INTERGOVERNMENTAL DATA QUALITY TASK FORCE

Uniform Federal Policy
For
Quality Assurance Project Plans
(UFP-QAPP)

Munitions Response QAPP Toolkit

Module 2:

Remedial Action

Final, March 2023

INTERGOVERNMENTAL DATA QUALITY TASK FORCE

Uniform Federal Policy For Quality Assurance Project Plans (UFP-QAPP)

Munitions Response QAPP Toolkit

Module 2:

Remedial Action

Final, March 2023

GREGORY GERVAIS

Digitally signed by GREGORY GERVAIS
Date: 2023.03.31 16:15:59 -04'00'

3/31/23

Gregory Gervais, P.E. Date
Director, U.S. Environmental Protection Agency, Federal Facilities Restoration and Reuse Office

KIDD.RICHARD.GOODWIN.IV.1163856081

Digitally signed by KIDD.RICHARD.GOODWIN.IV.1163856081
Date: 2023.04.07 07:03:49 -04'00'

4/7/23

Richard Kidd Date
Deputy Assistant Secretary of Defense for Environment & Energy Resilience

Acknowledgement

The Intergovernmental Data Quality Task Force (IDQTF) would like to thank the members of the IDQTF Munitions Response Subgroup for their time and efforts preparing this document. Comprised of technical experts and stakeholders representing DoD, the Strategic Environmental Research Demonstration Program (SERDP), the Environmental Security Technology Certification Program (ESTCP), the U.S. Environmental Protection Agency (EPA) Federal Facilities Restoration and Reuse Office (FFRRO), and the states of Colorado and California, the IDQTF Munitions Response Subgroup includes the following members:

Jordan Adelson, Ph.D., Navy Laboratory Quality and Accreditation Office, NAVSEA 04Q
William Corl, Ph.D., Navy Laboratory Quality and Accreditation Office, NAVSEA 04Q
Bryan Harre, Naval Facilities Engineering and Expeditionary Warfare Center, NAVFAC EXWC
John Jackson, Military Munitions Division, USACE/EMCX, Huntsville District
Brian Jordan, DoD Cleanup, OSD/ODASD (Environment & Energy Resilience)
Doug Maddox, P.E., U.S. EPA Federal Facilities Restoration and Reuse Office
Herb Nelson, Ph.D., SERDP & ESTCP
Ed Walker, California EPA, Department of Toxic Substances Control
James Salisbury, Military Munitions Division, USACE/EMCX, Huntsville District
Andrew Schwartz, Military Munitions Division, USACE/EMCX, Huntsville District
Jeff Swanson, P.E., Colorado Department of Public Health & Environment
Jon Ussery, Air Force Civil Engineer Center, AFCEC/CZR
Anne Andrews, Ph.D., Prince Street Consulting (Contract support)
Carla Garbarini, NSTECH (Contract support)
Daniel Steinhurst, Ph.D., Nova Research, Inc. (Contract support)

The IDQTF also thanks the members of the Munitions Response Dialog, including Mr. Brian Jordan (DoD Co-chair), Mr. Doug Maddox (EPA Co-chair), and Ms. Tracie White (State Co-chair) for their support, and gratefully acknowledges the National Association of Ordnance Contractors for their helpful insights and contributions made during the development of this document.

Table of Contents

List of Tables

List of Figures

Appendices

[This page intentionally left blank.]

Preface

The IDQTF Munitions Response Subgroup has developed the Munitions Response Quality Assurance Project Plan (MR-QAPP) Toolkit to assist project teams in planning for the characterization and remediation of munitions and explosives of concern (MEC) using geophysical methods at Department of Defense (DoD) installations and formerly used defense sites (FUDS) (collectively referred to as Munitions Response Sites (MRS)). The MR-QAPP Toolkit is based on requirements and guidance contained in the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP, IDQTF, 2005) and makes use of applicable worksheets contained in the Optimized UFP-QAPP Worksheets (IDQTF, 2012), which have been adapted for this purpose.

This Toolkit employs the systematic planning process (SPP) to illustrate scientifically sound approaches to characterizing and remediating MEC at MRS in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended. It does not address the characterization or remediation of munitions constituents (MC) or chemical warfare materiel (CWM). A separate systematic planning process must be used, and separate data quality objectives (DQOs) documented, for projects involving the characterization and remediation of MC or CWM. In addition, all worksheets pertaining to chemical sampling and analysis contained in the 2012 Optimized UFP-QAPP worksheets must be completed.

The use of the Toolkit will help project teams plan data collection efforts and generate QAPPs addressing all elements of the national consensus standard ANSI/ASQ E4-2004, Quality Systems for Environmental Data and Environmental Technology Programs.

MR-QAPP Module 1, Update 1, March 2020, provides guidance and illustrates approaches for planning and implementing the Remedial Investigation (RI)/Feasibility Study (FS) phase of the process. MR-QAPP Module 2 (this document) provides guidance and illustrates approaches for planning and implementing the Remedial Action (RA).

Planning for the Remedial Action begins during the FS, where Remedial Action Objectives (RAO) are first established. Following development of a proposed plan and a public comment period, the remedy selection decision is documented in the site-specific Record(s) of Decision (ROD), which formally documents the RAO; describes components of the remedy (e.g., treatment, engineering controls, and institutional controls); and specifies remediation goals (i.e., cleanup levels).

A site-specific MR-QAPP prepared in accordance with this document will contain all procedures necessary to conduct and demonstrate successful RA implementation and achievement of RAO applicable to MEC removal presented in the site-specific ROD. [Note: Procedures necessary to demonstrate achievement of RAOs related to land use controls (LUC) would be described in a separate document (e.g., a Land Use Control Implementation Plan).

As in Module 1, this document places heavy emphasis on the role of the Data Usability Assessment (DUA) in decision-making. Specifically, achievement of the RAO will require an evaluation during the DUA of whether 1) key underlying assumptions presented in the conceptual site model (CSM) are correct; 2) data completeness objectives were achieved, 3) the remedy was implemented as planned, and 4) if Unlimited Use (UU)/Unrestricted Exposure (UE) is a feasible and desirable end state for the RA at any MRS, all necessary lines of evidence defined in the DQOs support UU/UE.

Using green text, this document provides instructions and guidance for completing each worksheet to make sure all specifications necessary to implement the remedy and achieve the RAO are captured. Blue text provides examples of the types of information typically needed, based on a fictional site, “Camp

Example," which includes former targets, ranges, and a maneuver area. Other types of MRSs exist (e.g., old disposal/burial pits, etc.) for which different lines of evidence may be needed.

Where applicable, minimum recommended requirements contained in worksheets are presented in black text. Project teams must provide the rationale for changes to black text, which are subject to regulatory review and acceptance. A convenient and efficient way to do this is to provide an appendix to the project-specific QAPP describing any changes and providing the rationale. [Note: Specifications contained in the site-specific ROD supersede any specifications in this document presented in black text.]

As in Module 1, the examples make use of both digital and analog geophysical technology, to illustrate the appropriate applications of each. It should be noted, however, that the use of analog technology is appropriate only in cases where it is the only viable option. The examples do not address all currently available detection/classification systems. Appendix A includes measurement quality objectives (MQO) applicable to currently available geophysical systems not addressed in the examples.

Table 1: Crosswalk: Optimized UFP-QAPP Worksheets to MR-QAPP Module 2: RA

Optimized UFP-QAPP Worksheets		MR-QAPP Module 2: RA
1 & 2	Title and Approval Page	Included
3 & 5	Project Organization and QAPP Distribution	Included
4, 7 & 8	Personnel Qualifications and Sign-off Sheet	Included
6	Communication Pathways and Procedures	Included
9	Planning Process for Remedial Action	Included
10	Conceptual Site Model	Included
11	Data Quality Objectives	Included
12	Measurement Performance Criteria	Included
13	Secondary Data Uses and Limitations	Not included – At the start of the RA, all relevant previously collected data, including secondary data, should be compiled in the CSM.
14 & 16	Project Tasks & Schedule	Included
15	Project Action Limits and Laboratory-Specific Detection/Quantitation Limits	Not applicable – No chemical testing being performed
17	Sampling Design and Rationale	Included – Title changed to “Survey Design and Project Workflow”
18	Sampling Locations and Methods	Not applicable – No environmental samples being collected
19 & 30	Sample Containers, Preservation, and Hold Times	Not applicable – No environmental samples being collected
20	Field Quality Control (QC)	Worksheet not included – Field QC procedures are included on Worksheet #22
21	Field Standard Operating Procedures (SOPs)	Worksheet not included – SOPs are referenced on Worksheet #17 and Worksheet #22
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	Included – Title changed to “Equipment Testing, Inspection, and Quality Control
23	Analytical SOPs	Not applicable – No laboratory analysis being performed

Table 1: Crosswalk: Optimized UFP-QAPP Worksheets to MR-QAPP Module 2: RA (Continued)

Optimized UFP-QAPP Worksheets		MR-QAPP Module 2: RA
24	Analytical Instrument Calibration	Not applicable – No laboratory analysis being performed
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	Not applicable – No laboratory analysis being performed
26 & 27	Sample Handling, Custody, and Disposal	Not applicable – No samples being collected
28	Analytical Quality Control and Corrective Action	Not applicable – No laboratory analysis being performed
29	Project Documents and Records	Included – Title changed to "Data Management, Project Documents and Records"
31, 32 & 33	Assessments and Corrective Action	Included
34	Data Verification and Validation Inputs	Worksheet not included – Use is optional
35	Data Verification Procedures	Included – Title changed to "Data Verification and Validation Procedures"
36	Data Validation Procedures	Worksheet not included – Data validation is addressed in Worksheet #35
37	Data Usability Assessment	Included

Uses and Limitations of Analog Technology

Introduction: Due in large part to efforts conducted under the Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP) and supported by the Interstate Technology & Regulatory Council (ITRC), geophysical technology employed to permit the detection, and removal of MEC at munitions response sites has matured and been successfully demonstrated. Available tools now include advanced geophysical classification (AGC) sensor platforms, "one-pass" detection/classification systems, planning and data analysis software, and more accurate and reliable geolocation and navigation tools. According to *The DoD/EPA Management Principles for Implementing Response Actions at Closed, Transferring, and Transferred Ranges* (March 7, 2000) "Rapid employment of the better performing, demonstrated technologies needs to occur."

Relevant Requirements: The DoD Information Quality Guidelines (February 10, 2003) prescribe policy and procedures for ensuring and maximizing the quality of information disseminated to the public by DoD. Specifically, the level of quality necessary for influential scientific data requires that such information **be capable of being substantially reproduced.** With regard to analysis of risks to health, safety, or the environment, the guidelines adopt the quality principles of the Safe Drinking Water Act, which are to use:

- **The best available, peer-reviewed science, and**
- **Data collected by accepted methods or best available methods.**

As further provided and explained in The DoD/EPA Management Principles, adequate characterization of ranges, which is necessary to make informed risk management decisions and conduct effective response actions, requires the following:

- A permanent record of the data including a clear audit trail of data analysis and resulting decisions and actions. **Exceptions should be limited to emergency response actions or cases where impractical.**
- Selection of the most appropriate and effective detection technologies.
- Regulatory and public involvement when selecting the most appropriate detection technologies at a site.

Geophysical Detection Systems: EM 200-1-15 provides a comprehensive description of the capabilities and limitations of various geophysical systems used to detect geophysical anomalies associated with items of concern (IOC). The two principal sensor technologies used are electromagnetic induction (EMI) and magnetometer, both of which can be operated in either an analog or digital recording mode. The detection and location of IOC depend on the ability of the systems to distinguish the measured signals arising from IOC from those of the surrounding environment.

In 2005-2006, the Interstate Technology & Regulatory Council (ITRC), together with the SERDP, conducted a survey of existing studies to document the application and performance of munitions detection technologies available at that time, including magnetometer and EMI in both analog and digital modes. The study found that while both technologies are capable of detecting most munitions under typical site conditions, there are large variations in performance across demonstrators, even when using systems based around the same basic sensors. It further found that digital sensors generally achieved a higher probability of detection (Pd) and lower false-alarm rate than mag and flag. Across all technologies the report observed, "The ability of a system to achieve optimum performance is a function of both the capabilities of the detection technology and quality of its implementation. Real-world challenges such as terrain, geologic noise, overlapping signatures, surface clutters, variations in operator technique, target selection, and data processing all detract from and affect optimum performance. Quality control and quality assurance programs are critical to achieving successful results with any munitions detection technology."

Analog geophysical tools produce an audible output, meter deflection, and/or numeric output, which is interpreted in real time by the instrument operator. Analog tools include handheld EMI detectors and ferrous locators (magnetometers). The operator holding the sensor serves as the survey platform, positioning system, and data-processing system. Unexploded ordnance (UXO) technicians have used analog tools ("Mag & Flag" or "Mag & Dig") for many years to screen areas for IOC and conduct clearance activities. When an anomaly is detected, the location is marked immediately by placing a small flag in the ground. Analog tools can be useful in certain applications because they provide real-time field observations, anomaly locations can be manually flagged at the time the signal is observed and excavated immediately following the survey, and there are few constraints due to vegetation or topography. Their use is limited by the following, however:

- Data quality depends on human factors that cannot be measured (including attentiveness/distraction and individual interpretations of audible signals).
- Decisions are made in the field based on the operator's judgment.
- The instrument response provides no information regarding the source of the anomaly; therefore, it is unable to distinguish munitions from non-hazardous debris or geology.
- The probability of detection for munitions of concern has been demonstrated to be between 50 and 72% (ITRC 2006).
- No permanent electronic record (of either location coordinates or instrument response) is provided; therefore, no auditable decision record exists.

Digital geophysical tools measure the same physical properties but also digitally record and geo-reference data to measurement locations. All digital tools provide a permanent electronic record of the data, ensuring data reproducibility and permitting after-the-fact data analysis. Data can be interpreted immediately or at any time after data collection is complete. Digital instruments also include advanced EMI sensors that provide information on the physical attributes of the anomaly source, enabling the classification of anomalies as targets of interest (TOI) or non-TOI. Their use is limited in areas where vegetation or topography limit access or impede the function of positioning systems.

Quality Considerations: The data recorded using digital methods support a range of quality checks that can verify the quality of the overall data package, as well as the proper operation of individual components of the detection system; for example, (1) in the instrument verification strip (IVS), measured responses morning and evening consistent with known responses of previously characterized munitions or test objects verify sensor operation and correspondence of measured and known seed locations verify geolocation, (2) in field data, track files verify actual coverage is consistent with planned coverage and reveal any deficiencies, (3) locations and signals of seeds in field data verify ongoing performance of the system, (4) measures of battery strength and/or transmit current verify the sensor is operating within specifications, (5) anomaly selection criteria are quantitative and analyst adherence to specified criteria can be verified. These checks and others can be used to verify the system is in control throughout data collection and analysis operations.

None of the above quality measures can be applied to analog systems, constraining quality control and quality assurance options. In the absence of demonstrating that a system (and/or its components) is continuously in control with quantitative parameters, quality control is limited to whether the system is detecting the items of interest. This approach requires extensive seeding to demonstrate that the system is operating as required throughout data collection operations, requiring that each system (i.e., operator) encounter and detect multiple seeds per day that represent the IOC. If the data are only to be used to identify the location of a high-density area, the IOC (and therefore the seeds) may be any metal object. However, if the data are ultimately to be used to estimate the site-specific performance of a technology in a remedial action, the seeds must represent the munitions of interest at the depth of interest.

Summary: Because of recent, significant developments in geophysical technology, analog tools currently do not represent the best available science for most applications. Specifically, they do not provide a permanent, auditable record of the data and do not generate data capable of being substantially reproduced. Developing rigorous QC measures capable of assessing operator performance is more challenging and less precise than for digital methods. For these reasons, analog geophysical tools should not be used for munitions response activities, except in an iterative multi-survey approach or in rare cases where threatened or endangered vegetation or difficult terrain preclude the use of digital tools. Furthermore, when using analog technology and making analog data publicly available, project teams must disclose the uses and limitations of the data; specifically, the probability of detection is inferior to that achieved using digital methods, and the manner in which coverage is assessed is qualitative and subjective.

[This page intentionally left blank.]

Abbreviations, acronyms, and trade names

AFCEC/CZR – Air Force Civil Engineer Center

AGC – Advanced geophysical classification

ANSI/ASQ – American National Standards Institute/American Society for Quality

bgs – below ground surface

CA – Corrective action

CAR – Corrective action request

CERCLA – Comprehensive Environmental Response Compensation and Liability Act

cm - centimeter

CSM – Conceptual site model

CWM – Chemical warfare materiel

DAGCAP – DoD Advanced Geophysical Classification Accreditation Program

DD – Decision document

DDESB – Department of Defense Explosives Safety Board

DESR – Defense Explosives Safety Regulation

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

DUA – Data usability assessment

EOD – Explosive ordnance disposal

EM61® - Time-domain electromagnetic metal detector (Geonics)

EMI – Electromagnetic induction

EPA – U.S. Environmental Protection Agency

ESTCP – Environmental Security Technology Certification Program

EXWC – Expeditionary and Warfare Center

FCR – Field change request

FFRRO – Federal Facilities Restoration and Reuse Office

FS – Feasibility Study

FUDS – Formerly used defense sites

GIS – Geographic information system

GPS – Global positioning system

HAZWOPER – Hazardous Waste Operations and Emergency Response

HD – High anomaly density

HE – High explosive

i/a/w – in accordance with

IDQTF – Intergovernmental Data Quality Task Force

IOC – Item of concern

ISO – Industry standard object

ISO80 – Schedule 80 small ISO

ISS – Informed source selection

ITRC – Interstate Technology and Regulatory Council

ITS – Instrument test strip

IVS – Instrument verification strip

LD – Low anomaly density

LUC – Land use control

m – meter

MC – Munitions constituents

MD – Munitions debris

MEC – Munitions and explosives of concern

mm – millimeter

MPC – Measurement performance criteria

MPPEH – Material potentially presenting an explosive hazard

MQO – Measurement quality objective

MRDC – Maximum reliable depth of classification

MRDD – Maximum reliable depth of detection

MR-QAPP – Munitions Response Quality Assurance Project Plan

MRA – Munitions response area

MRS – Munitions response site

mV – millivolt

mV/A – millivolt per Ampere

N/A – Not applicable

NAVFAC – Naval Facilities

NAVSEA – Naval Sea Systems Command

NMEA – National Marine Electronics Association

Oasis montaj® - Suite of tools for modeling and analyzing geophysical data (Seequent)

OB/OD – Open burning/open detonation

OSD – Office of the Secretary of Defense

OASD – Office of the Assistant Secretary of Defense

Pd – Probability of detection

PLS – Professional licensed surveyor

PM – Project manager

QA – Quality assurance

QAPP – Quality assurance project plan

QC – Quality control

RA – Remedial action

RACR - Remedial action completion report

RAO – Remedial action objective

RCA – Root cause analysis

RD – Remedial design

RI – Remedial investigation

RMS – Root mean square

ROD – Record of decision

RPM – Remedial project manager

RTK – Real time kinematic

RTS – Robotic total station

Schonstedt® GA-52Cx – A handheld analog magnetometer used to detect ferrous metal (Radiodetection)

SERDP – Strategic Environmental Research and Development Program

SLAM-- Simultaneous Location and Mapping

SNR – Signal to noise ratio

SOP – Standard operating procedure

SPP – Systematic planning process

SRA – Saturated response area

SUXOS – Senior Unexploded Ordnance Supervisor

TBD – To be determined

TEMTADS® - Time-Domain Electromagnetics Multi-Sensor Towed Array Detection System (U.S. Navy)

TOI – Target of interest

TP – Technical paper

UFP-QAPP – Uniform Federal Policy for Quality Assurance Project Plans

USACE/EMCX – U.S. Army Corps of Engineers/Environmental and Munitions Center of Expertise

USGS – U.S. Geological Survey

UU/UE – Unlimited Use/Unrestricted Exposure

UX-Analyze – A data analysis tool that is part of Oasis montaj®

UXO – Unexploded ordnance

UXOQCS – Unexploded Ordnance Quality Control Specialist

UXOSO – Unexploded Ordnance Safety Officer

VSP – Visual Sample Plan

Glossary

[Note: This glossary includes the MR-QAPP Module 1 glossary as well as terms used in Module 2. The hierarchy for the sources of definitions presented here is 1) statute, 2) regulation, 3) DoD/EPA policy, and 4) DoD/EPA guidance documents.]

Anomaly: [IDQTF] Measured response associated with one or more sources that can be distinguished from background.

Background anomaly density: [IDQTF Module 1] The anomaly density in an area where anomalies occur solely from geologic material or anthropogenic clutter not related to DoD range activities. This information may not be known prior to field investigation activities. Background anomalies are assumed to be uniformly distributed throughout the site, or throughout defined sub-areas of the site, as explained in the preliminary CSM. Initial estimates of background density are based on information contained in the CSM, including site history, geology, and the results of previous investigations. The actual background density can be measured using geophysical sensors in areas where no range activities have occurred.

Buffer zone: [IDQTF Module 1] A low anomaly density (LD) area surrounding a confirmed high use area (HUA) designed to accommodate uncertainty associated with establishing HUA boundaries. The buffer zone will always be located in the LD area; that is, the anomaly density in the buffer zone will always be below the critical density. Project teams will determine the size and configuration of buffer zones based on uncertainty in the sampling design and site-specific properties related to range design, e.g., type of munitions used and surface danger zone (SDZ)/weapon danger zone (WDZ) calculations. Within a buffer zone, the presence of intact munitions is much less likely than in a HUA but has not been ruled out.

Critical (anomaly) density: [IDQTF Module 1 – A Visual Sample Plan (VSP) input parameter] Defined in VSP as "the upper bound of acceptable anomaly density", i.e., the estimated, site-specific upper bound of anomaly density considered to be attributable to background (non-munitions-related) sources. It is the project-specific, user-defined value for anomaly density (inclusive of background) used to delineate high anomaly density (HD) areas from low anomaly density (LD) areas.

Delivery unit: [IDQTF] One or more survey units grouped into a single unit for the purpose of conducting the data usability assessment. Final verification and validation digs are tied to the delivery unit. Delivery units will encompass one or more contiguous geographic areas for which 100% of relevant coverage metrics have been achieved. Delivery units are established by the project team during project planning. Smaller sites may have only one delivery unit per MRS while larger sites may have more.

Dig list: [IDQTF] List of anomaly locations that must be excavated to determine their sources. For AGC, the dig list will include TOI, verification digs, validation digs, and inconclusive AGC analyses; for non-AGC digital methods, the dig list will include TOI.

Discarded Military Munitions (DMM): [10 U.S.C. 2710(e)(2)] Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include unexploded ordnance, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations.

Engineering controls: [EPA DD Guidance] Physical barriers to exposure.

Explosive: [DESR 6055.09] A substance or a mixture of substances that is capable by chemical reaction of producing gas at such temperature, pressure, and speed as to cause damage to the surroundings.

Formerly Used Defense Sites (FUDS): [FUDS Program Policy, ER 200-3-1, May 2004, included in AFCEC MMRP Guide] Facility or site (property) that was under the jurisdiction of the Secretary of Defense and owned by, leased to, or otherwise possessed by the United States at the time of actions leading to the contamination by hazardous substances. By the DoD Environmental Restoration Policy, the FUDS program is limited to those real properties that were transferred from DoD control prior to 17 October 1986. FUDS properties can be located within the 50 States, District of Columbia, Territories, Commonwealths, and possessions of the United States.

High anomaly density (HD) area: [IDQTF Module 1] Area within a munitions response site (MRS) where the anomaly density has been determined to be ≥ critical density. HD areas will be presumed to result from munitions use unless it can be demonstrated otherwise.

High explosive (HE): [DESR 6055.09] An explosive substance designed to function by detonation (e.g., main charge, booster, or primary explosive).

High use area (HUA): [IDQTF Module 1] HD area where munitions use has been confirmed. Unexploded ordnance (UXO) and/or DMM are anticipated to be present in HUAs.

Informed source selection: [SERDP-ESTCP] The use of extra information inherent in the signals from advanced EMI sensors, when used in dynamic mode (anomaly detection), to discriminate against sources resulting from environmental noise, geologic noise, and small clutter, thereby reducing the number of sources requiring further investigation.

Institutional Controls: [DoDM 4715.20] A subset of Land Use Controls that are primarily legal mechanisms to ensure the continued effectiveness of LUCs imposed as part of a remedial decision. [EPA DD Guidance] Non-engineering methods intended to affect human activities in such a way as to prevent or reduce exposure to hazardous substances.

Items of Concern (IOC): [IDQTF] Munitions-related items that must be removed from the MRS during the RA. IOC are documented in the CSM as potentially present at the site and include UXO, DMM, and hazardous munitions components. The IOC will inform the data collection and analysis plan, as well as the items included in the AGC TOI library. On well characterized sites with known limited use, IOC may be a short list of specific items. On other complex or poorly characterized sites, IOC may include a wide variety of munitions potentially present.

Land Use Control (LUC): [DoDM 4715.20] Any type of physical, legal, or administrative mechanism that restricts access to real property to prevent or reduce risks to human health and the environment. Physical mechanisms encompass a variety of engineered remedies to contain or reduce contamination and physical barriers to limit access to property, such as fences or signs. The legal mechanisms used for LUCs are generally the same as those used for institutional controls as discussed in the NCP. Legal mechanisms include restrictive covenants, negative easements, equitable servitudes, and deed notices. Administrative mechanisms include notices, adopted local land use plans and ordinances, construction permitting, or other land use management systems to ensure compliance with use restrictions.

Library-matching: [SERDP-ESTCP] The process by which the AGC-derived polarizability decay curves (EMI fingerprints) of unknown objects are compared to a library of polarizabilities for known munitions.

Low anomaly density (LD) area: [IDQTF Module 1] Area(s) within an MRS where the anomaly density has been determined to be < critical density. LD areas can include both low use areas (LUA) and no-evidence-of-use areas (NEU).

Low use area (LUA): [IDQTF Module 1] LD area where the potential presence of munitions has been confirmed or cannot be ruled out. Examples of LUA include buffer zones and maneuver areas.

Maneuver area: [IDQTF Module 1] A type of LUA for which the CSM indicates activities involving munitions (e.g., transport, training, and practice) may have occurred. Typically, the anomaly density in a maneuver area is less than the critical density; however, there can be areas with elevated anomaly density within a maneuver area due to historical munitions use and/or non-munitions-related use.

Material potentially presenting an explosive hazard (MPPEH): [DoDI 4140.62, August 20, 2015 Ch3 – September 9, 2019] Material owned or controlled by the DoD that, before determination of its explosives safety status, potentially contains explosives or munitions (e.g., munitions containers and packaging material; munitions debris remaining after munitions use, demilitarization, or disposal; and range-related debris) or potentially contains a high enough concentration of explosives that the material presents an explosive hazard (e.g., equipment, drainage systems, holding tanks, piping, or ventilation ducts that were associated with munitions production, demilitarization, or disposal operations). Excluded from MPPEH are: Military munitions and military munitions-related materials, including inert components (e.g., fins, launch tubes, containers, packaging material), that are to be used or reused for their intended purpose and are within a DoD Component-established munitions management system. Non-munitions-related material (e.g., horseshoes, rebar, other solid objects) and munitions debris that are solid metal fragments that do not realistically present an explosive hazard, other items (e.g., gasoline cans, compressed gas cylinders) that are not munitions or munitions-related material but may present an explosion hazard. [Note: There are no clear exceptions for "munitions debris that are solid metal fragments that do not realistically present an explosive hazard" in the Army and Navy requirements, unless specifically defined and approved in the project Explosive Safety Submission and Explosive Safety Plan.]

Munitions and explosives of concern (MEC): [DESR 6055.09] A term distinguishing specific categories of military munitions that may pose unique explosives safety risks: 1) UXO, as defined in 10 U.S.C 101(e)(5); 2) DMM, as defined in 10 U.S.C 2710(e)(2); or 3) munitions constituents, as defined in 10 U.S.C. 2710(e)(3), present in high enough concentrations to pose an explosive hazard.

Munitions debris (MD): [DESR 6055.09] Remnants of munitions (e.g., fragments, penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization, or disposal.

Munitions response: [DESR 6055.09] Response actions, including investigation, removal actions, and remedial actions, to address the explosives safety, human health, or environmental risks presented by UXO, DMM, or MC or to support a determination that no removal or remedial action is required.

Munitions response area (MRA): [DESR 6055.09] Any area on a defense site that is known or suspected to contain UXO, DMM, or MC.

Munitions response site (MRS): [DESR 6055.09] A discrete location within an MRA that is known to require a munitions response.

No-evidence-of-use (NEU) area: [IDQTF] An area within a MRA where the weight of evidence indicates that no munitions were used or disposed of. All available and relevant lines of evidence supporting this delineation (e.g., historical records review (HRR), historical photo interpretation, visual observations, interviews, and field investigations) must be documented in the CSM and considered. NEU areas include:

- LD areas for which the CSM contains adequate evidence that no munitions were used or disposed of in the area. This includes areas where historical information provides no evidence of munitions use or disposal (i.e., no evidence of range fans, targets, maneuver areas, OB/OD, storage/staging, etc.);

- LD areas where field investigations and other lines of evidence, as documented in the CSM, have confirmed historical target locations or other munitions use or disposal areas were never constructed, or munitions were never used; and
- HD areas determined to be unrelated to munitions use or disposal and that are not located within a larger LUA.

Ordnance: [DESR 6055.09] Explosives, chemicals, pyrotechnics, and similar stores (e.g., bombs, guns and ammunition, flares, smoke, or napalm).

RMS background noise: [IDQTF] The root-mean-square noise measured in area where there are no metal objects present.

Range-related debris (RRD): [DESR 6055.9] Debris, other than munitions debris, collected from operational ranges or from former ranges (e.g., target debris, military munitions packaging, and crating material).

Record of Decision (ROD): [DoDM 4715.20] The ROD documents the remedial action plan for a site addressed pursuant to CERCLA authority.

Release: [CERCLA, Section 101(22)] Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment.

Remedial Action Objectives (RAO): [EPA DD Guidance] General descriptions contained in the ROD of what the cleanup will accomplish.

Remedial Design (RD): [NCP 300.5] The technical analysis and procedures which follow the selection of remedy for a site and result in a detailed set of plans and specifications for implementation of the remedial action.

Remediation Goals: [EPA DD Guidance 6.1.2] Cleanup levels the remedy is expected to achieve that are protective of human health and the environment.

Remedy or Remedial Action (RA): [NCP] Those actions consistent with permanent remedy taken instead of, or in addition to, removal action in the event of a release or threatened release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment. According to the NCP, “hazardous substances” includes MEC.

Remedy components: [EPA DD Guidance] Treatment, engineering controls, institutional controls, and monitoring.

Response: [CERCLA 101(25)] Removal, remedy, or remedial action, including enforcement activities related thereto.

Seeds: [SERDP-ESTCP & IDQTF] Munitions surrogates, such as Industry Standard Objects (ISO), or inert munitions used to monitor contractor performance and provide ongoing quality assurance and quality control for Munitions Response projects. The following types of seeds are used:

- Quality control (QC) seeds, which are “blind” (i.e., number, placement and identity of seeds are unknown) to the field geophysicists and analysts, and placed by the contractor to monitor the field team’s ongoing ability to detect and correctly classify MEC. The use of QC seeds allows problems to be identified daily, so that corrective action, where necessary, can be implemented during project implementation. Seeds are placed in accordance with a contractor-developed QC Seed Plan, which includes a Firewall Plan describing how the contractor maintains the firewall between management and the field team.

- Quality assurance (QA) seeds, which are blind to the entire contractor team, are placed by, or under the direction of, the government to monitor the contractor's overall performance on munitions response projects involving the use of analog technology. Seeds are placed in accordance with a QA seed plan developed by the government. Through QA seeds, the government can monitor and evaluate the contractor's performance on both detecting and removing MEC.
- Validation seeds, which are blind to the entire contractor team, are placed by the government to evaluate the contractor's overall performance on munitions response projects involving the use of digital technology. The use of validation seeds allows the government to monitor and evaluate contractor performance at different phases of the project: Detection, classification (AGC only), and MEC removal. Seeds are placed in accordance with a Verification/Validation Plan, which is developed by the government and updated following each phase of the project.

Source: [IDQTF] As applied to geophysical investigations, any feature or item that produces a measured response.

Surface clearance: [USACE/EMCX] Operational range clearance and maintenance operations conducted as part of explosives safety management. [Note: This term is defined here as clarification only. The term "surface clearance" is not used in this document, because it is not a term related to CERCLA response actions.]

Surface removal: [IDQTF] Cleanup of UXO or DMM that are either entirely or partially exposed above the ground surface conducted as a response action under CERCLA.

Surface sweep: [USACE/EMCX] An action conducted in advance of a response action, to remove MEC and/or metal debris from the surface prior to geophysical operations. The surface sweep can serve the following purposes: 1) to make the area accessible for follow-on removal work, and/or 2) to reduce the anomaly density for follow-on removal work.

Survey unit: [IDQTF] A portion of the site for which geophysical survey data and other field observations and measurements, including quality control (QC) results and results for blind QC seeds and quality assurance (QA) seeds, will be collected, verified, validated, and reported as a unit, for evaluation and use by the project team. Survey units are established by the project team during project planning and commonly tied to contractual payment milestones. The survey unit is not necessarily a geographically contiguous unit, and, in rare cases, it may not be required that all coverage metrics are met, as long as any data gaps are identified and addressed in a future survey unit. For investigations conducted in phases, survey units for one phase may or may not be the same as those for a different phase.

Target Area Density (above background): [IDQTF Module 1 – A VSP input parameter] The expected anomaly density of a target area, above background, used in the VSP Transect Spacing planning tool. When a "Bivariate Normal" distribution of anomalies across a target is assumed, the target area density can be expressed in one of three ways. The default option is "Target Average", or the average anomaly density (above background) across the target. Other options are "Outer Edge of Target" and "Center of Target", which refer to the expected density near the perimeter of the target area and the center of the target area, respectively. [Note: The examples in Module 1 make use of the "Outer Edge of Target" option.]

Target (or HUA) boundary: [IDQTF Module 1] For the purpose of this document, the location, moving away from the target (or HUA) center, where the anomaly density drops to background. [Note: the background density is assumed to be uniform throughout the site or defined subsets of the site as explained in the initial CSM.]

Targets of Interest (TOI): [IDQTF] Sources of anomalies that meet the project-specific target selection criteria. For AGC, TOI include sources predicted by the AGC analysis to be IOC and seeds, sources predicted to have physical attributes similar to IOC, and clusters of unknown sources with similar attributes that are similar to potential munitions or hazardous components. For non-AGC digital methods, TOI include sources meeting anomaly selection criteria.

Technology-aided surface removal: [DESR 6055.09] A removal of UXO, DMM, or CWM on the surface (i.e., the top of the soil layer) only, in which the detection process is primarily performed visually, but is augmented by technology aids (e.g., hand-held magnetometers or metal detectors) because vegetation; the weathering of UXO, DMM, or CWM; or other factors make visual detection difficult.

Threshold verification: [IDQTF] When using AGC, the process of determining whether the threshold between TOI and non-TOI in the ranked anomaly list has been correctly identified and, if necessary, subsequently adjusting the threshold, based on a comparison of physical properties of excavated items to their predicted properties.

TOI library: [SERDP-ESTCP] A library, maintained and updated by the USACE EMCX, containing polarizability decay curves for known munitions used by DoD. In a process called library matching, the polarizability decay curves from a specific site are compared to those contained in the TOI library to help identify targets of interest. At the beginning of a munitions response project, any item unique to the site that is not included in the TOI library can be added to a “site-specific” library to be used on that site.

Treatment technology: [NCP 300.5] Any unit operation or series of unit operations that alters the composition of a hazardous substance or pollutant or contaminant through chemical, biological, or physical means to reduce toxicity, mobility, or volume of the contaminated materials being treated.

Unexploded ordnance (UXO): [10 U.S.C. 101(e)(5)] Military munitions that have been primed, fuzed, armed, or otherwise prepared for action and have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material, and remain unexploded either by malfunction, design, or any other cause.

Visual Sample Plan (VSP): A software tool developed by Pacific Northwest National Laboratory that supports the development of a defensible sampling plan based on statistical sampling theory and the statistical analysis of sample results to support confident decision-making.

Worksheet #1 & 2: Title and Approval Page

(UFP-QAPP Manual Section 2.1)

This worksheet identifies the principal points of contact for all organizations having a stakeholder interest in the project. Stakeholders are likely the same as those identified during the RI/FS phase of the project. Signatories usually include the DoD Remedial Project Manager (RPM) and Quality Assurance (QA) Manager, contractor Project Manager (PM) and QA Manager (however named), and individuals with oversight authority from regulatory agencies. Signatures indicate that officials have reviewed the QAPP, have had an opportunity to provide comments, and concur with its implementation as written. Add signature lines as necessary to reflect additional stakeholders having approval authority (e.g., explosives safety organizations.) If separate concurrence letters are issued, the original correspondence should be maintained with the final, approved QAPP in the project file. It is the lead organization's responsibility to make sure all signatures are in place before work begins.

1. Project Identifying Information
   a. Site name/project name
   b. Site location/number
   c. Lead organization
   d. Contractor
   e. Contract number
2. Lead Organization
   a. DoD Remedial Project Manager

      ____

      (name/title/signature/date)
   b. DoD QA Manager

      ____

      (name/title/signature/date)
3. Prime Contractor
   a. Prime Contractor PM

      ____

      (name/title/signature/date)
   b. Prime Contractor QA Manager

      ____

      (name/title/signature/date)

4. Subcontractor[1]
   a. Subcontractor PM

      ____

      (name/title/signature/date)
   b. Subcontractor QA Manager

      ____

      (name/title/signature/date)
5. Federal Regulatory Agency

   ____

   (name/title/signature/date)
6. State Regulatory Agency

   ____

   (name/title/signature/date)
7. Other Stakeholders (as needed)

   ____

   (name/title/signature/date)
8. List plans and reports from previous investigations relevant to this project
   a. __
   b. __
   c. __
   d. __
9. The undersigned concur that the use of analog technology is justified in area (to be completed) [Note: if ROD specifies the use of analog technology, this signature requirement is waived.]
   a. Lead Organization, Flag Level

      ____

      (name/title/signature/date)
   b. Lead Regulatory Agency

      ____

      (name/title/signature/date)

[1]Project Teams should decide which subcontractors should be listed on, and required to sign, this Project Title and Approval Page. In general, any subcontractors participating in project planning activities should be listed.

Worksheet #3 & 5: Project Organization and QAPP Distribution

(UFP-QAPP Manual Section 2.3 and 2.4)

This worksheet identifies key project personnel, as well as lines of authority and lines of communication among the lead organization, prime contractor, subcontractors, and regulatory organizations. Two examples follow. Figure 3-1 provides an example of the project organization for munitions response activities, and Figure 3-2 provides an example of the project organization for explosives safety operations. Both examples assume the organization performing the geophysical surveys is the prime contractor. The project organization structure will need to be modified in cases where it is a subcontractor. [Note: Although this toolkit does not address explosives safety per se, including a copy of the organizational structure for explosives safety operations is useful for facilitating project communications.] Project teams may combine Figures 3-1 and 3-2. For the purpose of the draft QAPP, it is permissible to show “to be determined” (TBD) in cases where roles have not been assigned; however, the final, approved QAPP must identify all key personnel. If the Explosives Safety Operations organization is addressed in a separate submittal, that document may be referenced.

For the purpose of document control, this worksheet can also document designated recipients of controlled copies of the QAPP including updates. (Alternatively, a list of QAPP recipients along with their contact information may be attached.) Contractors and subcontractors shown on this chart are responsible for document control within their organizations.

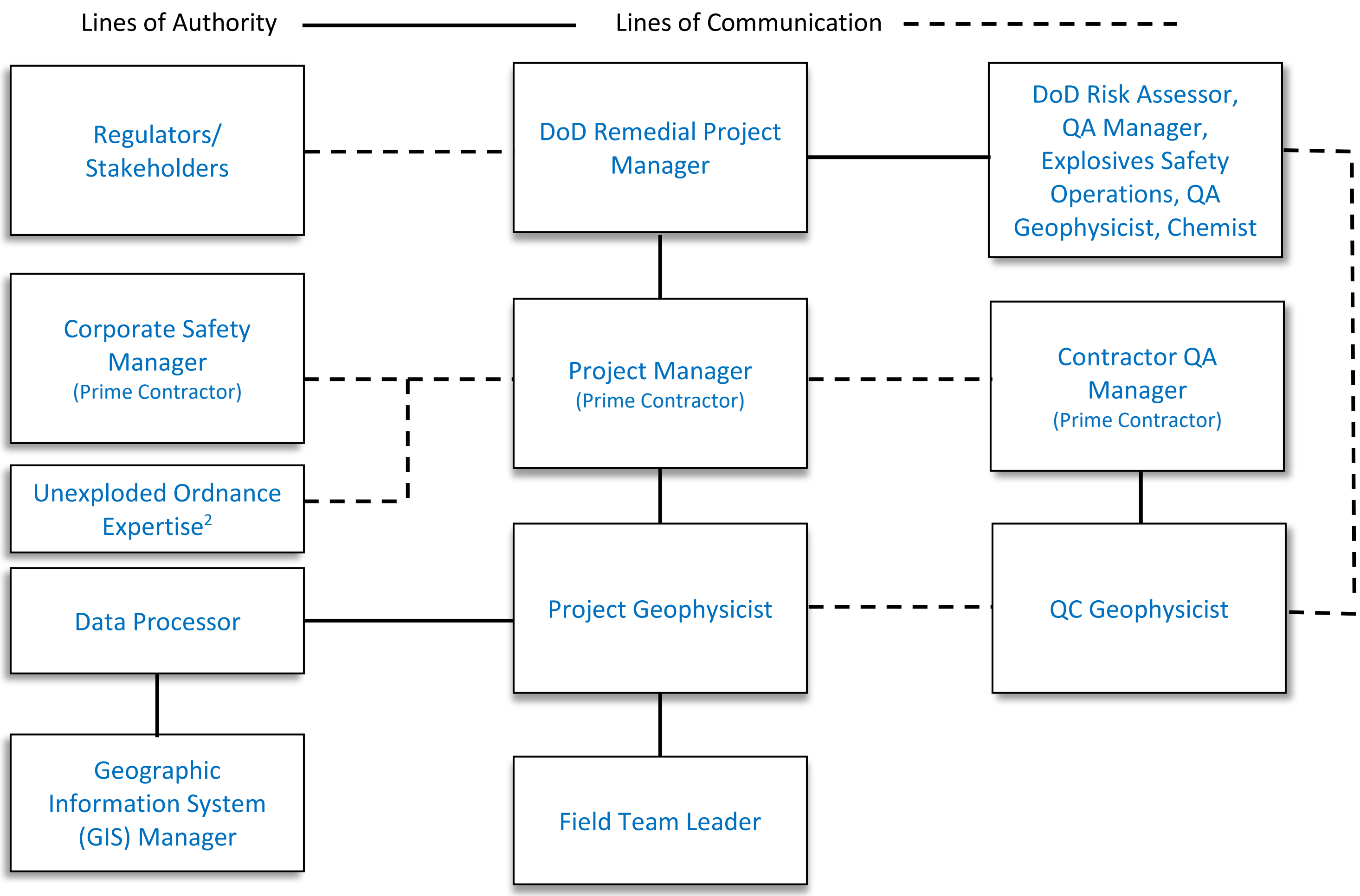

Figure 3-1: Project Organizational Structure

[2] UXO expertise is required to make sure the TOI, which can range from intact munitions to sub-components or fragments with residual explosive and/or chemical constituents, are defined.

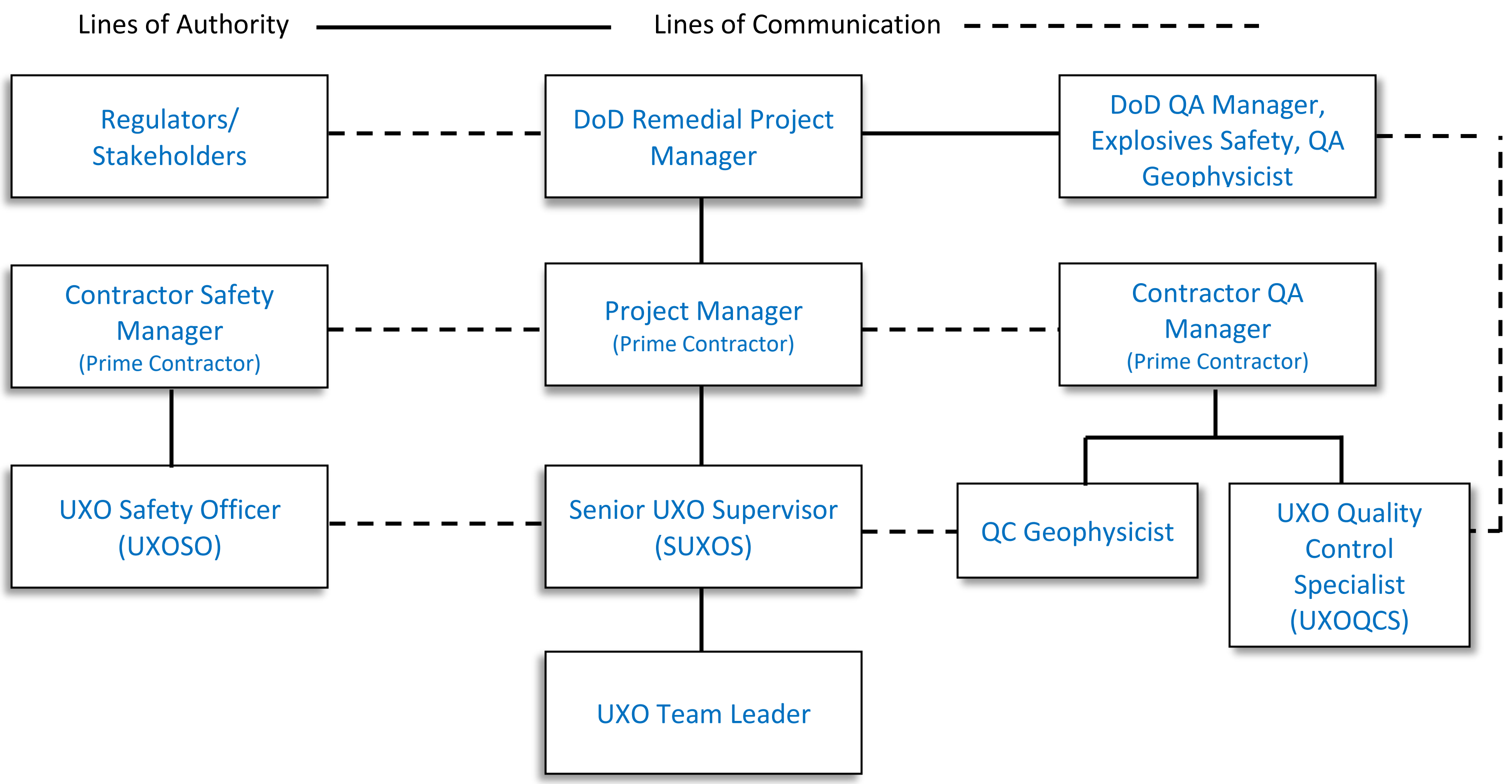

Figure 3-2: Explosives Safety Operations Organizational Structure

[This page intentionally left blank.]

Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet

(UFP-QAPP Manual Section 2.3.2 – 2.3.4)

This worksheet identifies key project personnel for each organization performing tasks defined in this QAPP and summarizes their title or role, qualifications (e.g., training and experience), and any specialized training, licenses, certifications, or clearances required by the project. With the appropriate qualifications, personnel may fill more than one role. Examples are provided in blue text. It is outside the scope of this document to establish minimum qualifications for personnel. Users of this template should add spaces for additional organizations and personnel as needed. Resumes or documentation of relevant experience and training should be contained in an appendix to the QAPP. Signatures indicate personnel have read the QAPP and agree to implement it as written.

Table 4-1: DoD Personnel

Name/Contact Information	Project Title/Role	Education/Experience[2]	Specialized Training	Required Licenses/Certifications/ Authorizations[3]	Signature/Date
	DoD RPM	Environmental Engineer, __ years managing munitions response projects			
	DoD QA Geophysicist	DoD MMRP geophysicist for __ years Oversight of __ munitions response projects			
	DoD Project Chemist	DoD MMRP risk assessor for __ years Oversight of __ munitions response projects			

[2] Resumes should be included in an appendix.
[3] This column should include any State-specific requirements.

Table 4-1: DoD Personnel (Continued)

Name/Contact Information	Project Title/Role	Education/Experience	Specialized Training	Required Licenses/Certifications/ Authorizations	Signature/Date
	DoD Risk Assessor	DoD MMRP risk assessor for __ years On __ munitions response projects			
	DoD OESS	DoD MMRP OESS for __ years Explosives safety oversight of __ munitions response projects			

Table 4-2: Prime Contractor and Subcontractor(s)

Name/Contact Information	Project Title/Role	Education/Experience	Specialized Training	Required Licenses/Certifications/ Authorizations	Signature/Date
	Project Manager	M.S. Physics __ years managing munitions response projects Project Manager for __ munitions response projects			
	Contractor QA Manager	B.S. Civil Engineering Contractor QA Manager for __ years Oversight of __ munitions response projects			
	Contractor Safety Manager	M.S. Industrial Engineering		Certified Industrial Hygienist	
	Project Geophysicist	M.S. Physics Project Geophysicist on Geophysical Classification at MRS __	Oasis montaj Geophysical Data Processing for UXO 3-day UX-Analyze instruction by ESTCP		
	Quality Control (QC) Geophysicist	M.S. Physics Project Geophysicist on Geophysical Classification at MRS__	Oasis montaj Geophysical Data Processing for UXO 3-day UX-Analyze instruction by ESTCP		

Table 4-2: Prime Contractor and Subcontractor(s) (Continued)

Name/Contact Information	Project Title/Role	Education/Experience	Specialized Training	Required Licenses/Certifications/ Authorizations	Signature/Date
	Field Team Leader	B.S. Engineering Field Geophysicist on Geophysical Classification at MRS__	Oasis montaj Geophysical Data Processing for UXO Working with UX-Analyze		
	Data Processor	B.S. Physics Project Geophysicist on Geophysical Classification at MRS__	Oasis montaj Geophysical Data Processing for UXO 3-day UX-Analyze instruction by ESTCP		
	GIS Manager	M.S. in Geoinformatics and Geospatial Intelligence			

Table 4-3: Explosives Safety Operations Organization

Name/Contact Information	Project title/Role	Education/Experience	Specialized Training	Required Licenses/Certifications/ Authorizations	Signature/Date
	Project Manager	M.S. Geology __ years managing munitions response projects PM for __ advanced geophysical classification projects	Project Management Professional		
	Contractor QA Manager	B.S. Civil Engineering Contractor QA Manager for __ years Oversight of __ munitions response projects			
	Corporate Safety Manager	M.S. Industrial Engineering		Certified Industrial Hygienist	
	SUXOS	Graduate Naval Explosives Ordnance Disposal (EOD) School	Hazardous Waste Operations and Emergency Response (HAZWOPER)	Qualified SUXOS i/a/w Department of Defense Explosives Safety Board (DDESB) TP-18	
	UXOQCS	B.S. Civil Engineering	HAZWOPER	Qualified UXOQCS i/a/w DDESB TP-18	

Table 4-3: Explosives Safety Operations Organization (Continued)

Name/Contact Information	Project title/Role	Education/Experience	Specialized Training	Required Licenses/Certifications/ Authorizations	Signature/Date
	QC Geophysicist	M.S. Physics Project Geophysicist on Geophysical Classification at MRS __	Oasis montaj Geophysical Data Processing for UXO 3-day UX-Analyze instruction by ESTCP		
	UXO Safety Officer	B.S. Civil Engineering	HAZWOPER	Qualified UXOSO i/a/w DDESB TP-18	
	UXO Team Leader		HAZWOPER	Qualified UXO III i/a/w DDESB TP-18	

Worksheet #6: Communication Pathways and Procedures

(UFP-QAPP Manual Section 2.4.2)

This worksheet documents specific issues (communication drivers) that will trigger the need for formal (documented) communication with other project personnel or stakeholders. Its purpose is to ensure there are procedures in place for providing notifications, obtaining approvals, and generating the appropriate documentation when handling important communications, including those involving regulatory interfaces, approvals to proceed from one DFW to the next, field changes, emergencies, non-conformances, and stop-work orders. Communication pathways and procedures should be agreed upon by the project team during project planning. Examples are provided below; additional communication drivers and procedures should be added as needed, including any additional contract management and safety communication pathways and procedures.

Table 6-1: Communication Pathways and Procedures

Communication Driver	Initiator (Name, project title)	Recipient (Name, project title)	Procedure (Timing, pathway, documentation)
General Project Communications			
General communications between DoD lead organization and other project team members	Name, DoD RPM	Appropriate project team member(s), including regulatory organization	Communicate directly, as needed (verbally and/or in writing)
Regulatory oversight	Name, regulatory organization	Name, DoD RPM	Communicate directly, as needed (verbally and/or in writing)
Regulatory agency interface	Name, DoD RPM	Name, regulatory organization	DoD RPM coordinates communication with regulators regarding project updates, notification of quality failures, requests for concurrence of QAPP modifications as documented in field change requests, review of project documents, coordination of site visits and field inspections, and other information about the project.
Field Progress Reporting			
Daily field progress reports	Name, Contractor SUXOS	Name, Contractor PM	The SUXOS provides daily progress by phone or email to Contractor PM.

Table 6-1: Communication Pathways and Procedures (Continued)

Communication Driver	Initiator (Name, project title)	Recipient (Name, project title)	Procedure (Timing, pathway, documentation)
Field Progress Reporting			
Daily QC Reports	Name, Contractor QC Geophysicist Name, UXOQCS	Name, Contractor PM	At end of each day of field work, Contractor QC Geophysicist provides daily QC reports to Contractor PM via email.
Weekly QC reports	Name, Contractor PM	Name, DoD RPM, project team member(s), Name, regulatory organization	Contractor PM provides weekly QC report, consolidating daily field progress reports and daily QC reports, to DoD RPM for distribution to project team and regulatory organization.
Workflow Documentation, Reporting and Approval-to-proceed			
Surface sweep activities are complete	Name, Contractor SUXOS	Name, Contractor PM Name, DoD RPM, Project team member(s), Name, regulatory organization	Upon completion of surface sweep activities, the SUXOS informs the Contractor PM via surface sweep technical memorandum. Before proceeding to detection survey activities, Contractor PM distributes surface sweep technical memorandum to DoD RPM, project team, and regulatory organization for review for consistency with approved plans/criteria.
QC seeding and IVS construction are complete	Name, Contractor QC Geophysicist	DoD QA Geophysicist	Before proceeding to detection survey activities within a survey unit, Contractor QC Geophysicist submits documentation of as-built seed locations for the IVS and QC seeds to DoD QA Geophysicist per QC seed firewall plan.
QA or validation seed emplacement complete	DoD OESS or 3rd party contractor	DoD QA Geophysicist	Before proceeding to detection survey activities within a survey unit, DoD OESS distributes documentation of as-built QA or validation seed locations to DoD QA Geophysicist

Table 6-1: Communication Pathways and Procedures (Continued)

Communication Driver	Initiator (Name, project title)	Recipient (Name, project title)	Procedure (Timing, pathway, documentation)
Initial IVS completed and geophysical system performance confirmed	Name, Contractor QC Geophysicist	Name, Contractor PM, Name, DoD RPM, Name, DoD QA Geophysicist, Project team member(s), Name, regulatory organization	Upon completion of initial IVS testing, contractor QC Geophysicist documents anomaly selection criteria and geophysical system performance meet project objectives in initial IVS technical memorandum. Within 48 hours of initial IVS testing, contractor PM submits initial IVS technical memorandum to DoD RPM, project team, and regulatory organization for review.
Target selection technical memorandum and draft detection survey DUA report	Name, Contractor QC Geophysicist	Name, Contractor PM, Name, DoD RPM, Name, DoD QA Geophysicist, Project team member(s), Name, regulatory organization	Upon completion of detection survey activities within a delivery unit, Contractor QC Geophysicist informs DoD RPM via target selection technical memorandum and detection survey DUA report. Before proceeding to cued data collection activities within a delivery unit, the Contractor PM submits the target selection technical memorandum and detection survey DUA report to DoD RPM, project team, and regulatory organization for review and concurrence.

Table 6-1: Communication Pathways and Procedures (Continued)

Communication Driver	Initiator (Name, project title)	Recipient (Name, project title)	Procedure (Timing, pathway, documentation)
Ranked anomaly dig list and draft cued survey DUA report	Name, Contractor QC Geophysicist	Name, Contractor PM Name, DoD RPM, Name, DoD QA Geophysicist, Project team member(s), Name, regulatory organization	Upon completion of cued survey activities and anomaly classification within a delivery unit, the Contractor QC Geophysicist informs the DoD RPM via ranked anomaly dig list and draft cued survey DUA report. Before proceeding to intrusive investigation within a delivery unit, the Contractor PM submits the ranked anomaly dig list and draft cued survey DUA report to DoD RPM, project team, and regulatory organization for review and concurrence.
Classification validation target selection	Name, DoD RPM, Project team member(s), regulatory organization	Name, Contractor PM	Project team will review draft cued survey DUA report and select initial 200 classification validation targets for inclusion in verification/ validation plan
Classification verification and validation plan	Name, Contractor QC Geophysicist	Name, Contractor PM Name, DoD RPM, Name, DoD QA Geophysicist, Project team member(s), Name, regulatory organization	Upon receipt of classification validation targets, the Contractor QC Geophysicist submits updated verification and validation plan to DoD RPM, project team, and regulatory organization for review and concurrence.
Intrusive results technical memorandum	Name, Contractor QC Geophysicist	Name, DoD RPM, Name, DoD QA Geophysicist	Upon completion of intrusive investigation within a delivery unit, the Contractor QC Geophysicist informs the DoD RPM via intrusive results technical memorandum and transmission of intrusive results database (update).
Draft final DUA reports	Name, DoD RPM	Name, regulatory organization	DoD RPM transmits draft final DUA reports to regulatory organization for review and concurrence.

Table 6-1: Communication Pathways and Procedures (Continued)

Communication Driver	Initiator (Name, project title)	Recipient (Name, project title)	Procedure (Timing, pathway, documentation)
Non-conformances			
QA stand-down (missed validation seed)	Name, DoD RPM	Name, Contractor PM, Name, regulatory organization	DoD RPM notifies Contractor PM and the regulatory organization by email. Contractor stops all activities under the DoD Advanced Geophysical Classification Accreditation Program (DAGCAP) and initiates root-cause analysis RCA)/corrective action CA).
QA stand-down: Root-cause analysis and corrective action report	Name, Contractor QA Manager	Name, Contractor QA Manager, Name, Contractor PM, Name, DoD RPM, Project team, regulatory organization	Corporate PM initiates meeting with full project team to discuss RCA/CA and document results of QA stand-down in QA stand-down memorandum and transmits to DoD RPM for approval. Following DoD RPM approval, DoD RPM forwards memorandum to regulatory organization for concurrence.
Resume work following a QA stand-down	Name, DoD RPM	Name, Contractor PM	The DoD RPM will provide the Contractor PM with written notice of approval before work may resume.
Geophysical QC nonconformance notification	Name, Contractor QC Geophysicist	Name, Project Geophysicist, Name, Contractor QA Manager, Contractor PM	QC Geophysicist generates corrective action request (CAR) form and transmits to Project Geophysicist and Corporate QC Manager. Project Geophysicist notifies Contractor PM by email.

Table 6-1: Communication Pathways and Procedures (Continued)

Communication Driver	Initiator (Name, project title)	Recipient (Name, project title)	Procedure (Timing, pathway, documentation)
Geophysical QC nonconformance: RCA/CA	Name, Project Geophysicist	Name, Contractor QA Manager, Name, Contractor PM, Name, DoD RPM, Name, DoD QA Geophysicist, Project team, regulatory organization	Project Geophysicist conducts RCA, identifies CA, and generates RCA/CA form to address CAR. RCA/CA transmitted to Contractor QA Manager and DoD RPM for approval. Following DoD RPM approval, DoD RPM forwards RCA/CA to regulatory organization for review for consistency with approved plans/criteria.
Field Safety – Project teams may include safety communications here or reference other plans where safety communications are addressed.			

