.

Test pit measurements will be conducted as necessary prior to the classification survey to acquire signatures of TOI that are not currently in the classification library. Test pit measurements will be conducted by placing the item at precisely-measured depths and orientations in an excavated pit below the advanced EMI sensor and acquiring cued measurements as described in SOP AGCMR-07 (Appendix B). The test pit measurements will be processed as described in SOP AGCMR-08 (Appendix B) and added to the site-specific classification library utilizing the purpose-built classification library utilities in UX-Analyze Advanced.

Establish Background Measurement Locations

Background measurement locations will be established throughout the survey area as described in SOP AGCMR-04 (Appendix B) to allow background measurements to be acquired under conditions closely resembling those of the classification survey acquisition. The suitability of each background location will be verified and documented as described in SOP AGCMR-04.

Perform Advanced EMI Sensor Classification Survey

Anomalies identified for cued interrogation will be surveyed in accordance with SOP AGCMR-07 (Appendix B).

Data Verification

Data verification will be conducted each day of data acquisition to demonstrate that project MQOs have been achieved and will be documented in a weekly QC report. Classification survey data verification procedures are conducted both in the field during data acquisition activities and remotely during data processing activities. Field verification of data quality will be conducted in accordance with SOP AGCMR-07, Section 3. Data processing verification of data quality will be conducted in accordance with SOP AGCMR-08, Section 3.2.

Quality control of advanced geophysical classification data, processing and classification will be conducted by NAEVA Geophysicists experienced in advanced geophysical classification work. Every week, data that has undergone quality verification by the data processor will be provided to the QC Geophysicist for validation prior to data processing and classification. The QC Geophysicist will validate the data quality by monitoring the data for agreement with the MQOs in Worksheet 22 and return the data to the data processor within one week for completion of data classification. The QC Geophysicist will also validate the completeness and quality of the site-specific classification library.

Data Processing, Analysis and Classification

Process Classification Survey Data, Classify Anomalies and Generate TOI/Non-TOI Classification Spreadsheet

Data processing and classification will be performed in accordance with SOP AGCMR-08 (Appendix B). Each anomaly will be classified as TOI, non-TOI or inconclusive on the ranked dig list. If an anomaly is classified as TOI, it will be intrusively investigated. If an anomaly is classified as non-TOI, it will not be intrusively investigated (unless it is selected for investigation on the validation dig list). If an anomaly is classified as inconclusive, it will be intrusively investigated.

A preliminary database of anomaly classifications will be provided to USACE after completion of the initial classification. A final classification database and technical memorandum will be provided after any necessary threshold verification digs have been performed and the results used to finalize the classification process.

The data processing, classification, and ranking process will be validated against the MQOs in Worksheet 22 by the QC Geophysicist prior to finalization of the ranked dig list and delivery to the client.

Geographic Information System Incorporation

All relevant geospatial-related data and information will be incorporated into the existing Fort Ord GIS. The final submittal in electronic format will contain all required project (ArcGIS.mxd) files and layout files for all drawings that are presented in the final report. Environmental Systems Research Institute, Inc. (ESRI)–compliant formats (shapefiles, coverages, or geodatabases) will be used to present GIS data during the project, with supporting tabular data provided in Microsoft Excel format, Microsoft Access format, or both, as needed.

In addition, each GIS data set will be accompanied by metadata conforming to Federal Geographic Data Committee's (FGDC) *Content Standard for Digital Geospatial Metadata* (CSDGM) and be provided in a geodatabase that is compliant with the *Spatial Data Standards for Facilities, Infrastructure, and Environment* (SDSFIE). The horizontal accuracy of GIS data created by KEMRON will be tested in accordance with the National Standard for Spatial Data Accuracy (NSSDA), and the results will be recorded in the metadata.

Finalize Advanced Geophysical Classification Validation Plan

The draft Advanced Geophysical Classification Validation Plan (Appendix D) will be evaluated and revised as necessary for final review and approval by USACE prior to the performance of the validation digs. Additional anomalies beyond the 'Stop Dig' point, the cutoff threshold for the library match metric, will be defined in the final Advanced Geophysical Classification Validation Plan and placed on the validation list to verify that the 'Stop Dig' point was selected at an appropriate cutoff point.

Intrusive Investigation

Intrusive investigation will include reacquisition and flagging of anomalies selected for removal and the excavation of the sources of those anomalies. Anomalies to be intrusively investigated will include those identified as TOI and inconclusive as well as those selected as part of the validation process. All intrusive operations will be performed in accordance with the Fort Ord MPS (KEMRON, 2015a) and SOP AGCMR-09 (Appendix B).

Reacquire and Flag Anomalies Selected for Removal

Anomalies selected for removal will be reacquired by KEMRON personnel using RTK GPS to place a flag at the modeled target location derived through the data processing and classification process in accordance with SOP AGCMR-09 (Appendix B). Reacquisition teams will include one geophysicist and one UXO Technician II. The anomaly ID will be written in indelible marker on a survey flag placed at the anomaly location.

Investigate Anomalies and Remove Identified Anomaly Sources

After reacquisition of the anomalies selected for removal, each anomaly will be intrusively investigated in accordance with SOP AGCMR-09 (Appendix B). The initial anomalies to be investigated will be those selected as threshold verification digs in order to determine whether certain signatures should be added to the classification library from the cluster analysis and to verify the appropriate threshold (see the draft Advanced Geophysical Classification Validation Plan in Appendix D). After completion of the threshold verification digs, the intrusive team will proceed to investigate the remainder of the anomalies identified on the dig list. The final set of anomalies to be investigated will be those selected as part of the validation process approved in the final Advanced Geophysical Classification Validation Plan.

Specific intrusive investigation procedures, including vertical and lateral excavation limits, are detailed in SOP AGCMR-09 (Appendix B). Due to the precision of advanced geophysical classification data and modeling results, as well as to the nature of classification surveys, where non-TOI metallic items are purposely left in the ground, intrusive investigations will be conducted with different procedures than those of intrusive investigations based on standard DGM. Each excavation will be conducted only in the immediate vicinity of the reacquired target location, with an approximate search radius of one standard shovel width. The investigation will proceed until the predicted item (or a metallic item of comparable size and shape) is recovered or until the excavation depth has reached 12 inches below the predicted depth.

Post-investigation anomaly resolution will be verified by comparing the modeled classification results (predicted item identity and depth) to the actual intrusive investigation results. Any anomaly investigated from the validation dig list and identified as a TOI will trigger an RCA and corrective action, as appropriate. Documentation of the intrusive investigation results will be performed in accordance with Section 7.3.4 (MMRP Database) of the Fort Ord MPS (KEMRON, 2015B).

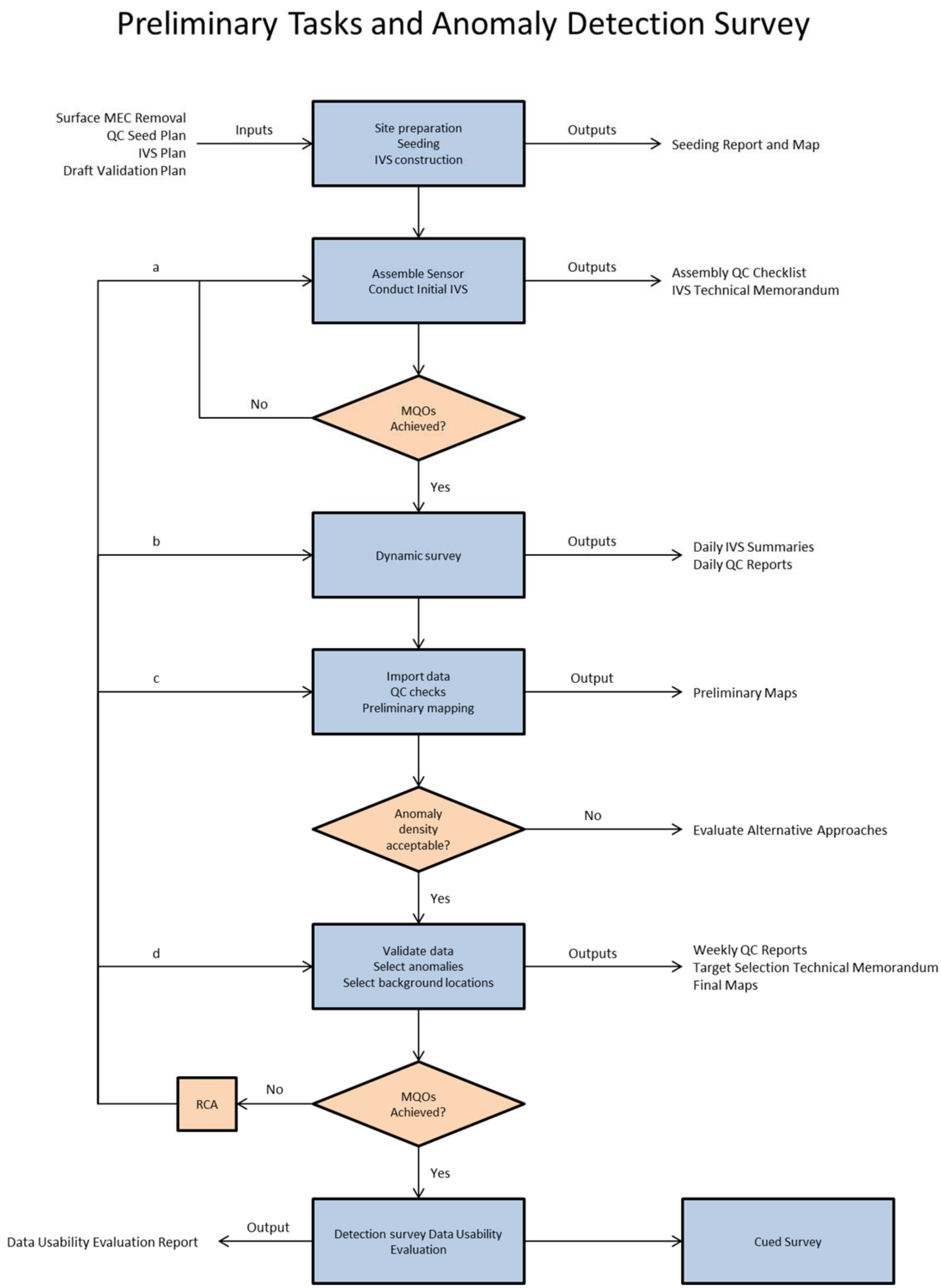
Demobilization

After completion of all field operations, equipment and personnel will be demobilized from the project site.

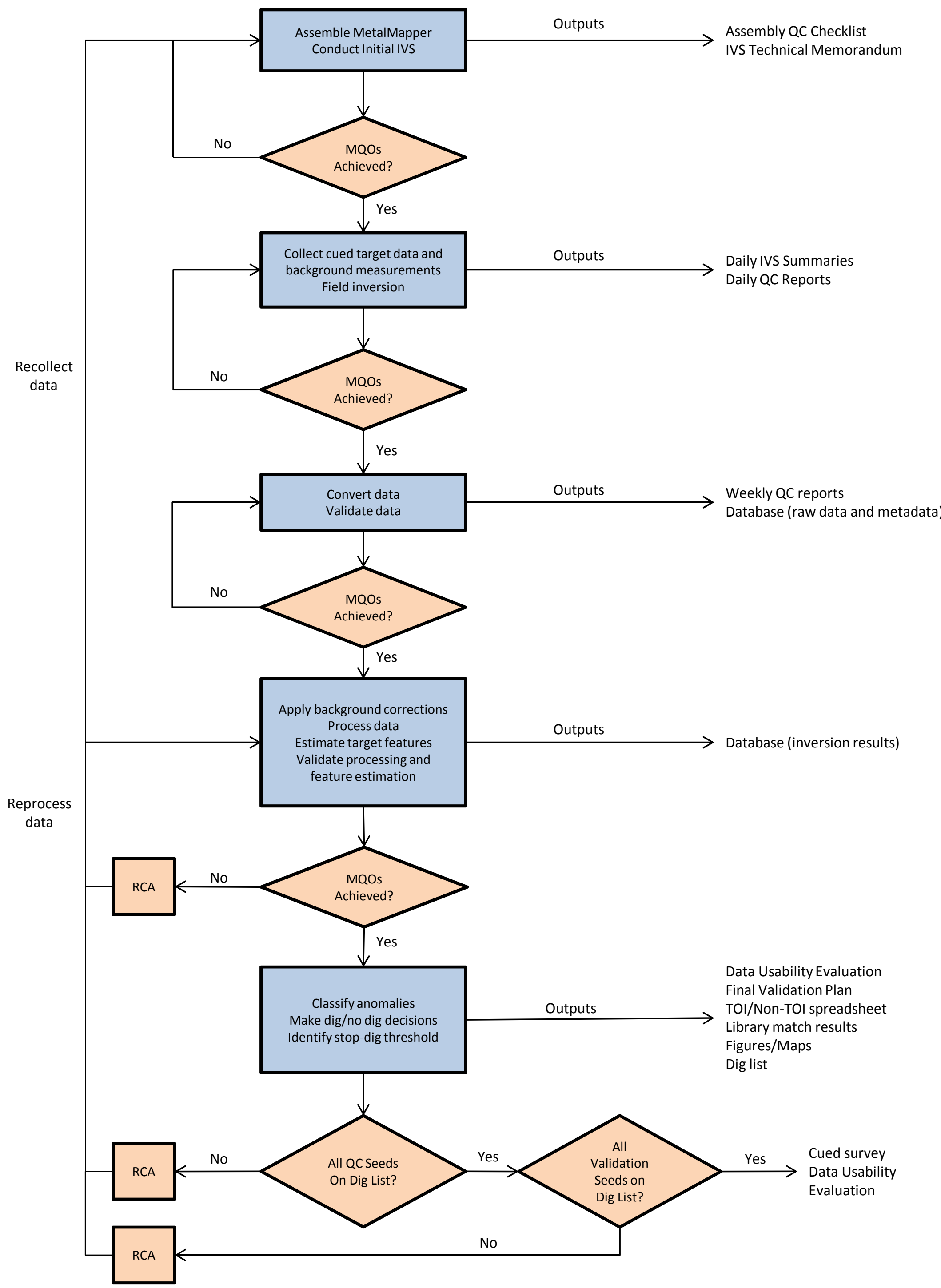
Reporting

Final reporting will include the preparation of an Advanced Geophysical Classification Technical Memorandum to summarize advanced geophysical classification activity details and results. A Data Usability Assessment will be prepared as described in Worksheet 37.

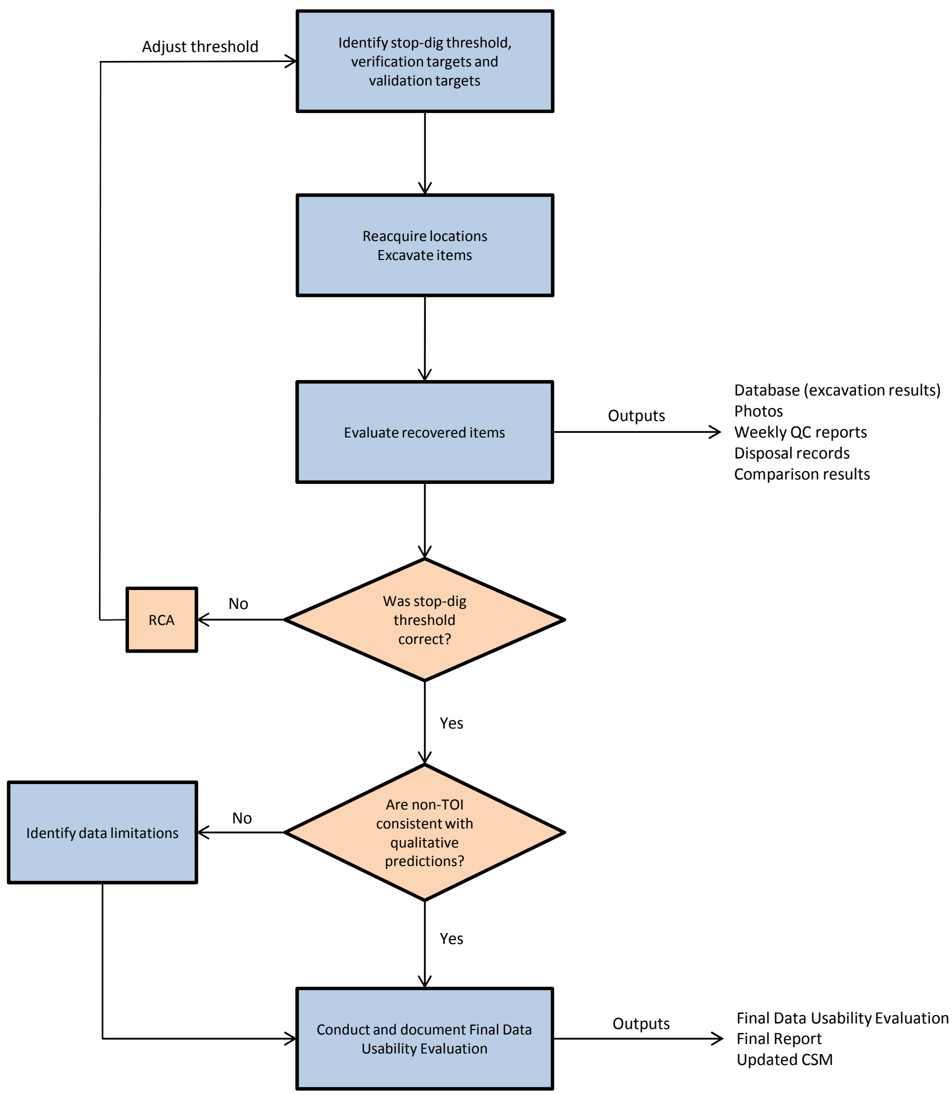
Figure 3-1. Advanced Geophysical Classification Decision Tree



Classification Survey



Intrusive Investigation



3.2 Standard Operating Procedures References Table (QAPP Worksheet #21)

This worksheet documents specific SOPs for advanced geophysical classification work. SOPs currently include procedures and information specific to the MetalMapper system and will be updated to include other advanced EMI sensors, such as TEMTADS or OPTEMA, if those sensors are selected for use at Fort Ord. Applicable SOPs will be readily available to all field personnel responsible for their implementation. The SOPs listed below are included in Appendix B.

SOP Reference No.	Title, Revision, Date	Modified for Project Work? (Y/N)	Comments
AGCMR-01	Advanced EMI Sensor Assembly and Verification	Yes	SOP has been prepared as a general document for advanced geophysical classification activities.
AGCMR-02	Advanced EMI Sensor Instrument Verification Strip	No	SOP has been prepared as a general document for advanced geophysical classification activities.
AGCMR-03	Quality Control Seeding for Advanced Geophysical Classification	No	SOP has been prepared as a general document for advanced geophysical classification activities.
AGCMR-04	Advanced EMI Sensor Background Measurement Acquisition	No	SOP has been prepared as a general document for advanced geophysical classification activities.
AGCMR-05	Advanced EMI Sensor Dynamic Data Acquisition	Yes	SOP has been prepared as a general document for advanced geophysical classification activities.
AGCMR-06	Advanced EMI Sensor Dynamic Data Processing and Analysis	Yes	SOP has been prepared as a general document for advanced geophysical classification activities.
AGCMR-07	Advanced EMI Sensor Cued Data Acquisition	Yes	SOP has been prepared as a general document for advanced geophysical classification activities.
AGCMR-08	Advanced EMI Sensor Cued Data Processing and Analysis	Yes	SOP has been prepared as a general document for advanced geophysical classification activities.
AGCMR-09	Anomaly Reacquisition and Intrusive Investigation	No	SOP has been prepared as a general document for advanced geophysical classification activities.

3.3 Equipment Testing, Inspection and Quality Control (QAPP Worksheet #22)

This worksheet documents procedures for performing testing, inspections and quality control for all field equipment. References to the applicable DFWs and SOPs are included. Where appropriate, the failure response will proscribe a corrective action (CA). Otherwise, both an RCA and CA are required. MQOs developed specifically for use of the MetalMapper system at Fort Ord are currently presented in this worksheet. If other advanced EMI sensors, such as TEMTADS or OPTEMA, are selected for use, appropriate MQOs will be developed and submitted to the project team for approval prior to implementation of those systems.

Detection (Dynamic) Survey (MetalMapper)

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
QC seed item placement	Place Subsurface QC Seeds/ SOP AGCMR-03/Blind Seed Firewall Plan (Appendix C)	Evaluated for each QC seed item	QC Geophysicist / Final Seed Report	Each seed item has been buried away from the immediate vicinity of strong anomalies, the burial parameters have been recorded with 1-inch precision for locations, 2-inch precision for depths, and 10° precision for inclinations and azimuths, and a photograph has been taken of the item in place.	CA: Replace the seed item, if necessary, or reacquire burial parameter information prior to commencement of data acquisition activities.
Verify correct MetalMapper assembly	Dynamic Detection Survey/ SOP AGCMR-01	Once following assembly	Data Acquisition Geophysicist/Assembly Checklist	As specified in SOP AGCMR-01, Assembly Checklist	CA: Make necessary adjustments and re-verify

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
Initial sensor function test (five measurements over an emplaced IVS item, 1 with item directly under center of array and 1 each with item centered under each diagonal quadrant of the array). Derived polarizabilities for each measurement are compared to the classification library using UXA	Dynamic Detection Survey/ SOP AGCMR-01/ SOP AGCMR-08	Once following assembly	Data Acquisition Geophysicist/Assembly Checklist/Lead Data Processor	Library Match metric ≥ 0.95 for each of the five sets of inverted polarizabilities	CA: make necessary repairs/adjustments and re-verify
Initial sensor function test (five measurements over an emplaced IVS item, 1 with item directly under center of array and 1 each with item centered under each diagonal quadrant of the array). Modeled locations are compared to the known locations of the ISO for each measurement.	Dynamic Detection Survey/ SOP AGCMR-01/ SOP AGCMR-08	Once following assembly	Data Acquisition Geophysicist/Assembly Checklist/Lead Data Processor	Modeled location of each measurement is under the correct quadrant of the MetalMapper sensor array	CA: make necessary repairs/adjustments and re-verify
Initial derived target position accuracy (IVS)	Dynamic Detection Survey/ SOP AGCMR-02/ SOP AGCMR-05/ SOP AGCMR-06	Once during initial system IVS test	Lead Data Processor and Gilbane Project Geophysicist/Initial IVS Technical Memorandum	All IVS item fit locations within 10 inches of ground truth locations	CA: make necessary repairs/adjustments and re-verify

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
Initial detection response amplitudes (IVS)	Dynamic Detection Survey/ SOP AGCMR-02/ SOP AGCMR-05/ SOP AGCMR-06	Once during initial system IVS test	Lead Data Processor and Gilbane Project Geophysicist/Initial IVS Technical Memorandum	Response amplitudes within 25% of predicted (or baseline) amplitudes	CA: make necessary repairs/adjustments and re-verify
Ongoing derived target position precision (IVS)	Dynamic Detection Survey/ SOP AGCMR-02/ SOP AGCMR-05/ SOP AGCMR-06	Twice daily, at the beginning and end of data acquisition, as part of IVS testing	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	All IVS item fit locations within 10 inches of the average locations	RCA/CA
Ongoing detection response precision (IVS)	Dynamic Detection Survey/ SOP AGCMR-02/ SOP AGCMR-05/ SOP AGCMR-06	Twice daily, at the beginning and end of data acquisition, as part of IVS testing	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	Response amplitudes ≥ 25% average	RCA/CA
Down-line measurement spacing	Dynamic Detection Survey/ SOP AGCMR-05	Verified for each survey unit using existing UX Detect tools based upon monostatic Z coil data positions	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	98% ≤ 8 inches between successive measurements	RCA/CA CA assumption: Reacquire portions that fail
Coverage	Dynamic Detection Survey/ SOP AGCMR-05	Verified for each survey unit using existing UX Detect tools based upon GPS antenna positions	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	95% (or greater) of the lane spacing is to be at the project design lane spacing of 2 ft. 100% of the lane spacing is to be at 3 ft. No unexplained data gaps.	RCA/CA CA assumption: Gaps require fill-in survey to achieve required coverage
Transmit current levels	Dynamic Detection Survey/ SOP AGCMR-05	Evaluated for each sensor measurement	Data Acquisition Geophysicist/failures noted in field log and tracking summary	Peak transmit current ≥ 5.5 amps	CA: reject data acquired with current levels outside of the acceptable range

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
Dynamic detection performance	Dynamic Detection Survey/ SOP AGCMR-05/ SOP AGCMR-06	Evaluated for each dataset	QC Geophysicist/tracking summary	All blind seed items detected and positioned within 16-inch radius of ground truth location	RCA/CA
Position data are valid (1 of 2)	Dynamic Detection Survey/ SOP AGCMR-05/ SOP AGCMR-06	Evaluated for each sensor measurement	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	GPS status flag indicates RTK fix	RCA/CA
Position data are valid (2 of 2)	Dynamic Detection Survey/ SOP AGCMR-05/ SOP AGCMR-06	Evaluated for each sensor measurement	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	Orientation data valid Data input string checksum passes	RCA/CA

Classification (Cued) Survey (MetalMapper)

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
QC seed item placement	Place Subsurface QC Seeds/ SOP AGCMR-03	Evaluated for each QC seed item	QC Geophysicist / Final Seed Report	Each seed item has been buried away from the immediate vicinity of strong anomalies, the burial parameters have been recorded with 1-inch precision for locations, 2-inch precision for depths, and 10° precision for inclinations and azimuths, and a photograph has been taken of the item in place.	CA: Replace the seed item, if necessary, or reacquire burial parameter information prior to commencement of data acquisition activities.
Verify correct MetalMapper assembly	Cued Classification Survey/ SOP AGCMR-01	Once following assembly	Data Acquisition Geophysicist/Assembly Checklist	As specified in SOP AGCMR-01, Assembly Checklist	CA: Make necessary adjustments and re-verify
Initial sensor function test (five measurements over an emplaced IVS item, 1 with item directly under center of array and 1 each with item centered under each diagonal quadrant of the array). Derived polarizabilities for each measurement are compared to the classification library using UXA	Cued Classification Survey/ SOP AGCMR-01/ SOP AGCMR-08	Once following assembly	Data Acquisition Geophysicist/Assembly Checklist/Lead Data Processor	Library Match metric ≥ 0.95 for each of the five sets of inverted polarizabilities	CA: make necessary repairs/adjustments and re-verify

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
Initial sensor function test (five measurements over an emplaced IVS item, 1 with item directly under center of array and 1 each with item centered under each diagonal quadrant of the array). Modeled locations are compared to the known locations of the schedule 80 small industry standard object (ISO 80) for each measurement.	Cued Classification Survey/ SOP AGCMR-01/ SOP AGCMR-08	Once following assembly	Data Acquisition Geophysicist/Assembly Checklist/Lead Data Processor	Modeled location of each measurement is under the correct quadrant of the MetalMapper sensor array	CA: make necessary repairs/adjustments and re-verify
Initial IVS background measurement (five background measurements – 1 centered at the flag and 1 offset 15 inches (40cm) in each cardinal direction)	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Once during initial system IVS test	Data Acquisition Geophysicist/Initial IVS Technical Memorandum/ Lead Data Processor	Decay amplitudes are below the selected background threshold at each offset background location	CA: reject/replace BG location
Initial derived polarizabilities accuracy (IVS)	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Once during initial system IVS test	Lead Data Processor and Gilbane Project Geophysicist/Initial IVS Technical Memorandum	Library Match metric ≥ 0.9 for each set of inverted polarizabilities	RCA/CA
Initial derived target position accuracy (IVS)	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Once during initial system IVS test	Lead Data Processor and Gilbane Project Geophysicist/Initial IVS Technical Memorandum	All IVS item fit locations within 5 inches of ground truth locations	RCA/CA

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
Ongoing IVS background measurements	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Twice daily as part of IVS testing	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	All decay amplitudes lower than project threshold and qualitatively agree with initial measurement	RCA/CA CA assumption: rejection of BG measurement (unless RCA indicates system failure)
Ongoing derived polarizabilities precision (IVS)	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Twice daily as part of IVS testing	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	Library match to initial polarizabilities metric ≥ 0.9 for each set of three inverted polarizabilities	RCA/CA
Ongoing derived target position precision (IVS)	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Twice daily as part of IVS testing	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	All IVS item fit locations within 5 inches of average of derived fit locations	RCA/CA
Initial measurement of production area background locations	Cued Classification Survey/ SOP AGCMR-04/ SOP AGCMR-08	Once per background location	Data Acquisition Geophysicist and Lead Data Processor/ tracking summary	All decay amplitudes lower than project threshold	CA: reject BG location and find alternate
Ongoing production area background measurement frequency	Cued Classification Survey/ SOP AGCMR-04/ SOP AGCMR-07	Evaluated for each background measurement	Data Acquisition Geophysicist/failures noted in field log and tracking summary	Time separation between background measurement and anomaly measurement < 2 hour	CA: reject data that does not have a corresponding background measurement recorded within acceptable time period
Ongoing production area background measurement	Cued Classification Survey/ SOP AGCMR-04/ SOP AGCMR-07/ SOP AGCMR-08	Evaluated for each background measurement	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	All decay amplitudes lower than project threshold and qualitatively agree with initial measurement	CA: background measurement rejected and reacquired

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
Transmit current levels	Cued Classification Survey/ SOP AGCMR-07	Evaluated for each sensor measurement	Data Acquisition Geophysicist/failures noted in field log and tracking summary	Peak transmit current ≥ 5.5 amps	CA: reject data acquired with current levels outside of the acceptable range
Initial anomaly (flag) location interrogated	Cued Classification Survey/ SOP AGCMR-07/ SOP AGCMR-08	Evaluated for each flag position	Data Acquisition Geophysicist/failures noted in field log and tracking summary	For each anomaly, a measurement must be acquired with the center of the array < 16 inches from the flag location.	CA: Reacquire measurement at flag location
Position data are valid (1 of 2)	Cued Classification Survey/ SOP AGCMR-07	Evaluated for each sensor measurement	Data Acquisition Geophysicist/failures noted in field log and tracking summary	GPS status flag indicates RTK fix	RCA/CA
Position data are valid (2 of 2)	Cued Classification Survey/ SOP AGCMR-07/ SOP AGCMR-08	Evaluated for each sensor measurement	Data Acquisition Geophysicist/Lead Data Processor/tracking summary	Orientation data valid Data input string checksum passes	RCA/CA
Confirm inversion model supports classification (1 of 2)	Cued Classification Survey/ SOP AGCMR-08	Evaluated for all models derived from a measurement (i.e., single item and multi-item models)	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	Derived model response must fit the observed data with a fit coherence > 0.8	CA: If no valid model is derived, classify as inconclusive
Confirm inversion model supports classification (2 of 2)	Cued Classification Survey/ SOP AGCMR-08	Evaluated for derived target	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	Fit location estimate of item ≤ 15 inches from center of sensor	CA: If no target within 15 inch radius using multi-solver inversion, classify as inconclusive

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
Confirm all anomalies classified	Cued Classification Survey/ SOP AGCMR-08	Evaluated for each anomaly (flag) location	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	100% of anomalies are classified as: TOI/ Non-TOI/Inconclusive	Documentation required identifying reason for missing data with RCA/CA if necessary. If data cannot be acquired, classify as inconclusive.
Confirm reacquisition GPS accuracy and precision	Intrusive Investigation/ SOP AGCMR-09	Daily	Reacquisition Geophysicist/Daily Report	Benchmark positions repeatable to within 3 inches	CA: Make adjustments and re-verify
Confirm derived features match ground truth (1 of 2)	Intrusive Investigation/ SOP AGCMR-09	Evaluated for all recovered items	QC Geophysicist/QC reports	95% of recovered item positions < 10 inches from predicted position	RCA/CA
Confirm derived features match ground truth (2 of 2)	Intrusive Investigation/ SOP AGCMR-09	Evaluated for all recovered seed items	QC Geophysicist/QC reports	100% of predicted seed item positions < 10 inches from known position	RCA/CA
Classification performance	Intrusive Investigation/ SOP AGCMR-09	For each delivered dig list	QC Geophysicist/QC reports	100% of seed items classified as TOI	RCA/CA
Classification validation	Intrusive Investigation/ SOP AGCMR-09	For each delivered dig list	QC Geophysicist/QC reports	100% of predicted intrusively investigated non-TOI are confirmed to be non-TOI	RCA/CA

4.0 DATA MANAGEMENT AND DATA REVIEW

4.1 Project Documents and Records (QAPP Worksheet #29)

Part 1: Data Management Specifications

GIS: The existing Fort Ord GIS will be used to store and manage all relevant geospatial-related data and information. All geospatial data will conform to the FGDC *Geospatial Positioning Accuracy Standards, Part 2: NSSDA*, and *Part 4: Standards for Architecture, Engineering, and Construction (A/E/C) and Facility Management*. Each GIS data set will be accompanied by metadata conforming to the FGDC CSDGM and provided in a database that complies with the *SDSFIE*. The final GIS submittal will contain all required ArcGIS.mxd files and layout files for all drawings contained in the final report.

