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| Intergovernmental Data Quality Task Force |
| Uniform Federal Policy  For  Quality Assurance Project Plans |
| Advanced Geophysical Classification for Munitions Response |
| (AGC-QAPP) |
|  |
| **Version 1.0, March 2016** |
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**Acknowledgement**

The Intergovernmental Data Quality Task Force would like to thank the members of the IDQTF Advanced Geophysical Classification (AGC) 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 AGC Subgroup includes the following members:

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# Preface

The Intergovernmental Data Quality Task Force (IDQTF) has produced this Advanced Geophysical Classification Quality Assurance Project Plan (AGC-QAPP) template, as a voluntary consensus document, to assist project teams in planning for the investigation of buried munitions and explosives of concern (MEC) at Department of Defense (DoD) installations and formerly used defense sites (FUDS). The template documents the systematic planning process (SPP) steps leading to *in-situ* detection and classification of MEC and other debris using advanced geophysical classification. This template was developed following extensive research and development of advanced geophysical classification technology under the Environmental Security Technology Certification Program (ESTCP) and the Strategic Environmental Research and Development Program (SERDP). It is based on requirements and guidance contained in the *Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP)*, (IDQTF, 2005). It also draws upon similar efforts by the Interstate Technology & Regulatory Council (ITRC) Geophysical Classification for Munitions Response Team*.* Use of this template will help project teams generate a complete QAPP, i.e., a stand-alone document addressing all elements of the national consensus standard ANSI/ASQ E4-2004, *Quality Systems for Environmental Data and Environmental Technology Programs.* Similar to the overarching policy document *Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP)* (IDQTF, 2005), this document was not developed or promulgated through the Federal rulemaking process, it does not have the force of regulation, and is not subject to regulatory enforcement or a Notice of Violation. [Notice of Violations would be applicable only in circumstances in which two parties have chosen to make the use of the AGC-QAPP part of an enforceable agreement.] Once adopted by an agency for a specific program or project, however, use of this document is required to ensure a consistent approach to QAPP development and compliance with ANSI/ASQ E4-2004.

DoD has used military munitions for live-fire testing and training to prepare the United States military for combat operations. As a result, MEC, including unexploded ordnance (UXO) and discarded military munitions (DMM) may be present on former ranges and other facilities (such as production and disposal areas). During a traditional cleanup, a site is typically mapped using either a magnetometer or electromagnetic induction (EMI) sensor, and the locations of all signals above a stated detection threshold are excavated, because this technology does not provide a validated means to discriminate between MEC and nonhazardous metallic debris. Experience has shown that most of the costs to remediate munitions-contaminated sites have been spent excavating items that pose no threat. Remediation of the entire inventory of munitions-contaminated sites in this manner would be cost-prohibitive, and estimated completion dates for munitions response at many sites would be decades away.

Advanced geophysical classification uses advanced geophysical sensors and classifiers to estimate physical properties of the item (e.g., depth, size, aspect ratio, wall thickness, symmetry) and determine whether the item is a target of interest (TOI) (i.e., highly likely to be MEC) or non-TOI (i.e., highly unlikely to be MEC). Using this information in a structured decision-making process, documented in a project-specific QAPP, project teams will be able to make informed decisions about whether an item should be excavated or can be left in place. Following more than a decade of research and development, the technology has been successfully demonstrated on several live sites under the ESTCP, even as it continues to evolve. Use of this technology has the potential for significant cost savings by avoiding unnecessary and costly excavation of non-hazardous debris, and thus expediting the cleanup and reuse of munitions response sites.

The AGC-QAPP template follows the format of the Optimized UFP-QAPP Worksheets (IDQTF, 2012); however, use of the original UFP-QAPP Workbook (IDQTF, 2005) is also acceptable. This template provides information and examples to facilitate the SPP and not replace it. Use of the template will result in a more rigorous, transparent, and better documented investigation. It should be noted there are some distinct differences between the SPP used for AGC and that used for typical environmental (i.e., chemical) investigations:

1. Unlike traditional chemical investigations where a sample of the soil is taken from the field and sent to an off-site laboratory for analysis, geophysical data for target identification and classification are collected *in-situ*. Data processing may take place either in the field or off-site.
2. The AGC process is performed dynamically, allowing decision-making to occur while project teams are in the field; therefore, a structured process for evaluating data quality and subsequently making decisions is vital to the success of meeting project objectives.