Table 6-1: Communication Pathways and Procedures (Continued)

Communication Driver	Initiator (Name, project title)	Recipient (Name, project title)	Procedure (Timing, pathway, documentation)
QAPP Modifications			
Updates to CSM during project execution	Name, Project Geophysicist, Name, Contractor PM	Name, DoD RPM, Name, Contractor QA Manager, Name, regulatory organization Name, QC Geophysicist	Updates and revisions to the CSM will be documented using field change request (FCR) forms to Corporate QA Manager and DoD RPM for approval. Minor updates to the CSM will follow process for minor QAPP changes and include distribution of updated QAPP WS #10 pages. Major updates and revisions to the CSM will follow the process for major QAPP changes and include regulatory organization concurrence. Project changes due to revisions to the CSM will not be implemented until FCR acceptance occurs.
Minor QAPP changes during project execution[4]	Name, QC Geophysicist Name, UXOQCS	Name, Corporate QC Manager, Name, Project Geophysicist	Minor QAPP changes will be noted on the Daily QC reports and forwarded to the Project Geophysicist and the Corporate QC Manager at the end of each day. Minor QAPP changes will be highlighted in weekly QC reports for distribution to DoD RPM, project team and regulatory organization.

[4] Project teams should determine what constitutes minor and major QAPP changes during project planning.

Table 6-1: Communication Pathways and Procedures (Continued)

Communication Driver	Initiator (Name, project title)	Recipient (Name, project title)	Procedure (Timing, pathway, documentation)
Major QAPP changes during project execution	Name, Contractor PM	Name, DoD RPM, Name, Contractor QA Manager, Name, regulatory organization	Contractor PM submits FCR form to Corporate QA Manager and DoD RPM for approval. Following DoD RPM approval, DoD RPM forwards FCR to regulatory organization for concurrence. FCR not implemented until acceptance occurs.

Worksheet #9: Project Planning Session Summary

(UFP-QAPP Manual Section 2.5.1)

The MR-QAPP worksheets will be completed in a series of project planning sessions. This worksheet provides a concise record of participants, key decisions or agreements reached, and action items. A copy of this worksheet should be completed for each planning session and included in the final QAPP. Meeting minutes can be referenced and attached.

Multiple planning sessions typically are conducted to complete the MR-QAPP. Each session should involve the key technical personnel and decision-makers needed for that specific stage of planning. Project teams will find it helpful to have a copy of all MR-QAPP worksheets on hand for all planning sessions, in whatever state of completion they may be.

Figure 9-1 illustrates the recommended project-planning process for the RA phase of the CERCLA process at Munitions Response Sites. As depicted, planning sessions #1 and #2 involve only the lead agency and regulators and generate the information typically needed to prepare the scope of work and solicitation. In this process, the first opportunity for contractor participation is planning session #3, at which point the entire project team should review DQO steps 1 through 4 and make any changes, if necessary, before proceeding through DQO steps 5-7. The DQO process is iterative, and as it proceeds, project teams likely will need to revisit previous steps. The process illustrated in Figure 9-1 is flexible and should be modified as necessary based on component-specific contracting practices and project-specific requirements; for example, planning sessions may be consolidated.

Date of planning session:

Location:

Purpose:

Participants:

Table 9-1: Project-Planning Participants

Name	Organization	Title/Role	Email/Phone

Notes/Comments:

Consensus decisions made:

Table 9-2: Action Items

Action	Responsible Party	Due Date

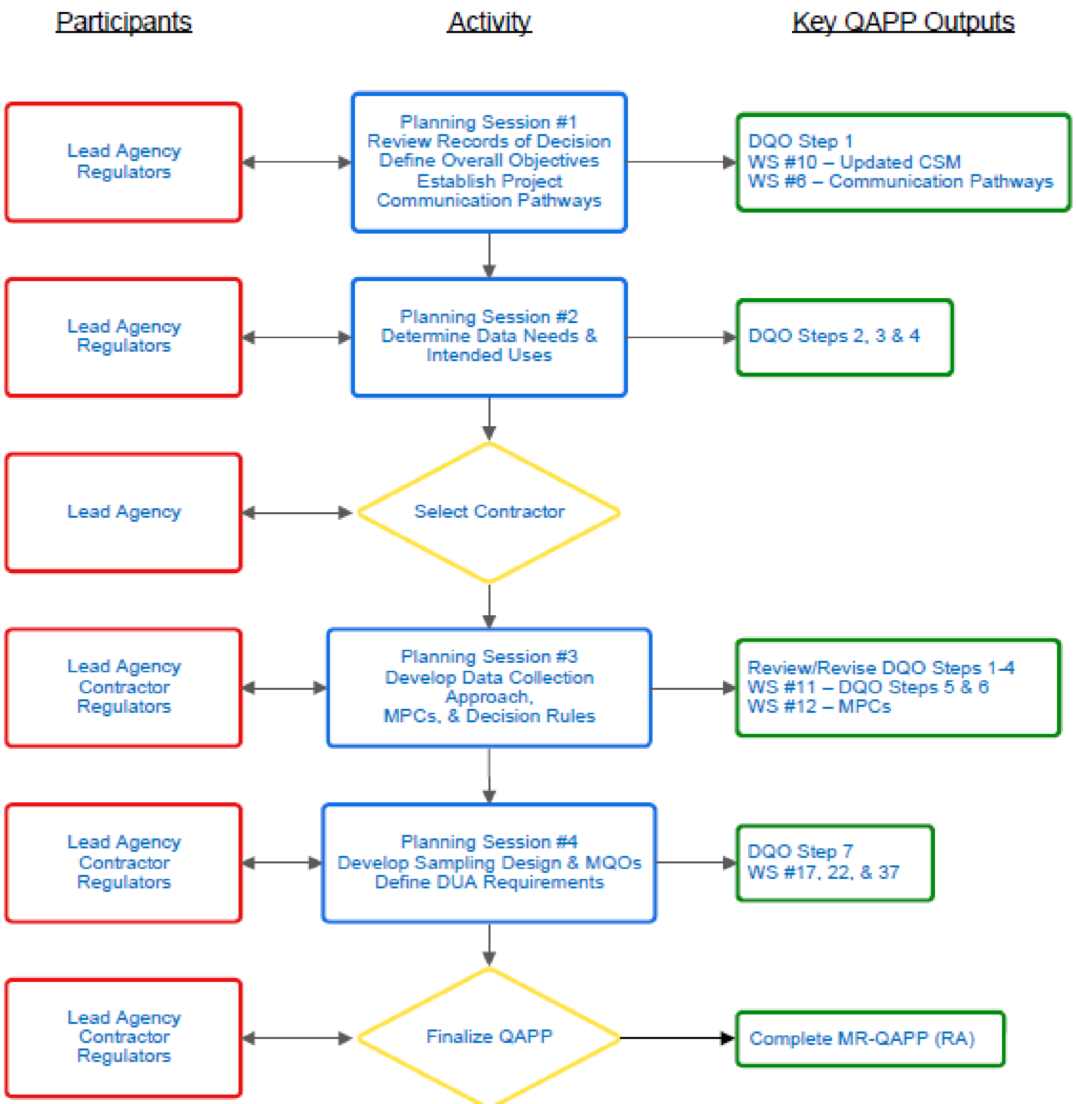

Figure 9-1: Example Planning Process for RA

Worksheet #10: Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2)

This worksheet presents a concise summary of the project's Conceptual Site Model, a working model that depicts sources, pathways, and receptors for MEC at each Munitions Response Site. In most cases, the CSM at the conclusion of the RI/FS will serve as the CSM at the start of the RA phase.[5]

The major elements of the CSM include the facility profile, physical profile, release profile, and land use and exposure profile. As a tool to assist in the visualization and communication of site conditions and the development of DQOs, the CSM may include text, maps, graphic images, and tables. The CSM should describe any data gaps or uncertainty that could affect implementation of the selected remedy (e.g., areas inaccessible to the field team) and these must be reflected in the remedial design (RD) described in Worksheet #17.

Facility Profile:

- Site location, size, and ownership
- MRS boundaries and acreage
- Concise history of the use, storage, and disposal of munitions at the MRS and the installation that managed or used the MRS
- Structures, infrastructure present

Physical Profile:

- Topography and vegetation
- Geologic and hydrogeologic setting, including depth to bedrock across the site
- Background anomaly density
- Climate
- Endangered species, sensitive habitats, and cultural resources
- Areas that are inaccessible to investigation

Release Profile:

- Descriptions and locations of each munitions response site (MRS) (e.g., targets, maneuver areas, storage facilities or open-burning (OB)/open detonation (OD) areas)
- Identification of munitions and hazardous substances known or suspected to be present
- Current understanding of the location and distribution (horizontal and vertical) of anomaly density, munitions, and hazardous substances within each MRS. This should include a graphic depiction of the vertical CSM.
- Description of prior land-disturbing activities that may have had the potential to redistribute MEC

[5] While the CSM for an actual MRS must also address sources, pathways, and receptors for munitions constituents (MC), the scope of this document is limited to MEC.

Land Use and Exposure Profile:

- Detailed descriptions of current and reasonably anticipated future site uses (refer to RI/FS or ROD)
- Neighboring land uses
- Current and reasonably anticipated future receptors, exposure pathways, and interaction zone depths
- Access conditions and frequency of use

The following is an example of a CSM for the fictional Camp Example. The 18,000-acre munitions response area (MRA) includes five MRSs, which illustrate different objectives, technical approaches, and decision-making strategies that could come into play during the RA. Specific details, including the land use and exposure profile, are summarized in Tables 10-1 through 10-5. Please note these tables do not provide all the details described above; they only provide sufficient information to support the examples.

Facility Profile: [The following description applies to the entire Camp Example]

The former Camp Example is located in Yuba and Nevada Counties, California, along the foothills of the Sierra Nevada. In 1940, the Camp Example area consisted of grassland, rolling hills, and the abandoned mining town of Exampleville. The U.S government purchased 87,000 acres in 1942 for a training post for the 13th Armored Division. Camp Example also held training facilities for the 81st and 96th Infantry Division, a 1,000-bed hospital, and a prisoner of war camp. As a complete training environment, Camp Example had training maneuver areas, mortar and rifle ranges, and bombardier-navigator training. In 1948, Camp Example became Example Air Force Base. In 1959, the installation ceased being used as a bombing range and the U.S. government declared portions of Example Air Force Base as excess, eventually transferring 60,805 acres to private individuals and the State of California.

Physical Profile: [The following description applies to the entire Camp Example]

Former Camp Example lies along the foothills of the Sierra Nevada Mountains. Topography varies from a valley west of the site to mountains to the east. Site elevation ranges between approximately 120 and 200 feet above mean sea level. Terrain consists of grasslands and rolling hills. The eastern portion of the site is drained by Dry Creek and Rock Creek. Hilly areas in the northern and western portions of the site are drained by Reeds Creek and Hutchinson Creek.

The predominant soils are the Sobrante-Auburn soils, formed in material that was weathered from basic meta-volcanic rocks (U.S. Department of Agriculture, 1998). Soils are moderately deep to shallow and well-drained. Numerous prehistoric and historic sites have been identified including village sites, campsites, bedrock milling stations, mining and ranching sites, and WWII military training areas. Former Camp Example experiences cool, wet winters (35-50°F) and warm, dry summers (60-98°F). The average annual precipitation is 28 inches.

Release Profile:

Camp Example includes five Munitions Response Sites, which are described below:

Following the RI/FS, the historic Maneuver Area was divided into two MRSs because future use scenarios and hence selected remedies are unique to each: **MRS A1 – Maneuver Area Development Area**, and **MRS A2 – Maneuver Area Recreational Area**. The Maneuver Area was used near the end of WWII for troop maneuvering and encampment. No records of live-fire training have been discovered. During the RI, the maneuver area was determined using an EM61 transect survey to be a low anomaly density (LD) area. The estimated anomaly density throughout the site was 75 anomalies/acre. The estimated total number of anomalies for MRS A1 and A2 is included in Tables 10-1 and 10-2. During the RI, the field team observed surface evidence of mortars and grenades as shown in Figure 10-1. MRS A1 and MRS A2 were determined to be low-use areas (LUA) without further investigation. The expected maximum depth of MEC, if present, is above the depth of detection for EM61 (based on the RI/FS). The boundaries of MRS A1 and MRS A2 are shown in Figure 10-1. Tables 10-1 and 10-2 provide additional details.

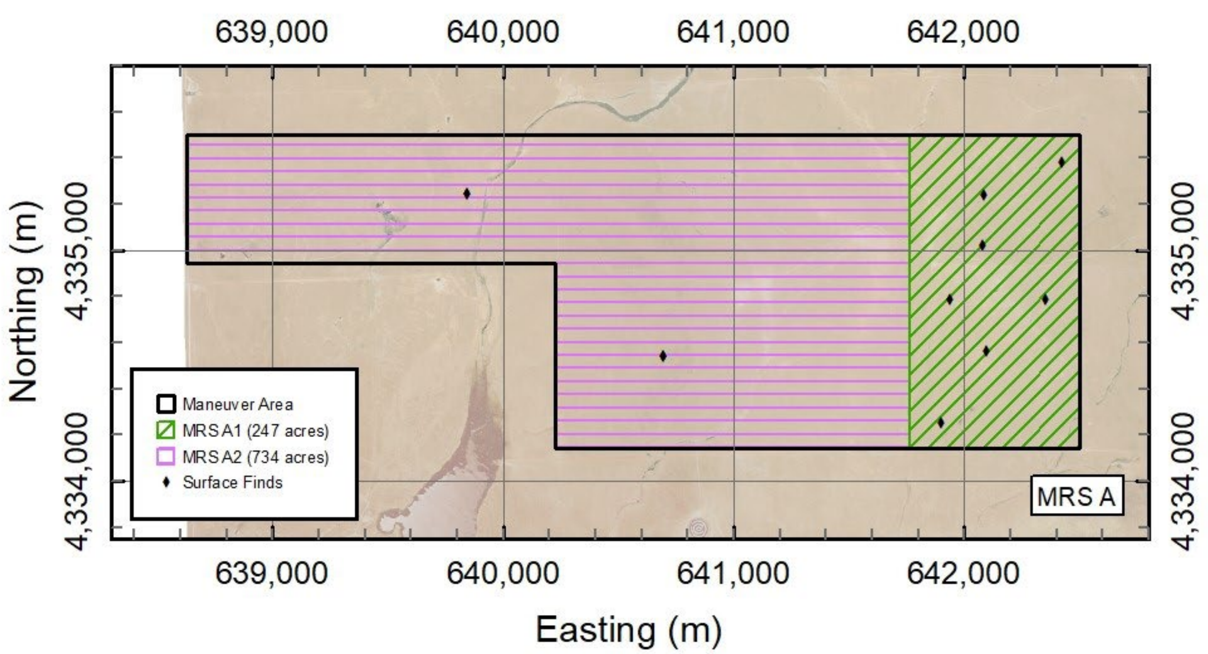

Figure 10-1: MRS A1 (Maneuver Area Development Area) and MRS A2 (Maneuver Area Recreational Area)

Following the RI/FS, the former Mortar Range was divided into two MRSs based on topography, which necessitated the selection of two separate remedies: **MRS B1 – Mortar Range Flat Terrain Area and MRS B2 – Mortar Range Steep Terrain Area.** The Mortar Range was used during the early 1940s for firing 60-mm high explosive (HE) mortars. During the RI, a high-anomaly-density (HD) area corresponding to the expected location of the impact area was confirmed in MRS B2 using a Schonstedt handheld gradiometer transect survey. The estimated total number of anomalies for MRS B1 and B2 is listed in Tables 10-3 and 10-4. False-color plots showing anomaly densities are in shown in WS 17. The remainder of the mortar range, MRS B1, was surveyed using a 3-m-wide EM61 array transect survey and shown to be an LD area corresponding to the location of the mortar range fan. The measured background density in MRS B1 was 92 anomalies/acre. All MEC and MD recovered at MRS B1 and B2 were consistent with 60-mm mortars. The maximum depth of recovered targets of interest was 25 cm. Figure 10-2 shows the boundaries of MRS B1 and B2. Tables 10-3 and 10-4 provide additional details.

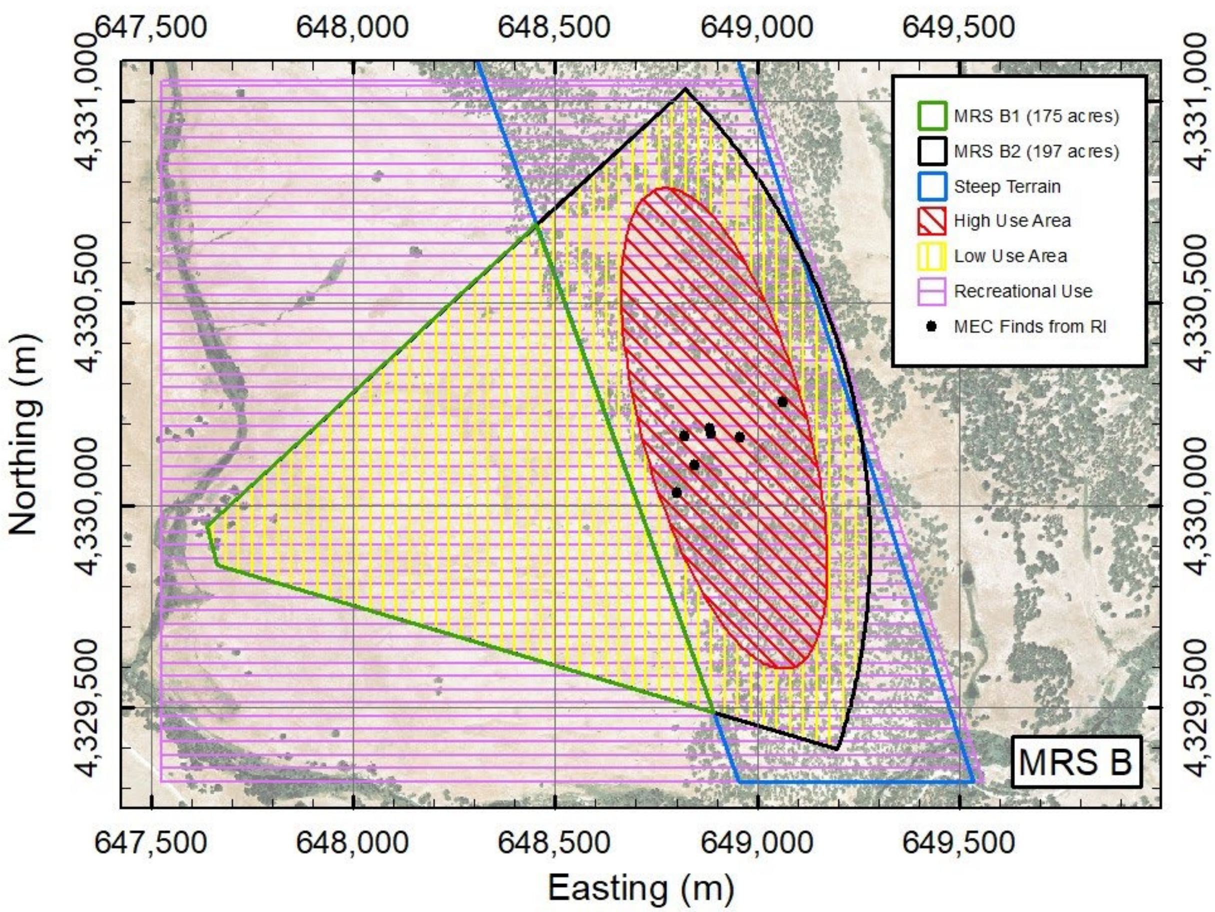

Figure 10-2: MRS B1 (Mortar Range Flat Terrain Area) and MRS B2 (Mortar Range Steep Terrain Area)

MRS C – Bomb Target was used for bombing training, with both practice and HE 100-lb bombs, near the end of WWII. During the preliminary characterization step of the RI, an HD area corresponding to the suspected target location was identified using a TEMTADS transect survey. The estimated total number of anomalies is listed in Table 10-5. A false-color plot showing anomaly densities is shown in WS 17. During the detailed characterization step, additional transects were interleaved across the HD area, and the locations of all anomalies consistent with intact munitions were dug. In addition, to confirm the CSM and gather additional information about the types of munitions used and their depth profiles, ten ¼-acre grids were surveyed using TEMTADS and all 886 anomalies were analyzed. Anomalies matching TOI, those exhibiting characteristics of TOI, and a representative sample of unexpected clusters of anomalies were dug. A total of 24 anomaly locations were dug. The measured background density was 87 anomalies/acre. The boundaries of MRS C are shown in Figure 10-3. Table 10-5 provides additional details.

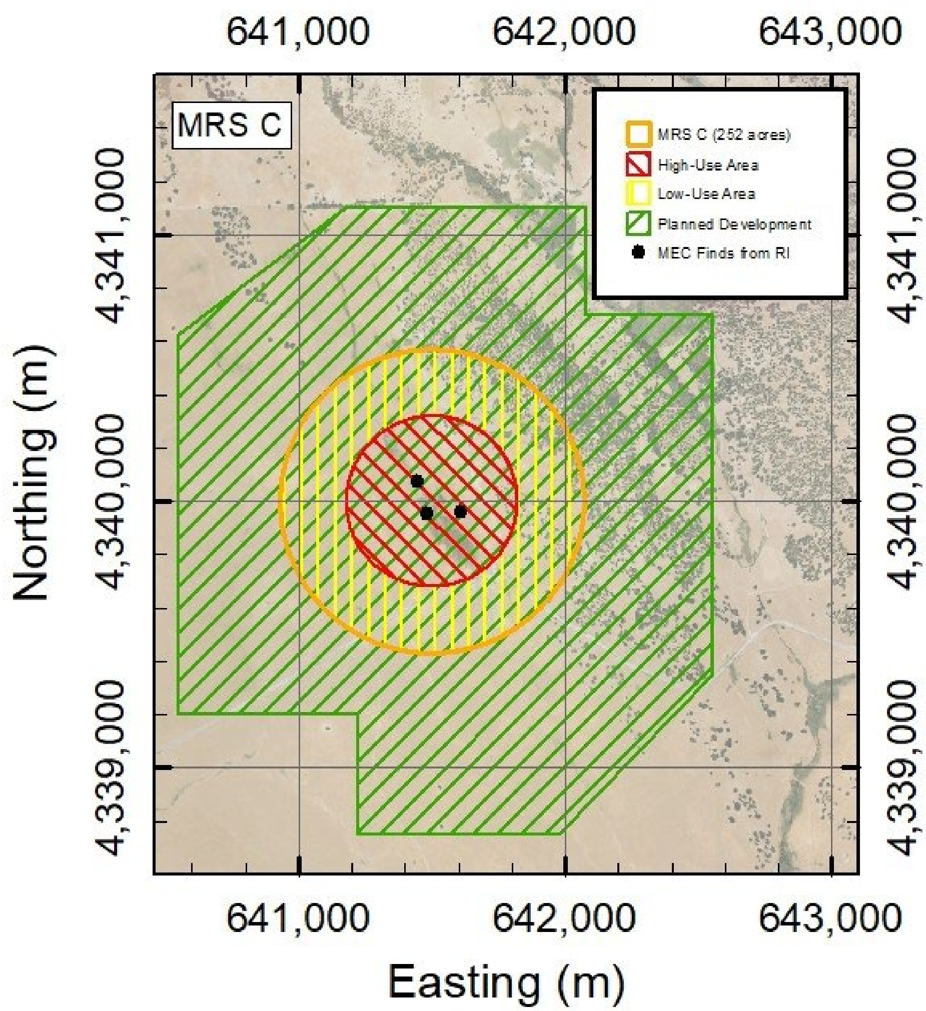

Figure 10-3: MRS C (Bomb Target)

Land Use and Exposure Profile

Tables 10-1 through 10-5 summarize land use and exposure assumptions contained in the RI/FS Report and ROD.

Table 10-1: Conceptual Site Model Summary for MRS A1 – Maneuver Area Development Area

Facility Profile	
MRS boundary and acreage	247 acres See Figure 10-1
Known/suspected past DoD usage	Troop maneuvering and encampment during WWII. No records of live-fire training.
Structures/infrastructure present	None known
Physical Profile	
Background anomaly density	75/acre
Depth to bedrock	3-6 m below ground surface (bgs)
Access restrictions	None known
Release Profile	
Munitions potentially present (based on RA results for similar maneuver areas and all lines of historical evidence from the site, e.g., surface finds from vegetation reduction, the Archives Search Report, etc.)	MEC may include: MKII practice hand grenades, signals, flares, pyrotechnics, practice anti-tank mines, 2.36" practice anti-tank rockets, and 60-mm smoke and illumination mortars. Evidence of mortars and grenades was observed on the surface during the RI.
Vertical profile	N/A – No digging was conducted during the RI
HUA anomaly density	No HUA. See Figure 17-1
Estimated number of anomalies from transect analysis using EM61	18,525
Estimated number of anomalies from grids	N/A
Maximum depth of recovered MEC/MD	N/A – no intrusive investigation performed during RI
Maximum anticipated depth of contamination[6]	0.30 m bgs (assumed to result from firing 60-mm smoke and illumination mortars)
Maximum reliable depth of detection (MRDD)	See Table 11-3
Land Use and Exposure Profile	
Current land use	Cattle-grazing
Current receptors	Ranchers, trespassers
Future planned land use	Planned residential community
Maximum depth of anticipated future land disturbance (depth of exposure)	1.8 m bgs
Future anticipated receptors	Pre-remediation: Site workers, trespassers Post-remediation: Residents, trespassers

[6] Based on prior work at similar sites and professional judgment.

Table 10-1: Conceptual Site Model Summary for MRS A1 – Maneuver Area Development Area (Continued)

Land Use and Exposure Profile	
Exposure medium	Surface and subsurface soils
Exposure pathways	Pre-remediation: Potentially complete exposure pathway to surface and/or subsurface MEC Post-remediation: Incomplete pathway

Table 10-2: Conceptual Site Model Summary for MRS A2 – Maneuver Area Recreational Area

Facility Profile	
MRS boundaries and acreage	734 acres See Figure 10-1
Known/suspected past DoD usage	Troop maneuvering and encampment during WWII. No records of live-fire training.
Structures/infrastructure present	None known
Physical Profile	
Background anomaly density	75/acre
Depth to bedrock	3-6 m bgs
Access restrictions	None known
Release Profile	
Munitions potentially present (based on RA results for similar maneuver areas and all lines of historical evidence from the site e.g., surface finds from vegetation reduction, the Archives Search Report, etc.)	MEC may include: MKII practice hand grenades, signals, flares, pyrotechnics, practice anti-tank mines, 2.36" practice anti-tank rockets, and 60-mm smoke and illumination mortars. Evidence of mortars and grenades was observed on the surface during the RI.
Vertical profile	N/A – no digging was conducted during the RI
HUA anomaly density	No HUA. See Figure 17-2
Estimated number of anomalies from transect analysis using EM61	55,050
Estimated number of anomalies from grids	N/A
Maximum depth of recovered MEC/MD	NA – no intrusive investigation performed during RI
Maximum anticipated depth of contamination[7]	0.3 m bgs (assumed to result from firing 60-mm smoke and illumination mortars)
Maximum reliable depth of detection (EM61)	See Table 11-3
Land Use and Exposure Profile	
Current land use	Cattle-grazing
Current receptors	Ranchers, trespassers
Future planned land use	Recreational area as shown on Figure 10-1
Maximum depth of anticipated future land disturbance (depth of exposure)	Surface only (recreational area)
Future anticipated receptors	Hikers/bikers/campers/horseback riders (within recreational area)

[7] Based on prior work at similar sites and professional judgment.

Table 10-2: Conceptual Site Model Summary for MRS A2 – Maneuver Area Recreational Area (Continued)

Land Use and Exposure Profile	
Exposure medium	Surface soils
Exposure pathways	Potentially complete exposure pathway to surface MEC

Table 10-3: Conceptual Site Model Summary for MRS B1 – Mortar Range Flat Terrain Area

Facility Profile	
MRS boundaries and acreage	175 acres See Figure 10-2
Known/suspected past DoD usage	Mortar range used during early 1940s for firing 60-mm HE mortars
Structures/infrastructure present	None
Physical Profile	
Background anomaly density	92/acre (where EM61 was used)
Depth to bedrock	≥ 3 m bgs
Access restrictions	None
Release Profile	
Known/suspected munitions present	60-mm M49A2 HE mortars
Vertical profile	See Figure 10-4
HUA anomaly density	See figure 17-3
Estimated number of anomalies within range fan from transect analysis using EM61	16,100
Estimated number of anomalies within from grids	N/A
Maximum depth of recovered MEC/MD	0.25 m bgs
Maximum anticipated depth of contamination[8]	0.60 m bgs
Maximum reliable depth of detection (EM61)	See Table 11-3
Land Use and Exposure Profile	
Current land use	Recreational/Camping
Current receptors	Hikers/bikers/campers/horseback riders
Future planned land use	Recreational/camping
Maximum depth of anticipated future land disturbance (depth of exposure)	0.40 m
Future anticipated receptors	Hikers/bikers/campers/horseback riders/site workers
Exposure medium	Surface and subsurface soils
Exposure pathways	Potentially complete exposure pathway to surface and/or subsurface MEC

[8] Based on prior work at similar sites and professional judgment.

Table 10-4: Conceptual Site Model Summary for MRS B2 – Mortar Range Steep Terrain Area

Facility Profile	
MRS boundaries and acreage	197 acres See Figure 10-2
Known/suspected past DoD usage	Mortar range used during early 1940s for firing 60-mm HE mortars
Structures/infrastructure present	None
Physical Profile	
Background anomaly density	200/acre (where analog was used)
Depth to bedrock	0-0.30 m bgs
Access restrictions	Steep terrain area is accessible to analog technology use only.
Release Profile	
Known/suspected munitions present	60-mm M49A2 HE mortars
Vertical profile	See Figure 10-4
HUA anomaly density	See Figure 17-4
Estimated number of anomalies within impact area from transect analysis using Schonstedt	62,400
Estimated number of anomalies within impact area from grids	N/A
Maximum depth of recovered MEC/MD	0.25 m bgs
Maximum anticipated depth of contamination[9]	0.30 m (due to bedrock)
Maximum reliable depth of detection	See Table 11-3
Land Use and Exposure Profile	
Current land use	Recreational/camping
Current receptors	Hikers/bikers/campers/horseback riders
Future planned land use	Recreational
Maximum depth of anticipated future land disturbance (depth of exposure)	Surface and subsurface soil. Concern for erosion
Future anticipated receptors	Hikers/bikers/horseback riders/site workers
Exposure medium	Surface and subsurface soils
Exposure pathways	Potentially complete exposure pathway to surface and subsurface MEC

[9] Based on prior work at similar sites and professional judgment.

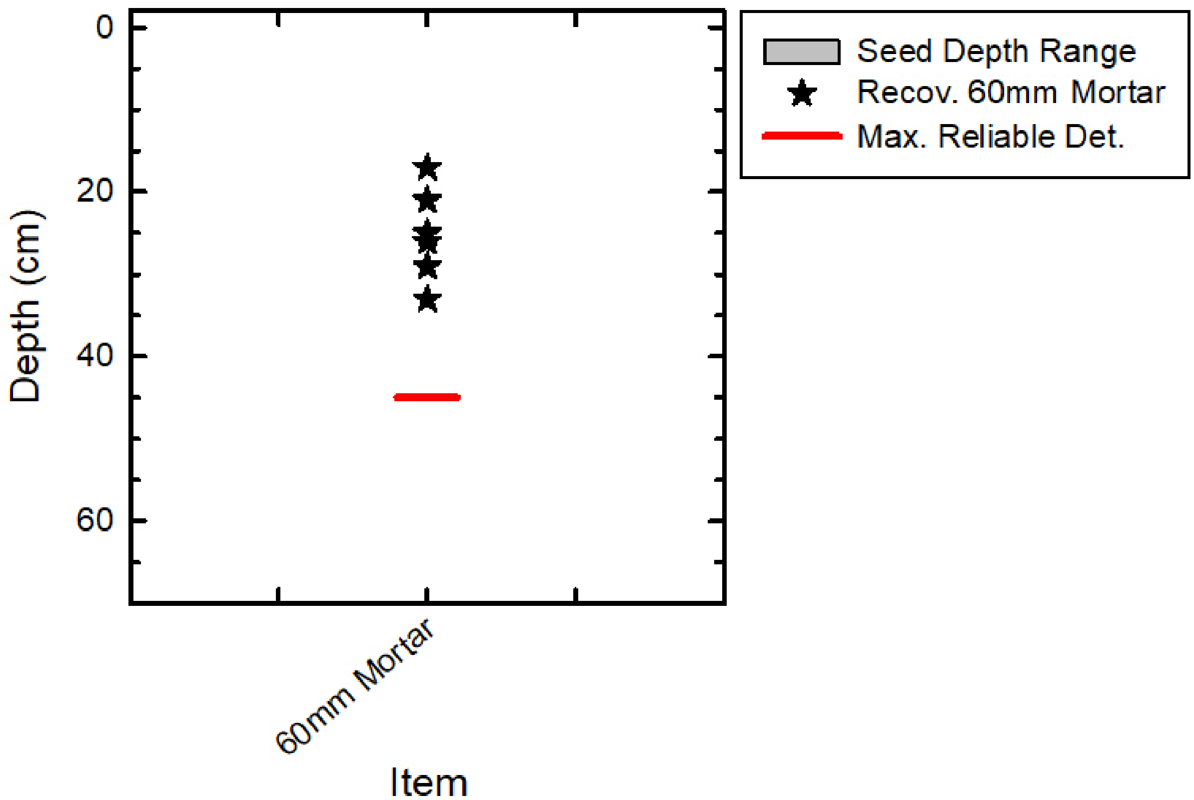

Figure 10-4: Initial Vertical CSM for MRS B1/B2

Table 10-5: Conceptual Site Model Summary for MRS C – Bomb Target

Facility Profile	
MRS boundaries and acreage	252 acres See Figure 10-3
Known/suspected past DoD usage (release mechanisms)	Bomb target used throughout WWII for both practice and HE 100-lb bombs
Structures/infrastructure present	None
Physical Profile	
Background anomaly density	87/acre
Depth to bedrock	1.2 m
Access restrictions	None
Release Profile	
MRS acreage	252 acres
Vertical profile	See Figure 10-5
Known/suspected munitions present	100-lb M38A2 practice bombs, M1A1 spotting charges, 100-lb AN-M30A1 HE bombs, nose fuzes AN-M103 series, tail fuzes AN-M100 series
HUA anomaly density	See Figure 17-5
Estimated number of anomalies from transect analysis using TEMTADS	386,000
Estimated number of anomalies from grids	250,000
Maximum depth of recovered MEC/MD	Bombs – 0.90 m Fuzes, spotting charges – 0.12 m
Maximum anticipated depth of contamination[10]	Bombs – 1.2 m bgs (due to bedrock) Fuzes, spotting charges – 0.15 m
Maximum reliable depth of detection	See Table 11-3
Land Use and Exposure Profile	
Current land use	Cattle-grazing
Current receptors	Ranchers, trespassers
Future planned land use	Residential
Maximum depth of anticipated future land disturbance (depth of exposure)	1.2 m bgs
Future anticipated receptors	Residents
Exposure medium	Surface and subsurface soils

[10] Based on prior work at similar sites and professional judgment.

Table 10-5: Conceptual Site Model Summary for MRS C – Bomb Target (Continued)

Land Use and Exposure Profile	
Exposure pathways	Pre-remediation: Potentially complete exposure pathway to surface and subsurface MEC Post-remediation: Following MEC removal, no complete pathway remains

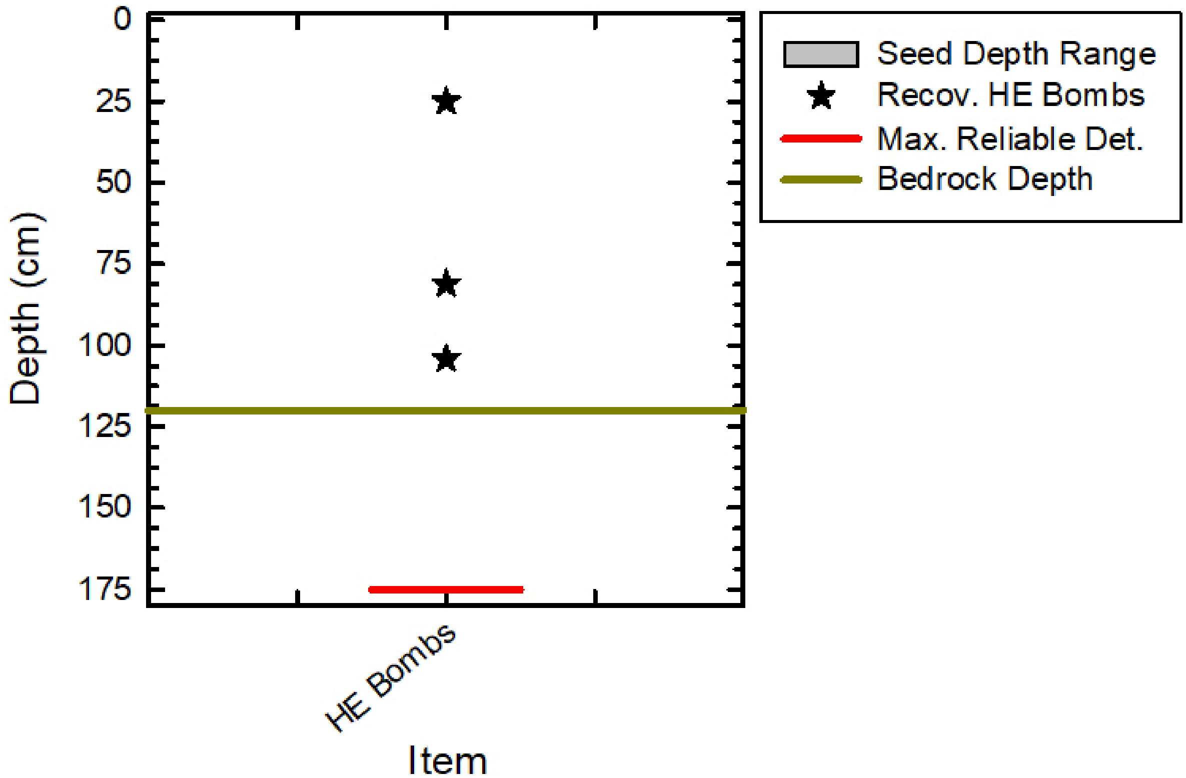

Figure 10-5: Initial Vertical CSM for MRS C

Worksheet #11: Data Quality Objectives

(UFP-QAPP Manual Section 2.6.1)

This worksheet documents the systematic planning process, which is used to generate performance and acceptance criteria for collecting environmental data. The process described below is based on EPA's seven-step DQO process as applied to the Remedial Action phase of the CERCLA process for munitions and explosives of concern, excluding munitions constituents.[11] The performance and acceptance criteria described in this document apply to field activities that would be described in the project-specific MR-QAPP.

Step 1: State the Problem

The problem statement is developed in the context of information and assumptions contained in the most recent conceptual site model. For the RA, this usually will be the CSM generated during the feasibility study and summarized in the ROD. The general problem statement for the RA phase of the CERCLA process is to implement the selected remedy described in the MRS-specific ROD. The problem statement should identify the selected remedy and include a table summarizing the remedial action objectives, remediation goals and remedy components for each MRS.

[Example] This project is being undertaken to implement the selected remedies and document achievement of RAOs described in the Records of Decision for the five MRSs at Camp Example depicted in Worksheet #10.

Remedial action objectives: General descriptions contained in the ROD of what the cleanup will accomplish. [EPA DD Guidance] Remediation goals: Clean-up levels the remedy is expected to achieve that are protective of human health and the environment. [EPA DD Guidance] Remedy components: Treatment, engineering controls, institutional controls, and monitoring. [EPA DD Guidance]

Table 11-1 summarizes the selected remedy, RAO, remediation goals, and remedy components for each MRS. Appendix B includes the Records of Decision.

[11] For detailed guidance on the DQO process, refer to "Guidance on Systematic Planning using the DQO Process," EPA/240/B-06/001, February 2006

Table 11-1: Summary of Selected Remedy

MRS/Selected Remedy	Remedial Action Objectives	Selected Remedy Components		
		MEC Removal	MEC Treatment	Land-Use Controls[12]
MRS A1 Maneuver Area Development Area Alternative # __ MEC surface and subsurface removal using non-AGC DGM detection and cued AGC with interim land use controls	Remove MEC in the surface and subsurface Remedial action is designed to achieve UU/UE <u>MEC Removal Remediation Goal:</u> Detection and removal of: • 60-mm mortar to a minimum depth of 0.45 m bgs • Practice hand grenades, signals, flares, pyrotechnics, 2.36" practice rockets, and practice anti-tank mines to a depth of 0.30 m bgs • Any other munitions present on the site that are detectable at the anomaly selection criteria	Anomaly detection using non-AGC DGM TOI selection using cued AGC TOI investigation and source removal using manual and backhoe-assisted excavation	All recovered MEC to be detonated in place or otherwise destroyed on-site	Add interim LUCs if specified in applicable decision document (DD) Upon successful remediation, LUCs will be removed

[12] Major LUC components of the remedy should be identified in the project-specific MR-QAPP to provide a complete summary of the selected remedies; however, implementation of long-term LUCs is captured in other project documents.

Table 11-1: Summary of Selected Remedy (Continued)

MRS/Selected Remedy	Remedial Action Objectives	Selected Remedy Components		
		MEC Removal	MEC Treatment	Land-Use Controls
MRS A2 Maneuver Area Recreational Area Alternative #__ MEC surface removal using instrument-aided visual identification with land use controls	Remove MEC from the surface and minimize the likelihood of exposure to MEC in the subsurface Remedial action is not designed to achieve UU/UE <u>MEC Removal Remediation Goal</u>: Detection and removal of munitions items on the surface Subsurface MEC exposure to be managed using LUCs	Surface removal using instrument-aided visual identification	All recovered MEC to be detonated in place or otherwise destroyed on site	[Add LUCs as specified in applicable decision document.]
MRS B1 Mortar Range Flat Terrain Area Alternative #__ MEC surface and subsurface removal using non-AGC DGM with land use controls	Remove MEC from the surface and subsurface Remedial action is not designed to achieve UU/UE <u>MEC Removal Remediation Goal:</u> Detection and removal of: • 60-mm mortar to a minimum depth of 0.45 m bgs • Any other munitions present on the site that are detectable at the anomaly selection criteria Post-removal potential exposure to MEC to be managed using LUC	Anomaly detection using non-AGC DGM TOI investigation and source removal using manual and backhoe-assisted excavation	All recovered MEC to be detonated in place or otherwise destroyed on site	[Add LUCs as specified in applicable decision document.]

Table 11-1: Summary of Selected Remedy (Continued)

MRS/Selected Remedy	Remedial Action Objectives	Selected Remedy Components		
		MEC Removal	MEC Treatment	Land-Use Controls
MRS B2 Mortar Range Steep Terrain Area Alternative #__ MEC surface and subsurface removal using analog detection and manual excavation, with land use controls	Remove MEC from the surface and subsurface Remedial action is not designed to achieve UU/UE MEC Removal Remediation Goal: Detection and removal of: • 60-mm mortar to a minimum depth of 0.45 m bgs • Any other munitions present on the site that are detectable Post-removal potential exposure to MEC to be managed using LUC	Anomaly detection using analog technology Anomaly investigation and source removal using manual excavation	All recovered MEC to be detonated in place or otherwise destroyed on site	[Add LUCs as specified in applicable decision document]
MRS C Bomb Target Alternative #__ MEC surface and subsurface removal using dynamic AGC followed by cued AGC with interim LUC	Remove MEC from the surface and subsurface Remedial action is designed to achieve UU/UE MEC removal remediation goal: • 100-lb HE and practice bombs to bedrock • Fuzes and spotting charges to a minimum depth of 0.30 m bgs • Any other munitions present on the site that are detectable at the anomaly selection criteria	Surface sweep using instrument-aided visual identification Anomaly detection using AGC TOI selection using cued AGC TOI investigation and source removal using manual and backhoe-assisted excavation	All recovered MEC to be detonated in place or otherwise destroyed on site	[Add interim LUCs if specified in applicable decision document.] Upon successful remediation, any LUCs will be removed.

Step 2: Identify the data collection goals

State how data will be used in meeting objectives and solving the problem. Identify principal study questions. Considering the CSM and future land use assumptions, if Unlimited Use/Unrestricted Exposure is both a desirable and feasible end state for a given MRS, assembling the lines of evidence necessary to support a determination of UU/UE should be a stated data collection goal.

Step 3: Identify information inputs

Identify types and sources of information needed to answer the study questions identified in Step 2. State in terms specific to each MRS.

Table 11-2 [Example] addresses DQO Steps 2 and 3 by summarizing data collection goals, principal study questions, and inputs for data collection activities at each MRS.

Table 11-2: Data Collection Goals and Information Inputs (DQO Steps 2 and 3)

Activity	DQO Step 2		DQO Step 3	
	Data Collection Goals	**Principal Study Questions**	**Inputs**	**Data Uses**
MRS A1: MEC surface and subsurface removal using non-AGC DGM detection and cued AGC				
Anomaly detection using non-AGC DGM	• Detect IOC within the surface and subsurface as geophysical anomalies • Confirm underlying assumptions in CSM	• Have all anomaly locations been identified and recorded in a manner that supports cued AGC collection? • Are field observations (site conditions) consistent with CSM?	• Field observations • Validated EM61 data • Geolocation data • Detection survey DUA report	• Process data to identify locations of geophysical anomalies that exceed selection criteria for cued AGC data collection • Verify site conditions support achieving remediation goal (see Table 11-1) • Document successful implementation of EM61 detection survey • Update CSM

Table 11-2: Data Collection Goals and Information Inputs (DQO Steps 2 and 3) (Continued)

Activity	DQO Step 2		DQO Step 3	
	Data Collection Goals	Principal Study Questions	Inputs	Data Uses
MRS A1: MEC surface and subsurface removal using non-AGC DGM detection and cued AGC				
TOI selection using cued AGC	• Classify subsurface anomalies and select TOI for intrusive investigation • Justify non-TOI decisions	• Have sources from all cued locations been classified as TOI, non-TOI, or inconclusive? • Have all TOI been placed on the dig list? • Have locations of inconclusive analyses been resolved or placed on the dig list?	• Validated AGC cued data • Geolocation data • Software (specify) • TOI library • Dig list • Cued survey DUA report	• Process data to obtain polarizabilities and perform classification to identify TOI • Determine location and depth of sources • Verify site conditions support achieving remediation goals (see Table 11-1) • Document successful implementation of cued AGC • Update CSM
TOI investigation and source removal	• Create a record of all locations excavated and items removed from the site	• Have all IOC been recovered? • Have sources at all locations on the dig list been resolved? • Have all recovered objects been correctly classified?	• Description, depth, mass, photograph, and location of recovered objects • Disposal records • Final DUA report	• Verify recovered objects are consistent with AGC analyses • Identify MPPEH for inspection and destruction • Document achievement of remediation goal • Update CSM
UU/UE recommendation	• Compile lines of evidence supporting UU/UE	• Do all available lines of evidence support UU/UE?	• All inputs listed above • Administrative record	• Prepare documentation supporting or rejecting UU/UE for consideration by final decision-makers

Table 11-2: Data Collection Goals and Information Inputs (DQO Steps 2 and 3) (Continued)

Activity	DQO Step 2		DQO Step 3	
	Data Collection Goals	Principal Study Questions	Inputs	Data Uses
MRS A2: MEC surface removal using instrument-aided visual identification				
Surface removal using instrument-aided visual identification	• Detect IOC on the surface for removal • Confirm underlying assumptions in CSM • Document achievement of remediation goal	• Have all IOC on the surface been detected and removed? • Has visible evidence of munitions training been documented? • Are field observations (site conditions) consistent with CSM?	• Field observations • Description, mass, photograph, and lane # of recovered items • Final DUA	• Locate and remove IOC • Verify site conditions support achieving remediation goal (see Table 11-1) • Identify material potentially posing an explosive hazard (MPPEH) for inspection and destruction • Document achievement of remediation goal • Update CSM • Provide information to support implementation of LUC
MRS B1: MEC surface and subsurface removal using non-AGC DGM				
Anomaly detection using non-AGC DGM	• Detect IOC within the surface and subsurface as geophysical anomalies • Record selected anomaly locations as TOI to support intrusive investigation • Confirm underlying assumptions in CSM	• Have all TOI locations been identified in such a manner as to be placed on the dig list? • Are field observations consistent with CSM?	• Field observations • Validated EM61 data • Detection survey DUA	• Verify site conditions support achieving remediation goal • Document successful implementation of detection survey • Update CSM

Table 11-2: Data Collection Goals and Information Inputs (DQO Steps 2 and 3) (Continued)

Activity	DQO Step 2		DQO Step 3	
	Data Collection Goals	Principal Study Questions	Inputs	Data Uses
MRS B1: MEC surface and subsurface removal using non-AGC DGM				
TOI investigation and source removal	• Create a record of all locations excavated and items removed from the site	• Have sources at all locations on the dig list been resolved?	• Description, mass, depth, photograph, and location of all recovered items • Disposal records • Final DUA	• Identify MPPEH for inspection and destruction • Document achievement of remediation goal • Update CSM • Provide information to support implementation of LUC
MRS B2: MEC surface and subsurface removal using analog detection.				
Anomaly detection using analog technology and source removal using manual excavation	• Detect IOC within the surface and subsurface as geophysical anomalies • Confirm underlying assumptions in CSM • Create a record of all locations excavated and items removed from the site • Document achievement of remediation goal	• Are field observations consistent with CSM? • Have all IOC been detected? • Have sources at all anomaly locations been resolved? • Have all IOC been removed?	• Field observations • Description, mass, depth, photograph, and location of all recovered items • Final DUA report	• Verify site conditions support achieving remediation goal • Update CSM • Identify MPPEH for inspection and destruction • Update CSM • Provide information to support implementation of LUC

Table 11-2: Data Collection Goals and Information Inputs (DQO Steps 2 and 3) (Continued)

Activity	DQO Step 2		DQO Step 3	
	Data Collection Goals	**Principal Study Questions**	**Inputs**	**Data Uses**
MRS C: MEC Surface and subsurface removal using dynamic AGC followed by cued AGC				
Anomaly detection using dynamic AGC	• Detect IOC within the surface and subsurface as geophysical anomalies • Confirm underlying assumptions in CSM	• Have all anomaly locations been identified and recorded in a manner that supports cued AGC collection? • Are field observations consistent with CSM?	• Field observations • Validated dynamic AGC survey data • Geolocation data • Detection survey DUA report	• Process data to identify locations of geophysical anomalies that exceed selection criteria for cued AGC data collection • Verify site conditions support achieving remediation goal • Document the successful implementation of AGC detection survey • Update CSM
TOI selection using cued AGC	• Classify subsurface anomalies and select TOI for intrusive investigation • Record TOI locations and characteristics to support intrusive investigation	• Have sources from all selected anomaly locations been classified as TOI, non-TOI or inconclusive? • Have all TOI been placed on the dig list? • Have inconclusive analyses been resolved or placed on the dig list?	• Validated AGC cued data • Geolocation data • Cued survey DUA report	• Process data to obtain polarizabilities and perform classification to identify TOI • Verify site conditions support achieving remediation goal • Determine location and depth of sources • Document successful implementation of AGC cued survey • Update CSM

Table 11-2: Data Collection Goals and Information Inputs (DQO Steps 2 and 3) (Continued)

Activity	DQO Step 2		DQO Step 3	
	Data Collection Goals	Principal Study Questions	Inputs	Data Uses
MRS C: MEC surface and subsurface removal using dynamic AGC followed by cued AGC				
TOI investigation and source removal	• Create a record of all locations excavated and items removed from the site	• Have all IOC been recovered? • Have sources at all locations on the dig list been resolved? • Have all recovered objects been correctly classified?	• Description, depth, mass, photograph, and location of recovered objects • Disposal records • Final DUA report	• Verify recovered objects are consistent with AGC analyses • Identify MPPEH for inspection and destruction • Document achievement of remediation goal • Update CSM
UU/UE recommendation	• Compile lines of evidence supporting UU/UE	• Do all available lines of evidence support UU/UE?	• All inputs listed above for • Administrative record	• Prepare documentation supporting or rejecting UU/UE for consideration by final decision-makers

Step 4: Define the project boundaries

Specify the target population and characteristics of interest. Define spatial and temporal boundaries. Spatial boundaries are established in the Record of Decision for each MRS and described in the CSM. Spatial boundaries address both the horizontal area and vertical depth of the study. Spatial boundaries should identify any areas that will be inaccessible to RA activities (e.g., presence of power lines, structures, ponds, sensitive habitats, historic sites, and forested areas). They should also identify potential saturated response areas resulting from known surface features and infrastructure or from high target-area anomaly density. Vertical boundaries for each MRS are determined by the remediation goals outlined in the ROD, which considers the maximum expected depth that IOC are buried, the maximum predicted depth of future excavations and disturbances based on anticipated future land use, and detector limitations, i.e., the maximum depth at which sensors can collect useable data for specific munitions. Temporal boundaries consider seasonal conditions that could limit site access (e.g., periods of high rainfall, nesting seasons, etc.)

Table 11-3 describes the target population for MEC removal at each MRS. [Note: The project-specific MR-QAPP must also address the remaining project boundaries described above.

Table 11-3: Target Population [Example]

Known or suspected munitions used (including nomenclature, if known)	MRS	MEC Type (UXO, DMM, or both)	Maximum Reliable Detection Depth (MRDD) (bgs)[13]	ROD-required clearance depth	Approx. Diameter	Approx. Length
MKII practice hand grenades	A1/A2	Both	0.30 m (EM61)	0.30 m	58 mm	110 mm
Mk1 mod 0 Trip Flares	A1/A2	UXO	0.30 m EM61)	0.30 m	64 mm	140 mm
Mk 1 target flares	A1/A2	UXO	0.30 m (EM61)	0.30 m	83 mm	203 mm
60-mm smoke and illumination mortars	A1/A2	UXO	0.50 m (EM61)	0.45 m	60 mm	363 mm
Practice anti-tank mines M1/M1A1	A1/A2	UXO	0.20 m (EM61)	0.30 m	203 mm	102 mm
2.36" practice anti-tank rockets M6A1	A1/A2	UXO	0.66 (EM61)	0.30 m	60 mm	493 mm
60-mm M49A2 HE mortars	B1/B2	UXO	0.60 m (EM61) Unknown (Schonstedt)	0.45 m	60 mm	244 mm
100-lb M38A2 practice bombs	C	UXO	0.75 m (TEMTADS)	1.2 m (Bedrock)	208 mm	1180 mm
100-lb M30A1 HE bombs	C	UXO	1.75 m (TEMTADS)	1.2 m (Bedrock)	208 mm	660 mm
AN-M103 series nose fuzes	C	UXO	0.30 m (TEMTADS)	0.30 m	41 mm	164 mm

[13] The MRDD were determined using data in the NRL EM61 Response Memo Report and the site noise measured during the RI. For items not in the NRL report, MRDD were developed by scaling similar library items as described in SOP X.

Table 11-3: Target Population [Example] (Continued)

Known or suspected munitions used (including nomenclature, if known)	MRS	MEC Type (UXO, DMM, or both)	Maximum Reliable Detection Depth (bgs)[14]	ROD-required clearance depth	Approx. Diameter	Approx. Length
AN-M100 series tail fuzes	C	UXO	0.30 m (TEMTADS)	0.30 m	41 mm	102 mm excluding arming vane and vane arm
M1A1 spotting charges for 100-lb practice bombs	C	UXO	0.40 m (TEMTADS)	0.30 m	87 mm	284 mm

Step 5: Develop the Project Data Collection and Analysis Approach

Define the parameters of interest, specify the type of inference, and develop the logic (decision rules) for drawing conclusions from the data.

[Example] The data collection and analysis approaches at Camp Example are driven by the selected remedies described in the ROD and presented in Table 11-1. Decision rules for each MRS are presented below.

MRS A1 – Maneuver Area Development Area

Selected Remedy: MEC surface and subsurface removal using non-AGC DGM detection and cued AGC

Activity: Anomaly detection using EM61

[14] The MRDD were determined using data in the NRL EM61 Response Memo Report and the site noise measured during the RI. For items not in the NRL report, MRDD were developed by scaling similar library items as described in SOP X.

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.
2. If signals meet the anomaly selection criteria (to be established in Step 6), they will be selected for cued data collection using AGC.
3. If areas of the site are deemed unsuitable for the cued AGC survey that is to follow (criteria to be established in Step 6), the project team will document those areas and revise the remedial design, as necessary.

Activity: TOI selection using cued AGC

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.
2. If AGC analyses meet any of the following criteria, they will be selected as TOI and placed on an ordered dig list: a) the polarizability decay curve matches that of an item in the project-specific TOI library, or b) estimates of the size, shape, symmetry, and wall thickness indicate the item is long, cylindrical or spherical, and thick-walled, or c) there is a group (cluster) of unknown anomalies having similar polarizability decay curves that, after investigation, are discovered to be IOC. The procedures for designating a cluster are described in SOP __.
3. If AGC analyses yield inconclusive results, they will be added to the dig list or otherwise resolved.

Activity: TOI investigation and source removal

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.
2. If the threshold verification digs do not uncover any IOC, then the threshold is verified. If any IOC are recovered, then the project team will conduct an RCA/CA that results in an adjustment of the threshold and determination of the impacts on project objectives.
3. The geophysical classification results will be valid if:
    a. validation digs do not uncover any IOC, and
    b. the properties of all recovered objects are consistent with predicted properties
4. If the validation digs uncover any IOC, the project team will conduct a QA stand-down and evaluate the impacts on measurement performance criteria (MPCs) and DQOs.
5. If the properties of recovered objects are inconsistent with predicted properties, the project team will conduct an RCA/CA and determine the impacts on the achievement of MPCs and DQOs.

6. If all lines of evidence (i.e., DQO step 3 inputs) are complete and support UU/UE, the project team will develop the Remedial Action Completion Report (RACR) supporting UU/UE. If lines of evidence are incomplete or any line of evidence does not support UU/UE, the project team will update the CSM and determine the impacts on the DQOs, remedial design, and the ROD.

MRS A2 – Maneuver Area Recreational Area

Selected Remedy: Surface removal using instrument-aided visual identification

Activity: Surface removal using instrument-aided visual identification

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.
2. If MPCs have been achieved, the project will have implemented the removal component of the remedy. The LUCs specified in the ROD will be used to manage residual risk. If not, the team will recommend that the appropriate representatives of the responsible offices revisit and reconsider the ROD.

MRS B1 – Mortar Range Flat Terrain Area

Selected Remedy: MEC surface and subsurface removal using non-AGC DGM

Activity: Anomaly detection using EM61

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.
2. If signals meet the anomaly selection criteria (to be established in Step 6), they will be selected for intrusive investigation.
3. If areas of the site are deemed unsuitable for individual target selection at the established target selection threshold, (criteria to be established in Step 6), the project team will document those areas and revise the remedial design, as necessary.

Activity: TOI investigation and source removal

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.
2. If reanalysis does not reveal any new anomalies that meet anomaly selection criteria that cannot be resolved, the project has achieved DQOs. If reanalysis identifies new anomalies that cannot be resolved, the project team will conduct an RCA/CA and determine the impacts on project objectives.

MRS B2 – Mortar Range Steep Terrain Area

Selected Remedy: MEC surface and subsurface removal using analog detection and manual excavation.

Activity: Anomaly detection using analog technology

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.

Activity: Source investigation and removal

1. If MPCs have been achieved, the project will have implemented the removal component of the remedy. The LUCs specified in the ROD will be used to manage residual risk. If not, the team will recommend that the appropriate representatives of the responsible offices revisit and reconsider the ROD.