Unless otherwise noted, GPS survey data will meet or exceed the Third Order, Class I specification. Horizontal GPS data will be repeatable to within 3 cm. The horizontal accuracy of GIS data will be tested in accordance with the National Standards. In addition, the location, identification, coordinates, and elevations of all established control points will be plotted on one or more site maps. Each control point will be identified on the map by its name and number and the final adjusted coordinates.

ESRI-compliant formats (shapefiles, coverages, or geodatabases) will be used to present GIS data, with supporting tabular data provided in Microsoft Excel, Microsoft Access, or both, as needed.

Computer Files and Digital Data: All final document files, including reports, figures, and tables, will be submitted in electronic format (both Microsoft Office, and portable document format [.pdf]) on CD-ROM. CDs containing .pdf files will also include Adobe™ Acrobat Reader®.
Classification Library: The specific version and date of the DoD classification library used for each advanced geophysical classification project will be documented in the site-specific work plan for that project. Procedures used to update the library for each project, including QC and QA measures used to verify and validate the site-specific classification library will be documented in the final report. The complete classification library for each project will be included in the final data deliverables.

Part 2: Control of Documents, Records, and Databases

Fields Records/Data				
Record	**Generation**	**Verification**	**Frequency (generation of document / record)**	**Format/Storage Location**
Safety Log	UXOSO	KEMRON Project Manager	Daily	Database, .pdf/KEMRON network
Geophysical Log	Data Acquisition Geophysicist	Gilbane Project Geophysicist	Daily during detection or cued data acquisition	Database, .pdf/KEMRON network
QC Log	UXOQCS, QC Geophysicist	KEMRON Project Manager	Daily	Database, .pdf/KEMRON network
QC/Safety Daily Reports (including QC audits)	UXOQCS, QC Geophysicist, UXOSO	KEMRON Project Manager	Daily	Database, .pdf/KEMRON network
QC Weekly Reports (including QC audits)	UXOQCS, QC Geophysicist	KEMRON Project Manager	Weekly	Database, .pdf/KEMRON network
Safety Bi-Weekly Reports	UXOSO	KEMRON Project Manager	Bi-Weekly	Database, .pdf/KEMRON network
SUXOS Daily Reports	SUXOS	KEMRON Project Manager	Daily	Database, .pdf/KEMRON network
SUXOS Bi-Weekly Reports	SUXOS	KEMRON Project Manager	Bi-Weekly	Database, .pdf/KEMRON network
Photo Documentation	Various	KEMRON Project Manager	As necessary	.jpg/KEMRON Network
QC Seed Item Locations, Depths, and Orientations	QC Geophysicist	Gilbane Project Geophysicist	Daily during QC seeding	Microsoft Excel/KEMRON network (limited to QC personnel)
MetalMapper Assembly Checklist	Data Acquisition Geophysicist	Gilbane Project Geophysicist	On initial use of equipment	Microsoft Word/KEMRON network
IVS Memorandum	Gilbane Project Geophysicist	KEMRON Project Manager	After completion of initial dynamic IVS and initial cued IVS	Microsoft Word/KEMRON network
UXO Team Leader Log (paper or digital records)	UXO Team Leader	KEMRON Project Manager	Daily during UXO Team operations	Database, .pdf/KEMRON network

Fields Records/Data				
Record	**Generation**	**Verification**	**Frequency (generation of document / record)**	**Format/Storage Location**
Geophysical Data	Data Acquisition Geophysicist	Gilbane Project Geophysicist	Daily during detection or cued data acquisition	Various/KEMRON network
Nonconformance, root cause analysis and corrective action reports	UXOQCS, QC Geophysicist, CQCSM	Program QC Manager	As necessary	Various/KEMRON network
Equipment and Instrument Check Logs	Data Acquisition Geophysicist/UXO Team Leader	Gilbane Project Geophysicist	As necessary	Various/KEMRON network
Data Usability Assessment	Gilbane Project Geophysicist	KEMRON Project Manager	After completion of AGCMR activity	Microsoft Word/KEMRON network
Advanced Geophysical Classification Technical Memorandum	Gilbane Project Geophysicist	KEMRON Project Manager	After completion of AGCMR activity	Microsoft Word/KEMRON network

Daily QC Reports

Daily work activity summary reports will be maintained by the QC Geophysicist. These daily reports may include, but are not limited to, the following items:

- QC reports and findings
- H&S reports
- Training logs
- SUXOS reports (including activity log)
- Emergency response action reports
- MEC discovery and classification of the item
- Records of site work and progress

The daily QC reports provide backup information and are intended to aid in the preparation of the weekly QC report discussed below.

Weekly QC report

The QC Geophysicist is responsible for preparing and submitting a weekly QC report to the USACE Quality Assurance Geophysicist. The weekly QC report is to be submitted to the USACE Quality Assurance Geophysicist on the first work day following the dates covered by the report. The weekly QC report is to provide an overview of QC activities during the previous two weeks, including those performed by subcontractors. The weekly QC reports must present an accurate and complete picture of QC activities by reporting both conforming and deficient conditions. Reports should be precise, factual, legible, and objective. Copies of supporting documentation, such as checklists and surveillance reports, are to be attached.

Copies of weekly QC reports with attachments and field QC logs no longer in use are to be maintained in the project QC file. Upon project closeout, all QC reports are to be included in the project QC file.

Field Logs

The data acquisition team leader will maintain a field log or digital record in a tablet device to record activities that occur each work day. In addition to field conditions and daily system functional test information, log entries will include a record of anomalies investigated, any unusual conditions related to the acquisition of data for individual anomalies, and a record of background measurement locations and acquisition times. At the conclusion of the project, field logs will become a permanent part of the contract record.

Safety Log

The UXOSO will also maintain a log of daily safety activities. This safety log will document compliance with the APP. The safety log will be maintained as paginated, bound, and dated hard copy logs or digital records in a tablet device. The safety log will record such information as the date, the start and stop times of work, weather conditions, the names of field team personnel, specific description of the work being conducted, break times, names and times of visitors to the site, and any incidents or other unusual events that occurred that day. This includes documentation of the performance and content of daily health and safety meetings.

The safety log will describe conditions or activities leading up to or contributing to safety incidents or lost time due to safety issues. The safety log will be archived by the Project Manager and become a permanent part of the contract record.

Quality Control Log

The QC Geophysicist will maintain a QC log of field QC inspections. This QC log will document compliance with this AGCMR-QAPP and specify workmanship acceptability. The QC log will be maintained as paginated, bound, and dated hard copy logs or digital records in a tablet device. The area, the DFW being inspected, and the date will be recorded. Each log entry will be event-, area- or site-specific and clearly noted accordingly. The QC log will be archived by the CQCSM and will become a permanent part of the contract record, in addition to the completed specific QC forms specified above.

Test and Maintenance Records

Equipment test and maintenance tasks will be documented digitally in tablet devices or on appropriate forms or field log books by the individual performing the task. Testing and maintenance of equipment will be performed according to the manufacturer's specifications, this AGCMR-QAPP, and applicable SOPs. Geophysical detection equipment will be tested daily when in use. At a minimum, the test or maintenance log will contain the date and time of the task, equipment name and identification numbers, name of individual performing the task, and results of the task. Upon project closeout, all test and maintenance records will be included in the project QC file.

The QC Geophysicist is responsible for ensuring that the tests are performed and that the results are summarized and provided with the weekly QC report. To track each failing test for future retesting, the failing test must be noted on the CAR. Resolution of the failing test is complete when retesting is performed and the corrective action is verified on the CAR.

Training Records

The SUXOS will maintain a file for each site employee, including KEMRON and subcontractor personnel, to document qualifications and the successful completion of required training courses. Documentation may be in the form of a certificate, letter, memorandum, or other written form of documentation but must include training completion dates. If required refresher training courses do not take place by the anniversary date of the employee's initial training, a record must be added to the employee's file indicating why the training has been delayed and when the training will be completed.

Photograph Log

Photographic history and evolution of the project will be documented in a photograph log. The log will be used by the SUXOS, team leaders, and UXOQCS to document the location, date, and subject of each photo taken. Handheld forms digitally recording the same information may take the place of or supplement the photograph log.

4.2 Assessments and Corrective Action (QAPP Worksheets #31, 32, & 33)

This worksheet documents assessment standards for field activities described in the AGCMR-QAPP and specifies the minimum requirements that must be met, including the extent to which QC monitoring must be conducted and documented. The specific QC monitoring requirements for each DFW are discussed below. References to the applicable DFW and standard operating procedures are included. Failures will result in stop work, generation of an NCR and, as applicable, generation of a CAR, RCA and CAP.

The QC Team, which consists of the CQCSM, UXOQCS and QC Geophysicist, is responsible for verifying compliance with this portion of the AGCMR-QAPP through implementation of a three-phase control process comprising a preparatory phase, an initial phase, and a follow-up phase. The three-phase inspection process will verify that project activities in each DFW comply with the approved plans and procedures. Each phase is relevant for verifying necessary product quality, but the preparatory and initial inspections are particularly valuable for preventing problems before they escalate. Work will not be performed on a DFW until the preparatory and initial phase inspections have been completed and non-conformance issues are resolved.

Checklists for the preparatory, initial, and final phase inspections for each DFW are included as attachments to the SOPs in Appendix B. The QC checklists include the inspection requirements and the QC Team members responsible for each inspection.

Preparatory Phase Inspection

The preparatory phase comprises the planning and design process leading up to the actual field activities. A member of the QC Team will perform a preparatory phase inspection before beginning each DFW. The purposes of this inspection are to review applicable specifications and plans to verify that the necessary resources, conditions, and controls are in place and compliant before the commencement of work activities.

During the preparatory phase inspection, a member of the QC Team will review the applicable sections of the AGCMR-QAPP and verify the following:

- Required plans and procedures have been approved and are available to the field staff
- Field equipment is appropriate, available, functional, and properly tested for its intended/stated use
- Personnel responsibilities have been assigned and communicated
- Personnel have the necessary knowledge, expertise, and information to perform their assigned tasks;
- Arrangements have been made for necessary support services
- Personnel have completed training in accordance with the requirements of this AGCMR-QAPP
- Mobilization tasks have been completed.

Project personnel must correct or resolve discrepancies between existing conditions and the approved AGCMR-QAPP identified by the QC Team during the preparatory phase inspection. A member of the QC Team will verify that unsatisfactory and/or nonconforming conditions have been corrected before beginning work.

Upon completion of the preparatory phase inspection, a member of the QC Team will complete the Preparatory Phase Inspection Checklist.

Initial Phase Inspection

The Initial Phase (IP) occurs at the onset of field activities associated with each DFW.
The main objectives of the IP inspection are to check preliminary work for compliance with procedures and specifications, establish an acceptable level of workmanship, check for omissions, and resolve differences of interpretation. During the IP inspection, the QC Team will ensure that discrepancies between site practices and approved plans or specifications are identified and resolved. The resolution of discrepancies is a critical step in the IP inspection. The IP inspection will also verify that the APP/SSHP adequately identifies all hazards associated with actual field conditions and verify that appropriate safe work practices are being followed. The inspection results will be documented by the QC Team in the form of daily reports. Should results of the inspection be unsatisfactory, the IP will be rescheduled and performed again.

Upon completion of the IP inspection, a member of the QC Team will complete the IP Inspection Checklist.

Follow-up Phase Inspection

The follow-up phase (FP) inspection, which covers the routine day-to-day activities at the site, will begin upon completion of the IP inspection and will include inspections at regular intervals during the performance of each DFW. The FP inspection ensures continuous compliance with procedures and specifications and verifies an acceptable level of workmanship. During the FP inspection, a member of the QC Team will review the applicable sections of the AGCMR-QAPP and monitor onsite practices and operations to verify continued compliance with the specifications and requirements of the AGCMR-QAPP. Information documented in the FP inspection may be accompanied by Field QC Inspection Form. The QC Team will also verify that daily health and safety inspections are performed and documented as prescribed in the health and safety plan. Discrepancies between site practices and approved plans or specifications will be resolved, and corrective actions for unsatisfactory and nonconforming conditions or practices will be completed before continuing work.

Upon completion of FP inspections, a member of the QC Team will complete the FP Inspection Checklist.

Additional Inspections

Additional inspections performed on a DFW may be required at the discretion of USACE, the

Project Manager, the SUXOS, the appropriate senior technical consultant, the Program QC Manager, or any member of the QC Team. Additional preparatory and IP inspections could be warranted under any of the following conditions:

- Unsatisfactory work, as determined by KEMRON or USACE
- Changes in key personnel
- Resumption of work after a substantial period of inactivity (2 weeks or more)
- Changes to the project scope of work

Additional inspections will be documented on the appropriate inspection checklist forms and in the QC Daily Report.

Final Phase Inspection

The final phase inspection is performed upon conclusion of a DFW and before closeout to verify that project requirements relevant to that DFW have been satisfied. Outstanding and nonconforming items will be identified and documented on the Final Inspection Checklist.

Notification of Definable Features of Work and Three Phases of Control

The QC Team will ensure that the three-phase control process is implemented for each DFW listed in Worksheet 17.

Audit Procedures

The QC Team is responsible for verifying compliance with this AGCMR-QAPP through audits and surveillance. The QC Team is required to audit and inspect the quality of work being performed for each DFW and verify that work practices conform to the specifications of the AGCMR-QAPP and other applicable guidance. Discrepancies are to be communicated to the responsible individual and documented in the daily and weekly QC reports. Corrective actions are to be verified by the QC Team and recorded in the daily QC report.

The Assessment Schedule is to be used by the QC Team for planning, scheduling, and tracking the progress of audits. The information on the form must be current and reviewed by the QC Team. Audit activities and corrective actions are to be documented by the QC Team, and the audit records are to be maintained as part of the project QC file.

Detailed QC procedures for advanced geophysical classification activities are included in the SOPs associated with this AGCMR-QAPP. The QC activities performed for advanced geophysical classification work will be audited and documented by the QC Geophysicist on a daily basis.

Preventative and Corrective Actions

The preventative and corrective actions incorporated within this AGCMR-QAPP are designed to prevent and correct quality problems that may arise during the project work. The procedures facilitate process improvements and describe the available mechanisms to identify, document, and track discrepancies until a corrective action has been verified.

Continual Improvement

A continual improvement process will be implemented for the project. Project personnel at all levels will be encouraged to provide recommendations for improvements in established work processes and techniques to identify activities that are compliant but could be performed in a more efficient or cost-effective manner. Typical quality improvement recommendations include identifying an existing practice that can and should be improved (e.g., a bottleneck in production) and/or recommending an alternative practice that would provide a benefit without compromising prescribed standards of quality. Project personnel should bring their recommendations to the attention of the SUXOS or QC Team through verbal or written means. Deviations from established protocols will not to be implemented without prior written approval.

Deficiency Identification and Resolution

While deficiency identification and resolution occurs primarily at the operational level, QC audits provide a backup mechanism to address problems that are either not identified or cannot be resolved at the operational level. Through implementation of the audit program prescribed in this AGCMR-QAPP, the project team is responsible for verifying that deficiencies are identified, documented, and corrected in a timely manner. Deficiencies identified by the project team will be corrected by operational staff and documented by the QC Team.

Corrective Action Request

A CAR can be issued by any member of the project team, including subcontractor personnel. If the individual issuing the CAR is also responsible for correcting the problem, he/she should document the results on Part B of the CAR. Otherwise, the CAR should be forwarded to the QC Team who is then responsible for evaluating the validity of the request. If the CAR is valid, the QC team will address the corrective action with the appropriate individuals to resolve the deficiency.

The QC Team will determine if an RCA and/or CAP are necessary. The CAP will include assigning personnel and resources, and will specify and enforce a schedule for corrective actions. Once a corrective action has been completed, the CAR, CAP and supporting information will be forwarded to the Program QC Manager for closure.

The recommendations provided in the CAP and implemented on the project will be reviewed during follow-up QC inspections. The CAP review has the following objectives:

- Verify that established protocols are properly implemented
- Verify that corrective actions have been implemented
- Verify that corrective actions are effective in resolving problems

- Identify trends within and among similar work units
- Facilitate system root cause analysis of larger systemic problems

The QC Team will determine whether a written CAP is necessary, based on whether any of the following conditions are met:

- The CAR priority is high
- The identified deficiency requires a rigorous corrective action planning process to identify work products or activities affected by the deficiency
- Extensive resources and planning are required to correct the deficiency and to prevent recurrence

The CAP will be developed by the QC Team and approved and signed by the Program QC Manager. The CAP will indicate whether it is submitted for informational purposes or for review and approval. In either event, operational personnel are encouraged to discuss corrective action strategy with the QC Team throughout the process.

Corrective Action Request Tracking

Each CAR will be given a unique identification number and tracked until corrective actions have been implemented in the field, documented in Part B of the CAR form, and the CAR has been submitted to the Project Manager for verification and closure.

Lessons Learned and Other Documentation

Lessons learned through the discrepancy management process are documented on CARs and CAPs. To share the lessons learned, these documents will be submitted to USACE through the Daily QC Report, which summarizes daily QC activities conducted.

Minor deficiencies identified during a QC audit that are readily correctable and can be verified in the field will be documented in the QC log (hardcopy or digital) and daily QC Report. Discrepancies that cannot be readily corrected will be documented by a member of the QC Team on a CAR and in the daily QC Report. Copies of CARs will be referenced in and attached to the daily QC Report. CAPs will also be attached to daily QC Reports to document the final outcome of the deficiency and corrective action. Similar or related deficiencies may be addressed on a single CAP.

Assessment Schedule

DFW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Pre-Mobilization Activities	AGCMR-QAPP	Verify the AGCMR-QAPP has been developed and approved.	Preparatory Phase (PP)	Once	AGCMR-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
	Blind Seed Firewall Plan	Verify the Blind Seed Firewall Plan has been developed and approved.	PP	Once	Blind Seed Firewall Plan has been prepared and approved	Do not proceed with field activities until criterion is passed
	Draft Advanced Geophysical Classification Validation Plan	Verify the draft Advanced Geophysical Classification Validation Plan has been developed and approved.	PP	Once	Draft Advanced Geophysical Classification Validation Plan has been prepared and approved, all parties agree to the approach	Do not proceed with field activities until criterion is passed
Mobilization and Site Preparation	Kickoff/Safety Meeting	Verify that AGCMR-QAPP and site-specific safety requirements have been reviewed with project team and document appropriate signatures.	PP/IP	Once	Documents have been reviewed and signed by appropriate project team members	Personnel who are not familiar with the AGCMR-QAPP and site-specific safety requirements may not proceed with field activities until criteria are passed
	Verify Site-Specific Training	Verify that all site-specific training has been performed and documented.	PP/IP	Once	Site-specific training is performed and documented	Do not proceed with field activities until criterion is passed

DFW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
	Subsurface QC Seed Item Placement	Verify QC seed items have been properly placed and their positions properly recorded. Complete SOP AGCMR-03 Preparatory Checklist.	PP/IP	Once/Daily/As Required	QC seed items have been properly placed, covered and surveyed	Do not proceed with classification surveys until QC seed items have been appropriately placed and recorded
	Establish Instrument Verification Strip	Verify that IVS is constructed in accordance with AGCMR-QAPP. Complete SOP AGCMR-02 Preparatory Checklist.	PP/IP	Once	IVS constructed in accordance with AGCMR-QAPP	Do not proceed with IVS survey until IVS is properly constructed or alternate construction is approved by USACE Project Manager
Detection Survey	Daily Safety Briefing	Confirm that the UXOSO or his representative conducted a daily safety briefing and all field personnel acknowledged by signature.	PP/IP/FP	Daily	The UXOSO or his representative conducted a daily safety briefing and all field personnel acknowledged it by signature	Personnel not receiving a safety briefing are not authorized in the Impact Area until it is received and acknowledged by signature
	MetalMapper Assembly	Observe assembly and initial function testing of MetalMapper. Complete SOP AGCMR-01 Preparatory Checklist.	PP	Once	System assembled in accordance with SOP AGCMR-01	Do not proceed with IVS until system is properly assembled

DFW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
	Initial IVS Survey	Verify that IVS related MQOs are being met and documented in the IVS Memorandum. Complete SOP AGCMR-02 Initial Checklist.	IP/FP	Once	MQOs are being met and documented in the IVS Memorandum	Root cause analysis and corrective action
	Dynamic Detection Survey	Verify detection survey related MQOs are being met. Complete SOP AGCMR-02 Follow-On Daily Checklist. Complete SOP AGCMR-05 Follow-On Checklist.	IP/FP	Daily/As Required	MQOs are being met	Root cause analysis and corrective action
Detection Survey Data Processing, Analysis, and Classification Target Selection	Process and Analyze Detection Data and Select Targets for Classification Survey	Verify dynamic detection processing related MQOs are being met. Complete SOP AGCMR-06 Follow-On Checklists.	IP/FP	Daily/As Required	MQOs are being met	Root cause analysis and corrective action
	Geographic Information System Integration	Verify that relevant geospatial-related data and information is incorporated into the Fort Ord GIS.	IP/FP	Once/Daily/As Required	Relevant geospatial-related data and information is incorporated into the Fort Ord GIS	Root cause analysis and corrective action

DFW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Classification Survey	Daily Safety Briefing	Confirm that the UXOSO or his representative conducted a daily safety briefing and all field personnel acknowledged by signature.	PP/IP/FP	Daily	The UXOSO or his representative conducted a daily safety briefing and all field personnel acknowledged it by signature	Personnel not receiving a safety briefing are not authorized in the Impact Area until it is received and acknowledged by signature
	MetalMapper Assembly	Observe assembly and initial function testing of MetalMapper. Complete SOP AGCMR-01 Preparatory Checklist.	PP	Once	System assembled in accordance with SOP AGCMR-01	Do not proceed with IVS until system is properly assembled
	Initial IVS Survey	Verify that IVS related MQOs are being met and documented in the IVS Memorandum. Complete SOP AGCMR-02 Initial Checklist.	IP/FP	Once	MQOs are being met and documented in the IVS Memorandum	Root cause analysis and corrective action

DFW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
	Classification Survey	Verify classification survey related MQOs are being met. Complete SOP AGCMR-02 Follow-On Daily Checklist. Complete SOP AGCMR-04 Preparatory, Initial, and Follow-On Checklists. Complete SOP AGCMR-07 Follow-On Checklist.	PP/IP/FP	Daily/As Required	MQOs are being met	Root cause analysis and corrective action
Classification Survey Data Processing, Analysis, and Classification	Process, Analyze, and Classify Cued Data	Verify classification processing related MQOs are being met. Complete SOP AGCMR-08 Follow-On Checklists.	IP/FP	Daily/As Required	MQOs are being met	Root cause analysis and corrective action
	Geographic Information System Integration	Verify that relevant geospatial-related data and information is incorporated into the Fort Ord GIS.	IP/FP	Once/Daily/As Required	Relevant geospatial-related data and information is incorporated into the Fort Ord GIS	Root cause analysis and corrective action

DFW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
	Finalize Advanced Geophysical Classification Validation Plan	Verify that the Advanced Geophysical Classification Validation Plan has been evaluated and revised as necessary and submitted to USACE for final review and approval.	IP/FP	Once	The Advanced Geophysical Classification Validation Plan has been evaluated and revised as necessary and submitted to USACE for final review and approval	Do not proceed with validation digs until the Advanced Geophysical Classification Validation Plan has been evaluated and revised as necessary and submitted to USACE for final review and approval
Intrusive Investigation	Daily Safety Briefing	Confirm that the UXOSO or his representative conducted a daily safety briefing and all field personnel acknowledged by signature.	PP/IP/FP	Daily	The UXOSO or his representative conducted a daily safety briefing and all field personnel acknowledged it by signature	Personnel not receiving a safety briefing are not authorized in the Impact Area until it is received and acknowledged by signature
	Anomaly Reacquisition	Verify anomaly reacquisition performed in accordance with QCMR-QAPP and SOP AGCMR-09. Complete SOP AGCMR-09 Follow-On Checklist.	IP/FP	Once/Daily/As Required	Anomaly reacquisition is being performed in accordance with AGCMR-QAPP and SOP AGCMR-09	Root cause analysis and corrective action

DFW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
	Handheld Metal Detector Functional Checks	Team Leader to verify personnel conduct equipment checks and the detector is serviceable by visually observing the checks and documenting the checks in the daily log (hardcopy or digital).	PP/IP/FP	Daily	Personnel conducted equipment check, the detector is serviceable and functioning properly, and the team leader has completed the daily log entry	Repair or replace a malfunctioning instrument. Complete the daily log entries.
	Exclusion Zone Boundaries	UXOSO to verify that signs are in place to identify the work site exclusion zone. QC to perform daily spot checks.	PP/IP/FP	Daily	Signs are in place to identify the work site exclusion zone.	Stop operations until signs are put in place.
	Investigate Anomalies	Verify intrusive investigation performed in accordance with AGCMR-QAPP and SOP AGCMR-09. Complete SOP AGCMR-09 Follow-On Checklist.	IP/FP	Daily/As Required	Intrusive Investigation is being performed in accordance with AGCMR-QAPP and SOP AGCMR-09	Root cause analysis and corrective action
	Backfilling Excavations	QC to verify that all excavations have been backfilled, seedbed (plug) has been replaced, and leveled to grade.	PP/IP/FP	Daily/As Required	All excavations backfilled, seedbed (plug) replaced, and leveled to grade.	Root cause analysis and corrective action

DFW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
	Database Updates	Confirm database is updated with intrusive investigation results.	IP/FP	Daily/As Required	Database is updated on a daily basis with intrusive investigation results	Root cause analysis and corrective action
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	Equipment and personnel have been demobilized from the site and the site is in pre-mobilization condition	Notify responsible party if equipment is left behind; responsible party will be responsible for equipment or materials left behind after completion of field work

4.3 Data Verification, Validation, and Usability Inputs (QAPP Worksheet #34)

This worksheet lists the inputs that will be used during data verification, validation, and usability assessment. Inputs include all requirements documents (e.g. contracts, SOPs, planning documents), field records (both hard-copy and electronic), and interim and final reports. Data verification is a completeness check that all specified activities involved in data acquisition and processing have been completed and documented and that the necessary records (objective evidence) are available to proceed to data validation. Data validation is the evaluation of conformance to stated requirements.

Item	Description	Verification (completeness)	Validation (conformance to specifications)	Usability (achievement of DQOs and MPCs)
Field Records				
	QC Seeding Records	X	X	
	Production Area Seeding QC Checklist	X	X	
	Field logs (hardcopy or digital)	X		
	Photographs	X		
	IVS Construction Details	X	X	
	Daily QC Reports	X		
	Instrument Assembly Checklist	X	X	
	Sensor Function Test Results	X	X	
	IVS Checklists	X	X	
	Dynamic Data Acquisition QC Checklist	X	X	
	Dynamic Data Processing QC Checklist	X	X	
	Cued Data Acquisition QC Checklist	X	X	
	Cued Data Processing QC Checklist	X	X	
Electronic Data				
	Target Anomaly List	X	X	
	Digital Field Notes	X		
	Raw advanced EMI sensor (TEM) data files (EMI, GPS, and IMU)	X	X	
	Converted advanced EMI sensor (ASCII.csv) files	X	X	
	Cued Measurement Data (Target Measurement Data, Background Measurement Data, and Target Features Database)	X	X	
	Classification Images (PDF files)	X		
	Final Data Archive	X	X	
Interim and Final Reports/Deliverables				
	Production Area Seed Report			X

Item	Description	Verification (completeness)	Validation (conformance to specifications)	Usability (achievement of DQOs and MPCs)
	IVS Memorandum			X
	Site-specific munitions library			X
	Classification Survey QC Report (data validation report)			X
	Prioritized Target List			X
	Target Classification Report			X
	Revised Advanced Geophysical Classification Validation Plan			X
	Final Advanced Geophysical Classification Validation Plan			X

4.4 Data Verification and Validation Procedures (QAPP Worksheet #35)

This worksheet documents procedures that will be used to verify and validate project data. Data verification is a completeness check to confirm that all required activities were conducted, all specified records are present, and the contents of the records are complete. Data validation is the evaluation of conformance to stated requirements.

Activity and Records Reviewed	Requirements and Specifications	Process Description and Frequency	Responsible Person	Documentation
Subsurface QC Seeding	AGCMR-QAPP SOP AGCMR-03	Subsurface QC seeding has been conducted in accordance with SOP AGCMR-03. The Preparatory QC Seeding Checklist has been completed. MQOs have been achieved, with exceptions noted. If appropriate, corrective actions have been completed. Verify signatures and dates are present on any hard copies generated.	QC Geophysicist	SOP AGCMR-03 Preparatory QC Checklist QC Seed Database Daily QC Report
Field Data Forms	AGCMR-QAPP	Verify that data for each form have been filled out properly and are complete	Gilbane Project Geophysicist	Daily QC Report
Instrument Assembly	SOP AGCMR-01	Instrument assembly has been completed in accordance with SOP AGCMR-01. The Preparatory MetalMapper Assembly Checklist has been completed. MQOs have been achieved, with exceptions noted. If appropriate, corrective actions have been completed. Verify signatures and dates are present on any hard copies generated.	Gilbane Project Geophysicist	SOP AGCMR-01 Preparatory QC Checklist Daily QC Report
Initial IVS Survey	AGCMR-QAPP SOP AGCMR-02	Initial IVS survey has been conducted in accordance with SOP AGCMR-02. The Initial IVS Survey Checklist has been completed. MQOs have been achieved, with exceptions noted. If appropriate, corrective actions have been completed. Verify signatures and dates are present on any hard copies generated.	Gilbane Project Geophysicist	SOP AGCMR-02 Initial QC Checklist Daily QC Report
Detection Survey	AGCMR-QAPP SOP AGCMR-05	Dynamic detection survey has been conducted in accordance with SOP AGCMR-05. The Follow-on Dynamic Detection Data Acquisition Checklist has been completed. MQOs have been achieved, with exceptions noted. If appropriate, corrective actions have been completed. Verify signatures and dates are present on any hard copies generated.	Gilbane Project Geophysicist	SOP AGCMR-05 Follow-on Checklist Daily QC Report

Activity and Records Reviewed	Requirements and Specifications	Process Description and Frequency	Responsible Person	Documentation
Detection Data Processing, Analysis, and Target Selection	AGCMR-QAPP SOP AGCMR-06	Dynamic detection data processing, analysis, and classification have been conducted in accordance with SOP AGCMR-06. The Follow-on Dynamic Detection Data Processing and Analysis Checklist have been completed. All data has been processed and analyzed, targets have been selected, MQOs have been achieved, with exceptions noted, and QC seed items have been detected. If appropriate, corrective actions have been completed. Verify signatures and dates are present on any hard copies generated.	Gilbane Project Geophysicist QC Geophysicist	SOP AGCMR-06 Follow-on QC Checklist Daily QC Report
Classification Survey	AGCMR-QAPP SOP AGCMR-07	Classification survey has been conducted in accordance with SOP AGCMR-07. The Follow-on Cued MetalMapper Data Acquisition Checklist has been completed. MQOs have been achieved, with exceptions noted. If appropriate, corrective actions have been completed. Verify signatures and dates are present on any hard copies generated.	Gilbane Project Geophysicist	SOP AGCMR-07 Follow-on Checklist Daily QC Report
Cued Data Processing, Analysis, and Classification	AGCMR-QAPP SOP AGCMR-08	Classification survey data processing, analysis, and classification have been conducted in accordance with SOP AGCMR-08. The Follow-on Cued MetalMapper Data Processing and Analysis Checklist have been completed. All anomalies have been classified, MQOs have been achieved, with exceptions noted, and QC seed items have been correctly classified. If appropriate, corrective actions have been completed. Verify signatures and dates are present on any hard copies generated.	Gilbane Project Geophysicist QC Geophysicist	SOP AGCMR-08 Follow-on QC Checklist Daily QC Report
Anomaly Reacquisition	AGCMR-QAPP SOP AGCMR-09	Anomaly Reacquisition has been conducted in accordance with SOP AGCMR-09. The Follow-on Anomaly Reacquisition Checklist has been completed. All target anomalies have been reacquired, and MQOs have been achieved, with exceptions noted. If appropriate, corrective actions have been completed. Verify signatures and dates are present on any hard copies generated.	Gilbane Project Geophysicist	SOP AGCMR-09 Follow-on QC Checklist Daily QC Report

Activity and Records Reviewed	Requirements and Specifications	Process Description and Frequency	Responsible Person	Documentation
Intrusive Investigation	AGCMR-QAPP SOP AGCMR-09	Intrusive Investigation has been conducted in accordance with SOP AGCMR-09. The Follow-on Intrusive Investigation Checklist has been completed. All intrusive investigations have been completed, and MQOs have been achieved, with exceptions noted. If appropriate, corrective actions have been completed. Signatures and dates are present.	UXOQCS Gilbane Project Geophysicist QC Geophysicist	SOP AGCMR-09 Follow-on QC Checklist Daily QC Report

4.5 Data Validation Procedures (QAPP Worksheet #36)

This worksheet documents procedures that will be used to validate the overall anomaly classification approach. The purpose of process validation is to provide added confidence in the ability of the sample design to correctly classify anomalies to distinguish between TOI and non-TOI.