Because of these differences, the AGC-QAPP does not require all of the worksheets contained in either the original Workbook or the Optimized Worksheets. Table 1 identifies worksheets not used in the template and explains why they have been excluded.

The worksheets in this template include green text, which provides instructions and guidance on completing each worksheet. Certain worksheets also include blue text, which provides examples of the types of information typically needed. Green and blue text should be removed before completing a project-specific QAPP. Where applicable, minimum recommended requirements are presented in black text. Guidance, examples, and minimum recommended requirements contained in this template are based on the Remedial Action (RA) phase of investigation; therefore, they will not apply to every situation. Project teams should modify this template as needed to suit other phases of investigation and their project-specific data quality objectives (DQOs). The rational for any changes to black text must be specifically identified, documented and concurred upon by the project team. 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.

The following limitations should be noted:

* This template addresses detection and classification only. It does not address the intrusive investigation (removal of items) or associated explosives safety operations per se.
* Although modern advanced geophysical classification technologies have dramatically increased the accuracy and sensitivity of geophysical investigations, it cannot be assumed that 100% of all MEC can be identified and removed at all sites.
* Advanced geophysical classification does not evaluate potential risks from munitions constituents (MC).
* Wherever possible, a global positioning system (GPS) with centimeter-level precision, or other high-precision positioning system, should be used for referencing sample locations. The examples in this template cannot be used for line and fiducial positioning.
* Advanced geophysical classification may not be suitable for use at all sites. Readers should refer to the ITRC document, “Geophysical Classification for Munitions Response”, August 2015 for further guidance on its uses and limitations.
* Users of this AGC-QAPP template must comply with any applicable State, Federal, and DoD Component-specific requirements, policies, and procedures.

| Table 1. Crosswalk: Optimized UFP-QAPP Worksheets to GCMR-QAPP Template | | |
| --- | --- | --- |
| **Optimized UFP-QAPP Worksheets** | | **GCMR-QAPP Template** |
| 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 | Project Planning Session Summary | Included |
| 10 | Conceptual Site Model | Included |
| 11 | Project/Data Quality Objectives | Included |
| 12 | Measurement Performance Criteria | Included |
| 13 | Secondary Data Uses and Limitations | Included |
| 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 Work Flow” |
| 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 #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 |
| 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 | Included – title changed to “Data Verification, Validation, and Usability Inputs” |
| 35 | Data Verification Procedures | Included – title changed to “Data Verification and Validation Procedures” |
| 36 | Data Validation Procedures | Included – title changed to “Advanced Geophysical Classification Validation” |
| 37 | Data Usability Assessment | Included |