MRS C – Bomb Target

Selected Remedy: MEC subsurface removal using dynamic AGC detection and cued AGC

Activity: Anomaly detection using dynamic AGC

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.
2. If signals meet the anomaly selection criteria for Informed Source Selection (ISS) provided on Worksheet # 22, they will be selected for cued data collection using AGC.
3. If areas of the site are deemed unsuitable for AGC use (to be established in Step 6) the project team will document the areas and revise the remedial design, as necessary.

Activity: TOI selection using cued AGC

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.
2. If AGC analyses meet any of the following criteria, they will be selected as TOI and placed on an ordered dig list:
    a. The polarizability decay curve matches that of an item in the project-specific TOI library, or
    b. Estimates of the size, shape, symmetry, and wall thickness indicate the item is long, cylindrical or spherical, and thick-walled, or
    c. There is a group (cluster) of unknown anomalies having similar polarizability decay curves that, after investigation, are discovered to be IOC. The procedure for designating a cluster are described in SOP __. The presence and description of any clusters will be added to the CSM.
3. If AGC analyses yield inconclusive results, they will be added to the dig list or otherwise resolved.

Activity: TOI investigation and source removal

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.
2. If the threshold verification digs do not uncover any IOC, the threshold is verified. If any IOC are recovered, the project team will conduct RCA/CA that results in adjustment of the threshold and determination of the impacts on the project objectives.
3. The geophysical classification results will be valid if:
    a. Validation digs do not uncover any IOC and
    b. The properties of all recovered objects are consistent with predicted properties.
4. If the validation digs uncover any IOC, the project team will conduct a QA stand-down and evaluate the impacts on MPCs and DQOs.
5. If the properties of recovered objects are inconsistent with predicted properties, the project team will conduct RCA/CA and determine the impacts on MPCs and DQOs.

Activity: UU/UE recommendation

1. If all lines of evidence (i.e., DQO Step 3 inputs) are complete and support UU/UE, the project team will develop the Remedial Action Completion Report supporting UU/UE. If lines of evidence are incomplete or any line of evidence does not support UU/UE, the project team will update the CSM and determine the impacts on DQOs, remedial design and the ROD.

Step 6: Specify Project-specific Measurement Performance Criteria (MPC)

Discuss the considerations for developing the project-specific MPCs that collected data must meet to minimize the possibility of failing to meet the requirements of the ROD (e.g., failing to detect or remove required objects to required depths). MPCs are the qualitative and quantitative specifications for accuracy, sensitivity, representativeness, completeness, and comparability that collected data must meet to satisfy the DQOs described in Steps 1 through 5 above. Some of the quality considerations may result in multiple MPCs and others may not be directly measurable, in which case surrogates will be required to provide a quality standard. For example, detecting all seeds may be a surrogate for the underlying consideration of detecting all IOC. MPCs will be articulated in WS #12. MPCs guide the development of the sampling design (which is developed during Step 7 and presented in Worksheet #17), and they are the criteria against which data usability will be evaluated at the end of the study.

[Example] The MPCs must demonstrate that the geophysics data are sufficient to meet the DQOs, such that the data will identify and support the removal of all IOC required by the ROD. For each technology to be used in the distinct phases of the remedial action, the project team has considered the factors that are important to make this determination, which are discussed below. To avoid repetition, the discussions of key aspects are presented in the category where they are most applicable. Many of the considerations will derive multiple MPCs that may be applicable to multiple categories. The MPCs derived from these considerations are documented in Worksheet #12

Non-AGC DGM Survey and Analysis

Completeness:

- The MPCs will identify and document those areas deemed unsuitable for individual target selection, as well as how they will be handled.
- The MPCs must ensure that the entire site was surveyed at the required data density. MPCs will include review of the geolocation records of the survey and seeding by both the contractor and the government.
- The MPCs must demonstrate that the instrument was operating per specifications throughout the data collection.
- The MPCs must demonstrate that all the anomalies meeting selection criteria are included in the detection survey database. MPCs will include review of the anomaly lists and random reanalysis of the detection data to ensure the target selection process successfully identified all anomalies.
- If AGC is to follow, MPCs will identify and document those areas deemed unsuitable for AGC use, as well as how they will be handled.

Sensitivity:

- The MPCs must demonstrate that all the required IOC can be detected to the required depth using the specified anomaly selection criteria. Sensitivity MPCs will rely on detection and location of items in the IVS and seeds. MPCs will document and evaluate:
  - Instrument response to IOC
  - Sample rate appropriate to detecting IOC
  - Site noise
  - Correct operation of the instrument
  - Correct operation of the navigation system

Accuracy:

- The MPCs must demonstrate that signals for IOC are as expected. The expected signals of all IOC are known. MPCs will use an IVS, seeds, and recovered sources to assess signals.
- The MPCs must demonstrate that the location accuracy will support the next phase of the RA, i.e., cued data collection or reacquisition and excavation. MPCs will use the IVS, seeds, and reacquisition of known control points for comparison.

Comparability:

- N/A

Representativeness:

- Seeds will be a critical component of the MPCs. MPCs must ensure that the seeds are appropriate to represent the IOC in type and depth range.

AGC Cued Data Collection and Analysis

Completeness:

- The MPCs must ensure that data were collected at all cued locations.
- The MPCs must demonstrate that the instrument was operating per specifications throughout the data collection.
- MPCs must demonstrate that analyses of data from all cued locations result in determination of TOI, non-TOI, or inconclusive. This will require review of the anomaly database and comparison to the final intrusive database.
- MPCs must demonstrate that background data are collected at appropriate locations and per manufacturer specification.
- All suspected IOC must be in the AGC library.

Sensitivity:

- The MPCs must demonstrate that the AGC system was capable of correctly classifying all IOC. Sensitivity MPCs will rely on detection and location of seeds and items in the IVS. MPCs will document and evaluate:
  - Instrument response to IOC
  - Site noise
  - Correct operation of the instrument

Accuracy:

- To demonstrate that all TOI are identified, the MPCs must demonstrate that AGC analyses for IOC are as expected. The responses of all IOC are known and documented in the AGC library. MPCs will use the IVS, seeds, and recovered sources, including additional digs for validation, to assess analyses for consistency.
- The MPCs must demonstrate that the correct dig/no-dig threshold was established. MPCs will rely on additional threshold verification digs.
- To assess whether non-TOI are correctly classified, the MPCs must excavate and evaluate a sampling of non-TOI.

Comparability:

- The MPCs must ensure the use of background samples from appropriate locations to support AGC analyses across the site.

Representativeness:

- Seeds will be a critical component of the MPCs. MPCs must ensure that the seeds represent the IOC in both type and depth range.

Excavation following DGM

Accuracy/Completeness:

- The MPCs must demonstrate that all dig list locations were dug, holes were cleared, recovered items were documented, and all recovered items were consistent with DGM signals and analyses.

Sensitivity: N/A

Comparability: N/A

Representativeness: N/A

Analog Detection and Removal

Completeness:

- The MPCs must demonstrate that the entire site was surveyed at the required coverage. MPCs will include review of the geolocation records of the survey, seeding by both the contractor and the government.
- The MPCs must demonstrate that the instrument was operating per specifications throughout the data collection.
- The MPCs must provide evidence indicating all required objects were removed from the area searched.

Sensitivity:

- The MPCs must demonstrate that all the required IOC can be detected to the required depth. Sensitivity MPCs will rely on detection and location of items in the ITS and seeds. MPCs will document and evaluate:
  - Detection capability of the instrument
  - Correct operation of the instrument
  - Correct operation of the navigation system

Accuracy: N/A

Comparability: N/A

Representativeness:

- Seeds will be a critical component of the MPCs. MPCs must ensure that the types and depths of seeds represent the expected types and depths of the IOC.

Step 7: Develop Sampling Design (Survey Design and Project Workflow)

Develop a resource-effective design for collecting data that will meet the project-specific MPCs developed during Step 6. This step usually refers to Worksheet #17.

[Example] The MPCs developed in Step 6, above, were used to develop the sampling design, which is described in detail Worksheet #17. The sampling design is broken down into a series of specific processes and data collection steps, termed definable features of work (DFW). Figures 17-1 – 17-5 summarize the sampling design for each MRS in decision diagrams.

Worksheet #12: Measurement Performance Criteria

(UFP-QAPP Manual Section 2.6.2)

This worksheet documents the project-specific measurement performance criteria in terms of data quality indicators (i.e., accuracy, sensitivity, representativeness, completeness, and comparability) for remedial actions at munitions response sites (MRS). MPCs are the minimum performance specifications that the remedial action must meet to ensure collected data will satisfy the DQOs documented in Steps 1-5 on Worksheet #11. They are the criteria against which the intermediate and final data usability assessments will be conducted as documented on Worksheet #37. The DUA must evaluate and document the data quality and decision-making impacts of any failures to meet these criteria (See Worksheet #37). Minimum recommended MPCs applicable to the RA phase are presented in black text. Project teams may revise these MPCs or establish additional MPCs if necessary to achieve project-specific DQOs; however, the project-specific QAPP must explain and justify any changes to black text. An appendix may be used for this purpose.

Table 12-1: MPC for MRS A1, Maneuver Area Development Area - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
DFW 1 – Site Preparation and CSM			
1. Accessibility	Completeness	All areas inaccessible to remediation or inaccessible to use of proposed geophysical systems are identified and mapped in a GIS.	Visual Inspection QA Report and/or GIS Database
2. Surface Sweep Coverage	Representativeness/ Completeness	Surface sweep completed across the entire site. Identified Saturated Response Areas (SRAs) have been documented.	Surface Sweep Technical Memorandum and updated CSM
3. IOC Completeness	Representativeness/ Completeness (recoverability)	All recoveries (IOC and MD) were reviewed and CSM confirmed or updated. All recovered munitions, as well as munitions related to recovered MD, were included in the site-specific TOI library.	Surface Sweep Technical Memorandum and Updated CSM
4. Survey Control	Completeness	All survey control points placed by Professional Licensed Surveyor (PLS) and survey control report submitted.	Surveyor and/or QC Report
DFW 2 & 3 – IVS			
5. IVS Construction	Accuracy/Completeness	Seeds placed so that each sensor passes at least one seed item during IVS surveys. Seed type, depth, and location accuracy recorded during placement.	IVS Memorandum

Table 12-1: MPC for MRS A1, Maneuver Area Development Area - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
6. IVS Testing	Sensitivity/ Completeness	Detection equipment assembled correctly and functioning as designed. Detection threshold confirmed or the effects of site-specific conditions on detection capabilities are documented.	IVS Memorandum
DFW 2 – QC and Validation Seeding			
7. QC Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QC seeds will be placed at the site by the contractor (1). Blind QC seeds must be detectable as defined by the DQOs and located throughout the horizontal and vertical survey boundaries defined in the DQOs (2,3). [The blind seed plan describes the number and types of blind QC seeds (2,4)]	Production Area QC Seeding Report
8. Validation Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind Validation seeds will be placed throughout the MRS footprint by the Government (or its third-party contractor) (1). Validation seeds must be detectable as defined by the DQOs and located at depths that result in signals equivalent to 2-5 times the detection threshold (2,3). [The Validation Seed Plan describes the number and types of validation seeds (2,4)]	Validation Seeding Report
DFW 4 & 5 – Data Acquisition Detection Survey			
9. Detection threshold (DGM)	Sensitivity	This worksheet must describe the project-specific detection threshold that will achieve the required depth of the selected remedy. The detection threshold used to detect a 60-mm mortar lying horizontally at a depth of 0.45 m is 11.7 mV on channel 2.	1) Review of sampling design 2) Initial and ongoing IVS surveys 3) Blind QC and validation seed detection 4) RMS background maps show all areas are less than or equal to 20% of the threshold
10. Detection Survey	Accuracy/Completeness	100% of QC seeds must be detected.	1) QC Seed Database 2) RCA/CA review and acceptance

Table 12-1: MPC for MRS A1, Maneuver Area Development Area - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
11. Detection Survey	Accuracy/Completeness	100% of validation seeds must be detected.	1) Validation Seed Database 2) RCA/CA review and acceptance
12. Detection Survey Coverage	Representativeness/ Completeness	100% of the site is sampled at required lane spacing and point-to-point sampling specifications.	1) Coverage Maps 2) Detection Survey Database
13. Anomaly Selection	Completeness	Complete project-specific databases and anomaly lists delivered. All QC and validation seeds listed in Detection Survey Database.	Detection Survey Database
14. Background	Representativeness/ Sensitivity	Background areas where detection threshold does not exceed five times the root mean square (RMS) background are identified.	1) GIS Database 2) Detection Survey Database
15. AGC Cued Survey Background Locations	Representativeness/ Comparability	Representative areas determined to be background are selected and bounded in the detection survey.	1) GIS Database 2) Cued Background Database
16. Variability for Cued Background locations	Representativeness/ Sensitivity	Representative backgrounds are selected in all noise regimes. Background areas where detection threshold is less than 5 times background are identified. All anomaly cued locations appropriate for each expected background are identified. Background measurements used to level cued measurements must be in the same noise regime as the cued measurements.	1) GIS Database 2) Cued Background Database

Table 12-1: MPC for MRS A1, Maneuver Area Development Area - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
DFW 4 & 5 – Data Acquisition Detection Survey			
17. Saturated Response Areas	Completeness	No SRAs in final detection survey data. All SRAs digitally remapped to confirm anomaly densities reduced to below DQO thresholds. [Example] The analog anomaly reduction survey reduces the anomaly density to below 3500 anomalies/acre.	1) Detection Survey Database 2) GIS database
DFW 7 & 8 – Data Acquisition – Cued Survey			
18. Background data collection (AGC)	Representativeness/ Accuracy	Each cued analysis is performed with a representative background and verified during quality control.	1) Background Validation Database 2) Cued Survey Database 3) QC Verification
19. Background Frequency	Completeness	Background data are collected at a minimum of the interval specified by the manufacturer.	Background Validation Database
20. Anomaly classification (AGC)	Completeness/ Comparability	Site-specific library must include representative signatures for all items considered by the project team to be IOC as listed in the CSM.	Site-specific TOI Library
21. Anomaly classification (AGC)	Completeness	Cued data collected at all anomalies meeting the target selection criteria and all cued data classified as: 1) TOI 2) Non-TOI 3) Inconclusive	1) Source Database 2) Final Intrusive Database
22. Anomaly classification (QC Seeds)	Accuracy/Completeness	100% of QC seeds are correctly classified as TOI for excavation. QC seeds classified as inconclusive are discussed in DUA.	1) QC Seed Database 2) RCA/CA Review and Acceptance
23. Anomaly classification (Validation Seeds)	Accuracy/ Completeness	100% of validation seeds are correctly classified as TOI for excavation.	1) Validation Seed Database 2) RCA/CA Review and Acceptance

Table 12-1: MPC for MRS A1, Maneuver Area Development Area - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
DFW 9, 10, & 11 – Anomaly Resolution and Excavation			
24. Anomaly resolution (QC Seeds)	Accuracy/Completeness	100% of QC seeds are recovered.	1) Intrusive Results Database 2) RCA/CA Review and Acceptance
25. Anomaly resolution (Validation Seeds)	Accuracy/ Completeness	100% of validation seeds are recovered.	1) Intrusive Results Database 2) RCA/CA Review and Acceptance
26. Anomaly resolution	Accuracy/ Completeness	100% of predicted non-TOI that are intrusively investigated are confirmed to be non-TOI. This includes final threshold verification digs and validation digs.	1) Intrusive Results Database 2) RCA/CA Review and Acceptance
27. Intrusive Investigation	Accuracy	Inversion results correctly predict one or more physical properties (e.g., size, symmetry, or wall thickness) of all recovered items (specific tests and test objectives established during project planning).	Intrusive Results Database
28. Intrusive Investigation	Completeness/ Comparability	A complete project-specific database including records reconciling inversion results to the physical properties of the recovered items. 100% of anomalies on the dig list are intrusively investigated.	Intrusive Results Database
29. Intrusive Investigation	Accuracy/Completeness	AGC results indicate original polarizabilities resulting in TOI are no longer present and no additional TOI sources present above the project-specific stop-dig threshold.	Post-mapping database

Table 12-2: MPC for MRS A2, Maneuver Area Recreational Area – MEC Surface Removal using Instrument-Aided Visual Identification

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
DFW 1 – Site Preparation and CSM			
1. Accessibility	Completeness	All areas inaccessible to remediation or inaccessible to use of proposed geophysical systems are identified and mapped in a GIS.	Visual Inspection QA Report and/or GIS Database
2. IOC Completeness	Representativeness/ Completeness (recoverability)	All recoveries (IOC and MD) were reviewed and CSM confirmed or updated.	Updated CSM
3. Survey Control	Completeness	All survey control points placed by PLS and survey control report submitted.	Surveyor and/or QC Report
DFW 2 & 3 – ITS			
4. Instrument Test Strip (ITS) Construction	Accuracy/Completeness	Seeds placed so that each sensor passes at least one seed item during ITS. Seed type, depth, and location accuracy recorded during placement.	ITS Memorandum
5. ITS Testing	Sensitivity/ Completeness	Analog equipment assembled correctly and functioning as designed. Detection threshold confirmed and tested daily with ITS seeds at depth of detection.	1) ITS Memorandum 2) ITS Database
DFW 2 – QC and QA Seeding			
6. QC Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QC seeds will be placed at the site by the contractor (1). Blind QC seeds must be located throughout the horizontal boundaries defined in the DQOs (2,3). [The blind seed plan must describe the number and types of blind QC seeds. (2,4)]	Production Area QC Seeding Report
7. QA Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QA seeds will be placed on the surface throughout the MRS footprint by the Government (or its third-party contractor) (1,2,3). [The QA Seed Plan describes the number and types of QA seeds. (2,4)]	QA Seeding Report

Table 12-2: MPC for MRS A2, Maneuver Area Recreational Area – MEC Surface Removal using Instrument-Aided Visual Identification (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
DFW 4 – Surface Removal			
8. Planned Survey Coverage	Completeness	Survey lanes are designed and located not to exceed 3-foot spacing and cover the entire MRS footprint.	1) Global positioning system (GPS) or photographic documentation 2) Grid/lane GIS database
9. Detection threshold (analog)	Sensitivity	This worksheet must describe the instrument and project-specific threshold to be used for instrument-aided surface removal. [Example] The analog instrument must be leveled to manufacturer settings and set to a sensitivity of 5 for the duration of the survey.	1) Initial and ongoing ITS surveys 2) Blind QC and QA seed detection 3) Periodic Verification by QC Geophysicist (or designee)
10. Detection Survey	Accuracy/Completeness	100% of QC seeds detected.	1) QC Seed Database 2) RCA/CA review and acceptance
11. Detection Survey	Accuracy/Completeness	100% of QA seeds must be detected.	1) QA Seed Database 2) RCA/CA review and acceptance
12. Detection Survey Coverage	Representativeness/ Completeness	100% of the site is sampled.	1) Seed Recovery 2) Operator GPS Records
13. Surface Item Removal	Completeness	All QC and QA seeds and pieces of metal exceeding 1”x2” in dimension recovered. All surface finds documented in the project-specific database.	1) GIS Database 2) QC Database 3) QA Database 4) Project Database

Table 12-3: MPC for MRS B1, Mortar Range – Flat Terrain Area – MEC Surface and Subsurface Removal using non-AGC DGM

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
DFW 1 – Site Preparation and CSM			
1. Accessibility	Completeness	All areas inaccessible to remediation or inaccessible to use of proposed geophysical systems are identified and mapped in a GIS.	Visual Inspection QA Report and/or GIS Database
2. IOC Completeness	Representativeness/ Completeness (recoverability)	All recoveries (IOC and MD) were reviewed and CSM confirmed or updated.	Surface Sweep Technical Memorandum and Updated CSM
3. Surface Sweep Coverage	Representativeness/ Completeness	Surface sweep completed across the entire site. Identified SRAs have been documented.	Surface Sweep Technical Memorandum and Updated CSM
4. Survey Control	Completeness	All survey control points placed by PLS and survey control report submitted.	Surveyor and/or QC Report
DFW 2 & 3 – IVS			
5. IVS Construction	Accuracy/Completeness	Seeds placed so that each sensor passes at least one seed item during IVS surveys. Seed type, depth, and location accuracy recorded during placement.	IVS Memorandum
6. IVS Testing	Sensitivity/ Completeness	Detection equipment assembled correctly and functioning as designed. Detection threshold confirmed or the effects of site-specific conditions on detection capabilities are documented.	IVS Memorandum

Table 12-3: MPC for MRS B1, Mortar Range – Flat Terrain Area – MEC Surface and Subsurface Removal using non-AGC DGM (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
DFW 2 – QC and Validation Seeding			
7. QC Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QC seeds will be placed at the site by the contractor (1). Blind QC seeds must be detectable as defined by the DQOs and located throughout the horizontal and vertical survey boundaries defined in the DQOs (2,3). [The blind seed plan describes the number and types of blind QC seeds. (2,4)]	Production Area QC Seeding Report
8. Validation Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind Validation seeds will be placed throughout the MRS footprint by the Government (or its third-party contractor) (1). Validation seeds must be detectable as defined by the DQOs and located at depths that result in signals equivalent to 2-5 times the detection threshold (2,3). [The Validation Seed Plan describes the number and types of validation seeds. (2,4)]	Validation Seeding Report
DFW 4 & 5 – Data Acquisition Detection Survey			
9. Detection threshold (DGM)	Sensitivity	This worksheet must describe the project-specific detection threshold that will achieve the required depth of the selected remedy. The detection threshold used to detect a 60-mm mortar lying horizontally at a depth of 0.45 m is 11.7 mV on channel 2.	1) Review of sampling design 2) Initial and ongoing IVS surveys 3) Blind QC and validation seed detection 4) RMS background maps show all areas are less than or equal to 20% of the threshold
10. Detection Survey	Accuracy/Completeness	100% of QC seeds detected.	1) QC Seed Database 2) RCA/CA review and acceptance
11. Detection Survey	Accuracy/Completeness	100% of validation seeds must be detected.	1) Validation Seed Database 2) RCA/CA review and acceptance
12. Detection Survey Coverage	Representativeness/ Completeness	100% of the site is sampled at required lane spacing and point-to-point sampling specifications.	1) Coverage Maps 2) Detection Survey Database

Table 12-3: MPC for MRS B1, Mortar Range – Flat Terrain Area – MEC Surface and Subsurface Removal using DGM (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
13. Anomaly Selection	Completeness	Complete project-specific databases and anomaly lists delivered. All QC and validation seeds listed in Detection Survey Database.	Detection Survey Database
14. Background	Representativeness/ Sensitivity	Background areas where detection threshold does not exceed five times background are identified.	1) GIS Database 2) Detection Survey Database
15. SRAs	Completeness	No SRAs in final detection survey data. All designated SRAs anomaly densities reduced to below DQO thresholds and digitally remapped. SRA boundaries documented in GIS deliverable. [Example] The analog anomaly reduction survey reduces the anomaly density to below 1500 anomalies/acre equivalent.	1) GIS Database 2) Detection Survey Database
DFW 6 – Verification of Non-AGC DGM Dig List			
16. Anomaly list (QC Seeds)	Accuracy/Completeness	100% of QC seeds are identified as TOI for excavation.	1) QC Seed Database 2) RCA/CA Review and Acceptance
17. Anomaly list (Validation Seeds)	Accuracy/ Completeness	100% of validation seeds are identified as TOI for excavation.	1) Validation Seed Database 2) RCA/CA Review and Acceptance
DFW 7 & 8 – Anomaly Resolution and Excavation			
18. Anomaly resolution (QC Seeds)	Accuracy/Completeness	100% of QC seeds are recovered.	1) Intrusive Results Database 2) RCA/CA Review and Acceptance
19. Anomaly resolution (Validation Seeds)	Accuracy/ Completeness	100% of validation seeds are recovered.	1) Intrusive Results Database 2) RCA/CA Review and Acceptance
20. Intrusive Investigation	Accuracy/Completeness	Digital post-mapping verification of selected excavated locations result in a geophysical response less than the detection threshold or documented as fully resolved	Post-mapping database
21. Intrusive Investigation	Completeness/ Comparability	A complete project-specific database including records reconciling detection results to the physical properties of the recovered items. 100% of anomalies identified for investigation (i.e., TOI dig list) intrusively investigated.	Intrusive Results Database

Table 12-4: MPC for MRS B2, Mortar Range – Steep Terrain Area – MEC Surface and Subsurface Removal using Analog Detection

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
DFW 1 – Site Preparation and CSM			
1. Accessibility	Completeness	All areas inaccessible to remediation or inaccessible to use of proposed geophysical systems are identified and mapped in a GIS.	Visual Inspection QA Report and/or GIS Database
2. IOC Completeness	Representativeness/ Completeness (recoverability)	All recoveries (IOC and MD) were reviewed and CSM confirmed or updated.	Updated CSM
3. Survey Control	Completeness	All survey control points placed by PLS and survey control report submitted.	Surveyor and/or QC Report
DFW 2 & 3 – ITS, QC Seeding, and QA Seeding			
4. ITS Construction	Accuracy/Completeness	Seeds placed so that each sensor passes at least one seed item during ITS. Seed type, depth, and location accuracy recorded during placement.	ITS Memorandum
5. ITS Testing	Sensitivity/ Completeness	Analog equipment assembled correctly and functioning as designed. Detection threshold confirmed and tested daily with ITS seeds at depth of detection.	1) ITS Memorandum 2) ITS Database
6. QC Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QC seeds will be placed at the site by the contractor (1). Blind QC seeds must be located throughout the horizontal boundaries defined in the DQOs (2,3). [The blind seed plan must describe the number and types of blind QC seeds. (2,4)]	Production Area QC Seeding Report
7. QA Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QA seeds (medium ISOs) will be placed throughout the MRS footprint by the Government (or its third-party contractor) (1, 2, 3). QA Seeds must be placed at the required depth of detection (0.45 m) (2, 3). [The QA Seed Plan describes the number and types of QA seeds. (2,4)]	QA Seeding Report
DFW 4 – Conduct Analog Surface and Subsurface Removal			
8. Planned Survey Coverage	Completeness	Survey lanes are designed and located not to exceed 3-foot spacing and cover the entire MRS footprint.	1) GPS or Photographic Documentation 2) Grid/Lane GIS database

12-4: MPC for MRS B2, Mortar Range – Steep Terrain Area – MEC Surface and Subsurface Removal using Analog Detection (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
9. Detection threshold (analog)	Sensitivity	This worksheet must describe the instrument and project-specific threshold to be used for sub-surface removal. [Example] The analog instrument must be leveled to manufacturer settings and set to a sensitivity of 5 for the duration of the survey. Detection of a 60-mm mortar and medium ISO at 0.45 m must be demonstrated in the ITS.	1) Initial and ongoing instrument test strip (ITS) surveys 2) Blind QC and QA seed detection 3) Periodic Verification by QC Geophysicist (or designee)
10. Detection Survey	Accuracy/Completeness	100% of QC seeds detected.	1) QC Seed Database 2) RCA/CA review and acceptance
11. Detection Survey	Accuracy/Completeness	100% of QA seeds must be detected.	1) QA Seed Database 2) RCA/CA review and acceptance
12. Detection Survey Coverage	Representativeness/ Completeness	100% of the site is sampled.	1) Seed Recovery 2) Operator GPS Records
DFW 5 – Anomaly Resolution and Excavation			
13. Anomaly Resolution (QC Seeds)	Accuracy/Completeness	100% of QC seeds are excavated.	QC Seed Database
14. Anomaly Resolution (QA Seeds)	Accuracy/Completeness	100% of QA seeds must be excavated.	QA Seed Database
15. Intrusive Investigation	Accuracy	QC or 3rd party re-check of 10% of the excavated locations result in zero additional intrusive investigations	QC Database
16. Intrusive Investigation	Completeness	Complete project-specific database with all intrusive records.	Project Database

Table 12-5: MPC for MRS C, Bombing Target – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
DFW 1 & 2 – Site Preparation, CSM, and Anomaly Reduction			
1. Accessibility	Completeness	All areas inaccessible to remediation or inaccessible to use of proposed geophysical systems are identified and mapped in a GIS.	Visual Inspection QA Report and/or GIS Database
2. IOC Completeness	Representativeness/ Completeness (recoverability)	All recoveries (IOC and MD) were reviewed and CSM confirmed or updated. All recovered munitions, as well as munitions related to recovered MD, were included in the site specific AGC library.	Surface Sweep Technical Memorandum and Updated CSM
3. Surface Sweep Coverage	Representativeness/ Completeness	Surface sweep completed across the entire site. Identified SRAs have been documented.	Surface Sweep Technical Memorandum and Updated CSM
4. Survey Control	Completeness	All survey control points placed by PLS and survey control report submitted.	Surveyor and/or QC Report
DFW 3 & 4 – QC Seeding, Validation Seeding, and IVS			
5. IVS Construction	Accuracy/Completeness	Seeds placed so that each sensor passes at least one seed item during IVS surveys. Seed type, depth, and location accuracy recorded during placement.	IVS Memorandum
6. IVS Testing	Sensitivity/ Completeness	Detection equipment assembled correctly and functioning as designed. Detection threshold confirmed or adjusted as appropriate.	IVS Memorandum
7. QC Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QC seeds will be placed at the site by the contractor (1). Blind QC seeds must be detectable as defined by the DQOs and located throughout the horizontal and vertical survey boundaries defined in the DQOs (2,3). [The blind seed plan describes the number and types of blind QC seeds. (2,4)]	Production Area QC Seeding Report

Table 12-5: MPC for MRS C, Bombing Target – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
8. Validation Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind Validation seeds will be placed throughout the MRS footprint by the Government (or its third-party contractor) (1). Validation seeds must be detectable as defined by the DQOs and located at depths that result in signals equivalent to 2-5 times the detection threshold (2,3). [The Validation Seed Plan describes the number and types of validation seeds (2,4).]	Validation Seeding Report
DFW 5 – Detection Survey, Data Processing, and Detection Survey DUA			
9. ISS Thresholds	Sensitivity	This worksheet must describe the project-specific informed-source-selection threshold that will achieve the required depth of the selected remedy. [Example] A detection threshold of ≥ 0.87 mV/A on Channel 14, modeled sized > 0.3, and polarizability fit > 0.9 are required to detect a [100-lb bomb] lying horizontally at a depth of [1.5 m].	1) Review of sampling design 2) Initial and ongoing instrument verification strip (IVS) surveys 3) Blind QC and validation seed detection 4) RMS background maps show all areas are less than or equal to 20% of the threshold
10. Detection Survey	Accuracy/Completeness	100% of QC seeds detected.	1) QC Seed Database 2) RCA/CA review and acceptance
11. Detection Survey	Accuracy/Completeness	100% of validation seeds must be detected.	1) Validation Seed Database 2) RCA/CA review and acceptance
12. Detection Survey Coverage	Representativeness/ Completeness	100% of the site is sampled at required lane spacing and point-to-point sampling specifications.	1) Coverage Maps 2) Detection Survey Database
13. Anomaly Selection	Completeness	Complete project-specific databases and anomaly lists delivered. All QC and QA seeds listed in Detection Survey Database. All other detected metallic objects screened out by ISS are documented in Detection Survey Database.	Detection Survey Database

Table 12-5: MPC for MRS C, Bombing Target – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
14. Background	Representatives / Sensitivity	. Background areas where detection threshold does not exceed five times background are identified.	1) GIS Database 2) Detection Survey Database
15. AGC Cued Survey Background Locations	Representativeness/comparability	Representative areas determined to be background are selected and bounded in the detection survey.	1) GIS Database 2) Cued Background Database
16. Variability for Cued Background locations	Representativeness/sensitivity	Representative backgrounds are selected in all noise regimes. All anomaly cued locations appropriate for each expected background are identified.	1) GIS Database 2) Cued Background Database
17. Saturated Response Areas (SRAs)	Completeness	No SRAs in final detection survey data. Anomaly density in all SRAs is reduced to below DQO thresholds and areas have been digitally remapped. SRA boundaries documented in GIS deliverable. [Example] The analog anomaly reduction survey reduces the anomaly density to below 3500 anomalies/acre equivalent.	1) Detection Survey Database 2) GIS Database
DFW 7, 8, & 9 – Data Processing and Cued Survey DUA			
18. Background data collection (AGC)	Representativeness/ Accuracy	Each cued analysis is performed with a representative background and verified during quality control.	1) Background Validation Database 2) Cued Survey Database 3) QC Verification
19. Background frequency	Accuracy	Background data are collected at the interval specified by the manufacturer.	Background Validation Database
20. Anomaly classification (AGC)	Completeness/ Comparability	Site-specific library must include representative signatures for all items considered by the project team to be IOC as listed in the CSM.	Site-Specific TOI Library

Table 12-5: MPC for MRS C, Bombing Target – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance
21. Anomaly classification (AGC)	Completeness	Cued data collected at all anomalies meeting the target selection criteria and all cued data classified as: classified as: 1) TOI 2) Non-TOI 3) Inconclusive	1) Source Database 2) Final Intrusive Database
22. Anomaly classification (QC seeds)	Accuracy/Completeness	100% of QC seeds are correctly classified as TOI for excavation. QC Seeds classified as inconclusive are discussed in DUA.	1) QC Seed Database 2) RCA/CA review and acceptance
23. Anomaly classification (validation seeds)	Accuracy/Completeness	100% of validation seeds are correctly classified as TOI for excavation.	1) Validation Seed Database 2) RCA/CA review and acceptance
DFW 10, 11, and 12 – Anomaly Resolution, Excavation, and Final DUA			
24. Anomaly resolution (QC seeds)	Accuracy/Completeness	100% of QC seeds are recovered.	1) Intrusive Results Database 2) RCA/CA review and acceptance
25. Anomaly resolution (Validation seeds)	Accuracy/ Completeness	100% of validation seeds are recovered.	1) Intrusive Results Database 2) RCA/CA review and acceptance
26. Anomaly resolution	Accuracy	100% of predicted non-TOI that are intrusively investigated are confirmed to be non-IOC. This includes threshold verification digs and validation digs.	Intrusive Results Database
27. Intrusive Investigation	Accuracy	Inversion results correctly predict one or more physical properties (e.g., size, symmetry, or wall thickness) of the recovered items (specific tests and test objectives established during project planning).	Intrusive Results Database
28. Intrusive Investigation	Completeness/ Comparability	A complete project-specific database including records reconciling inversion results to the physical properties of the recovered items.	Intrusive Results Database
29. Intrusive Investigation	Accuracy/Completeness	AGC results indicate original polarizabilities resulting in TOI are no longer present and no additional TOI sources are present above the project-specific stop-dig threshold.	Post-mapping database

Worksheet #14 & 16: Project Tasks and Schedule

(UFP-QAPP Manual Section 2.8.2)

The QAPP should include a project schedule. The following template may be used, or a Gantt chart can be attached and referenced. Examples of activities that should be listed are shown below; however, this is not a comprehensive list, and any critical deliverables and related DFWs should be added. Critical steps and dates should be highlighted.

Table 14-1: Project Tasks and Schedule [The following examples are based on MRS A1]

DFW	Activity	Responsible party	Planned start date	Planned completion date	Deliverables	Deliverable due date
1	Site preparation	Contractor name and title			• Surface sweep technical memorandum • Database of control points and survey units	
2	QC seeding & IVS construction	Contractor name and title			• Seed placement reports/spreadsheets	
2	Validation seeding	Lead organization name and title			• Seed placement reports/spreadsheets	
3	Assemble & test EM61	Contractor name and title			• Completed instrument assembly checklist • Detection survey IVS memorandum	
4	Detection survey	Contractor name and title			• Field notes • Daily IVS summaries • Daily QC reports • Weekly QC reports	

Table 14-1: Project Tasks and Schedule [The following examples are based on MRS A1] (Continued)

DFW	Activity	Responsible party	Planned start date	Planned completion date	Deliverables	Deliverable due date
5	Data processing and anomaly selection	Contractor name and title			• Target selection technical memorandum • Maps • Weekly QC reports	
5	Detection survey DUA	Contractor, lead organization, regulator, names and titles			• Detection survey DUA report • Updated CSM	
6	Assemble & test advanced sensor	Contractor name and title			• Instrument assembly checklist • Cued survey IVS memorandum	
7	Collect cued data	Contractor name and title			• Daily IVS summaries • Daily and weekly QC reports	
8	Data processing and anomaly classification	Contractor name and title			• Database • Classification spreadsheet • Classification decision plots • Ranked anomaly list • Dig list • Weekly QC reports	

Table 14-1: Project Tasks and Schedule [The following examples are based on MRS A1] **(Continued)**

DFW	Activity	Responsible party	Planned start date	Planned completion date	Deliverables	Deliverable due date
8	Cued survey DUA	Contractor, lead organization, regulator, names and titles			• Cued survey DUA report	
9	Excavate items on dig list	Contractor name and title			• Database • Photographs • Weekly QC reports	
10	Verify dig/no-dig threshold	Contractor name and title			• Comparison results • Final verification/ validation plan	
11	Excavate and evaluate classification validation targets	Contractor name and title			• Comparison results	
12	Conduct MPPEH handling & disposal	Contractor name and title			• Disposal records	
13	Conduct final DUA	Contractor, lead organization, regulator, names and titles			• Final CSM • Final DUA report • Final RA report • UU/UE memorandum	

[This page intentionally left blank.]

Worksheet #17: Survey Design and Project Workflow

(UFP-QAPP Manual Section 3.1.1)

This worksheet describes and justifies the design for remedies to be implemented. It documents Step 7 of the DQO process. If a munitions response site consists of multiple areas to be surveyed, then a separate survey design section or worksheet should be completed for each area. Factors that will influence the survey design include the size of the site, types and expected distribution of munitions and other debris present, the terrain, and other site conditions that could limit the ability of field teams or equipment to access portions of the site.

The survey design and project workflow must include the following:

1. A map showing physical boundaries for the area(s) under study. (See Figures 17-1 – 17-5 for examples)
2. The basis for dividing the site into survey units and how they will be managed at each phase of the process.
3. Decision-logic diagrams (See Figures 17-6 – 17-10 for examples)
4. Concise descriptions for each DFW. (SOPs containing detailed procedures must be included in an appendix to the project-specific QAPP.)
5. Contingencies in the event field conditions are different than expected and could have an effect on the survey design (e.g., a portion of the site is inaccessible at the time the site work is planned to occur or anomaly density is higher than expected.)
6. Points in the process at which lead organization, regulatory, and stakeholder interface will occur, as agreed upon during project planning.

Project Workflow

This section provides concise descriptions for each DFW and highlights government (lead organization and/or regulatory) inspection/oversight activities, key deliverables, and decision points, as they have been agreed upon during project planning. Worksheet #17 should reference other worksheets or SOPs containing detailed procedures. Project teams may modify this workflow description to consolidate DFW or provide further break-down of DFW, as necessary to accommodate project specifications. At the conclusion of each DFW, the QC geophysicist or other appropriate personnel must verify the relevant MQOs and MPCs have been achieved.

MRS A1 Maneuver Area Development Area

Selected Remedy: MEC surface and subsurface removal using non-AGC DGM detection and cued AGC

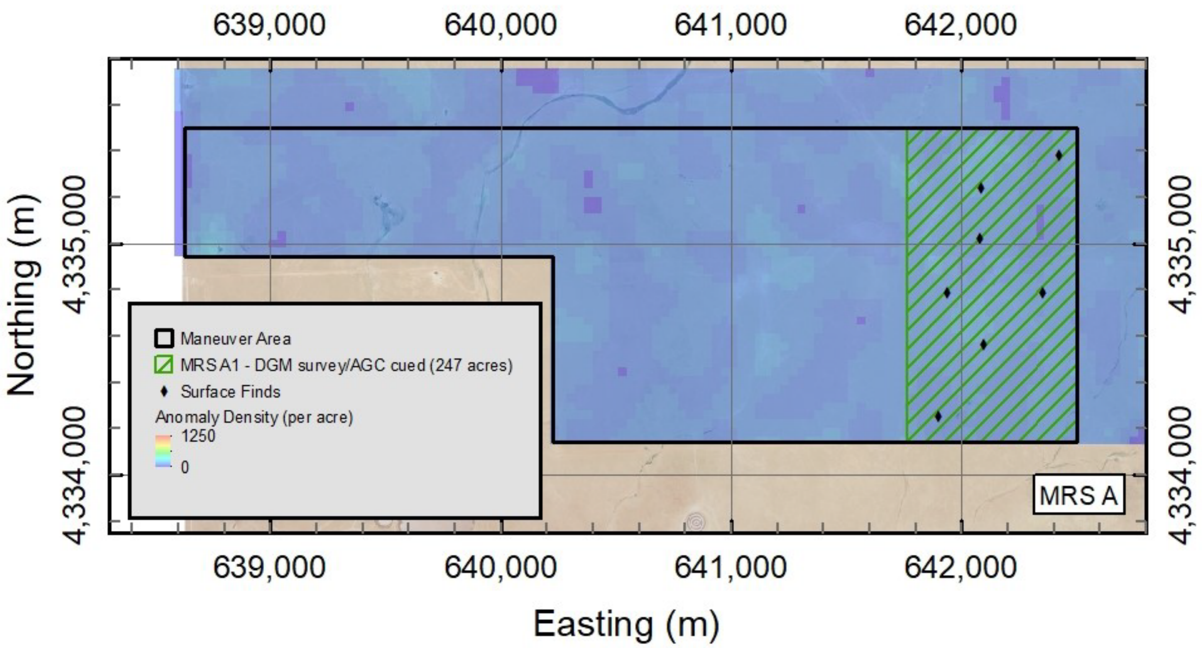

Figure 17-1: MRS A1

DFW 1: Conduct site preparation (contractor and lead organization)

Describe activities that must be completed prior to collecting geophysics data. This should include vegetation reduction, surface sweep, construction of silt fences or other barriers, if needed (for example, to prevent access by or exposure to potential receptors during site activities), and activities to preserve cultural resources or sensitive habitats, if needed. Describe procedures used to establish and document survey boundaries and grid corners, including the use of control points for data positioning, and the establishment of survey units. Indicate observations and information that the site preparation team will be recording to enhance the initial CSM.

Contractor: The contractor will conduct site preparation activities in the survey area, as well as any areas needed for equipment ingress/egress. [Specifications: MPCs__, SOPs __, MQOs___]

- No vegetation removal is needed on this site.
- A professional licensed surveyor will establish survey control points, survey boundaries, survey grid corners and survey units of 50 acres.
- A surface sweep team comprising qualified UXO technicians will conduct a surface sweep to remove all exposed or partially exposed potential MEC items. The team will also remove sufficient metallic objects that are equal to or greater than 1”x2” to permit a successful EM61 detection survey and cued AGC.
- The team will document the type (mark/mod), location, quantity, and estimated mass of objects removed, and will note any observations from the visual inspection that contribute to identifying the locations of specific munitions-related activity. The team will note any indication of conditions that will interfere with the geophysics or are inconsistent with the CSM.

- Following the lead organization's inspection of the surface sweep, the contractor will [describe remaining site preparation activities]. Detailed procedures are contained in SOP(s) __ [list relevant SOPs].

Documentation: Surface sweep technical memorandum, including field observations; database of control points and survey units

Lead organization: Following the surface sweep, the lead organization (or designee) will review and accept the surface sweep technical memorandum.

Decision rule: If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]

DFW 2: Conduct validation seeding, QC seeding, and construct IVS (contractor and lead organization)

Contractor: Describe the contractor's placement of blind QC seeds and construction of the IVS. Provide the rationale for the types, number, and placement of QC seeds. Describe procedures for assuring the QC seeds remain blind to the data collection and data analysis teams. Describe procedures for constructing the IVS, including the number, descriptions, depths, and orientation of seed items. The details of the seed planning are included here for completeness. These details could be documented in the seeding plans instead.

Lead organization: Describe the placement of validation seeds by or on behalf of the lead organization.

Contractor: The contractor will construct an IVS and place QC seeds in the area to be surveyed. [Specifications: QC seeding plan; QC firewall plan; IVS plan; draft verification/validation plan; MPCs__; SOPs __; MQOs___]

- The lead or project geophysicist supported by a qualified UXO escort will select a location free of existing anomalies that is 10 m wide and 25 m long. The geophysicist and UXO technician will emplace ten small ISO80 in two groups of five separated by 0.5 m in the cross-tack direction so that each sensor will pass directly over one ISO80. The groups will be placed at a minimum separation distance of 5 m in the down-track direction. The site team selected small objects for the IVS because potential munitions to be encountered are small. The field geophysicist using real-time kinematic (RTK) GPS will survey the location of each object in the IVS and record the as-buried positions.
- The UXO QCS and seeding team will emplace QC seeds to support the MQOs described in Worksheet #22 at a density to support one encounter per team per day. The towed-array EM61 survey will require an estimated 35 survey-days to complete and therefore 35 seeds will be required. The acquisition of cued AGC data, estimating a production rate of 180 cued locations per team-day, will require 94 survey team-days and 94 seeds. The digging will require approximately ten days to complete; therefore, the seed numbers are determined by the cued data acquisition. To ensure against any lags in production rate, the contractor will emplace 112 seeds throughout MRS A1. All QC seeds will be small ISO80s buried throughout the depth range up to 30 cm in a horizontal orientation, with burial depth biased to deeper depths.
- The seeding team will survey and record the location of each QC seed.
- The contractor will establish and document an internal firewall between the QC activities and the field and data analysis activities following procedures outlined in SOP__.

Lead Organization: The government team will emplace validation seeds to support the MQOs described in Worksheet #22. The government team will survey and record the location of each validation seed.

Documentation: Report or spreadsheet documenting the as-built seed locations for the IVS, validation seeds and QC seeds

DFW 3: Assemble and verify correct operation of geophysical sensor to be used for the detection survey (contractor)

Describe procedures to be used to assemble and verify correct operation of the detection system (initial function test). Describe procedures for testing sensor operation at the IVS. Refer to SOPs.

Contractor: The field geophysicist will assemble the sensor and verify correct operation by: [Specifications: Instrument assembly checklist, MPCs__, SOPs __, MQOs___].

- Conducting an initial function test
- Testing the system at the IVS
- Confirming the detection threshold or adjusting as appropriate

Documentation: Completed instrument assembly checklist; Detection Survey IVS memorandum

DFW 4: Conduct detection survey (contractor)

Describe the equipment and procedures that will be used to conduct the detection survey, including ongoing field QC activities (e.g., ongoing function tests). Describe requirements for detection and positioning. Describe and provide the rationale for coverage specifications (based on sensor geometry and sizes of targets). Describe how the site will be partitioned to conduct field work. Describe how lanes will be established and marked, if necessary.

Contractor: The field team will use a 3-m wide 5-sensor staggered EM61 array to collect data in MRS A1. [Specifications: MPCs__, SOPs__, MQOs__]

- The system will be equipped with cm-level global positioning system (GPS) and an electronic navigation system for following the data collection plan and geolocating the sensor readings.
- The data will be collected in 50-acre survey units, as designated in DFW 1.
- Lanes will be spaced 2 m apart to minimize the likelihood of data gaps.
- The operator will maintain a down-track speed that does not exceed 1.5 m/s. Although a speed of 2.5 m/s is required to maintain the data rate specified in Worksheet #22, the slower speed is selected to reduce noise from the motion and bouncing of the array, reducing smearing of the signals caused by lag in the data recording, and allow for some cushion on the Worksheet #22 requirement.
- The field geophysicist will review data twice daily at the conclusion of morning and afternoon data collection sessions.
- The QC geophysicist will perform QC activities as indicated in Worksheet #22, including specified visits to the IVS and daily assessments of data completeness.
- The team will document field observations of site conditions that may aid in interpreting the geophysical data and supporting the CSM, including the location and nature of indications of munitions or non-munitions related activity encountered.
- Detailed procedures are contained in SOP(s) __.

Documentation: Field notes, daily IVS summaries, daily QC reports, weekly QC reports.

DFW 5: Conduct data processing, select anomalies for cued data collection, and conduct detection survey DUA (contractor, lead organization, and regulator)

Contractor: Describe the procedures that will be used to process the detection data, validate the detection data (Worksheet #35 may be referenced), document locations to be used for background data collection during cued data collection, and select anomalies for cued data collection. Describe the process to identify any unanticipated SRAs in the data and how such areas will be investigated or documented. Describe the review and acceptance process by the lead agency.

Lead Organization: Describe the process for review and acceptance of target selection memoranda. For large sites where work may proceed to subsequent DFWs in survey units, describe the sequence and timeline of this process. Reference the communication flow as described in WS 6 and 9.

Contractor: The contractor will conduct data processing as follows: [Specifications: MPCs__, SOPs__, MQOs__]

- All data will be delivered to the government in survey units of 50 acres. All data processing validation checks will be performed per survey unit. The formal detection survey DUA will be conducted when all survey units are completed. The project geophysicist or designee will validate processed data and verify that all information is complete for each day of field activities and any changes or exceptions are documented and have been reported in accordance with requirements.
- The project geophysicist or designee will preprocess the data as described in SOP__.
- The project geophysicist or designee will document the boundaries of any inaccessible areas and describe the approach to resolving them.
- The project geophysicist or designee will select anomalies for cued data collection and record the location of all anomalies that exceed a threshold 11.7 mV on Channel 2, which is the amplitude necessary to detect a 60-mm mortar lying horizontally at a depth of 0.45 m.
- From segments of the data where no anomalies are present, the project geophysicist or designee will measure the RMS background noise. This will be done in more than one location and the contractor will note any areas where the signal to noise ratio (SNR) ≥ 5 cannot be achieved for a 60-mm mortar at a depth of 0.45 m.
- The QC geophysicist will confirm that all QC seeds have been selected.
- The project geophysicist or designee will recommend locations where AGC background measurements should be collected.
- The project geophysicist or designee will determine if any parts of the site have anomaly densities that exceed 3500 anomalies/acre and are unsuitable for the use of cued AGC. The contractor will conduct anomaly reduction processes and remap areas, as necessary. Detailed procedures are contained in SOP(s) __.

Lead organization:

- The lead organization will determine whether all validation seeds have been selected and inform the contractor of any missed seeds.
- The government will review and accept target selection memoranda on survey units of the site as they are completed.

Lead organization, contractor, and regulator: Conduct the detection survey DUA and update the CSM.

Documentation: Target selection technical memorandum (data analysis, anomaly density, list of selected anomalies, recommended background locations) for each survey unit, maps (depicting data and coverage, anomaly density, and selected anomalies), weekly QC reports, detection survey DUA report, and updated CSM.

Decision rules:

- If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]
- If signals meet the anomaly selection criteria (anomalies exceeding 11.7 mV on channel 2 and SNR ≥ 5), they will be selected for cued data collection using AGC.
- If areas of the site are deemed unsuitable for AGC use (areas where anomaly density ≥ 3500/acre), the project team will document the areas, and revise the remedial design, as necessary.

DFW 6: Assemble advanced geophysical sensor and test sensor at IVS (contractor)

Describe procedures to be used to assemble the advanced geophysical sensor and verify its correct operation (initial function test and initial cued survey IVS). Reassess the appropriateness of the IVS.

Contractor: The field geophysicist will assemble the sensor and verify correct operation by: [Specifications: Instrument assembly checklist, MPCs__, SOPs __, MQOs___].

- Conducting an initial function test
- Testing the system at the IVS

Documentation: Completed instrument assembly checklist; cued survey IVS memorandum

DFW 7: Collect cued data (contractor)

Describe procedures for locating each anomaly identified for cued data collection, positioning the sensor, collecting the cued data, and conducting field inversions (i.e., quick checks by field personnel to confirm the acquired signal is representative of the target anomaly). Describe the procedures and frequency for conducting ongoing function tests and collecting cued background data. Describe procedures and frequency for verifying ongoing operations at the IVS and conducting field QC.

The field geophysicist or designee will use TEMTADS in its standard cart configuration to collect data over the selected cued locations. Detailed procedures are contained in SOP(s) __. [Specifications: MPCs __, SOPs__, MQOs__]. Specifically,

- The cued AGC data will be collected in 50-acre survey units, as designated in DFW 1.
- The field geophysicist or designee will conduct function tests at the beginning, middle, and end of each survey day.
- The field geophysicist or designee will test the system at the IVS at the beginning and end of each survey day.
- The field geophysicist or designee will reacquire anomalies, collect cued data, and record field observations.
- The field geophysicist will collect background validation and ongoing background data.

- The field geophysicist or designee will conduct an immediate real-time screening of cued data to determine whether metrics for position offset were achieved. Failures identified in the field evaluation will be immediately recollected.
- The field geophysicist will conduct field inversions and ongoing QC. The QC geophysicist will validate cued data (evaluate conformance to SOPs and field MQOs).

Documentation: Daily IVS summaries, daily & weekly QC reports

DFW 8: Conduct data processing, classify anomalies, construct ranked anomaly list, and conduct cued survey DUA (contractor, lead organization, and regulator)

Contractor: Describe the procedure for processing the data. Describe procedures for removing the effects of background signals on the advanced sensor data to isolate the signature from the buried metal object. Describe the software and procedures generating the response curves that will be the basis for classification. Describe procedures for classifying anomalies. Specify relevant aspects of the classification process, i.e., how well the signature matches the library data (Worksheet #22 contains specifications for library fit coherence). Specify analysis procedures to be used in cases where the signature does not match a library signature but either 1) is a member of a cluster of numerous similar signatures that should be investigated as potential TOI or 2) exhibits properties consistent with those of a munition not contained in the library. Describe the methods and reasoning for setting the initial dig/no-dig threshold.

Contractor: The contractor will process the data using UX-Analyze as described in SOP__. [Specifications: MPCs __, SOPs__, MQOs__]

- All data will be delivered to the government in survey units of 50 acres. All data processing validation checks will be performed per survey unit. The formal cued survey DUA will be conducted when all survey units are completed.
- The project geophysicist or designee will use UX-Analyze as described in SOP__ to process the data daily to produce target response curves and perform library matches to identify TOI.
- TOI will include 1) all anomalies that match to a library member, 2) clusters of items not in the library that have similar response curves and require investigation, and 3) anomalies with response curves that suggest the properties of a munition (i.e., long, narrow, and axisymmetric or spherical).
- All data and the TOI list will be passed to the QC geophysicist who will determine whether all QC seeds were correctly classified and to verify that all QC metrics in Worksheet #22 were achieved. Any missed QC seeds will be reported to the government accompanied by an RCA/CA.
- The project geophysicist or designee will create a ranked anomaly list, arranged in order from highest likelihood the object is a TOI to highest likelihood the object is a non-TOI. The project geophysicist or designee will identify the threshold that will separate TOI and non-TOI to create a dig list as described in SOP__.
- The project geophysicist or designee will identify additional potential “threshold verification” targets such that 200 targets beyond the initial threshold will be identified. These targets will be the next targets below the TOI/non-TOI threshold in order.
- The project geophysicist or designee will assemble a dig list to include all TOI, any signals that could not be analyzed, and the threshold verification targets.

Lead organization: The government QA geophysicist will review any missed QC seed RCA/CA and approve or make recommendations to the contractor for modifications. The QA geophysicist will review all TOI lists to determine whether all validation seeds were correctly classified and inform the contractor of any failures (all information about the missed seed). The QA geophysicist will review data submissions for conformance with metrics in Worksheet #22. The lead organization will review and accept the classification results.

Documentation: Database (library match results), TOI/non-TOI classification spreadsheet, figures & maps (classification decision plots), ranked anomaly list, dig list, weekly QC reports, cued survey DUA report)

Project team: The project team will conduct the cued survey DUA, review the draft verification/validation plan, and make changes, as necessary.

Decision rules:

- If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]
- If AGC analyses meet any of the following criteria, they will be selected as TOI and placed on an ordered dig list:
  - The polarizability decay curve matches that of an item in the project-specific TOI library, or
  - Estimates of the size, shape, symmetry, and wall thickness indicate the item is long, cylindrical or spherical, and thick-walled, or
  - There is a group (cluster) of unknown anomalies having similar polarizability decay curves that, after investigation, are discovered to be TOI. The procedures for designating a cluster, including criteria for similarity and number of items are described in SOP ___.
- If AGC analyses yield inconclusive response curves, they will be added to the dig list or otherwise resolved.

DFW 9: Excavate buried objects (contractor)

Describe procedures to reacquire and flag anomalies selected for intrusive investigation and investigate anomalies. This includes investigation of the initial TOI/non-TOI threshold verification targets.

Contractor: [Specifications: Dig list, MPCs__, SOPs__, MQOs__]

- All excavation will take place in survey units of 50 acres. All validation checks will be performed per survey unit. The formal final DUA will be conducted when all survey units are completed.
- The field geophysicist or designee with a UXO technician escort will use a RTK cm-level GPS to relocate anomaly locations and emplace plastic pin flags.
- The intrusive team comprising qualified UXO technicians will navigate to each pin flag and conduct intrusive operations. All digging will be conducted according to the detailed procedures described in SOP__.
- For each anomaly location, the intrusive team will record the approximate size, depth, and specific information that can be obtained about the identity of the source.
- The intrusive team lead or designee will photograph each recovered item for later comparison with AGC analysis.
- If any clusters are identified, the CSM will be revised to include their locations and sources. If they are munitions, their signatures will be added to the library and anomaly classification reprocessed.

- If excavation of any anomalies that were deemed munitions-like are found to be munitions, their signatures will be added to the library and anomaly classification reprocessed.

Documentation: Database of excavation results (locations and descriptions), photographs, weekly QC reports

Decision rules:

- If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions.
- If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]
- If any clusters are identified, the CSM will be revised to include their locations and sources. If they are munitions, their signatures will be added to the library and anomaly classification reprocessed.
- If excavation of any anomalies that were deemed munitions-like are found to be munitions, their signatures will be added to the library and anomaly classification reprocessed.

DFW 10: Verify dig/no-dig threshold, update verification/validation plan, and conduct cued survey DUA (contractor, lead organization, and regulator)

Describe procedures for evaluating verification digs. If necessary, adjust the TOI/non-TOI threshold and identify additional threshold verification targets for investigation such that there are 200 non-TOI targets on the ranked anomaly list below the final threshold. Once the final threshold has been verified, identify classification validation targets for investigation.

Contractor: The QC geophysicist will determine whether any IOC are in the 200 verification digs. [Specifications: MPCs__, SOPs__, MQOs__]

- The intrusive team will excavate items from the threshold verification list such that 200 items beyond the last IOC recovered are investigated.
- If an IOC is found in the threshold verification list, the contractor will conduct an RCA/CA and the team will reevaluate the threshold selection.
- After determination of a new threshold, the threshold verification will be repeated by selecting another 200 targets past the last recovered IOC in the list at the new threshold. For example, if the last IOC recovered from the ranked list is 100 places before the threshold, an additional 100 of the threshold verification digs will be conducted. If the last target on the dig list is an IOC, an additional 200 targets will be dug. If no additional IOC are recovered, the threshold will be considered verified.

Project team: Once a final threshold has been established, the project team will select 200 classification validation targets, review the draft verification and validation plan and make changes as appropriate, and conduct the cued survey DUA. For each validation target, the team will document the characteristics that resulted in the non-TOI designation. [Note: The classification validation targets will be selected to address any questions or uncertainties in the data, if present. Randomly selected targets will make up the remainder of the 200.]

Documentation: Comparison results, final verification/validation plan

Decision rule: If the threshold verification digs do not uncover any IOC as described above, then the threshold is verified. If any IOC are recovered, then the project team will conduct RCA/CA that results in adjustment of the threshold and determination of the impacts on the project objectives.

DFW 11: Excavate and evaluate classification validation targets and conduct post-dig verification (contractor)

Describe procedures to reacquire and flag classification validation targets. Describe procedures for evaluating validation digs.