The validation approach involves testing the process for anomaly classification in the following three ways:

1. Placing blind QC seed items at the site prior to advanced geophysical classification activities to confirm that the seed items can be correctly classified.
2. Conducting threshold verification digs, i.e., the excavation of additional anomalies classified as non-TOI just beyond the threshold used for classification or, excavation of additional anomalies identified from feature-space analysis to verify selection of the appropriate threshold (see draft Advanced Geophysical Classification Validation Plan – Appendix D).
3. Conducting validation digs, which involves a qualitative evaluation of how well the classification process predicted physical properties of the non-TOI. Validation digs are conducted at the end of the project, following the intrusive investigation. The results of the validation digs will be considered during the data usability assessment described in Worksheet 37.
4. Conducting validation of depth predictions to demonstrate that advanced geophysical classification activities have successfully identified TOI to the targeted depths. The depth validation process will be detailed in the Final Validation Report.

The USACE QA Geophysicist will independently review and validate all phases of advanced geophysical classification activities. USACE QA validation will include the placement of blind validation seed items at the site prior to advanced geophysical classification activities to confirm that the seed items can be correctly classified, as well as review of advanced geophysical classification data quality, processing and analysis procedures, and classification decision logic. The USACE QA Geophysicist will also be involved in the preparation of the Final Data Validation Plan and in the selection of the validation digs described in the Final Data Validation Plan.

Process Validation Approach

The draft Advanced Geophysical Classification Validation Plan is included in Appendix D. The draft Advanced Geophysical Classification Validation Plan describes how each decision-making threshold for anomaly classification will be tested and identifies how anomalies will be selected for threshold verification and validation digs. It addresses the QC seeding plan, threshold verification digs, and validation digs. The number, type, and placement of QC seed items are described in Worksheet 12. The final number and distribution of threshold verification digs and validation digs will be determined after analyzing actual performance in the field against established MPCs. For that reason, the validation approach will evolve as the project is implemented. The final Advanced Geophysical Classification Validation Plan will be generated following cued classification data processing. Results of validation digs will be presented in the final advanced geophysical classification report.

4.6 Data Usability Assessment (QAPP Worksheet #37)

This worksheet documents procedures that will be used to perform the data usability assessment. The data usability assessment will be performed at the conclusion of data acquisition and classification activities, using the outputs from data verification and data validation (Worksheet 35, Worksheet 36, and the Final Validation Report). The data usability assessment will be a qualitative and quantitative evaluation of acquired data against project MPCs and DQOs to determine if the project data are of the right type, quality, and quantity to meet the project objectives and support future decisions. It involves a retrospective review of the systematic planning process to evaluate whether underlying assumptions are supported, sources of uncertainty have been managed appropriately, data are representative of the population of interest, and the results can be used as intended with an acceptable level of confidence.

Personnel responsible for participating in the data usability assessment preparation or review:

Name	Title	Organization	Role in Usability Assessment
David Eisen	Fort Ord Project Manager	USACE	Review
Shawn Meek	Ordnance and Explosives Safety Specialist (OESS)	USACE	Review
John Jackson	QA Geophysicist	USACE	Review
Steve Crane	Project Manager	KEMRON	Preparation
John Stine	QC Manager	KEMRON	Preparation
Erin Caruso	Deputy Project Manager	Gilbane	Preparation
Andy Gascho	Project Geophysicist	Gilbane	Preparation
Kevin Hagie	Field Project Geophysicist	NAEVA Geophysics	Preparation
Alison Paski	Lead Data Processor	NAEVA Geophysics	Preparation
Alex Kostera	QC Geophysicist	NAEVA Geophysics	Preparation

Documents used as input to the data usability assessment:

- AGCMR-QAPP
- Contract Specifications
- Final Advanced Geophysical Classification Validation Plan
- Weekly QC Reports
- Assessment Reports
- CARs
- Production Area Seed Report
- IVS Memorandum
- Site-Specific Library

- Classification Survey Validation Report
- Prioritized Dig List
- Target Classification Report
- Validation Dig Report

Describe how the usability assessment will be documented:

The data usability report will be included as an appendix to the final advanced geophysical classification report. The following steps will be followed in conducting the data usability assessment:

Step 1	**Review the project's objectives and sampling design** Review project DQOs. Are underlying assumptions valid? Were the project boundaries appropriate? Review the sampling design as implemented for consistency with stated objectives. Were sources of uncertainty accounted for and appropriately managed? Summarize any deviations from the planned sample design.
Step 2	**Review the data verification/validation outputs and evaluate conformance to MPCs** Review the site-specific munitions classification library for completeness. Review available QA/QC reports, including weekly QC reports, assessment reports, corrective action reports, and the data validation report. Evaluate the implications of unacceptable QC results. Evaluate conformance to MPCs documented on Worksheet 12. Summarize the impacts of non-conformances on data usability.
Step 3	**Document data usability, update the CSM, and draw conclusions** Determine if the data can be used as intended, considering implications of deviations and corrective actions. Assess the performance of the sampling design and identify any limitations on data use. Update the CSM and document conclusions.
Step 4	**Document lessons learned and make recommendations** Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for future similar studies. Prepare the data usability summary report.

5.0 REFERENCES

Army, 2008. *Final Record of Decision, Impact Area Munitions Area, Track 3 Munitions Site, Former Fort Ord, California.* April. [AR # OE-0647]

Environmental Protection Agency (EPA), 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process*, QA/G-4.

Environmental Security Technology Certification Program (ESTCP), 2009. *Geophysical System Verification (GSV): A Physics-Based Alternative to Geophysical Prove-Outs for Munitions Response, Final Report*. July.

Intergovernmental Data Quality Task Force (IDQTF), 2005. *Uniform Federal Policy for Quality Assurance Project Plans*, March.

IDQTF, 2012. *Uniform Federal Policy for Quality Assurance Project Plans*, Part 2a (Revised): Optimized UFP-QAPP Worksheets. March.

IDQTF, 2015. *Uniform Federal Policy for Quality Assurance Project Plans Template: Geophysical Classification for Munitions Response, Revised Beta Draft*. February.

Interstate Technology Regulatory Council, 2015. Geophysical Classification for Munitions Response. August. (GCMR-2)

ITSI Gilbane Company, 2014a. *Final, MRS-BLM Units 4, 11, and 12, Munitions and Explosives of Concern, Remedial Action Report, Former Fort Ord, California.* July. [AR # OE-0799B]

ITSI Gilbane Company, 2015. *Final Track 2, Remedial Investigation/Feasibility Study, BLM Area B and MRS-16, Former Fort Ord, California.* August, Revision 2. [AR # OE-0802D]

KEMRON, 2015a. *Munitions and Explosives of Concern Procedures Supplement, Former Fort Ord, California*. August. [AR # OE-0858]

KEMRON, 2015b. *Quality Assurance Project Plan, Former Fort Ord, California; Volume II, Appendix A, Munitions and Explosives of Concern Remedial Action.* August. [AR # OE-0861]

KEMRON, 2015c. *Site-Specific Work Plan, Munitions and Explosives of Concern Remedial Action, MRS-BLM Unit 23 and in Support of Units 11 and 12 Prescribed Burns (Includes Portions of 5A, 9, 25, 28, and 31), Former Fort Ord, California*. August. [AR # OE-0850]

MACTEC Engineering and Consulting, Inc. (MACTEC), 2007. *Final Track 3 Impact Area Munitions Area Munitions Remedial Investigation/Feasibility Study, Former Fort Ord, California.* June. [AR # OE-0596R]

MACTEC/Shaw, 2010. *Final Remaining Remedial Investigation/Feasibility Study Areas Management Plan Former Fort Ord, California*. February 4. [AR # OE-0687E]

U.S. Army Corps of Engineers (USACE), 1997. *Installation-wide Multispecies Habitat Management Plan for Former Fort Ord, California (HMP)*. April. With technical assistance from Jones and Stokes, Sacramento, California. [AR # BW-1787]

USACE, 2009. *Final Work Plan, Remedial Design (RD)/Remedial Action (RA), Track 3 Impact Area Munitions Response Area (MRA) Munitions and Explosives of Concern (MEC) Removal, Former Fort Ord, California.* August 4. [AR # OE-0660K]

USACE, 2013. Engineering Manual 200-1-15, *Technical Guidance for Military Munitions Response Actions, Environmental and Munitions Center of Expertise Interim Guidance Document (IGD) 14-01.* October.

U.S. Department of the Interior, Fish and Wildlife Service, 2011. *Biological Opinion for the Former Fort Ord Vegetation Clearance Activities and Transfer of Parcel E29b.3.1* (8-8-11-F-39). August.

U.S. Department of the Interior, Fish and Wildlife Service, 2015. *Programmatic Biological Opinion for Cleanup and Property Transfer Actions Conducted at the Former Fort Ord, Monterey County, California* (8-8-09-F-74). May.

U.S. Environmental Protection Agency (U.S. EPA). 2005. *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* EPA-505-B-04-900A. March.

U.S. EPA. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4. February.

U.S. EPA. 2012. *Guidance on Quality Assurance Project Plans*, EPA CIO 2106-G-05 QAPP, Final Draft. January.

APPENDIX A
PROJECT SCHEDULE

APPENDIX B
STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE
AGCMR-01

Advanced EMI Sensor Assembly and Verification

Advanced Geophysical Classification Activities
Former Fort Ord, California

Gilbane

August 2016

1 Purpose and Scope

The purpose of this standard operating procedure (SOP) is to describe the assembly of advanced EMI sensors for dynamic and cued advanced geophysical classification surveys and the process for verification that all components are correctly assembled, functioning properly, and capable of acquiring data of sufficient quality. This SOP describes MetalMapper system assembly and verification. If other advanced EMI sensors, such as TEMTADS or OPTEMA, are selected for use, this SOP will be updated to include assembly and verification details for those systems.

2 Personnel, Equipment, and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Geometrics MetalMapper sensor coupled with a real-time kinematic global positioning system (RTK GPS) and inertial measurement unit (IMU) for orientation measurements
- A schedule 80 small industry standard object (small ISO 80) for operational testing
- Digital camera

2.1 Personnel and Qualifications

The following individuals will be involved in the assembly and verification of the MetalMapper:

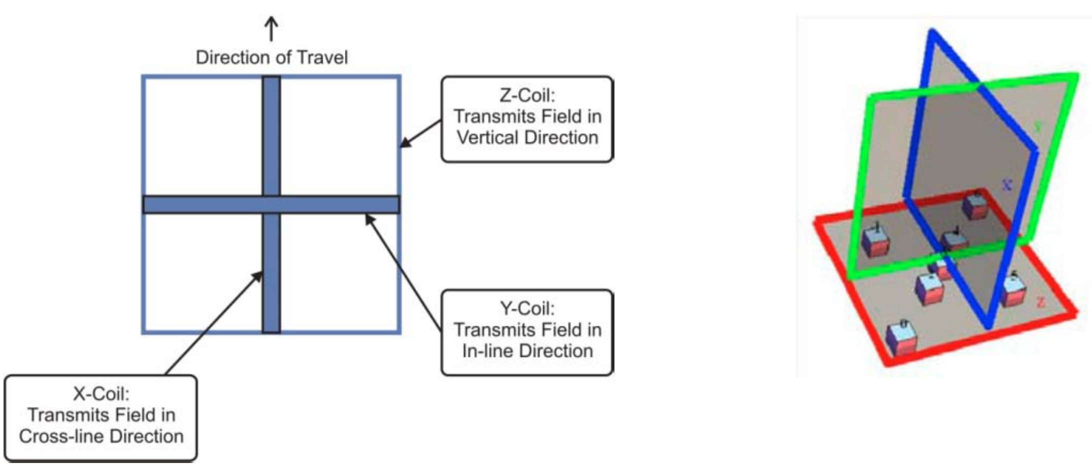
- Data Acquisition Geophysicist
- Lead Data Processor (off-site)

Personnel involved in performance of the assembly and check-out procedures will meet the qualifications as described in Quality Assurance Project Plan (QAPP) Worksheet 7.

3 Procedures and Guidelines

The Geometrics MetalMapper is an advanced electromagnetic induction sensor designed for the detection and classification of buried metal objects. The sensor consists of three orthogonal 1-meter (m) x 1-m transmit coils for target illumination and seven, three-axis receive cubes. It measures the decay curve up to 25 milliseconds (ms) after the transmitters are turned off for each of the 21 receiver coils, resulting in the recording of 63 different EM transients. The orientation of the three transmit coils and seven receive cubes is shown on **Figure 1**.

Figure 1. Orientation of MetalMapper transmit coils and receive cubes



The MetalMapper sampling parameters are programmable and therefore flexible to meet site-specific objectives. The decay curve of induced responses is typically measured to 8 ms after the transmitters are turned off with each of the 21 receiver coils, but a 25 ms decay curve will be used for this project based on the large targets of interest (TOI) which are the focus of the investigation.

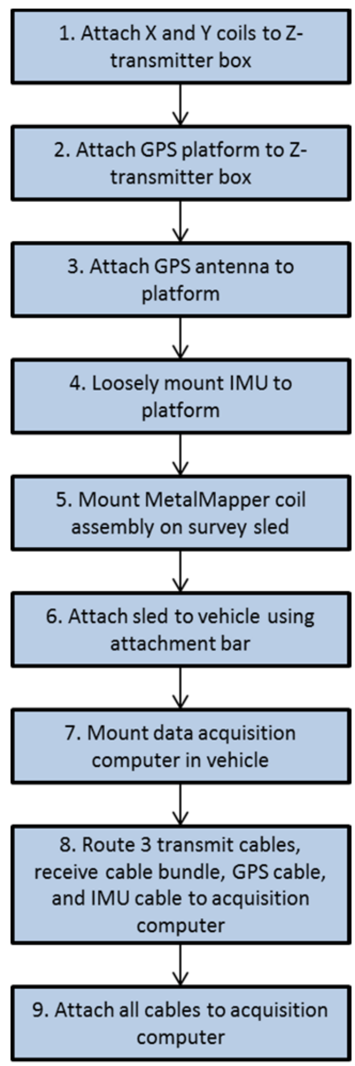
Positioning of the MetalMapper is accomplished using RTK GPS, and orientation is measured using a six-degree-of-freedom IMU. For proper functioning, the IMU must be mounted to the MetalMapper in the correct orientation.

3.1 Assemble the MetalMapper

MetalMapper assembly operations are described in the MetalMapper manual as published by Geometrics (http://www.geometrics.com/files/metalmapper_manual_beta1.pdf). The detailed instructions contained in the manual should be followed precisely. The assembly steps are briefly described below and shown as a schematic overview on **Figure 2**.

1. Using the bolts and brackets provided, attach the X transmitter coil followed by the Y transmitter coil to the Z-transmitter box.
2. Attach the GPS platform legs to the Z-transmitter box and the GPS platform to the platform legs.
3. Securely attach the GPS antenna to the GPS platform.
4. Loosely attach the IMU to the GPS platform. The attachment will be secured after correct IMU orientation is verified.
5. Mount the MetalMapper coil assembly on the survey sled, cushioned with a partially-inflated truck tire inner tube to reduce shock to the sensor assembly, if necessary.
6. Mount one end of the attachment bar to the survey sled and the other end to the vehicle using the provided hitch mount.
7. Mount the data acquisition computer in the vehicle so that it is accessible to the operator and can be easily seen during normal vehicle operations. Confirm that the operator's view of the sensor sled is not obstructed by the computer or display screen.
8. Route all cables (three transmit cables, the receive cable bundle, and the cables for the GPS and IMU) along the attachment bar to the acquisition computer. Secure the cables to the bar at several points.
9. Attach all cables to the marked connectors on the acquisition computer.

Figure 2. MetalMapper assembly overview



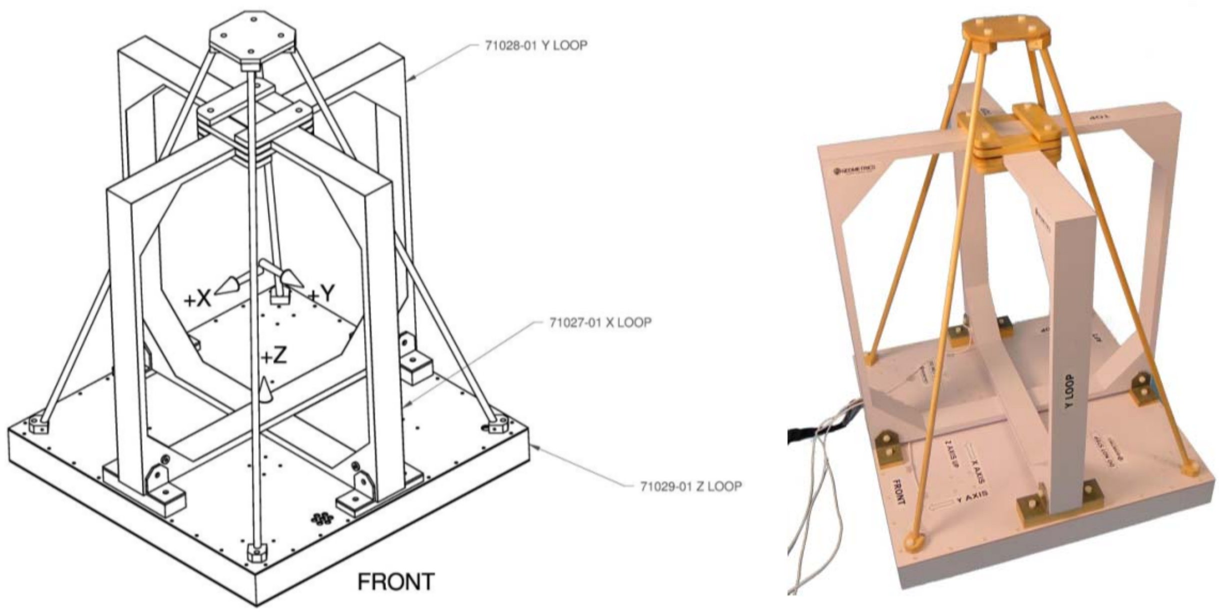
3.2 Verify MetalMapper Assembly

Successful data acquisition with the MetalMapper is dependent on proper assembly of the system. The following subsections describe the processes for verification that the sensor coils and IMU are properly oriented and the RTK GPS measurements are being received at the data acquisition computer.

3.2.1 Verify Orientation of the Transmit Coils

The correct orientation of the transmit coils and their polarities are shown on **Figure 3**. Visually verify that the assembled sensor matches this diagram.

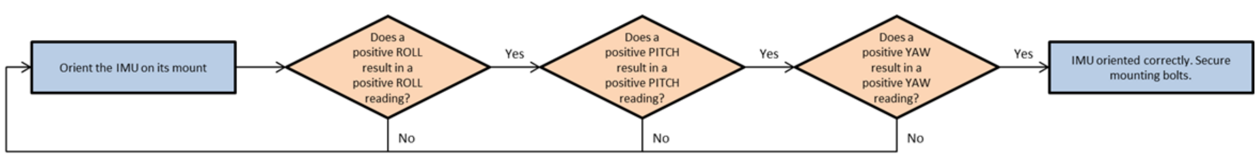
Figure 3. Correct orientations and polarities of the three MetalMapper transmit coils



3.2.2 Verify Orientation of the IMU

The procedure to verify the correct orientation of the IMU is shown on **Figure 4**, with detailed instructions following the figure.

Figure 4. Procedure for verification of IMU orientation



1. Facing the direction of travel, rotate the IMU around the along-track axis to produce a positive ROLL as shown on **Figure 5**. The primary data acquisition system window, including IMU displays, is shown on **Figure 6**. Verify that the data acquisition system records a positive ROLL. If it does not, reorient the IMU on its mount and test again.

Figure 5. Positive ROLL, PITCH, and YAW rotations of the IMU

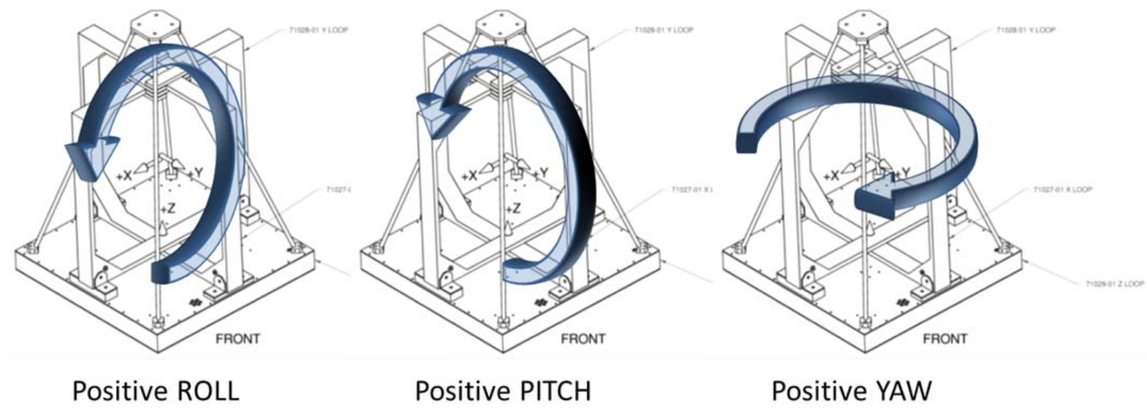
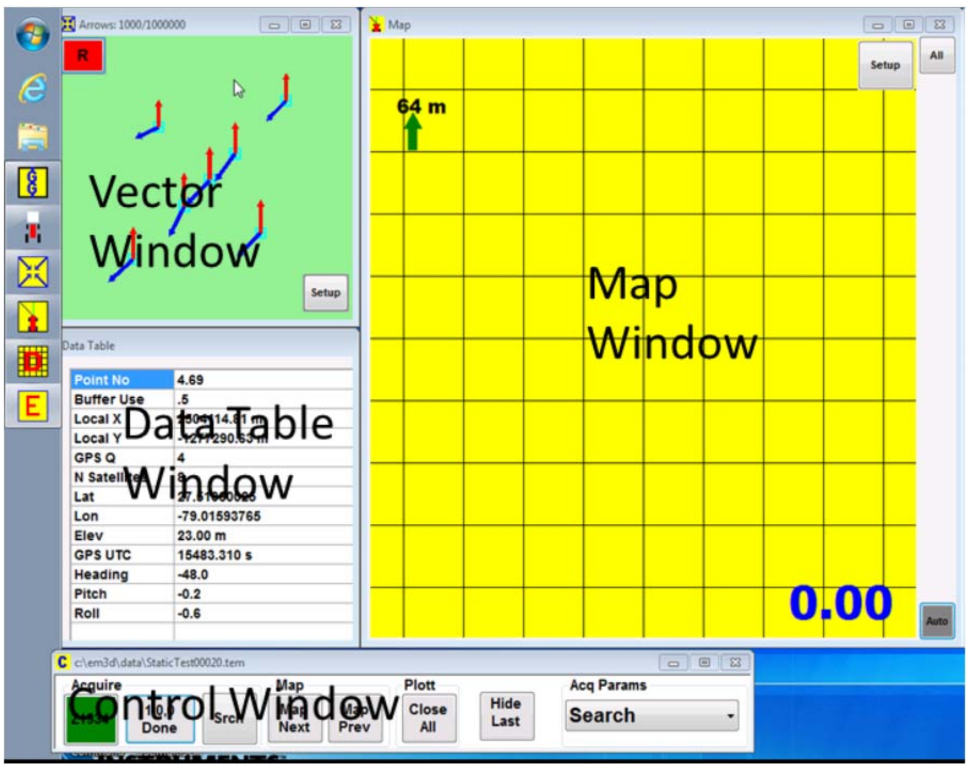


Figure 6. Default data acquisition system window



2. Standing on the side of the sensor with the direction of travel to your right, rotate the IMU around the cross-track axis to produce a positive PITCH as shown on **Figure 5**. The primary data acquisition system window, including IMU displays, is shown on **Figure 6**. Verify that the data acquisition system records a positive PITCH. If it does not, reorient the IMU on its mount and return to step 1.

3. Looking down on the sensor from above, rotate the IMU around the vertical axis to produce a positive YAW as shown on **Figure 5**. The primary data acquisition system window, including IMU displays, is shown on **Figure 6**. Verify that the data acquisition system records a positive YAW (displayed as “heading” in the data acquisition system). If it does not, reorient the IMU on its mount and return to step 1.

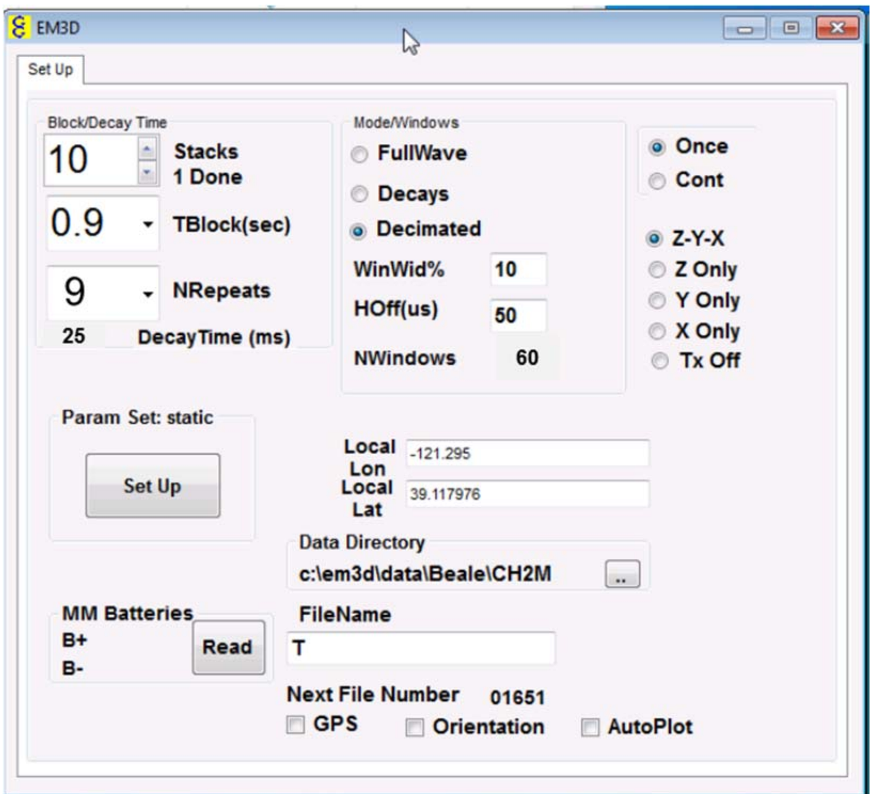
3.2.3 Verify Operation of the RTK GPS

Turn on the GPS receiver and allow sufficient time to acquire a fixed position. Verify that GPS readings are being received at the data acquisition computer. The primary data acquisition system window, including the GPS position display, is shown on **Figure 6**.

3.2.4 Verify Data Acquisition Parameters

Verify that the project-specific data acquisition parameters are set in the MetalMapper data acquisition system by opening the data acquisition parameter control window, shown on **Figure 7**.

Figure 7. Data acquisition parameter control window

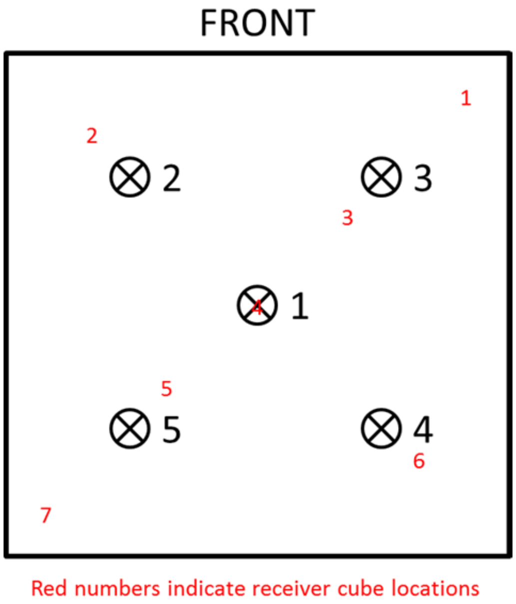


For Fort Ord advanced geophysical classification risk reduction activities, verify that the decay time is set to the long (25ms) window length, TBlock is set to 0.9 seconds, NRepeats is set to 9, and NWindows is set to 60. Different data acquisition parameters may be utilized depending on site-specific advanced classification objectives. These parameters will be defined in the Site-Specific Work Plan for each advanced geophysical classification activity.

3.2.5 Verify MetalMapper Operation

Center the MetalMapper over the blank location in the Instrument Verification Strip (IVS) and acquire a background measurement. Next, center the MetalMapper over an IVS item in position 1 as shown on **Figure 8**. Acquire a cued measurement with the MetalMapper, verifying that the transmit current is within the expected range. Position the MetalMapper with the IVS item directly under measurement positions 2 through 5, acquiring a cued measurement at each position. Invert each of the five data sets and verify that the modeled location is under the correct quadrant of the MetalMapper sensor array and that the resulting polarizability decay curves match the library values for the IVS item with a match metric of 0.95 or greater.

Figure 8. MetalMapper operation verification diagram



3.3 Photograph the MetalMapper System

Using a digital camera, photograph the assembled MetalMapper system for documentation of the MetalMapper assembly. Verify that the photographs depict the orientation of the MetalMapper relative to the tow vehicle and show the locations of the GPS and IMU sensors.

4 Data Management

The following sections describe the input data needed to perform this SOP and the resulting output data.

4.1 Input Data Required

Input data consists of the MetalMapper manual as published by Geometrics. The MetalMapper manual is available for download from http://www.geometrics.com/files/metalmapper_manual_beta1.pdf.

4.2 Output Data

Output data consist of the five static verification measurements over the IVS item described in Section 3.2.5, photographs of the assembled MetalMapper system described in Section 3.3, and the completed Advanced EMI Sensor Assembly Quality Control (QC) Checklist in Attachment 1 of this SOP. Data files from the five static verification measurements over the IVS item will be saved along with the inversion results and library match metric for each of the measurements. The Advanced EMI Sensor Assembly QC Checklist will be completed, signed, and filed with the assembled MetalMapper system photographs as documentation of correct system assembly.

5 Quality Control

This definable feature of work is completed only during the preparatory QC phase, and only preparatory QC checks will therefore be performed. QC consists of performing the inspections listed on the Preparatory Advanced EMI Sensor Assembly Checklist that is included as Attachment 1 to this SOP. The checklist will be completed by the Data Acquisition Geophysicist and reviewed by the QC Geophysicist. The QC Geophysicist will document the implementation of this SOP in the Daily QC Report.

5.1 Measurement Performance Criteria (MPC)

The measurement quality objectives (MQO) for this task, as presented in Worksheet 22 of the Advanced Geophysical Classification for Munitions Response (AGCMR)-QAPP, include verification of correct MetalMapper assembly as shown on the completed Advanced EMI Sensor Assembly Checklist and by an IVS item library match metric of ≥ 0.95 with a modeled location under the correct quadrant of the MetalMapper sensor array for each of the five sets of inverted polarizability decay curves from the static verification measurements over the IVS item described in Section 3.2.5. MetalMapper system performance will not be verified on the instrument verification strip (IVS) (SOP MR-AC-02) until documentation that the MQO for MetalMapper assembly have been completed as described below.

6 Reporting

Achievement of the MetalMapper Assembly MPCs (see the MQO in Worksheet 22 of the AGCMR-QAPP) will be documented by the Data Acquisition Geophysicist by completion of the Advanced EMI Sensor Assembly Checklist in Attachment 1 to this SOP and will be verified by the QC Geophysicist in the Daily QC Report.

The delivered data package for the assembled and tested MetalMapper will include the following:

- A brief description of the assembly and test process along with the photographs taken in Section 3.3 included in the IVS letter report
- The completed Advanced EMI Sensor Assembly Checklist signed by the Data Acquisition Geophysicist verifying the assembly and orientation tests described above
- The inversion results from the five static verification measurements over the IVS item overlain over the library polarizabilities for the IVS item
- A plot of the modeled locations of each of the five static verification measurements over the IVS item
- Verification documentation in the Daily QC Report

Attachment 1

Preparatory Advanced EMI Sensor Assembly Checklist

Preparatory Advanced EMI Sensor Assembly Checklist

This checklist is to be completed by the Data Acquisition Geophysicist during assembly and initial testing of the advanced EMI sensor and reviewed and verified by the QC Geophysicist.