# Glossary

## Part 1 – Abbreviations and Acronyms

**(A) Ampere**

**(A/E/C) Architecture, Engineering, and Construction**

**(AGC-QAPP) Advanced Geophysical Classification Quality Assurance Project Plan**

**(bgs) Below Ground Surface**

**(CA) Corrective Action**

**(CAR) Corrective Action Request**

**(CSM) Conceptual Site Model**

**(DDESB) Department of Defense Explosives Safety Board**

**(DFW) Definable Feature of Work**

**(DGM) Digital Geophysical Mapping**

**(DMM) Discarded Military Munitions**

**(DoD) Department of Defense**

**(DQI) Data Quality Indicator**

**(DQO) Data Quality Objective**

**(DUA) Data Usability Assessment**

**(EMI) Electromagnetic Induction**

**(EPA) U.S. Environmental Protection Agency**

**(ESRI) Environmental System Research Institute**

**(ESTCP) Environmental Security Technology Certification Program**

**(FUDS) Formerly Used Defense Sites**

**(GIS) Geographic Information System**

**(GPS) Global Positioning System**

**(HAZWOPER) Hazardous Waste Operations and Emergency Response**

**(IDQTF) Intergovernmental Data Quality Task Force**

**(IMU) Inertial Measurement Unit**

**(ISO) Industry Standard Object**

**(ISO 80) Schedule 80 small Industry Standard Object**

**(ISO/IEC) International Organization for Standardization/International Electrotechnical Commission**

**(ITRC) Interstate Technology Regulatory Council**

**(IVS) Instrument Verification Strip**

**(MC) Munitions Constituents**

**(MEC) Munitions and Explosives of Concern**

**(MPC) Measurement Performance Criteria**

**(MQO) Measurement Quality Objective**

**(PA) Preliminary Assessment**

**(pdf) portable document format**

**(PM) Project Manager**

**(QA) Quality Assurance**

**(QC) Quality Control**

**(QAPP) Quality Assurance Project Plan**

**(RA) Remedial Action**

**(RCA) Root Cause Analysis**

**(RI/FS) Remedial Investigation/Feasibility Study**

**(RPM) Remedial Project Manager**

**(SDSFIE) Spatial Data Standards for Facilities, Infrastructure, and Environment**

**(SI) Site Inspection**

**(SNR) Signal to noise ratio**

**(SOP) Standard operating procedure**

**(SPP) Systematic Planning Process**

**(SUXOS) Senior UXO Supervisor**

**(TBD) to be determined**

**(TPP) Technical Project Planning**

**(TOI) Target of Interest**

**(Tx/Rx) transmit/receive**

**(UFP QAPP) Uniform Federal Policy for Quality Assurance Project Plans**

**(USACE) U.S. Army Corps of Engineers**

**(UXO) Unexploded Ordnance**

**(UXOQCS) Unexploded Ordnance Quality Control Specialist**

**(UXOSO) Unexploded Ordnance Safety Officer**

## Part 2 – Definitions

Accuracy A measure of the overall agreement of a measurement to a known or accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias). [EPA]

Advanced geophysical classification The use of data from an advanced geophysical sensor system to estimate the intrinsic properties of a buried metal object; specifically, for munitions response and UXO removal, to determine whether the object is a target of interest (TOI) that must be removed or other non-explosive debris (non-TOI) that can be left in the ground. Intrinsic properties include size, symmetry, aspect ratio, material composition, and wall thickness. Advanced geophysical classification requires three components: 1) a geophysical sensor system capable of measuring EM signals from multiple aspects, 2) a model to estimate intrinsic properties of the buried item based on its polarizability decay curve or “EMI fingerprint”, and 3) classification algorithms to assign likelihood that a buried item is a target of interest. [SERDP, ESTCP]

Anomaly As used in geophysics, a deviation from an expected background condition that can result from either a real, physical change (e.g. buried metal object) in the subsurface, or various kinds of interference related to the geophysical equipment or external sources. Note: The anomaly is the deviation. It is to be differentiated from the buried metal object or “source” resulting in the anomaly.

Background verification Process of verifying that a proposed location for background measurements is, in fact, free of buried metal. The process involves collecting a static measurement at the proposed background location and four more measurements offset by a half sensor width in the four cardinal directions. If the measured amplitudes of all five measurements are within the noise level of each other, then the user can have confidence that the proposed location is free of buried metal.

Classification validation A qualitative assessment of the EMI fingerprints predicted from geophysical inversions used to evaluate overall investigation performance. This is achieved by making one or more predictions about the size or general shape of non-TOI items selected by the project team, followed by excavation of the items and comparison of actual intrinsic characteristics to predicted characteristics. It may also include a comparison of actual to predicted extrinsic properties such as location and depth of the item. [EDQW]

Classifier Software (algorithm) used during advanced classification to assign likelihood, based on the EMI fingerprint of a buried metallic item, that the item is a target of interest. [SERDP, ESTCP]

Comparability A qualitative measure of the confidence with which one data set or method can be compared to another. The ability to describe likenesses and differences in the quality and relevance of two or more data sets. [EPA]