Contractor: Specifications: Final verification/validation plan, MPCs__, SOPs__, MQOs__]

- The field geophysicist or designee with a UXO technician escort will use a RTK cm-level GPS to relocate classification validation targets and emplace plastic pin flags.
- The intrusive team comprising qualified UXO technicians will navigate to each pin flag and conduct intrusive operations. All digging will be conducted according to the detailed procedures described in SOP__.
- For each anomaly location, the intrusive team will record the approximate size, depth, and specific information that can be obtained about the identity of the source.
- The intrusive team lead or designee will photograph each recovered item for later comparison with AGC analysis. [Specifications: Dig list, MPCs__, SOPs__, MQOs__]
- The QC geophysicist will determine whether any IOC are in the 200 validation digs. If an IOC is found in the validation digs, the contractor will conduct a QA stand-down and recommendation for CA, and the site team will determine the next steps.
- For each recovered object, the QC geophysicist will compare the characteristics of the object to the AGC results. If any properties are inconsistent, the project team will conduct an RCA/CA and determine the impacts on project objectives.
- For all locations where digging was conducted, the contractor will re-interrogate the location with the AGC sensor to verify the original polarizability no longer exists for TOI and that inconclusive analyses have been resolved.

Documentation: Comparison results

Decision rules:

- The geophysical classification results will be valid if:
    - validation digs do not uncover any IOC, and
    - the properties of all recovered objects are consistent with predicted properties
- If the validation digs uncover any IOC as described above the project team will conduct a QA stand-down and evaluate the impacts on MPCs and DQOs. [edited to be consistent with MRS C.]
- If the properties of recovered objects are inconsistent with predicted properties, the project team will conduct an RCA/CA and determine the impacts on the achievement of MPCs and DQOs.

DFW 12: Conduct MPPEH handling and disposal (contractor)

Briefly describe the procedures for handling and disposal of MPPEH.

Contractor: MPPEH will be handled and disposed of as described in SOP__ [Specifications: Explosives Safety Plan, MPCs__, SOPs__, MQOs__]

Documentation: Disposal records

DFW 13: Conduct final DUA (contractor, lead organization, and regulator)

Briefly describe procedures to conduct the final DUA. (Refer to Worksheet #37 for detailed procedures.

Lead Organization, contractor, and regulator:

- Conduct final DUA
- Evaluate UU/UE lines of evidence

Documentation: Final DUA, final report, updated CSM, UU/UE memorandum

Decision rule: If all lines of evidence are complete and support UU/UE, the project team will develop documentation supporting UU/UE for consideration by final decision-makers. If lines of evidence are incomplete, or any line of evidence does not support UU/UE, the project team will develop documentation rejecting UU/UE for consideration by final decision-makers.

MRS A2 – Maneuver Area Recreational Area

Selected Remedy: Surface removal using instrument-aided visual identification

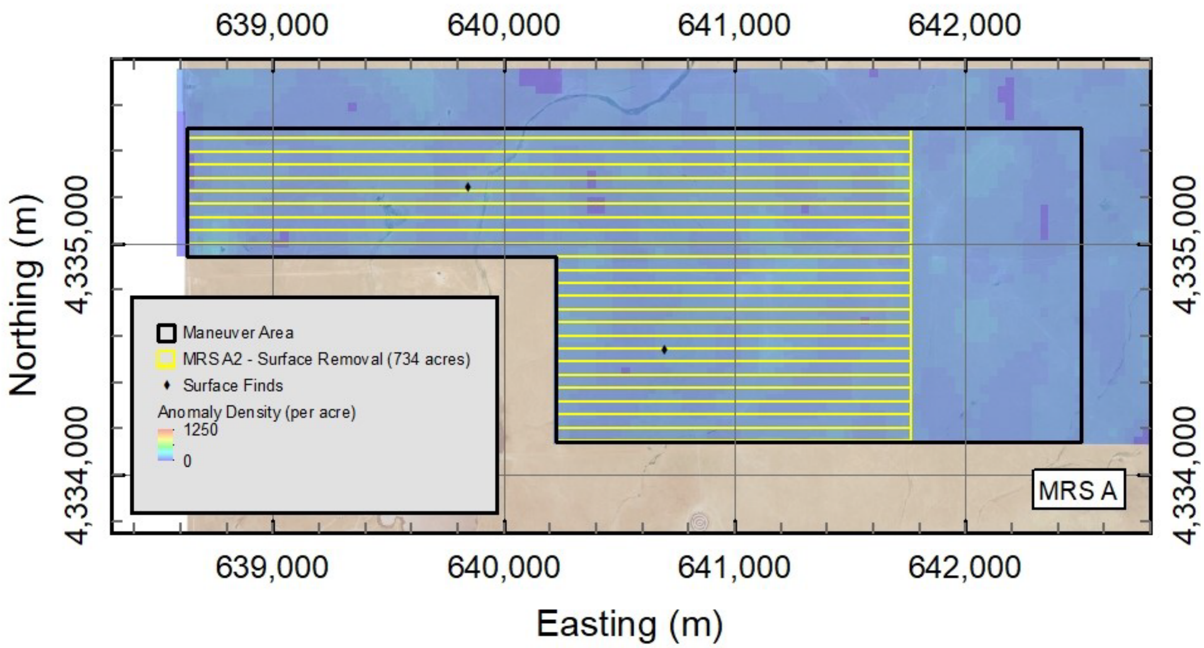

Figure 17-2: MRS A2

DFW 1: Conduct site preparation (contractor and lead organization)

Describe activities that must be completed prior to conducting surface removal. This should include vegetation reduction, surface sweep, construction of silt fences or other barriers, if needed (for example, to prevent access by or exposure to potential receptors during site activities), and activities to preserve cultural resources or sensitive habitats, if needed. Describe procedures used to establish and document survey boundaries and grid corners, including the use of control points for data positioning, and the establishment of survey units. Indicate observations and information that the site preparation team will be recording to enhance the initial CSM.

Contractor: The contractor will conduct site preparation activities in the survey area as well as any areas needed for equipment ingress/egress. [Specifications: MPCs__, SOPs __, MQOs___]

- No vegetation removal is needed on this site.
- A professional licensed surveyor will establish survey control points, survey boundaries and grid corners, and survey units of 50 acres.
- The team will note any observations from the visual inspection that contribute to identifying the locations of specific munitions-related activity. The team will note any indication of conditions that are inconsistent with the CSM.

Documentation: Site preparation technical memorandum, including field observations; database of control points and survey units

Lead organization: Following the site preparation, the lead organization (or designee) will review and accept the Site preparation technical memorandum.

Decision rule: If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]

DFW 2: Conduct QA seeding, QC seeding, and construct ITS (contractor and lead organization)

Contractor: Describe the contractor's placement of blind QC seeds and construction of the ITS. Provide the rationale for the types, number, and placement of QC seeds. Describe procedures for assuring the QC seeds remain blind to the data collection and data analysis teams. Describe procedures for constructing the ITS, including the number, descriptions, depths, and orientation of targets. The details of the seed planning are included here for completeness. These details could be documented in the seeding plans instead.

Lead organization: Describe the placement of QA seeds by or on behalf of the lead organization.

Contractor: The contractor will construct an ITS and place QC seeds in the area to be surveyed. [Specifications: QC seeding plan; QC firewall plan, ITS plan; draft verification/validation plan; MPCs__, SOPs __, MQOs___]

- The lead or project geophysicist supported by a qualified UXO escort will select a location free of existing anomalies that is 2 m wide and 25 m long. The geophysicist and UXO technician will emplace two small ISO80 at a minimum separation distance of 5 m. The site team selected small objects for the ITS because potential munitions to be encountered are small. The field geophysicist using RTK GPS will survey the location of each object in the ITS and record the emplaced positions.
- The UXOQCS and seeding team will emplace QC seeds to support the MQOs described in Worksheet #22 at a density to support five encounters per operator per day. Seeds were selected based on the size range of items expected on this site and include smaller stressing hardware (nail, washer), larger hardware (1/2-inch X 3-inch bolt) and small ISOs, in proportions of approximately one third of each category. We estimate the surface removal will require 625 operator-days to complete and therefore require 3125 seeds. Seeds will be placed on the surface. Based on site conditions described in the CSM, it is estimated that approximately 10% of the site will have access challenges, so 10% of the seeds will be placed in areas that are challenging to access (obscured from view, behind rocks, partially buried).
- The team will survey and record the location of each QC seed.
- The contractor will establish and document an internal firewall between the QC activities and the field and data analysis activities following procedures outlined in SOP __.

Lead Organization: The government team will emplace QA seeds to support the MQOs described in Worksheet #22. The government team will survey and record the location of each QA seed.

Documentation: Report or spreadsheet documenting the as-built seed locations for the ITS, QC seeds and QC seeds

DFW 3: Assemble and verify correct operation of geophysical sensor to be used for the detection survey (contractor)

Describe procedures to be used to assemble and verify correct operation of the detection instrument (initial function test). Describe procedures for testing sensor operation at the ITS. Refer to SOPs.

Contractor: The field geophysicist will assemble the Schonstedt GA-52Cx sensor and verify correct operation by: [Specifications: Instrument assembly checklist, MPCs__, SOPs __, MQOs___]

- Conducting an initial function test
- Testing the system at the ITS

Documentation: Completed instrument assembly checklist, ITS memorandum

DFW 4: Conduct surface removal (contractor)

Describe the procedures to be used to conduct an instrument-aided surface removal. Specify the instrument to be used and indicate the lane width, operator spacing, and down-track speed. Describe navigation procedures. Describe the process for collecting and disposing of recovered material, including the procedures for handling and disposing of MPPEH and MEC. Describe the process for reporting and evaluating recovered seeds. Describe information to be recorded documenting any evidence of types of munitions found to be present. Reference SOPs as appropriate.

The contractor will deploy teams of six qualified UXO Technicians and a UXO Technician III team leader to perform an instrument-aided surface removal using a Schondstedt GA-52Cx magnetometer on the site as detailed in SOP__.

- Surface removal will be conducted in 50-acre survey units as indicated in DFW 1. Quality checks will be performed upon completion of each survey unit. The formal DUA will be completed at the conclusion of the project.
- The technicians will mark lanes using polypropylene rope to be spaced three feet apart. The technicians will walk at no more than 0.5 m/sec. When a signal is observed by the technicians, the technicians will stop and immediately retrieve any objects that are larger than 1”x2”.
- The recovered objects will be collected in a bucket for each lane.
- The supervisor will photograph representative examples of recovered objects.
- The supervisor will make a record of any munitions recovered and any munitions debris that are indicative of the types of munitions that may be present.
- The locations of recovered seeds will be recorded with a handheld GPS.
- The QC geophysicist will determine if any QC seeds were missed, report it to the lead agency, and provide RCA/CA. The contractor will submit results for each survey unit only after all QC seeds have been recovered.
- The QA geophysicist will determine if any QA seeds were missed.

Documentation: Field notes including photographs, daily QC reports, weekly QC reports (including RCA/CA)

DFW 5: Verify surface removal (contractor)

Describe the procedures for verifying the surface removal.

Contractor: The QC geophysicist or their designee will resurvey one lane from each operator in each survey unit; lanes will be randomly located. [Specifications: Instrument assembly checklist, MPCs__, SOPs __, MQOs___]

Documentation: Surface removal verification memorandum or weekly QC report

Any recovered metallic object that exceeds the dimension specification will be a failure.

DFW 6: Conduct MPPEH handling and disposal (contractor)

Briefly describe the procedures for handling and disposal of MPPEH

Contractor: MPPEH will be handled and disposed of as described in SOP__ [Specifications: Explosives Safety Plan, MPCs__, SOPs__, MQOs__]

Documentation: Disposal records

DFW 7: Conduct final DUA and update the CSM (contractor, lead organization, and regulator)

Briefly describe procedures to conduct the final DUA. (Refer to Worksheet #37 for detailed procedures.

Contractor, lead organization, and regulator: Conduct final DUA

Documentation: Final DUA, final surface removal report

Decision rule: If MPCs have been achieved, the project team will have implemented the removal component of the remedy. The LUC specified in the ROD will be used to manage residual risk. If not, the team will recommend that the appropriate representatives of the responsible offices revisit and reconsider the ROD.

MRS B1 – Mortar Range Flat Terrain Area

Selected Remedy: Surface and subsurface removal using non-AGC DGM

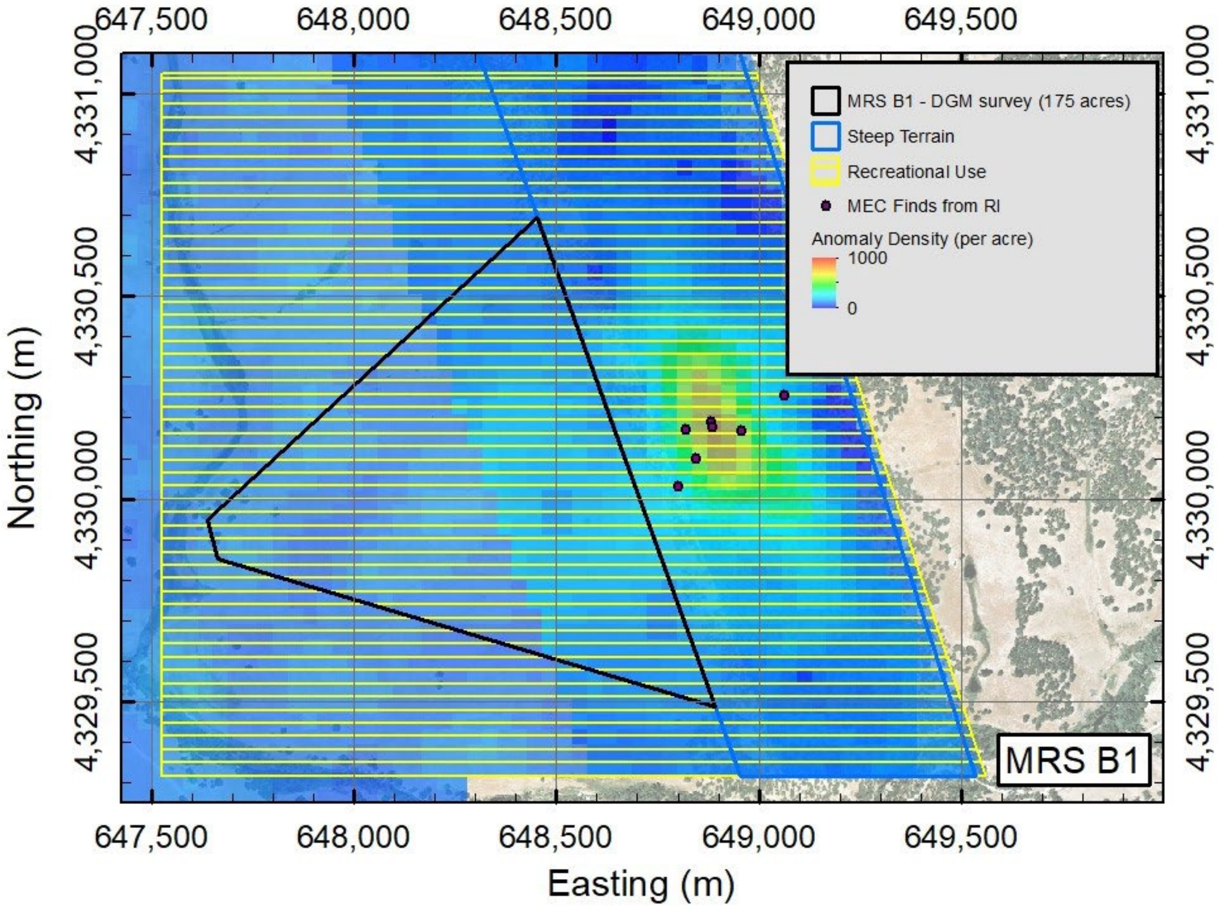

Figure 17-3: MRS B1

DFW 1: Conduct site preparation (contractor and lead organization)

Describe activities that must be completed prior to collecting geophysics data. This should include vegetation reduction, surface sweep, construction of silt fences or other barriers, if needed (for example, to prevent access by or exposure to potential receptors during site activities), and activities to preserve cultural resources or sensitive habitats, if needed. Describe procedures used to establish and document survey boundaries, including the use of control points for data positioning, and the establishment of survey units. Indicate observations and information that the site preparation team will be recording to enhance the initial CSM.

Contractor: The contractor will conduct site preparation activities in the survey area as well as any areas needed for equipment ingress/egress. [Specifications: MPCs__, SOPs __, MQOs__]

- No vegetation removal is needed on this site.
- A professional licensed surveyor will establish survey control points, survey boundaries, and survey units of 50 acres.

- A surface sweep team comprising qualified UXO technicians will conduct a surface sweep to remove all exposed or partially exposed potential MEC items. The team will also remove sufficient metallic objects that are equal to or greater than 1”x2” to permit a successful EM61 survey.
- The team will document the type, quantity, and estimated mass of objects removed, and will note any observations from the visual inspection that contribute to identifying the locations of specific munitions-related activity. The team will note any indication of conditions that will interfere with the geophysics or are inconsistent with the CSM.
- Following the lead organization’s inspection of the surface sweep, the contractor will [describe remaining site preparation activities]. Detailed procedures are contained in SOP(s) __ [list relevant SOPs].

Lead organization: Following the surface sweep, the lead organization (or designee) will review and accept the surface sweep technical memorandum.

Documentation: Surface sweep technical memorandum, including field observations; database of control points and survey units

Decision rule: If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]

DFW 2: Conduct validation seeding, QC seeding, and construct IVS (contractor and lead organization)

Contractor: Describe the contractor’s placement of blind QC seeds and construction of the IVS. Provide the rationale for the types, number, and placement of QC seeds. Describe procedures for assuring the QC seeds remain blind to the data collection and data analysis teams. Describe procedures for constructing the IVS, including the number, descriptions, depths, and orientation of seed items. The details of the seed planning are included here for completeness. These details could be documented in the seeding plans instead.

Lead organization: Describe the placement of validation seeds by or on behalf of the lead organization.

Contractor: The contractor will construct an IVS and place QC seeds in the area to be surveyed. [Specifications: QC seeding plan; QC firewall plan, IVS plan; verification/validation plan, MPCs__, SOPs __, MQOs__]

- The lead or project geophysicist supported by a qualified UXO escort will select a location free of existing anomalies that is 10 m wide and 25 m long. The geophysicist and UXO technician will emplace ten small ISO80 in two groups of five separated by 0.5 m in the cross-tack direction so that each sensor will pass directly over one ISO80. The groups will be placed at a minimum separation distance of 5 m in the down-track direction. The site team selected small objects for the IVS because potential munitions to be encountered are small. The field geophysicist using RTK GPS will survey the location of each object in the IVS and record the as-buried positions.
- The UXO QCS and seeding team will emplace QC seeds to support the MQOs described in Worksheet #22 at a density to support one encounter per team per day. It is estimated the towed-array EM61 survey will require 54 survey days to complete and the digging with require 224 team days; therefore 224 seeds will be required. To ensure against any lags in production rate, the contractor will emplace 250 seeds throughout MRS B1. All seeds will be medium ISOs buried at a depth of 30-45 cm in a horizontal orientation, corresponding to 67-100% of the

objective detection depth. The team will establish and document an internal firewall between the QC activities and the field and data analysis activities following procedures outlined in SOP__.

- The team will survey and record the location of each QC seed.
- The contractor will establish and document an internal firewall between the QC activities and the field and data analysis activities following procedures outlined in the QC firewall plan.

Lead Organization: The government team will emplace validation seeds to support the MQOs described in Worksheet #22. The government team will survey and record the location of each validation seed.

Documentation: report or spreadsheet documenting the as-built seed locations for the IVS, QC seeds and validation seeds

DFW 3: Assemble and verify correct operation of geophysical sensor to be used for the detection survey (contractor)

Describe procedures to be used to assemble and verify correct operation of the detection instrument (initial function test). Describe procedures for testing sensor operation at the IVS. Refer to SOPs.

Contractor: The field geophysicist will assemble the sensor and verify correct operation by: [Specifications: Instrument assembly checklist, MPCs__, SOPs __, MQOs___].

- Conducting an initial function test
- Testing the system at the IVS

Documentation: Completed instrument assembly checklist, IVS Memorandum

DFW 4: Conduct detection survey (contractor)

Describe the equipment and procedures that will be used to conduct the detection survey, including ongoing field QC activities (e.g., ongoing function tests). Describe requirements for detection and positioning. Describe and provide the rationale for coverage specifications (based on sensor geometry and sizes of targets). Describe how the site will be partitioned to conduct field work. Describe how lanes will be established and marked, if necessary.

Contractor: The field team will use a 3-m wide, 5-sensor staggered EM61 array to collect data in MRS B1. [Specifications: MPCs__, SOPs__, MQOs__].

- The data will be collected in 50-acre survey units, as designated in DFW 1.
- The system will be equipped with cm-level GPS and an electronic navigation system for locating and following the data collection plan and for geolocating the sensor data.
- Lanes will be spaced 2 m apart to minimize the likelihood of data gaps.
- The operator will maintain a down-track speed that does not exceed 1.5 m/s. Although a speed of 2.5 m/s is required to maintain the data rate specified in Worksheet #22, the slower speed is selected to reduce noise from the motion and bouncing of the array, reduce smearing of the signals caused by lag in the data recording, and allow for some cushion on the Worksheet #22 requirement.
- The field geophysicist will review data twice daily at the conclusion of morning and afternoon data collection sessions.
- The QC geophysicist will perform QC activities as indicated in Worksheet #22, including specified visits to the IVS and daily assessments of data completeness.

- The team will document field observations of site conditions that may aid in interpreting the geophysical data and supporting the CSM, including the location and nature of indications of munitions or non-munitions related activity encountered.
- Detailed procedures are contained in SOP(s) __.

Documentation: Field notes, daily IVS summaries, daily QC reports, weekly QC reports (including RCA/CA)

DFW 5: Conduct data processing, select TOI, and conduct detection survey DUA (contractor, lead organization, and regulator)

Contractor: Describe the procedures that will be used to process the detection data, validate the detection data (Worksheet #35 may be referenced), and select TOI. Describe the process to identify any unanticipated SRAs in the data and how such areas will be investigated or documented. Describe the review and acceptance process by the lead agency.

Lead Organization: Describe the process for review and acceptance of target selection memoranda. For large sites where work may proceed to subsequent DFWs in survey units, describe the sequence and timeline of this process. Reference the communication flow as described in Worksheets #6 and #9.

Contractor: The contractor will conduct data processing [Specifications: MPCs__, SOPs__, MQOs__]

- All data will be delivered to the government in survey units of 50 acres. All data processing validation checks will be performed per survey unit. The formal detection survey DUA will be conducted when all survey units are completed. The project geophysicist or designee will verify that all information is complete for each day of field activities and any changes or exceptions are documented and have been reported in accordance with requirements.
- The project geophysicist or designee will preprocess the data as described in SOP__.
- The project geophysicist or designee will document the boundaries of any inaccessible areas and describe the approach to resolving them.
- The project geophysicist or designee will record the location of all anomalies that exceed a threshold of 11.7 mV on Channel 2, which is the amplitude necessary to detect a 60-mm mortar lying horizontally at a depth of 0.45 m.
- From segments of the data where no anomalies are present, the project geophysicist or designee will measure the RMS background noise. This will be done in more than one location and the contractor will note any areas where SNR ≥ 5 cannot be achieved.
- The QC geophysicist will confirm that all QC seeds have been selected.

Lead organization:

- The lead organization will determine whether validation seeds have been selected and inform the contractor of any missed seeds.
- The government will review and accept target selection memoranda on survey units of the site as they are completed.

Lead organization, contractor, and regulator: Conduct detection survey DUA and update the CSM.

Documentation: Target selection technical memorandum (data analysis, anomaly density, list of selected anomalies), maps (depicting data and coverage, anomaly density, and selected anomalies), weekly QC reports, detection survey DUA report

Decision rules:

- If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]
- If signals meet the anomaly selection criteria (anomalies exceeding 11.7 mV on channel 2 and SNR ≥ 5) they will be selected for intrusive investigation.

DFW 6: Excavate buried objects (contractor)

Describe procedures to reacquire and flag anomalies selected for intrusive investigation and investigate anomalies

Contractor: [Specifications: MPCs__, SOPs__, MQOs__]

- All excavation will take place in survey units of 50 acres. All validation checks will be performed per survey unit. The formal final DUA will be conducted when all survey units are completed.
- The field geophysicist or designee with a UXO technician escort will use a RTK cm-level GPS to relocate anomaly locations and emplace plastic pin flags.
- The intrusive team comprising qualified UXO technicians will navigate to each pin flag and conduct intrusive operations. All digging will be conducted according to the detailed procedures described in SOP__.
- For each anomaly location, the intrusive team will record the approximate size, depth, and specific information that can be obtained about the identity of the source.
- The intrusive team lead or designee will photograph each recovered item using a ruled whiteboard for scale.
- The field geophysicist or designee will re-interrogate each anomaly locations with the EM61 in analog mode to verify that the peak response is below the detection threshold. Any locations where the peak response remains above the detection threshold will be subject to further intrusive investigation.

Documentation: Database of excavation results (locations and descriptions), photographs, weekly QC reports

Decision rule: If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]

DFW 7: Conduct excavation verification (contractor)

Describe procedures for verifying that the correct locations were excavated and that all required objects were removed.

Contractor: [Specifications: MPCs__, SOPs__, MQOs__]

- Upon completion of excavation, the QC geophysicist will recollect digital EM61 data at the locations of 200 of the intrusive investigation anomaly locations to verify that the signal is reduced in amplitude at target selection criteria, as described in SOP X and in Worksheet #22.
- The QC geophysicist will verify that the correct locations were re-interrogated and that the recovered items are consistent with the original EM61 signal.

Documentation: Weekly QC report

DFW 8: Conduct MPPEH handling and disposal (contractor)

Briefly describe the procedures for handling and disposal of MPPEH.

Contractor: MPPEH will be handled and disposed of as described in SOP__ [Specifications: Explosives Safety Plan, MPCs__, SOPs__, MQOs__]

Documentation: Disposal records

DFW 9: Conduct final DUA and update the CSM (contractor, lead organization, and regulator)

Briefly describe procedures to conduct the final DUA. (Refer to Worksheet #37 for detailed procedures.

Contractor, lead organization, and regulator: Conduct final DUA

Documentation: Final DUA, final report

Decision rule: If MPCs have been achieved, the project team will have implemented the removal component of the remedy.

Documentation: Updated CSM, Final DUA, Final Report

MRS B2 – Mortar Range Steep Terrain Area

Selected Remedy: Surface and subsurface removal using analog detection

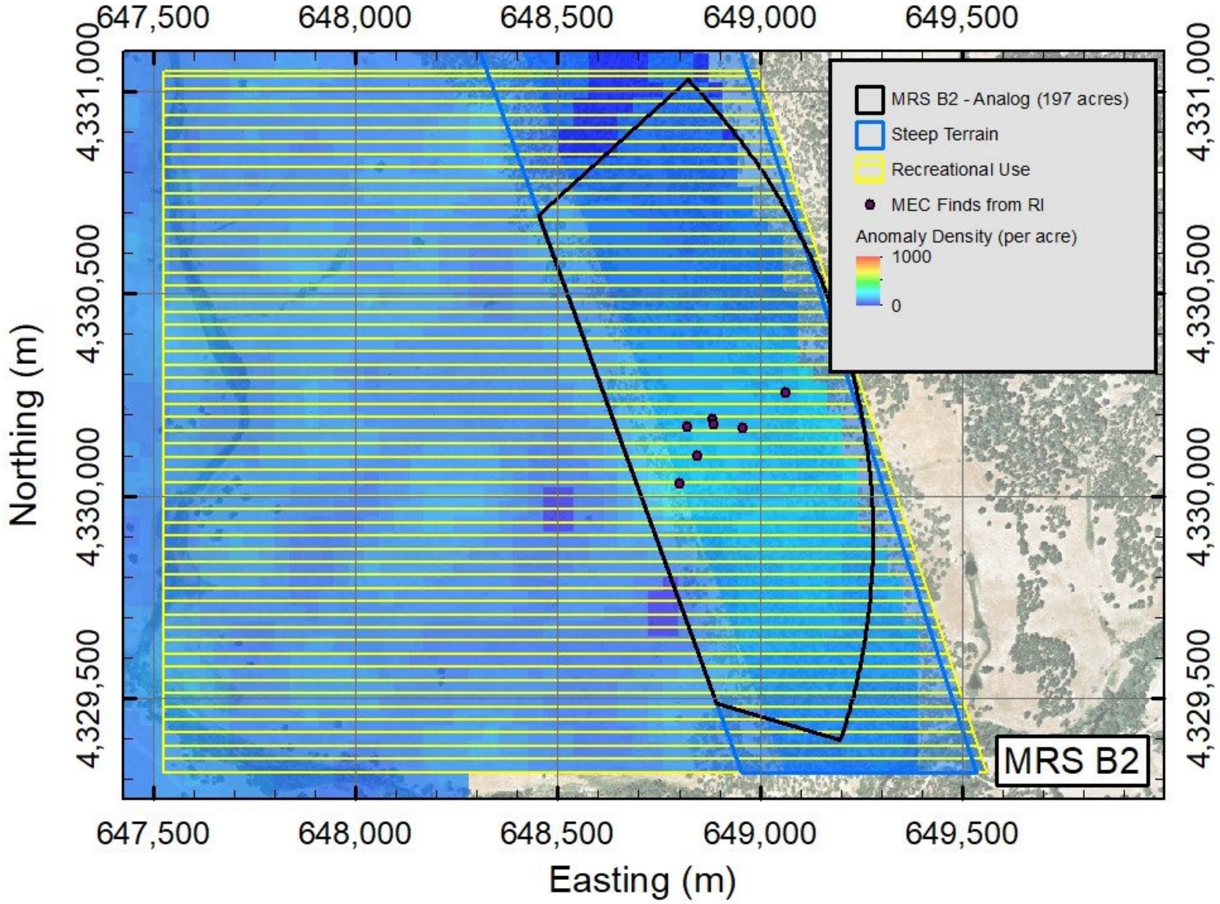

Figure 17-4: MRS B2

DFW 1: Conduct site preparation (contractor and lead organization)

Describe activities that must be completed prior to collecting geophysics data. This should include vegetation reduction, surface sweep, construction of silt fences or other barriers, if needed (for example, to prevent access by or exposure to potential receptors during site activities), and activities to preserve cultural resources or sensitive habitats, if needed. Describe procedures used to establish and document survey boundaries, including the use of control points for data positioning, and the establishment of survey units. Indicate observations and information that the site preparation team will be recording to enhance the initial CSM.

Contractor: The contractor will conduct site preparation activities in the survey area as well as any areas needed for equipment ingress/egress. [Specifications: MPCs__, SOPs __, MQOs__]

- The vegetation removal team will remove vegetation to a height of 6 inches.
- A professional licensed surveyor will establish survey control points, survey boundaries, and survey units of 50 acres.

- The team will note any observations from the visual inspection that contribute to identifying the locations of specific munitions-related activity. The team will note any indication of conditions that are inconsistent with the CSM.

Documentation: Site preparation technical memorandum, including field observations; database of control points and survey units.

Lead organization: Following the site preparation, the lead organization (or designee) will review and accept the site preparation technical memorandum.

Decision rule: If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]

DFW 2: Conduct QA seeding, QC seeding, and construct ITS (contractor and lead organization)

Contractor: Describe the contractor's placement of blind QC seeds and construction of the ITS. Provide the rationale for the types, number, and placement of QC seeds. Describe procedures for assuring the QC seeds remain blind to the data collection and data analysis teams. Describe procedures for constructing the ITS, including the number, descriptions, depths, and orientation of targets. . The details of the seed planning are included here for completeness. These details could be documented in the seeding plans instead.

Lead organization: Describe the placement of QA seeds by or on behalf of the lead organization.

Contractor: The contractor will construct an ITS and place QC seeds in the area to be surveyed. [Specifications: QC Seeding Plan; QC Firewall Plan; ITS Plan; QA seeding plan; MPCs__, SOPs __, MQOs___]

- The lead or project geophysicist supported by a qualified UXO escort will select a location free of existing anomalies that is 2 m wide and 25 m long. The geophysicist and UXO technician will emplace two medium ISO at a depth of 30 cm, separated by at least 5 m. Medium ISOs were selected because they are of comparable size to the mortars expected on this site. The geophysicist will survey the location of each object in the ITS using cm-level GPS and record the as-buried positions.
- The UXOQCS and seeding team will emplace QC seeds to support the MQOs described in Worksheet #22 at a density to support five encounters per operator per day. All seeds will be medium ISOs buried to a depth of 40-45 cm in the horizontal orientation. We estimate the surface/subsurface removal will require 67 operator-days to complete and therefore require 335 seeds. The team will survey and record the location of each QC seed. The team will establish and document an internal firewall between the QC activities and the field activities following procedures outlines in SOP__.
- The team will survey and record the location of each QC seed.

Lead Organization: The government team will emplace QA seeds to support the MQOs described in Worksheet #22. The government team will survey and record the location of each QA seed.

Documentation: Report or spreadsheet documenting the as-built seed locations for the ITS, QA seeds and QC seeds.

DFW 3: Assemble and verify correct operation of geophysical sensor to be used for the detection survey (contractor)

Specify the sensor and describe procedures to assemble and verify correct operation of the sensor (initial function test). Describe procedures for testing sensor operation at the ITS. Refer to SOPs.

Contractor: The field geophysicist will assemble the Schonstedt gradiometer and verify correct operation by: [Specifications: Instrument assembly checklist, MPCs__, SOPs __, MQOs___].

- Conducting an initial function test
- Testing the system at the ITS

Documentation: Completed instrument assembly checklist, ITS memorandum

DFW 4: Conduct analog surface and subsurface removal (contractor and lead organization)

Describe the procedures to conduct the analog surface and sub-surface removal. Indicate the lane width, operator spacing, and down-track speed. Describe navigation procedures. Describe the process of collecting recovered material. Describe the process for reporting and evaluating recovered seeds. Describe information to be recorded documenting any evidence of types of munitions found to be present. Reference SOPs as appropriate.

Contractor: The contractor will deploy teams of six qualified UXO Technicians and a UXO Technician III team leader to perform an analog sub-surface removal on the site using Schonstedt gradiometer systems. [Specifications: MPC__, SOPs__, MQOs__]

- The subsurface removal will take place in survey units of 50 acres. All validation checks will be performed per survey unit. The formal DUA will be conducted when all survey units are completed.
- The technicians will mark lanes using polypropylene rope to be spaced three feet apart. The technicians will walk at no more than 0.5 m/sec
- The technicians will be spaced in lanes three feet apart walking at no more than 0.5 m/sec.
- When a signal is observed by the technicians, the technicians will stop and immediately excavate to retrieve the source object.
- After an object has been recovered, the operator will reinterrogate the hole with the instrument to determine if other objects remain and continue until no residual signal is detected.
- The recovered objects will be collected in a bucket for each lane.
- The supervisor will photograph representative examples of recovered objects.
- The supervisor will make a record of any munitions recovered and any munitions parts that are indicative of the types of munitions that may be present. Any fragments indicating the presence of munitions other than mortars will be reported.
- The locations of recovered seeds will be recorded with a handheld GPS.
- The QC geophysicist will determine if any QC seeds were missed, report it to the lead agency, and provide RCA/CA. The contractor will resurvey as needed and submit results for each survey unit only after all QC seeds have been recovered.

Lead organization: The QA geophysicist will determine if any QA seeds were missed. The analog survey will be repeated until all QA seeds are recovered.

Documentation: Database of excavation results (descriptions and locations), photographs of recovered objects, daily QC reports (including re-interrogation results), weekly QC reports.

DFW 5: Verify subsurface removal (contractor)

Describe the procedures for verifying the subsurface removal.

Contractor: The QC geophysicist or their designee will resurvey one lane from each operator in each survey unit; lanes will be randomly located. [Specifications: Instrument assembly checklist, MPCs__, SOPs __, MQOs___]

Documentation: Subsurface removal verification memorandum or weekly QC report

Any recovered metallic object that exceeds the dimension specification will be a failure.

DFW 6: Conduct MPPEH handling and disposal (contractor)

Briefly describe the procedures for handling and disposal of MPPEH.

Contractor: MPPEH will be handled and disposed of as described in SOP__ [Specifications: Explosives Safety Plan, MPCs__, SOPs__, MQOs__]

Documentation: Disposal records

DFW 7: Conduct final DUA and update the CSM (contractor, lead organization, and regulator)

Briefly describe procedures to conduct the final DUA. (Refer to Worksheet #37 for detailed procedures.]

Contractor, lead organization, and regulator: Conduct final DUA

Documentation: Final DUA, final report

Decision rule: If MPCs have been achieved, the project team will have implemented the removal component of the remedy. If not, the team will recommend that the appropriate representatives of the responsible offices revisit and reconsider the ROD. The LUC specified in the ROD will be used to manage residual risk.

MRS C – Bomb Target

Selected Remedy: MEC subsurface removal using dynamic AGC detection and cued AGC

On this example site, the team decided to use a two-step AGC dynamic survey followed by cued AGC classification. The work could also have been done using a single-pass AGC system. Appendix A shows example MQOs for the single-pass approach.

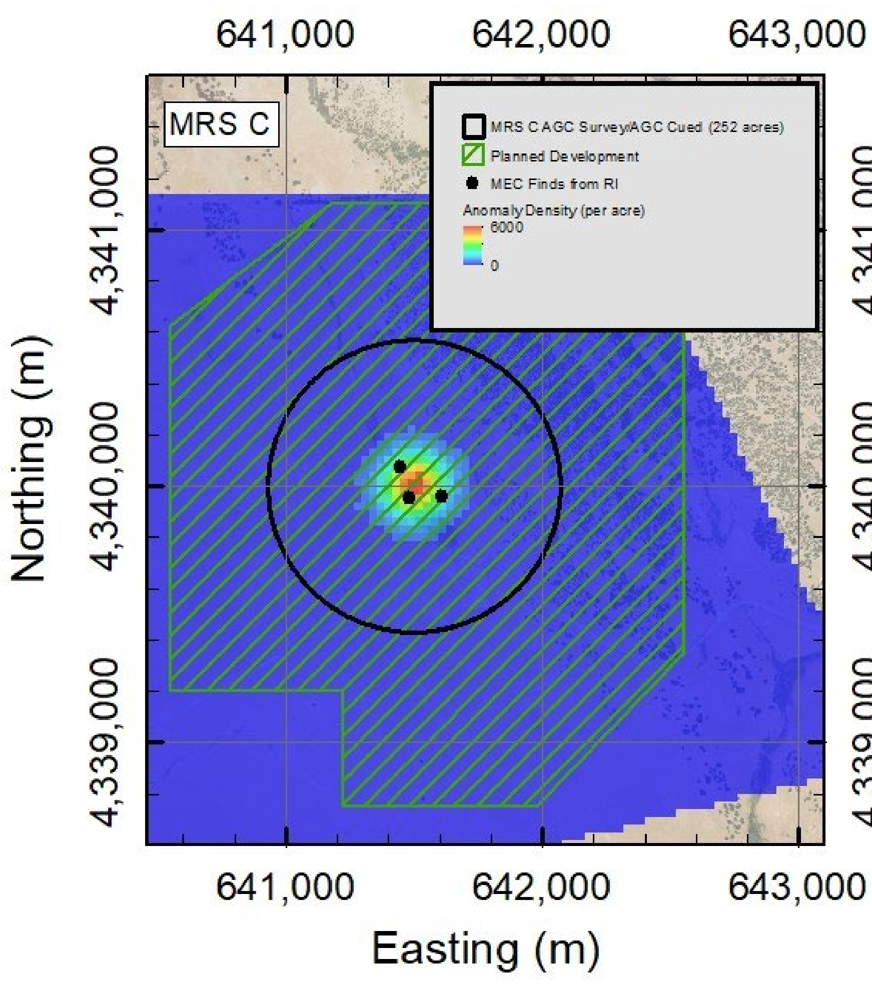

Figure 17-5: MRS C

DFW 1: Conduct site preparation (contractor and lead organization)

Describe activities that must be completed prior to collecting geophysics data. This should include vegetation reduction, surface sweep, construction of silt fences or other barriers, if needed (for example, to prevent access by or exposure to potential receptors during site activities), and activities to preserve cultural resources or sensitive habitats, if needed. Describe procedures used to establish and document survey boundaries, including the use of control points for data positioning, and the establishment of survey units. Indicate observations and information that the site preparation team will be recording to enhance the initial CSM.

Contractor: The contractor will conduct site preparation activities in the survey area, as well as any areas needed for equipment ingress/egress. [Specifications: MPCs__, SOPs __, MQOs___]

- No vegetation removal is needed on this site.
- A professional licensed surveyor will establish survey control points, survey boundaries, and survey units of 50 acres.
- A surface sweep team comprising qualified UXO technicians will conduct a surface sweep to remove all exposed or partially exposed potential MEC items. The team will also remove sufficient metallic objects that are equal to or greater than 1”x2” to permit successful dynamic and cued AGC data collection and analysis.
- The team will document the type (mark/mod), location, quantity, and estimated mass of objects removed, and will note any observations from the visual inspection that contribute to identifying the locations of specific munitions-related activity. The team will note any indication of conditions that will interfere with the geophysics or are inconsistent with the CSM. If evidence of any unexpected munitions is encountered, the munitions will be added to the classification library.
- Following the lead organization’s inspection of the surface sweep, the contractor will [describe remaining site preparation activities]. Detailed procedures are contained in SOP(s) __ [list relevant SOPs].

Documentation: Surface sweep technical memorandum, including field observations; database of control points and survey units

Lead organization: Following the surface sweep, the lead organization (or designee) will review and accept the surface sweep technical memorandum.

Decision rule: If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]

DFW 2: Conduct anomaly density reduction activities in high density areas (contractor and lead organization)

Contractor: In the area where the anomaly density estimated from the RI is too high to permit the use AGC mapping (this value is to be determined on a project-specific basis) describe procedures for removing sufficient anomaly sources to achieve an acceptable anomaly density for dynamic AGC mapping and cued classification. Describe the method for verifying that the final anomaly density meets criteria.

Contractor: The estimated anomaly density from the transects and the grid data collected during the RI indicate the presence of a 6-acre area where the anomaly density exceeds 3500/acre. [Specifications: MPCs__, SOPs __, MQOs___]

- A team comprising qualified UXO technicians will conduct an analog Mag-and-Dig sub-surface sweep to remove sufficient metallic items so that the anomaly density in this area conforms to the project-specific MPC of ≤ 3500/acre.

- The team lead will document the type, quantity, and estimated mass of objects removed in each lane, and will note any observations that are inconsistent with the CSM.

Lead Organization: The lead organization or designee will inspect the area and verify the remaining anomaly density by surveying three randomly selected ¼-acre grids with the AGC system.

Documentation: GIS, anomaly density reduction memorandum

DFW 3: Conduct QC seeding, validation seeding, and construct IVS (contractor and lead organization)

Contractor: Describe the contractor's placement of blind QC seeds and construction of the IVS. Provide the rationale for the types, number, and placement of QC seeds. Describe procedures for assuring the QC seeds remain blind to the data collection and data analysis teams. Describe procedures for constructing the IVS, including the number, descriptions, depths, and orientation of seed items.

Lead organization: Describe the placement of validation seeds by or on behalf of the lead organization. The details of the seed planning are included here for completeness. These details could be documented in the Seed Plan instead.

Contractor: The contractor will construct an IVS and place QC seeds in the area to be surveyed. [Specifications: QC Seeding Plan, QC firewall plan, IVS Plan, QA seeding plan, MPCs__, SOPs __, MQOs___, draft verification/validation plan]

- The lead or project geophysicist supported by a qualified UXO escort will select a location free of existing anomalies that is 2 m wide and 25 m long. The geophysicist and UXO technician will emplace two small ISO80 at a minimum separation distance of 5 m. The site team selected small objects for the IVS because potential hazardous munitions components that may be encountered are small. The field geophysicist using RTK GPS will survey the location of each object in the IVS and record the as-buried positions.
- The UXO QCS and seeding team will emplace QC seeds to support the MQOs described in Worksheet #22 at a frequency to support one encounter per team per day. The dynamic AGC survey will require approximately 325 survey days to complete and therefore 325 seeds would be required. Estimating a production rate of 180 cued locations per team-day, the acquisition of cued AGC data will require 834 survey team-days and 834 seeds. The digging will require approximately fifty team-days to complete; therefore, the seed numbers are determined by the cued data acquisition. To ensure against any lags in production rate, the contractor will emplace 900 seeds throughout MRS C. All seeds will be small ISO80s buried throughout the range to a depth of 30 cm in a horizontal orientation, with the depths biased to deeper depths.
- The team will survey and record the location of each QC seed.
- The contractor will establish and document an internal firewall between the QC activities and the field and data analysis activities following procedures outlined in SOP__.

Lead Organization: The government team will emplace validation seeds to support the MQOs described in Worksheet #22. The government team will survey and record the location of each QA seed.

Documentation: Report or spreadsheet documenting the as-built seed locations for the IVS, validation seeds, and QC seeds

DFW 4: Assemble and verify correct operation of AGC sensor to be used for the detection survey (contractor)

Describe procedures to be used to assemble and verify correct operation of the detection system (initial function test). Describe procedures for testing sensor operation at the IVS. Refer to SOPs.

Contractor: The field geophysicist will assemble the TEMTADS and verify correct operation by: [Specifications: Instrument assembly checklist, MPCs__, SOPs __, MQOs___].

- Conducting an initial function test
- Testing the system at the IVS

Documentation: Completed instrument assembly checklist; IVS memorandum

DFW 5: Conduct detection survey (contractor)

Describe the equipment and procedures that will be used to conduct the detection survey, including ongoing field QC activities (e.g., ongoing function tests). Describe requirements for detection and positioning. Describe and provide the rationale for coverage specifications (based on sensor geometry and sizes of targets). Describe how the site will be partitioned to conduct field work. Describe how lanes will be established and marked, if necessary.

Contractor: The field team will use a cart-pushed 1-m wide TEMTADS to collect data in MRS C. [Specifications: MPCs__, SOPs__, MQOs__]

- The detection survey will take place in 50-acre survey units, as designated in DFW 1.
- The system will be equipped with cm-level GPS and an electronic navigation system for following the data collection plan and geolocating the sensor readings.
- Lanes will be spaced 80 cm apart to minimize the likelihood of data gaps.
- The operator will maintain a down-track speed that does not exceed 1 m/s.
- The field geophysicist will review data twice daily at the conclusion of morning and afternoon data collection sessions.
- The QC geophysicist will perform QC activities as indicated in Worksheet #22, including specified visits to the IVS and daily assessments of data completeness.
- The team will document field observations of site conditions that may aid in interpreting the geophysical data and supporting the CSM, including the location and nature of indications of munitions or non-munitions related activity encountered.
- Detailed procedures are contained in SOP(s) __.

Documentation: Field notes, daily IVS summaries, daily QC reports, weekly QC reports.

DFW 6: Conduct data processing, select anomalies for cued data collection, and conduct detection survey DUA (contractor and lead organization)

Contractor: Describe the procedures that will be used to process the detection data, validate the detection data (Worksheet #35 may be referenced), document locations to be used for background data collection during cued data collection, and select anomalies for cued data collection. Describe the process to identify any unanticipated SRAs in the data and how such areas will be investigated or documented. Describe the review and acceptance process by the lead agency.

Lead Organization: Describe the process for review and acceptance of target selection memoranda. For large sites where work may proceed to subsequent DFWs in work units, describe the sequence and timeline of this process. Reference the communication flow as described in WS 6 and 9.

Contractor: The contractor will conduct data processing, [Specifications: MPCs__, SOPs__, MQOs__]

- All data will be delivered to the government in survey units of 50 acres. All data processing validation checks will be performed per survey unit. The formal detection survey DUA will be conducted when all survey units are completed.
- The project geophysicist or designee will verify that all information is complete for each day of field activities and any changes or exceptions are documented and have been reported in accordance with requirements.
- The project geophysicist or designee will preprocess the data as described in SOP__.
- The project geophysicist or designee will document the boundaries of any inaccessible areas or unanticipated SRAs and describe the approach to resolving them.
- The project geophysicist or designee will perform informed source selection (ISS) as described in SOP__ to select and record the location of all anomalies that meet the criteria necessary to reliably detect a 100-lb bomb lying horizontally at a depth of 1.2 m (bedrock). These criteria will also detect the other munitions components IOC to their required depths.
- The project geophysicist or designee will identify the next 200 anomalies beyond the ISS threshold for verification.
- From segments of the data where no anomalies are present, the project geophysicist or designee will measure the RMS background noise. This will be done in more than one location and the contractor will note any areas where SNR > 5 cannot be achieved for 100-lb bomb at a depth of 1.2 m.
- The QC geophysicist will confirm that all QC seeds have been selected
- The project geophysicist or designee will recommend locations where AGC background measurements should be collected.
- The project geophysicist or designee will determine if any parts of the site have remaining anomaly densities that are unsuitable for AGC. The contractor will repeat DFW 2 if necessary to conduct additional anomaly-reduction processes and remap areas, as necessary. Detailed procedures are contained in SOP(s) __.

Lead organization:

- The lead organization will determine whether all validation seeds have been selected and inform the contractor of any missed seeds.
- The lead organization will review and accept target selection memoranda on survey units of the site as they are completed.

Lead organization, contractor, and regulator: Conduct the detection survey DUA and update the CSM.

Documentation: Target selection technical memorandum (data analysis, anomaly density, list of selected anomalies, recommended background locations), maps (depicting data and coverage, anomaly density, and selected anomalies), weekly QC reports, detection survey DUA report, updated CSM.

Decision rules:

- If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]
- If signals meet the anomaly selection criteria for ISS, they will be selected for cued data collection using AGC.

DFW 7: Assemble advanced geophysical sensor and test sensor at IVS (contractor)

Describe procedures to be used to assemble any additional advanced geophysical sensors that will be used to collect cued data and verify their correct operation (initial function test and initial cued survey IVS). Reassess the appropriateness of the IVS.

Contractor: The field geophysicist will assemble the TEMTADS and verify correct operation by: [Specifications: Instrument assembly checklist, MPCs__, SOPs __, MQOs___].

- Conducting an initial function test
- Testing the system at the IVS

The IVS from the detection survey is suitable for the classification survey.

Documentation: Completed instrument assembly checklist; IVS memorandum

DFW 8: Collect cued data (contractor)

Describe procedures for locating each anomaly identified for cued data collection, positioning the sensor, collecting the cued data, and conducting field inversions (i.e., quick checks by field personnel to confirm the acquired signal is representative of the target anomaly). Describe the procedures and frequency for conducting ongoing function tests and collecting cued background data. Describe procedures and frequency for verifying ongoing operations at the IVS and conducting field QC.

The field geophysicist or designee will use TEMTADS in its standard cart configuration to collect data over the selected cued locations. Detailed procedures are contained in SOP(s) __. [Specifications: MPCs __, SOPs__, MQOs__]. Specifically,

- The field geophysicist or designee will conduct function tests at the beginning, middle and end of each survey day.
- The field geophysicist or designee will test the system at the IVS at the beginning and end of each survey day.
- The field geophysicist or designee will reacquire anomalies, collect cued data, and record field observations.
- The field geophysicist will collect background validation and ongoing background data.
- The field geophysicist or designee will conduct an immediate real-time screening of cued data to determine whether metrics for position offset were achieved. Failures identified in the field evaluation will be immediately recollected.
- The field geophysicist will collect cued data over the 200 verification anomalies identified.
- The field geophysicist will conduct field inversions and ongoing QC.
- The QC geophysicist will validate cued data (evaluate conformance to SOPs and field MQOs).

Documentation: Daily IVS summaries, daily & weekly QC reports

DFW 9: Conduct data processing, classify anomalies, construct ranked anomaly list, and conduct cued survey DUA (contractor, lead organization, and regulator)

Contractor: Describe the procedure for processing the data. Describe procedures for removing the effects of background signals on the advanced sensor data to isolate the signature from the buried metal object. Describe the software and procedures for generating the polarizability curves that will be the basis for classification. Describe procedures for classifying anomalies. Specify relevant aspects of the classification process, i.e., how well the signature matches the library data (Worksheet #22 contains specifications for library fit coherence). Specify analysis procedures to be used in cases where the signature does not match a library signature but either 1) is a member of a cluster of numerous similar signatures that should be investigated as potential TOI or 2) exhibits properties consistent with those of a munition not contained in the library. Describe the methods and reasoning for setting the dig/no-dig threshold.

Contractor: The contractor will process the data using UX-Analyze as described in SOP__. [Specifications: MPCs __, SOPs__, MQOs__]

- All data will be delivered to the government in survey units of 50 acres. All data processing validation checks will be performed per survey unit. The formal cued survey DUA will be conducted when all survey units are completed.
- The project geophysicist or designee will use UX-Analyze as described in SOP__ to process the data daily to produce target polarizability curves and perform library matches to identify TOI.
- TOI will include 1) all anomalies that match to a library member, 2) clusters of items not in the library that have similar polarizability curves and require investigation, and 3) anomalies with polarizability curves that suggest the properties of a munition (i.e., long, narrow, and axisymmetric or spherical).
- All data and the TOI list will be passed to the QC geophysicist who will determine whether all seeds were correctly classified and verify that all QC metrics in Worksheet #22 were achieved. Any missed QC seeds will be reported to the government accompanied by an RCA/CA.
- The project geophysicist or designee will create a ranked anomaly list, arranged in order from highest likelihood the object is a TOI to highest likelihood the object is a non-TOI. The project geophysicist or designee will identify the threshold that will separate TOI and non-TOI to create a dig list as described in SOP__.
- The project geophysicist or designee will identify additional potential "threshold verification" targets such that 200 targets beyond the initial threshold will be identified. These targets will be the next targets below the TOI/non-TOI threshold in order. For example, if the last IOC recovered from the ranked list is 100 places before the threshold, an additional 100 of the threshold verification digs will be conducted. If the last target on the dig list is an IOC, an additional 200 targets will need to be dug. If no additional IOC are recovered, the threshold will be considered verified.
- The project geophysicist or designee will assemble a dig list to include all TOI, any signals that could not be analyzed, and the threshold verification targets.
- The project geophysicist will determine if any IOCI are in the 200 verification targets.

Lead organization: The QA geophysicist will review any missed QC seed RCA/CA and approve or make recommendations to the contractor for modifications. The QA geophysicist will review all TOI lists to determine whether all validation seeds were correctly classified and inform the contractor of any failures (all information about the missed seed). The QA geophysicist will review data submissions for conformance with metrics in Worksheet #22. The lead organization will review and accept the classification results. The lead agency will review interim spread sheets and inform the contractor if any validation seeds are not on the preliminary dig lists.

Documentation: Database (library match results), TOI/non-TOI classification spreadsheet, figures & maps (classification decision plots), ranked anomaly list, dig list, weekly QC reports, cued survey DUA report)

Decision rules:

- If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]
- If AGC analyses meet any of the following criteria, they will be selected as TOI and placed on an ordered dig list:
    - The polarizability decay curve matches that of an item in the project-specific TOI library, or
    - Estimates of the size, shape, symmetry, and wall thickness indicate the item is long, cylindrical or spherical, and thick-walled, or
    - There is a group (cluster) of unknown anomalies having similar polarizability decay curves that, after investigation, are discovered to be IOC. The procedure for designating a cluster, including criteria for similarity and number of items are described in SOP ___.
- If AGC analyses yield inconclusive results curves, they will be added to the dig list or otherwise resolved.

DFW 10: Excavate buried objects (contractor)

Describe procedures to reacquire and flag anomalies selected for intrusive investigation and investigate anomalies. This includes selecting the threshold verification targets.

Contractor: [Specifications: Dig list, MPCs__, SOPs__, MQOs__]

- The excavation will take place in survey units of 50 acres. All validation checks will be performed per survey unit. The formal final DUA will be conducted when all survey units are completed.
- The field geophysicist or designee with a UXO technician escort will use a RTK cm-level GPS to relocate anomaly locations and emplace plastic pin flags.
- The intrusive team comprising qualified UXO technicians will navigate to each pin flag and conduct intrusive operations. All digging will be conducted according to the detailed procedures described in SOP__.
- For each anomaly location, the intrusive team will record the approximate size, depth, and specific information that can be obtained about the identity of the source.
- If any clusters are identified, the CSM will be revised to include their locations and sources. If they are munitions, their signatures will be added to the library.
- If excavation of any anomalies that were deemed munitions-like are found to be munitions, their signatures will be added to the library.
- The intrusive team lead or designee will photograph each recovered item for later comparison with AGC analysis.

Documentation: Database of excavation results (locations and descriptions), photographs, weekly QC reports

Decision rules:

- If field observations are consistent with the CSM, the project team will continue with the remedial action under the current assumptions.
- If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design. [This applies at any point in the process where such observations occur.]
- If any clusters are identified, the CSM will be revised to include their locations and sources. If they are munitions, their signatures will be added to the library.
- If excavation of any anomalies that were deemed munitions-like are found to be munitions, their signatures will be added to the library.

DFW 11: Verify dig/no-dig threshold, update verification/validation plan, and conduct cued survey DUA (contractor, lead organization, and regulator)

Describe procedures for evaluating verification digs. If necessary, adjust the TOI/non-TOI threshold and identify additional threshold verification targets such that there are 200 non-TOI targets on the ranked anomaly list below the final threshold. Once the final threshold has been verified, identify final classification validation targets.

Contractor: The QC geophysicist will determine whether any IOC are in the 200 verification digs. [Specifications: MPCs__, SOPs__, MQOs__]

- The intrusive team will excavate items from the threshold verification list such that 200 items beyond the last IOC recovered are investigated.
- If an IOC is found in the threshold verification list, the contractor will conduct an RCA/CA and the team will reevaluate the threshold selection.
- After determination of a new threshold, the threshold verification will be repeated by selecting another 200 targets past the last IOC in the list at the new threshold. For example, if the last IOC recovered from the ranked list is 100 places before the threshold, an additional 100 of the threshold verification digs will be conducted. If the last target on the dig list is an IOC, an additional 200 targets will need to be dug. If no additional IOC are recovered, the threshold will be considered verified.

Contractor, lead organization, and regulator: Once a final threshold has been established, the project team will conduct the cued survey DUA, select 200 classification validation targets, review the draft verification/ validation plan, and make changes, as necessary. For each validation target, the team will document the characteristics that resulted in the non-TOI designation. [Note: The classification validation targets will be selected to address any questions or uncertainties in the data if present. Randomly selected targets will make up the remainder of the 200.]

Documentation: Comparison results, final verification/validation plan

Decision rule: If the threshold verification digs do not uncover any IOC as described above, then the threshold is verified. If any IOC are recovered, then the project team will conduct RCA/CA that results in adjustment of the threshold and determination of the impacts on the project objectives.

DFW 12: Excavate and evaluate classification validation targets and conduct post-dig verification (contractor)

Describe procedures to reacquire and flag anomalies selected for intrusive investigation and investigate anomalies. Describe procedures for evaluating validation digs.

Contractor: Specifications: Final verification/validation plan, MPCs__, SOPs__, MQOs__]

- The field geophysicist or designee with a UXO technician escort will use a RTK cm-level GPS to relocate anomaly locations and emplace plastic pin flags.
- The intrusive team comprising qualified UXO technicians will navigate to each pin flag and conduct intrusive operations. All digging will be conducted according to the detailed procedures described in SOP__.
- For each anomaly location, the intrusive team will record the approximate size, depth, and specific information that can be obtained about the identity of the source.
- The intrusive team lead or designee will photograph each recovered item for later comparison with AGC analysis. [Specifications: Dig list, MPCs__, SOPs__, MQOs__]
- The QC geophysicist will determine whether any IOC are in the 200 validation digs. If an IOC is found in the validation digs, the contractor will conduct a QA stand-down and recommendation for CA, and the site team will determine the next steps.
- For each recovered classification/validation object, the QC geophysicist will compare the characteristics of the object to the AGC results. If any properties are inconsistent, the project team will conduct an RCA/CA and determine the impacts on project objectives.
- For all locations where digging was conducted, the contractor will re-interrogate the location with the AGC sensor to verify the original polarizability no longer exists for TOI and that inconclusive analyses have been resolved.

Documentation: Comparison results

Decision rules:

- The geophysical classification results will be valid if:
  - validation digs do not uncover any IOC and
  - the properties of all recovered objects are consistent with predicted properties
- If the validation digs uncover any IOC as described above, the project team will conduct a QA stand-down and evaluate the impacts on MPCs and DQOs.
- If the properties of recovered objects are inconsistent with predicted properties, the project team will conduct an RCA/CA and determine the impacts on the achievement of MPCs and DQOs.