QC Step	QC Process and Guidance Reference	Yes/No	Data Acquisition Geophysicist Initials
1. Qualifications	Are the qualifications of the Data Acquisition Geophysicist and the Lead Data Processor in accordance with AGCMR-QAPP Worksheet 7?		
2. Assembly	Has the MetalMapper been assembled in accordance with the published instructions and in the sequence specified in Section 3.1?		
3. Assembly: Transmit coil verification	Has the orientation of the transmit coils been verified to be correct (Section 3.2.1)?		
4. Testing: IMU orientation verification	Have the procedure and tests for verification of the IMU orientation been completed (Section 3.2.2)?		
5. Testing: GPS verification	Has the GPS been warmed up and allowed time to lock onto position (Section 3.2.3)?		
6. Testing: Data acquisition parameters verification	Have data acquisition parameters been verified (Section 3.2.4)?		
7. Testing: ISO 80 placement	Has an IVS item been used for testing and was it placed as specified in Section 3.2.5?		
8. Testing: MetalMapper functioning	Has the MetalMapper been tested over the IVS item in all five locations (Section 3.2.5)? Record the library match metric and correct modeled location for each of the five inversions below: 1. ______________________________ 2. ______________________________ 3. ______________________________ 4. ______________________________ 5. ______________________________		
9. Photograph the assembled system	Have photographs showing the orientation of the MetalMapper relative to the vehicle and the placement of the GPS and IMU been taken?		
10. MPC documentation	Have the MPCs for MetalMapper assembly been achieved in accordance with AGCMR-QAPP Worksheet 22?		

Data Acquisition Geophysicist: ____ Date: _______________

Lead Data Processor: ____ Date: _______________

STANDARD OPERATING PROCEDURE
AGCMR-02

Advanced EMI Sensor Instrument Verification Strip

Advanced Geophysical Classification Activities
Former Fort Ord, California

Gilbane

August 2016

1 Purpose and Scope

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed when verifying the operation of an advanced electromagnetic induction (EMI) sensor system prior to and during site surveys. The instrument verification strip (IVS) is constructed of buried industry standard objects (ISO). During the IVS process, the advanced EMI sensor system measures the response of each item in the IVS, and these responses are subsequently compared to a library of expected responses to verify and document proper functioning of the system. This SOP describes MetalMapper IVS operations. If other advanced EMI sensors, such as TEMTADS or OPTEMA, are selected for use, this SOP will be updated to include IVS details for those systems.

2 Personnel, Equipment, and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Advanced EMI sensor coupled with a real-time kinematic global positioning system (RTK GPS) and inertial measurement unit (IMU) for orientation measurements
- Two industry standard objects (ISO) to construct the IVS
- Hand tools, including shovels, pike axes, breaker bars, etc. to construct the IVS
- Data processing computer suitable for and equipped to run the UX-Analyze Advanced module of Geosoft's Oasis Montaj geophysical processing environment

2.1 Personnel and Qualifications

The following individuals will be involved in verifying correct operation of the MetalMapper system at the IVS:

- Data Acquisition Geophysicist
- Lead Data Processor
- QC Geophysicist
- UXO Personnel[1]

The qualifications for the Data Acquisition Geophysicist and the Lead Data Processor are listed in Worksheet 7 of the AGCMR-QAPP.

3 Procedures and Guidelines

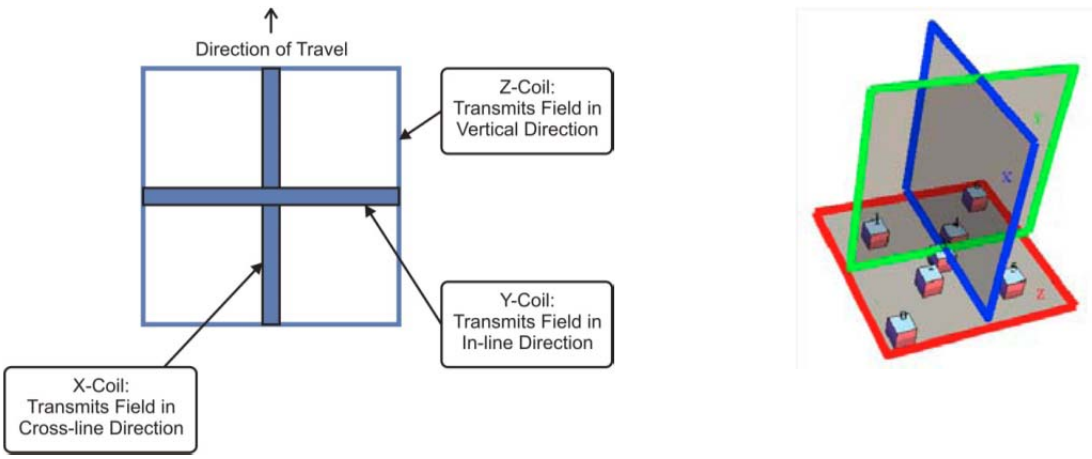
3.1 Advanced EMI Sensor System

The Geometrics MetalMapper is an advanced EMI sensor designed for the detection and classification of buried metal objects. The sensor consists of three orthogonal 1-meter by 1-meter transmit coils for target illumination and seven, three-axis receive cubes. It measures the decay curve up to 25 milliseconds (ms) after the transmitters are turned off with each of the 21 receiver coils, resulting in the recording of 63 different EM transients. The orientation of the three transmit coils and seven receive cubes is shown on **Figure 1**. The MetalMapper sampling parameters are programmable and therefore flexible to meet site-specific objectives. The decay curve of induced responses is typically measured to 8 ms after the

[1] UXO personnel will be responsible for overall daily site access and safety aspects of the project, compiling health and safety documents, conducting daily safety briefings, and performing munitions and explosives of concern avoidance, as needed, in the field. Information on the specific qualifications for various UXO personnel support roles can be found in the project Health and Safety Plan.

transmitters are turned off for each of the 21 receiver coils, but a 25 ms decay curve may be used for individual advanced geophysical classification projects, depending on site-specific objectives. Data acquisition parameters will be defined in the Site-Specific Work Plan for each advanced geophysical classification activity.

Figure 1. Orientation of MetalMapper transmit coils and receive cubes



Positioning of the MetalMapper is accomplished using RTK GPS, and orientation is measured using a six-degree-of-freedom inertial measurement unit (IMU). Combining the sensor orientation and location measurements in this manner typically results in derived target locations within 6 inches (15 centimeters) of the ground truth.

3.2 Instrument Verification Strip Construction

Verification of the DGM system is accomplished using an IVS. Multiple IVS locations may be constructed during the project for efficiency of data acquisition. The constructions details and verification procedures described in this document apply to each IVS location.

3.2.1 Location and Configuration of the Instrument Verification Strip

IVS locations will be identified during initial site reconnaissance by the DGM field team. The IVS should be established in an area that is easily accessible, not prone to flooding and other weather-related incidents, and is determined to be relatively free of subsurface metal objects. The IVS for this MetalMapper survey includes two ISO and one 'blank' location, where nothing is buried.

3.2.2 Instrument Verification Strip Objects

Seed objects for the IVS will be small schedule 80 ISO, medium schedule 40 ISO, or large schedule 40 ISO, depending on sizes of the site-specific TOI. **Table 1** lists the specifications for the three sizes of ISO, photographs of which are presented on **Figure 2**.

Table 1. Industry standard objects characterized for use as munitions surrogates

Item	Nominal Pipe Size	Outside Diameter	Length	Part Number[1]	Schedule
Small ISO 80	1 inch	1.315 inches	4 inches	4550K226	80
Medium ISO 40	2 inches	2.375 inches	8 inches	44615K529	40
Large ISO 40	4 inches	4.500 inches	12 inches	44615K137	40

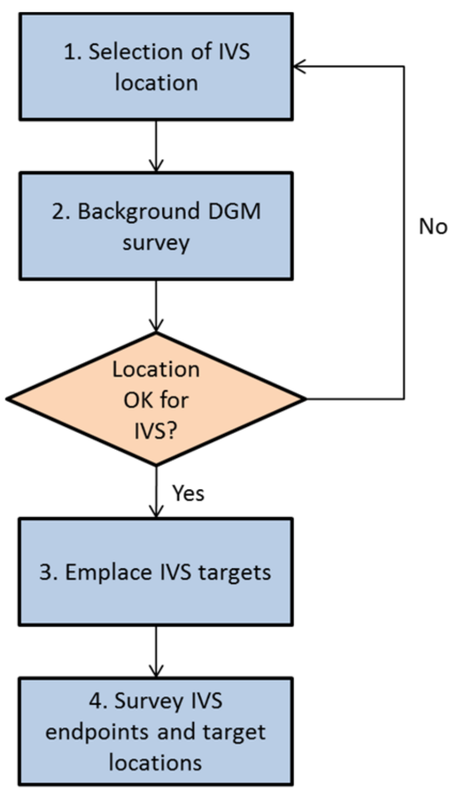
[1] Part number from McMaster-Carr supplier (http://www.mcmastercarr.com/)

Figure 2. Small, medium, and large ISO

3.2.3 Instrument Verification Strip Emplacement

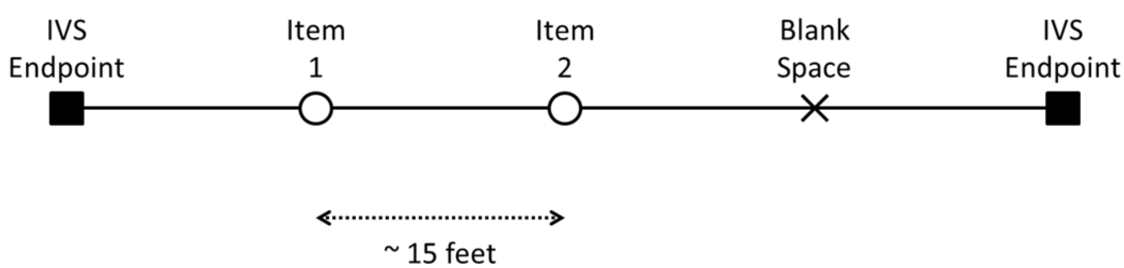
Figure 3 illustrates the overall IVS process and the procedures to be followed during the siting, and emplacement of the IVS. Detailed descriptions of each step are described in the following section.

Figure 3. IVS siting and emplacement



1. An IVS location will be selected with preference for the following (although none of the conditions are vital for IVS success):
    - Terrain, geology, and vegetation similar to that of a majority of the survey area
    - Geophysical noise conditions similar to those expected across the survey area
    - Large enough site to accommodate all necessary IVS tests and equipment and for adequate spacing (at least 3-m separation and preferably greater) of the ISO items to avoid ambiguities in data evaluation
    - Readily accessible to project personnel
    - Close proximity to the actual survey site (if not within the site)
2. A dynamic background DGM survey will be performed with the advanced EMI sensor or other DGM instrument using RTK GPS. The purpose of the background survey is to document the suitability of the location (e.g. few existing anomalies), and verify that IVS targets are not seeded near existing anomalies. The data from this IVS pre-survey will be processed and provided to the Project Geophysicist and QC Geophysicist for evaluation.
3. After determination that the IVS area is free of significant subsurface anomalies or contains only anomalies that are clearly identified and can be avoided during seeding, one ISO will be buried horizontally, perpendicular to the transect, and one will be buried vertically, both at depths below ground surface (measured to the center of mass of the ISO) determined to provide adequate signal to noise ratio for detecting the targets. The generalized diagram of the seeded IVS transect is presented as **Figure 4**.

Figure 4. Example IVS layout



On-site personnel will bury the IVS targets using shovels to dig the holes to the appropriate depths for burial of the seed items in coordination with the QC Geophysicist. UXO personnel will implement MEC avoidance procedures using analog instruments during installation, if necessary. The background survey data and anomaly avoidance techniques will be reviewed so that transect start and end stakes and seed items are not placed on top of or near existing anomalies. IVS construction personnel will bury the ISO and record the following information:

- Transect endpoints
- Blank space location
- Target type with unique seed item identifier and photograph of item (with a whiteboard displaying its identity depth, and orientation)
- Target emplacement location
- Target emplacement depth
- Target emplacement orientation

4. The holes will then be backfilled with soil to the original ground surface grade, and a wooden survey stake or other suitable non-metallic marker will be placed at each buried item location as well as at the blank location, start and end points of the IVS survey line. Wooden stakes will not extend more than 3 inches above the ground surface to prevent interference with the advanced EMI sensor when passing over them.

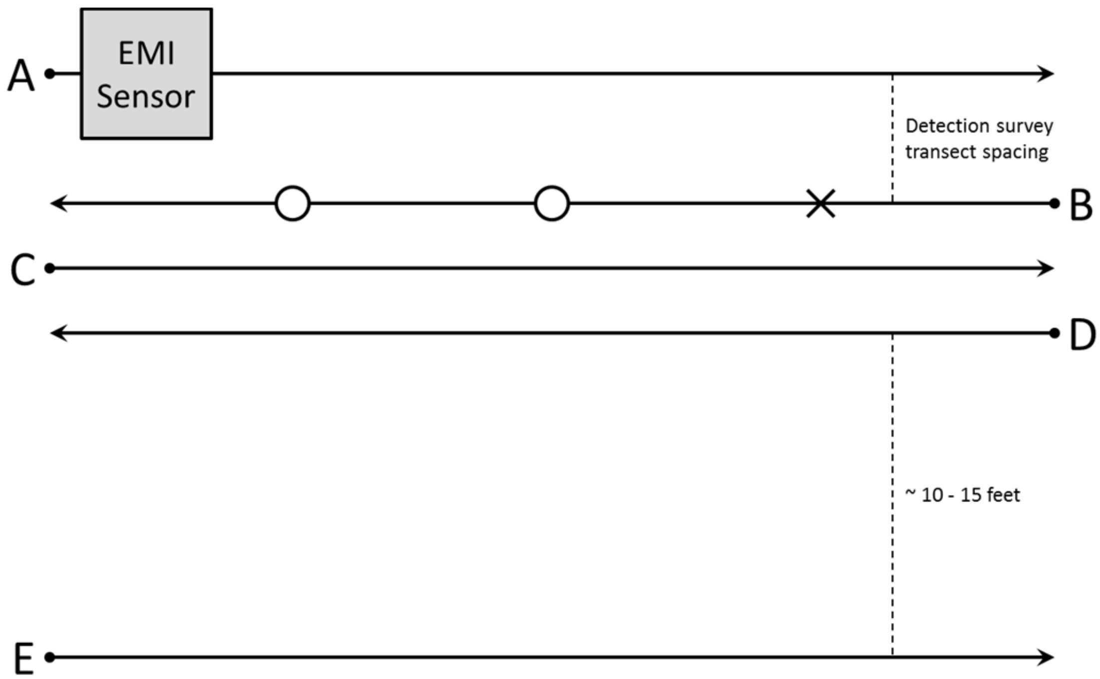
3.3 Initial Instrument Verification Strip Survey

Prior to acquiring dynamic or cued production data, the advanced EMI sensor will be assembled and tested in accordance with SOP AGCMR-01, and the initial IVS survey will be completed in dynamic and/or cued mode, depending on the nature of the advanced EMI sensor survey.

3.3.1 Initial Dynamic Instrument Verification Strip Survey

During the initial dynamic IVS survey, advanced EMI sensor data will be acquired along four transects over the seeded IVS and along one background transect, as illustrated on **Figure 5**. Three of the dynamic transects will be acquired at the intended detection survey line spacing – one transect directly over the IVS items, one transect to the left of the seeded transect, and one transect to the right of the seeded transect. The fourth dynamic transect will be offset from the seeded item transect by ½ the intended detection survey line spacing as an assessment of the detection capability of targets located between survey lines. The background transect will be offset 10-15 feet from the seeded IVS transect.

Figure 5. Initial Dynamic IVS survey transect locations



The raw .tem files and converted .csv files for each transect will be delivered to the data processor, who will process the data in the same manner as the detection survey data. The data processor will verify successful achievement of the initial dynamic IVS survey measurement performance criteria (MPC) described in Worksheet 22 of the QCMR-QAPP by performing the following data quality verifications:

- Verify that all IVS item fit locations are within 10 inches of the ground truth locations
- Verify that all IVS item response amplitudes are within 25% of the predicted amplitudes

If the MPC have not been met, the QC Geophysicist will initiate a root cause analysis (RCA) to determine the source of the discrepancy. If modifications to the instrument or procedures can be made so that the MPC can be met, these modifications will be made. If the MPC cannot be met, the Project and QC Geophysicists will meet with the project team to discuss potential resolutions.

After verification that the dynamic IVS survey MPC (initial or modified) have been met, the dynamic IVS survey will be complete, and the advanced EMI sensor and operators will be verified for detection data acquisition.

3.3.2 Initial Cued Instrument Verification Strip Survey

During the initial cued IVS survey, advanced EMI sensor data will be acquired over each of the item positions in the IVS, including the background location (blank space). The raw .tem files and converted .csv files for each measurement will be delivered to the data processor, who will process the data in the same manner as the cued survey data. The data processor will verify successful achievement of the initial cued IVS survey MPC described in Worksheet 22 of the QCMR-QAPP by performing the following data quality verifications:

- Examine the data from each IVS location and verify that all measured decays are valid
- Use the measurement over the blank space to background-correct cued data points, and invert the corrected data
- Verify that the resulting polarizabilities match the expected library values with a match metric of 0.9 or greater
- Verify that the horizontal fit locations are within 5 inches of IVS seed item ground truth locations

If the initial MPC have not been met, the QC Geophysicist will initiate an RCA to determine the source of the discrepancy. If modifications to the instrument or procedures can be made so that the MPC can be met, these modifications will be made. If the MPC cannot be met (e.g., the initial background decay amplitudes are too large), the Project and QC Geophysicists will meet with the project team to discuss potential resolutions.

After verification that the cued IVS survey MPC (initial or modified) have been met, the cued IVS survey will be complete, and the advanced EMI sensor and operators will be verified for cued data acquisition.

3.3.3 Daily Instrument Verification Strip Survey

Twice each day during dynamic or cued data acquisition operations, IVS data will be acquired with the advanced EMI sensor. The daily IVS surveys will be conducted prior to beginning data acquisition activities and following completion of data acquisition activities.

When dynamic surveys are being conducted, the daily IVS survey will consist of the acquisition of a single line over the IVS items. The raw .tem files and converted .csv files for the transect will be delivered to the data processor, who will process the data in the same manner as the detection survey data. The data processor will verify successful achievement of the daily dynamic IVS survey MPC described in Worksheet 22 of the QCMR-QAPP by performing the following data quality verifications:

- Verify that the IVS item fit locations are within 10 inches of the average locations
- Verify that the IVS item response amplitudes are greater than or equal to 25% of the average response amplitudes

When cued surveys are being conducted, the daily IVS survey will consist of the acquisition of cued data over each of the item positions in the IVS, including the background location. The raw .tem files and converted .csv files for each measurement will be delivered to the data processor, who will process the data in the same manner as the cued survey data. The data processor will verify successful achievement of the daily cued IVS survey MPC described in Worksheet 22 of the QCMR-QAPP by performing the following data quality verifications:

- Examine the data from each IVS location and verify that all measured decays are valid
- Verify that the background decay amplitudes are lower than project threshold and qualitatively agree with the initial measurement
- Use the measurement over the blank space to background-correct cued data points, and invert the corrected data
- Verify that the resulting polarizabilities match the initial IVS polarizability values with a match metric of 0.9 or greater
- Verify that all IVS item fit locations are within 5 inches of the average derived fit locations

4 Data Management

The following sections describe the input data needed to perform this SOP and the resulting output data.

4.1 Input Data Required

Input data required for this SOP are the locations and identities of the IVS items, the dynamic response values for each item, and the library polarizabilities for each item.

4.2 Output Data

Output data consist of the dynamic measurements over the IVS items described in Sections 3.3.1 and 3.3.3, the cued measurements over the IVS items described in Sections 3.2.2 and 3.3.3, and the QC checklists in Attachments 1 - 5 of this SOP. The test measurement data will be saved along with the dynamic IVS data and the cued inversion results and library match metric for each IVS measurement. The QC checklists will be completed, signed, and filed as documentation of system performance.

5 Quality Control

5.1 IVS Quality Control

Dynamic and/or cued IVS measurements are performed throughout the project and therefore require preparatory, initial, and follow-on QC checks. Performance of the required QC checks will be documented by the Data Acquisition Geophysicist or Lead Data Analyst on the Preparatory, Initial and Follow-on QC checklists in Attachments 1 - 5 of this SOP. Successful completion of these procedures will be verified by the QC Geophysicist in the daily Geophysics QC Report.

- The Preparatory QC Checklist covers the construction of the IVS and preparation of the advanced EMI sensor prior to the first IVS tests. This checklist is completed once per IVS.
- The Initial Dynamic IVS Checklist covers the initial IVS tests to demonstrate proper functioning of the advanced EMI sensor system prior to performing dynamic data acquisition.
- The Initial Cued IVS Checklist covers the initial IVS tests to demonstrate proper functioning of the advanced EMI sensor system prior to performing cued data acquisition.
- The Follow-on Dynamic Daily IVS Checklist documents the twice-daily IVS tests that are performed each morning prior to beginning dynamic data acquisition and following completion of dynamic data acquisition.

- The Follow-on Cued Daily IVS Checklist documents the twice-daily IVS tests that are performed each morning prior to beginning cued data acquisition and following completion of cued data acquisition.
- The QC checks in Attachments 1 - 5 will be performed as part of IVS procedure. In addition, instrument-specific start-up and function checks for the advanced EMI sensor system will also be performed at start-up prior to data acquisition activities, including IVS data acquisition.
- Achievement of the IVS MQO will be verified by the Field Geophysicist and QC Geophysicist on their QC checklists.
- During review of the initial and follow-on data packages, the data processor will overlay the polarizabilities of each IVS target from all cued measurements to observe the time variation of the inverted results. Should an issue be detected (such as a data trend indicating a MPC limit is being approached) or a MQO not be met, a comprehensive RCA will be conducted and a corrective action determined.

5.2 Measurement Quality Objectives

The MQO for the IVS are presented in Worksheet 22 of the AGCMR-QAPP. The advanced EMI sensor will not be used for production area data acquisition until it is able to meet initial IVS MQO or until the project team agrees on modifications to the MQO. If ongoing IVS MQO are not met, a comprehensive RCA will be performed and a corrective action determined.

6 Reporting

System verification at the IVS will be documented through the completion of the preparatory, initial, and follow-on QC Checklists in Attachments 1 - 5. The IVS construction and implementation will be documented in an IVS Technical Memorandum. Copies of the completed Advanced EMI Sensor Assembly Checklist (from SOP AGCMR-01), the Preparatory and Initial Checklists (from this SOP), and/or the Advanced EMI Sensor Dynamic Data Acquisition Checklist (from SOP AGCMR-05) and the Advanced EMI Sensor Cued Data Acquisition Checklist (from SOP AGCMR-07) will be included as attachments to the IVS Technical Memorandum. A follow-on QC Checklist will be completed by the Data Acquisition Geophysicist and Lead Data Processor each time IVS data are acquired during the production survey, and copies will be included with the advanced geophysical classification report at the completion of the project.

Attachment 1

Preparatory IVS Construction Checklist

Preparatory IVS Construction Checklist

This checklist is to be completed by the Data Acquisition Geophysicist during construction of the IVS and reviewed and verified by the QC Geophysicist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	Data Acquisition Geophysicist Initials
1. Qualifications	Are the qualifications of the Data Acquisition Geophysicist and the Lead Data Processor in accordance with AGCMR-QAPP Worksheet 7?		
2. IVS construction	Has an appropriate location for the IVS been selected (Sections 3.2.1 and 3.2.3, Step 1)?		
3. IVS construction	Have appropriate IVS seed targets been selected (Section 3.2.2)?		
4. IVS construction	Has the background geophysical survey been performed (Section 3.2.3, Step 2)?		
5. IVS construction	Have the IVS seed targets been buried appropriately (Section 3.2.3, Step 3)?		
6. IVS construction	Has the required IVS construction information (Section 3.2.3, Step 3) been recorded for inclusion in the IVS Letter Report?		
7. IVS construction	Have the IVS seed target holes been backfilled and marked (Section 3.2.3, Step 4)?		

Data Acquisition Geophysicist: ____ Date: _______________

Lead Data Processor: ____ Date: _______________

Attachment 2

Initial Dynamic IVS Checklist

Initial Dynamic IVS Checklist

This checklist is to be completed by the Data Acquisition Geophysicist and the Lead Data Processor during the initial demonstration of the advanced EMI sensor dynamic performance on the IVS and reviewed and verified by the QC Geophysicist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	Data Acquisition Geophysicist or Lead Data Processor Initials
1. Preparation	Has the SOP AGCMR-02 Preparatory Checklist been successfully completed?		
2. Preparation	Have the advanced EMI sensor start-up procedures and the Advanced EMI Sensor Dynamic Data Acquisition Checklist (from SOP AGCMR-05) been successfully completed?		
3. Data acquisition	Has the IVS data been acquired in accordance with Section 3.3.1?		
4. Data processing	Has the data been processed in accordance with Section 3.3.1?		
5. Data analysis	Have the IVS item horizontal fit locations been verified to be within 10 inches of ground truth locations?		
6. Data analysis	Have the IVS item response amplitudes been verified to be within 25% of the predicted amplitudes?		
7. MPC documentation	Have the MPCs for the initial dynamic IVS survey been achieved in accordance with AGCMR-QAPP Worksheet 22?		

Data Acquisition Geophysicist: ______________________________________ Date: _______________

Lead Data Processor: ____ Date: _______________

Attachment 3

Initial Cued IVS Checklist

Initial Cued IVS Checklist

This checklist is to be completed by the Data Acquisition Geophysicist and the Lead Data Processor during the initial demonstration of the advanced EMI sensor cued performance on the IVS and reviewed and verified by the QC Geophysicist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	Data Acquisition Geophysicist or Lead Data Processor Initials
1. Preparation	Has the SOP AGCMR-02 Preparatory Checklist been successfully completed?		
2. Preparation	Have the advanced EMI sensor start-up procedures and the Advanced EMI Sensor Cued Data Acquisition Checklist (from SOP AGCMR-07) been successfully completed?		
3. Data acquisition	Has the IVS data been acquired in accordance with Section 3.3.2?		
4. Data processing	Has the data been processed in accordance with Section 3.3.2?		
5. Data analysis	Has the data acquired on the blank space been verified to be suitable for use as background (Section 3.3.2)?		
6. Data analysis	Have the background decay amplitudes been verified to be below the selected threshold (Section 3.3.2)?		
7. Data analysis	Has the background data from the blank space been used to correct the target data sets and to invert the data (Section 3.3.2)?		
8. Data analysis	Have the resulting polarizabilities been verified to match the expected library values with a match statistic of 0.9 or greater (Section 3.3.2)?		
9. Data analysis	Have the horizontal fit locations been verified to be within 5 inches of ground truth locations?		
10. MPC documentation	Have the MPCs for the initial cued IVS survey been achieved in accordance with AGCMR-QAPP Worksheet 22?		

Data Acquisition Geophysicist: ______________________________________ Date: _______________

Lead Data Processor: ____ Date: _______________

Attachment 4

Follow-on Dynamic Daily IVS Checklist

Follow-On Dynamic Daily IVS Checklist

This checklist is to be completed by the Data Acquisition Geophysicist and Data Processor during each dynamic IVS survey (twice each day during data acquisition operations, prior to beginning data acquisition and following completion of data acquisition) and reviewed and verified by the QC Geophysicist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	Data Acquisition Geophysicist or Data Processor Initials
1. Qualifications	Are the same geophysical personnel being used as in SOP AGCMR-01? If not, are the qualifications of the new personnel in compliance with the requirements of AGCMR-QAPP Worksheet 7?		
2. Preparation	Have the advanced EMI sensor start-up procedures and the Advanced EMI Sensor Dynamic Data Acquisition Checklist (from SOP AGCMR-05) been successfully completed?		
3. Data acquisition	Has the IVS data been acquired in accordance with Section 3.3.3?		
4. Data processing	Has the data been processed in accordance with Section 3.3.3?		
5. Data analysis	Have the IVS item horizontal fit locations been verified to be within 10 inches of the average derived fit locations?		
6. Data analysis	Have the IVS item response amplitudes been verified to be greater than or equal to 25% of the average amplitudes?		
7. MPC documentation	Have the MPCs for the dynamic daily IVS survey been achieved in accordance with AGCMR-QAPP Worksheet 22?		

Field Geophysicist: ____ Date: _______________

Lead Data Processor: ____ Date: _______________

Attachment 5

Follow-on Cued Daily IVS Checklist

Follow-on Cued Daily IVS Checklist

This checklist is to be completed by the Data Acquisition Geophysicist and Data Processor during each cued IVS survey (twice each day during data acquisition operations, prior to beginning data acquisition and following completion of data acquisition) and reviewed and verified by the QC Geophysicist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	Data Acquisition Geophysicist or Data Processor Initials
1. Qualifications	Are the same geophysical personnel being used as in SOP AGCMR-01? If not, are the qualifications of the new personnel in compliance with the requirements of AGCMR-QAPP Worksheet 7?		
2. Preparation	Have the advanced EMI sensor start-up procedures and the Advanced EMI Sensor Cued Data Acquisition Checklist (from SOP AGCMR-07) been successfully completed?		
3. Data acquisition	Has the IVS data been acquired in accordance with Section 3.3.3?		
4. Data processing	Has the data been processed in accordance with Section 3.3.3?		
5. Data analysis	Has the background data from the blank space been used to correct and invert the target data (Section 3.3.3)?		
6. Data analysis	Have the resulting polarizabilities been verified to match the expected library values with a match statistic of 0.9 or greater (Section 3.3.3)?		
7. Data analysis	Have the IVS item horizontal fit locations been verified to be within 5 inches of the average derived fit locations?		
8. MPC documentation	Have the MPCs for the cued daily IVS survey been achieved in accordance with AGCMR-QAPP Worksheet 22?		

Field Geophysicist: ____ Date: _______________

Lead Data Processor: ____ Date: _______________

STANDARD OPERATING PROCEDURE
AGCMR-03

Quality Control Seeding for Advanced Geophysical Classification

Advanced Geophysical Classification Activities
Former Fort Ord, California

Gilbane

August 2016

1 Purpose and Scope

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed when emplacing quality control (QC) seed items in the production area in preparation for dynamic or cued advanced EMI sensor digital geophysical mapping.

2 Personnel, Equipment, and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Inert munitions and/or industry standard objects (ISO) as seed items
- Hand tools including shovels, pick axes, breaker bars, etc. to emplace the seed items
- Excavators if required by the production seed plan

2.1 Personnel and Qualifications

The following individuals will be involved in emplacing QC seed items:

- QC Geophysicist, or designee
- UXO Personnel[1]
- Real-time kinematic global positioning system (RTK GPS) operator

The minimum qualifications for the QC Geophysicist are listed in Worksheet 7 of the AGCMR-QAPP.

3 Procedures and Guidelines

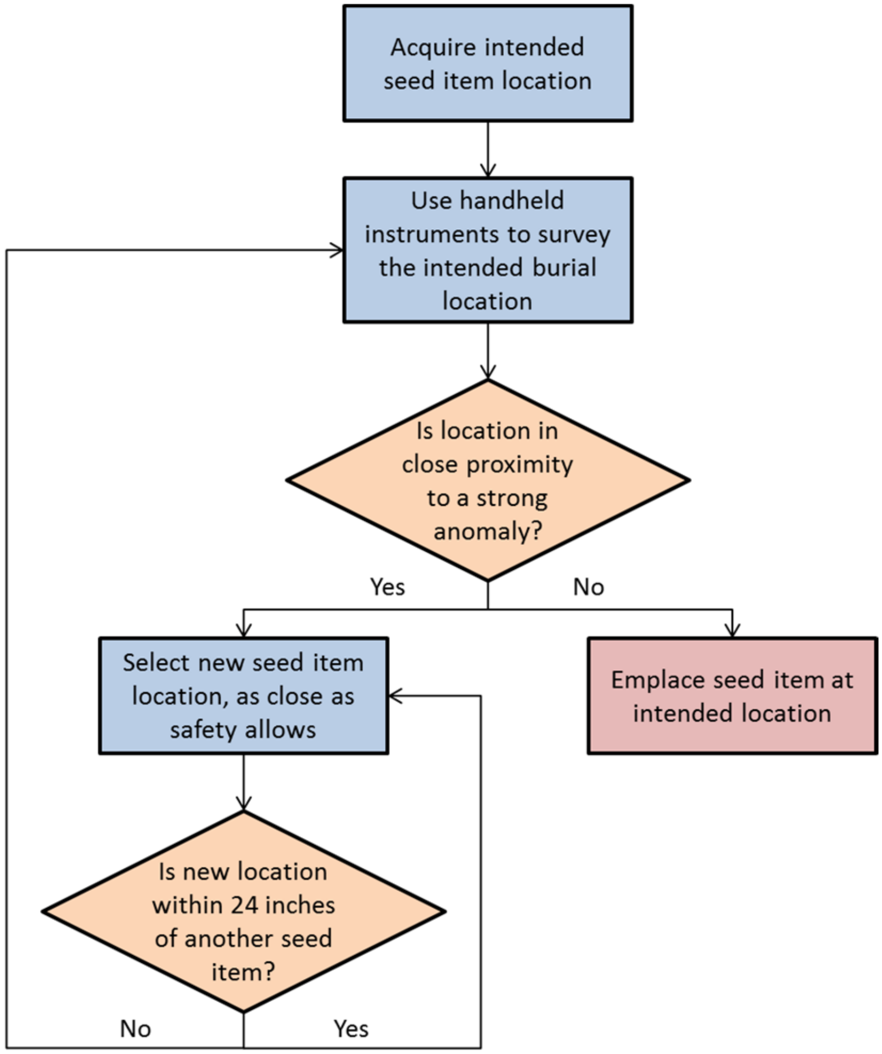
The production area seed plan provides a list of seed identities, locations, depths, and orientations. When emplacing the seeds, the emplacement team will employ anomaly avoidance techniques as described in Section 3.1 and use the emplacement procedure described in Section 3.2.