Completeness A measure of the amount of valid data obtained from a measurement system. The quantity of data that is successfully collected with respect to the amount intended in the experimental design. [EPA]

Cued survey Collection of geophysical data by positioning an advanced EMI sensor over each buried metal object and then collecting 60-120 seconds of data. As the technology develops, this step may be combined with the detection step, requiring the collection of fewer cued data and reducing data collection to one mobilization. [ITRC]

Data quality objectives (DQOs) Qualitative and quantitative statements of the overall level of uncertainty that a decision-maker will accept in results or decisions based on environmental data. They provide the statistical framework for planning and managing environmental data operations consistent with user's needs. [EPA]

Data usability assessment For the purposes of this document, an evaluation of the overall quality of a data set making up a delivery unit, to determine whether the data support their intended uses. It is an evaluation of conformance to the MPCs presented in AGC-QAPP Worksheet #12. [EDQW]

Data validation For the purposes of this document, a detailed evaluation of data for compliance to stated requirements, e.g., the contract, SOPs and MQOs contained in AGC-QAPP Worksheet #22. [EDQW]

Data verification For the purposes of this document, a completeness check that all specified activities involved in data collection and processing have been completed and documented and that the necessary records (objective evidence) are available to proceed to data validation. [EDQW]

Delivery unit For the purposes of this document, a portion of the site, consisting of one or more survey units, for which data verification, data validation, and the data usability assessment have been conducted. Contracting documents normally will establish the specifications for delivery units.

Detection survey The initial mapping and identification of buried metal objects at the site, which can be accomplished using either traditional or advanced geophysical sensors (also called reconnaissance survey or dynamic survey). [ITRC]

Electromagnetic induction (EMI) sensor Geophysical sensors that operate by emitting magnetic fields and detecting the response from electric currents generated when these fields interact with metallic objects. They are often referred to as “all-metals locators.” [SERDP, ESTCP]

EMI fingerprint Set of three magnetic polarizabilities that express how an object responds following electromagnetic excitation along each of its three principal axis directions. These intrinsic properties of the object are determined by geophysical inversion of multi-axis EMI sensor data. [SERDP, ESTCP]

Geophysical inversion A process that uses geophysical data and a physics-based model to iteratively estimate intrinsic properties of a buried item. [SERDP, ESTCP]

Industry standard object (ISO) An object, constructed from steel pipe manufactured to ASTM specifications, used as a munitions surrogate for the purpose of quality assurance or quality control. [ESTCP] [Note: DoD uses the following three types of ISO: 1-inch diameter X 4-inch long Schedule 80 pipe nipple (a surrogate for 37mm projectiles), 2-inch diameter X 8-inch long Schedule 40 pipe nipple (a surrogate for 60-mm mortars), and 4-inch diameter X 12-inch long Schedule 40 pipe nipple (a surrogate for 105mm projectiles)].

Informed source selection (ISS) The use of the extra information inherent in the signals, when advanced EMI sensors are used in the detection phase, to select only those buried metal sources that could be caused by a target of interest (TOI) for further consideration. This technique focuses on the buried metal items (sources) that result in the anomaly rather than the anomaly itself. The advanced EMI sensors can be configured to excite the source along multiple axes and sense the induced fields along three axes for much longer times. This provides at least an order of magnitude more information to use for source selection compared to information produced by a traditional sensor. This extra information can be used to 1) discriminate between a TOI and noise spikes caused by environmental interference, 2) lessen the interference caused by site geology, and 2) discriminate TOI from anomalies caused by small, shallow clutter. [ESTCP]

Instrument verification strip (IVS) A constructed series of buried inert munitions or industry standard objects used to verify proper functioning of the geophysical sensor system. [SERDP, ESTCP]

Geophysical inversion (alternate definition based on ESTCP FAQ) The process of generating polarizability decay curves or “EMI fingerprints” from measured geophysical data through a model-matching process. The decay curves reflect the size, symmetry, aspect ratio, material composition, and wall thickness of the object.