DFW 13: Conduct MPPEH handling and disposal (contractor)

Briefly describe the procedures for handling and disposal of MPPEH.

Contractor: MPPEH will be handled and disposed of as described in SOP__ [Specifications: Explosives Safety Plan, MPCs__, SOPs__, MQOs__]

Documentation: Disposal records

DFW 14: Conduct final DUA (contractor, lead organization, and regulator)

Briefly describe procedures to conduct the final DUA. (Refer to Worksheet #37 for detailed procedures.

Contractor, lead organization, and regulator:

- Conduct final DUA
- Evaluate UU/UE lines of evidence

Documentation: Final DUA, final report, updated CSM, UU/UE memorandum

Decision rule: If all lines of evidence are complete and support UU/UE, the project team will develop documentation supporting UU/UE for consideration by final decision-makers. If lines of evidence are incomplete, or any line of evidence does not support UU/UE, the project team will develop documentation rejecting UU/UE for consideration by final decision-makers.

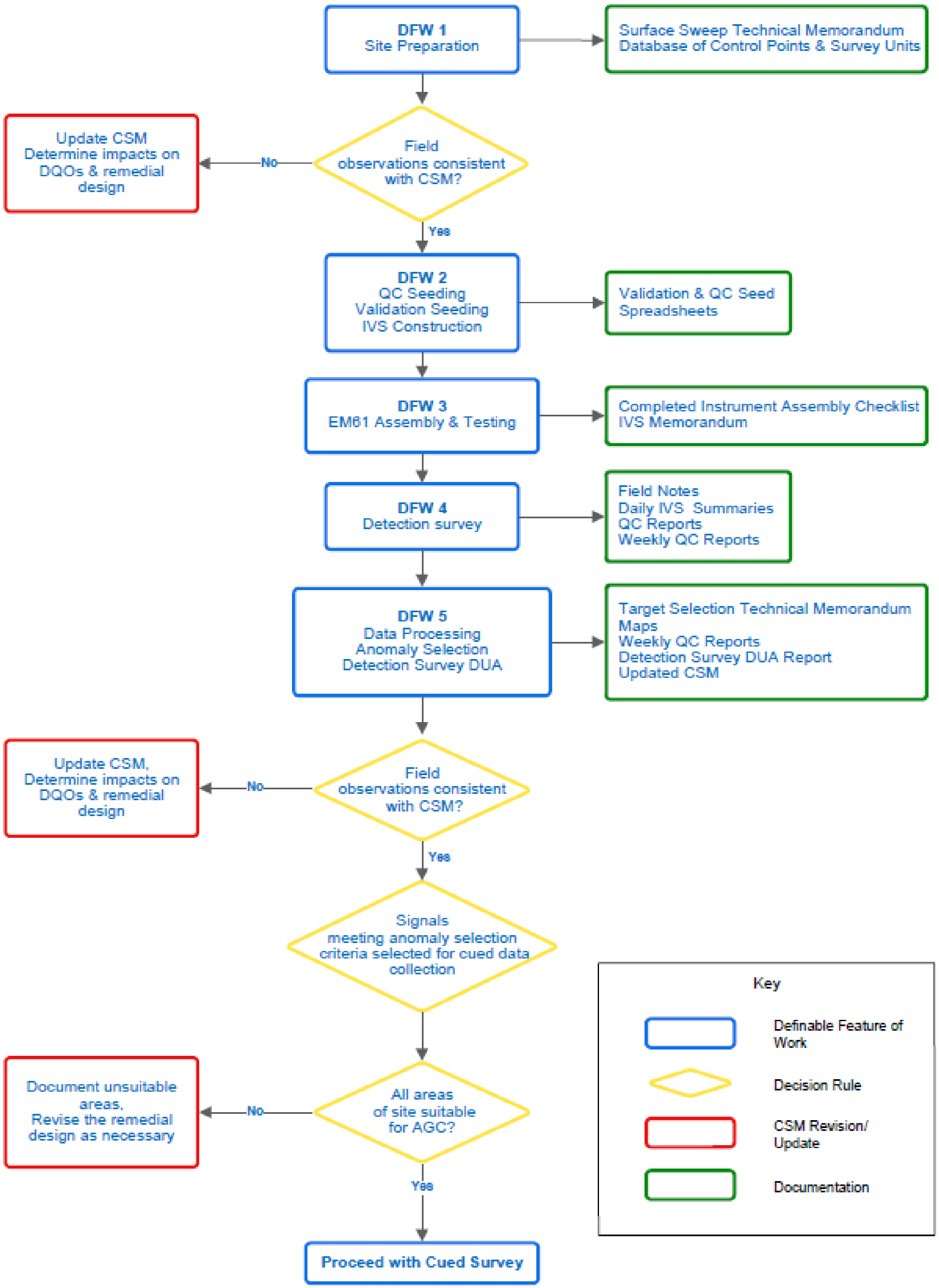

Figure 17-6: MRS A1 Decision Diagram

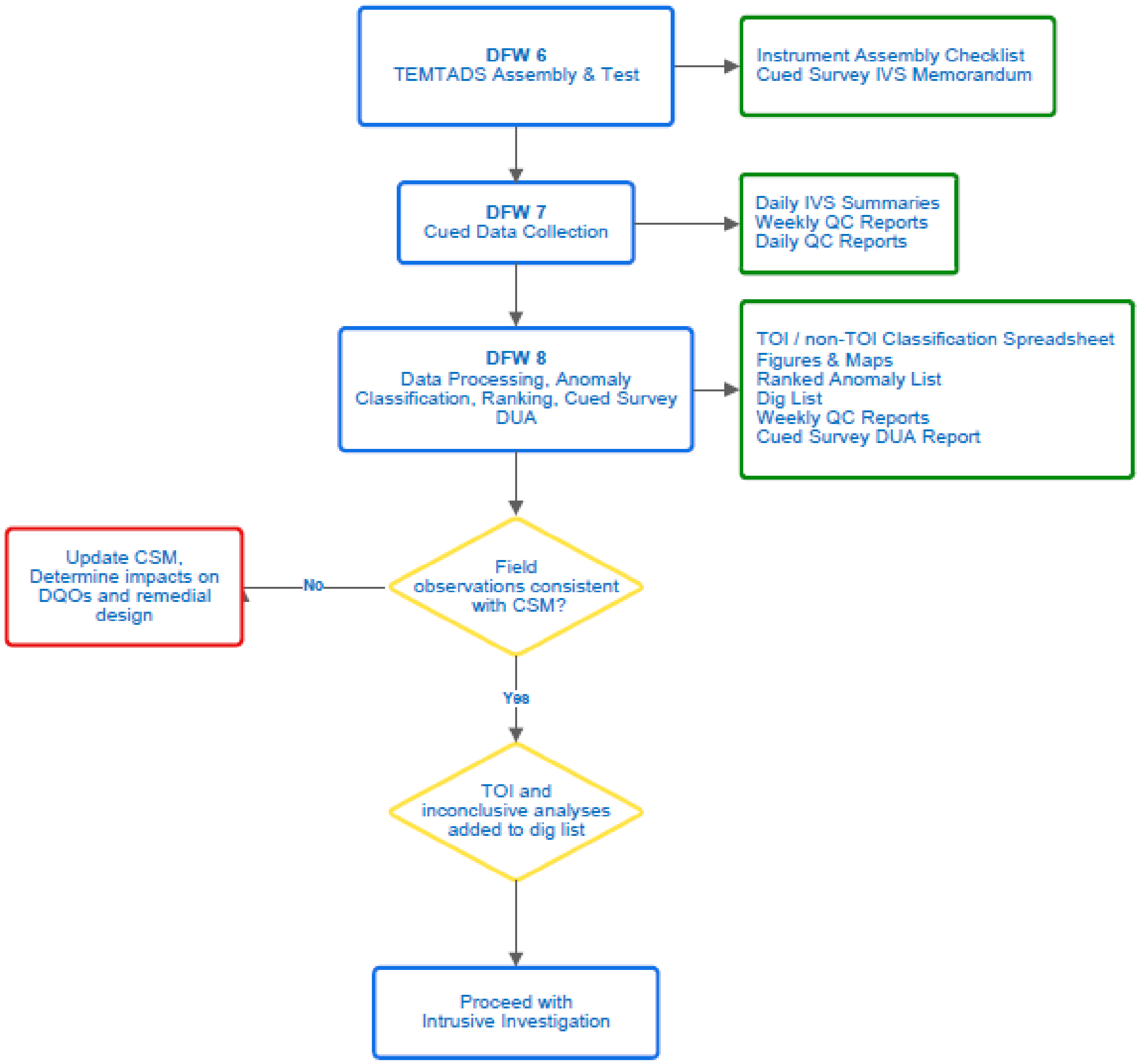

Figure 17-6: MRS A1 Decision Diagram (Continued)

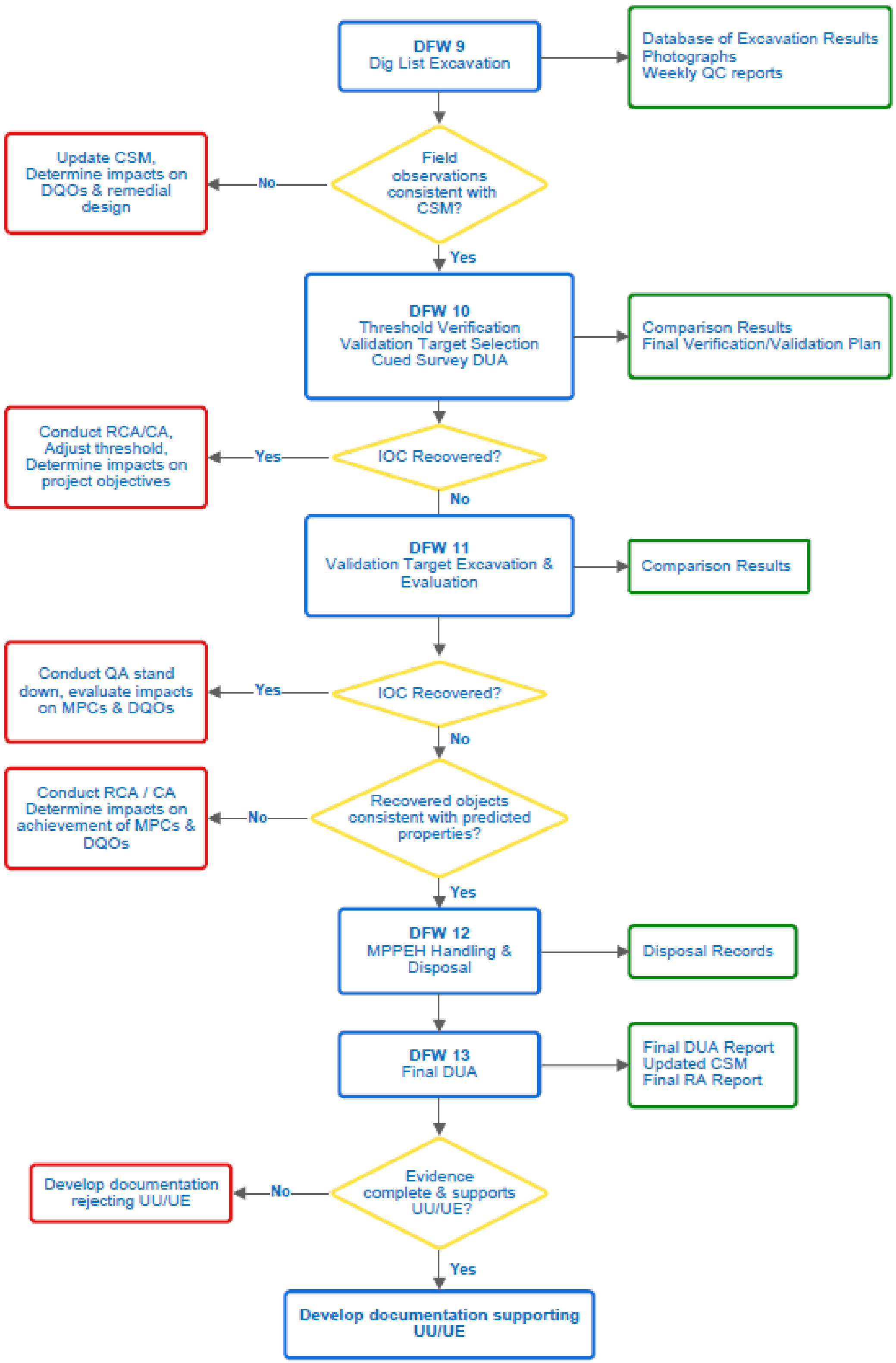

Figure 17-6: MRS A1 Decision Diagram (Continued)

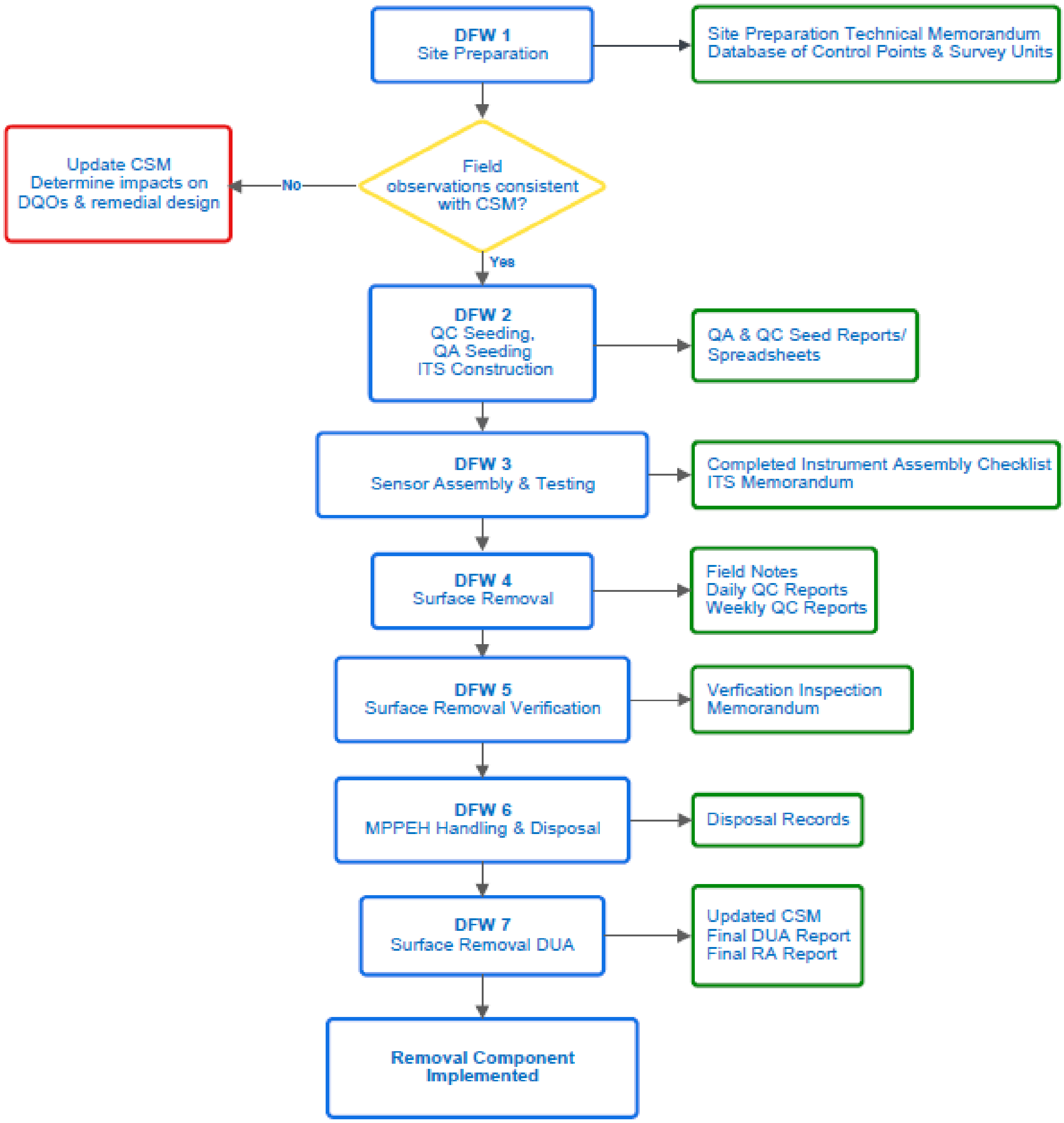

Figure 17-7: MRS A2 Decision Diagram

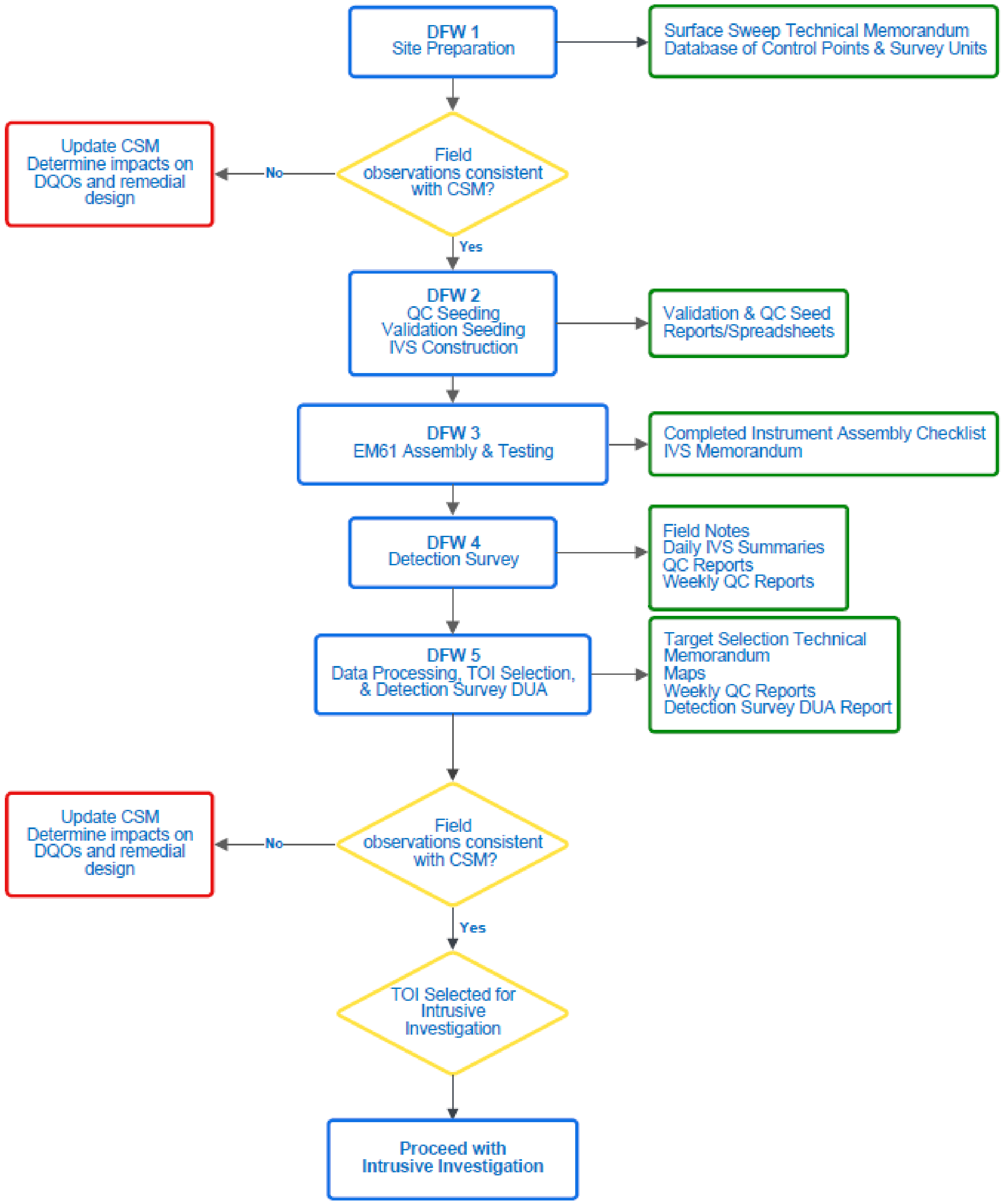

Figure 17-8: MRS B1 Decision Diagram

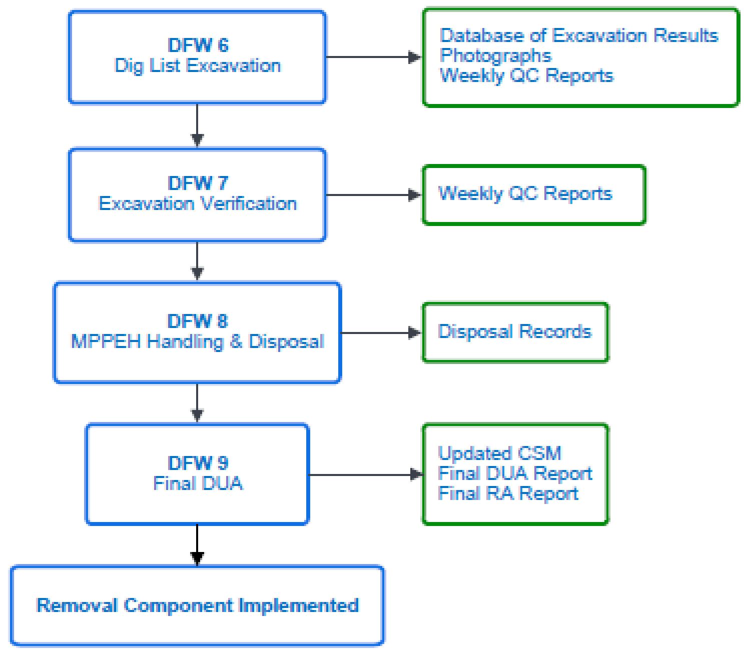

Figure 17-8: MRS B1 Decision Diagram (Continued)

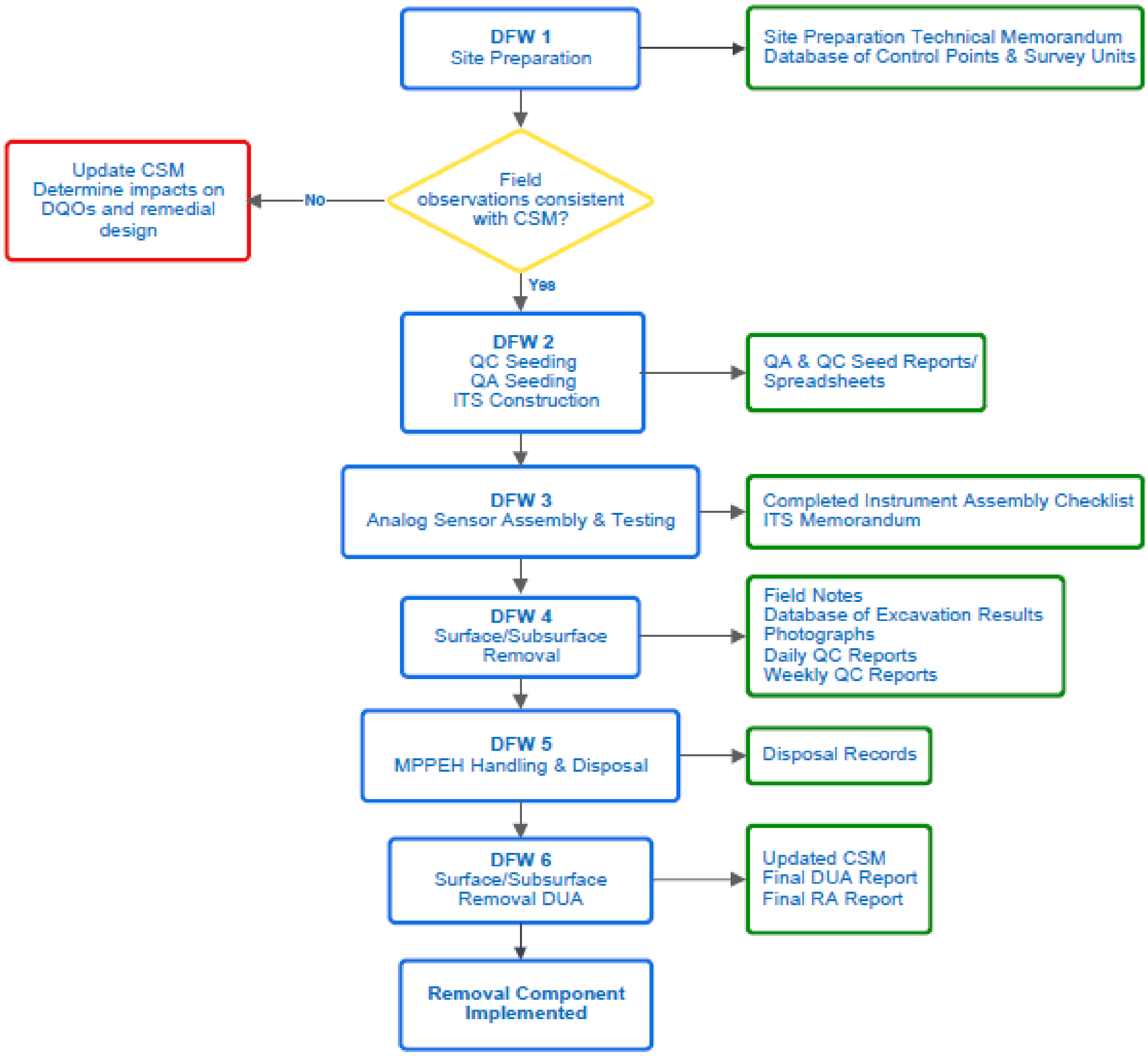

Figure 17-9: MRS B2 Decision Diagram

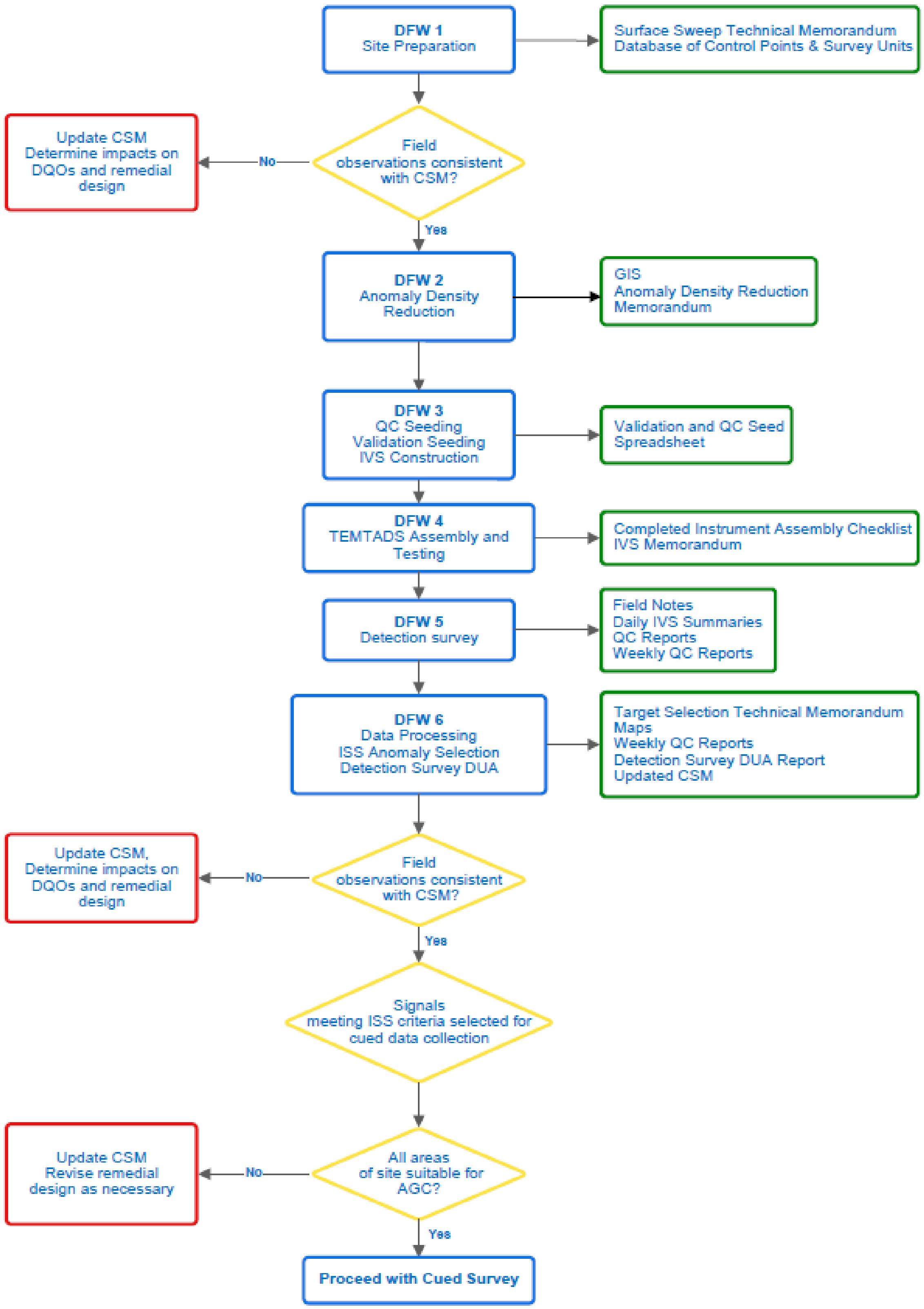

Figure 17-10: MRS C Decision Diagram

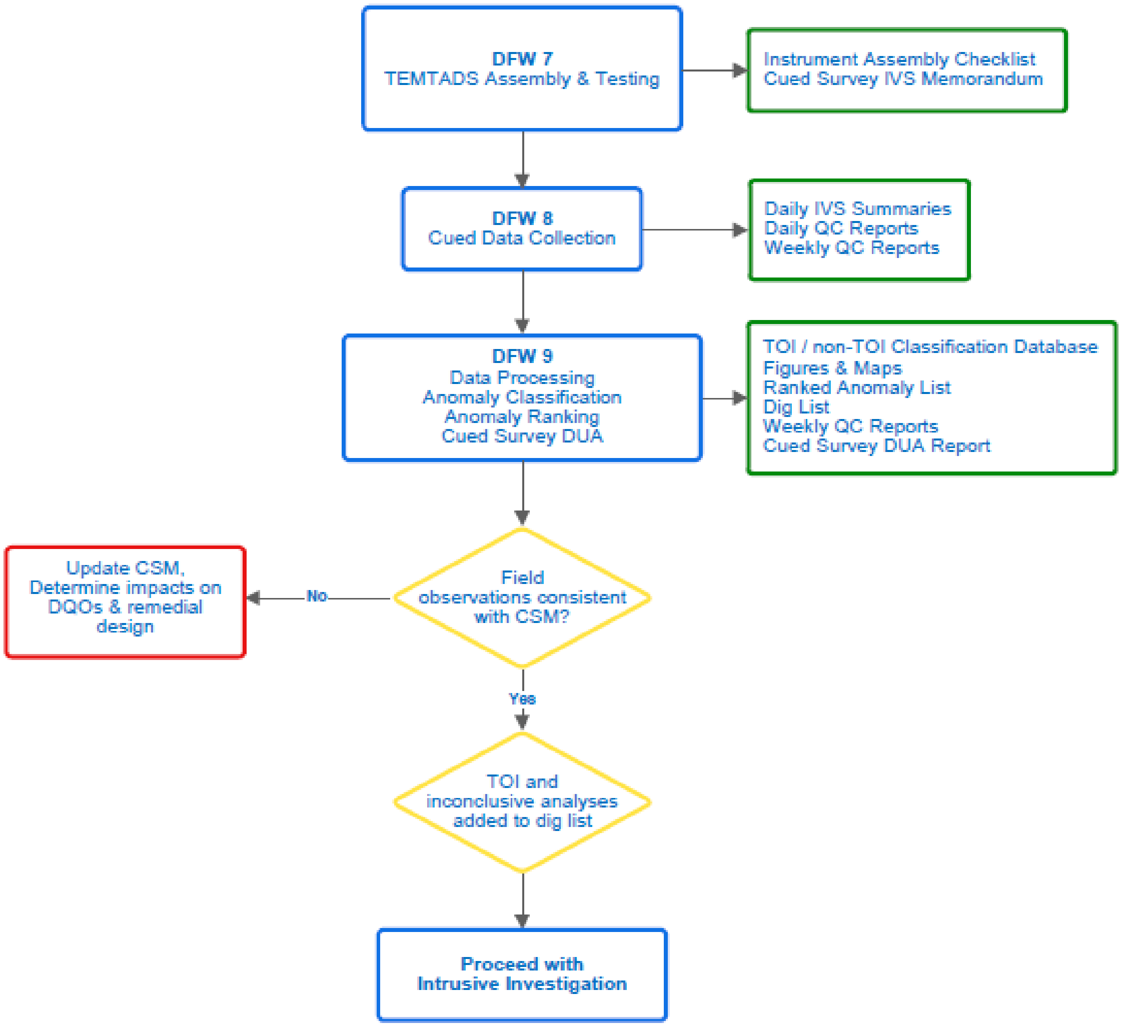

Figure 17-10: MRS C Decision Diagram (Continued)

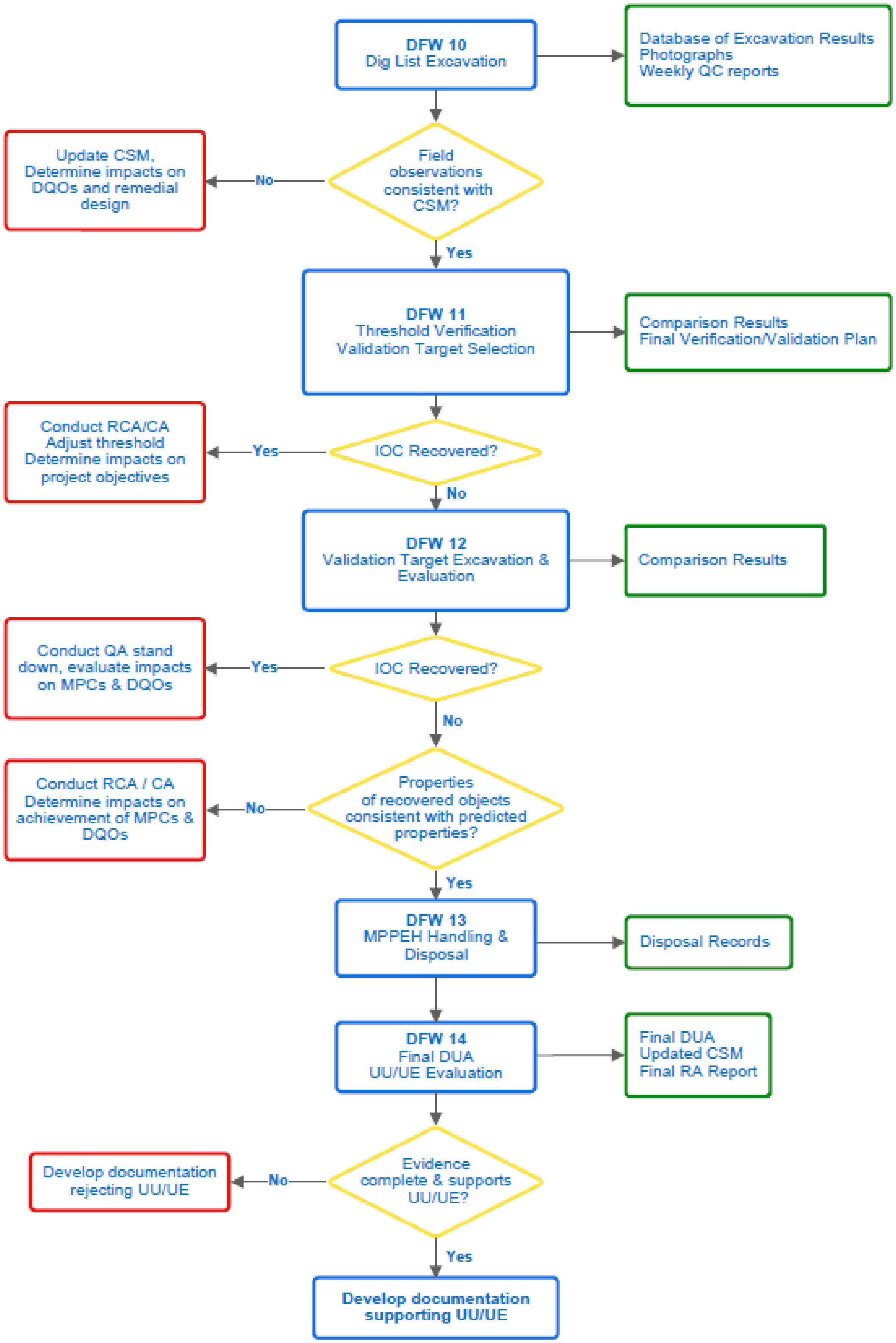

Figure 17-10: MRS C Decision Diagram (Continued)

[This page intentionally left blank.]

Worksheet #22: Equipment Testing, Inspection, and Quality Control

(UFP-QAPP Manual Section 3.1.2.4)

This worksheet documents procedures for performing testing, inspections, and quality control for all field data collection activities. Failure response must include a root cause analysis (RCA) to determine the appropriate corrective action (CA). Examples are provided in blue text. Minimum recommended specifications are provided in black text. The project-specific QAPP must explain and justify any changes to black text, which are subject to regulatory approval. An appendix may be used for this purpose. The following tables include MQOs that apply to each of the examples. The MQO# should be assigned on a project-specific basis and included in WS #17. To assist users in preparing site-specific MR-QAPPs, Appendix C provides MQOs organized according to technology.

Table 22-1: MRS A1 – MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC

Site Preparation [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Survey control (loop closure)		At beginning of project	Project Geophysicist or Surveyor/ Survey Control Report/ QC Geophysicist	All loop closures within 0.05 m (if established from existing monument(s)) Estimated accuracy from static GPS occupation calculations (e.g., OPUS) less than or equal to 0.05 m.	RCA/CA: reset survey monuments
Construct IVS: Verify as-built IVS against design plan (DGM)		Once following IVS construction	Project Geophysicist/ IVS Technical Memorandum/ Lead Organization	Small ISO seed items buried at 0.15 m; All seeds buried horizontally in the cross-track orientation	RCA/CA: Make necessary changes to seeded items and re-verify

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Site Preparation [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Construct Instrument Test Strip (ITS): Verify as-built ITS against design plan (Analog sensors)		Once following ITS construction	SUXOS/ ITS Technical Memorandum/ UXOQCS	Small ISO seed items for analog methods buried at 0.30 m; All seeds buried horizontally in the cross-track orientation	RCA/CA: Make necessary changes to seeded items and re-verify
Verify correct assembly (All sensors)		Once following assembly	Field Team Leader/ Instrument Assembly Checklist/ Project Geophysicist	As specified in Assembly Checklist	RCA/CA: Make necessary adjustments and re-verify
Initial instrument function test: Five measurements over a small ISO80 target, one in each quadrant of the sensor and one directly under the center of the array; Derived polarizabilities for each measurement are compared to the library (AGC)		Once following assembly	Field Team Leader/ Instrument Assembly Checklist/ Project Geophysicist	Library match metric ≥ 0.95 for each of the five sets of inverted polarizabilities	RCA/CA: Make necessary adjustments, and re-verify

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Site Preparation [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Initial Instrument Function Test (Non-AGC DGM)		Once following assembly	Field Geophysicist/ Initial IVS Memorandum/ Project Geophysicist	Response (mean static spike minus mean static background) within 20% of predicted response	RCA/CA: Make necessary adjustments, and re-verify
Initial Instrument Function Test (Analog)		Once upon arrival at project site	Field Geophysicist or UXO Team Lead/ Initial IVS Memorandum/ Project Geophysicist or designee	Audible response consistent with expected change in tone in presence of standard object	RCA/CA: Make necessary adjustments, and re-verify
Initial detection survey positioning accuracy (IVS) (DGM)		Once prior to start of data acquisition	Project Geophysicist/ IVS Memorandum/ QC Geophysicist	Derived positions of IVS target(s) are within 0.25 m of the ground truth locations	RCA/CA: Make necessary adjustments, and re-verify
Initial detection survey Check for interference surrounding seed response (IVS) (All sensors)		Once prior to start of data acquisition	Project Geophysicist/ IVS Memorandum/ QC Geophysicist	All seeds placed in locations that are free of detected anomalies within a radius of ≥ 1.5 m	RCA/CA; and re-verify MQO
Initial derived polarizabilities accuracy (IVS) (AGC)		Once during initial system IVS test	Project Geophysicist/ IVS memorandum/ QC Geophysicist	Library Match metric ≥ 0.9 for each set of inverted polarizabilities	RCA/CA

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Detection Survey [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Geodetic Equipment Function Test		Daily (RTK GPS) Each time equipment is moved (robotic total station RTS))	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	Measured position of control point within 0.10 m of ground truth	RCA/CA; document questionable information in database
Ongoing instrument function test (Non-AGC DGM)		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	Response (mean static spike minus mean static background within 20% of predicted response	RCA/CA: Make necessary repairs and reverify
Ongoing instrument function test (Analog- Surface sweep)		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	Audible response consistent with expected change in tone in presence of object with documented response	RCA/CA
Ongoing instrument settings check (Analog)		Hourly	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	All instrument settings adjusted to [insert instrument-specific specification]	RCA/CA
Ongoing detection survey positioning precision (IVS) (Non-AGC DGM)		Beginning and end of each day	Project Geophysicist/ Running QC Summary/ QC Geophysicist	Derived positions of IVS target(s) within 0.25 m of the average locations	RCA/CA
Ongoing detection survey seed interpretations (IVS) (Non-AGC DGM)		Beginning and end of each day	Project Geophysicist/ Running QC Summary/ QC Geophysicist	Peak response > 75% of minimum predicted response	RCA/CA

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Detection Survey [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
In-line measurement spacing (Non-AGC DGM)		Verified for each transect using [describe tool to be used] based upon monostatic Z coil data positions	Project Geophysicist/ Running QC Summary/ QC Geophysicist	99% ≤ 0.25 m between successive measurements; 100% ≤ 0.40 m. Coverage gaps are filled or adequately explained (e.g., unsafe terrain)	RCA/CA
Coverage (Non-AGC DGM)		Verified for each survey unit using (describe tool to be used)	Project Geophysicist/ Running QC Summary/ QC Geophysicist	100% ≤ instrument-specific cross-track measurement spacing (excluding site specific access limitations, e.g., obstacles, unsafe terrain) EM61-MK2: 100% <0.50 m cross-track measurement spacing (excluding site-specific access limitations, e.g., obstacles, unsafe terrain)	RCA/CA
Battery voltage (Non-AGC DGM)		Verify battery voltage is within operating specifications of sensor	Field Team Leader/ Running QC Summary/ Project Geophysicist	Voltage must be ≥ [Enter minimum instrument-specific requirement]	RCA/CA: out of spec data rejected

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Detection Survey [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Dynamic noise assessment (Non-AGC DGM)		Verified for each selected background window	Project Geophysicist / Project database/ QC Geophysicist	All receiver channels exceeding pre-defined dynamic noise threshold for (Define time gate: e.g., EM61-MK2 = 2 mV channel 2) time gate are flagged for review	RCA/CA; (SOP must address process for flagging and recollecting data as necessary)
Detection survey repeatability (Non-AGC DGM)		Blind QC seeds will be distributed such that each field team encounters an average of at least one seed per day. Seeds to be placed throughout expected detection depth range. [QC seeding design will vary between 1-3 seeds per day to account for production variability]	QC Geophysicist/ Running QC Summary/ Lead Organization QA Geophysicist	All blind QC seeds must have a response > 75% of minimum expected response and be detected and positioned within a 0.40 m radius of ground truth. [Positioning metric must be tighter than cued instrument requirements.]	RCA/CA: Verify instrument is functioning correctly; if so, reduce threshold, or determine if item is buried too deep. If instrument is not functioning correctly, recollect data. If seeding density not met, the density will be increased in subsequent survey units.

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Detection Survey [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Detection survey repeatability (non-AGC DGM)		Blind validation seeds will be distributed such that each field team encounters an average of at least one seed per day [Validation seeding design will vary between 1-3 seeds per day to account for production variability]	QA Geophysicist or 3rd party seeding contractor/ Validation Seed Log	All blind validation seeds must have a response > 75% of minimum expected response and be detected and positioned within a 0.75 m radius of ground truth. [Positioning metric must be tighter than cued instrument requirements.]	RCA/CA: Verify instrument is functioning correctly; if so, reduce threshold, or determine if item is buried too deep. If instrument is not functioning correctly, recollect data. If seeding density not met, the density will be increased in subsequent survey units.
Verification of target selection (non-AGC DGM)		Evaluated for each survey unit (post SRA)	Project Geophysicist/ QC Summary/ QC Geophysicist	All leveled data with an amplitude greater than or equal to the selection threshold are accounted for within 0.40 m of the cued footprint. [cued measurements cover the entire anomaly footprint].	RCA/CA
Verification of leveling (non-AGC DGM)		Evaluated for each survey unit	Project Geophysicist/ QC Summary/ QC Geophysicist	Leveled data with a background amplitude below zero are identified and reviewed to ensure no additional targets are present.	RCA/CA

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Detection Survey [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Verification of leveling (amplitude suppression) (non-AGC DGM)		Evaluated for 200 of the lowest amplitude anomalies selected as targets, per survey unit	Project Geophysicist/ QC Summary/ QC Geophysicist	Raw anomaly peak amplitude minus local background amplitude is within 3x RMS noise of leveled anomaly peak amplitude minus leveled local background amplitude.	RCA/CA
Geodetic Accuracy (Confirm Valid Position)		Evaluated for each measurement	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	GPS status flag indicates Real Time Kinematic (RTK) fix (RTK GPS) Robotic Total Station (RTS) passes Geodetic Function Test (RTS)	RCA/CA; document questionable information in database

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Cued Survey [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Geodetic Equipment Function Test		Daily (RTK GPS) Each time equipment is moved (RTS)	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	Measured position of control point within 10 cm of ground truth	RCA/CA; document questionable information in database
Geodetic Accuracy (Confirm Valid Position)		Evaluated for each measurement	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	GPS status flag indicates RTK fix (RTK GPS) RTS passes Geodetic Function Test (RTS)	RCA/CA; document questionable information in database
Valid Orientation Data		Evaluated for each sensor measurement	Field Team Leader/ QC Database/ Project/QC Geophysicist	Orientation data reviewed and appear reasonable within bounds appropriate to site (e.g., roll and pitch < 15 degrees absolute value)	RCA/CA

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Cued Survey [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Ongoing production area background measurements		Background data collected a minimum of every two hours during production (or more frequently, per instrument-specific requirements	Field Team Leader/ Field Log and Running QC Summary/ Project Geophysicist	Background data from a verified location collected within [Insert instrument-specific requirements, not to exceed two hours] of all cued data points	RCA/CA: Document environmental changes; Project Geophysicist must approve before proceeding.
Ongoing derived target position precision (IVS)		Beginning and end of each day as part of IVS testing	Project Geophysicist/ Running QC Summary/ QC Geophysicist	All IVS items fit locations within 0.25 m of average of derived fit locations	RCA/CA
Ongoing derived polarizabilities precision (IVS)		Beginning and end of each day as part of IVS testing	Project Geophysicist/ Running QC Summary/ QC Geophysicist	Library Match to initial polarizabilities metric ≥ 0.9 for each set of three inverted polarizabilities	RCA/CA
Ongoing Instrument Function Test (Instrument response amplitudes)		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ Running QC Summary (Excel/Geosoft)/ Project/QC Geophysicist or designee	Response (mean static spike minus mean static background) within 20% of predicted response for all Tx/Rx combinations	RCA/CA: Make necessary repairs and re-verify

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Cued Survey [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Transmit current levels		Evaluated for each sensor measurement	Field Team Leader/ Running QC Summary/ Project Geophysicist	Current must be ≥ [Insert instrument-specific requirements]	RCA/CA: stop data acquisition activities until condition corrected
Confirm adequate spacing between units		Evaluated at start of each day (or grid)	Field Team Leader/ Field Logbook/ Project Geophysicist	Separation must be > [Insert instrument-specific requirements]	RCA/CA: Recollect data
Cued interrogation		Evaluated for all non-TOI on cued list	Project Geophysicist/ UX-A Source Geosoft database/ QC Geophysicist	Offset between center of the sensor and the flag, or target, location must be ≤ 0.40 m	RCA/CA: Recollect data
Confirm inversion model supports classification (1 of 3)		Evaluated for models derived from a measurement and used to make TOI/non-TOI decision (i.e., single item and/or multi-item models)	Project Geophysicist/ UX-A Source Geosoft database/ QC Geophysicist	Derived model response must fit the observed data with a fit coherence ≥ 0.8	Follow procedure in SOP or RCA/CA
Confirm inversion model supports classification (2 of 3)		Evaluated for derived target	Project Geophysicist/ UX-A Source Geosoft database/ QC Geophysicist	Fit location estimate of item ≤ 0.40 m from center of sensor	Follow procedure in SOP or RCA/CA; if designated as TOI, no additional recollection necessary

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Cued Survey [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Confirm inversion model supports classification (3 of 3)		Evaluated for all seeds	QC Geophysicist/ Seed Tracking Log/ Lead Organization QA Geophysicist	100% of predicted seed (QC and Validation) positions ≤ 0.25 m radially from known position (x, y). Z ≤ 0 .15 m.	RCA/CA
Classification performance		Evaluated for all seeds	QC Geophysicist/ Seed Tracking Log/ Lead Organization QA Geophysicist	100% of QC/Validation Seeds classified as TOI and the correct size is predicted	RCA/CA

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Intrusive Investigation [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Geodetic Equipment Function Test		Daily (RTK GPS) Each time equipment is moved (RTS)	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	Measured position of control point within 10 cm of ground truth	RCA/CA; document questionable information in database
Geodetic Accuracy (Confirm Valid Position)		Evaluated for each measurement	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	GPS status flag indicates RTK fix (RTK GPS) RTS passes Geodetic Function Test (RTS)	RCA/CA; document questionable information in database
Documenting recovered sources		Daily	UXOQC/ GIS data recorded/ QC Geophysicist	All metallic debris collected is documented for the following attributes: Designation as MEC, MD, Seed, RRD or non-munitions-related debris (NMRD); MEC and MD described by type; weight; depth; and as TOI or non-TOI. Photos displaying all MD recovered at each target location (individual MD photos not necessary), and photos showing all surfaces of each MEC are recorded.	RCA/CA; document questionable information in database

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Intrusive Investigation [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Confirm derived features match ground truth (1 of 2)		Evaluated for all recovered items including seeds (applies only to single, compact objects [e.g., does not apply to a bed of nails or long wires])	Project Geophysicist/ Running QC Summary or Intrusive Database/ QC Geophysicist	100% of recovered item positions (excluding inconclusive category) ≤ 0.25 m from predicted position (x, y); Recovered item depths are recorded within 15 cm of predicted	RCA/CA
Confirm derived features match ground truth (2 of 2)		Evaluated for all recovered items including seeds	Project Geophysicist/ Dig List and Intrusive Database/ Project or QC Geophysicist	Cued data analysis shows 100% of seeds & recovered items have polarizability parameters that are consistent with their actual size, shape/symmetry, and wall thickness	RCA/CA
Verification of TOI/non-TOI threshold		Dig 200 anomalies beyond the last recovered IOC on the Dig List per delivery unit Verification of any other threshold is also required.	Project Geophysicist/ Verification and Validation Report/ QC Geophysicist	100% of predicted non-TOI intrusively investigated are non-IOC	RCA/CA; Adjust threshold.
Classification Validation		Selection of 200 non-TOI per delivery unit	QC Geophysicist/ Verification and Validation/ Lead Organization QA Geophysicist	100% of predicted non-TOI qualitatively matches predicted size/shape and are non-IOC	RCA/CA

Table 22-1: MRS A1 - MEC Surface and Subsurface Removal using non-AGC DGM Detection and Cued AGC (Continued)

Intrusive Investigation [MRS A1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Post-dig Verification [In cases where UU/UE is a goal.]		Evaluated for each dig location	Project Geophysicist/ Post-dig digital remapping (dynamic or cued)/ QC Geophysicist	AGC results indicate original polarizabilities resulting in TOI are no longer present and no additional TOI sources present above the project stop-dig threshold. Inconclusive dig locations verify signal is resolved.	RCA/CA

Table 22-2: MRS A2 - MEC Surface Removal using Instrument-Aided Visual Identification

Site Preparation [MRS A2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Survey control (loop closure)		At beginning of project	Project Geophysicist or Surveyor/ Survey Control Report/ QC Geophysicist	All loop closures within 0.50 m (if established from existing monument(s)) Estimated accuracy from static GPS occupation calculations (e.g., OPUS) less than or equal to 0.50 m.	RCA/CA: reset survey monuments
Construct Instrument Test Strip (ITS): Verify as-built ITS against design plan (Analog sensors)		Once following ITS construction	Project Geophysicist/ ITS Technical Memorandum/ Lead Organization	Small ISO seed items for analog methods buried at 0.30 m; All seeds buried horizontally in the cross-track orientation	RCA/CA: Make necessary changes to seeded items and re-verify
Verify correct assembly (All sensors)		Once following assembly	Field Team Leader/ Instrument Assembly Checklist/ Project Geophysicist	As specified in Assembly Checklist	RCA/CA: Make necessary adjustments and re-verify

Table 22-2: MRS A2 - MEC Surface Removal using Instrument-Aided Visual Identification (Continued)

Site Preparation [MRS A2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Initial Instrument Function Test (Analog)		Once upon arrival at project site	Field Geophysicist or UXO Team Lead/ Initial ITS Memorandum/ Project Geophysicist or designee	Audible response consistent with expected change in tone in presence of standard object	RCA/CA: Make necessary adjustments, and re-verify
Placement of QC seeds		Prior to survey unit production. QC seeds placed at variable densities throughout survey units such that each operator encounters at least 5 seeds per day [QC seeding design will vary between 5-8 seeds per day to account for production variability]. Seeds are obscured to the maximum extent practicable	UXOQCS/ QC Seed log/ QC Geophysicist	All seeds recovered	RCA/CA; If seeding density not met, the density will be increased in subsequent survey units.

Table 22-2: MRS A2 - MEC Surface Removal using Instrument-Aided Visual Identification (Continued)

Site Preparation [MRS A2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Placement of QA seeds		Prior to survey unit production. QA seeds placed at variable densities throughout survey units such that each operator encounters at least 5 seeds per day [QA seeding design will vary between 5-8 seeds per day to account for production variability]. Seeds are obscured to the maximum extent practicable	OESS or 3rd party contractor/ QA Seed Log/ QA Geophysicist	All seeds recovered	RCA/CA; If seeding density not met, the density will be increased in subsequent survey units.
Survey lane spacing		Each grid	UXOQCS/ QC Summary/ QC Geophysicist	Survey lanes are placed 3 feet apart	RCA/CA; replace survey lanes

Table 22-2: MRS A2 - MEC Surface Removal using Instrument-Aided Visual Identification (Continued)

Instrument Aided Surface Clearance [MRS A2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Ongoing instrument function test (Analog- Surface sweep)		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	Audible response consistent with expected change in tone in presence of object with documented response	RCA/CA
Ongoing instrument settings check (Analog)		Hourly	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	All instrument settings adjusted to [insert instrument-specific specification]	RCA/CA
Geodetic Function Test		Daily (RTK GPS) Each time equipment is moved (RTS)	Field Team Leader/ GIS Data Recorded/ Project/QC Geophysicist or designee	Measured position of control point within 10cm of ground truth	RCA/CA; document questionable information in database
Geodetic Accuracy (Confirm Valid Position)		Evaluated for each measurement	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	GPS status flag indicates RTK fix (RTK GPS)	RCA/CA; document questionable information in database
Survey Speed		Evaluated for each survey lane	UXOQCS/ QC Summary/ QC Geophysicist	98% <0.45 m/s; 100% < 0.50 m/s	RCA/CA; recollect data

Table 22-2: MRS A2 - MEC Surface Removal using Instrument-Aided Visual Identification (Continued)

Instrument Aided Surface Clearance [MRS A2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Documenting recovered material		Daily	UXOQC/ GIS data recorded/ QC Geophysicist	All metallic debris collected is documented for the following attributes: Designation as MEC, MD, Seed, RRD or NMRD; MEC and MD described by type; weight; and as TOI or non-TOI. Photos displaying all MD recovered (individual MD photos not necessary), and photos showing all surfaces of each MEC are recorded.	RCA/CA; document questionable information in database

Table 22-2: MRS A2 - MEC Surface Removal using Instrument-Aided Visual Identification (Continued)

Instrument Aided Surface Clearance [MRS A2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Verification of Surface Clearance		Survey Unit	UXOQCS/ QC Summary/ QC Geophysicist	Per each survey unit, minimum one lane from each operator is inspected, or Per each survey unit, minimum [insert number of operators per team] are inspected; lanes are randomly located and must be oriented perpendicular to the survey team's lanes No pieces of metal larger than 1" x 2"	RCA/CA; Redo survey unit
Seed Recovery		Survey Unit	QC Geophysicist/ QC Summary/ QA Geophysicist	100% of the QC and QA seeds recorded in the project database	RCA/CA; Redo survey unit

Table 22-3: MRS B1 – MEC Surface and Subsurface Removal using non-AGC DGM

Site Preparation [MRS B1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Survey control (loop closure)		At beginning of project	Project Geophysicist or Surveyor/ Survey Control Report/ QC Geophysicist	All loop closures within 0.50 m (if established from existing monument(s)) Estimated accuracy from static GPS occupation calculations (e.g., OPUS) less than or equal to 0.50 m.	RCA/CA: reset survey monuments
Construct IVS: Verify as-built IVS against design plan (Non-AGC DGM)		Once following IVS construction	Project Geophysicist/ IVS Technical Memorandum/ Lead Organization	Small ISO seed items buried at 0.15 m; All seeds buried horizontally in the cross-track orientation	RCA/CA: Make necessary changes to seeded items and re-verify
Construct Instrument Test Strip (ITS): Verify as-built ITS against design plan (Analog sensors)		Once following ITS construction	Project Geophysicist/ ITS Technical Memorandum/ Lead Organization	Small ISO seed items for analog methods buried at 0.30 m; All seeds buried horizontally in the cross-track orientation	RCA/CA: Make necessary changes to seeded items and re-verify

Table 22-3: MRS B1 – MEC Surface and Subsurface Removal using non-AGC DGM (Continued)

Site Preparation [MRS B1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Verify correct assembly (All sensors)		Once following assembly	Field Team Leader/ Instrument Assembly Checklist/ Project Geophysicist	As specified in Assembly Checklist	RCA/CA: Make necessary adjustments and re-verify
Initial Instrument Function Test (Non-AGC DGM)		Once following assembly	Field Geophysicist/ Initial IVS Memorandum/ Project Geophysicist	Response (mean static spike minus mean static background) within 20% of predicted response	RCA/CA: Make necessary adjustments, and re-verify
Initial Instrument Function Test (Analog)		Once upon arrival at project site	Field Geophysicist or UXO Team Lead/ Initial IVS Memorandum/ Project Geophysicist or designee	Audible response consistent with expected change in tone in presence of standard object	RCA/CA: Make necessary adjustments, and re-verify
Initial detection survey positioning accuracy (IVS) (Non-AGC DGM)		Once prior to start of data acquisition	Project Geophysicist/ IVS Memorandum/ QC Geophysicist	Derived positions of IVS target(s) are within 0.25 m of the ground truth locations	RCA/CA: Make necessary adjustments, and re-verify
Initial detection survey Check for interference surrounding seed response (IVS) (Non-AGC DGM)		Once prior to start of data acquisition	Project Geophysicist/ IVS Memorandum/ QC Geophysicist	All seeds placed in locations that are free of detected anomalies within a radius of ≥ 1.5 m	RCA/CA; and re-verify MQO

Table 22-3: MRS B1 – MEC Surface and Subsurface Removal using DGM (Continued)

Detection Survey [MRS B1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Geodetic Equipment Function Test		Daily (RTK GPS) Each time equipment is moved (RTS)	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	Measured position of control point within 0.10 m of ground truth	RCA/CA; document questionable information in database
Ongoing instrument function test (Non-AGC DGM)		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	Response (mean static spike minus mean static background within 20% of predicted response	RCA/CA: Make necessary repairs and reverify
Ongoing instrument function test (Analog- Surface sweep)		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	Audible response consistent with expected change in tone in presence of object with documented response	RCA/CA
Ongoing instrument settings check (Analog)		Hourly	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	All instrument settings adjusted to [insert instrument-specific specification]	RCA/CA
Ongoing detection survey positioning precision (IVS) (Non-AGC DGM)		Beginning and end of each day	Project Geophysicist/ Running QC Summary/ QC Geophysicist	Derived positions of IVS target(s) within 0.25 m of the average locations	RCA/CA
Ongoing detection survey seed interpretations (IVS) (Non-AGC DGM)		Beginning and end of each day	Project Geophysicist/ Running QC Summary/ QC Geophysicist	Peak response > 75% of minimum predicted response	RCA/CA

Table 22-3: MRS B1 – MEC Surface and Subsurface Removal using DGM (Continued)

Detection Survey [MRS B1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
In-line measurement spacing (Non-AGC DGM)		Verified for each transect using [describe tool to be used] based upon monostatic Z coil data positions	Project Geophysicist/ Running QC Summary/ QC Geophysicist	99% ≤ 0.25 m between successive measurements; 100% ≤ 0.40 m. Coverage gaps are filled or adequately explained (e.g., unsafe terrain)	RCA/CA
Coverage (Non-AGC DGM)		Verified for each unit using (describe tool to be used)	Project Geophysicist/ Running QC Summary/ QC Geophysicist	100% ≤ Instrument Specific cross-track measurement spacing (excluding site specific access limitations, e.g., obstacles, unsafe, terrain) EM61-MK2: 100% < 0.60 m cross-track measurement spacing for IOC the size of 40 mm in diameter and smaller, otherwise, 0.80 m (excluding site-specific access limitations, e.g., obstacles, unsafe terrain)	RCA/CA
Battery voltage (Non-AGC DGM)		Verify battery voltage is within operating specifications of sensor	Field Team Leader/ Running QC Summary/ Project Geophysicist	Voltage must be ≥ [Enter minimum instrument-specific requirement]	RCA/CA: out of spec data rejected

Table 22-3: MRS B1 – MEC Surface and Subsurface Removal using DGM (Continued)

Detection Survey [MRS B1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Dynamic noise assessment (Non-AGC DGM)		Verified for each selected background window	Project Geophysicist / Project database/ QC Geophysicist	All receiver channels exceeding pre-defined dynamic noise threshold for (Define time gate: e.g., EM61-MK2 = channel 2) time gate are flagged for review	RCA/CA; (SOP must address process for flagging and recollecting data as necessary)
Detection survey performance (Non-AGC DGM)		Blind QC seeds will be distributed such that each field team encounters an average of at least one seed per day. Seeds to be placed throughout expected detection depth range. [QC seeding design will vary between 1-3 seeds per day to account for production variability]	QC Geophysicist/ Running QC Summary/ Lead Organization QA Geophysicist	All blind seeds must have a response > 75% of minimum expected response and be detected and positioned within a 0.75 m radius of ground truth. [Positioning metric must be tighter than dig radius; recommended metric is 0.25 m plus ½ sensor width]	RCA/CA: Adjust picking routine. If seeding density not met, the density will be increased in subsequent survey units.