3.1 Anomaly Avoidance

It is likely that the survey area will contain metallic items or electromagnetically active geology. These will produce anomalies in data collected with a magnetometer or electromagnetic induction instrument. The emplacement team should avoid emplacing seeds in the immediate vicinity of strong anomalies. **Figure 1** describes the process that will be used to avoid strong anomalies when emplacing a seed. First, the emplacement team will acquire the seed item's intended location. The team will then use a hand-held detector to survey within the immediate vicinity of the intended location. If there are no strong anomalies in the immediate vicinity, the team will emplace the seed at the intended location. If, however, the intended location is in the immediate vicinity of any strong anomaly, the team will select a new location for the seed, as close as safety allows. The new location should not be within the immediate vicinity of any strong anomaly or within 5 feet of another seed item.

[1] UXO personnel will be responsible for overall daily site access and safety aspects of the project, compiling health and safety documents, conducting daily safety briefings, and performing munitions and explosives of concern avoidance, as needed, in the field. Information on the specific qualifications for various UXO personnel support roles can be found in the project Health and Safety Plan.

Figure 1. Anomaly avoidance during QC seed item emplacement



3.2 Seed Emplacement

Advanced geophysical classification will attempt to reconstruct the physical parameters of buried targets, such as location, depth, inclination, azimuth, and size. It is therefore critical for the success of the project that the actual locations of the buried seed items are surveyed as accurately and precisely as possible. To that end, the emplacement team should dig in a fashion to minimize seed migration (e.g., settling) after burial.

The QC seed item list specifies the intended burial parameters of each seed item. The intended locations are given to 1 inch precision, the intended depths to 2 inch precision, and the intended inclinations and azimuths to 10 degree precision. All locations should be acquired as accurately and precisely as possible using RTK GPS before digging begins, to maximize anomaly avoidance.

The QC seed item list is a guide for seed emplacement, but the emplacement team may allow small deviations from the intended burial parameters. Variations from the intended burial parameters must be documented by recording the actual burial parameters as accurately and precisely as possible. The emplacement team should adjust the inclination angles of the seed items to ensure at least 2 inches of soil covering the shallowest point of each seed item.

After emplacing a seed item in the ground, but before covering it with soil, the following information should be accurately recorded:

- The x, y, and z coordinates for the center of mass of the seed item
- The depth of the seed item, measured as the vertical distance from the bottom of a straight edge placed across the opening of the hole down to the center of the seed
- A photograph of the seed item, showing its serial number and a ruler or similar scale

For each seed item, the emplacement team should also complete the following:

- Ensure the seed item is marked with blue paint to identify it as inert
- Rebury any metallic items that were found in the hole along with the seed
- Replace soil in the hole as completely as possible
- Level the burial location
- Replace the grass plug over the burial location, if possible

4 Data Management

The following sections describe the input data needed to perform this SOP and the resulting output data.

4.1 Input Data Required

Input data required for this SOP consists of the QC seed item list, which contains the intended locations, depths, and orientations of each seed item.

4.2 Output Data

Output data consists of the final production area seed report. The report includes of a brief narrative describing the seed item emplacement and a discussion of significant deviations from the seed plan. The bulk of the report consists of a seed location table that includes the "as emplaced" identity, location, depth, and orientation of each emplaced seed item accompanied by a photograph of the item in the ground before being covered.

5 Quality Control

5.1 Measurement Quality Objectives

The MQO for QC seeding for advanced geophysical classification is presented in Worksheet 22 of the AGCMR-QAPP and specifies verification that all seed items have been emplaced with the specified precision. Advanced EMI sensor data acquisition will not be conducted until conformance with this MQO has been documented as described below.

6 Reporting

QC seeding for advanced geophysical classification will be documented through the completion of the Preparatory Quality Control Seeding for Advanced Geophysical Classification Checklist in Attachment 1. The preparatory QC checklist for this SOP will be completed by the QC Geophysicist. Production area seeding will also be documented in the production area seed report as described in Section 4.2.

Attachment 1

Preparatory Quality Control Seeding for Advanced Geophysical Classification Checklist

Preparatory Quality Control Seeding for Advanced Geophysical Classification Checklist

This checklist is to be completed by the QC Geophysicist following completion of production area seeding. The QC Geophysicist will observe the emplacement of production area seed items and will document the successful completion of this checklist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	QC Geophysicist Initials
1. Qualifications	Are the qualifications of the QC Geophysicist in compliance with the requirements of AGCMR-QAPP Worksheet 7?		
2. Preparation	Have appropriate QC seed items been selected and procured?		
3. Seed emplacement	Have the target seed items been buried appropriately, measured, photographed, and backfilled?		
4. Reporting	Has the production area seed report been prepared in accordance with Section 4.2?		

QC Geophysicist: ____ Date: ______________

STANDARD OPERATING PROCEDURE AGCMR-04

Advanced EMI Sensor Background Measurement Acquisition

Advanced Geophysical Classification Activities
Former Fort Ord, California

Gilbane

August 2016

1 Purpose and Scope

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed when selecting the locations for background measurements using an advanced electromagnetic induction (EMI) sensor system for geophysical classification and verifying the usability of the resulting background data. This SOP describes background data acquisition with the MetalMapper system. If other advanced EMI sensors, such as TEMTADS or OPTEMA, are selected for use, this SOP will be updated to include background data acquisition details for those systems.

The observed signal in a cued advanced EMI sensor measurement includes the following three components:

- the EMI response of the buried target
- the self-signature of the sensor system
- any response from the ambient environment in which the target is buried

The objective of acquiring background measurements is to independently measure the last two contributors to the overall EMI response. These “non-target” values can then be subtracted from the overall signal response to isolate the signal response from only the unknown object being evaluated. For the background removal process to be successful, the background measurements must be acquired in an area free of buried metal objects and with geologic conditions representative of the location of the unknown items. Background measurements must also be acquired throughout the survey day because environmental changes such as significant changes in geologic/soil conditions, ambient temperature, or background moisture (morning dew evaporating, rain showers passing through, etc.), or significant changes to the sensor itself (cable replacement, new GPS antenna, etc.) will cause the environmental or sensor contribution to the background reading to change.

2 Personnel, Equipment, and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Advanced EMI sensor coupled with a real-time kinematic global positioning system (RTK GPS) and inertial measurement unit (IMU) for orientation measurements
- Data processing computer suitable for and equipped to run the UX-Analyze Advanced module of Geosoft’s Oasis Montaj geophysical processing environment

2.1 Personnel and Qualifications

The following individuals will be involved in advanced EMI sensor background measurement acquisition and evaluation:

- Data Acquisition Geophysicist
- QC Geophysicist
- Lead Data Processor

The minimum qualifications for the Data Acquisition and QC Geophysicists, and the Lead Data Processor are listed in Worksheet 7 of the AGCMR-QAPP.

3 Procedures and Guidelines

Background measurements will be acquired immediately prior to the onset of data acquisition, immediately following data acquisition, and throughout the survey day at maximum intervals of 2 hours.

Multiple geographic locations may be required to document the response of near-surface soils present at the site. Background measurements involve positioning the sensor and acquiring static measurements over a pre-identified set of background locations. In combination with SOPs for advanced EMI sensor assembly (SOP AGCMR-01) and testing at the IVS (SOP AGCMR-02), background data are acquired and used to correct the cued MetalMapper data that are acquired as described in SOP AGCMR-07.

Prior to cued data collection, including the acquisition of background measurements, the correct operation of the geophysical sensor and navigation and orientation systems must be verified at the IVS as described in SOP AGCMR-02. This will be verified by completion of the Follow-on QC checklist attached to SOP AGCMR-02.

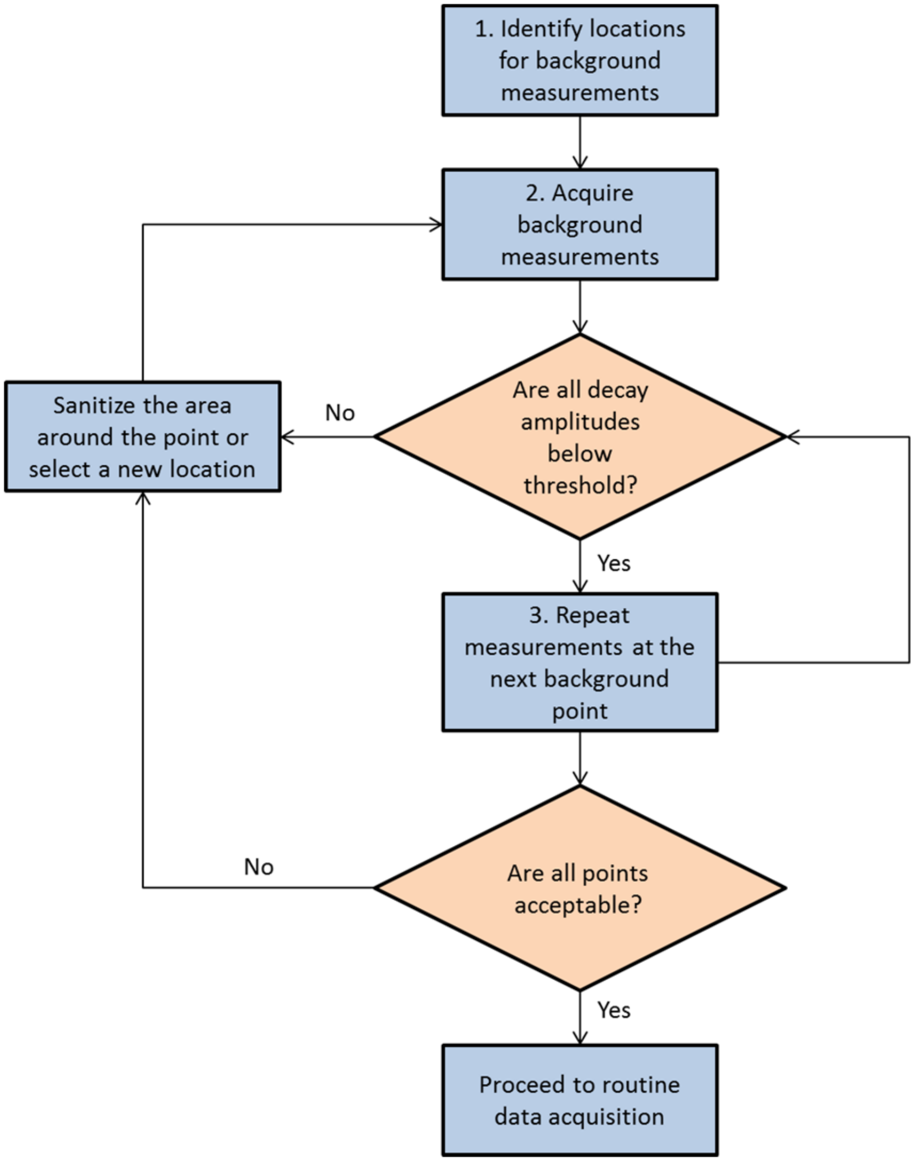
3.1 Choose Background Measurement Locations and Verify Their Suitability

One or more locations for background measurements will be planned at each site. The number and location of the background measurements will be influenced by the following considerations:

- The background measurements should be acquired at locations that are similar to that of the production survey area with regard to geophysical noise, terrain, geology, and vegetation. If these factors change appreciably, additional background measurements, taken at more representative locations, will be required.
- The background measurements should be collected at locations free of buried metal objects. If a suitable object-free area cannot be identified from the existing detection data, attempts should be made to create a clear 5-foot square area by locating and removing all metal objects. Once sanitized, the background measurements should be acquired in the clear area.
- For efficiency, background measurements should be acquired in areas that are close to the survey area to minimize travel time.
- Data from the dynamic survey will be used to assist in selection of initial background locations

Once an adequate number of background locations have been identified, an initial cued measurement should be acquired over each background location in turn as illustrated on **Figure 1**.

Figure 1. Choosing and verifying background measurement locations



The following is a description of each step shown above:

1. **Identify locations for background measurements.** Initial locations for background measurement are chosen most easily by referencing the detection survey data to guide the geophysicist to suitable locations that satisfy the considerations noted above.

2. **Acquire background measurements.** Once an adequate number of initial locations have been identified, a set of initial measurements should be collected over each background location as follows:

    a. Center the MetalMapper over the location chosen as a background point. Mark the corners of the sensor with non-metallic pin flags to allow the same location to be occupied again for future background readings.

    b. Acquire cued MetalMapper data at the potential background location.

c. Verify that the signal amplitude for the measured decay is below the background threshold chosen for the project. If higher amplitude decays are observed, the location should be inspected and any metal contamination removed. Alternatively, another nearby location can be chosen.

d. Document if the location is verified for future use during the production survey as a background measurement location.

3. **Repeat measurements at the next background point.** Continue this process at each of the chosen initial locations until their suitability for background measurements has been verified.

4. **Proceed to routine data acquisition.** After verification of each background measurement location, the measurements will serve as baseline values for future background measurements at each point.

3.2 Acquire Background Measurements throughout the Survey Day

Background locations will be stored in the MetalMapper data acquisition computer to assist in navigating each location. Background measurements will be acquired immediately prior to the onset of data acquisition, immediately following data acquisition, and throughout the survey day at maximum intervals of 2 hours. Background measurement frequency can be increased if the Project Geophysicist or Field Team Leader determines that changes to the sensor or natural environment may have caused the sensor or environmental contribution to the background reading to change. Specific documentation of changes to the sensor or environment and the reasons for additional background readings is critical to guide the Data Processor in choosing the correct background for each cued data measurement.

The procedure for acquiring background measurements during cued data acquisition is as follows:

1. Return the sensor to a previously verified background measurement location and position the sensor as closely as possible to the initial location and orientation.
2. Acquire a cued background measurement.
3. Evaluate the decay amplitudes and transmitter current levels. Decay amplitudes must be below the background threshold. If there are noticeable deviations or changes in the decays, document in the field notes any environmental changes that may be responsible and repeat the background measurement if necessary.

The Data Processor will compare the measured decays to previous measurements at this location. If there are significant deviations in the measured amplitudes or character of the decay curves, the Data Processor will determine if the background measurements are acceptable or if they must be rejected.

4 Data Management

The following sections describe the input data needed to perform this SOP and the resulting output data.

4.1 Input Data Required

Input data required for this SOP includes an initial list of background locations, identified from the detection survey data. After verification of the background the locations, they become the final background location list.

4.2 Output Data

Output data consist of the cued background measurement data acquired at each background location and the QC checklists in Attachments 1 - 3 of this SOP. The background measurement data described in Section 3.1 will be saved for each background location. The QC checklists will be completed, signed, and filed as documentation of system performance.

5 Quality Control

5.1 Background Quality Control

Background measurements are acquired throughout the project and therefore require preparatory, initial, and follow-on QC checks. Performance of the required QC checks will be documented by the Data Acquisition Geophysicist and Lead Data Processor on the Preparatory, Initial and Follow-on QC checklists in Attachments 1 - 3 of this SOP. Successful completion of these procedures will be verified by the QC Geophysicist in the Geophysics Daily QC Report.

- The Preparatory QC Checklist (Attachment 1) will be completed to document the identification of background locations.
- The Initial QC Checklist (Attachment 2) will be completed to document responses at each initial background location.

Background measurements acquired throughout the duration of the MetalMapper survey verify that the MetalMapper is functioning properly and that the geophysical field team is collecting data of adequate quality. After initial verification of background measurement locations, daily data acquisition activities require only follow-on QC inspections, which are documented as follows:

- The operating software automatically logs the responsible geophysicist's identification in each data file. By acquiring the data, and thereby taking responsibility for it, the geophysicist certifies compliance with the requirements of this SOP.
- The QC Geophysicist will observe background data acquisition each morning and afternoon of data acquisition activities and document the observation in the Daily Geophysics QC Report.
- The Data Acquisition Geophysicist will also maintain a field log, which will be reviewed daily by the QC Geophysicist to note issues that potentially affect data quality.

Achievement of the background measurement measurement performance criteria will be documented by the Data Acquisition Geophysicist and verified by the QC Geophysicist in the Geophysics Daily QC Report. During review of each background measurement, the Data Processor will overlay the measured decays from all previous measurements at that location to observe any variation. Should variations be observed that are not the result of changing environmental conditions documented by the field crew, a comprehensive root cause analysis will be performed and corrective actions determined.

5.2 Measurement Quality Objectives (MQO)

The MQO for background measurements are presented in Worksheet 22 of the AGCMR-QAPP. Measured backgrounds will not be used to correct field MetalMapper data until the MQO are met or the project team agrees on modifications to the MQO.

6 Reporting

Background measurement acquisition will be documented through the completion of the preparatory, initial, and follow-on QC Checklists in Attachments 1 – 3 by the Data Acquisition Geophysicist and Lead Data Processor. The Preparatory Inspection Checklist (Attachment 1) will document the selection and preparation of the background measurement locations. The Initial Inspection Checklist (Attachment 2) will document the initial background measurements acquired at each background location. The Follow-on Checklist (Attachment 3) will document the routine background measurements acquired at maximum 2-hour intervals throughout the production survey. The QC Geophysicist will observe the acquisition of background measurements and will document completion of all checklists in the Daily Geophysics QC Report. Copies will be included with the advanced geophysical classification project report at the completion of the project.

Attachment 1

Preparatory Background Measurement Acquisition Checklist

Preparatory Background Measurement Acquisition Checklist

This checklist is to be completed by the Data Acquisition Geophysicist during selection and preparation of background measurement locations. Successful completion of the process will be verified by the QC Geophysicist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	Data Acquisition Geophysicist Initials
1. Qualifications	Are the same geophysical personnel being used as in SOP AGCMR-01? If not, are the qualifications of the new personnel in compliance with the requirements of AGCMR-QAPP Worksheet 7?		
2. Background area selection	Do the selected background locations have similar geophysical noise, terrain, geology and vegetation as the production survey area they represent (Section 3.1)?		
3. Background area selection and preparation	Are the selected background locations free of buried metal objects or has a 5-foot square area been sanitized (Section 3.1)?		
4. Background area selection	Are the selected background locations sufficiently close to the production area to minimize travel (Section 3.1)?		

Data Acquisition Geophysicist: ______________________________________ Date: _______________

Attachment 2

Initial Background Measurement Acquisition Checklist

Initial Background Measurement Acquisition Checklist

This checklist is to be completed by the Data Acquisition Geophysicist and the Lead Data Processor during initial data acquisition at each background measurement location. Successful completion of the process will be verified by the QC Geophysicist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	Data Acquisition Geophysicist or Lead Data Processor Initials
1. Qualifications	Are the same geophysical personnel being used as in SOP AGCMR-01? If not, are the qualifications of the new personnel in compliance with the requirements of AGCMR-QAPP Worksheet 7?		
2. Preparation	Has the Preparatory Advanced EMI Sensor Assembly Checklist (SOP AGCMR-01) been successfully completed?		
3. Preparation	Has the Follow-on IVS QC checklist (SOP AGCMR-02) been successfully completed?		
4. Data acquisition	Has the MetalMapper been properly centered on each background location and have the corners of the sensor been marked with non-metallic pin flags (Section 3.1, Step 2)?		
5. Data acquisition	Have all signal amplitudes for measured decays been verified to be below the selected threshold (Section 3.1, Step 2)?		
6. MPC documentation	Have the MPCs for background measurement acquisition been achieved in accordance with AGCMR-QAPP Worksheet 22?		

Data Acquisition Geophysicist: ______________________________________ Date: _______________

Lead Data Processor: ____ Date: _______________

Attachment 3

Follow-on Background Measurement Acquisition Checklist

Follow-on Background Measurement Acquisition Checklist

This checklist is to be completed by the QC Geophysicist daily during background measurement acquisition activities. The operating software automatically logs the responsible geophysicist's identification in each data file. By acquiring background data, and thereby taking responsibility for it, the geophysicist certifies compliance with the requirements of this SOP. The QC Geophysicist will observe the background measurement acquisition process at least twice per day and will document the successful completion of this checklist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	QC Geophysicist Initials
1. Qualifications	Are the same geophysical personnel being used as in SOP AGCMR-01? If not, are the qualifications of the new personnel in compliance with the requirements of AGCMR-QAPP Worksheet 7?		
2. Preparation	Has the Preparatory Advanced EMI Sensor Assembly Checklist (SOP AGCMR-01) been successfully completed?		
3. Preparation	Has the Follow-on Daily Cued IVS Checklist (SOP AGCMR-02) been successfully completed?		
4. AM field observation	Has the AM field observation been performed? Time:_________ Background #s:_______________		
5. PM field observation	Has the PM field observation been performed? Time:_________ Background #s:_______________		
6. Field Documentation	Has the QC Geophysicist reviewed the day's data acquisition with the Data Acquisition Geophysicist and reviewed the field log? Have any technical issues been noted?		
7. MPC documentation	Have the MPCs for background measurement acquisition been achieved in accordance with AGCMR-QAPP Worksheet 22?		

QC Geophysicist: ____ Date: _______________

STANDARD OPERATING PROCEDURE AGCMR-05

Advanced EMI Sensor Dynamic Data Acquisition

Advanced Geophysical Classification Activities
Former Fort Ord, California

Gilbane

August 2016

1 Purpose and Scope

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed when performing dynamic surveys using an advanced electromagnetic induction (EMI) sensor for target detection. This SOP describes cued data acquisition with the MetalMapper system. If other advanced EMI sensors, such as TEMTADS or OPTEMA, are selected for use, this SOP will be updated to include cued data acquisition details for those systems.

Advanced EMI sensor dynamic data acquisition involves navigating the sensor along pre-determined transects designed to meet the project target of interest (TOI) detection performance objectives. The detection objectives and transect spacing for individual projects and survey areas are identified in the AGCMR-QAPP and Site-Specific Work Plans.

The signal measured by the advanced EMI sensor is composed of the following three individual components:

1. the EMI response of buried metallic targets,
2. the self-signature of the sensor system, and
3. the response from the ambient environment in which the target is buried.

To isolate responses associated with discrete buried metal objects, a background model comprised of the sensor system self-signature and the ambient environment response must be derived and removed from the raw data. The remaining leveled signal data are used as inputs into a detection algorithm that identifies anomalous responses due to potential TOI, which are then mapped and selected for further investigation or removal. Details of the processing and analysis of dynamic advanced EMI sensor data are covered in SOP AGCMR-06.

2 Personnel, Equipment, and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Advanced EMI sensor coupled with a real-time kinematic global positioning system (RTK GPS) and inertial measurement unit (IMU) for orientation measurements
- Data processing computer suitable for and equipped to run the UX-Analyze Advanced module of Geosoft's Oasis Montaj geophysical processing environment

2.1 Personnel and Qualifications

The following individuals will be involved in dynamic advanced sensor data acquisition and evaluation:

- QC Geophysicist
- Data Acquisition Geophysicist
- Lead Data Processor

The minimum qualifications for the Data Acquisition and QC Geophysicists and the Lead Data Processor are listed in Worksheet 7 of the AGCMR-QAPP.

3 Procedures and Guidelines

3.1 Survey Grid Preparation

Survey grid preparation involves marking the site boundaries and survey transects required to achieve the coverage specified in the Site-Specific Work Plan. Start- and endpoints of individual transects, as well as intermediate points along each transect, will be physically measured and marked or entered into a real-time navigation system such that the sensor can be precisely navigated along the desired transect.

3.2 Daily Function Test Measurements

Daily function test measurements will be conducted at the IVS prior to the start of daily data acquisition to confirm that all transmit and receive components of the advanced EMI sensor are operational. The daily function test will consist of a static measurement acquired over the IVS background location (blank space) followed by a static measurement acquired in the same location with a schedule 80 small industry standard object centered under (or above) the sensor.

3.3 Daily IVS Survey

Twice daily during dynamic data acquisition activities (prior to the start of daily data acquisition and following the completion of daily data acquisition) a dynamic IVS survey will be performed as described in SOP AGCMR-02.

3.4 Dynamic Data Collection

Dynamic survey utilizing an advanced EMI sensor involves acquiring data along transects across the survey area. In combination with SOPs for advanced EMI sensor assembly (SPO AGCMR-01) and testing at the IVS (SOP AGCMR-02), dynamic data is collected along each transect at the spacing defined in the AGCMR-QAPP or Site-Specific Work Plan. Data acquisition is controlled by the Data Acquisition Geophysicist with the EM-3D software, which allows the user to assign a numerical ID to each transect line and start and stop data acquisition at the beginning and end of each transect. When an obstacle is encountered along a transect, the obstacle can be avoided by either altering the path of the transect or by stopping data acquisition and resuming with a new transect ID after the obstacle has been passed. Data gaps resulting from obstacles should be recorded in the field notes and submitted to the data processor. Data gaps resulting from line spacing greater than the defined acceptable spacing will be identified by the data processor and provided to the Data Acquisition Geophysicist for recollection. Data acquisition will be performed using the following steps:

1. **Power-on and test the sensor.** After starting the geophysical and navigation systems, a function test is performed prior to every data collection event, as described in Section 3.2. The data acquisition software is monitored during data acquisition to ensure that all data streams (EMI, GPS, and IMU) are valid and being recorded.

2. **Navigate and collect data along transects.** Navigation along transects is performed visually with the assistance of markers, which are placed at the discretion of the Data Acquisition Geophysicist or by real-time navigation using the data acquisition software. Physical transect markers may include, but are not limited to, ropes, tapes, spray paint, or flags. Coverage may be monitored by marking the track of the inside wheels as the sensor moves along a transect. Positioning in the data file is captured through the use of the RTK-GPS system and the IMU.

3. **Verify the integrity and quality of the collected data.** During data acquisition, the integrity and quality of the data will be verified by the Data Acquisition Geophysicist by inspection of the advanced EMI sensor data acquisition display to ensure the following:

    - Data acquisition starts and stops in coordination with the beginning and end of each transect
    - Each transect is assigned a unique numerical identifier (ID), in sequential order
    - The amplitude responses measured by each receiver coil appear reasonable and responses are not flat-lined or overly saturated

4. **Verify complete coverage of survey area.** 100% coverage surveys will require appropriate line spacing (presented in the AGCMR-QAPP and Site-Specific Work Plan. Data gaps resulting from obstacles or inaccessible terrain will be marked and verified by the data acquisition geophysicist. Data gaps exceeding the MQOs described in AGCMR-QAPP Worksheet #22 will be reacquired using RTK GPS and recollected.

4 Data Management

The following sections describe the input data needed to perform this SOP and the resulting output data.

4.1 Input Data Required

The following input data are required for performing a dynamic advanced EMI sensor survey:

- Site boundary coordinates
- IVS transect start and end point locations.

4.2 Output Data

Output data consist of the following:

- Dynamic advanced EMI sensor IVS data
- Dynamic advanced EMI sensor survey area data
- Daily function test data
- Field notes, including scanned pdf images of hand-written notes or digitally-recorded notes, as well as a digital spreadsheet containing data filenames as delivered and rectified field notes (in which differences between original field notes and delivered digital filenames and are resolved)

5 Quality Control

Real-time (QC) of the dynamic data acquisition activities is limited to qualitative assessments of data quality and survey area coverage. Quantitative QC and assessment of the collected daily function test, IVS, and survey area data will be performed during data processing and analysis, as described in SOP AGCMR-06. The preparatory and initial QC checks for this SOP are performed during testing of the advanced EMI sensor at the IVS (SOP AGCMR-02). SOP AGCMR-02 verifies that the system is working properly and that the data acquisition team is acquiring data of adequate quality. Therefore, the acquisition of dynamic advanced EMI sensor survey data requires only follow-on QC inspections, which are documented as follows:

- The operating software automatically logs the identification of the Data Acquisition Geophysicist in each data file. By acquiring the data, and thereby taking responsibility for it, the Data Acquisition Geophysicist certifies compliance with the requirements of this SOP.
- The QC Geophysicist will observe data acquisition periodically and document the observation in the Daily Geophysics QC Report.
- The Data Acquisition Geophysicist will maintain a field log, which will be reviewed daily by the Data Processor to note issues that potentially affect data quality.

Daily data packages containing the geophysical data from that day will be reviewed by the Data Processor to ensure that the measurement quality objectives (MQO) are being achieved. A comprehensive root cause analysis will be performed, including a corrective action, if the Data Processor or QC Geophysicist determines that the MQO are not being met or if a trend toward the MQO limits is observed.

5.1 Measurement Quality Objectives

The MQO for acquisition of dynamic advance EMI sensor data are presented in Worksheet 22 of the AGCMR-QAPP. The advanced EMI sensor will not be used for production area data acquisition until it is able to meet these MQO or until the project team agrees on modifications to the MQO.

6 Reporting

Acquisition of dynamic advanced EMI sensor data will be documented through the completion of the follow-on QC checklist in Attachment 1. The follow-on checklist for this SOP will be completed by the QC Geophysicist to document the successful completion of equipment start-up and the IVS (SOP AGCMR-02) and the periodic observation of data acquisition. The completion of all checklists will be documented by the QC Geophysicist in the Daily Geophysics QC Report, and copies will be included with the advanced geophysical classification project report at the completion of the project.

Attachment 1

Follow-on Advanced EMI Sensor Dynamic Data Acquisition Checklist

Follow-on Advanced EMI Sensor Dynamic Data Acquisition Checklist

This checklist is to be completed by the QC Geophysicist during data acquisition activities. The operating software automatically logs the identification of the Data Acquisition Geophysicist in each data file. By acquiring the data, and thereby taking responsibility for it, the Data Acquisition Geophysicist certifies compliance with the requirements of this SOP. The QC Geophysicist will periodically observe the data acquisition process and will document the successful completion of this checklist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	QC Geophysicist Initials
1. Qualifications	Are the same geophysical personnel being used as in SOP AGCMR-01? If not, are the qualifications of the new personnel in compliance with the requirements of AGCMR-QAPP Worksheet 7?		
2. Preparation	Has the Preparatory Advanced EMI Sensor Assembly Checklist (SOP AGCMR-01) been successfully completed?		
3. Function Tests	Were function tests performed, and did all function tests meet the MQOs in accordance with AGCMR-QAPP Worksheet 22?		
4. IVS Tests	Were transect surveys conducted over the IVS items at the start and end of the day with exceptions noted in the field notes?		
5. Sensor Navigation	Were valid dynamic data collected along the intended transects with any exceptions or gaps in coverage noted in the field notes?		
6. Data Measurements	Was the advanced EMI sensor system transmit current monitored with any exceptions noted in the field notes?		
7. Field observation	Has the field observation been performed? Time:_________ Anomaly #s:________________		
8. Field documentation	Has the QC Geophysicist reviewed the day's data acquisition with the Field Geophysicist and reviewed the Field Geophysicist's log? Have any technical issues been noted?		
9. MPC documentation	Have the MPCs for dynamic advanced EMI sensor data acquisition been achieved in accordance with AGCMR-QAPP Worksheet 22?		

QC Geophysicist: ____ Date: _______________

STANDARD OPERATING PROCEDURE
AGCMR-06

Advanced EMI Sensor Dynamic Data Processing and Analysis

Advanced Geophysical Classification Activities
Former Fort Ord, California

Gilbane

August 2016

1 Purpose and Scope

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed when processing and analyzing dynamic survey data acquired by an advanced electromagnetic induction (EMI) sensor for target detection. Dynamic surveys include the acquisition of dynamic data over predetermined transects. Dynamic data are also acquired over instrument verification strip (IVS) targets for quality control (QC) verification. This SOP details the steps required to verify the quality of the acquired dynamic data and to process the data to detect targets in the subsurface. This SOP describes data processing and analysis of cued MetalMapper data. If other advanced EMI sensors, such as TEMTADS or OPTEMA, are selected for use, this SOP will be updated to include cued data processing and analysis details for those systems.

The detection objectives and transect spacing for individual projects and survey areas are identified in the AGCMR-QAPP and Site-Specific Work Plans. Processing the dynamic data involves processing and assessing daily function tests and instrument verification strip (IVS) surveys, leveling the raw data to remove EMI signal due to the self-signature of the sensor systems and the ambient EMI soil response, and target selection. Function test measurements and IVS surveys are conducted during initial setup of the advanced EMI sensor and on a daily basis to verify correct operation and functionality of the dynamic survey system.

The signal measured by the advanced EMI sensor is composed of the following three individual components:

1. the EMI response of buried metallic targets,
2. the self-signature of the sensor system, and
3. the response from the ambient environment in which the target is buried.

To isolate responses associated with discrete buried metal objects, a background model comprised of the sensor system self-signature and the ambient environment response must be derived and removed from the raw data. The remaining leveled signal data are used as inputs into a detection algorithm that identifies anomalous responses due to potential TOI, which are then mapped and selected for further investigation or removal.