Table 22-3: MRS B1 – MEC Surface and Subsurface Removal using DGM (Continued)

Detection Survey [MRS B1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Detection survey repeatability (Non-AGC DGM)		Blind validation seeds will be distributed such that each field team encounters an average of at least one seed per day [Validation seeding design will vary between 1-3 seeds per day to account for production variability]	QA Geophysicist or 3rd party seeding contractor/ Validation Seed Log	All blind validation seeds must have a response > 75% of minimum expected response and be detected and positioned within a 0.75 m radius of ground truth [Positioning metric must be tighter than dig radius, recommended 0.25 m plus ½ sensor width].	RCA/CA: Verify instrument is functioning correctly; if so, reduce threshold, or determine if item is buried too deep. If instrument is not functioning correctly, recollect data. If seeding density not met, the density will be increased in subsequent survey units.
Geodetic Accuracy (Confirm Valid Position)		Evaluated for each measurement	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	GPS status flag indicates RTK fix (RTK GPS) RTS passes Geodetic Function Test (RTS)	RCA/CA; document questionable information in database
Verification of target selection (non-AGC DGM)		Evaluated for each survey unit (post SRA)	Project Geophysicist/ QC Summary/ QC Geophysicist	All leveled data with an amplitude greater than or equal to the selection threshold are accounted for within the associated dig radius [0.50 m].	RCA/CA

Table 22-3: MRS B1 – MEC Surface and Subsurface Removal using DGM (Continued)

Detection Survey [MRS B1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Verification of leveling (non-AGC DGM)		Evaluated for each survey unit	Project Geophysicist/ QC Summary/ QC Geophysicist	Leveled data with a background amplitude below zero are identified and reviewed to ensure no additional targets are present.	RCA/CA
Verification of leveling (amplitude suppression) (non-AGC DGM)		Evaluated for 200 of the lowest amplitude anomalies selected as targets, per survey unit	Project Geophysicist/ QC Summary/ QC Geophysicist	Raw anomaly peak amplitude minus local background amplitude is within 3x RMS noise of leveled anomaly peak amplitude minus leveled local background amplitude.	RCA/CA
Geodetic Equipment Function Test		Daily (RTK GPS) Each time equipment is moved (RTS)	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	Measured position of control point within 0.10 m of ground truth	RCA/CA; document questionable information in database
Geodetic Accuracy (Confirm Valid Position)		Evaluated for each measurement	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	GPS status flag indicates RTK fix (RTK GPS) RTS passes Geodetic Function Test (RTS)	RCA/CA; document questionable information in database

Table 22-3: MRS B1 – MEC Surface and Subsurface Removal using DGM (Continued)

Detection Survey [MRS B1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Documenting recovered sources		Daily	UXOQCS/ GIS data recorded/ QC Geophysicist	All metallic debris collected is documented for the following attributes: Designation as MEC, MD, Seed, RRD or non-munitions-related debris; MEC and MD described by type; weight; depth; and as TOI or non-TOI. Photos displaying all MD recovered at each target location (individual MD photos not necessary), and photos showing all surfaces of each MEC are recorded.	RCA/CA; document questionable information in database
Confirm derived features match ground truth (1 of 2)		Evaluated for all recovered items	Project Geophysicist/ Running QC Summary or Intrusive Database/ QC Geophysicist	100% of recovered item positions ≤ 0.75 m from predicted position (x, y);	RCA/CA
Confirm derived features match ground truth (2 of 2)		Evaluated for all recovered items including seeds	Project Geophysicist/ Dig List and Intrusive Database/ Project or QC Geophysicist	Recovered items match expected size, shape, and depth of instrument response	RCA/CA

Table 22-3: MRS B1 – MEC Surface and Subsurface Removal using DGM (Continued)

Detection Survey [MRS B1]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Seed Recovery		Survey Unit	QC Geophysicist/ QC Summary/ QA Geophysicist	100% of the QC and QA seeds recorded in the intrusive database	RCA/CA; Redo survey unit
Post-dig verification (non-AGC DGM)		100% of intrusive investigations	Field Geophysicist/ QC Summary/ QC Geophysicist	Response from properly nulled EM61 is lower than the selection threshold for the entire anomaly footprint.	RCA/CA
Post-dig verification (non-AGC DGM)		200 dig locations per survey unit (or all dig locations if there are less than 200)	Project Geophysicist/ Post-dig digital remapping/ QC Geophysicist	All targets with post-excavation responses above threshold and within the intrusive radius are reinvestigated and no recovered metallic object is larger than the smallest IOC.	RCA/CA

Table 22-4: MRS B2 – MEC Surface and Subsurface Removal using Analog Detection

Site Preparation [MRS B2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Survey control (loop closure)		At beginning of project	Project Geophysicist or Surveyor/ Survey Control Report/ QC Geophysicist	All loop closures within 0.50 m (if established from existing monument(s)) Estimated accuracy from static GPS occupation calculations (e.g., OPUS) less than or equal to 5cm.	RCA/CA: reset survey monuments
Construct Instrument Test Strip (ITS): Verify as-built ITS against design plan (Analog sensors)		Once following ITS construction	Project Geophysicist/ ITS Technical Memorandum/ Lead Organization	Small ISO seed items for analog methods buried at 0.30 m; All seeds buried horizontally in the cross-track orientation	RCA/CA: Make necessary changes to seeded items and re-verify
Verify correct assembly (All sensors)		Once following assembly	Field Team Leader/ Instrument Assembly Checklist/ Project Geophysicist	As specified in Assembly Checklist	RCA/CA: Make necessary adjustments and re-verify
Initial Instrument Function Test (Analog)		Once upon arrival at project site	Field Geophysicist or UXO Team Lead/ Initial ITS Memorandum/ Project Geophysicist or designee	Audible response consistent with expected change in tone in presence of standard object	RCA/CA: Make necessary adjustments, and re-verify

Table 22-4: MRS B2 – MEC Surface and Subsurface Removal using Analog Detection (Continued)

Site Preparation [MRS B2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Placement of QC seeds		Prior to survey unit production. Seeds placed at variable densities throughout survey units at 95-100% of reliable detection such that each operator encounters at least 5 seeds per day [QC seeding design will vary between 5-8 seeds per day to account for production variability].	UXOQCS/ QC Seed Log/ QC Geophysicist	All seeds recovered	RCA/CA; If seeding density not met, the density will be increased in subsequent survey units.

Table 22-4: MRS B2 – MEC Surface and Subsurface Removal using Analog Detection (Continued)

Site Preparation [MRS B2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Placement of QA seeds		Prior to survey unit production. QA seeds placed at variable densities throughout survey units at 95-100% of reliable detection such that each operator encounters at least 5 seeds per day [QC seeding design will vary between 5-8 seeds per day to account for production variability].	OESS or 3rd party contractor/ QA seed log/ QA Geophysicist	All seeds recovered	RCA/CA; If seeding density not met, the density will be increased in subsequent survey units.
Survey lane spacing		Each grid	UXOQCS/ QC Summary/ QC Geophysicist	Survey lanes are placed 3 feet apart	RCA/CA; replace survey lanes

Table 22-4: MRS B2 – MEC Surface and Subsurface Removal using Analog Detection (Continued)

Subsurface Clearance [MRS B2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Ongoing instrument function test (Analog)		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	Audible response consistent with expected change in tone in presence of object with documented response	RCA/CA
Ongoing instrument settings check (Analog)		Hourly	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	All instrument settings adjusted to [insert instrument-specific specification]	RCA/CA
Geodetic Function Test		Daily (RTK GPS) Each time equipment is moved (RTS)	Field Team Leader/ GIS Data Recorded/ Project/QC Geophysicist or designee	Measured position of control point within 0.10 m of ground truth	RCA/CA; document questionable information in database
Geodetic Accuracy (Confirm Valid Position)		Evaluated for each measurement	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	GPS status flag indicates RTK fix (RTK GPS)	RCA/CA; document questionable information in database
Survey Speed		Evaluated for each survey lane	UXOQCS/ QC Summary/ QC Geophysicist	98% <0.45 m/s; 100% < 0.50 m/s	RCA/CA; recollect data

Table 22-4: MRS B2 – MEC Surface and Subsurface Removal using Analog Detection (Continued)

Intrusive Investigation [MRS B2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Geodetic Equipment Function Test		Daily (RTK GPS) Each time equipment is moved (RTS)	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	Measured position of control point within 0.10 m of ground truth	RCA/CA; document questionable information in database
Documenting recovered material		Daily	UXOQC/ GIS data recorded/ QC Geophysicist	All metallic debris collected is documented for the following attributes: Designation as MEC, MD, Seed, RRD or NMRD; MEC and MD described by type; weight; depth; and as TOI or non-TOI. Photos displaying all MD recovered (individual MD photos not necessary), and photos showing all surfaces of each MEC are recorded.	RCA/CA; document questionable information in database
Verification of Subsurface Clearance		Survey Unit	UXOQCS/ QC Summary/ QC Geophysicist	Per each survey unit, minimum one lane from each operator is inspected, or Per each survey unit, minimum [insert number of operators per team] are inspected; lanes are randomly located.	RCA/CA; Redo survey unit

Table 22-4: MRS B2 – MEC Surface and Subsurface Removal using Analog Detection (Continued)

Intrusive Investigation [MRS B2]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Seed Recovery		Survey Unit	QC Geophysicist/ QC Summary/ QA Geophysicist	100% of the QC and QA seeds recorded in the intrusive database	RCA/CA; Redo survey unit

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC

Site Preparation [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Survey control (loop closure)		At beginning of project	Project Geophysicist or Surveyor/ Survey Control Report/ QC Geophysicist	All loop closures within 0.50 m (if established from existing monument(s)) Estimated accuracy from static GPS occupation calculations (e.g., OPUS) less than or equal to 5cm.	RCA/CA: reset survey monuments
Construct IVS: Verify as-built IVS against design plan (DGM)		Once following IVS construction	Project Geophysicist/ IVS Technical Memorandum/ Lead Organization	Small ISO seed items buried at 0.15 m; All seeds buried horizontally in the cross-track orientation	RCA/CA: Make necessary changes to seeded items and re-verify
Construct Instrument Test Strip (ITS): Verify as-built ITS against design plan (Analog sensors)		Once following ITS construction	Project Geophysicist/ ITS Technical Memorandum/ Lead Organization	Small ISO seed items for analog methods buried at 0.30 m; All seeds buried horizontally in the cross-track orientation	RCA/CA: Make necessary changes to seeded items and re-verify
Verify correct assembly (All sensors)		Once following assembly	Field Team Leader/ Instrument Assembly Checklist/ Project Geophysicist	As specified in Assembly Checklist	RCA/CA: Make necessary adjustments and re-verify

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Site Preparation [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Initial instrument function test: Five measurements over a small ISO80 target, one in each quadrant of the sensor and one directly under the center of the array; Derived polarizabilities for each measurement are compared to the library (AGC)		Once following assembly	Field Team Leader/ Instrument Assembly Checklist/ Project Geophysicist	Library match metric ≥ 0.95 for each of the five sets of inverted polarizabilities	RCA/CA: Make necessary adjustments, and re-verify
Initial Instrument Function Test (Analog)		Once upon arrival at project site	Field Geophysicist or UXO Team Lead/ Initial IVS Memorandum/ Project Geophysicist or designee	Audible response consistent with expected change in tone in presence of standard object	RCA/CA: Make necessary adjustments, and re-verify
Geodetic Equipment Function Test		Daily (RTK GPS) Each time equipment is moved (RTS)	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	Measured position of control point within 0.10 m of ground truth	RCA/CA; document questionable information in database
Initial detection survey positioning accuracy (IVS) (DGM)		Once prior to start of data acquisition	Project Geophysicist/ IVS Memorandum/ QC Geophysicist	Derived positions of IVS target(s) are within 0.25 m of the ground truth locations	RCA/CA: Make necessary adjustments, and re-verify

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Site Preparation [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Initial detection survey Check for interference surrounding seed response (IVS) (All sensors)		Once prior to start of data acquisition	Project Geophysicist/ IVS Memorandum/ QC Geophysicist	All seeds placed in locations that are free of detected anomalies within a radius of ≥ 1.5 m	RCA/CA; and re-verify MQO
Initial derived polarizabilities accuracy (IVS) (AGC)		Once during initial system IVS test	Project Geophysicist/ IVS memorandum/ QC Geophysicist	Library Match metric ≥ 0.9 for each set of inverted polarizabilities	RCA/CA

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Detection Survey [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Ongoing instrument function test (DGM)		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	Response (mean static spike minus mean static background within 20% of predicted response	RCA/CA: Make necessary repairs and reverify
Ongoing instrument function test (Analog- Surface sweep)		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	Audible response consistent with expected change in tone in presence of object with documented response	RCA/CA
Ongoing instrument settings check (Analog)		Hourly	Field Team Leader/ Running QC Summary/ Project/QC Geophysicist or designee	All instrument settings adjusted to [insert instrument-specific specification]	RCA/CA
Ongoing detection survey positioning precision (IVS) (DGM)		Beginning and end of each day	Project Geophysicist/ Running QC Summary/ QC Geophysicist	Derived positions of IVS target(s) within 0.25 m of the average locations	RCA/CA
In-line measurement spacing (DGM)		Verified for each transect using [describe tool to be used] based upon monostatic Z coil data positions	Project Geophysicist/ Running QC Summary/ QC Geophysicist	100% ≤ 0.20 m between successive measurements with mean ≤ 0.10 m. Coverage gaps are filled or adequately explained (e.g., unsafe terrain)	RCA/CA

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Detection Survey [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Coverage (DGM)		Verified for each survey unit using (describe tool to be used)	Project Geophysicist/ Running QC Summary/ QC Geophysicist	100% ≤ Instrument Specific cross-track (0.70 m) measurement spacing (excluding site specific access limitations, e.g., obstacles, unsafe, terrain)	RCA/CA
Battery voltage (DGM)		Verify battery voltage is within operating specifications of sensor	Field Team Leader/ Running QC Summary/ Project Geophysicist	Voltage must be ≥ [Enter minimum instrument-specific requirement]	RCA/CA: out of spec data rejected
Valid orientation data (DGM)		Evaluated for each sensor measurement	Field Team Leader/ QC Database/ Project/QC Geophysicist	Orientation data reviewed and appear reasonable within bounds appropriate to site (e.g., roll and pitch < 15 degrees absolute value)	RCA/CA
Dynamic noise assessment (DGM)		Verified for each selected background window	Project Geophysicist / Project database/ QC Geophysicist	All receiver channels exceeding pre-defined dynamic noise threshold for time gate (Define time gate: e.g., TEMSENSE = 0.3 mV/A channel 15) are flagged for review	RCA/CA; (SOP must address process for flagging and recollecting data as necessary)

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Detection Survey [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Detection survey performance (DGM)		Blind QC seeds will be distributed such that each field team encounters an average of at least one seed per day. Seeds to be placed throughout expected detection depth range. [QC seeding design will vary between 1-3 seeds per day to account for production variability]	QC Geophysicist/ Running QC Summary/ Lead Organization QA Geophysicist	All blind QC seeds must be detected and positioned within a 0.40 m radius of ground truth.	RCA/CA: Adjust picking routine. If seeding density not met, the density will be increased in subsequent survey units.
Detection Survey Performance (DGM)		Blind validation seeds will be distributed such that each field team encounters an average of at least one seed per day [Validation seeding design will vary between 1-3 seeds per day to account for production variability]	QA Geophysicist or 3rd party contractor/ Validation Seed Log/	All blind validation seeds must be detected and positioned within a 0.40 m radius of ground truth	RCA/CA: Verify instrument is functioning correctly; if so, reduce threshold, or determine if item is buried too deep. If instrument is not functioning correctly, recollect data. If seeding density not met, the density will be increased in subsequent survey units.

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Detection Survey [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Reporting Method/ Verified by:	Acceptance Criteria	Failure Response
Geodetic Accuracy (Confirm Valid Position)		Evaluated for each measurement	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	GPS status flag indicates RTK fix (RTK GPS) RTS passes Geodetic Function Test (RTS)	RCA/CA; document questionable information in database

Cued Survey [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Geodetic Equipment Function Test		Daily (RTK GPS) Each time equipment is moved (RTS)	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	Measured position of control point within 0.10 m of ground truth	RCA/CA; document questionable information in database
Geodetic Accuracy (Confirm Valid Position)		Evaluated for each measurement	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	GPS status flag indicates RTK fix (RTK GPS) RTS passes Geodetic Function Test (RTS)	RCA/CA; document questionable information in database

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Cued Survey [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Valid orientation data		Evaluated for each sensor measurement	Field Team Leader/ QC Database/ Project/QC Geophysicist	Orientation data reviewed and appear reasonable within bounds appropriate to site (e.g., roll and pitch < 15 degrees absolute value)	
Ongoing production area background measurements		Background data collected a minimum of every two hours during production (or more frequently, per instrument-specific requirements	Field Team Leader/ Field Log and Running QC Summary/ Project Geophysicist	Background data from a verified location collected within [Insert instrument-specific requirements, not to exceed two hours] of all cued data points.	RCA/CA: Document environmental changes; Project Geophysicist must approve before proceeding.
Ongoing derived target position precision (IVS)		Beginning and end of each day as part of IVS testing	Project Geophysicist/ Running QC Summary/ QC Geophysicist	All IVS items fit locations within 0.25 m of average of derived fit locations	RCA/CA
Ongoing derived polarizabilities precision (IVS)		Beginning and end of each day as part of IVS testing	Project Geophysicist/ Running QC Summary/ QC Geophysicist	Library Match to initial polarizabilities metric ≥ 0.9 for each set of three inverted polarizabilities	RCA/CA
Ongoing Instrument Function Test (Instrument response amplitudes)		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ Running QC Summary (Excel/Geosoft)/ Project/QC Geophysicist or designee	Response (mean static spike minus mean static background) within 20% of predicted response for all Tx/Rx combinations	RCA/CA: Make necessary repairs and re-verify
Transmit current levels		Evaluated for each sensor measurement	Field Team Leader/ Running QC Summary/ Project Geophysicist	Current must be ≥ [Insert instrument-specific requirements]	RCA/CA: stop data acquisition activities until condition corrected

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Cued Survey [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Confirm adequate spacing between units		Evaluated at start of each day (or grid)	Field Team Leader/ Field Logbook/ Project Geophysicist	Separation must be > [Insert instrument-specific requirements]	RCA/CA: Recollect data
Cued interrogation		Evaluated for all targets on cued list	Project Geophysicist/ UX-A Source Geosoft database/ QC Geophysicist	Offset between center of the sensor and the flag, or target, location must be ≤ 0.40 m	RCA/CA: Recollect data
Confirm inversion model supports classification (1 of 3)		Evaluated for models derived from a measurement and used to make TOI/non-TOI decision (i.e., single item and/or multi-item models)	Project Geophysicist/ UX-A Source Geosoft database/ QC Geophysicist	Derived model response must fit the observed data with a fit coherence ≥ 0.8	Follow procedure in SOP or RCA/CA
Confirm inversion model supports classification (2 of 3)		Evaluated for derived target	Project Geophysicist/ UX-A Source Geosoft database/ QC Geophysicist	Fit location estimate of item ≤ 0.40 m from center of sensor	Follow procedure in SOP or RCA/CA; if designated as TOI, no additional recollection necessary

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Cued Survey [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Confirm inversion model supports classification (3 of 3)		Evaluated for all seeds	QC Geophysicist/ Seed Tracking Log/ Lead Organization QA Geophysicist	100% of predicted seed (QC and Validation) positions ≤ 0.25 m radially from known position (x, y). Z ≤ 0 .15 m.	RCA/CA
Classification performance		Evaluated for all seeds	QC Geophysicist/ Seed Tracking Log/ Lead Organization QA Geophysicist	100% of QC/Validation Seeds classified as TOI and the correct size is predicted	RCA/CA

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Intrusive Investigation [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Geodetic Equipment Function Test		Daily (RTK GPS) Each time equipment is moved (RTS)	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	Measured position of control point within 0.10 m of ground truth	RCA/CA; document questionable information in database
Geodetic Accuracy (Confirm Valid Position)		Evaluated for each measurement	Field Team Leader/ GIS data recorded/ Project/QC Geophysicist or designee	GPS status flag indicates RTK fix (RTK GPS) RTS passes Geodetic Function Test (RTS)	RCA/CA; document questionable information in database
Documenting recovered sources		Daily	UXOQCS/ GIS data recorded/ QC Geophysicist	All metallic debris collected is documented for the following attributes: Designation as MEC, MD, Seed, RRD or non-munitions-related debris; MEC and MD described by type; weight; depth; and as TOI or non-TOI. Photos displaying all MD recovered at each target location (individual MD photos not necessary), and photos showing all surfaces of each MEC are recorded.	RCA/CA; document questionable information in database

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Intrusive Investigation [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Confirm derived features match ground truth (1 of 2)		Evaluated for all recovered items including seeds (applies only to single, compact objects [e.g., does not apply to a bed of nails or long wires])	Project Geophysicist/ Running QC Summary or Intrusive Database/ QC Geophysicist	100% of recovered item positions (excluding inconclusive category) ≤ 0.25 m from predicted position (x, y); Recovered item depths are recorded within 15 cm of predicted depth	RCA/CA
Confirm derived features match ground truth (2 or 2)		Evaluated for all recovered items including seeds	Project Geophysicist/ Dig List and Intrusive Database/ Project or QC Geophysicist	Cued data analysis shows 100% of seeds & recovered items have polarizability parameters that are consistent with their actual size, shape/symmetry, and wall thickness	RCA/CA
Verification of TOI/non-TOI threshold		Dig 200 anomalies beyond the last recovered IOC on the Dig List per delivery unit	Project Geophysicist/ Verification and Validation Report/ QC Geophysicist	100% of predicted non-TOI intrusively investigated qualitatively matches predicted size/shape and are non-IOC	RCA/CA; Adjust threshold.
Classification Validation		Selection of 200 non-TOI per delivery unit	QC Geophysicist/ Verification and Validation/ Lead Organization QA Geophysicist	100% of predicted non-TOI intrusively investigated qualitatively matches predicted size/shape and they are not IOC	RCA/CA

Table 22-5: MRS C – MEC Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC (Continued)

Intrusive Investigation [MRS C]

Measurement Quality Objective	MQO#	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Post-dig Verification [In cases where UU/UE is a goal]		Evaluated for each dig location	Project Geophysicist/ Post-dig digital remapping (dynamic or cued)/ QC Geophysicist	AGC results indicate original polarizabilities resulting in TOI are no longer present and no additional TOI sources present above the project stop-dig threshold. Inconclusive dig locations verify signal is resolved.	RCA/CA

[This page intentionally left blank]

Worksheet #29: Data Management, Project Documents, and Records

(UFP-QAPP Manual Section 3.5.1)

Part 1 of this worksheet provides minimum specifications for all data management tasks and deliverables. Where applicable, specific versions or dates of software used should be documented. Part 2 describes procedures for controlling project documents, records, and databases. Its purpose is to ensure data completeness, data integrity, traceability, and ease of retrieval. A separate table should be prepared for each MRS addressed in the project-specific MR-QAPP. The documents listed on this worksheet should include all planning documents as well as those listed on worksheet #17.

Part 1: Data Management Specifications

Computer Files and Digital Data: All final document files, including reports, figures, and tables, will be submitted in electronic format as specified by the DoD client. [List specifications] Data management and backup must be performed in accordance with the contractor's documented quality system. [Describe or reference applicable requirements]

TOI Library: This worksheet must document the version (date) of the DoD target of interest (TOI) library used and describe or reference procedures to be used to develop the site-specific TOI library. [Describe here] The site-specific TOI library used must be updated as noted below and included in data deliverables.

Part 2: Control of Documents, Records, and Databases

Table 29-1: Minimum Required Documents and Records [Examples are based on MRS A1]

Document/Record	Completion/ Update Frequency	Format/ Storage Location/ Archive Requirements
Conceptual site model		
Final project-specific MR-QAPP		
Standard operating procedures		
Site-specific TOI library		
QC seeding plan and firewall plan		
Surveyor reports		

Table 29-1: Minimum Required Documents and Records [Examples are based on MRS A1] **(Continued)**

Document/Record	Completion/ Update Frequency	Format/ Storage Location/ Archive Requirements
Surface sweep technical memoranda		
Database of control points and survey units		
QC seed placement reports		
Validation seed placement reports		
Completed instrument-assembly checklist		
IVS memoranda		
Daily IVS summaries		
Daily QC reports		
Weekly QC reports		
Target selection technical memorandum		
Anomaly lists & maps		
Database (library match results)		
TOI/non-TOI classification spreadsheet		
Classification decision plots		
Ranked anomaly list		
Database of excavation results		
Source database		
Photographs		
Comparison results (excavated objects)		
Intrusive results database		
Final verification/validation plan		
Disposal records		
Data validation reports		

Table 29-1: Minimum Required Documents and Records [Examples are based on MRS A1] **(Continued)**

Document/Record	Completion/ Update Frequency	Format/ Storage Location/ Archive Requirements
DUA reports		
Final RA report		
UU/UE memorandum		

[This page intentionally left blank.]

Worksheet #31, 32 & 33: Assessments and Corrective Action

(UFP-QAPP Manual Sections 4.1.1 and 4.1.2)

This worksheet is used to document responsibilities and procedures for conducting project assessments, documenting assessments, responding to assessment findings, and implementing corrective action. Appropriately scheduled assessments during each group of related project activities allow management to identify problems while the activities are being implemented, thereby allowing processes to be corrected before they have a negative impact on the achievement of DQOs and measurement performance criteria (MPCs). This worksheet should reference assessment checklists and include them in an appendix to the QAPP.

For this project, related activities are grouped as follows:

1. Site preparation
2. Detection survey
3. Cued survey (where applicable)
4. Intrusive investigation and removal

Table 31-1: Assessment Schedule

Assessment Type	Schedule/ Frequency	Responsible Party	Assessment Deliverable	Deliverable Due Date	Responsible for Responding to Assessment Findings	Assessment Response Documentation and Timeframe

[This page intentionally left blank.]

Worksheet #35: Data Verification and Validation Procedures

(UFP-QAPP Manual Sections 5.2.2)

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. [Some examples are provided in blue text; however, this is not a comprehensive list.]

Table 35-1: Data Verification and Validation Procedures

Activity and Records Reviewed	Requirements/ Specifications	Process Description/Frequency	Responsible Person	Documentation
Field Logbook/Running QC Summary	QAPP, SOPs	All information is complete for each day of field activities. Any changes/exceptions are documented and have been reported in accordance with requirements. Required signatures are present.	Project Geophysicist	Daily QC Report
Instrument Assembly Checklist	SOP X, WS #22	Instrument Assembly has completed according to SOP__. MQOs have been achieved, with any exceptions noted. If appropriate, corrective actions have been completed. Signatures and dates are present.	Project Geophysicist	SOP__ Checklist Daily QC Report
IVS Technical Memorandum	SOP Y, WS #22	Initial IVS Survey has been conducted according to SOP __. Checklist__ has been completed. All specifications have been achieved, or exceptions noted. If appropriate, corrective actions have been completed. Signatures and dates are present.	Project Geophysicist	SOP__ Checklist Daily QC Report

[This page intentionally left blank.]

Worksheet #37: Data Usability Assessment

The DUA involves a qualitative and quantitative evaluation of environmental data to determine if the project data are of the right type, quality, and quantity to support the MPCs and DQOs specific to each phase of the project. 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.

This worksheet documents procedures that will be used to perform the DUA. The DUA is performed by key members of the project team (defined during the SPP) at the conclusion of each phase of investigation before proceeding to the next phase, as shown on Figure 17-1. [Note: one or more survey units may be grouped into a delivery unit for the purpose of conducting the DUA. Final verification and validation digs are tied to the delivery unit. Delivery units will encompass one or more contiguous geographic areas for which 100% of relevant coverage metrics have been achieved. Delivery units are established by the project team during project planning. Smaller sites may have only one delivery unit per MRS while larger sites may have more.

The DUA will identify personnel (organization and position/title) responsible for participating in the data usability assessment: [Note: the same personnel should participate in all phases of the DUA.] It will identify documents used as input to each phase of the data usability assessment and describe how the phases of the DUA will be documented. Reference Worksheet #29 for required documents and Worksheet #17 for the timing of the document submission in the workflow of the project.

1. Identify personnel (organization and position/title) responsible for participating in the data usability assessment, [Note: the same personnel should participate in all phases of the DUA].

   For the Government

   - The DoD Remedial Project Manager
   - The DoD Technical Manager
   - The Project Geophysicist
   - The Project Quality Assurance Manager
   - The Ordnance and Explosives Safety Specialist

   For the Contractor

   - The Project Manager
   - The Project Geophysicist
   - The Quality Control Geophysicist
   - The Field Geophysicist (Lead)
   - The UXOQCS

   The Regulator

2. Identify documents used as input to each phase of the DUA.

   - Quality Assurance Project Plan
   - Contract Specifications
   - Quality Assurance Surveillance Plan

- Weekly QC Reports
- Assessment Reports
- Corrective Action Reports
- Production Area Seed Report
- IVS Memoranda
- Data Validation Reports

3. Describe how the DUA will be documented:

   [Example] The detection and cued survey DUAs will be documented in a detection survey DUA report and cued survey DUA report, respectively. The final data usability assessment report will be included as an appendix to the Final Report.

4. Describe the DUA process to be used:

   The DUA will be conducted by evaluating data products and project findings to answer the questions in the four-step process below.

Appendix D contains DUAs for the example sites.

Table 37-1: Data Usability Assessment

Step	Process
Step 1	**Review the project's objectives and sampling design** Are underlying assumptions in the initial CSM valid? Review the data quality objectives. 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 sampling design and describe their impacts on the data quality objectives.
Step 2	**Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12** Review available QA/QC reports, including weekly QC reports, assessment reports, corrective action reports, and the data verification/validation reports. Evaluate the implications of unacceptable QC results. For any non-conformances, was the RCA/CA effective? Evaluate conformance to MPCs documented on Worksheet #12. Summarize the impacts of non-conformances on data usability. Evaluate data completeness. Identify data gaps (i.e., data inputs that have not been satisfied) and summarize their impact on the DQOs.
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. Determine whether the data are suitable for proceeding to next phase of the project. Update the CSM, apply decision rules, and draw 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 delivery units at the site, or future investigations. Prepare the data usability summary report.

[This page intentionally left blank.]

Appendix A: Measurement Quality Objectives for Geophysical Systems not Illustrated in this Document

Table A-1: Dynamic One-Pass AGC Surveys

Measurement Quality Objective	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
Verify correct assembly	Once following assembly	Field Team Leader/ instrument assembly checklist/ Project Geophysicist	As specified in SOP, Assembly checklist	RCA/CA
Geodetic equipment functionality	Daily for RTK GPS	Operator/QC Database/QC Geophysicist	Confirm base station alignment with control point +/- 10 cm	RCA/CA
Initial sensor function test	Once following assembly	Field Team Leader/ instrument assembly checklist/ Project Geophysicist	For all channels tested, the response (mean static spike minus mean static background) is within 20% of reference response.	RCA/CA
Initial derived polarizabilities accuracy (IVS)	Once during initial system IVS test	Project Geophysicist/ IVS Technical Memorandum/ QC Geophysicist	Library match metric 0.9 or higher for each set of inverted polarizabilities	RCA/CA
Initial derived target position accuracy (IVS)	Once during initial system IVS test	Project Geophysicist/IVS Technical Memorandum/QC Geophysicist	All IVS item fit locations within 9.8 inches (0.25 meters) of ground truth locations	RCA/CA
Ongoing derived polarizabilities accuracy (IVS)	Beginning and end of each day as part of IVS testing	Project Geophysicist/ QC Database/QC Geophysicist	Library match metric of 0.9 or higher for each set of inverted polarizabilities	RCA/CA

Table A-1: Dynamic One-Pass AGC Surveys (Continued)

Measurement Quality Objective	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
Ongoing derived target position accuracy (IVS)	Beginning and end of each day as part of IVS testing	Project Geophysicist/ QC Database/ QC Geophysicist	All IVS items fit locations within 9.8 inches (0.25 meters) of ground truth locations	RCA/CA
Ongoing instrument function test	Beginning and end of each day as part of IVS testing	Field Team Leader/ QC Database/ Project Geophysicist	For all channels tested, the response (mean static spike minus mean static background) is within 20% of reference response.	RCA/CA
Battery Voltage/ Transmit current levels	Evaluated for each file	Field Team Leader/Field Logs/ Project Geophysicist	APEX: Battery voltage maintained above 12.5V UltraTEM Screener: Current ≥15A UltraTEM Classifier: Current ≥15A	RCA/CA
Valid orientation data	Evaluated for each sensor measurement	Field Team Leader/ QC Database/ Project Geophysicist	Orientation data reviewed and appear reasonable within bounds appropriate to site (e.g., roll and pitch <15 degrees absolute value)	RCA/CA
Dynamic Noise Assessment	Verified for each selected background window	GDA/QC Database/Project or QC Geophysicist	All receiver channels exceeding pre-defined dynamic noise threshold for (Define time gate: e.g., APEX = 3.43 ms) time gate are flagged for review	RCA/CA; (SOP must address process for flagging and recollecting data as necessary)
Valid position data	Per measurement	GDA/QC Database/QC Geophysicist	GPS status flag indicates RTK fix quality 4	RCA/CA

Table A-1: Dynamic One-Pass AGC Surveys (Continued)

Measurement Quality Objective	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
In-Line Measurement Spacing	Verified for each transect, based upon sensor head center positions.	Geophysical Data Analyst (GDA)/QC Database/QC Geophysicist	100% ≤ 0.2m between successive measurements (excluding background areas of the transect) with mean ≤ 0.1m	RCA/CA
Dynamic One-Pass Coverage	All transects	GDA/QC report/QC Geophysicist	100% at ≤ Instrument Specific cross-track measurement spacing (excluding site specific access limitations, e.g., obstacles, unsafe terrain, etc.) APEX: 0.8m Screener: 100% at ≤ 1.75 m (1-Tx man-portable) 2.05 (2-Tx towed) line spacing. Classifier: 100% at ≤ 2.25 m line spacing Transects: 100% of planned transect paths within receiver swath.	RCA/CA

Table A-1: Dynamic One-Pass AGC Surveys (Continued)

Measurement Quality Objective	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
Size and decay rate threshold verification (when ISS is used)	Collect cued data or intrusively investigate an additional 200 anomalies excluded on the basis of ISS	Project Geophysicist/QC report/QC Geophysicist	Cued data analysis or intrusive results confirm all 200 anomalies are non-TOI	RCA/CA
In-Line Measurement Spacing (Dynamic-Cued APEX)	Verified for each transect, based upon sensor head center positions.	Geophysical Data Analyst (GDA)/QC Database/QC Geophysicist	100% ≤ 0.2m between successive measurements (excluding background areas of the transect) with mean ≤ 0.1m	CA
Dynamic-cued survey coverage (Dynamic-Cued APEX)	All cued transects	GDA/QC report/QC Geophysicist	All flag locations are >1m from transect ends and <0.4m from center of sensor at closest point of approach	Recollect transects

Table A-2: Simultaneous Location and Mapping MQOs

Measurement Quality Objective	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
Geodetic Accuracy	Evaluated for each base map	Project Geophysicist/ QC Database/ QC Geophysicist	Maximum error reported in the UXO_QC.csv file less than or equal to 8cm.	RCA/CA
Geodetic Accuracy	Evaluated for each measurement	Project Geophysicist/ QC Database/ QC Geophysicist	Recorded SLAM localization confidence quality greater than 5 (National Marine Electronics Association (NMEA) output; 50,000 for SLAM output).	RCA/CA
Geodetic Equipment Function Test	Each time localization is initiated	Field Team Leader/ field forms/ Project Geophysicist	Measured position of control point within 10 cm of ground truth.	RCA/CA

QAPP Appendix B: Site-specific Records of Decision [Reserved]

QAPP Appendix C: Standard Operating Procedures [Reserved]

[This page intentionally left blank.]

Appendix D: Example Data Usability Assessment Reports

The format used in the following examples, based on Worksheet #37, is suitable to document the result of the DUA(s) as the project proceeds, and that is the format the project team has chosen to use.

Example #1: MRS A1 Maneuver Area Development Area – Surface and Subsurface Removal using non-AGC DGM/AGC

DUAs for MRS A1 were performed at (1) the conclusion of the detection survey and analysis, (2) the conclusion of the AGC data collection and analysis, and (3) the conclusion of the project.

MRS A1 – Detection Survey DUA

Identify personnel (organization and position/title) who participated in the data usability assessment: [Note: The same personnel should participate in all phases of the DUA.] For the Government

- The DoD Remedial Project Manager
- The DoD Technical Manager
- The Project Geophysicist
- The Project Quality Assurance Manager
- The Ordnance and Explosives Safety Specialist (OESS)

For the Contractor

- The Project Manager
- The Project Geophysicist
- The Quality Control Geophysicist
- The Field Geophysicist (Lead)
- The UXOQCS

The Regulator

Identify documents used as input to the detection survey data usability assessment:

- Quality Assurance Project Plan
- Contract Specifications
- Quality Assurance Surveillance Plan
- Weekly QC Reports

- Assessment Reports Corrective Action Reports
- Production Area Seed Report
- IVS Memoranda
- Detection Survey Data Validation Report

Step 1. Review the project's objectives and sampling design

Step 1a. Are underlying assumptions in the initial CSM still 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 sampling design.

The primary objective of the removal action in MRS A1 was to remove:

- All 60-mm mortars to a depth of 0.45 m bgs.
- Practice hand grenades, signals, flares, pyrotechnics, practice 2.36" rockets, and practice anti-tank mines to a depth of 0.30 m bgs.
- Any other munitions present on the site to their maximum reliable detection depth at the anomaly selection criteria set for the 60-mm mortars.

The munitions-related objects recovered in the surface sweep include:

- MD from 60-mm smoke and illumination mortars.
- MD associated with practice hand grenades.
- Debris from small arms.

No evidence of other munitions was found. The underlying assumptions are consistent with all observations to date.

The primary uncertainty related to the design of the detection step was lack of knowledge of the expected munitions in a maneuver area. The initial CSM provided evidence from historical records of use, but they are often incomplete and a wide variety of activities involving a variety of possible munitions could have taken place. MRS A1 was determined to be a low-use area during the RI, so no detailed characterization work was done. The anomaly selection criteria were set to detect a mortar to the required depth of 0.45 m, which will also detect the other items potentially present to 0.30 m.

Other uncertainties include whether site noise would allow for consistent detection of TOI to the required depth across the entire site and whether any portions of the site would have anomaly densities too high to apply AGC (such as trenches or burial pits). Data were reviewed and no areas were found where the noise or the density of anomalies was too high.

Step 1b. Summarize any deviations from the planned sampling design and describe their impacts on the data quality objectives.

The sampling design was implemented as planned.

Step 2. Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12

Step 2a. Review available QA/QC reports, including weekly QC reports, assessment reports, corrective action reports, and the data verification/validation reports. Evaluate the implications of unacceptable QC results. For any non-conformances, was the RCA/CA effective? Summarize the impacts of non-conformances on data usability.

The data validation report contains a summary of all data, QC results, as well as non-conformances and RCA/CA. All data were collected as planned. CA were effective. Upon implementation of the CA, no non-conformances were repeated. At the conclusion of the survey, all data complied with all MPCs and MQOs.

Table D-1: Summary of non-conformances, root causes, and corrective action

Non-conforming MQO	Root cause	Corrective action implemented?
Missed seed (small ISO80) in EM61 detection survey	Buried deeper than specified	N/A – Not a valid seed. Removed from consideration
EM61 swapped out battery and did not do a function test	Operators failed to follow SOP	Recollected data Retrained staff Added to daily brief
Data gaps in EM61 survey	Gullies	Infilled with handheld EM61 data collection that met detection requirements

Step 2b. Evaluate conformance to MPCs documented on Worksheet #12.

Table D-2: MPC Evaluation for MRS A1 – Detection Survey

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 1 – Site Preparation and CSM				
1. Accessibility	Completeness	All areas inaccessible to remediation or inaccessible to use of proposed geophysical systems are identified and mapped in a GIS.	Visual Inspection QA Report and/or GIS Database	Complete. Inaccessible areas documented in GIS.
2. IOC Completeness	Representativeness/ Completeness (recoverability)	All recoveries (IOC and MD) were reviewed and CSM confirmed or updated. All recovered munitions, as well as munitions related to recovered MD, were included in the site-specific TOI library.	Surface Sweep Technical Memorandum and Updated CSM	Complete. Recovered IOC and MD documented in surface sweep technical memorandum. CSM updated to reflect all recoveries were consistent with initial CSM. All recovered IOC verified in the AGC library.
3. Surface Sweep Coverage	Representativeness/ Completeness	Surface sweep completed across the entire site. Identified SRAs have been documented.	Surface Sweep Technical Memorandum and Updated CSM	Complete. Surface sweep memorandum and GIS indicate all parts of the site were covered.
DFW 1 – Site Preparation and CSM				
4. Survey Control	Completeness	All survey control points placed by PLS, and survey control report submitted.	Surveyor and/or QC Report	Complete

Table D-2: MPC Evaluation for MRS A1 – Detection Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 2 & 3 – IVS				
5. IVS Construction	Accuracy/Completeness	Seeds placed so that each sensor passes at least one seed item during IVS surveys. Seed type, depth, and location accuracy recorded during placement.	IVS Memorandum	Complete
6. IVS Testing	Sensitivity/ Completeness	Detection equipment assembled correctly and functioning as designed. Detection threshold confirmed or site-specific conditions on detection capabilities are documented.	IVS Memorandum	Complete. Signals consistent with REFERENCE REPORT. Measured noise supports detection at the chosen threshold.
DFW 2 – QC and Validation Seeding				
7. QC Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QC seeds will be placed at the site by the contractor (1). Blind QC seeds must be detectable as defined by the DQOs and located throughout the horizontal and vertical survey boundaries defined in the DQOs (2,3).	Production Area QC Seeding Report	Complete. QC seeding report contains verified, as-buried locations of seeds. All seeds were buried at depths in the detectable range of the sensor.

Table D-2: MPC Evaluation for MRS A1 – Detection Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
8. Validation Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind Validation seeds will be placed throughout the MRS footprint by the Government (or its third-party contractor) (1). Validation seeds must be detectable as defined by the DQOs and located at depths that result in signals equivalent to 2-5 times the detection threshold (2,3).	Validation Seeding Report	Complete. Validation seed report contains verified, as-buried locations of seeds. All seeds were buried at depths in the detectable range of the sensor.
DFW 4 & 5 – Data Acquisition Detection Survey				
9. Detection threshold (non-AGC DGM)	Sensitivity	The detection threshold used to detect a 60-mm mortar lying horizontally at a depth of 0.45 m is 11.7 mV on channel 2.	1) Review of sampling design 2) Initial and ongoing instrument verification strip (IVS) surveys 3) Blind QC and validation seed detection 4) RMS background maps show all areas are less than or equal to 20% of the threshold	Complete. IVS results support threshold met project objectives.

Table D-2: MPC Evaluation for MRS A1 – Detection Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 4 & 5 – Data Acquisition Detection Survey				
10. Detection Survey	Accuracy/Completeness	100% of QC seeds detected	1) QC Seed Database 2) RCA/CA review and acceptance	Complete. All QC seeds except one, detected at correct location with signal consistent with predictions. Seed 232 was not detected at the anomaly selection criteria. Upon investigation it was determined that this seed had been buried deeper than the specification in the seed plan and deeper than the MRDD. It was determined to be invalid and removed from the seed list. No CA necessary w/r/t survey data collection and analysis.
11. Detection Survey	Accuracy/Completeness	100% of validation seeds must be detected.	Validation Seed Database	Complete. All validation seeds detected at the correct locations and with signal consistent with the buried item.
12. Detection Survey Coverage	Representativeness/ Completeness	100% of the site is sampled at required lane spacing and point-to-point sampling specifications.	1) Coverage Maps 2) Detection Survey Database	Complete. Coverage met specifications. IVS locations within specification. Survey control point reacquisition within specification. Seed locations within specification.
13. Anomaly Selection	Completeness	Complete project-specific databases and anomaly lists delivered. All QC and QA seeds listed in Detection Survey Database.	Detection Survey Database	Complete. Reanalysis of 10% of the data did not result in any additional anomalies selected.
14. Background	Representativeness/ Sensitivity	Background areas where detection threshold does not exceed five times background are identified.	1) GIS Database 2) Detection Survey Database	Complete.

Table D-2: MPC Evaluation for MRS A1 – Detection Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 4 & 5 – Data Acquisition Detection Survey				
15. AGC Cued Survey Background Locations	Representativeness/ Comparability	Representative areas determined to be background are selected and bounded in the detection survey.	1) GIS Database 2) Cued Background Database	Complete. Representative locations were identified throughout the site.
16. Variability for Cued Background locations	Representativeness/ Sensitivity	Representative backgrounds are selected in all noise regimes. Background areas where detection threshold is less than 5 times background are identified. All anomaly cued locations appropriate for each expected background are identified.	1) GIS Database 2) Cued Background Database	Complete. Three areas of elevated background noise were identified and associated representative background locations identified for each.
17. Saturated Response Areas	Completeness	No SRAs in final detection survey data. All SRAs remapped to confirm anomaly densities reduced to below DQO thresholds. [Example] The analog anomaly reduction survey reduces the anomaly density to below 3500 anomalies/acre equivalent.	1) Detection Survey Database 2) GIS Database	Complete. No such areas were found.

Step 2c: Evaluate data completeness. Identify data gaps (i.e., data inputs that have not been satisfied) and summarize their impact on the DQOs.

EM61 data are complete in all accessible areas and are deemed to be useable to locate the munitions specified in the project goals. Following infill of a gully with handheld EM61 data collection, the only remaining data gaps are rocky outcroppings, where munitions cannot penetrate to the subsurface. These data gaps do not impact achievement of the DQOs.

Step 3: Document data usability, update the CSM, and draw conclusions

Step 3a: 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. Determine whether the data are suitable for proceeding to the cued AGC data collection phase.

The sampling design for the subsurface removal performed as expected. The MPCs/MQOs demonstrate the data meet remediation goal articulated in Step 1.

Step 3b: Apply decision rules and draw conclusions.

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.

   Field observations are consistent with the CSM. Remediation will continue under current assumptions.

2. If signals meet the anomaly selection criteria, they will be selected for cued data collection using AGC.

   Signals meeting the anomaly selection criteria were selected for AGC data collection. All seeds were detected. Random reanalysis of 10% of site revealed no additional anomalies that could not be resolved.

3. If areas of the site are deemed unsuitable (criteria to be established in Step 6) for AGC, the project team will document those areas and revise the remedial design, as necessary.

   No areas of the site were deemed unsuitable for AGC.

Overall Conclusion: All MPCs were achieved and the data support moving on to the Cued Data Collection and Analysis Phase.

Step 3c: Update the CSM

The CSM was updated to reflect the location of the gully that impeded the towed-array survey, as well as observations from the site preparation activities.

Step 4. Document lessons learned and make recommendations

Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for future delivery units at the site, or future investigations. Prepare the data usability summary report.

Recommendations: The EM61 data are sufficient to support the AGC cued data collection

MRS A1 Cued Survey DUA

Identify personnel (organization and position/title) who participated in the data usability assessment: [Note: the same personnel should participate in all phases of the DUA.]

For the Government:

- The DoD Remedial Project Manager
- The DoD Technical Manager
- The Project Geophysicist
- The Project Quality Assurance Manager
- The OESS

For the Contractor:

- The Project Manager
- The Project Geophysicist
- The Quality Control (QC) Geophysicist
- The Field Geophysicist (Lead)
- The UXOQCS

The Regulator

Identify documents used as input to the cued-survey data usability assessment:

- Quality Assurance Project Plan
- Contract Specifications
- Quality Assurance Surveillance Plan
- Final Verification and Validation Plan
- Weekly QC Reports
- Assessment Reports Corrective Action Reports
- Production Area Seed Report
- IVS Memoranda
- Site-Specific Library
- Cued Survey Data Validation Report
- Prioritized Target “Dig” List
- Target Classification Report

- Classification Validation Report

Step 1. Review the project's objectives and sampling design

Step 1a. Are underlying assumptions in the initial CSM valid? Review the data quality objectives. Were the project boundaries appropriate? Review the sampling design as implemented for consistency with stated objectives. Consider sources of uncertainty. Was uncertainty appropriately managed?

The primary objective of the removal action in MRS A1 was to remove:

- All 60-mm mortars to a depth of 0.45 m bgs.
- Practice hand grenades, signals, flares, pyrotechnics, 2.36" rockets, and anti-tank mines to a depth of 0.30 m bgs.
- Any other munitions present on the site to their maximum reliable detection depth at the anomaly selection criteria set for the 60-mm mortars.

The library and TOI selection criteria for the AGC step were both specified with the assumption that these munitions would make up the TOI.

The munitions-related objects recovered in the surface sweep include:

- MD from 60-mm mortar smoke and illumination mortars.
- MD associated with practice hand grenades.
- Debris from small arms.

No evidence of other munitions was found. The underlying assumptions are consistent with all observations to date.

Step 1b. Were sources of uncertainty accounted for and appropriately managed?

The primary uncertainty related to the design of the classification step was lack of knowledge of the expected munitions in a maneuver area. The CSM provided evidence from historical records of use, but they are often incomplete and a wide variety of activities involving a variety of possible munitions could have taken place. MRS A1 was determined to be a low-use area during the RI, so no detailed characterization work was done. The library contained all possible munitions from the historical records and the other TOI selection criteria were set to identify other items typically found on maneuver areas.

Other uncertainties included whether site noise would allow for consistent classification of TOI to the required depth across the entire site and the extent to which background variation would affect the analysis. Data were reviewed and no areas were found where the noise was too high. Background data were acquired multiple times per day and variability was as expected.

Step 1c. Summarize any deviations from the planned sampling design and describe their impacts on the data quality objectives.

The sampling design was implemented as planned. Cued AGC data were collected at the locations of all anomalies selected in the detection step. All cued data were analyzed and classified. Additional required verification and validation digs were identified.

Step 2. Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12

Step 2a. Review available QA/QC reports, including weekly QC reports, assessment reports, corrective action reports, and the data verification/validation reports. Evaluate the implications of unacceptable QC results. For any non-conformances, was the RCA/CA effective? Summarize the impacts of non-conformances on data usability.

The data validation report contains a summary of all data, QC results, as well as non-conformances and RCA/CA. CA were effective. Upon implementation of the CA, no non-conformances were repeated. All data were collected as planned. At the conclusion of the project, all data complied with all MPCs and MQOs.

Summary of non-conformances, root causes, and corrective action (from data validation report)

Table D-3: Summary of non-conformances, root causes, and corrective action

Non-conforming MQO	Root cause	Corrective action implemented?
AGC Failed IVS at end of day	A receive cube failed sometime between passing the IVS in the morning and failing it at the end of the day. Wire not secured properly.	Reviewed SOP Recollected the day's data

Step 2b. Evaluate conformance to MPCs documented on Worksheet #12

Table D-4: MPC Evaluation for MRS A1 – Cued Survey

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 7 & 8 – Data Acquisition – Cued Survey				
18. Background data collection (AGC)	Representativeness/ Accuracy	Each cued analysis is performed with a representative background and verified during quality control.	1) Background Validation Database 2) Cued Survey Database 3) QC Verification	Complete. Background data were collected at locations identified on the site. Data review confirmed appropriate background measurements were used in the analysis.
19. Background frequency	Completeness	Background data are collected at a minimum of the interval specified by the manufacturer.	Background Validation Database	Complete. All background measurements were repeated X times per day, per the manufacturer specifications, and drift was documented.
20. Anomaly classification (AGC)	Completeness/ Comparability	Site-specific library must include signatures for all items considered by the project team to be IOC as listed in the CSM.	Site-specific TOI Library	Complete. The library included signatures from all items confirmed or suspected to be present.
21. Anomaly classification (AGC)	Completeness	All detected anomalies classified as: 1) TOI 2) Non-TOI 3) Inconclusive	1) Source Database 2) Final Intrusive Database	Complete. All anomalies were assigned to one of TOI, non-TOI, or inconclusive.

Table D-4: MPC Evaluation for MRS A1 – Cued Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 7 & 8 – Data Acquisition – Cued Survey				
22. Anomaly classification (QC Seeds)	Accuracy/Completeness	100% of QC seeds are correctly classified as TOI for excavation. QC Seeds classified as inconclusive are discussed in DUA.	1) QC Seed Database 2) RCA/CA Review and Acceptance	Complete. All QC seeds correctly classified.
23. Anomaly classification (Validation Seeds)	Accuracy/ Completeness	100% of validation seeds are correctly classified as TOI for excavation.	Validation Seed Database	Complete. All validation seeds correctly classified.

Step 2c. Evaluate data completeness. Identify data gaps (i.e., data inputs that have not been satisfied.) and summarize their impact on the DQOs.

AGC data were collected at all EM61 anomaly locations, analyzed, and a TOI/non-TOI decision was made for each location.

Step 3. Document data usability, update the CSM, apply decision rules, and draw conclusions

Step 3a. 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. Determine whether the data are suitable for proceeding to the cued AGC data collection phase.

The sampling design for the AGC cued data collection performed as expected. The MPCs/MQOs demonstrate the data meet remediation goal articulated in Step 1.

Step 3b. Apply decision rules and draw conclusions

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.

   Field observations are consistent with the CSM. Remediation will continue under current assumptions.

2. If AGC analyses meet any of the following criteria, they will be selected as TOI and placed on an ordered dig list: a) the polarizability decay curve matches that of an item in the project-specific TOI library, or b) estimates of the size, shape, symmetry, and wall thickness indicate the item is long, cylindrical or spherical, and thick-walled, or c) there is a group (cluster) of unknown anomalies having similar polarizability decay curves that, after investigation, are discovered to be IOC.

All anomalies from the EM61 survey were assigned to one of TOI, non-TOI, or inconclusive. AGC analyses meeting the criteria were placed on the dig list. All seeds were correctly identified as TOI.

3. If AGC analyses yield inconclusive polarizability decay curves they will be added to the dig list or otherwise resolved.

   All inconclusive analyses were added to the dig list or otherwise resolved.

Step 3c. Update the CSM.

No updates to the CSM were required. The data are suitable to support intrusive investigation.

Step 4. Document lessons learned and make recommendations

Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for future delivery units at the site, or future investigations. Prepare the data usability summary report.

Recommendations: The intrusive investigation should begin.

MRS A1 – Project-Conclusion DUA

Identify personnel (organization and position/title) who participated in the data usability assessment: [Note: the same personnel should participate in all phases of the DUA.

For the Government:

- The DoD Remedial Project Manager
- The DoD Technical Manager
- The Project Geophysicist
- The Project Quality Assurance Manager
- The OESS

For the Contractor:

- The Project Manager
- The Project Geophysicist
- The Quality Control Geophysicist
- The Field Geophysicist (Lead)
- The UXOQCS

The Regulator

Identify documents used as input to the project-conclusion data usability assessment:

- Quality Assurance Project Plan
- Contract Specifications
- Quality Assurance Surveillance Plan
- Final Verification and Validation Plan
- Weekly QC Reports
- Assessment Reports Corrective Action Reports
- Production Area Seed Report
- IVS Memoranda
- Detection Survey Data Validation Report

- Site-Specific Library
- Cued Survey Data Validation Report
- Prioritized Target "Dig" List
- Target Classification Report
- Classification Validation Report

Step 1. Review the project's objectives and sampling design

Step 1a. Are underlying assumptions in the initial CSM valid? Review the data quality objectives. Review the data collection plan as implemented for consistency with stated objectives.

The primary objective of the removal action in MRS A1 was to remove:

- All 60-mm mortars to a depth of 0.45 m bgs.
- Practice hand grenades, signals, flares, pyrotechnics, practice 2.36" rockets, and practice anti-tank mines to a depth of 0.30 m bgs.
- Any other munitions present on the site to their maximum reliable detection depth at the anomaly selection criteria set for the 60-mm mortars.

The library and TOI selection criteria for the AGC step were both specified with the assumption that these munitions would make up the TOI.

The recovered objects include:

- 60-mm mortar smoke and illumination mortars that had been fired, to a depth of 0.30 m.
- Practice hand grenades to a depth of 0.20 m.
- Associated MD.
- Debris from small arms.

The vertical CSM in Figure D-1 shows the recovered MEC, seeds, and maximum reliable detection depths.

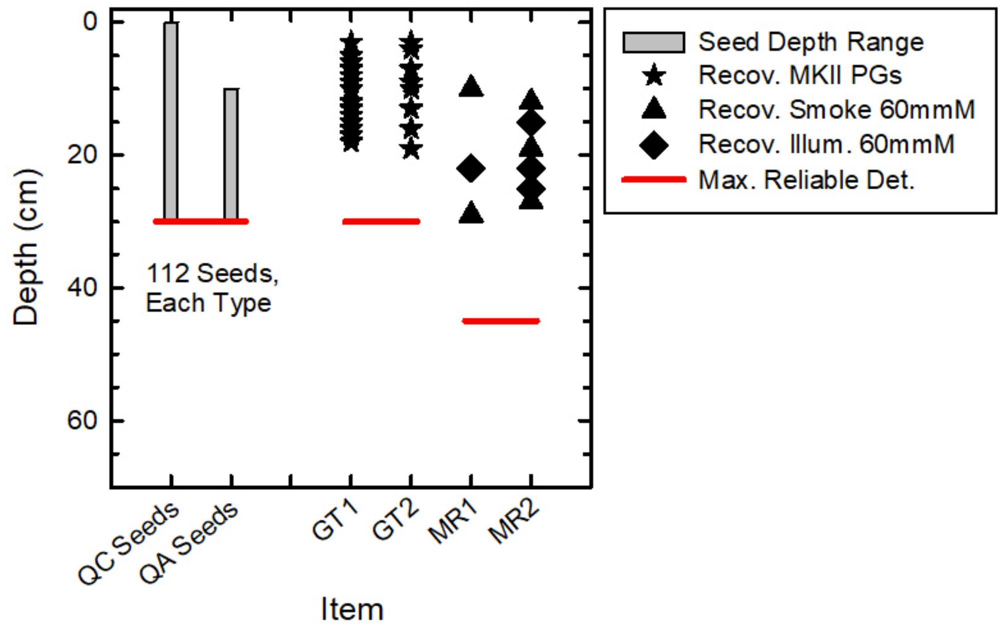

Figure D-1. Vertical CSM for MRS A1 at the conclusion of the RA

All information from the removal action is consistent with the initial CSM, confirming planning assumptions and the validity of the sample plan.

- The only munitions found on the site were fired mortars and practice hand grenades.
- EM61 target selection criteria were based on detecting a 60-mm mortar to 0.45 m bgs. Nine mortars were found in the subsurface at depths between 0.05 and 0.30 m.
- The target selection criteria correspond to a reliable detection depth of hand grenades to 0.3 m. Seventy-five practice hand grenades were recovered at depths ranging from 0.05 to 0.20 m.
- Mortars, hand grenades, and all other potential munitions identified in the CSM were included in the AGC TOI library.
- Seeded items and depths were appropriate to represent the munitions recovered.
- All field specifications, including line spacing, sample rate, and sensor standoff planned based on initial assumptions, were valid.

Conclusion: There are no inconsistencies of a nature that would call into question whether the data collection and analysis methodology can meet the project objectives.

Step 1b. Consider sources of uncertainty. Was uncertainty appropriately managed?

The primary uncertainty related to the design of the classification step was lack of knowledge of the expected munitions in a maneuver area. The CSM provided evidence from historical records of use, but they are often incomplete and a wide variety of activities involving a variety of possible munitions could have taken place. The library contained all possible munitions from the historical records and the other TOI selection criteria were set to identify other items typically found on maneuver areas.

Other uncertainties included whether site noise would allow for consistent classification of TOI to the required depth across the entire site and the extent to which background variation would affect the analysis. Data were reviewed and no areas were found where the noise was too high. Background data were acquired multiple times per day and variability was as expected.

Step 1c. Summarize any deviations from the planned sampling design and describe their impacts on the data quality objectives.

The sampling design was implemented as planned.

Step 2. Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12

Step 2a. Review available QA/QC reports, including weekly QC reports, assessment reports, corrective action reports, and the data verification/validation reports. Evaluate the implications of unacceptable QC results. For any non-conformances, was the RCA/CA effective? Summarize the impacts of non-conformances on data usability.

The data validation report contains a summary of all data, QC results, as well as non-conformances and RCA/CA. All data were collected as planned. There were no unacceptable QC results. CA were effective. Upon implementation of the CA, no non-conformances were repeated. At the conclusion of the project, all data complied with all MPCs and MQOs.

Table D-5: Summary of non-conformances, root causes, and corrective action

Non-conforming MQO	Root cause	Corrective action implemented?
The source of anomaly 136 on the dig list was not recovered on the first intrusive investigation	The dig team had dug in the area around the flag but did not dig in the center where the object was located upon a revisit to the anomaly location	Reviewed SOP Reviewed all recovery data

Step 2b. Evaluate conformance to MPCs documented on Worksheet #12.

Table D-6: MPC Evaluation for MRS A1 – Project Conclusion

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 9, 10, & 11 – Anomaly Resolution and Excavation				
24. Anomaly resolution QC seeds)	Accuracy/Completeness	100% of QC seeds are recovered.	Intrusive Results Database	Complete. All QC seeds recovered.
25. Anomaly resolution (validation seeds)	Accuracy/Completeness	100% of validation seeds are recovered.	Intrusive Results Database	Complete. All validation seeds recovered.
26. Anomaly resolution	Accuracy/Completeness	100% of predicted non-TOI that are intrusively investigated are confirmed to be non-TOI. This includes threshold verification digs and validation digs.	Intrusive Results Database	Complete. All predicted non-TOI that were investigated were non-TOI.
27. Intrusive Investigation	Accuracy	Inversion results correctly predict one or more physical properties (e.g., size, symmetry, or wall thickness) of the recovered items (specific tests and test objectives established during project planning).	Intrusive Results Database	Complete. All recovered items were consistent with predicted physical properties.
28. Intrusive Investigation	Completeness/ Comparability	A complete project-specific database including records reconciling inversion results to the physical properties of the recovered items.	Intrusive Results Database	Complete. All records are documented in the database. All anomaly locations were investigated and resolved.
29. Intrusive Investigation	Accuracy/Completeness	AGC results indicate original polarizabilities resulting in TOI are no longer present and no additional TOI sources present above the project-specific stop-dig threshold.	Post-mapping database	Complete.

Step 2c. Evaluate data completeness. Identify data gaps (i.e., data inputs that have not been satisfied.) and summarize their impact on the DQOs.

AGC data were collected at all EM61 anomaly locations, analyzed, and a TOI/non-TOI decision was made for each location. All MPCs were achieved. Together the MPCs provide evidence to support the design was successfully implemented.

- Full coverage of the site with the EM61 survey was achieved. All accessible data gaps were resurveyed. Any areas inaccessible to the array were surveyed with a handheld DGM system or otherwise resolved.
- The IVS confirmed the EM61 system was operating properly at the beginning and end of each data collection day.
- All seeds were detected and located in the EM61 detection step, correctly identified, and recovered.
- All recovered munitions were consistent with the AGC analysis predictions.
- All verification digs were non-IOC. All validation digs were consistent with AGC analysis.

Step 3. Document data usability, update the CSM, apply decision rules, and draw conclusions

Step 3a. 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. Bgs

The sampling design for the subsurface removal performed as expected. The MPCs/MQOs demonstrate the data meet remediation goal articulated in Step 1.

Step 3b. Considering the implications of any deviations and data gaps, can the data be used as intended? Are the data sufficient to answer the study questions?

The sampling design for the subsurface removal performed as expected. The data were successfully used to excavate and remove all surface and subsurface munitions for which there was evidence on the site. The MPCs/MQOs demonstrate the data meet remediation goal of no mortars to 0.45 m and no other IOC to 0.30 m bgs.

The data are suitable for supporting a weight-of-evidence decision regarding UU/UE; specifically:

- The EM61 survey was completed as planned and all MPCs were met.
- The AGC data collection and analysis was completed as planned and all MPCs were met.
- All results were consistent with the CSM and underlying planning assumptions were valid.
- No munitions were recovered that are more hazardous than anticipated.
- No unexpected munitions were recovered and no evidence suggesting their presence was observed.
- No munitions were recovered below their reliable detection and classification depth.
- All verification digs recovered non-IOC.
- All validation digs resulted in the recovery of an item consistent with the AGC analysis.

Step 3c. Apply decision rules and draw conclusions

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.

   Field observations are consistent with the CSM. Remediation was completed under current assumptions.

2. If the threshold verification digs do not uncover any IOC as described above, then the threshold is verified. If any IOC are recovered, then the project team will conduct an RCA/CA that results in an adjustment of the threshold and determination of the impacts on project objectives.

   Threshold verification digs did not uncover any IOC. The threshold is verified.

3. The geophysical classification results will be valid if:

   Validation digs do not uncover any IOC, and

   The properties of all recovered objects are consistent with predicted properties.

   No IOC were recovered and no objects were inconsistent with the predicated properties. Results are valid.

4. If validation digs uncover any IOC as described above, the project team will conduct a QA stand-down and evaluate the impacts on MPCs and DQOs.

   Validation digs did not recover any IOC. Analysis results are valid.

5. If the properties of any recovered object are inconsistent with predicted properties, then the project team will conduct an RCA/CA and determine the impacts on achievement of MPCs and DQOs.

   The properties of all recovered objects were consistent with the predicted properties.

6. If all lines of evidence are complete and support UU/UE, the project team will develop documentation supporting UU/UE for consideration by final decision makers. If lines of evidence are incomplete or any line of evidence does not support UU/UE, the project team will develop documentation rejecting UU/UE for consideration by final decision makers.

   All lines of evidence are complete and support UU/UE. The project team has developed documentation for decision-makers.

Step 3d. Update the CSM.

The CSM was updated to reflect the locations, depths, and types of all munitions recovered on the site. The post-removal CSM supports the site team making a decision regarding UU/UE. The following conclusions were reached:

- Four areas of munitions use were identified:
  GT1 – Grenade training area 1 acre in size containing 40 practice grenades
  GT2 – Grenade training area 1 acre in size containing 35 practice grenades
  MR1 – Mortar training area 15 acres in size containing 2 smoke and 1 illumination mortars and scattered fragments, parachutes, and pyrotechnics
  MR2 – Mortar training area 53 acres in size containing 3 smoke and 3 illumination mortars and scattered fragments, parachutes, and pyrotechnics
- No evidence was uncovered during the surface sweep, or the subsurface removal, of any other munitions identified in the original CSM as potentially present.
- No evidence of unexpected munitions was found. The AGC criteria for TOI looked for cylindrical or spherical items and looked at "clusters" of similar unknown items.
- No findings suggest a hazard that exceeds what is expected from the original CSM.
- No evidence suggests that IOC exist below their maximum reliable detection depth. All recovered IOC were considerably shallower. The findings regarding the use of smoke and illumination mortars are consistent with the CSM.
- Other than the four areas identified above, no evidence of munitions use was found.

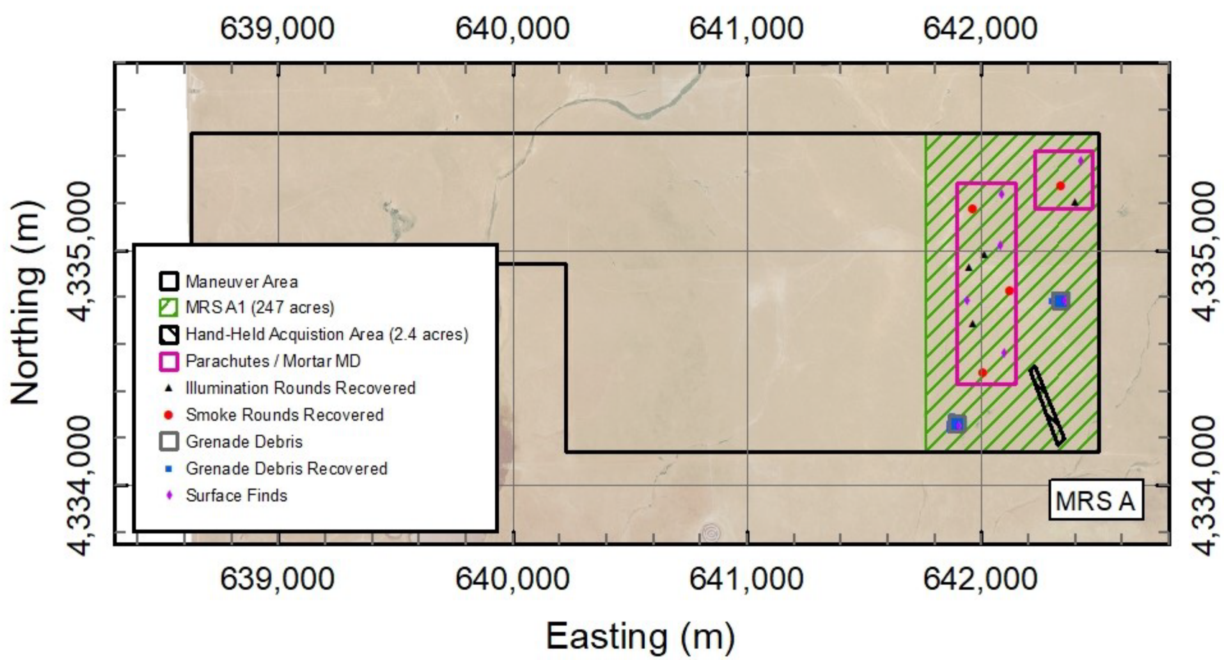

Figure D-2: Final MRS A1 CSM: Maneuver Area Aerial View

Step 4. Document lessons learned and make recommendations

Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for the next phase of investigation or future investigations. If this is the final DUA, prepare the final DUA report to be included in the RA report.

Recommendations: The RA has been performed as planned and all the DQOs have been achieved. The sitework is complete and MEC has been detected and removed to the required depths. The project team should prepare documentation supporting UU/UE for consideration by decision-makers.

Example #2: MRS A2 Maneuver Area Recreational Area – Surface Removal using Instrument-Aided Visual Identification

Because anomaly detection and source removal were conducted concurrently, the DUA was conducted at the conclusion of the project.

MRS A2 – Project Conclusion DUA:

Identify personnel (organization and position/title) who participated in the data usability assessment:

For the Government:

- The DoD Remedial Project Manager
- The DoD Technical Manager
- The Project Geophysicist
- The Project Quality Assurance Manager
- The OESS

For the Contractor:

- The Project Manager
- The Project Geophysicist
- The Quality Control Geophysicist
- The Field Geophysicist (Lead)
- The UXOQCS

The Regulator

Identify documents used as input to the data usability assessment:

- Quality Assurance Project Plan
- Contract Specifications
- Quality Assurance Surveillance Plan
- Weekly QC Reports
- Assessment Reports Corrective Action Reports
- Production Area Seed Report
- ITS Memoranda
- Surface Removal Final Report

Step 1. Review the project's objectives and sampling design

Step 1a. Are underlying assumptions in the initial CSM valid? Review the data quality objectives. Review the project plan as implemented for consistency with objectives. Consider sources of uncertainty.

The primary objective in MRS A2 was to remove munitions present on the site surface. The underlying assumption is that combination of visual inspection and analog magnetometer can detect all surface munitions for removal. The removal yielded MEC, MD, and cultural artifacts. All seeds were recovered, although some required multiple passes. The underlying assumptions are valid.

With no geophysics data record, the primary uncertainty related to the design of the instrument-aided surface removal was the unknown and unmeasurable reliability of the instrument and operator. The project design included the extensive use of both QC seeds, to assess completeness for the contactor, and QA seeds, to document overall performance.

Step 1b. Summarize any deviations from the planned sampling design and describe their impacts on the data quality objectives.

The sampling design was implemented as planned.

Step 2. Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12

Step 2a. Review the Data Verification/Validation Reports and supporting data, if necessary (e.g., daily/weekly QC reports, assessment reports and corrective action reports.

The data validation report contains a summary of all field activities, QC results, non-conformances, and RCA/CA. In 60% of the survey units on the site, seeds were missed on the first pass. These survey units were resurveyed until all seeds were recovered. In each resurvey, additional seeds and additional native items were recovered. Upon retraining, seed recovery increased to 85% for the remaining survey units.

Step 2b. For any non-conformances, was the RCA/CA effective? Evaluate the implications of unacceptable QC results.

Table D-7: Summary of non-conformances, root causes, and corrective action

Non-conforming MQO	Root cause	Corrective action implemented?
Missed seeds in first survey unit	Inherent limitations of the technology	Retrained operators Resurveyed all grids where seeds were missed Slowed pace of work

Step 2c. Evaluate conformance to MPCs

Table D-8: MPC Evaluation for MRS A2 – Project Completion

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 1 – Site Preparation and CSM				
1. Accessibility	Completeness	All areas inaccessible to remediation or inaccessible to use of proposed geophysical systems are identified and mapped in a GIS.	Visual Inspection QA Report and/or GIS Database	Complete. All inaccessible areas documented in the GIS.
2. IOC Completeness	Representativeness/ Completeness (recoverability)	All recoveries (IOC and MD) were reviewed and CSM confirmed or updated.	Updated CSM	Complete.
3. Survey Control	Completeness	All survey control points placed by PLS, and survey control report submitted.	Surveyor and/or QC Report	Complete. Survey report accepted.
DFW 2 & 3 – ITS				
4. ITS Construction	Accuracy/Completeness	Seeds placed so that each sensor passes at least one seed item during ITS. Seed type, depth, and location accuracy recorded during placement.	ITS Memorandum	Complete. ITS memorandum accepted.
5. ITS Testing	Sensitivity/ Completeness	Analog equipment assembled correctly and functioning as designed. Detection threshold confirmed and tested daily with ITS seeds at depth of detection.	1) ITS Memorandum 2) ITS Database	Complete. Sensor detected ITS items daily.

Table D-8: MPC Evaluation for MRS A2 – Project Completion (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 2 – QC and QA Seeding				
6. QC Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QC seeds will be placed at the site by the contractor (1). Blind QC seeds must be located throughout the horizontal boundaries defined in the DQOs (2,3).	Production Area QC Seeding Report	Complete. QC seeding report contains verified, emplaced locations. The correct number of seeds was emplaced.
7. QA Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QA seeds will be placed on the surface throughout the MRS footprint by the Government (or its third-party contractor) (1, 2, 3).	QA Seeding Report	Complete. Verification seeding report contains verified, emplaced locations. The correct number of seeds was emplaced.
DFW 4 – Surface Removal				
8. Planned Survey Coverage	Completeness	Survey lanes are designed and located not to exceed 3-foot spacing and cover the entire MRS footprint.	1) GPS or Photographic Documentation 2) Grid/Lane GIS database	Complete. Planned survey lanes conformed to specification.

Table D-8: MPC Evaluation for MRS A2 – Project Completion (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 4 – Surface Removal				
9. Detection threshold (analog)	Sensitivity	[Example] The analog instrument must be leveled to manufacturer settings and set to a sensitivity of 5 for the duration of the survey.	1) Initial and ongoing instrument test strip (ITS) surveys 2) Blind QC and QA seed detection 3) Periodic Verification by QC Geophysicist (or designee)	Complete. 1) Sensor detected ITS items daily 2) See 10 and 11 regarding seeds 3) Periodic checks by QC geophysicist documented
10. Detection Survey	Accuracy/Completeness	100% of QC seeds detected	1) QC Seed Database 2) RCA/CA review and acceptance	Complete. In the first survey unit, one or more seeds were missed on the first pass in 60% of the grids. These grids were resurveyed as necessary until all seeds were recovered. In each resurvey, additional seeds and additional native items were recovered. Upon retraining, seed recovery improved and 85% of grids had no missed seeds for the remaining survey units.

Table D-8: MPC Evaluation for MRS A2 – Project Completion (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 4 – Surface Removal				
11. Detection Survey	Accuracy/Completeness	100% of QA seeds must be detected.	QA Seed Database	Complete. The contractor submitted QA seed recovery to the government only after all QC seeds were recovered in each survey unit. One or more of the QA seeds were missed in 33% of the grids. Misses were randomly distributed across the site, indicating there were no systemic causes. The grids were then resurveyed until all QA seeds were recovered.
12. Detection Survey Coverage	Representativeness/ Completeness	100% of the site is sampled.	1) Seed Recovery 2) Operator GPS Records	Complete. GIS records show all lands surveyed. Photographs and GPS logs accepted.
13. Surface Item Removal	Completeness	All QC and QA seeds and pieces of metal exceeding 1”x2” in dimension recovered. All surface finds documented in the project-specific database.	1) GIS Database 2) QC Database 3) QA Database 4) Project Database	Complete. All databases have been accepted by the government.

Step 2c. Evaluate data completeness. Identify data gaps (i.e., data inputs that have not been satisfied.) and summarize their impact on the DQOs.

The surface removal, which was completed in all accessible areas, located some of the munitions specified in the project goals. These included MEC and MD associated with smoke and illumination mortars and practice grenades.

Step 3. Document data usability, update the CSM, apply decision rules, and draw conclusions

Step 3a. Assess the performance of the sampling design and identify any limitations on data use. Considering the implications of any deviations and data gaps, can the data be used as intended? Are the data sufficient to answer the study questions?

The surface removal performed as expected. A number of the expected munitions were removed from the site, along with a considerable amount of debris. However, QA and QC seeds were missed on the first pass even after the improvement from retraining, requiring multiple passes on many grids (see Seed Report for details) before all seeds were recovered. This is consistent with the known limitations of the technology and, even once all seeds are recovered, there is insufficient evidence to support a determination that all surface munitions were removed.

Step 3b. Apply Decision Rules

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.

   Field observations were consistent with the CSM. Remediation was completed under current assumptions.

2. If MPCs have been achieved, the project will have implemented the removal component of the remedy. If not, the team will recommend that the appropriate representatives of the responsible offices revisit and reconsider the ROD. The LUCs specified in the ROD will be used to manage residual risk.

   MPCs have been achieved. Removal component meets the specifications of the ROD.

Step 3c. Update the CSM and draw conclusions.

The CSM was updated to reflect the locations and types of all munitions recovered on the site; specifically:

- 60,000 items were removed from the site
- 87 practice hand grenades were removed.
- Small arms brass was also recovered

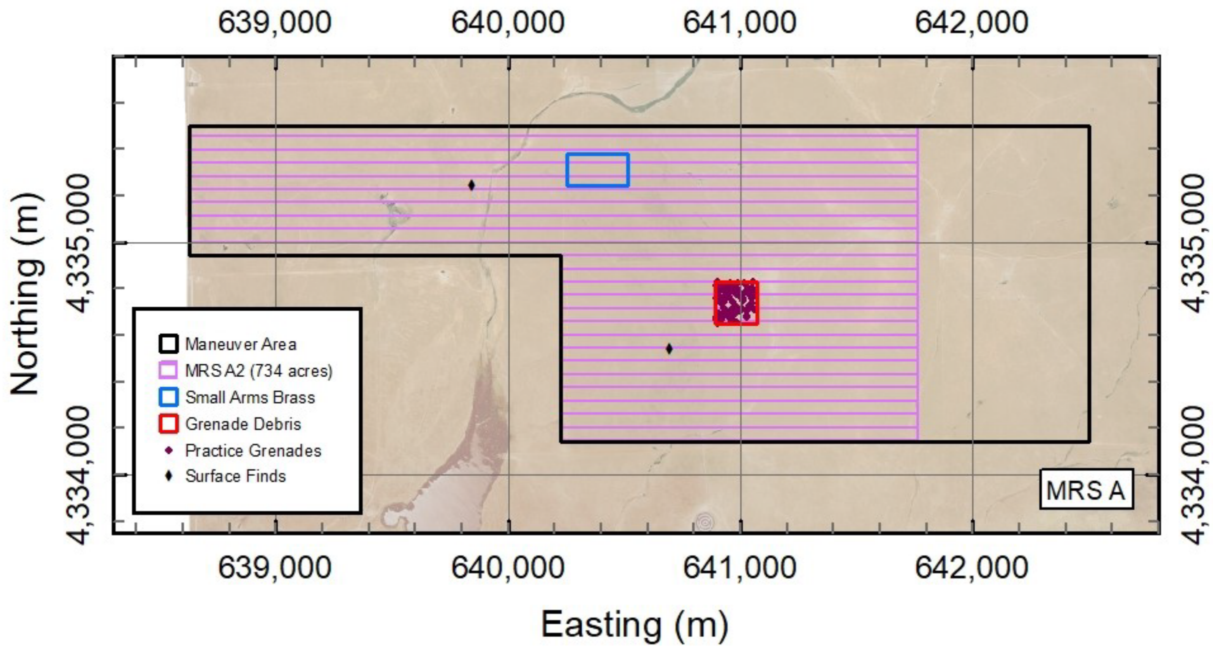

Figure D-3: Final MRS A2 CSM: Maneuver Area Aerial View

Step 4. Document lessons learned and make recommendations

Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for future delivery units at the site, or future investigations. Prepare the data usability summary report.

Recommendations: The work was completed to the capability of the technology and all MPCs were achieved, indicating the removal component had met the requirements of the ROD; however, there is insufficient evidence to support a conclusion that all MEC have been removed. The LUCs in the ROD will be used to manage the residual risk. Findings from the removal that will inform risk management include:

- The remedial action was implemented as planned.
- Missed QA and QC seeds were randomly distributed across the site, indicating failures resulted from technology limitations rather than systemic issues related to site conditions or personnel.
- All QA seeds were detected, some requiring multiple passes.
- The final CSM provides confidence that the UXO that were detected have been removed.

Example #3: MRS B1 Mortar Range, Flat-terrain Area – Surface and Subsurface Removal using non-AGC DGM

DUAs for MRS B1 were performed (1) at the conclusion of the detection survey and analysis and (2) at the conclusion of the project.

MRS B1 – Detection-Survey DUA

Identify personnel (organization and position/title) who participated in the data usability assessment: [Note: the same personnel should participate in all phases of the DUA.]

For the Government:

- Project Manager
- The DoD Technical Manager
- The Project Geophysicist
- The Project Quality Assurance Manager
- The OESS

For the Contractor:

- The Project Manager
- The Project Geophysicist
- The Quality Control Geophysicist
- The Field Geophysicist (Lead)
- The UXOQCS

The Regulator

Identify documents used as input to the detection-survey data usability assessment:

- Quality Assurance Project Plan
- Contract Specifications
- Quality Assurance Surveillance Plan
- Weekly QC Reports
- Assessment Reports Corrective Action Reports
- Production Area Seed Report
- IVS Memoranda

- Detection Survey Data Validation Report

Step 1. Review the project's objectives and sampling design

Step 1a. Are underlying assumptions in the initial CSM valid? Review the data quality objectives. Were the project boundaries appropriate? Review the sampling design as implemented for consistency with stated objectives. Summarize any deviations from the planned sample design.

The primary objective of the removal action in MRS B1 was to remove:

- All 60-mm mortars to a depth of 0.45 m bgs.
- Any other munitions present on the site to their maximum reliable detection depth at the anomaly selection criteria set for the 60-mm mortars.

The objects recovered in the surface sweep include:

- 60-mm HE mortars.
- Associated MD.

There was little uncertainty related to expected munitions in the design of the detection step. The CSM provided evidence from historical records of use and the RI data supported the use of MRS B as a mortar range, with an HUA down-range and no observed HD area in the safety fan, which was designated as an LUA. All MD and MEC recovered in the RI digging was associated with mortars. The anomaly selection criteria were set to detect a mortar to the required depth of 0.45 m.

The underlying assumptions are valid.

Step 1b. Were sources of uncertainty accounted for and appropriately managed?

Other uncertainties include whether site noise would allow for consistent detection of IOC to the required depth across the entire site. Data were reviewed and no areas were found where the noise was too high to support detection.

Step 1c. Summarize any deviations from the planned sampling design and describe their impacts on the data quality objectives.

The sampling design was implemented as planned.

Step 2. Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12

Step 2a. Review available QA/QC reports, including weekly QC reports, assessment reports, corrective action reports, and the data verification/validation reports. Evaluate the implications of unacceptable QC results. For any non-conformances, was the RCA/CA effective? Summarize the impacts of non-conformances on data usability.

The data validation report contains a summary of all data, QC results, non-conformances, and RCA/CA. Corrective actions were effective. Upon implementation of the CA, no non-conformances were repeated. At the conclusion of the survey, all data complied with all MPCs and MQOs.

Table D-9: Summary of non-conformances, root causes, and corrective action

Non-conforming MQO	Root cause	Corrective action implemented?
Detection threshold test 4 Area with SNR < 5	Local geology	The 3-acre area was documented in the GIS
Missed seed (small ISO80) in EM61 detection survey	Buried deeper than specified	N/A – Not a valid seed Removed from consideration
EM61 swapped out battery and did not do a function test	Operators failed to follow SOP.	Data recollected Retrained staff Added to daily brief

Step 2b. Evaluate conformance to MPCs documented on Worksheet #12.

Table D-10: MPC Evaluation for MRS B1 – Detection Survey

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 1 – Site Preparation and CSM				
1. Accessibility	Completeness	All areas inaccessible to remediation or inaccessible to use of proposed geophysical systems are identified and mapped in a GIS.	Visual Inspection QA Report and/or GIS Database	Complete. Inaccessible areas documented in GIS.
2. IOC Completeness	Representativeness/ Completeness (recoverability)	All recoveries (IOC and MD) were reviewed and CSM confirmed or updated.	Surface Sweep Technical Memorandum and Updated CSM	Complete. Recovered IOC and MD documented in surface sweep memorandum. CSM updated to reflect all recoveries are consistent with initial CSM.
3. Surface Sweep Coverage	Representativeness/ Completeness	Surface sweep completed across the entire site. Identified SRAs have been documented.	Surface Sweep Technical Memorandum and Updated CSM	Complete. Surface sweep memorandum and GIS indicate all parts of the site were covered.
4. Survey Control	Completeness	All survey control points placed by PLS, and survey control report submitted.	Surveyor and/or QC Report	Complete
5. IVS Construction	Accuracy/Completeness	Seeds placed so that each sensor passes at least one seed item during IVS surveys. Seed type, depth, and location accuracy recorded during placement.	IVS Memorandum	Complete

Table D-10: MPC Evaluation for MRS B1 – Detection Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 1 – Site Preparation and CSM				
6. IVS Testing	Sensitivity/ Completeness	Detection equipment assembled correctly and functioning as designed. Detection threshold confirmed or site-specific conditions on detection capabilities are documented.	IVS Memorandum	Complete. Signals consistent with REFERNCE REPORT. Measured noise supports detection at the chosen threshold.
DFW 2 – QC and Validation Seeding				
7. QC Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QC seeds will be placed at the site by the contractor (1). Blind QC seeds must be detectable as defined by the DQOs and located throughout the horizontal and vertical survey boundaries defined in the DQOs (2,3).	Production Area QC Seeding Report	Complete. QC seeding report contains verified, as-buried locations of seeds. All seeds were buried at depths in the detectable range of the sensor.
8. Validation Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind Validation seeds will be placed throughout the MRS footprint by the Government (or its third-party contractor) (1). Validation seeds must be detectable as defined by the DQOs and located at depths that result in signals equivalent to 2-5 times the detection threshold (2,3).	Validation Seeding Report	Complete. Validation seed report contains verified, as-buried locations of seeds. All seeds were buried at depths in the detectable range of the sensor.

Table D-10: MPC Evaluation for MRS B1 – Detection Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 4 & 5 – Data Acquisition Detection Survey				
9. Detection threshold (EM61)	Sensitivity	The detection threshold used to detect a 60-mm mortar lying horizontally at a depth of 0.45 m is 11.7 mV on channel 2.	1) Review of sampling design 2) Initial and ongoing instrument verification strip (IVS) surveys 3) Blind QC and validation seed detection 4) RMS background maps show all areas are less than or equal to 20% of the threshold, i.e., the threshold is 5 times the RMS noise	Complete. IVS results support threshold met project objectives, with the exception of one 3-acre area where the RMS background noise was elevated that does not meet criteria 4. In this area the detection threshold was 3 times the RMS noise. This area was documented in the GIS. The analyst noted that the anomaly density is this area was 25% higher compared to the rest of the site.
10. Detection Survey	Accuracy/Completeness	100% of QC seeds detected.	1) QC Seed Database 2) RCA/CA review and acceptance	Complete. All QC seeds detected at the correct locations and with signal consistent with the buried item.
11. Detection Survey	Accuracy/Completeness	100% of validation seeds must be detected.	Validation Seed Database	Complete. All validation seeds detected at the correct locations and with signal consistent with the buried item.
12. Detection Survey Coverage	Representativeness/ Completeness	100% of the site is sampled at required lane spacing and point-to-point sampling specifications.	1) Coverage Maps 2) Detection Survey Database	Complete. All survey data is within specification for coverage both in-line and cross-line.

Table D-10: MPC Evaluation for MRS B1 – Detection Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 4 & 5 – Data Acquisition Detection Survey				
13. Anomaly Selection	Completeness	Complete project-specific databases and anomaly lists delivered. All QC and validation seeds listed in Detection Survey Database.	Detection Survey Database	Complete. Reanalysis of 10% of the data did not result in any additional anomalies selected.
14. Background	Representativeness/ Sensitivity	Background areas where detection threshold does not exceed 5 x background are identified.	1) GIS Database 2) Detection Survey Database	Complete. The area identified in 9 was documented in the GIS.
15. SRAs	Completeness	No SRAs in final detection survey data. All designated SRAs anomaly densities reduced to below DQO thresholds and digitally remapped. SRA boundaries documented in GIS deliverable. [Example] The analog anomaly reduction survey reduces the anomaly density to below 1500 anomalies/acre equivalent.	1) GIS Database 2) Detection Survey Database	Complete
DFW 6 – Verification of EM61 Dig List				
15. Anomaly list (QC Seeds)	Accuracy/Completeness	100% of QC seeds are identified as TOI for excavation	1) QC Seed Database 2) RCA/CA review and acceptance	Complete. All QC seeds are identified.
16. Anomaly list (Validation Seeds)	Accuracy/ Completeness	100% of validation seeds are identified as TOI for excavation.	Validation Seed Database	Complete. All validation seeds are identified.

Step 2c. Evaluate data completeness. Identify data gaps (i.e., data inputs that have not been satisfied.) and summarize their impact on the DQOs.

EM61 data are complete in all accessible areas and are deemed to be useable to locate the munitions specified in the project goals.

Step 3: Document data usability, update the CSM, and draw conclusions

Step 3a. 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. Determine whether the data are suitable for proceeding to the cued AGC data collection phase.

The sampling design for the EM61 detection survey performed as expected. The MPCs/MQOs demonstrate the detection-survey data are complete.

Step 3b. Apply decision rules and draw conclusions.

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.

   Field observations are consistent with the CSM. The project will continue under current assumptions.

2. If signals meet the anomaly selection criteria, they will be selected for intrusive investigation.

   Signals meeting the anomaly selection criteria were selected for intrusive investigation. All seeds were detected, including in the 3-acre area with SNR < 5. Reanalysis of 10% of the site, which included the entire low SNR area, revealed no additional anomalies that could not be resolved.

Step 3c. Assess the performance of the sampling design and identify any limitations on data use. Considering the implications of any deviations and data gaps, can the data be used as intended? Are the data sufficient to answer the study questions?

The sampling design for the EM61 detection survey performed as expected. The MPCs/MQOs demonstrate the data meet the detection survey specifications.

Step 3d. Update the CSM decision rules and draw conclusions.

The CSM was updated to reflect the observations from the site preparation and data collection activities.

Step 4. Document lessons learned and make recommendations

Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for future delivery units at the site, or future investigations. Prepare the data usability summary report.

Recommendations: The EM61 data are sufficient to support the intrusive investigation.

MRS B1 – Project Conclusion DUA

Identify personnel (organization and position/title) who participated in the data usability assessment: [Note: the same personnel should participate in all phases of the DUA.

For the Government:

- The DoD Remedial Project Manager
- The DoD Technical Manager
- The Project Geophysicist
- The Project Quality Assurance Manager
- The OESS

For the Contractor:

- The Project Manager
- The Project Geophysicist
- The Quality Control Geophysicist
- The Field Geophysicist (Lead)
- The UXOQCS

The Regulator

Identify documents used as input to the project-completion data usability assessment:

- Quality Assurance Project Plan
- Contract Specifications
- Quality Assurance Surveillance Plan
- Final Verification and Validation Plan
- Weekly QC Reports
- Assessment Reports Corrective Action Reports
- Production Area Seed Report
- IVS Memoranda
- Detection Survey Data Validation Report

Step 1. Review the project's objectives and sampling design

Step 1a. Are underlying assumptions in the initial CSM valid? Review the data quality objectives. Review the data collection plan as implemented for consistency with stated objectives.

The primary objective of the removal action in MRS B1 was to remove:

- All 60-mm mortars to a depth of 0.45 m bgs.
- Any other munitions present on the site to their maximum reliable detection depth at the anomaly selection criteria set for the 60-mm mortars.

The recovered objects include:

- 60-mm HE mortars.
- Associated MD.

The vertical CSM in Figure D-2, below shows the recovered MEC, seeds, and maximum reliable detection depths.

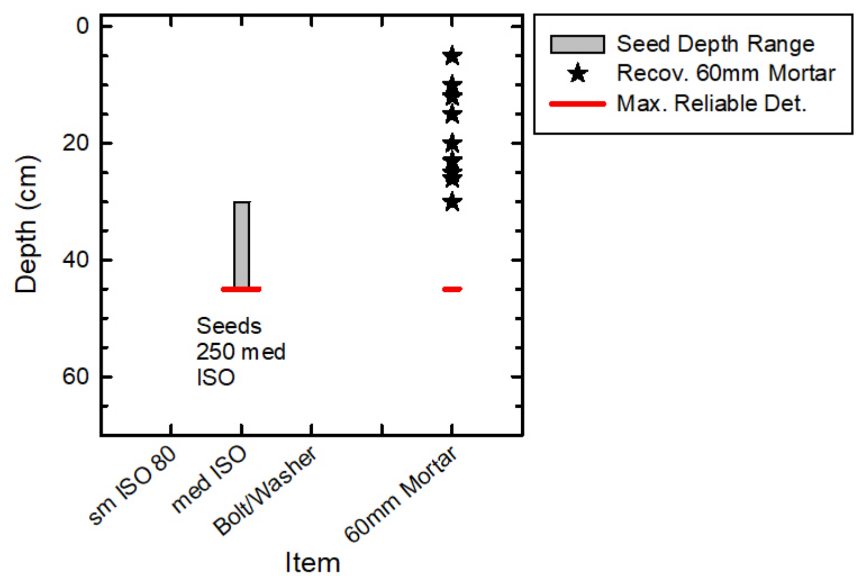

Figure D-4. Vertical CSM for MRS B1 at the conclusion of the RA

No unexpected munitions were recovered, and no munitions were recovered below their maximum reliable detection depth. Seeded items and depths reflected the recovery findings. The underlying assumptions are valid.

All information from the removal action is consistent with the initial CSM, confirming planning assumptions and the validity of the sampling plan; specifically:

- The only munitions found on the site were fired HE mortars.
- EM61 target selection criteria were based on detecting a 60-mm mortar to 0.45 m bgs. Nine mortars were found in the subsurface at depths between 0.05 and 0.30 m.
- Seeded items and depths were appropriate to represent the munitions recovered.
- All field specifications, including line spacing, sampling rate, and sensor standoff planned based on initial assumptions, were valid.

Conclusion: There are no inconsistencies of a nature that would call into question whether the data collection and analysis methodology can meet the project objectives.

Step 1b. Consider sources of uncertainty. Was uncertainty appropriately managed?

Uncertainties include whether site noise would allow for consistent detection of TOI to the required depth across the entire site. Data were reviewed and no areas were found where the noise was too high.

Step 1c. Summarize any deviations from the planned sampling design and describe their impacts on the data quality objectives.

The sampling design was implemented as planned.

Step 2. Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12

Step 2a. Review available QA/QC reports, including weekly QC reports, assessment reports, corrective action reports, and the data verification/validation reports. Evaluate the implications of unacceptable QC results. For any non-conformances, was the RCA/CA effective? Summarize the impacts of non-conformances on data usability.

The data validation report contains a summary of all data, QC results, as well as non-conformances and RCA/CA. The excavation report contains a summary of all recovered objects as well as non-conformances and RCA/CA. All data were collected as planned. CA were effective. Upon implementation of the CA, no non-conformances were repeated. At the conclusion of the project, all data complied with all MPCs and MQOs.

Table D-11: Summary of non-conformances, root causes, and corrective action

Non-conforming MQO	Root cause	Corrective action implemented?
Complete table from data validation report		

Step 2b. Evaluate conformance to MPCs documented on Worksheet #12.

Table D-12: MPC Evaluation for MRS B1 – Project Conclusion

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 7 & 8 – Anomaly Resolution and Excavation				
18. Anomaly resolution (QC Seeds)	Accuracy/Completeness	100% of QC seeds were recovered.	1) QC Seed Database 2) RCA/CA Review and Acceptance	Complete. All QC seeds were recovered.
19. Anomaly resolution (Validation Seeds)	Accuracy/ Completeness	100% of validation seeds were recovered.	Validation Seed Database	Complete. All validation seeds were recovered.
20. Intrusive Investigation	Accuracy	Digital post-mapping verification of selected excavated locations result in a geophysical response less than the detection threshold or documented as fully resolved	Post-mapping database	Complete. All locations had a final response less than the detection threshold.
21. Intrusive Investigation	Completeness/ Comparability	A complete project-specific database including records reconciling detection results to the physical properties of the recovered items. 100% of anomalies identified for investigation (i.e., TOI dig list) intrusively investigated.	Intrusive Results Database	Complete. All records are documented in the database. All anomaly locations were investigated and resolved.

Step 2c. Evaluate data completeness. Identify data gaps (i.e., data inputs that have not been satisfied.) and summarize their impact on the DQOs.

Together the MPCs provide evidence to support the design was successfully implemented:

- Full coverage of the site with the EM61 survey was achieved. All accessible data gaps were resurveyed. Any areas inaccessible to the array were surveyed with a handheld EM61 system or otherwise resolved.
- The IVS confirmed the EM61 system was operating properly at the beginning and end of each data collection day.
- All seeds were detected in the EM61 detection step and recovered.
- Objects were recovered at all dig locations.

Step 3. Document data usability, update the CSM, apply decision rules, and draw conclusions

Step 3a. 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.

The surface and subsurface removal performed as expected. The data were successfully used to excavate and remove all surface and subsurface munitions for which there was evidence on the site. The MPCs/MQO demonstrate the data meet the remediation goal. There was no evidence of munitions other than mortars.

The data are suitable for supporting a decision that the project is complete; specifically:

- The EM61 survey was completed as planned and all MPCs were met.
- All results were consistent with the CSM, and underlying planning assumptions were valid.
- No munitions were recovered that are more hazardous than anticipated.
- No unexpected munitions were recovered and no evidence suggesting their presence was observed.
- No munitions were recovered below their reliable detection depths.
- The firing point was located and excavated.

Step 3b. Apply decision rules and draw conclusions.

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.

   Field observations are consistent with the CSM. Remediation was completed under current assumptions.

2. If a reanalysis of the survey data does not reveal any new anomalies that meet anomaly selection criteria that cannot be resolved, the project has achieved DQOs. If new anomalies that cannot be resolved are identified, the team will conduct an RCA/CA to determine the impacts on project objectives.

   No additional anomalies were selected that could not be resolved. DQOs were achieved.

Step 3c. Document data usability and update the CSM.

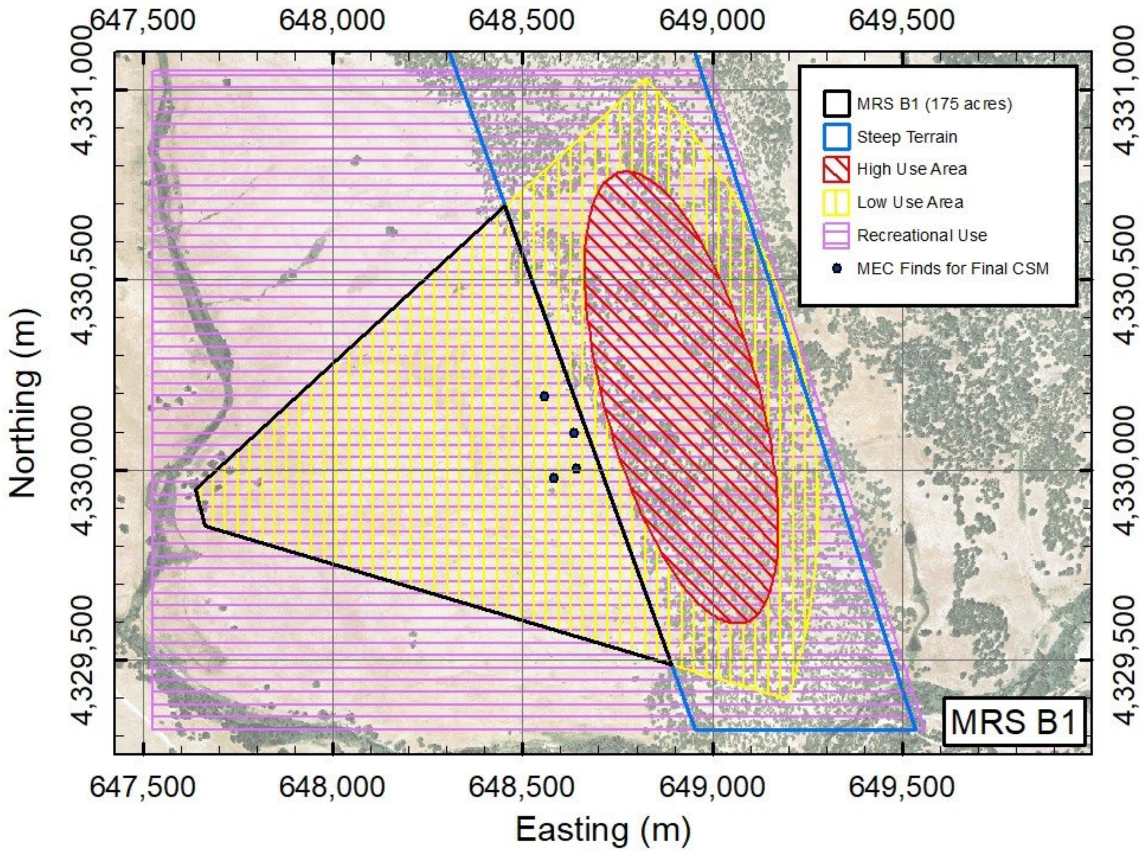

Figure D-5: Final MRS B1 CSM: Mortar Target Aerial View

The CSM was updated to reflect the locations, depths, and types of all munitions recovered on the site:

- Nine mortars were recovered in the far end of the firing fan near the impact area.
- The firing point was identified.
- No findings suggest a hazard that exceeds what is expected from the original CSM.
- No evidence suggests that items exist below their maximum reliable detection depth. All recovered items were shallow. The findings regarding the use of HE mortars are consistent with the CSM.

Step 4. Document lessons learned and make recommendations

Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for the next phase of investigation or future investigations. If this is the final DUA, prepare the final DUA report to be included in the RI/FS report.

Recommendations: The RA has been performed as planned and all the DQOs have been achieved. The sitework is complete and MEC has been detected and removed to the required depths. The removal is complete.

Example #4: MRS B2, Steep Terrain Area – Analog Surface and Subsurface Removal

Because detection and removal were conducted concurrently, the DUA was conducted at the conclusion of the project.

MRS B2 – Project-conclusion DUA

Identify personnel (organization and position/title) who participated in the data usability assessment: [Note: the same personnel should participate in all phases of the DUA.]

For the Government:

- The DoD Remedial Project Manager
- The DoD Technical Manager
- The Project Geophysicist
- The Project Quality Assurance Manager
- The OESS

For the Contractor:

- The Project Manager
- The Project Geophysicist
- The Quality Control Geophysicist
- The Field Geophysicist (Lead)
- The UXOQCS

The State Regulator

Identify documents used as input to the data usability assessment:

- Quality Assurance Project Plan
- Contract Specifications
- Quality Assurance Surveillance Plan
- Weekly QC Reports
- Assessment Reports Corrective Action Reports
- Production Area Seed Report
- ITS Memoranda

- Subsurface Removal Report

Describe how the usability assessment will be documented:

The data usability assessment report will be included as an appendix to the Final Report.

Step 1. Review the project's objectives and sampling design

Step 1a. Are underlying assumptions in the initial CSM valid? Review the data quality objectives. Review the project plan as implemented for consistency with objectives.

The primary objective of the removal action in MRS B2 was to remove:

- All 60-mm mortars to a depth of 0.45 m bgs.
- Any other munitions present on the site to their maximum reliable detection depth at the anomaly selection criteria set for the 60-mm mortars.

The recovered MEC-related objects include:

- 60-mm HE mortars to a depth of 35 cm.
- Associated MD.

The vertical CSM in Figure D-3 shows the recovered MEC, seeds, and maximum reliable detection depths.

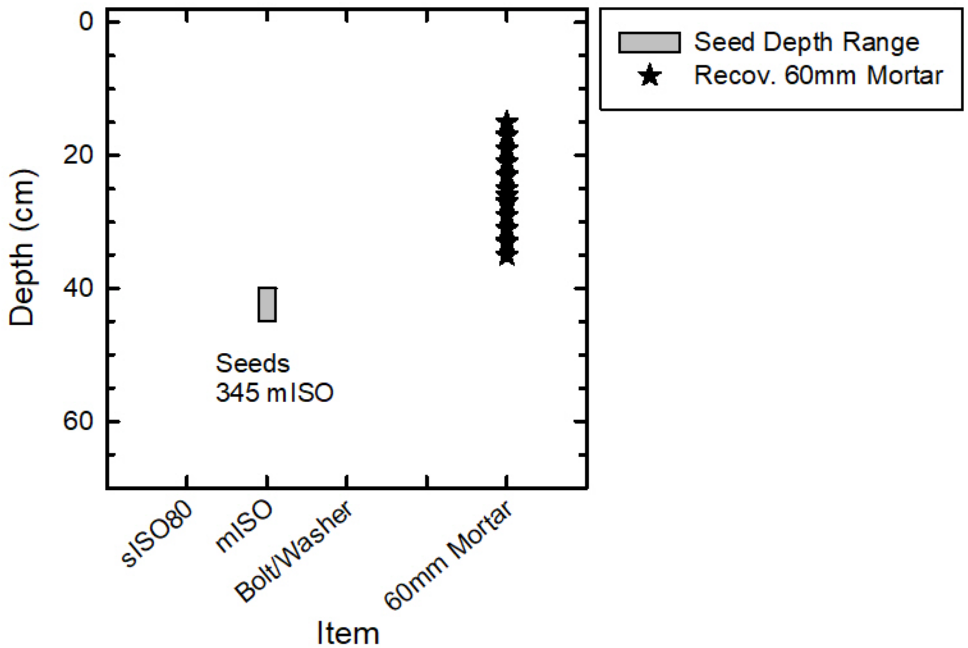

Figure D-6. Vertical CSM for MRS B2 at the conclusion of the RA

The assumptions regarding the target munitions were valid.

During the removal, one intact mortar was recovered 3 m from the MRS boundary at the farthest extent of the downrange direction of the firing fan, within the area designated as buffer zone in the RI. All the other recovered mortars were in the center of the impact area. This raised a concern that additional munitions could be outside the designated MRS boundary. The site team extended the MRS boundary in the downrange direction by an additional 45 m, doubling the length of the initial buffer zone, which was based on the distance between the transects in the RI. No additional intact munitions were found in the expanded buffer zone.

Step 1b. Were sources of uncertainty appropriately managed?

The underlying assumption is that an analog EMI metal detector can detect surface and subsurface munitions for removal. With no data record, the primary uncertainty related to the remedial design is the unknown and unmeasurable reliability of the instrument and operator. The project design included the extensive use of both QC and QA seeds to document performance. The removal yielded MEC, MD, and cultural artifacts. All seeds were recovered, although some required multiple passes. The underlying assumptions are valid.

Step 1c. Summarize any deviations from the planned sampling design and describe their impacts on the data quality objectives.

The sampling design was implemented as planned, with additional buffer zone added in the downrange direction around the impact area.

Step 2. Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12

Step 2a. Review the data verification/validation reports and supporting data, if necessary (e.g., daily/weekly QC reports, assessment reports and corrective action reports. For any non-conformances, was the RCA/CA effective? Evaluate the implications of unacceptable QC results.

The data validation report contains a summary of all field activities, QC results, non-conformances, and RCA/CA. In 65% of the survey units on the site, QC seeds were missed on the first pass. These survey units were resurveyed as necessary until all seeds were recovered. In each resurvey, additional seeds and additional native items were recovered. Upon retraining, seed recovery increased to 90-95% for the remaining survey units.

Table D-13: Summary of non-conformances, root causes, and corrective action

Non-conforming MQO	Root cause	Corrective action implemented?
Missed seeds	Inherent limitations of the technology – operator inconsistency	Retrained operators Reworked areas with missed seeds

Step 2b. Evaluate Conformance to MPCS documented on Worksheet #12.

Table D-14: MPC Evaluation for MRS B2 – Project Conclusion

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 1 – Site Preparation and CSM				
1. Accessibility	Completeness	All areas inaccessible to remediation or inaccessible to use of proposed geophysical systems are identified and mapped in a geographic information system (GIS).	Visual Inspection QA Report and/or GIS Database	Complete. All inaccessible areas documented in the GIS.
2. IOC Completeness	Representativeness/ Completeness (recoverability)	All recoveries (IOC and MD) were reviewed and CSM confirmed or updated.	Updated CSM	Complete
3. Survey Control	Completeness	All survey control points placed by PLS, and survey control report submitted.	Surveyor and/or QC Report	Complete. Survey report accepted.
DFW 2 & 3 – ITS, QC Seeding, and QA Seeding				
4. ITS Construction	Accuracy/Completeness	Seeds placed so that each sensor passes at least one seed item during ITS. Seed type, depth, and location accuracy recorded during placement.	ITS Memorandum	Complete. ITS Memorandum accepted.
5. ITS Testing	Sensitivity/ Completeness	Analog equipment assembled correctly and functioning as designed. Detection threshold confirmed and tested daily with ITS seeds at depth of detection.	1) ITS Memorandum 2) ITS Database	Complete. Sensor detected ITS items daily.
6. QC Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QC seeds will be placed at the site by the contractor (1). Blind QC seeds must be located throughout the horizontal boundaries defined in the DQOs (2,3).	Production Area QC Seeding Report	Complete. QC seeding report contains verified, as-buried locations.

Table D-14: MPC Evaluation for MRS B2 – Project Conclusion (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 2 – ITS, QC, and QA Seeding				
7. QA Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QA seeds (medium ISOs) will be placed throughout the MRS footprint by the Government (or its third-party contractor) (1, 2, 3). QA Seeds must be placed at the required depth of detection (0.45 m) (2, 3).	QA Seeding Report	Complete. Verification seeding report contains verified, as-buried locations.
DFW 4 – Conduct Analog Surface and Subsurface Removal				
8. Planned Survey Coverage	Completeness	Survey lanes are designed and located not to exceed 3-foot spacing and cover the entire MRS footprint.	1) GPS or Photographic Documentation 2) Grid/Lane GIS database	Complete. Planned survey lanes conform to specification.
9. Detection threshold (analog)	Sensitivity	[Example] The analog instrument must be leveled to manufacturer settings and set to a sensitivity of 5 for the duration of the survey. Detection of a 60-mm mortar and medium ISO at 0.45 m must be demonstrated in the ITS.	1) Initial and ongoing instrument test strip (ITS) surveys 2) Blind QC and QA seed detection 3) Periodic Verification by QC Geophysicist (or designee)	Complete. 1) Sensor detected ITS items daily. 2) Periodic checks by QC geophysicist documented.

Table D-14: MPC Evaluation for MRS B2 – Project Conclusion (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 4 – Conduct Analog Surface and Subsurface Removal				
10. Detection Survey	Accuracy/Completeness	100% of QC seeds detected.	1) QC Seed Database 2) RCA/CA review and acceptance	Complete. In the first survey unit, one or more seeds were missed on the first pass in 65% of the grids. These grids were resurveyed as necessary until all seeds were recovered. In each resurvey, additional seeds and additional native items were recovered. Upon retraining, seed recovery improved and 90-95% of grids had no missed seeds for the remaining survey units.
11. Detection Survey	Accuracy/Completeness	100% of QA seeds must be detected.	QA Seed Database	Complete. The contractor submitted QA seed recovery to the government only after all QC seeds were recovered in each delivery unit. One or more of the QA seeds were missed in 33% of the grids. Misses were randomly distributed across the site, indicating there were no systematic caused. The grids were then resurveyed until all QA seeds were recovered.
12. Detection Survey Coverage	Representativeness/ Completeness	100% of the site is sampled.	1) Seed Recovery 2) Operator GPS Records	Complete. GIS records show all lands surveyed. Photographs and GPS logs accepted.

Table D-14: MPC Evaluation for MRS B2 – Project Conclusion (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 5 – Anomaly Resolution and Excavation				
13. Anomaly Resolution (QC Seeds)	Accuracy/Completeness	100% of QC seeds are excavated	QC Seed Database	Complete
14. Anomaly Resolution (QA Seeds)	Accuracy/Completeness	100% of QA seeds must be excavated.	QA Seed Database	Complete
15. Intrusive Investigation	Accuracy	QC or 3rd party re-check of 10% of the excavated locations result in zero additional intrusive investigations	QC Database	Complete
16. Intrusive Investigation	Completeness	Complete project-specific database with all intrusive records.	Project Database	Complete

Step 2c. Evaluate data completeness. Identify data gaps (i.e., data inputs that have not been satisfied) and summarize their impact on the DQOs.

The removal was complete in all accessible areas and located mortars and MD associated with mortars. Based on seed recovery results, it is possible but not certain that all subsurface munitions were removed from the site.

Step 3. Document data usability, update the CSM, apply decision rules, and draw conclusions

Step 3a. Assess the performance of the sampling design and identify any limitations on data use. Considering the implications of any deviations and data gaps, can the data be used as intended? Are the data sufficient to answer the study questions?

The subsurface removal performed as expected:

- A total of 107 of the expected 60-mm mortars were removed from the site, along with associated MD.
- Missed seeds confirm that analog technology does not reliably detect all targets of interest.
- Multiple passes on parcels where misses occurred increase confidence, but do not address the underlying likelihood that native items could be missed even in parcels where all seeds were recovered.
- There is insufficient evidence to support a determination that all required subsurface munitions were removed.

Step 3b. Apply Decision Rules

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.

   Field observations were consistent with the CSM. The project was completed under current planning assumptions.

2. If MPCs have been achieved, the project will have implemented the removal component of the remedy. The LUCs specified in the ROD will be used to manage residual risk. If not, the team will recommend that the appropriate representatives of the responsible offices revisit and reconsider the ROD.

   All MPCs were achieved. The removal component of the remedy is complete.

Step 3c. Update the CSM and draw conclusions.

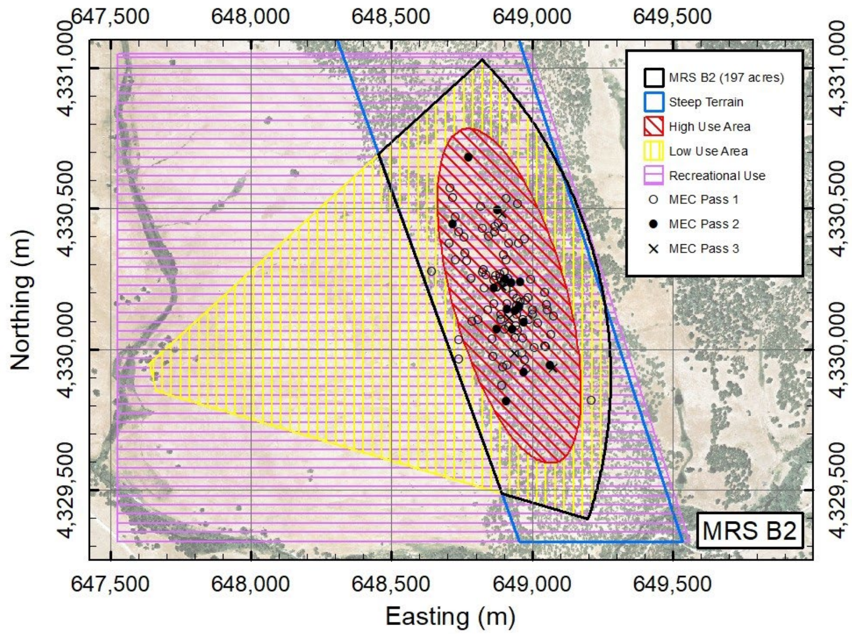

Figure D-7: Final MRS B2 CSM: Mortar Target Aerial View

The CSM was updated to reflect the locations and types of all munitions recovered on the site:

- 60,000 items were removed from the site
- 107 HE mortars

Step 4. Document lessons learned and make recommendations

Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for future delivery units at the site, or future investigations. Prepare the data usability summary report.