2 Personnel, Equipment, and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Data processing computer suitable for and equipped to run the UX-Analyze Advanced (UXA) module of Geosoft’s Oasis Montaj geophysical processing environment

2.1 Personnel and Qualifications

The following individuals will be involved in the processing and analysis of dynamic advanced EMI sensor data for target detection:

- Data Acquisition Geophysicist
- Lead Data Processor
- QC Geophysicist

The minimum qualifications for the Data Acquisition and QC Geophysicists and the Lead Data Processor are listed in Worksheet 7 of the AGCMR-QAPP.

3 Procedures and Guidelines

This section describes the procedures used to process dynamic advanced EMI sensor data including positioning and leveling of the data, processing and selecting target anomalies, and verification of the data quality through processing and assessment of daily QC measurements.

3.1 Advanced EMI Sensor Dynamic Data Processing

Advanced EMI sensors are composed of multiple transmit (Tx) and receive (Rx) coils in different orientations and positions within the sensor platform. As each Tx coil transmits, the response is measured at every Rx coil, resulting in measured data that is composed of numerous Tx/Rx combinations. This rich dataset provides the advantage of advanced EMI sensors over traditional geophysical sensors but also necessitates more involved and time-consuming processing and analysis of the data. Typical advanced EMI sensor detection surveys therefore utilize only the monostatic Z-component EMI measurements. This means that rather than analyzing every Tx/Rx combination, only the response at the Rx coil associated with the transmitting Tx coil (monostatic) and only the Tx and Rx coils oriented horizontally (Z-component) are used.

The processing of dynamic advanced EMI sensor data involves the following steps:

- Data import and QC
- Data positioning and background removal
- Target selection

3.1.1 Data Import and Initial QC

Advanced EMI sensor data files are imported into a Geosoft database in UXA, where they are inspected and assessed against the measurement quality objectives (MQO) described in Worksheet 22 of the AGCMR-QAPP and the Site-Specific Work Plan. The following data quality indicators are reviewed:

- Transmit current
- Global positioning system (GPS) fit quality
- Inertial measurement unit (IMU) data
- EMI response signal not saturated

Data measurements that do not meet the MQOs are identified and flagged by a series of scripts that maintain the chronologic integrity of the EMI data but prevent the out-of-specification data from being mapped and used for detection.

3.1.2 Data Positioning and Leveling

Coordinate positions are automatically assigned to the EMI measurements based on the GPS antenna location, platform geometry and platform attitude data (from the IMU). A site-specific de-median filter is applied to the raw data to derive a model that estimates the background response at the site. This background model is then subtracted from the raw data to provide a leveled data set with the background response component removed.

3.1.3 Target Selection

After leveling the data to remove the background response, the leveled data is gridded and mapped for target selection. Traditional anomaly selection is based almost entirely on signal response amplitude. Using the response amplitude of the monostatic Z-component of the advanced EMI sensor data as a detection metric is similar to traditional EM61 response amplitude detection. After the data have been leveled and gridded, the peak detection algorithm in Oasis Montaj is used to extract locations of all grid response peaks greater than the project detection threshold. These target anomaly locations are reviewed by the data processor, and manual additions and deletions may be made to the target list. The target list is reviewed by the QC Geophysicist prior to finalization.

3.2 Advanced EMI Sensor Data Quality Verification

Verification of the advanced EMI sensor data quality is accomplished through the processing and assessment of daily QC measurements. Daily function tests (described in SOP AGCMR-05) and IVS surveys (described in SOP AGCMR-02) are performed to verify the operation of the sensor system and the quality of the measured data. The processing and assessment of these daily tests is described below.

3.2.1 Function Test Measurement Processing

A function test measurement (described in SOP AGCMR-05) is performed prior to each data acquisition session to confirm that all Tx and Rx components of the advanced EMI sensor are functioning properly. The data from each function test are assessed relative to the MQO presented in AGCMR-QAPP Worksheet 22. Worksheet 22 also identifies the actions to be taken if function tests do not meet the MQO. Dynamic data associated with failed function tests will not be used for target detection until these MQO are met, or until the project team agrees on modifications to the MQO, and may need to be reacquired.

3.2.2 Daily IVS Survey Processing

Twice daily during dynamic data acquisition activities (prior to the start of daily data acquisition and following the completion of daily data acquisition) a dynamic IVS survey is performed as described in SOP AGCMR-02. The IVS survey data are positioned, leveled, and processed in the same manner as the detection survey data described in Section 3.1.2. The data from each IVS survey are assessed relative to the MQO presented in AGCMR-QAPP Worksheet 22. Worksheet 22 also identifies the actions to be taken if Daily IVS surveys do not meet the MQO. Dynamic data associated with failed daily IVS surveys will not be used for target detection until these MQO are met, or until the project team agrees on modifications to the MQO, and may need to be reacquired.

4 Data Management

The following sections describe the input data needed to perform this SOP and the resulting output data.

4.1 Input Data Required

Input data required for processing dynamic advanced EMI sensor data include the following:

- Raw dynamic advanced EMI sensor data files (daily function test data, daily dynamic IVS survey data, and dynamic detection survey data)
- Minimum amplitude response detection threshold (from the AGCMR-QAPP or Site-Specific Work Plan)

4.2 Output Data from Data Verification

Output data from the verification of daily dynamic advanced EMI sensor data quality include the following:

- QC report including documentation of performance relative to Worksheet 22 of the AGCMR-QAPP for the following:
    - Daily IVS results
    - Daily Function test results

4.3 Output Data from Detection Data Processing and Analysis

Output data from the processing and analysis of dynamic advanced EMI sensor detection data include the following:

- Mapped detection metric data (monostatic Z-component amplitude) in ASCII (x,y,z) format
- Target anomaly list with unique target ID and X and Y coordinates
- Geosoft databases for processed advanced EMI sensor data and identified targets
- QC seed detection results
- Description of processing approach details, including leveling and target selection procedures, to be included in the final report

5 Quality Control

Dynamic advanced EMI sensor data verification and analysis requires follow-on QC inspections that will be documented on the Follow-on Advanced EMI Sensor Dynamic Data Verification Checklist and Follow-on Advanced EMI Sensor Dynamic Data Processing and Analysis Checklist that are included as Attachments 1 and 2 to this SOP. The checklists will be completed by the QC Geophysicist and documented in the Daily QC Report.

5.1 Measurement Quality Objectives

The MQO for dynamic advanced EMI sensor data processing and analysis are presented in Worksheet 22 of the AGCMR-QAPP (including MQO for daily IVS and function test performance as well as for detection data quality). Performance relative to the MQO will be assessed during the processing and analysis of the data. Dynamic advanced EMI sensor data will not be used for target detection until these MQO are met or until the project team agrees on modifications to the MQO.

6 Reporting

Verification of dynamic advanced EMI sensor data processing and analysis will be documented through the completion of the follow-on QC checklists in Attachments 1 and 2. The follow-on checklists for this SOP will be completed by the QC Geophysicist and documented in the Daily Geophysics QC Report, and copies will be included with the final report at the completion of the project. The final advanced geophysical classification report will detail the specific approach to classification including final library make-up, cut-off threshold, cluster analysis approach and results, and feature space analysis approach and results.

Attachment 1

Follow-on Advanced EMI Sensor Dynamic Data Verification Checklist

Follow-on Advanced EMI Sensor Dynamic Data Verification Checklist

This checklist is to be completed by the QC Geophysicist for each daily advanced EMI sensor data verification event during dynamic data acquisition activities. The QC Geophysicist will document the successful completion of this checklist in the Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	QC Geophysicist Initials
1. Function tests	Has the functionality of the advanced EMI sensor components been verified for each dynamic data acquisition event using function tests, and did the function test results meet the associated MQO from AGCMR-QAPP Worksheet 22?		
2. IVS tests	Has the functionality of the advanced EMI sensor system been verified for each dynamic data acquisition event using IVS survey collected on the same day, and have the IVS survey results met the associated MQO from AGCMR-QAPP Worksheet 22 and the SOP AGCMR-02 Follow-On Daily Cued IVS Checklist?		
3. Reporting	Have daily data quality results been reported in the QC Report?		

QC Geophysicist: ____ Date: _____________

Attachment 2

Follow-on Advanced EMI Sensor Dynamic Data Processing and Analysis Checklist

Follow-on Advanced EMI Sensor Dynamic Data Processing and Analysis Checklist

This checklist is to be completed by the QC Geophysicist for each daily advanced EMI sensor dynamic data processing event. The QC Geophysicist will document the successful completion of this checklist in the Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	QC Geophysicist Initials
1. Data validity	Were invalid data, based on transmit current, GPS fit quality, IMU data quality, and EMI response range, for each data acquisition event identified and rejected?		
2. Coverage	Were gaps in data coverage due to down-line and across-line sampling identified and accounted for?		
3. Data leveling (background removal)	Was the background model inspected prior to leveling the raw data, and was the leveling process reviewed by the QC Geophysicist?		
4. Target selection	Was the final target list reviewed by the data processor and the QC Geophysicist?		
5. Reporting	Have the following documents been completed, reviewed, and delivered? • Mapped detection metric data • Target anomaly list • Geosoft databases for processed advanced EMI sensor data and identified targets • QC seed detection results		

QC Geophysicist: ____ Date: ______________

STANDARD OPERATING PROCEDURE
AGCMR-07

Advanced EMI Sensor Cued Data Acquisition

Advanced Geophysical Classification Activities
Former Fort Ord, California

August 2016

1 Purpose and Scope

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed when acquiring cued measurements using an advanced electromagnetic induction (EMI) sensor for geophysical classification. Cued data acquisition involves navigating the sensor to the precise anomaly location, collecting static, advanced EMI sensor data at this location, and verifying the integrity and validity of the collected data. Verification includes using the sensor data to derive an estimate of the target position relative to the center of the sensor. If this position estimate falls outside a predetermined threshold, the sensor will be repositioned, and a second data acquisition event will be performed. This SOP describes cued data acquisition with the MetalMapper system. If other advanced EMI sensors, such as TEMTADS or OPTEMA, are selected for use, this SOP will be updated to include cued data acquisition details for those systems.

2 Personnel, Equipment, and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Advanced EMI sensor coupled with a real-time kinematic global positioning system (RTK GPS) and inertial measurement unit (IMU) for orientation measurements
- The target list with unique IDs and locations to be investigated
- Data processing computer suitable for and equipped to run the UX-Analyze Advanced module of Geosoft's Oasis Montaj geophysical processing environment

2.1 Personnel and Qualifications

The following individuals will be involved in cued advanced EMI data acquisition and evaluation:

- QC Geophysicist
- Data Acquisition Geophysicist
- Lead Data Processor

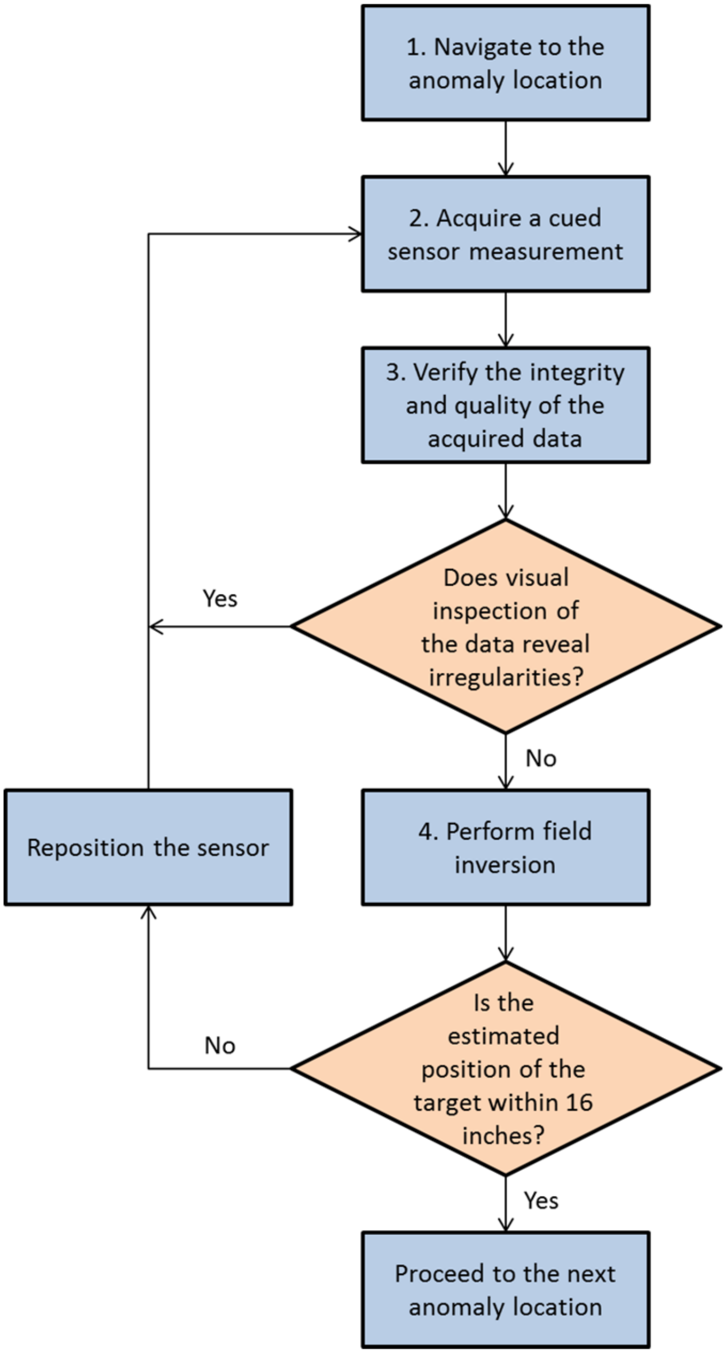
The minimum qualifications for the Data Acquisition and QC Geophysicists and the Lead Data Processor are listed in Worksheet 7 of the AGCMR-QAPP.

3 Procedures and Guidelines

Cued investigation for advanced geophysical target classification involves positioning the MetalMapper sensor and acquiring static measurements over a pre-identified set of anomalies. In combination with SOPs for advanced EMI sensor assembly (SOP AGCMR-01), testing at the instrument verification strip (IVS) (SOP AGCMR-02) and background measurement acquisition (SOP AGCMR-04), a set of static data measurements are acquired using the MetalMapper over each anomaly. At each anomaly, data acquisition will be performed in accordance with the steps shown on **Figure 1**.

Prior to cued data acquisition, the correct operation of the geophysical sensor and navigation and orientation systems must be verified at the IVS as described in SOP AGCMR-02. This will be verified by completion of the Follow-on Cued Daily IVS Checklist attached to SOP AGCMR-02.

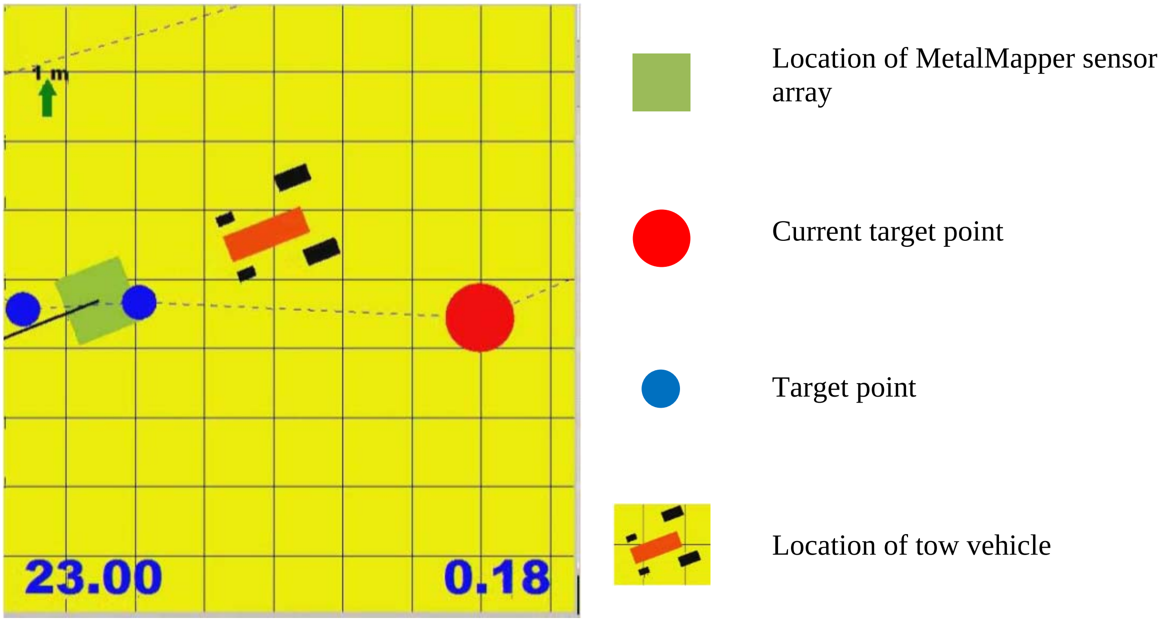
Figure 1. Cued data acquisition process



The following is a description of each step shown above:

1. **Navigate to the anomaly location**. Anomaly locations will be loaded into the MetalMapper acquisition computer prior to data acquisition operations to allow navigation to each anomaly location through the use of the MetalMapper RTK GPS positioning system and the data acquisition software's Map Window (**Figure 2**). Although the MetalMapper has the ability to direct the operator to an anomaly location based upon the geophysical signal received, the first measurement will be taken at the provided anomaly location as indicated by alignment with the displayed RTK GPS position.

Figure 2. Map window displaying navigation to target points



To implement this step, the sensor will be transported to the anomaly location and the center of the sensor precisely positioned (within 2 inches) over the provided anomaly location.

2. **Acquire a cued sensor measurement**. Initiate the acquisition of a measurement. During data acquisition, the sensor must remain stationary, and all external sources of electromagnetic signals must be kept away from the sensor.

   Any metal associated with the sensor and deployment mechanism (e.g., console, support structures) that cannot be reasonably distanced from the sensor must be kept in the same physical location with respect to the sensor as during background measurements.

3. **Verify the integrity and quality of the acquired data.** Immediately after data acquisition, the integrity and quality of the data will be verified by the operator by inspection of the MetalMapper data collection screen to ensure the following:

   - The data acquisition cycle completed properly
   - The transmit current for each transmitter was within an acceptable range (> 5.5 amps)
   - The decay curves measured by each receiver coil appear reasonable (i.e., decay curve displays are not ‘flat-lined’)
   - GPS and IMU information have been recorded

4. **Perform a field inversion**. Valid inversion results require that the target is located within 15 inches of the center of the sensor array. The initial target horizontal position may be significantly offset from the center of the sensor for the following reasons:

   - Positioning errors in the initial detection survey
   - Imprecision in the derivation of the anomaly position from the detection survey data
   - Imprecision in the reacquisition of the anomaly
   - Imprecision in positioning the sensor

- The presence of multiple anomaly sources in relatively close proximity

This step includes performance of an in-field inversion and inspection of the results to verify that the estimated horizontal target location is within 16 inches of center of the sensor array. After initiating the in-field inversion algorithm, an estimate of the target location relative to the center of the sensor array is provided. If the offset is greater than 16 inches, position the sensor over the target location estimate provided by the in-field inversion (visually or using the RTK GPS data) and repeat **Steps 2** and **3**.

This recollection should only be performed once. Assuming the repositioning was performed accurately, if the subsequent position estimate is still greater than 16 inches from the center of the sensor array, the cause is likely to be multiple anomaly sources, and additional data collection and data analysis may be required after further analysis by the Data Processor.

4 Data Management

The following sections describe the input data needed to perform this SOP and the resulting output data.

4.1 Input Data Required

Input data required for this SOP includes an anomaly list consisting of anomaly IDs and location coordinates to load into the MetalMapper data acquisition computer.

4.2 Output Data

Output data consist of one raw sensor data file (.tem or .hdf5) for each anomaly measured. The data files will be transferred daily (or more often as dictated by site procedures) to the Data Processor.

5 Quality Control

The preparatory and initial QC checks for this SOP are performed during testing of the MetalMapper at the IVS (SOP AGCMR-02). SOP AGCMR-02 verifies that the MetalMapper is working properly and that the field geophysical team is acquiring data of adequate quality. Therefore, the acquisition of cued MetalMapper survey data requires only follow-on QC inspections, which are documented as follows:

- The operating software automatically logs the identification of the Data Acquisition Geophysicist in each data file. By acquiring the data, and thereby taking responsibility for it, the Data Acquisition Geophysicist certifies compliance with the requirements of this SOP.
- The QC Geophysicist will observe data acquisition periodically and document the observation in the Daily Geophysics QC Report.
- The Data Acquisition Geophysicist will maintain a field log, which will be reviewed daily by the Data Processor to note issues that potentially affect data quality.

Daily data packages containing the geophysical data from that day will be reviewed by the Data Processor to ensure that the measurement quality objectives (MQO) are being achieved. A comprehensive root cause analysis will be performed, including a corrective action, if the Data Processor or QC Geophysicist determines that the MQO are not being met or if a trend toward the MQO limits is observed.

5.1 Measurement Quality Objectives

The MQO for acquisition of cued target measurements are presented in Worksheet 22 of the AGCMR-QAPP. The MetalMapper will not be used for production area data acquisition until it is able to meet these MQO or until the project team agrees on modifications to the MQO.

6 Reporting

Acquisition of cued target measurements will be documented through the completion of the follow-on QC checklist in Attachment 1. The follow-on checklist for this SOP will be completed by the QC Geophysicist to document the successful completion of equipment start-up and the IVS (SOP AGCMR-02) and the periodic observation of data acquisition. The completion of all checklists will be documented by the QC Geophysicist in the Daily Geophysics QC Report, and copies will be included with the advanced geophysical classification project report at the completion of the project.

Attachment 1

Follow-on Advanced EMI Sensor Cued Data Acquisition Checklist

Follow-on Advanced EMI Sensor Cued Data Acquisition Checklist

This checklist is to be completed by the QC Geophysicist during data acquisition activities. The operating software automatically logs the identification of the Data Acquisition Geophysicist in each data file. By acquiring the data, and thereby taking responsibility for it, the Data Acquisition Geophysicist certifies compliance with the requirements of this SOP. The QC Geophysicist will periodically observe the data acquisition process and will document the successful completion of this checklist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	QC Geophysicist Initials
1. Qualifications	Are the same geophysical personnel being used as in SOP AGCMR-01? If not, are the qualifications of the new personnel in compliance with the requirements of AGCMR-QAPP Worksheet 7?		
2. Preparation	Has the Preparatory Advanced EMI Sensor Assembly Checklist (SOP AGCMR-01) been successfully completed?		
3. Preparation	Has the Follow-on Daily Cued IVS Checklist (SOP AGCMR-02) been successfully completed?		
4. Field observation	Has the field observation been performed? Time:_________ Anomaly #s:________________		
5. Field observation	Have background measurements been acquired at appropriate background locations and time intervals in accordance with Worksheet 22?		
6. Field documentation	Has the QC Geophysicist reviewed the day's data acquisition with the Field Geophysicist and reviewed the Field Geophysicist's log? Have any technical issues been noted?		
7. MPC documentation	Have the MPCs for cued MetalMapper data acquisition been achieved in accordance with AGCMR-QAPP Worksheet 22?		

QC Geophysicist: ____ Date: ______________

STANDARD OPERATING PROCEDURE AGCMR-08

Advanced EMI Sensor Cued Data Processing and Analysis

Advanced Geophysical Classification Activities
Former Fort Ord, California

August 2016

1 Purpose and Scope

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed when processing and analyzing cued measurements acquired by an advanced electromagnetic induction (EMI) sensor for geophysical classification. Cued surveys include the acquisition of cued data over predetermined anomaly locations and background measurements. Cued data are also acquired over instrument verification strip (IVS) targets for quality control (QC) verification. This SOP details the steps required to verify the quality of these measurements, process the acquired data to derive features related to the physical characteristics of the anomaly sources, and use these features to classify the targets. This SOP describes data processing and analysis of cued MetalMapper data. If other advanced EMI sensors, such as TEMTADS or OPTEMA, are selected for use, this SOP will be updated to include cued data processing and analysis details for those systems.

2 Personnel, Equipment, and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Data processing computer suitable for and equipped to run the UX-Analyze Advanced (UXA) module of Geosoft's Oasis Montaj geophysical processing environment

2.1 Personnel and Qualifications

The following individuals will be involved in the processing and analysis of cued MetalMapper data for advanced analysis and classification:

- Data Acquisition Geophysicist
- Lead Data Processor
- QC Geophysicist

The minimum qualifications for the Data Acquisition and QC Geophysicists and the Lead Data Processor are listed in Worksheet 7 of the AGCMR-QAPP.

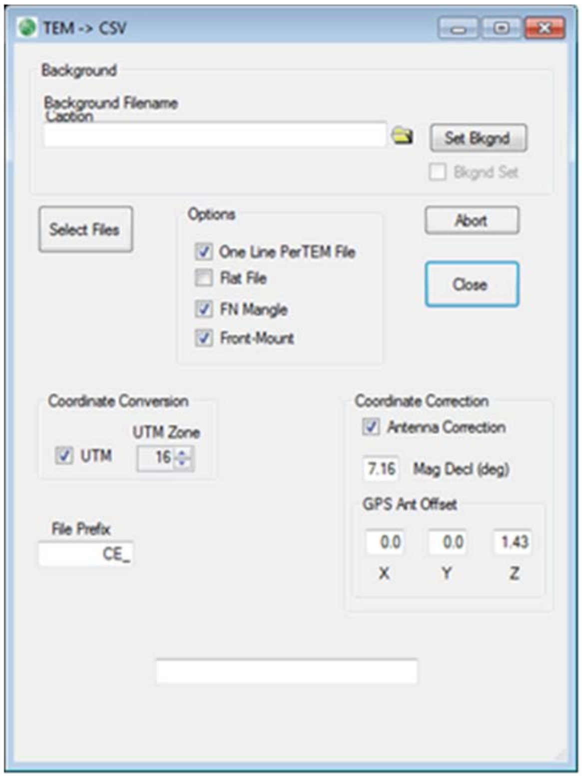
3 Procedures and Guidelines

3.1 Data Verification

3.1.1 Data Conversion

Raw MetalMapper data files (.tem format) must be converted to ASCII .csv format prior to data processing and analysis. The conversion is accomplished using TEM2CSV, a purpose built software utility supplied by Geometrics. The TEM2CSV conversion window is shown on **Figure 1**.

Figure 1. TEM2CSV utility for conversion of raw MetalMapper .tem files to ASCII .csv file format



The coordinate system, coordinate correction and file prefix must be set to project specific parameters prior to selecting files for conversion. The output .csv filenames must contain the anomaly ID in the last part of the filename, for example, if the file name is Test_1020_11.csv, the ID would be 11.

Any cued measurement that documented in the field notes as having the incorrect anomaly ID logged during data acquisition must have the filename corrected to contain the correct ID, and the anomaly ID field in the .csv file must be updated to that value. The anomaly ID cannot be corrected in the .tem file.

The background measurement filename should not be entered in the TEM -> CSV dialog. This correction will be applied later using UXA.

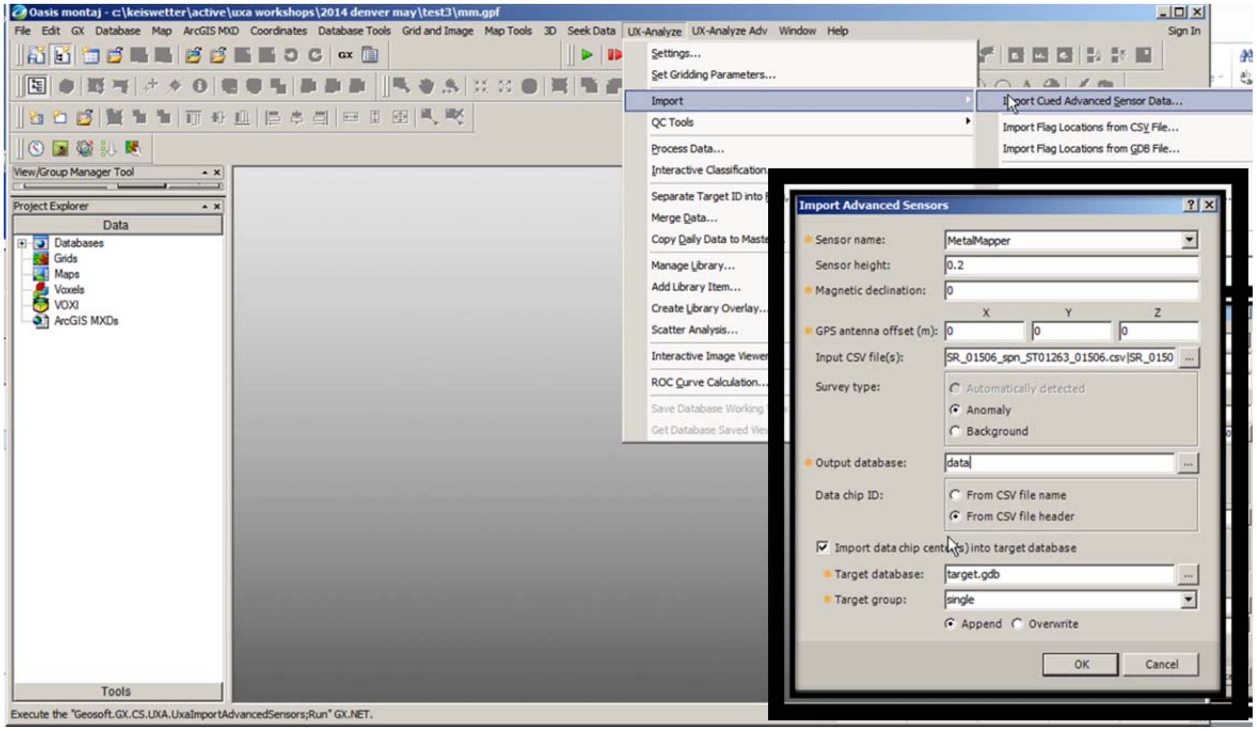
3.2.2 Data Import and Initial Data Checks

Data processing and analysis are conducted using the UXA module within Geosoft's Oasis Montaj geophysical processing environment. Prior to importing MetalMapper data, the data processor specifies general settings in UXA to define the data acquisition parameters for the survey, including settings such as survey mode (static or dynamic), database names, and distance units). After initial setup of the UXA project, the data processor imports data into the following four separate databases:

- Cued background measurement data
- Background features
- Cued anomaly measurement data
- Target features

Cued MetalMapper data is imported into separate databases for anomaly and background measurements using import routines in UXA, as shown on **Figure 2**. The target features database initially contains the locations of each surveyed anomaly but will subsequently be populated with summaries of the derived feature and classification information for each target. The background features database initially contains the locations of each background measurement but will subsequently be populated with statistics and quality control check values.

Figure 2. UX-Analyze Advanced data import window



After importing the cued data, the data processor verifies the quality of the measurements against the measurement quality objectives (MQO) provided in Worksheet 22 of the AGCMR-QAPP for the following characteristics:

- Transmit (Tx) current within limits
- Global positioning system (GPS) fix quality
- Valid inertial measurement unit (IMU) data
- EMI response signal not saturated
- Offset of acquisition location from flag/anomaly list location

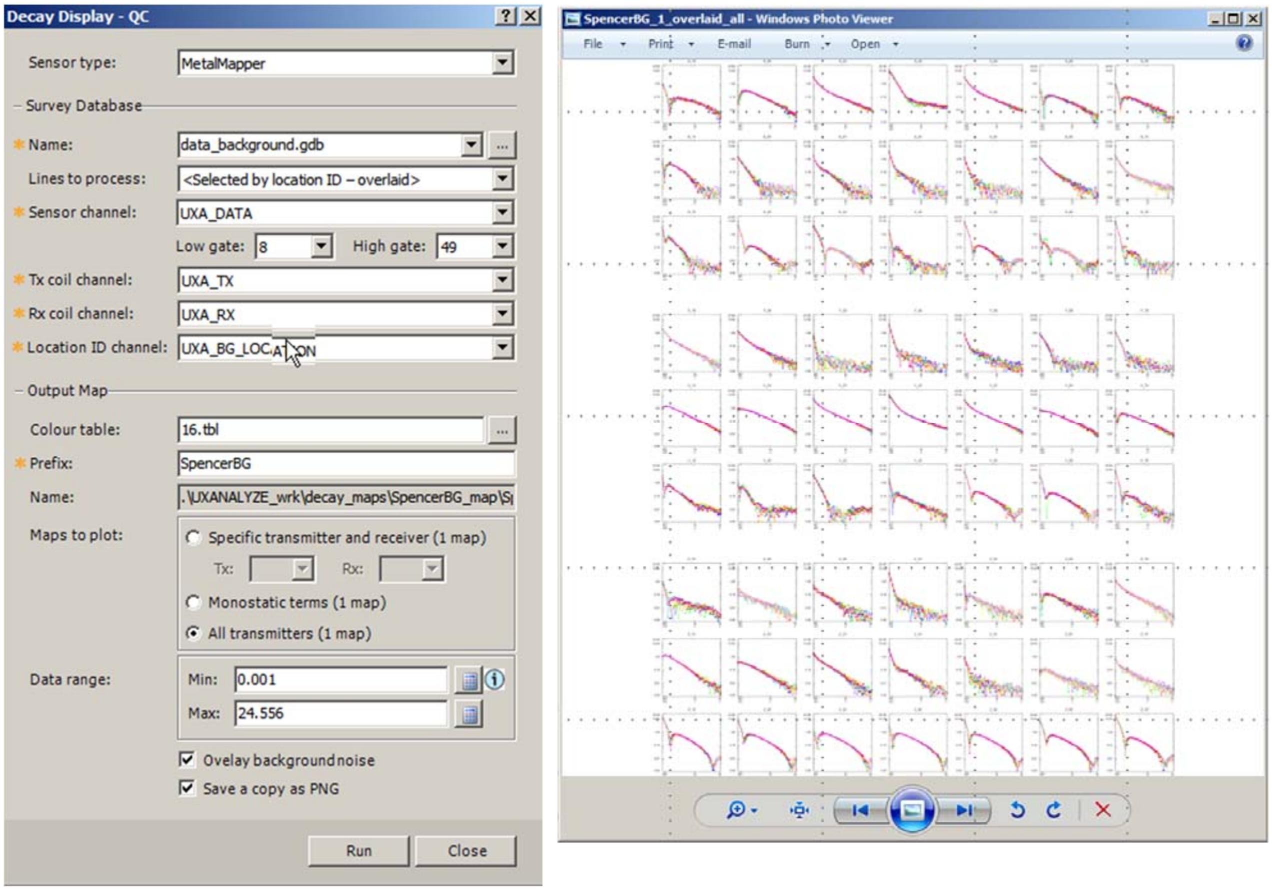
3.2.3 Background Corrections

Background corrections are used to remove the portions of the measured response that are caused by the MetalMapper system and the soil response from the measured anomaly data. Background measurements are acquired at locations selected from the detection survey data that are verified to be free of metal. Each background measurement is also verified as suitable prior to using it for background correction of the target measurement data as described in SOP AGCMR-04 Section 3.1.

3.2.3.1 Background Location Verification

The data processor verifies the suitability of each background location by analyzing a set of 5 measurements taken at the intended location: one measurement at the location and one each with the sensor offset by 15 inches in each cardinal direction, as described in SOP AGCMR-04. The background measurements are analyzed using the UXA decay display utility and considered valid if the signal amplitudes for all measured decays are below the threshold chosen for the project. Images of the decay curves are saved for presentation in a background summary report. The UXA decay display utility is shown on **Figure 3**.

Figure 3. UX-Analyze Advanced decay display utility and example decay comparison plot



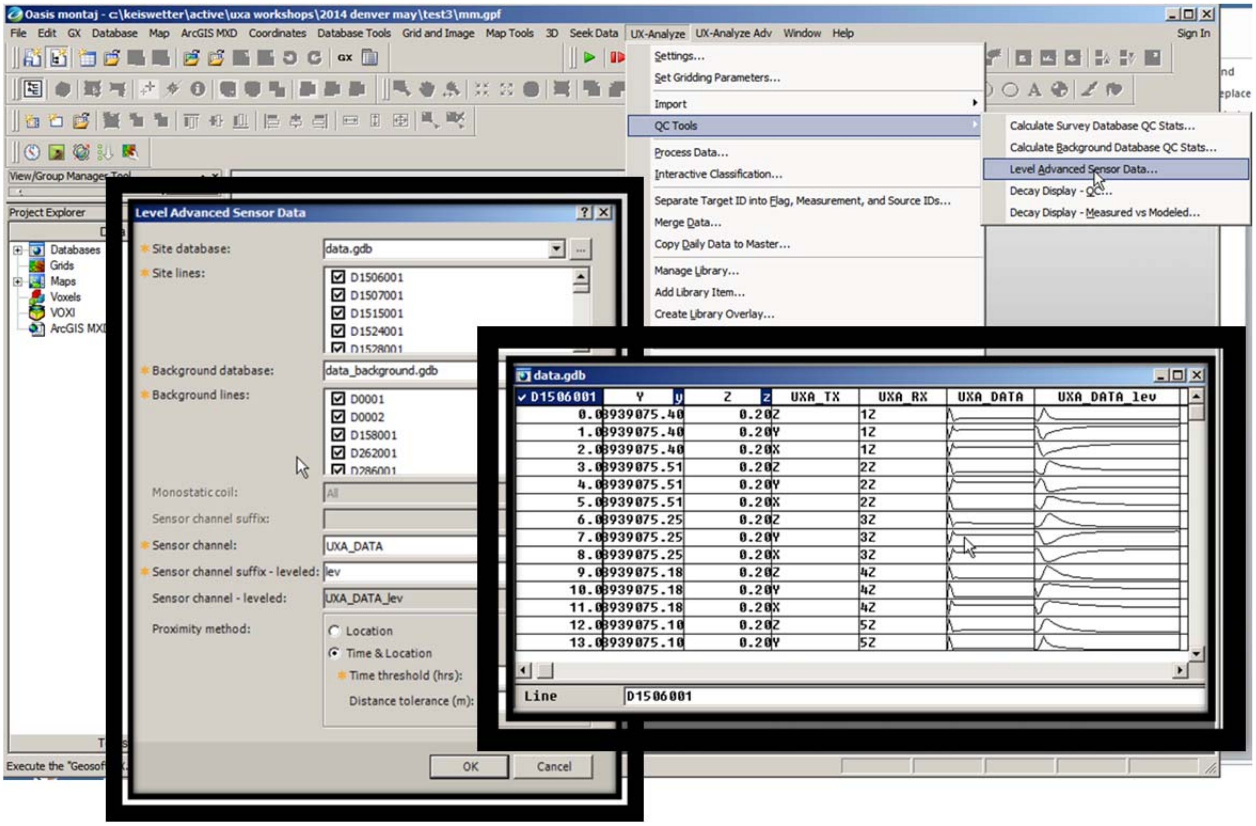
3.2.3.2 Background Measurement Verification

The data processor verifies each individual background measurement prior to its use for background correction. Each background measurement is qualitatively compared to the initial background verification measurement at that location using the UXA decay display QC utility and all decays are checked to be lower than the project threshold. Images of the decay curves are saved for presentation in a background summary report. Invalid measurements are removed from the background database to ensure that they are not used.

3.2.3.3 Background Corrections

After verification that individual background measurements are valid, the data processor subtracts the appropriate background correction from each target data measurement using the UXA level advanced sensor data utility. The background correction utility identifies the closest background (chronologically and spatially) to each target measurement. Only background corrections acquired within 2 hours of a target measurement are used to correct that measurement to ensure that background data measurements are most likely to mimic target measurement conditions. The background- corrected data are stored in the "UXA_Data_Lev" channel in the database and will be used for the subsequent inversion processes to derive target features. This data channel is not populated for those target measurements that do not have a suitable background measurement within the 2 hour time limit. The UXA level advanced sensor data utility is shown on **Figure 4**.

Figure 4. UX-Analyze Advanced Level advanced sensor data utility



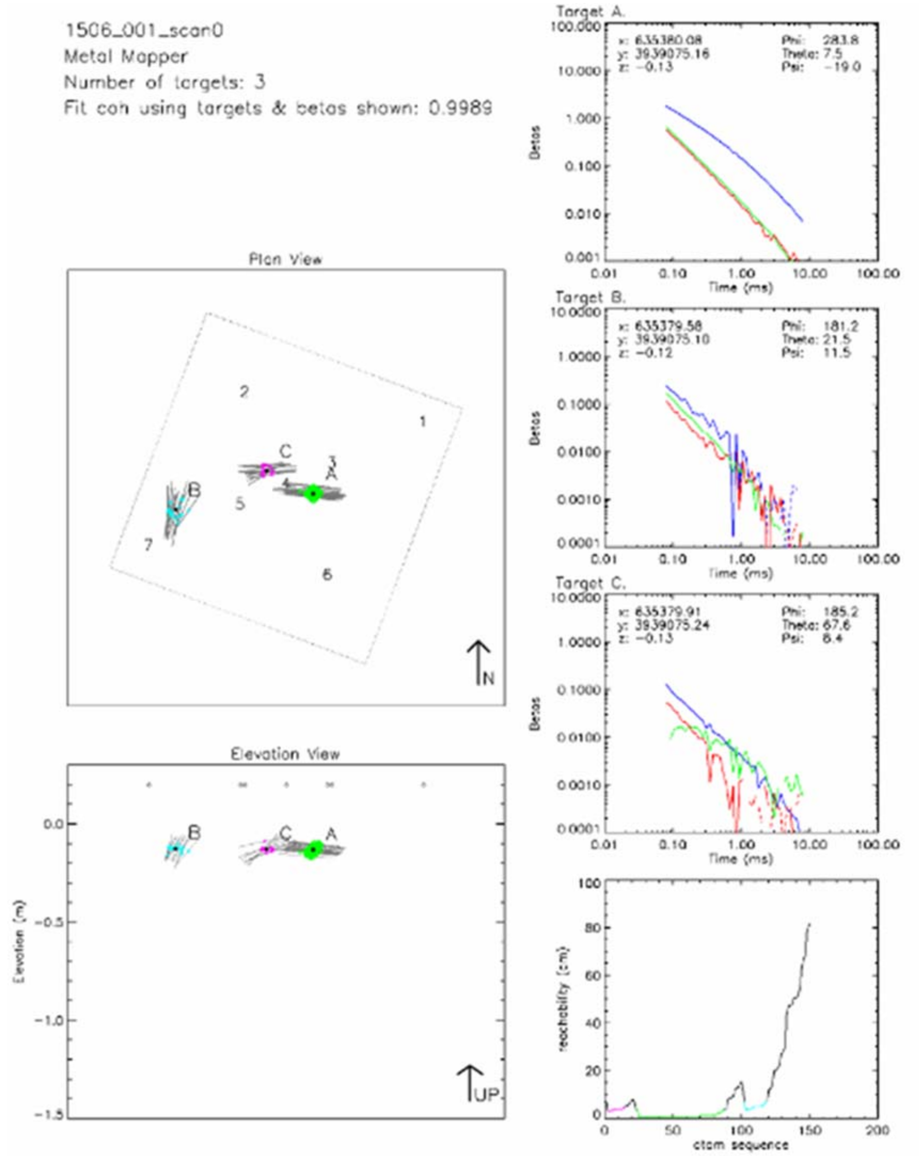
3.2.4 Target Feature Estimation

After background corrections are applied, the data processor estimates the intrinsic and extrinsic features for the target anomalies using the UXA process data interface. UXA applies single-target and multi-target inversion routines to determine the parameters of a target (single-target inversion), or of a group of targets (multi-target inversion), that would produce responses that closely match the observed responses. These parameters include extrinsic parameters (location and orientation) as well as the intrinsic parameters related to the object size, shape and composition. The intrinsic parameters, in the form of principal axis polarizabilities, also known as betas (β), are used for classification. Size and decay parameters at specific time gates are also calculated.

As the names suggest, the single-target inversion solves for a single target as the anomaly source, and the multi-target inversion assumes that the measured anomaly is the result of multiple targets. The multi-target solver not only presupposes multiple sources but will also produce a number of candidate realizations of targets. Each candidate realization proposes a configuration of targets whose modeled response reasonably fits the observed data. For example, one candidate realization may have three targets, while a second candidate realization for the same measurement may have two or four targets. This process reflects the fact that, with an unknown number of potential targets of different sizes and shapes, a number of different models can closely match the observed data. A separate fit coherence value, which measures the degree of fit to the observed data, is derived for each multiple-target candidate realization as well as for the single target model.

An example inversion fit summary is shown on **Figure 5**.

Figure 5 Example UX-Analyze Advanced inversion fit summary



Model results will only be used for classification if they meet the MQO in Worksheet 22 of the AGCMR-QAPP to verify that they are of sufficient quality to support classification.

3.2.5 Review of Processed and Modeled Data

A preliminary library match using the single source modeled parameters is performed as part of data verification to assist in determining the usability of the data and ensure that cued advanced geophysical classification survey MQOs have been satisfied.

Graphic decision plots that display a summary of measured and modeled data associated with each cued measurement are evaluate along with the targets feature database for the following:

- Tx current
- GPS fix is valid
- IMU reading is valid or correctable based on field notes

- Offset from flag is within MQO
- Fit error is acceptable
- Fit coherence is within MQO
- Size and decay are reasonable
- Library match is successful

If any readings fail to meet the MQOs a request for recollection will be sent to the field crew along with the reason, such as a request for the instrument to be located closer to the apparent source.

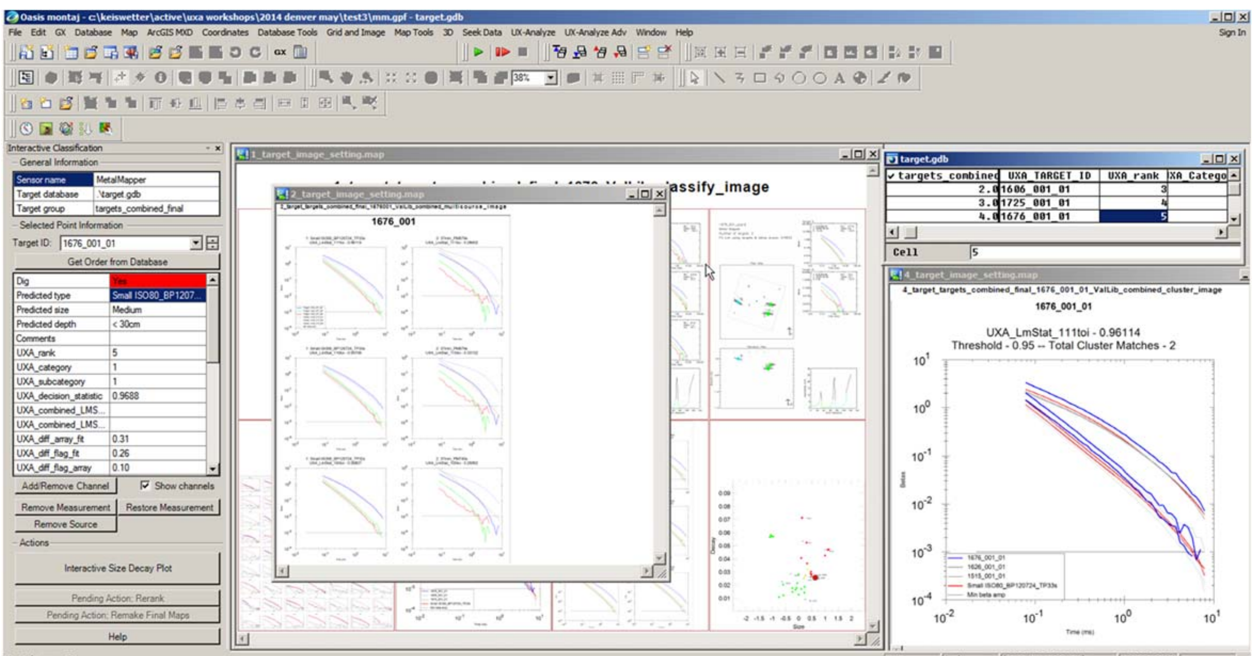
3.4 Daily IVS Survey

At the beginning and at the end of each day of data acquisition, cued measurements are acquired at each IVS target location, as described in SOP AGCMR-02. The IVS measurements are processed as described above, and the derived features are assessed against the MQO presented in Worksheet 22 of the AGCMR-QAPP. The results are documented and summarized in a QC report to accompany the classification list.

3.5 Classification

Advanced geophysical classification of targets is based upon objective, quantitative criteria. Using these criteria, a prioritized list is created with high likelihood targets of interest (TOI) placed at the top of the list (just after digs classified as "cannot analyze") and high likelihood non-TOI placed at the bottom of the list. "Cannot analyze" targets are those for which the measured data cannot support a confident classification decision. Because these targets cannot confidently be identified as non-TOI, they must be excavated. The primary method for classification is library matching, supplemented by cluster analysis and feature space analysis. The UXA interactive classification utility display shown on **Figure 6** provides an example of the data outputs that are considered in the classification decision metric.

Figure 6. UX-Analyze Advanced interactive classification utility



3.5.1 Library Matching

Advanced geophysical classification is based primarily on the fit metric (values from 0.0 to 1.0, with 1.0 representing a perfect match) generated by UXA during a comparison of the β values estimated for each surveyed target and the β values of the items in the munitions library developed for the project. The comparison is performed via the library match utility in UXA. The fit metric is a measure of the fit correlation between a target and the library entry that best fits that target, with higher values indicating a better fit between the target and the corresponding item in the library. The library fit analysis matches the following four combinations of βs to those of the candidate library TOI:

- β1, β1/β2, β1/β3
- β1, β1/β2
- β1/β2, β1/β3
- β1

The confidence metrics for each fit combination are averaged to derive a decision metric.

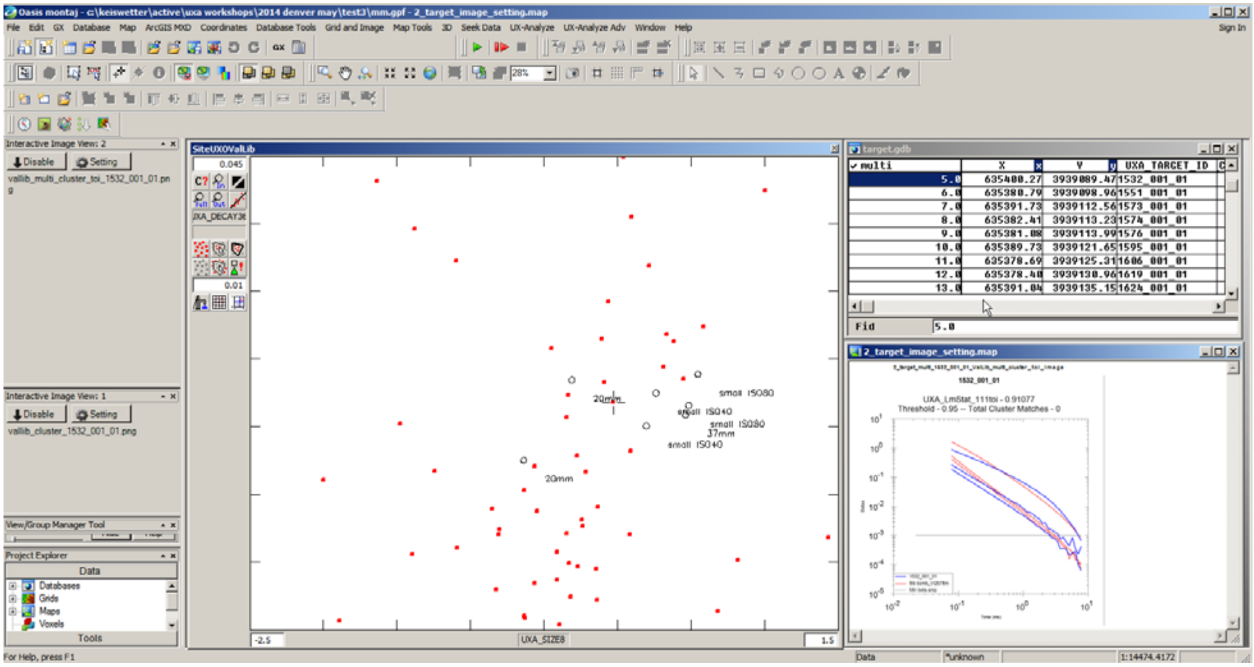
Single- and multi-source models are used during the inversion process for each flagged location. The results of all the models are compared against the library signatures, and the most conservative result, aka the result that is most similar to a TOI, is saved. Once completed, the targets are ranked, or ordered, from TOI to non-TOI according to their library-match comparison values. Library-match comparison values below the project decision metric threshold, which is nominally around 0.8, are considered non-TOI.

The intrusive investigation results of the training digs identified by the analyst as well as decision metrics derived for other known TOI (IVS and QC seed items) are used to finalize the decision metric threshold.

3.5.2 Cluster Analysis/Feature Space Analysis

Cluster analyses are performed using the UXA scatter analysis utility to identify clusters of anomalies with similar β signatures. The same library matching method as described above is used. However, instead of using a known TOI signature library, a “self-match” of each measured anomaly is performed. Cued measurements with a confidence metric above the selected cluster threshold are identified and reviewed along with a size-decay feature space plot to determine if they represent a grouping of unique signatures that may represent a TOI that is not contained in the initial library. For each identified cluster, the data processor selects a representative sample to be intrusively investigated as part of the training data. If the intrusive investigation identifies a potentially hazardous item that should be on the TOI list, a representative signature is placed in the site-specific library, and the library matching process is repeated to ensure that all items with similar β signatures are classified as TOI. An example of the UXA scatter analysis results is shown on **Figure 7**.

Figure 7. Example UX-Analyze Advanced scatter analysis results



Individual items that do not match any library items but have β signatures that indicate large, axially-symmetric, thick-walled objects are identified and investigated as part of the training data and added to the library if they are identified as TOI.

3.5.3 Library Validation and Site-Specific Munitions Library

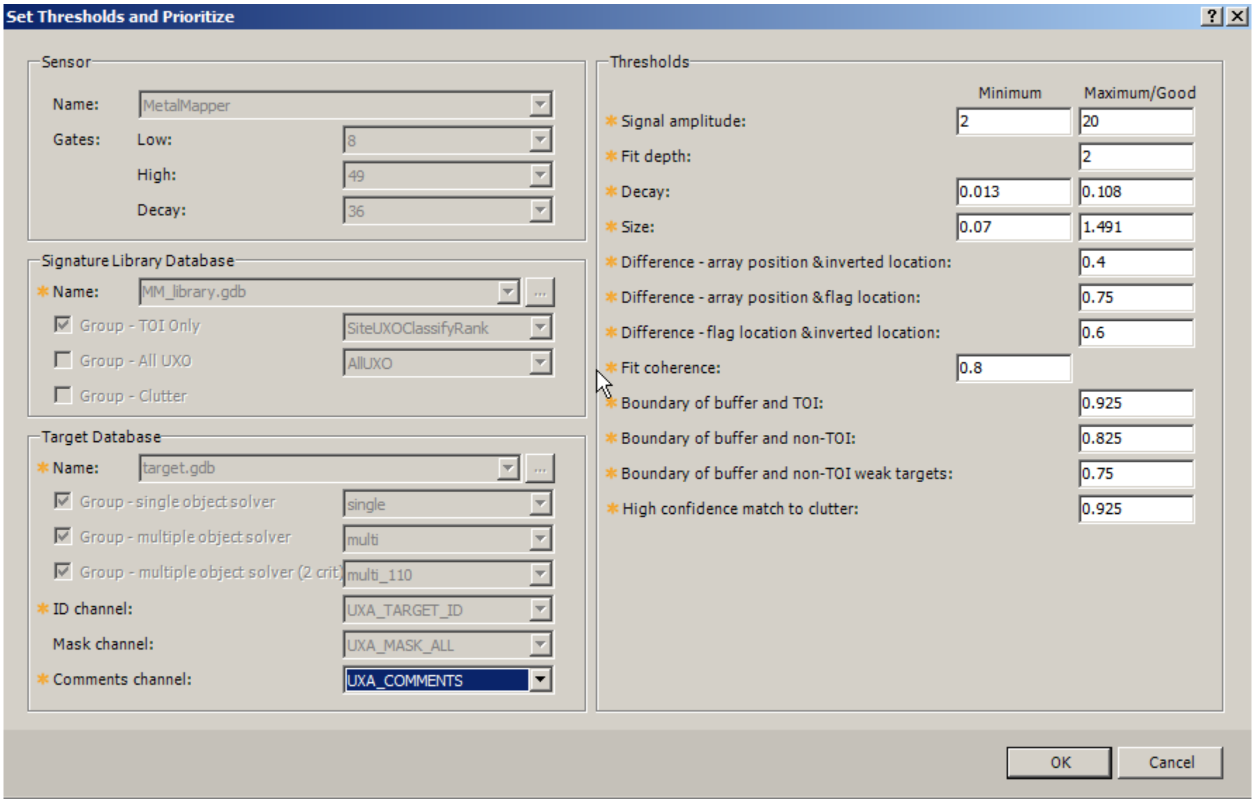
A site-specific library of βs for candidate munitions items identified in the conceptual site model (CSM) is used for classification. Intrinsic parameters for items listed in the CSM not confirmed to be in the existing munitions library will be derived from test measurements prior to the start of the advanced geophysical classification process and added to the library.

3.5.4 Threshold Selection and Classification Expressions

Initial threshold selection values will be evaluated during preliminary library matching and cluster analysis and will incorporate system performance observed at the test pit and IVS. A partial ranked list of approximately the first two weeks of survey data will be generated to demonstrate the initial thresholds and classification expressions to ensure the process is accurately classifying QC seed items. The classification expressions contain the logic for sorting the ranked target list; initial expressions are provided with the UXA module and can be customized to best suit the project goals. Further refinement of the analysis process may occur at this time, and details of the classification process will be documented in a target classification report.

3.5.5 Classify and Rank

The UXA tool to perform advanced geophysical classification and ranking of targets allows for user input of selected thresholds and applies the selected classification expressions to rank the targets.



All single and multi-solver results will be consolidated into a ranked list with a single entry for each anomaly ID on the target list within the target features database. Decision plots displaying measured and modeled data along with the target features database will be reviewed with the interactive classification tool by the data processor to refine the sorting of the prioritized target list. This function is run twice each time a prioritized list is generated. The first iteration ranks the targets and generates plots for the data processor to review and the second incorporates data processor comments to refine the sorting of the list.

3.5.6 Generate Prioritized Target List

A preliminary ranked list containing all anomalies will be delivered to the QC Geophysicist to determine if all relevant MQOs (including QC seed classification) have been met. At this time, the EM61 detection survey data will be provided by the USACE QA Geophysicist, and a final review of the ranked list will be performed to generate the prioritized target list. Every investigated target will be included on the prioritized list and will be classified as TOI, non-TOI, or cannot analyze and sorted based on their likelihood to be TOI. All targets in the cannot analyze and TOI categories will be selected for intrusive investigation. The target classification report will include descriptions and values for all thresholds and classification expressions used to generate interim and final ranked target lists.

4 Data Management

The following sections describe the input data needed to perform this SOP and the resulting output data.

4.1 Input Data Required

Input data required for this SOP include the following:

- A list of target anomalies including identifier (ID) and position (X, Y)
- A list of verified background locations (ID, X, Y)

- A list of IVS item locations (ID, X, Y)
- MetalMapper measurement data including those for target anomalies, daily IVS measurements, background measurements, and function tests
- Field notes for all data collection activities
- Site-specific munitions library signatures and/or test pit measurements of intended site-specific library items

4.2 Output Data for Data Verification

Output data include the following:

- QC report including documentation of performance relative to Worksheet 22 of the AGCMR-QAPP for the following:
    - IVS results
    - Function test results
    - Background measurements
    - Target anomaly measurements
- Geosoft databases for target measurement data, background measurement data, target features and background features

4.3 Output Data for Data Analysis

- Prioritized target list
- Target classification report
- Revised data validation plan
- Geosoft databases for target measurement data, background measurement data, target features, and background features
- Supporting documents for classification (.png images)

5 Quality Control

Cued MetalMapper data verification and analysis requires follow-on QC inspections that will be documented on the Follow-on Advanced EMI Sensor Cued Data Verification Checklist and Follow-on Advanced EMI Sensor Cued Data Analysis Checklist that are included as Attachments 1 and 2 to this SOP. The checklists will be completed by the QC Geophysicist and documented in the Daily QC Report.

5.1 Measurement Quality Objectives

The MQO for MetalMapper data processing and analysis are presented in Worksheet 22 of the AGCMR-QAPP (including MQO for daily IVS and function test performance as well as for individual measurement metrics). Performance relative to the MQO will be assessed during the processing and analysis of the data. Cued MetalMapper data will not be used to classify targets until these MQO are met or until the project team agrees on modifications to the MQO.

6 Reporting

Verification of MetalMapper data processing and analysis will be documented through the completion of the follow-on QC checklists in Attachments 1 and 2. The follow-on checklists for this SOP will be completed by the QC Geophysicist and documented in the Daily Geophysics QC Report, and copies will be included with the advanced geophysical classification report at the completion of the project. The final advanced geophysical classification report will detail the specific approach to classification including final library make-up, cut-off threshold, cluster analysis approach and results, and feature space analysis approach and results.

Attachment 1

Follow-on Advanced EMI Sensor Cued Data Verification Checklist

Follow-on Advanced EMI Sensor Cued Data Verification Checklist

This checklist is to be completed by the QC Geophysicist for each daily MetalMapper data verification event during data acquisition activities. The QC Geophysicist will document the successful completion of this checklist in the Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	QC Geophysicist Initials
1. Background locations	Have background locations been verified to be free of localized anomaly sources (from SOP AGCMR-04 Initial Background Measurement Acquisition Checklist)?		
2. Background measurements	Has the Data Processor reviewed the day's background measurements and verified them to be within the MQO defined limits?		
3. IVS tests	Has the functionality of the MetalMapper system been verified for each measurement using IVS tests collected on the same day, and have all associated IVS tests passed the associated MQO (from SOP AGCMR-02 Follow-On Daily Cued IVS Checklist)?		
4. Sensor navigation	Have valid RTK GPS data been collected with the sensor positioned over the initial detected anomaly location with any exceptions noted in the processing notes?		
5. Sensor orientation	Have valid IMU data been collected or manually documented orientation incorporated with any exceptions noted in the processing notes?		
6. Cued measurements	For each cued measurement used for advanced geophysical classification (including background measurements), have the MQO related to transmit current and receiver decay data been met?		
7. Cued measurements	Has the background correction been applied?		
8. Cued measurements	Have the initial single source inversion and preliminary library match performed?		
9. Reporting	Have anomalies with cued data that has passed verification been listed as complete and anomalies requiring resurvey been added to the redo list?		

QC Geophysicist: ____ Date: ______________

Attachment 2

Follow-on Advanced EMI Sensor Cued Data Analysis Checklist

Follow-on Advanced EMI Sensor Cued Data Analysis Checklist

This checklist is to be completed by the QC Geophysicist for each MetalMapper advanced geophysical data classification event. The QC Geophysicist will document the successful completion of this checklist in the Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	QC Geophysicist Initials
1. Feature Extraction	Has background corrected data been modeled with the single and multi-source inversion routines to extract model parameters? Are the inversion parameters (e.g., time gates) documented?		
2. Feature Extraction	Have the derived models for each classified anomaly been verified to fit the observed data with a fit coherence that meets the MQO with exceptions added to the dig list as cannot analyze (dig)?		
3. Feature Extraction	Have all targets classified as TOI or non-TOI been verified to have a fit position offset from the center of the array that meets the MQO?		
4. Cluster Analysis	Has cluster analysis using self-match of polarizations been performed using the parameters specified in Worksheet 22?		
5. Library Verification	Did the initial library contain examples of all TOI and other potential TOI? Was down-selection performed to reduce unnecessary library entries?		
6. Classify and rank	Is the ranking logic valid? Are applicable expressions, variables and thresholds specified?		
7. Threshold selection	Are all QC seeds correctly classified?		
8. Complete dig list	Are all anomalies on the dig list classified to meet the MQO? (Interim dig lists should identify which anomalies have not yet been classified; final dig list must include all anomalies with a classification decision).		
9. Reporting	Does the advanced geophysical classification report describe the classification approach and identify the decision thresholds used to place an item on the non-TOI list?		

QC Geophysicist: ____ Date: _____________

STANDARD OPERATING PROCEDURE
AGCMR-09

Anomaly Reacquisition and Intrusive Investigation

Advanced Geophysical Classification Activities
Former Fort Ord, California

Gilbane

August 2016

1 Purpose and Scope

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed when reacquiring and intrusively investigating targets classified from advanced electromagnetic induction (EMI) sensor data. Reacquisition includes navigating to each target and marking the location for intrusive investigation. Intrusive investigation includes excavating and removing the anomaly source, documenting the investigation results, and verifying that the targeted anomaly source has been removed. This SOP details the steps required to accurately flag selected target locations, intrusively investigate and remove the identified anomaly sources, sufficiently document the intrusive investigation process and results, and verify the success of the removal operation.

2 Personnel, Equipment, and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Real-time kinematic (RTK) global positioning system (GPS) receiver
- Tablet field computer equipped with intrusive investigation forms for recording intrusive investigation results
- Hand tools including shovels, pick axes, breaker bars, etc. to conduct intrusive investigation operations
- Digital camera

2.1 Personnel and Qualifications

The following individuals will be involved in the reacquisition and intrusive investigation of targets classified from cued MetalMapper data:

- Reacquisition Geophysicist
- UXO Technician II
- UXO Dig Team (1 UXO Technician III, 1 UXO Technician II, and 2 UXO Technician Is)

3 Procedures and Guidelines

Anomalies to be reacquired and intrusively investigated will include those identified as TOI and cannot analyze as well as those selected as part of the validation process.