Recommendations: The work was completed to the capability of the technology and all MPCs were achieved, indicating the removal component had met the requirements of the ROD to reduce risk. However, there is no evidence to support the claim that all munitions have been removed. The LUCs in the ROD will be used to manage the residual risk. Findings from the removal that will inform risk management include:

- The removal was implemented as intended.
- Additional buffer zone was added in the down-range direction as a consequence of finding an intact mortar within 3 m of the initial MRS boundary.
- Missed seeds were randomly distributed across the site, indicating technology limitations rather than systematic failures tied to site conditions or personnel.
- The QA seeds were detected, some requiring multiple passes.
- The updated CSM provides confidence that the UXO that were detected have been removed.

Example #5: MRS C Bomb Target – Surface and Subsurface Removal using Dynamic AGC followed by Cued AGC

DUAs for MRS C were performed at (1) the conclusion of the dynamic AGC detection survey and analysis, (2) the conclusion of the cued AGC data collection and analysis, and (3) the conclusion of the project.

MRS C – AGC Dynamic Detection Survey DUA

Identify personnel (organization and position/title) who participated in the data usability assessment: [Note: the same personnel should participate in all phases of the DUA.]

For the Government:

- The DoD Remedial Project Manager
- The DoD Technical Manager
- The Project Geophysicist
- The Project Quality Assurance Manager
- The OESS

For the Contractor:

- The Project Manager
- The Project Geophysicist
- The Quality Control Geophysicist
- The Field Geophysicist (Lead)
- The UXOQCS

The Regulator

Identify documents used as input to the detection survey data usability assessment:

- Quality Assurance Project Plan
- Contract Specifications
- Quality Assurance Surveillance Plan
- Weekly QC Reports
- Assessment Reports Corrective Action Reports
- Production Area Seed Report

- IVS Memoranda
- Detection Survey Data Validation Report

Step 1. Review the project's objectives and sampling design

Step 1a. Are underlying assumptions in the initial CSM valid? Review the data quality objectives. 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.

The primary objective of the removal action in MRS C was to remove:

- All 100-pound HE bombs to the depth of bedrock.
- Nose and tail fuzes to a depth of 0.30 m and spotting charges to a depth of 0.40 m.
- Any other munitions present on the site that are detectable at the anomaly selection criteria.

The munitions-related objects recovered in the surface sweep include:

- Fragments and debris from HE bombs.
- Munitions components in including fuzes and spotting charges.
- Debris from practice bombs.

No evidence of other munitions was found. The underlying assumptions are consistent with all observations to date.

The anomaly selection criteria were set to detect a 100-pound HE bomb to the maximum reliable detection depth of 1.75 m, which will also detect fuzes and spotting charges to 0.30 m and 0.40 m respectively, as required. As documented in the CSM, depth to bedrock is 1.2 m. The detection survey is appropriate to remove all required objects to bedrock.

From the RI report, it was expected that a 6-acre area in the target center would have anomaly density that exceeds the MPC of 3500/acre. This area was subject to mag-and-dig anomaly density reduction, and, upon completion of the detection survey, no portions remained where anomaly densities were too high to apply AGC.

Other uncertainties include whether background noise would allow for consistent detection of TOI to the required depth across the entire site. Data were reviewed and no areas were found where the background noise was too high to meet detection objectives.

Step 1b. Summarize any deviations from the planned sampling design and describe their impacts on the data quality objectives.

The sampling design was implemented as planned.

Step 2. Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12

Step 2a. Review available QA/QC reports, including weekly QC reports, assessment reports, corrective action reports, and the data verification/validation reports. Evaluate the implications of unacceptable QC results. For any non-conformances, was the RCA/CA effective? Summarize the impacts of non-conformances on data usability.

The data validation report contains a summary of all data, QC results, non-conformances, and RCA/CA. All data were collected as planned. CA were effective. Upon implementation of the CA, no non-conformances were repeated. At the conclusion of the survey, all data complied with all MPCs and MQOs.

Table D-15: Summary of non-conformances, root causes, and corrective action

Non-conforming MQO	Root cause	Corrective action implemented?
Complete this table from data validation report		

Step 2b. Evaluate conformance to MPCs documented on Worksheet #12.

Table D-16: MPC Evaluation for MRS C – Detection Survey

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 1 – Site Preparation, CSM, and Anomaly Reduction				
1. Accessibility	Completeness	All areas inaccessible to remediation or inaccessible to use of proposed geophysical systems are identified and mapped in a geographic information system (GIS).	Visual Inspection QA Report and/or GIS Database	Complete. Inaccessible areas documented in GIS.
2. IOC Completeness	Representativeness/ Completeness (recoverability)	All recoveries (IOC and MD) were reviewed and CSM confirmed or updated. All recovered munitions, as well as munitions related to recovered MD, were included in the site specific AGC library.	Surface Sweep Technical Memorandum and Updated CSM	Complete. Recovered IOC and MD documented in sweep technical memorandum. CSM updated to reflect all recoveries were consistent with initial CSM. All IOC verified in the AGC library
3. Surface Sweep Coverage	Representativeness/ Completeness	Surface sweep completed across the entire site. Identified SRAs have been documented.	Surface Sweep Technical Memorandum and Updated CSM	Complete. Surface sweep memorandum and GIS indicate all parts of the site were covered.
4. Survey Control	Completeness	All survey control points placed by PLS, and survey control report submitted.	Surveyor and/or QC Report	Complete
DFW 3 & 4 – QC Seeding, Validation Seeding, and IVS				
5. IVS Construction	Accuracy/Completeness	Seeds placed so that each sensor passes at least one seed item during IVS surveys. Seed type, depth, and location accuracy recorded during placement.	IVS Memorandum	Complete

Table D-16: MPC Evaluation for MRS C – Detection Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
6. IVS Testing	Sensitivity/ Completeness	Detection equipment assembled correctly and functioning as designed. Detection threshold confirmed or adjusted as appropriate.	IVS Memorandum	Complete. Signals consistent with REFERENCE REPORT. Measured noise supports detection at the chosen threshold.
7. QC Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind QC seeds will be placed at the site by the contractor (1). Blind QC seeds must be detectable as defined by the DQOs and located throughout the horizontal and vertical survey boundaries defined in the DQOs (2,3).	Production Area QC Seeding Report	Complete. QC seeding report contains verified, as-buried locations of seeds. All seeds are buried at depths in the detectable range of the sensor.
DFW 3 & 4 – QC Seeding, Validation Seeding, and IVS				
8. Validation Seeding	1) Representativeness 2) Completeness 3) Sensitivity 4) Accuracy 5) Comparability	Blind Validation seeds will be placed throughout the MRS footprint by the Government (or its third-party contractor) (1). Validation seeds must be detectable as defined by the DQOs and located at depths that result in signals equivalent to 2-5 times the detection threshold (2,3).	Validation Seeding Report	Complete. Validation seed report contains verified, as-buried locations of seeds. All seeds are buried at depths in the detectable range of the sensor.

Table D-16: MPC Evaluation for MRS C – Detection Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 5 – Detection Survey, Data Processing, and Detection Survey DUA				
9. ISS Threshold	Sensitivity	A detection threshold of ≥ 0.87 mV/A on Channel 14, modeled sized > 0.3, and polarizability fit > 0.9, are required to detect a 100-lb bomb lying horizontally at a depth of [1.5 m].	1) Review of sampling design 2) Initial and ongoing instrument verification strip (IVS) surveys 3) Blind QC and validation seed detection 4) RMS background maps show all areas are less than or equal to 20% of the threshold	Complete. 1) Sampling design parameters were appropriate for known and expected munitions 2) IVS surveys verified selection of required TOI 3) Blind QC and validation seed detection verified selection of required TOI 4) RMS background maps show all areas were less than or equal to 20% of the threshold
10. Detection Survey	Accuracy/Completeness	100% of QC seeds detected	1) QC Seed Database 2) RCA/CA review and acceptance	Complete. All QC seeds detected at correct location with signal consistent with predictions.

Table D-16: MPC Evaluation for MRS C – Detection Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 5 – Detection Survey, Data Processing, and Detection Survey DUA				
11. Detection Survey	Accuracy/Completeness	100% of validation seeds must be detected.	Validation Seed Database	Complete. All validation seeds detected at the correct locations and with signals consistent with the buried item.
12. Detection Survey Coverage	Representativeness/ Completeness	100% of the site is sampled at required lane spacing and point-to-point sampling specifications.	1) Coverage Maps 2) Detection Survey Database	Complete. Coverage within specification. IVS locations within specification. Survey control point reacquisition within specification. Seed locations within specification.
13. Anomaly Selection	Completeness	Complete project-specific databases and anomaly lists delivered. All QC and QA seeds listed in detection survey database. All other detected metallic objects screened out by ISS are documented in Detection Survey Database.	Anomaly Selection Database	Complete. Verification of 10% of the data did not result in any additional anomalies selected.
14. AGC Cued Survey Background Locations	Representativeness/ Sensitivity	Background areas where detection threshold does not exceed five times background are identified.	1) GIS Database 2) Cued Background Database	Complete. Representative locations were identified throughout the site.

Table D-16: MPC Evaluation for MRS C – Detection Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 5 – Detection Survey, Data Processing, and Detection Survey DUA				
15. AGC Cued Survey Background Locations	Representativeness/ Comparability	Representative areas determined to be background are selected and bounded in the detection survey.	1) GIS Database 2) Cued Background Database	Complete
16. Variability for Cued Background locations	Representativeness/ Sensitivity	Representative backgrounds are selected in all noise regimes. Background areas where detection threshold is less than 5 times background are identified. All anomaly cued locations appropriate for each expected background are identified.	1) GIS Database 2) Cued Background Database	Complete. No areas of elevated background noise were identified.
17. Saturated Response Areas (SRAs)	Completeness	No SRAs in final detection survey data. Anomaly density in all designated SRAs reduced to below DQO thresholds and remapped. SRA boundaries documented in GIS deliverable. [Example] The analog anomaly reduction survey reduces the anomaly density to below 3500 anomalies/acre.	1) Detection Survey database 2) GIS database	Complete. No such areas were present in the detection survey data.

Step 2c: Evaluate data completeness. Identify data gaps (i.e., data inputs that have not been satisfied) and summarize their impact on the DQOs.

Dynamic AGC data are complete in all accessible areas and are deemed to be useable to locate the munitions specified in the project goals. The only remaining data gaps are rocky outcroppings, where munitions cannot penetrate to the subsurface. These data gaps do not have an impact on achievement of the DQOs. No other data gaps remain.

Step 3: Document data usability, update the CSM, and draw conclusions

Step 3a: 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. Determine whether the data are suitable for proceeding to the cued AGC data collection phase.

The sampling design for the subsurface removal performed as expected. The MPCs/MQOs demonstrate the data meet the remediation goal articulated in Step 1.

Step 3b: Apply decision rules and draw conclusions. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions.

1. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.

   Field observations are consistent with the CSM. Remediation will continue under current assumptions.

2. If signals meet the ISS anomaly selection criteria, they will be selected for cued data collection using AGC.

   Signals meeting the ISS anomaly selection criteria were selected for AGC data collection. All seeds were detected.

3. If areas of the site are deemed unsuitable for AGC (criteria established in WS #12), the project team will document those areas and revise the remedial design, as necessary.

   No areas of the site were deemed unsuitable for AGC.

   The project team concluded all MPCs were achieved and the data support moving on to the cued data collection and analysis phase.

Step 3c: Update the CSM.

The CSM was updated to reflect the observations from the site preparation activities and document the area where anomaly reduction activities were performed.

Step 4. Document lessons learned and make recommendations

Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for future delivery units at the site, or future investigations. Prepare the data usability summary report.

Recommendations: The dynamic AGC data are sufficient to support the AGC cued data collection.

MRS C Cued Survey DUA

Identify personnel (organization and position/title) who participated in the data usability assessment: [Note: the same personnel should participate in all phases of the DUA.]

For the Government:

- The DoD Remedial Project Manager
- The DoD Technical Manager
- The Project Geophysicist
- The Project Quality Assurance Manager
- The OESS

For the Contractor:

- The Project Manager
- The Project Geophysicist
- The Quality Control Geophysicist
- The Field Geophysicist (Lead)
- The UXOQCS

The Regulator

Identify documents used as input to the cued-survey data usability assessment:

- Quality Assurance Project Plan
- Contract Specifications
- Quality Assurance Surveillance Plan
- Final Verification and Validation Plan
- Weekly QC Reports
- Assessment Reports Corrective Action Reports
- Production Area Seed Report
- IVS Memoranda
- Site-Specific Library

- Cued Survey Data Validation Report
- Prioritized Target "Dig" List
- Target Classification Report
- Classification Validation Report

Step 1. Review the project's objectives and sampling design

Step 1a. Are underlying assumptions in the initial CSM valid? Review the data quality objectives. Were the project boundaries appropriate? Review the sampling design as implemented for consistency with stated objectives. Consider sources of uncertainty. Was uncertainty appropriately managed?

The primary objective of the removal action in MRS C was to remove:

- All 100-pound HE bombs and practice bombs to the depth of bedrock.
- Nose and tail fuzes to a depth of 0.30 m and spotting charges to a depth of 0.40 m.
- Any other munitions present on the site that are detectable at the anomaly selection criteria.

The library and TOI selection criteria for the AGC step were both specified with the assumption that these munitions would make up the TOI.

The munitions-related objects recovered in the surface sweep include:

- Fragments and debris from HE bombs.
- Munitions components in including fuzes and spotting charges.
- Debris from practice bombs.

No evidence of other munitions was found. The underlying assumptions are consistent with all observations to date.

Step 1b. Were sources of uncertainty accounted for and appropriately managed?

There is little uncertainty in the expected munitions in MRS C that affected the design of the classification step. The CSM provided evidence from historical records of use and the detailed characterization in the RI that MRS C was used as a bombing target. The library contained bombs and bomb-related munitions debris from the historical records and the TOI selection criteria were set to identify the required items.

Other uncertainties included whether site noise would allow for consistent classification of TOI to the required depth across the entire site and the extent to which background variation would affect the analysis. Data were reviewed and no areas were found where the noise was too high. Background data were acquired multiple times per day and variability was as expected.

Step 1c. Summarize any deviations from the planned sampling design and describe their impacts on the data quality objectives.

The sampling design was implemented as planned. Cued AGC data were collected at the locations of all anomalies selected in the detection step. All cued data were analyzed and classified. Additional required verification and validation digs were identified.

Step 2. Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12

Step 2a. Review available QA/QC reports, including weekly QC reports, assessment reports, corrective action reports, and the data verification/validation reports. Evaluate the implications of unacceptable QC results. For any non-conformances, was the RCA/CA effective? Summarize the impacts of non-conformances on data usability.

The data validation report contains a summary of all data, QC results, non-conformances and RCA/CA. CA were effective. Upon implementation of the CA, no non-conformances were repeated. All data were collected as planned. At the conclusion of the project, all data complied with all MPCs and MQOs.

Table D-17: Summary of non-conformances, root cause analysis, and corrective action

Non-conforming MQO	Root cause	Corrective action implemented?
Complete table from data validation report		

Step 2b. Evaluate conformance to MPCs documented on Worksheet #12

Table D-18: MPC Evaluation for MRS C – Cued Survey

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 7, 8, and 9 – Data Processing and Cued Survey DUA				
18. Background data collection (AGC)	Representativeness/ Accuracy	Each cued analysis is performed with a representative background and verified during quality control.	1) Background Validation Database 2) Cued Survey Database 3) QC Verification	Complete. Background data were collected at locations identified on the site. Data review confirmed appropriate background measurements were used in the analysis.

Table D-18: MPC Evaluation for MRS C – Cued Survey (Continued)

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 7, 8, and 9 – Data Processing and Cued Survey DUA				
19. Background frequency	Accuracy	Background data are collected at a minimum of the interval specified by the manufacturer.	Background Validation Database	Complete. All background measurement were repeated X times per day, per the manufacturer specifications, and drift was documented.
20. Anomaly classification (AGC)	Completeness/ Comparability	Site-specific library must include signatures for all items considered by the project team to be IOC as listed in the CSM.	Site-Specific TOI Library	Complete. The library included signatures from all items confirmed or suspected to be present
21. Anomaly classification (AGC)	Completeness	Cued data collected at all anomaly locations. All detected anomalies classified as: 1) TOI 2) Non-TOI 3) Inconclusive	1) Source Database 2) Final Intrusive Database	Complete. All anomalies were assigned to one of TOI, non-TOI, or inconclusive.
22. Anomaly classification (QC seeds)	Accuracy/Completeness	100% of QC seeds are correctly classified as TOI. QC seeds classified as inconclusive are discussed in DUA.	1) QC seed database 2) RCA/CA review and acceptance	Complete. All QC seeds correctly classified.
23. Anomaly classification (validation seeds)	Accuracy/Completeness	100% of validation seeds are correctly classified as TOI.	Validation seed database	Complete. All validation seeds correctly classified.

Step 2c. Evaluate data completeness. Identify data gaps (i.e., data inputs that have not been satisfied.) and summarize their impact on the DQOs.

AGC data were collected at all cued anomaly locations, analyzed, and a TOI/non-TOI decision was made for each location.

Step 3. Document data usability, update the CSM, apply decision rules, and draw conclusions

Step 3a. 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. Determine whether the data are suitable for proceeding to the cued AGC data collection phase.

The sampling design for the AGC cued data collection performed as expected. The MPCs/MQOs demonstrate the data meet the remediation goal articulated in Step 1.

Step 3b. Apply decision rules and draw conclusions

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.

   Field observations are consistent with the CSM. Remediation will continue under current assumptions.

2. If AGC analyses meet any of the following criteria, they will be selected as TOI and placed on an ordered dig list: a) the polarizability decay curve matches that of an item in the project-specific TOI library, or b) estimates of the size, shape, symmetry, and wall thickness indicate the item is long, cylindrical or spherical, and thick-walled, or c) there is a group (cluster) of unknown anomalies having similar polarizability decay curves that, after investigation, are discovered to be TOI.

   All anomalies from the AGC cued survey were assigned to one of TOI, non-TOI, or inconclusive. AGC analyses meeting the criteria were placed on the dig list. All seeds were correctly identified as TOI.

3. If AGC analyses yield inconclusive polarizability decay curves they will be added to the dig list or otherwise resolved.

   All inconclusive analyses were added to the dig list or otherwise resolved.

Step 3c. Update the CSM.

No updates to the CSM were required. The data are suitable to support intrusive investigation.

Step 4. Document lessons learned and make recommendations

Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for future delivery units at the site, or future investigations. Prepare the data usability summary report.

Recommendations: The intrusive investigation should begin.

MRS C – Project-Conclusion DUA

Identify personnel (organization and position/title) who participated in the data usability assessment: [Note: the same personnel should participate in all phases of the DUA.

For the Government:

- The DoD Remedial Project Manager
- The DoD Technical Manager
- The Project Geophysicist
- The Project Quality Assurance Manager
- The OESS

For the Contractor:

- The Project Manager
- The Project Geophysicist
- The Quality Control Geophysicist
- The Field Geophysicist (Lead)

The Regulator

Identify documents used as input to the project-conclusion data usability assessment:

- Quality Assurance Project Plan
- Contract Specifications
- Quality Assurance Surveillance Plan
- Final Verification and Validation Plan
- Weekly QC Reports
- Assessment Reports Corrective Action Reports
- Production Area Seed Report
- IVS Memoranda
- Detection Survey Data Validation Report
- Site-Specific Library

- Cued Survey Data Validation Report
- Prioritized Target "Dig" List
- Target Classification Report
- Classification Validation Report

Step 1. Review the project's objectives and sampling design

Step 1a. Are underlying assumptions in the initial CSM valid? Review the data quality objectives. Review the data collection plan as implemented for consistency with stated objectives.

The primary objective of the removal action in MRS C was to remove:

- All 100-pound HE bombs to the depth of bedrock.
- Nose and tail fuzes to a depth of 0.30 m and spotting charges to a depth of 0.40 m.
- Any other munitions present on the site that are detectable at the anomaly selection criteria.

The library and TOI selection criteria for the AGC step were both specified with the assumption that these munitions would make up the TOI.

The munitions-related objects recovered in the intrusive investigation include:

- 15 HE bombs to a depth of 1.1 m.
- Fragments and debris from HE bombs.
- Munitions components in including fuzes and spotting charges.
- Debris from practice bombs.

No evidence of other munitions was found.

The vertical CSM in Figure D-4 shows the recovered MEC, seeds, and maximum reliable detection depths.

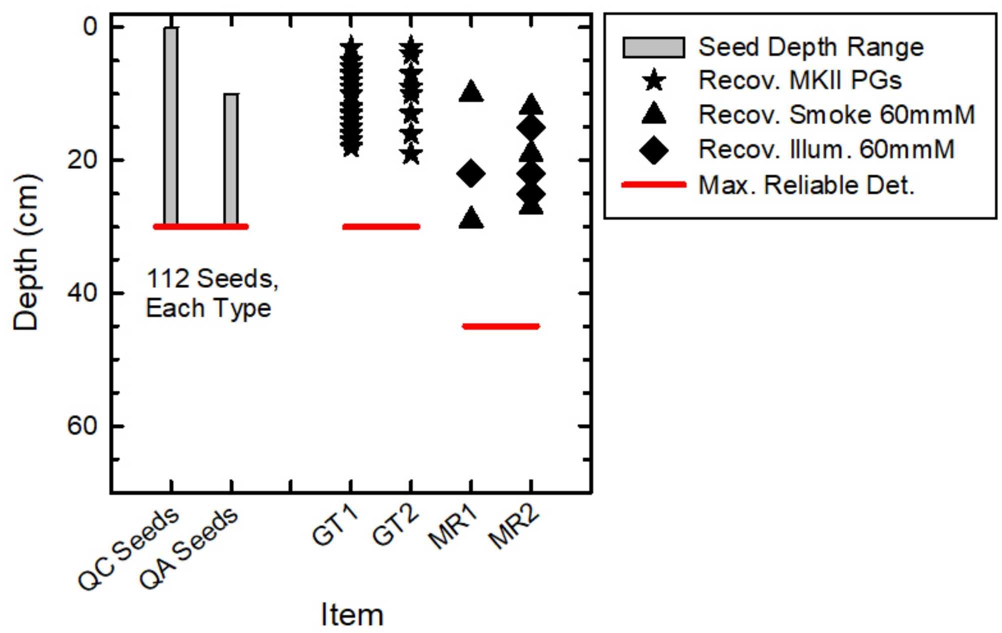

Figure D-8. Vertical CSM for MRS C at the conclusion of the RA

All information from the removal action is consistent with the initial CSM, confirming planning assumptions and the validity of the sample plan. The project team reached the following conclusions:

- Dynamic AGC target selection criteria were based on detecting a 100-pound bomb to its maximum reliable detection depth of 1.75 m (deeper than bedrock). Fifteen intact bombs were found in the subsurface at depths between 0.3 and 1.1 m.
- The target selection criteria correspond to a reliable detection depth of fuzes to 0.30 m. 115 fuzes were recovered at depths ranging from 0.05 to 0.20 m.
- The target selection criteria correspond to a reliable detection depth of spotting charges to 0.40 m. Ninety-three spotting charges were recovered at depths ranging from 0.05 to 0.3 m.
- All potential munitions and hazardous components identified in the CSM were included in the AGC TOI library.
- Seeded items and depths were appropriate to represent the munitions recovered.
- All field specifications, including line spacing, sampling rate and sensor standoff planned to the initial assumptions were valid.

Conclusion: There are no inconsistencies of a nature that would call into question whether the data collection and analysis methodology can meet the project objectives.

Step 1b. Consider sources of uncertainty. Was uncertainty appropriately managed?

There was little uncertainty related to the design of the classification step regarding the expected munitions. The CSM provided compelling evidence from historical records of use and the detailed classification in the RI that MRS C was used as a bomb target. The library contained all possible munitions and hazardous components from the historical records, and the TOI selection criteria were set to identify the required items.

Other uncertainties included whether site noise would allow for consistent classification of TOI to the required depth across the entire site and the extent to which background variation would affect the analysis. Data were reviewed and no areas were found where the noise was too high. Background data were acquired multiple times per day and variability was as expected.

Step 1c. Summarize any deviations from the planned sampling design and describe their impacts on the data quality objectives.

The sampling design was implemented as planned.

Step 2. Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12

Step 2a. Review available QA/QC reports, including weekly QC reports, assessment reports, corrective action reports, and the data verification/validation reports. Evaluate the implications of unacceptable QC results. For any non-conformances, was the RCA/CA effective? Summarize the impacts of non-conformances on data usability.

The data validation report contains a summary of all data, QC results, as well as non-conformances and RCA/CA. All data were collected as planned. There were no unacceptable QC results. CA were effective. Upon implementation of the CA, no non-conformances were repeated. At the conclusion of the project, all data complied with all MPCs and MQOs.

Table D-19: Summary of non-conformances, root causes, and corrective action

Non-conforming MQO	Root cause	Corrective action implemented?
Complete table from data validation report		

Step 2b. Evaluate conformance to MPCs documented on Worksheet #12.

Table D-20: MPC Evaluation for MRS C – Project Conclusion

Measurement	Data Quality Indicator	Specification	Document/Activity Used to Assess Performance	Status
DFW 10, 11, and 12 – Anomaly Resolution, Excavation, and Final DUA				
24. Anomaly resolution (QC Seeds)	Accuracy/Completeness	100% of QC seeds are recovered.	1) QC Seed Database 2) RCA/CA Review and Acceptance	Complete. All QC seeds recovered.
25. Anomaly resolution (Validation Seeds)	Accuracy/ Completeness	100% of validation seeds are recovered.	Validation Seed Database	Complete. All validation seeds recovered.
26. Anomaly resolution	Accuracy	100% of predicted non-TOI that are intrusively investigated are confirmed to be non-IOC. This includes threshold verification digs and validation digs.	Intrusive Results Database	Complete. All predicted non-TOI that were investigated were non-TOI.
27. Intrusive Investigation	Accuracy	Inversion results correctly predict one or more physical properties (e.g., size, symmetry, or wall thickness) of the recovered items (specific tests and test objectives established during project planning).	Intrusive Results Database	Complete. All recovered items were consistent with predicted physical properties.
28. Intrusive Investigation	Completeness/ Comparability	A complete project-specific database including records reconciling inversion results to the physical properties of the recovered items.	Intrusive Results Database	Complete. All records are documented in the database. All anomaly locations were investigated and resolved.
29. Intrusive Investigation	Accuracy/Completeness	AGC results indicate original polarizabilities resulting in TOI are no longer present and no additional TOI sources present above the project-specific stop-dig threshold.	Post-mapping database	Complete

Step 2c. Evaluate data completeness. Identify data gaps (i.e., data inputs that have not been satisfied.) and summarize their impact on the DQOs.

AGC dynamic survey data were collected as specified throughout the site. AGC cued data were collected at all cued anomaly locations, analyzed, and a TOI/non-TOI decision was made for each location. All MPCs were achieved. Together the MPCs provide evidence to support the design was successfully implemented; specifically:

- Full coverage of the site with the AGC dynamic survey was achieved. All accessible data gaps were resurveyed or otherwise resolved.
- The IVS confirmed the AGC dynamic system was operating properly at the beginning and end of each data collection day.
- All seeds were detected in the AGC dynamic detection step, correctly classified in the AGC analysis, and recovered.
- All recovered munitions were consistent with the AGC analysis predictions.
- All verification digs were non-TOI.
- All validation digs were consistent with AGC analysis.

Step 3. Document data usability, update the CSM, apply decision rules, and draw conclusions

Step 3a. 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.

The sampling design for the subsurface removal performed as expected. The MPCs/MQOs demonstrate the data meet the remediation goal articulated in Step 1.

Step 3b. Considering the implications of any deviations and data gaps, can the data be used as intended? Are the data sufficient to answer the study questions?

The sampling design for the surface and subsurface removal performed as expected. The data were successfully used to excavate and remove all surface and subsurface munitions for which there was evidence on the site. The MPCs/MQOs demonstrate the data meet the remediation goal of no bombs to bedrock, no fuzes to 0.30 m, and no spotting charges to 0.40 m.

The data are suitable for supporting a weight-of-evidence decision regarding UU/UE; specifically:

- The AGC dynamic survey was completed as planned and all MPCs were met.
- The AGC data collection and analysis was completed as planned and all MPCs were met.
- All results were consistent with the CSM, and underlying planning assumptions were valid.
- No munitions were recovered that are more hazardous than anticipated.
- No unexpected munitions were recovered and no evidence suggesting their presence was observed.
- No munitions were recovered below their reliable detection and classification depth.

- Verification digs recovered no IOC.
- Validation digs recovered no IOC and all recovered items were consistent with the AGC analysis.

Step 3c. Apply decision rules and draw conclusions

1. If field observations are consistent with the CSM, the project team will continue with the remediation under the current assumptions. If field observations are inconsistent with the CSM, the project team will update the CSM and determine the impacts on the DQOs and remedial design.

   Field observations were consistent with the CSM. Remediation was completed under current assumptions.

2. If the threshold verification digs do not uncover any IOC as described above, then the threshold is verified. If any IOC are recovered, then the project team will conduct an RCA/CA that results in an adjustment of the threshold and determination of the impacts on project objectives.

   Threshold verification digs did not uncover any IOC. The threshold is verified.

3. The geophysical classification results will be valid if:
   a. Validation digs do not uncover any IOC, and
   b. The properties of all recovered objects are consistent with predicted properties.

   No IOC were recovered, and no recovered items were inconsistent with the predicated properties. Results are valid.

4. If validation digs uncover any IOC as described above, the project team will conduct a QA stand-down and evaluate the impacts on MPCs and DQOs.

   Validation digs did not recover any IOC. Analysis results are validated.

5. If the properties of any recovered object are inconsistent with predicted properties, then the project team will conduct an RCA/CA and determine the impacts on achievement of MPCs and DQOs.

   The properties of all recovered objects were consistent with the predicted properties.

6. If all lines of evidence are complete and support UU/UE, the project team will develop documentation supporting UU/UE for consideration by final decision-makers. If lines of evidence are incomplete or any line of evidence does not support UU/UE, the project team will develop documentation rejecting UU/UE for consideration by final decision-makers.

   All lines of evidence are complete and support UU/UE. The project team has developed documentation for decision-makers.

Step 3d. Update the CSM.

The CSM was updated to reflect the locations, depths, and types of all munitions recovered on the site. The post-removal CSM supports the site team making a recommendation regarding UU/UE, specifically:

- The only munitions found on the site are 100-pound HE and practice bombs and associated components.
- Dynamic AGC target selection criteria were based on detecting a 100-pound bomb to its maximum reliable detection depth of 1.75 m (deeper than bedrock depth of 1.4 m). Fifteen intact bombs were found in the subsurface at depths between 0.3 and 1.1 m.
- No evidence was uncovered during the surface sweep, or the subsurface removal of any other munitions identified in the original CSM as potentially present.
- No evidence of unexpected munitions was found. The AGC criteria for TOI looked for cylindrical or spherical items and looked at "clusters" of similar unknown items.
- No findings suggest a hazard that exceeds what is expected from the original CSM.
- No evidence suggests that IOC exist below their maximum reliable detection depth. Bedrock limited penetration of bombs to 1.4 m.

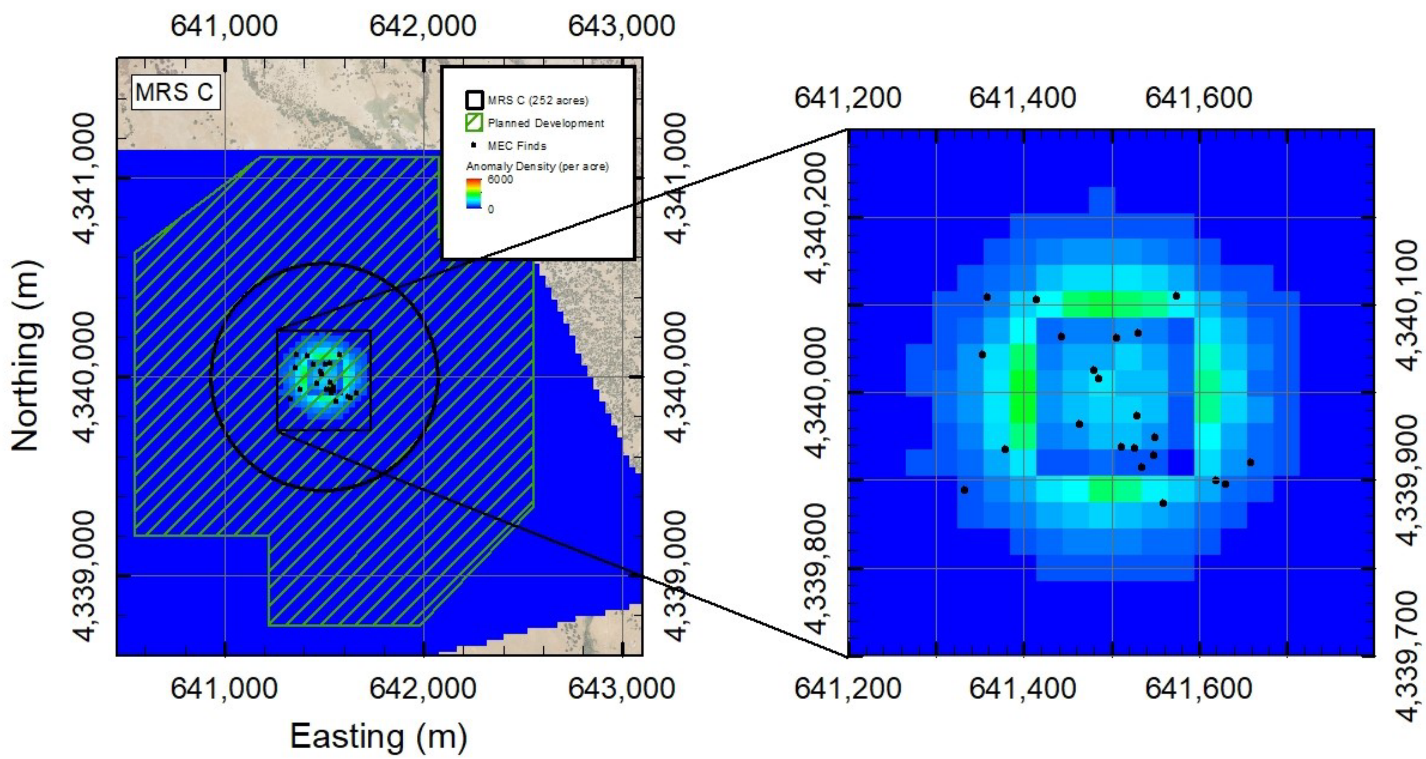

Figure D-9: Final MRS C CSM: Bomb Target Aerial View

Step 4. Document lessons learned and make recommendations

Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for the next phase of investigation or future investigations. If this is the final DUA, prepare the final DUA report to be included in the RA report.

Recommendations: The RA has been performed as planned and all the DQOs have been achieved. The site work is complete and IOC has been detected and removed to the required depths. The project team should prepare documentation supporting UU/UE for consideration by decision-makers.

Appendix E: Example Memorandum Supporting Unrestricted Use/Unlimited Exposure

MEMORANDUM

1. SITE NAME AND LOCATION

Site Name: Former Camp Example, MRS A1

Site Location: Example County, California

Site ID: XXXX-XX-XX

2. STATEMENT OF BASIS AND PURPOSE

This Memorandum approves the recommendation that MRS A1 of the former Camp Example in Example County, California become designated for Unlimited Use/Unrestricted Exposure (UU/UE) following the completion of the remedy specified in the Record of Decision. The selected remedy was chosen and implemented in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

This Memorandum is issued by the DoD LEAD AGENCY and the ENVIRONMENTAL REGULATORY AGENCY. The DoD LEAD AGENCY managed the Remedial Action, with participation of the ENVIRONMENTAL REGULATORY AGENCY, in accordance with CERCLA, as required by the Defense Environmental Restoration Program (DERP). As the lead agency, DoD LEAD AGENCY designates MRS A1 of the former Camp Example for UU/UE. ENVIRONMENTAL REGULATORY AGENCY concurs.

The Administrative Record (AR) files, containing information supporting this decision, are located in the LOCATION at ADDRESS. The AR includes the following documents:

- Archives Search Report (ASR)
- Preliminary Assessment (PA)
- Historical Records Review (HRR)
- Site Inspection (SI)
- Remedial Investigation (RI)
- Record of Decision (ROD)
- Remedial Action Report (RACR) and associated Remedial Action Deliverables

3. DESCRIPTION OF SELECTED REMEDY

The remedy selected in the ROD was the removal of subsurface MEC from the maneuver area designated as MRS A1 using non-AGC DGM detection and cued (AGC) with Interim Land Use Controls. The goal stated in the ROD is to demonstrate achievement of conditions that support designation for UU/UE following MEC removal to permit site development. The military training that typically occurs on a maneuver area is expected to result in munitions that are contained in the shallow subsurface. The detection and classification systems specified in the remedy are capable of detecting likely munitions to the depths that they are expected (specified below). Rigorous quality control measures are specified to demonstrate the successful implementation of the remedy and support a UU/UE determination.

The specific MEC removal remediation goals were detection and removal of:

- 60-mm mortar to a minimum depth of 0.45 m bgs.
- Hand grenades, signals, flares, pyrotechnics, 2.36” rockets, and anti-tank mines to a depth of 0.30 m bgs.

- Any other munitions detected.

The technology approach specified was:

- Detection of anomalies indicating subsurface MEC using EM61.
- Classification to identify targets of interest using cued AGC.
- TOI investigation and source removal using manual and backhoe-assisted excavation.
- All recovered MEC to be detonated in place or otherwise destroyed on site.

4. EFFECTIVENESS OF IMPLEMENTED REMEDY

All lines of evidence indicate no munitions remain on the site. The accompanying report summarizes the steps that were taken to ensure that the RA removed the required munitions. Details can be found in the referenced documents.

The recommendation of UU/UE is based on the determination that the remedy, as implemented, removed all IOC and is protective of human health and the environment for any potential use. The remedy has successfully removed munitions contamination as required in the ROD. The technology used in the remedy is capable of detecting all specified munitions to the required depths. All recovered munitions were shallower than reliable detection depths and seeds that were placed deeper than any recovered munitions were all detected and correctly classified. All evidence indicates that no deeper munitions exist. All quality measures evaluated in the data usability assessment indicate that the work done on the site is in accordance with the measurement performance criteria and meets all applicable standards.

All data and quality metrics support the conclusion that the UU/UE determination is scientifically valid and meets the ROD requirements and no other remedial action is required. As a result, the site does not require continuation of institutional controls and is fully protective of human health and the environment. Munitions Response activities for Camp Example MRS A1 are now considered to have reached the Response Complete stage.

5. AUTHORIZING SIGNATURES

This signature documents concurrence of UU/UE decision for MRS A1 on the former Camp Example.

____ ________________

NAME Date

DoD Lead Agency Signature Authority

____ ________________

NAME Date

Lead Regulatory Agency Signature Authority

UU/UE Recommendation and Report

Camp Example MRS A1

1. Site Background

The former Camp Example is located in Yuba and Nevada Counties, California, along the foothills of the Sierra Nevada Mountains. In 1940, the Camp Example area consisted of grassland, rolling hills, and the abandoned mining town of Exampleville. The U.S government purchased 87,000 acres in 1942 for a training post for the 13th Armored Division. Camp Example also held training facilities for the 81st and 96th Infantry Division, a 1,000-bed hospital, and a prisoner of war camp. As a complete training environment, Camp Example had training maneuver areas, mortar and rifle ranges, and bombardier-navigator training. In 1948, Camp Example became Example Air Force Base. In 1959, the installation ceased being used as a bombing range, and the U.S. government declared portions of Example Air Force Base as excess, eventually transferring 60,805 acres to private individuals and the State of California.

Following the RI/FS, the Maneuver Area was designated as MRS A. MRS A was used near the end of WWII for troop maneuvering and encampment. No records of live-fire training have been discovered. During the RI, an EM61 transect survey determined the maneuver area to be a low anomaly density (LD) area. No surface evidence of MEC, MD, or RRD was found during the RI; however, because of its documented use as a historic maneuver area, the presence of MEC could not be ruled out.

Subsequently, MRS A was divided into two MRSs as shown in Figure E-1 because future use scenarios and selected remedies are unique to each:

- MRS A1 – Maneuver Area Development Area, shown in green
- MRS A2 – Maneuver Area Recreational Area, the remainder of the site

The ultimate goal of the remedy is to achieve Unlimited Use/Unrestricted Exposure (UU/UE) for MRS A1 to allow future residential development.

The anomaly density map shown in Figure E-1 illustrates that no part of MRS A1 showed evidence of a high-use area. However, the RI transect survey was designed to detect target areas of the size and anomaly density expected for 60-mm mortar target areas. Since no High-Density Areas were found, no detailed characterization was performed on MRS A1. In a maneuver area, munitions would have been used in low intensity throughout the area. Further, maneuver exercises such as grenade training would produce areas where munitions were used with smaller spatial footprints that would not be detected by the transect survey.

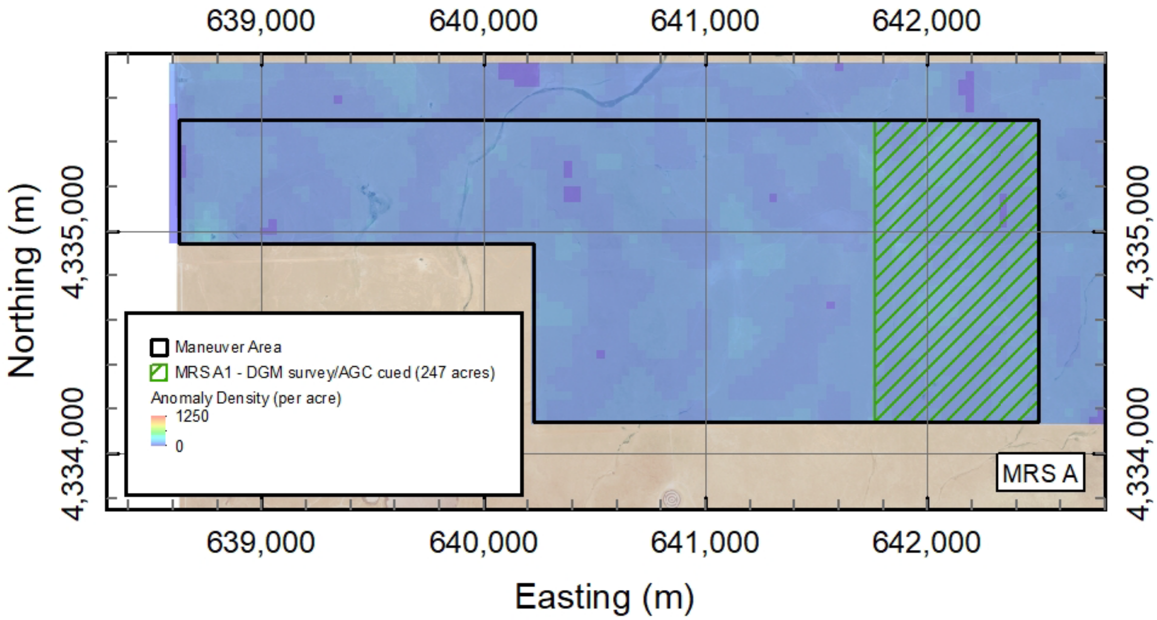

Figure E-1: MRS A1 Maneuver Area Development Area

Munitions known or suspected to be present on MRS A1 in the initial CSM that were used to plan the technical approach include:

- MKII practice hand grenades
- Mk1 Mod 0 Trip Flares
- M83 60-mm Illumination mortars
- M2 60-mm smoke mortars
- M1/M1A1 practice anti-tank mines
- M6A1 2.36" practice anti-tank rockets

Typical maneuver-area training would not result in these munitions penetrating beyond their reliable detection depths. Experience and professional judgement indicate that they will be significantly shallower than 0.45 m for the mortars and 0.30 m for the other munitions. Full details of the Conceptual Site Model can be found in Worksheet 10 of the Quality Assurance Project Plan. (Ref)

2. Description of Remedy

The remedy selected in the ROD was the removal of subsurface MEC using non-AGC DGM detection followed by cued AGC to identify targets of interest for excavation, with Interim Land Use Controls during remedy implementation. The goal stated in the ROD is to demonstrate achievement of conditions that support designation for UU/UE following MEC removal to permit site development. Table E-1 provides an overview of the remedy. Full details are in Worksheet 17 of the QAPP.

Table E-1: Overview of the Remedy for Camp Example MRS A1

Activity	Remedial Action Objective	Remedy Component		
		MEC Removal	MEC Treatment	Land-Use Controls
MRS A1 Maneuver Area Development Area Alternative # – MEC Subsurface Removal using non-AGC DGM detection and Cued AGC with Interim Land Use Controls	Remove MEC in the surface and subsurface. Following MEC removal and site development, demonstrate achievement of (UU/UE) **MEC Removal Remediation Goals** Detection and removal of: • 60mm mortar to a minimum depth of 0.45 m bgs • Hand grenades, signals, flares, pyrotechnics, 2.36" rockets, and anti-tank mines to a depth of 0.30 m bgs • Any other munitions detected	Subsurface anomaly detection using non-AGC DGM TOI Selection using cued AGC TOI investigation and source removal using manual and backhoe-assisted excavation	All recovered MEC to be detonated in place or otherwise destroyed on-site	Interim LUCs as specified in the ROD. Upon successful demonstration of UU/UE, removal of LUCs.

Measurement Performance Criteria (MPCs) and Measurement Quality Objectives (MQOs) as shown in QAPP Worksheets 12 and 22 were developed to ensure data usability. Key MPCs included:

- Instrument Verification Strip to ensure correct instrument operation on each survey day
- Completeness of coverage in the EM61 survey
- Verification of EM61 anomaly selection
- Sensitivity to support detecting the required munitions
- Detection of blind QC (contractor) and QA (government) seeds
- Completeness of the detection survey anomaly selection
- Completeness of the cued anomaly AGC data collection
- Completeness of the AGC library
- Correct classification of blind QC (contractor) and QA (government) seeds
- Completeness of excavation of anomaly sources
- Accuracy of compared AGC analyses with recovered items
- Verification of AGC target-of-interest threshold
- Validation of AGC analysis parameters

3. Remedy Implementation and Results

The remedy was implemented as described in Table E-1. Upon completion of the work, four areas of munitions use were identified, as shown in Figure E-2.

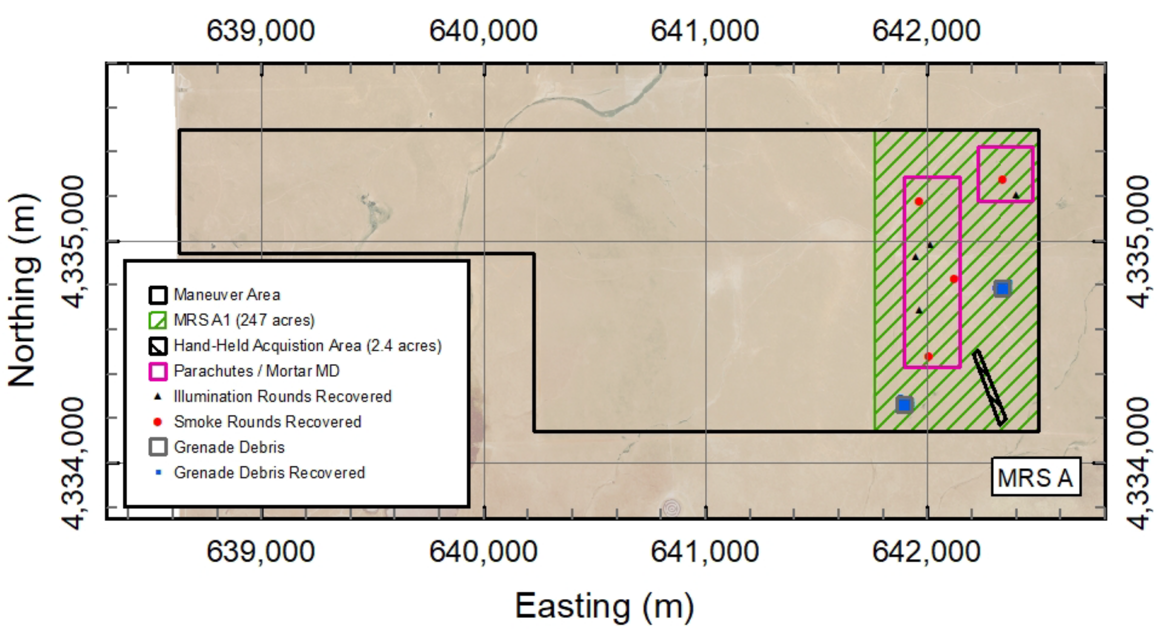

Figure E-2: Final CSM for MRS A1 showing findings of the RA

They are identified in Figure E-2 as:

- GT1 – Grenade training area 1 acre in size containing 40 MKII practice grenades.

- GT2 – Grenade training area 1 acre in size containing 35 MKII practice grenades.
- MR1 – Mortar area 15 acres in size containing two M2 smoke and one M83 illumination 60-mm mortars and scattered fragments, parachutes, and pyrotechnics.
- MR2 – Mortar area 53 acres in size containing three M2 smoke and three M83 illumination 60-mm mortars and scattered fragments, parachutes, and pyrotechnics.

Figure E-3 shows the depth distribution for each of the recovered munitions types, as well as the depths of the seeds that were emplaced as part of the quality control and the maximum depth of reliable detection for each type of item.

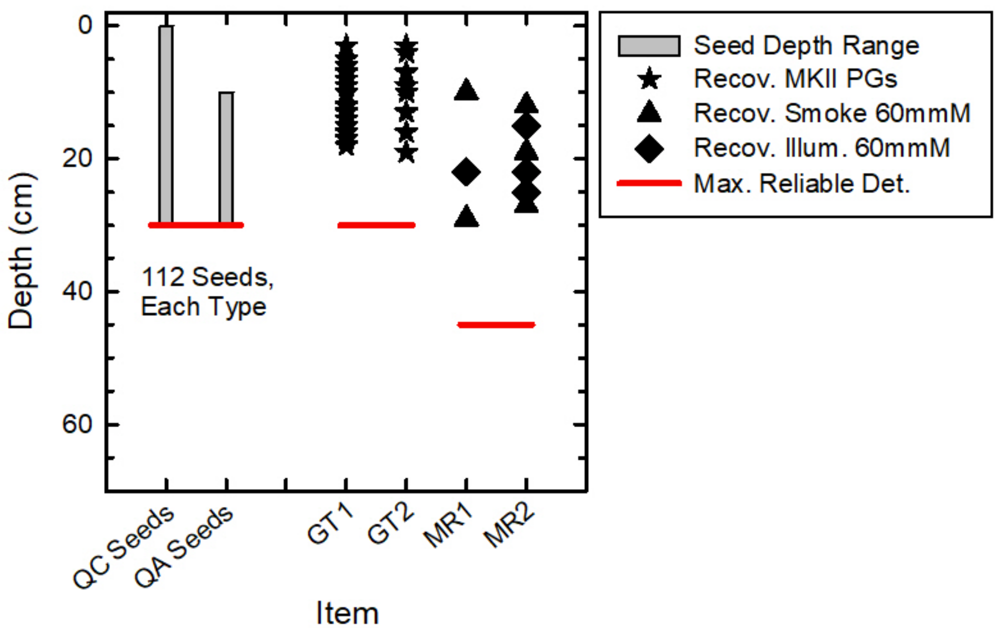

Figure E-3: Depth profile of recovered munitions, seeds, and maximum reliable detection depths

Beyond the four areas described the removal action:

- Found no evidence during the surface sweep or the subsurface removal of any other munitions identified in the original CSM as potentially present.
- Found no evidence of unexpected munitions, including MEC, MD, objects resembling munitions, and clusters of similar AGC responses that were investigated.
- Had no findings suggest a presence of any MEC with a hazard that exceeds the sensitivity and severity of the munitions expected from the original CSM.
- Found no evidence that items exist below their maximum reliable detection depth. All recovered items were shallower than both the maximum reliable detection depth and the seeds. This is consistent with the use of practice grenades, as well as of smoke and illumination mortars.
- Identified large areas of the site that show no evidence that munitions were ever used.

4. Quality and Effectiveness of Remedy Implementation

The data usability assessment determines whether the results of a project can be used as intended with an acceptable level of confidence. It is performed at key decision point in a project as a qualitative and quantitative evaluation to determine if the project data are of the right type, quality, and quantity to support the MPCs and DQOs, and ultimately to conclude that a project was conducted successfully. Specifically, it is a retrospective review of the systematic planning process to evaluate whether the underlying assumptions are valid, the sources of uncertainty have been managed appropriately, and the data are of acceptable quality.

The full DUA for MRS A1 is in the RACR. DUA was performed at the conclusion of the EM61 detection survey and analysis, at the conclusion of the AGC cued data collection and analysis, and at the conclusion of the project. Specifically, at each stage it evaluated:

Step 1. The project's planning assumptions, objectives, and sample design.

Step 2. The data and its conformance to all MPCs.

Step 3. The overall usability and application of decision rules.

Step 4. The lessons learned and recommendations.

The overall conclusion of the DUA is that the data are suitable to support a weight-of-evidence recommendation of UU/UE for MRS A1. Here we summarize the key findings that support this recommendation.

4.1 Documentation of all RA activities is complete:

- All deliverables are present.
- All deliverables were reviewed and approved by the government.
- All deliverables were provided for review to all Project Team members.

See [REFERENCE] for a list of deliverables and dates of draft, government review, regulator review, final, and acceptance, as applicable.

4.2 The site findings, as documented in the final CSM, do not raise any unanticipated concerns with regard to explosive hazards and site safety. Specifically:

- The four areas of munitions use identified were within expectations and consistent with the initial CSM:
  - GT1 contained 40 practice grenades.
  - GT2 contained 35 practice grenades.
  - MR1 contained 2 smoke and 1 illumination mortars and scattered fragments, parachutes, and pyrotechnics.
  - MR2 contained 3 smoke and 3 illumination mortars and scattered fragments, parachutes, and pyrotechnics.
- No evidence (including MD) was uncovered during the surface sweep, or the subsurface removal of any other munitions identified in the original CSM as potentially present.
- No evidence (including MD) of unexpected munitions was found.
- No findings suggest a hazard that exceeds the sensitivity and severity of the munitions expected from the original CSM.
- No evidence suggests that items exist below their maximum reliable detection depth.
- Large areas of the site show no evidence that munitions were ever used.

4.3 The site findings, as documented in the final CSM, are consistent with planning assumptions and raise no questions about the validity of the sample design:

- The only munitions found on the site were mortars and practice hand grenades that were in the initial CSM.
- EM61 target selection criteria were based on detecting a 60-mm mortar to 0.45 m bgs. Nine mortars were found in the subsurface at depths between 0.05 and 0.30 m.
- The target selection criteria correspond to a reliable detection depth of hand grenades to 0.30 m. Seventy-five practice hand grenades were recovered at depths ranging from 0.05 to 0.20 m.
- Mortars, hand grenades, and all other potential munitions identified in the CSM were included in the AGC TOI library.
- Seeded items and depths are representative of the munitions recovered and verify the depth of detection.
- All field specifications, including line spacing, sample rate, sensor standoff planned to the initial assumptions were valid.

There are no inconsistencies of a nature that would call into question whether the data collection and analysis methodology can meet the project objectives.

4.4 All MPCs were achieved and demonstrate successful execution of the remedy. A complete evaluation of the MPCs is in the DUA. Key conclusions are:

- The IVS confirmed the EM61 system and AGC systems were operating properly at the beginning and end of each data collection day.
- Completeness of coverage in the EM61 survey: The EM61 survey achieved full coverage of the site at the specified data metrics. All accessible data gaps were resurveyed. Any areas inaccessible to the array were surveyed with a handheld DGM system that was capable of meeting the ROD requirements.
- Sensitivity to support detecting the required munitions. Measurements of site noise support detection of required items to required depths at the thresholds chosen.
- Detection of blind QC (contractor) and QA (government) seeds: All valid blind QC (contractor) and QA (government) seeds were detected in the EM61 detection step at the correct locations with signals consistent with the buried item and placed on the cued list.
- Completeness of the detection survey anomaly selection: All anomaly locations were placed on the cued list. Verification reanalysis of 10% of the data did not result in any additional anomalies selected.
- Completeness of the cued anomaly AGC data collection: AGC data were collected at all locations on the cued list, and all were designated as either TOI, non-TOI or inconclusive. All TOI and inconclusive designations were placed on the list to be excavated.)
- Completeness of the AGC library: The library included signatures from all items confirmed or suspected to be present.
- Correct classification of blind QC (contractor) and QA (government) seeds: All valid blind QC (contractor) and QA (government) seeds were correctly classified.
- Completeness of excavation of anomaly sources: All locations on the excavation list were excavated and resolved.
- Accuracy of compared AGC analyses with recovered items: All recovered items were consistent with predicted physical properties.
- Verification of AGC target-of-interest threshold: No IOC were found in the threshold verification digs.

- Validation of AGC analysis parameters: No IOC were recovered in the validation digging and the recovered objects were consistent with the AGC analysis parameters.
- Post-dig verification: At all TOI locations, re-interrogation with the AGC sensor confirmed that the original polarizability was no longer detected. Locations of inconclusive analyses were resolved.

4.5 The contractor's quality program was implemented as planned:

- The contractor performing the RA is fully DAGCAP-accredited.
- The contractor's quality program identified MQO failures, which were effectively corrected:
  - The QC geophysicist identified 12 MQO deficiencies throughout the project. (Reference deliverables).
  - In all cases, an RCA was performed, a corrective action was implemented, and the corrective action was accepted by the government.
- The CA were implemented throughout the rest of the project and there were no repeat non-conformances after the CA was implemented.
- The work met all the quality metrics set by the government.

4.6 No significant technical challenges that would compromise the implementation of the remedy were encountered:

- The munitions recovered on the site did not stress the maximum reliable detection and classification depth. Seeds were placed to their maximum reliable detection depth, and all were detected and correctly classified. All recovered MEC were substantially shallower.
- With one exception discussed below, the site was accessible and presented no significant technical challenges:
  - The site is open and flat and suitable for vehicular access.
  - Geologic noise was low and consistent throughout the site.
  - The site is remote and has no power, water, or sewer lines or other man-made sources of noise or interference.
- Gully:
  - A gully area of approximately 10 m X 100 m could not be surveyed using the EM61 array.
  - This area was surveyed using a handheld DGM EMI system capable of meeting ROD requirements.
  - The threshold for target selection was adjusted to account for the lower sensitivity of the HH system and the SNR>5 was maintained assuring selection of required munitions.

5. Findings and Conclusions

Al lines of evidence indicate no munitions remain on the site. The recommendation of UU/UE is based on the determination that the remedy, as implemented, is protective of human health and the environment. The remedy has successfully removed contamination. The technology used in the remedy is capable of detecting all specified munitions to the required depths. All quality measures evaluated in the data usability assessment indicate that the work done on the site is in accordance with normal measurement performance criteria and meets all applicable standards.

All data and quality metrics support the conclusion that the UU/UE determination is scientifically valid and meets the ROD requirements and no other remedial action is required. As a result, the site does not require continuation of institutional controls and is fully protective of human health and the environment. Munitions Response activities for Camp Example MRS A1 are now considered to have reached the Response Complete stage.

6. References

Remedial Investigation/Feasibility Study, Camp Example Munitions Response Area, Final Report, January 2018

Munitions Response Quality Assurance Project Plan, Remedial Action, Camp Example Munitions Response Area, January 2021

Remedial Action Report, Camp Example Munitions Response Area, Final, January 2022