3.1 Reacquisition

Anomalies selected for intrusive investigation will be reacquired by a reacquisition team composed of one geophysicist and one UXO Technician II. The reacquisition team will navigate to the location of each anomaly to be intrusively investigated using an RTK GPS and will place a non-metallic survey flag at the modeled target location derived through the data processing and classification process. The anomaly ID will be written in indelible marker on the survey flag. The reacquisition team will take care to reacquire each target location with accuracy within 1 inch.

3.2 Intrusive Investigation

After reacquisition of the anomalies selected for intrusive investigation, each anomaly will be intrusively investigated in accordance with the Fort Ord MEC Procedures Supplement (KEMRON, 2015) with exceptions described below. The initial anomalies to be investigated will be those selected as threshold verification digs in order to determine whether certain signatures should be added to the classification library from the cluster analysis and to verify the appropriate threshold (see the draft Advanced

Geophysical Classification Validation Plan in Appendix D). After completion of the threshold verification digs, the intrusive team will proceed to investigate the remainder of the anomalies identified on the dig list. The final set of anomalies to be investigated will be those selected as part of the validation process approved in the final Advanced Geophysical Classification Validation Plan.

Due to the precision of advanced EMI sensor data and modeling results, as well as to the nature of advanced geophysical classification surveys, where non-TOI metallic items are purposely left in the ground, intrusive investigations will be conducted with different procedures than those of intrusive investigations based on standard DGM. Each excavation will be conducted only in the immediate vicinity of the reacquired target location, with an approximate search radius of one standard shovel width. The investigation will proceed until the predicted item (or a metallic item of comparable size and shape) is recovered or until the excavation depth has reached 12 inches below the predicted depth (to the center of mass of the target item).

3.3 Post-Investigation Anomaly Resolution

Post-investigation anomaly resolution will be verified by comparing the modeled classification results (predicted item identity and depth) to the actual intrusive investigation results. Any anomaly investigated from the validation dig list and identified as a TOI will trigger an root cause analysis and corrective action, as appropriate. Documentation of the intrusive investigation results and anomaly resolution will be performed in accordance with the Fort Ord MEC Procedures Supplement (KEMRON, 2015), with exceptions discussed below.

4 Data Management

The following sections describe the input data needed to perform this SOP and the resulting output data.

4.1 Input Data Required

Input data required for this SOP include the following:

- A dig list containing target identifiers (ID) with a modeled anomaly source location (X,Y), depth, and identity for each target

4.2 Output Data

Output data include the following:

- Digitally-recorded intrusive investigation results including the following:
    - Recovered item identity
    - Specific type and model of MEC or MD, if possible
    - Precisely-measured recovery depth, within 1 inch, to the center of mass of the recovered item
    - Recovery orientation
    - Offset of recovered item from predicted location, within 1 inch
- Photograph of recovered item
- QC report including documentation of performance relative to Worksheet 22 of the AGCMR-QAPP for the following:
    - Daily verification of reacquisition RTK GPS accuracy and precision
    - Recovered item locations match predicted positions within MQO tolerance

- Recovered item depths match predicted depths
- Predicted seed item locations match known positions within MQO tolerance
- All seed items are classified as TOI and recovered
- Validation of classification results – all intrusively investigated non-TOI are confirmed to be non-TOI

5 Quality Control

Reacquisition and intrusive investigation require follow-on QC inspections that will be documented on the Follow-on Advanced EMI Sensor Reacquisition Checklist and the Follow-on Advanced EMI Sensor Intrusive Investigation Checklist that are included as Attachments 1 and 2 to this SOP. The checklists will be completed by the Reacquisition Geophysicist and the QC Geophysicist, respectively. Successful completion of these procedures will be documented by the QC Geophysicist in the Geophysics Daily QC Report.

5.1 Measurement Quality Objectives

The MQO for advanced EMI sensor reacquisition and intrusive investigation are presented in Worksheet 22 of the AGCMR-QAPP. Performance relative to the MQO will be assessed during reacquisition and intrusive investigation activities. Resolution of classified targets will not be considered complete until these MQO are met or until the project team agrees on modifications to the MQO.

6 Reporting

Documentation of intrusive investigation results will be entered on digital dig sheet forms in the dig team's tablet computer and will include recovered item identity, a detailed description of specific features and variety of MEC, if applicable, the precisely-measured recovery depth, and the recovery orientation. Photographs will be taken of recovered items. Recovered items will be compared to the predicted item identity and modeled burial depth to verify that the correct item was recovered from the excavation location and to validate the advanced geophysical classification process. Verification of reacquisition and intrusive investigation activities will be documented through the completion of the Follow-on Advanced EMI Sensor Reacquisition Checklist and the Follow-on Advanced EMI Sensor Intrusive Investigation Checklist that are included as Attachments 1 and 2 to this SOP. The checklists will be completed by the Reacquisition Geophysicist and the QC Geophysicist, respectively. Successful completion of these procedures will be documented by the QC Geophysicist in the Geophysics Daily QC Report.

Attachment 1

Follow-on Advanced EMI Sensor Reacquisition Checklist

Follow-on Advanced EMI Sensor Reacquisition Checklist

This checklist is to be completed by the Reacquisition Geophysicist for each cued advanced EMI sensor reacquisition event. The QC Geophysicist will document the successful completion of this checklist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	Reacquisition Geophysicist Initials
1. Reacquisition GPS accuracy and precision	Has the RTK GPS performance been verified by conducting a static position check on a local benchmark position?		
2. Reacquisition accuracy	Have all reacquired targets been located with accuracy within 1 inch?		
3. Reacquisition completeness	Have all targets identified for intrusive investigation been reacquired?		
4. Reacquisition completeness	Have all target locations been marked with pin flags clearly displaying their unique target IDs?		

Reacquisition Geophysicist: ____ Date: _______________

Attachment 2

Follow-on Advanced EMI Sensor Intrusive Investigation Checklist

Follow-on Advanced EMI Sensor Intrusive Investigation Checklist

This checklist is to be completed by the QC Geophysicist for each advanced EMI sensor intrusive investigation event. The QC Geophysicist will document the successful completion of this checklist in the Daily Geophysics QC Report.

QC Step	QC Process and Guidance Reference	Yes/No	QC Geophysicist Initials
1. Intrusive investigation completeness	Have all targets identified for intrusive investigation been excavated?		
2. Intrusive investigation reporting	Have complete descriptions been recorded for each recovered item?		
3. Intrusive investigation reporting	Have accurate recovery depth measurements, to the center of mass of the recovered item, been recorded for each recovered item?		
4. Intrusive investigation reporting	Have recovery orientations been recorded for each recovered item?		
5. Intrusive investigation reporting	Have accurate recovery offsets been recorded?		
6. Intrusive investigation reporting	Have photographs been taken of each recovered item?		
7. Modeled location validation	Have recovered item locations been verified to match predicted positions within MQO tolerance?		
8. Modeled depth validation	Have recovered item depths been verified to match predicted depths?		
9. Classification validation	Have all seed items been classified as TOI and recovered?		
10. Modeled location validation	Have all predicted seed item locations been verified to match known positions within MQO tolerance?		
11. Classification validation	Have modeled advanced geophysical classification results (predicted item identity and depth) been compared to the actual intrusive investigation results?		
12. Classification validation	Have all intrusively investigated non-TOI been verified to be non-TOI?		

QC Geophysicist (or designee): ____________________________________ Date: ______________

APPENDIX C
BLIND SEED FIREWALL PLAN

Blind Seed Firewall Plan

Quality Assurance Project Plan
Superfund Response Actions
Former Fort Ord, California

Volume II
Munitions Response

Appendix B
Advanced Geophysical Classification for Munitions Response
Quality Assurance Project Plan

Appendix C

Worldwide Environmental Remediation Services Contract
Contract No. W912DY-10-D-0027
Task Order No. CM01

Prepared for:
United States Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814

Prepared for KEMRON Environmental Services, Inc.by:
Gilbane
1655 Grant Street, Floor 12
Concord, California 94520

August, 2016

Signature Page

By signing this Blind Seed Firewall Plan, all personnel identified in the plan, or others added by U.S. Army Corps of Engineers, certify that they have read the plan and agree to maintain the integrity of the blind seed item information in accordance with the requirements of the plan.

Signature:	**Date:**

1 Introduction

This Blind Seed Firewall Plan has been developed for advanced geophysical classification activities at the former Fort Ord under Contract W912DY-10-0027, Task Order CM01. This plan describes the "firewall" established between project quality control (QC) personnel that require access to blind seed item information and those who are initially denied access to that information to protect the integrity of the QC program.

2 Data Access

Seed item information will be withheld from personnel involved with collection of advanced geophysical classification data, data processing, classification, target reacquisition, and intrusive investigation activities until these tasks have been completed in any given unit. Seed item information will be made available to these personnel only after permission to share this information has been granted by the U.S. Army Corps of Engineers (USACE). Only the following personnel will have initial access to seed item information:

- USACE Quality Assurance Geophysicist
- Quality Control Geophysicist
- Unexploded Ordnance Quality Control Specialist (UXOQCS)

3 Information Transfer/Storage

Upon emplacement of seed items, the QC team will digitally record the type, position, orientation and depth of each seed item in accordance with SOP AGCMR-03. Seed item information will be transferred to the QC Geophysicist via email immediately upon generation and will not be provided to non-QC personnel. The QC Geophysicist will store the seed item information in a protected location outside the KEMRON network to maintain the integrity of the seed item information. After the Lead Data Processor delivers the initial classification list, the QC and QA Geophysicists will confirm that all seed items have been correctly classified. Should a seed item be incorrectly classified, the QC and QA Geophysicists will release information for the incorrectly classified seed item to the appropriate project personnel to conduct a root cause analysis and determine the appropriate corrective action.

4 Firewall Compliance

All personnel identified in this Blind Seed Firewall Plan, or others added by USACE, are required to sign the Blind Seed Firewall Plan signature page and certify that they have read the plan and agree to maintain the integrity of the blind seed item information in accordance with the requirements of the plan. The signatures of compliance will be kept on record by the KEMRON Project Manager and added to the project files.

APPENDIX D

DRAFT ADVANCED GEOPHYSICAL CLASSIFICATION VALIDATION PLAN

Advanced Geophysical Classification Validation Plan

Quality Assurance Project Plan
Superfund Response Actions
Former Fort Ord, California

Volume II
Munitions Response

Appendix B
Advanced Geophysical Classification for Munitions Response
Quality Assurance Project Plan

Appendix D

Worldwide Environmental Remediation Services Contract
Contract No. W912DY-10-D-0027
Task Order No. CM01

Prepared for:
United States Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814

Prepared for KEMRON Environmental Services, Inc.by:
Gilbane
1655 Grant Street, Floor 12
Concord, California 94520

August, 2016

1 Introduction

This draft Advanced Geophysical Classification Validation Plan has been developed to describe procedures for verifying and validating the results of advanced geophysical classification activities at the former Fort Ord. The work is being conducted under Contract W912DY-10-D-0027, Task Order number CM01. The intent of the validation process is to provide assurance that targets of interest (TOI) have been correctly classified and identified for removal and that no TOI have been classified as non-TOI. The verification and validation process will involve the following quality demonstrations:

- threshold verification to verify correct placement of the "stop dig" threshold
- selection and intrusive investigation of validation digs from the population of anomalies classified as non-TOI to demonstrate that anomalies have been correctly classified
- validation of modeled TOI identities and depths

This plan presents the rationale for the verification and validation approach and the initial description of the verification and validation process. The final identity, quantity, and distribution of intrusive investigations necessary to verify and validate the classification process will be determined during the course of classification activities and will be dependent upon the following factors (and others, if necessary):

- total investigated anomaly population size
- specific details of the classification approach
- classification performance demonstrated by quality control (QC) and quality assurance (QA) seed item identification

This draft Advanced Geophysical Classification Validation Plan will be amended prior to implementation based upon the above factors (and others, if necessary).

2 Background

There are two general components to advanced geophysical classification activities: identification of anomalies from an initial detection DGM survey, followed by an advanced cued geophysical classification survey of those identified anomalies. The initial detection survey can be seen as the first step in the classification process where anomalies are selected or rejected based upon a detection threshold. Once an anomaly is identified and an advanced cued geophysical classification measurement is acquired, the anomaly can be classified as a TOI if it meets any of the following criteria:

1. Its derived polarizabilities (βs) match those of any TOI in the classification library
2. It is a member of a cluster or group of anomalies with similar (βs) that are identified as TOI through intrusive investigation
3. Its derived βs indicate features that are typical of TOI (large, axial symmetry, and thick-walled)

The goal of the validation process is to demonstrate that no TOI are classified as non-TOI. The above criteria can be restated in terms of how anomalies are classified as non-TOI. An anomaly is classified as a non-TOI if it meets any of the following criteria:

1. Its derived polarizabilities do not match those of any TOI in the classification library
2. It does not belong to an identified cluster of anomalies with similar βs that are identified as TOI through intrusive investigation
3. Its derived βs indicate that it is not large, axially symmetric, and thick-walled

The following discussion presents an initial approach to classification validation for each mode of classification (including initial selection), with emphasis on describing what thresholds will be tested and the rationale for these tests. Any validation failures will require a root cause analysis and appropriate corrective action developed and implemented in consultation with the U.S. Army Corps of Engineers

(USACE).

3 Anomaly Selection Validation

Anomaly selection will be performed using the traditional response amplitude method. The response amplitude anomaly selection method is similar to standard EM61 detection surveys that use the amplitude response of a monostatic transmit (Tx)/receive (Rx) coil system. The advanced geophysical classification sensor, however, has much higher resolution due to multiple Tx/Rx coil combinations with smaller footprints and a more densely sampled data set.

Traditional anomaly selection is based nearly entirely on signal response amplitude. Using the advanced geophysical sensor dynamic survey monostatic Z coil response amplitude as a detection metric, a response threshold in millivolt (mV)/Ampere (amp) will be calculated to achieve the site-specific detection criteria. Based on this response amplitude threshold, maximum detection depths will be derived for each munition type identified in the conceptual site model as a TOI.

Validation of the response amplitude threshold will involve sampling through intrusive investigation of anomalies beyond this threshold. A set of validation digs will be selected close to the cut-off threshold to provide additional assurance that the threshold is sufficiently low to meet the stated detection requirements. A validation failure will result if any TOI is recovered in the set of validation investigations at or shallower than its maximum detection depth.

4 Library Match Threshold Verification

Classification will be based primarily on the fit metrics generated by the Geosoft Oasis Montaj UX-Analyze module during a comparison of the β values estimated for each surveyed anomaly and the β values in the classification library developed for the project. The fit metric indicates the fit correlation between an anomaly and the item in the library that best matches it. The fit metric ranges from 0 to 1, with a fit metric of 1 being a perfect match. The library fit analysis matches the following combinations of βs to those of the classification library TOIs:

1. β1, β1/β2, β1/β3
2. β1, β1/β2
3. β1/β2, β1/β3
4. β1

The confidence metrics for each fit combination are averaged to derive a decision metric. The library matching process is performed for each single-target model and every target in each of the multi-target models. For each measured anomaly, the highest value decision metric (i.e., most likely TOI) from the combined set of single-solver and multi-solver targets will be used as the decision metric for that anomaly.

A cut-off threshold is determined based upon review of the decision metrics derived for the known targets (QC seeds, bench measurements and training dig results) and is used to rank and classify the target list. Decision metric values above the threshold are classified as TOI, and values below the decision metric are classified as non-TOI.

Verification of the library match threshold will involve sampling through intrusive investigation of anomalies beyond this threshold. The number of additional digs required to achieve verification will depend to a large degree on intrusive investigation results – in particular the results for the lowest-ranked anomalies that are classified as TOI, but it is anticipated that 200 targets beyond the final recovered TOI on the ranked classification list will be intrusively investigated. Partial receiver operating characteristic (ROC) curves showing a steep ascent early in the prioritized list (indicating most targets are TOI), followed by a small section of no vertical (Y direction) gain indicating the absence of TOI in the latter part of the prioritized list are indicative of successful classification. Partial ROC curves that do not display a distinct inflection point between the TOI and non-TOI sections, and have TOI in close proximity (on the prioritized list) to the library match threshold require more verification digs. A verification failure will result if any TOI is recovered in the set of verification investigations.

5 Cluster Analysis Verification

The cluster analysis is designed to detect unanticipated TOI at the site by identifying existing groups of anomalies with similar βs that do not match any of the classification library TOI, and intrusively investigating anomalies within these clusters to determine if the clusters are comprised of TOI or non-TOI. Within any such cluster, the individual items will all be very similar in size, shape and composition. The β signature of any cluster that is identified as TOI is added to the classification library, and the items in the cluster are classified as TOI.

Verification of the cluster analysis will proceed with validation of the library match results (described above). For each cluster that is not found to be comprised of TOI, additional verification digs will be performed to confirm the finding that the population of this cluster is not comprised of TOI. A validation failure will result if any TOI is recovered in the set of verification investigations.

6 Feature Analysis Verification

The feature analysis is designed to detect unanticipated TOI at the site by identifying individual anomalies with βs indicating features that are typical of TOI (large, axial-symmetric, and thick-walled) but do not match any of the classification library items, and intrusively investigating those anomalies to determine if their sources are TOI or non-TOI. The β signature of any item that is identified as a TOI is added to the classification library, and the item is classified as a TOI.

Verification of the feature analysis will involve sampling through intrusive investigation of a set of anomalies beyond the cut-off thresholds for feature space identification of potential TOI. Values related to size, axial symmetry and decay (longer decays are indicative of thick-walled objects) are calculated from the βs during the data processing and classification process. A set of verification digs will be selected close to the cut-off threshold used for each of these parameters. A validation failure will result if any TOI is recovered in the set of verification investigations.

7 Modeled Identity and Depth Validation

The classification process results in a modeled identity and depth of each classified target. Validation of modeled TOI identities and depths will involve comparison of the intrusive investigation results of each recovered item to the modeled identities and depths from the data analysis. The specific parameters that will be compared include burial depth, rough size, and item shape. This comparison will validate the classification match and depth prediction capability of the data modeling process. Intrusive investigation results that are not similar in shape and mass to the predicted item identities or recovered depths that differ from the predicted depths by more than 12 inches will require re-examination of the anomaly and/or re-analysis of the advanced sensor data and may result in a root cause analysis and potential corrective action.

Recovered item sizes will be compared to a predicted size band. The Oasis Montaj project database will include a predicted size for each item within one of three size bands. The small size band includes items the size of a 37mm projectile and smaller. The medium size band includes items larger than a 37mm projectile and smaller than a 105mm projectile. The large size band includes items the size of a 105mm projectile and larger.

Recovered item shapes will be compared to the predicted shape inferred from the polarizability curves in the project database. Predicted shapes are based on the relationships between the three primary axis polarizabilities that indicate the degree of symmetry of the item. Basic item shapes include symmetric (or near-symmetric), non-symmetric, and plate-like.

If the data analysis indicates that an anomaly is the result of multiple items, each recovered item will be compared to the predicted sources.

8 Summary of Verification and Validation Investigations

The final identity, quantity, and distribution of intrusive investigations necessary to validate the classification process will be determined during the course of classification activities and presented in the final Advanced Geophysical Classification Validation Plan. It is anticipated, however, that the anomaly selection validation process (Section 3) will result in approximately 20 validation investigations; the library match validation process (Section 4) will result in up to 200 validation investigations; the cluster and feature analysis processes (Sections 5 and 6), while more difficult to quantify, and will result in approximately 20 validation investigations. The modeled identity and depth validation process (Section 7) will involve analysis of investigation results for each recovered item from the ranked classification list and will not involve additional intrusive investigations. The USACE QA Geophysicist will add up to 200 additional validation investigations, resulting in a total of up to 440 total verification and validation investigations. Based on the total number of investigated anomalies and specific details of the classification approach and classification performance demonstrated by QC and QA seed item identification, the actual quantity of validation investigations may be lower than anticipated. Results of verification and validation digs will be presented in the final advanced geophysical classification report.

APPENDIX E
RESPONSES TO COMMENTS

Draft-Final Fort Ord AGCMR-QAPP
Response to Comments

No.	Commentor	Reference	Comment	Response
1	Mike Weaver, Fort Ord Community Advisory Group	N/A	The FOCAG accessed the Fort Ord BRAC website: fortordcleaniup.com We looked under this website's Documents tab for a list of "Documents Under Review" No documents are listed. This subject document wasn't listed although KEMRON's transmittal memorandum states that comments are requested by May 4, 2016 and should be sent to you, William K. Collins. The FOCAG requests that the availability of this document be put on the website as being available for review and that the deadline date for comments be extended.	In the "Reports Under Review" section of the website, links to documents appear during the period of their public review. Public members who have questions about documents under review may contact the Administrative Record coordinator for assistance. The public review period was not extended for this document.
2	Mike Weaver, Fort Ord Community Advisory Group	Distribution List	This is a technical document but the FOCAG notes that the distribution list includes no representative from the County of Monterey government, no representatives of surrounding City government, no FORA representatives, and no ESCA representatives. All of these have been previously sent copies of documents. Please expand the list and send additional documents.	The County of Monterey, the cities whose jurisdictions cover portions of the former Fort Ord, and FORA are informed of the status of the Fort Ord environmental cleanup program through the Army's interested parties mailing list and other avenues. Cleanup related documents such as work plans and remedial action completion reports are included in the Fort Ord Administrative Record which is available to the public (online at www.fortordcleanup.com), including these municipal agencies.
3	Mike Weaver, Fort Ord Community Advisory Group	Figure 2-1	The FOCAG questions the purposes and limited audience for this document. It is not until page 25 under the heading "SOURCES OF KNOWN OR SUSPECTED MEC", that we get a one-paragraph history of Fort Ord, then a one-paragraph description of the Fort Ord Impact Area MRA. This is followed by a one-paragraph general location description of BLM Area B with reference to Figure 2-1, and MRS-16. Referencing Figure 2-1 in this document on page 26 we find MRS-16 to be highlighted in orange. MRS-16 has boundaries of Eucalyptus Road on its south and Parker Flats Road on its northern boundary. Figure 2-1 does not identify the roadway on MRS-16 eastern boundary. The FOCAG cannot find a description or location of proposed FORA uses for MRS-16. Nor can the FOCAG find any City and County boundaries defined.	Additional information about the history of Fort Ord and previous munitions responses at Fort Ord is provided in Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume II, Munitions Response (Administrative Record number: OE-0861). This Appendix B specifically describes the guidelines for project activities and data quality assessment for advanced geophysical classification as part of the Munitions Response Actions at Fort Ord. BLM Area B and MRS-16 are part of the Fort Ord National Monument. MRS-16 will be transferred to BLM in the future. Figure 2-1 is a broad overview map of the general Fort Ord area without space for many individual road names. Figure 2-2, which focuses on the Impact Area MRA will be revised to show that MRS-16 is bound by Watkins Gate Road to the east. There are no city or county boundaries within the extent of the figure.

No.	Commentor	Reference	Comment	Response
4	Mike Weaver, Fort Ord Community Advisory Group	Figure 2-1	Again referencing Figure 2-1, the large area north of Eucalyptus Road is depicted in a pink color and is labeled BLM Area B with adjoining subareas of B-2, B-3, B-3A, and B-4. Independent of these are two separate pink areas labeled B-5 to the east, and another area labeled B-6 to the southeast. We could find no explanation for this. What type and kinds of visitors might be expected in all these areas?	BLM Area B was separated into sub-areas for evaluation in the Final, Revision 2, Track 2 Remedial Investigation/Feasibility Study BLM Area B and MRS-16, Former Fort Ord, California (Gilbane, 2015). BLM Area B is part of the Fort Ord National Monument. BLM-designated roads and trails are open to recreational uses.
5	Mike Weaver, Fort Ord Community Advisory Group	Page 28, Step 1: State the Problem	The FOCAG requests that the Fort Ord Ordnance Penetration Table from the 1997 be included with this "State the Problem". The historical document is referenced on page 13 of this Volume II, Appendix B-AGCMR-QAPP. The title is "Penetration of Projectiles into the Ground, An Analysis of UXO Clearance Depths at Fort Ord. The author was the company USACE, dated 1997. The table is just after page 10 and is identified as B-1. Please include this table with "State the Problem"	The referenced table (Table B-1) does not apply to the advanced classification geophysical work that is the subject of this QAPP. Detection depths reported in the table are based on magnetometer surveys and cannot be compared to detection depths with the advanced EMI sensors utilized for classification surveys.
6	Mike Weaver, Fort Ord Community Advisory Group	Page 28, Step 2: Identify the Goals of the Project	Anomalies are referred to here, and it is unclear to the reader as to how to determine which anomalies require removal and which may be left in place. Because there are no defined proposed future uses of specific areas revealed here, the reader couldn't begin to assess goals of the project. That doesn't come until Step 3, which is labeled, "Identify Information Inputs". The FOCAG finds Steps 2 and 3 to be out of order, backwards.	This AGCMR-QAPP describes the guideline for project activities and data quality assessment for advanced geophysical classification as part of the Munitions Response Actions at Fort Ord in general rather than for a specific project or area of the Former Fort Ord. Some of the specific details for each individual project will vary based on the goals and objectives of that particular site. Those details, such as project-specific future land uses and measurement quality objectives, when they differ from that presented here, will be described in a Site-Specific Work Plan. The order of the DQO process steps presented in Section 2.2 (Worksheet #11) has been established by the EPA in the document "Guidance on Systematic Planning Using the Data Quality Objectives Process" and set forth as the standard for QAPP documents by the Intergovernmental Data Quality Task Force.

No.	Commentor	Reference	Comment	Response
7	Mike Weaver, Fort Ord Community Advisory Group	Page 4, QAPP Worksheets #3 & 5	Page 4 of this document 1.2, dated March 2016 and is labeled the Project Organization and QAPP Distribution (QAPP Worksheets #3 & 5). Underneath this it is Figure 1-1. Organizational Structure. There are Lines of Authority and Lines of Communication. The legend reveals Denise Duffy & Associates, Project Biologist Jami Davis. However it is unclear to the FOCAG what part Denise Duffy & Associates plays, who they answer to, and who they give direction or reports to. The FOCAG requests an explanation of persons, companies, and clarification of the organizational structure.	All contractors for the former Fort Ord project work for the U.S. Army Corps of Engineers who manages the project for the U.S. Army BRAC Office. Denise Duffy and Associates is a subcontractor to KEMRON and is responsible for oversight of field activities associated with following the requirements of the HMP for work completed in this QAPP.

Draft Fort Ord AGCMR-QAPP
Response to Comments

No.	Commentor	Reference	Comment	Response
1	Ed Walker, DTSC	General	Although it is mentioned, there is very little information about the classification data library that will be used. For example, Worksheet 12 says there will be a site-specific classification library. But there is no explanation for how the site-specific library be developed and how the quality and completeness of the library be ensured? Worksheet 17 discusses taking test pit measurements on Page 42 but, again, the management and quality control of the overall library is not discussed. This section references SOPs 07 and 08, but detailed information on developing and managing the quality of the site-specific data library is not found in those SOPs. It is assumed that a modified version of the USACE data library will be used but this is not stated in the QAPP. Please add more information on the data library and describe how it will be developed, managed and the QC and QA that will be applied to it. This is important because an inadequate data library may result in unidentified TOI.	Details of the site-specific classification library have been added to the Classification Survey section of WS 17, along with the procedures for adding additional site-specific munitions signatures through test pit measurements and the classification library utilities in UX-Analyze. QC/QA measures applied to the classification library have been added to the Project Documents and Records discussion in WS 29.
2	Ed Walker, DTSC	Worksheet 17	For some Definable Features of Work Worksheet 17 only lists the GCMR-QAPP as the supporting documentation. However, all of the DFW are discussed in at least one SOP including the DFW for detection survey data verification, detection survey QC and classification survey data verification. Please add the appropriate SOPs and other supporting documents as references with guidance for these DFW.	The supporting documents for each DFW have been reviewed, and additional SOPs and other supporting documents have been added, where appropriate.
3	Ed Walker, DTSC	Worksheet 17, "Data Verification"	There is very little information on "data verification" in Worksheet 17. The description of this DFW in Worksheet 17 should include the location of the SOP guidance for "data verification" on Page 41 and 42.	Additional details of the data verification steps, including SOP guidance locations for both in-field data verification and remote (data processing) data verification have been added to the Data Verification sections of both the Detection Survey and Classification Survey DFW descriptions.
4	Ed Walker, DTSC	Worksheet 17, "Quality Control"	The brief section on "quality control" in Worksheet 17 on Page 43 appears to be inadequate because it only discusses data validation by NAEVA prior to the data being processed. There is much more to the GCMR QC program in this document than just the few requirements of this one paragraph. Please evaluate what this paragraph is intended to accomplish and either make it complete or, possibly, delete it if it is determined that the information in this paragraph is adequately covered elsewhere in the QAPP.	The Quality Control section in WS 17 describes QC verification of the geophysical data processing rather than overall project QC. This section has been removed, and the text has been moved to the sections for the Detection Survey and Classification Survey DFWs.
5	Ed Walker, DTSC	Worksheet 21	In Worksheet 21 on Page 49 every SOP has the notation "yes" under the column headed "modified for production work". Is this correct? It appears that the SOPs for sensor assembly and QC seeding should not need to be modified for each specific site and there may be others that do not require modification because they are done the same way on all sites. Please evaluate this and determine if any of these SOPs do not require modification for each project.	SOPs that are not expected to require modification for individual project work have been listed as such. SOPs that may require modification based on specific project requirements remain listed as "Yes".

Draft Fort Ord AGCMR-QAPP
Response to Comments

No.	Commentor	Reference	Comment	Response
6	Ed Walker, DTSC	Worksheet 31, 32, 33	The discussion of the three-phased QC inspections in Worksheet 31, 32, 33 should include statements that checklists showing the requirements for inspections of each DFW are included in the SOPs.	Text has been added to WS 31, 32, 33 stating that the QC inspection checklists for each DFW are included in the SOPs.
7	Ed Walker, DTSC	Worksheet 31, 32, 33	The QC inspection audit checklists and who is responsible for performing the QC inspections should be added to the "assessment schedule" in Worksheet 31, 32, 33.	All SOP QC inspection checklists have been added to the WS 31, 32, 33 Assessment Schedule. The QC team member responsible for performing the QC inspections is specified in each QC checklist in the SOPs.
8	Ed Walker, DTSC	SOP-06	SOP-06 includes a section describing "advanced detection" during the dynamic data processing and analysis. However, performing advanced detection with dynamic data is not discussed anywhere in the QAPP and appears to be excluded by the description of the DQOs in Worksheet 11 (Page 30 and 31) and the description of the dynamic detection survey in Worksheet 17 (Page 41). From this, it appears that "advanced detection" (classification) using dynamic data is not anticipated as a DFW and references to advanced detection should be removed from the SOP.	Advanced (dipole response filter) detection is not currently planned for geophysical classification work at Fort Ord, so those references have been removed from the SOP. If advanced detection will be employed in the future, the AGCMR-QAPP and applicable SOPs will be revised to include the data analysis procedures and applicable MQOs. All revisions and additions will be submitted for review and approval prior to incorporating advanced detection data processing and analysis.
9	Ed Walker, DTSC	SOP-07	QC checks for collecting background data should be added to the QC checklists in SOP-07 for cued data acquisition.	A QC check of background measurement acquisition location and frequency has been added to the SOP AGCMR-07 QC checklist.
10	Ed Walker, DTSC	Validation Plan	Similar to Comment 8 above, the Validation Plan contains a section on "dipole response filter detection." Dipole response filter detection is a method of classification using dynamic data. As described in Comment 8 above, since dipole response filter detection is not a DFW under this QAPP, text on dipole response filter detection should be removed from the Validation Plan.	Advanced (dipole response filter) detection is not currently planned for geophysical classification work at Fort Ord, so those references have been removed from the Validation Plan. If dipole response filter detection will be employed in the future, the AGCMR-QAPP, the Validation Plan, and applicable SOPs will be revised. All revisions and additions will be submitted for review and approval prior to incorporating advanced detection data processing and analysis.

Draft Fort Ord AGCMR-QAPP
Response to Comments

No.	Commentor	Reference	Comment	Response
11	Ed Walker, DTSC	Validation Plan, Section 7	Please provide more information on "modeled identify and depth validation" in the Section 7 of the Validation Plan. This is a valuable procedure but it needs a more detailed description. Will this procedure be performed for every identified TOI and does it include selection of some non-TOI for excavation and comparison to the predictive results modeled from the geophysical data? Section 8 of the Validation Plan says that this validation procedure does not require any additional intrusive investigations and the description of it is not sufficiently detailed to be fully understood by DTSC based on the text. Please explain this validation process in more detail.	The modeled identity and depth validation process described in Section 7 of the Data Validation Plan has been expanded to include the specific parameters that are to be compared (burial depth, rough size, and item shape) and details of the comparison process. Text has been added to both Section 7 and Section 8 to indicate that every recovered item will be compared to the predicted results contained in the Oasis Montaj database and the ranked classification list. This process provides sufficient validation of the classification results No additional validation digs (items identified as non-TOI) will be required to validate the classification process.