Inversion Fitting measured sensor data from an object to an EMI response model to obtain the model parameters including the object’s location and depth, orientation of its principal axes, and its principal axis response functions. [ITRC]

Library matching The process of comparing the derived polarizabilities of a detected buried metal object (i.e., unknown object) with the polarizabilities of a collection of known munitions items in a library. The objective is to classify the unknown object based on the similarity of its polarizabilities to a library entry.

Measurement performance criteria (MPC) Qualitative and quantitative specifications for measurement activities developed during systematic planning to ensure collected data will satisfy the data quality objectives. MPCs are stated in terms of data quality indicators, including accuracy, representativeness, completeness, comparability and sensitivity. [EPA, various]

Polarizabilities Three principal axis responses returned by the inversion process, which relate directly to the physical attributes of the object under investigation. Information inferred from the responses (e.g. size, shape, aspect ratio and wall thickness) is the basis for classification decisions. [ITRC]

Quality control (QC) seed Industry standard object or inert munition buried at a recorded location and depth, used as a process quality control check for munitions response tasks, including detection surveys, cued surveys, and anomaly recovery operations. The identity, location, and depth of the seed item are blind (not known) to all members of the field team. [EDQW]

Quality system (also management system) The means by which an organization ensures the quality of the products or services it provides and includes a variety of management, technical, and administrative elements such as policies and objectives, procedures and practices, organizational authority, responsibilities, and accountability. [EPA QA G-4]

Representativeness The degree to which a sample or measurement is characteristic of the population for which the sample or measurement is being used to make inferences. [EDQW]

Sensitivity The capability of a method to discriminate between measured responses representing different levels of a variable of interest.

Standard method For the purposes of this document, a method for performing advanced geophysical classification that 1) has been successfully performed in an ESTCP demonstration and 2) is capable of meeting the minimum specifications contained in Appendix B of this document. [EDQW]

Survey unit A portion of the site for which geophysical survey data, including quality control (QC) results and results for blind QC seeds and validation seeds, will be collected, verified, validated, and reported as a unit, for evaluation by the project team. Survey units are established by the project team during project planning. The survey unit is not necessarily a geographically contiguous unit, and survey units for the detection phase may or may not be the same as those for the cued phase. The survey units should be designed such that data reporting occurs at regular (e.g., weekly) intervals as agreed upon during project planning. [EDQW]

Target of interest (TOI) Any item that must be removed from a munitions response site and subsequently examined to determine whether it is hazardous or inert. Common TOI include unexploded ordnance (UXO), other inert munitions that must be excavated to be identified as inert, quality control (QC) and validation seeds, and substantial components of munitions that the site manager selects for removal. [SERDP, ESTCP]

TOI/non-TOI threshold verification A quality assurance (QA) measure involving the excavation of buried items predicted to be non-TOI, to verify correct placement of the threshold dividing the ranked anomaly list into TOI and non-TOI. Threshold verification targets are selected in consecutive order on the ranked anomaly list, beginning with the first target classified as non-TOI below the threshold. [EDQW]

Validation seed Industry standard object or inert munition buried at a recorded location and depth by, or on behalf of, the government, which is used to evaluate overall contractor performance on advanced geophysical classification. The identity, location, and depth of the seed item are blind to the contractor. [EDQW]

# QAPP 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. Signatories usually include the DoD Remedial Project Manager (RPM) and Quality Assurance (QA) Manager, contractor Project Manager (PM) and QA Manager, 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
   1. Site name/project name
   2. Site location/number
   3. Lead organization
   4. Contractor
   5. Contract number
2. Lead Organization
   1. DoD RPM

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(name/title/signature/date)

* 1. DoD QA Manager

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(name/title/signature/date)

1. Contractor
   1. Contractor PM

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(name/title/signature/date)

* 1. Contractor QA Manager

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(name/title/signature/date)

1. Federal Regulatory Agency

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(name/title/signature/date)

1. State Regulatory Agency

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(name/title/signature/date)

1. Other Stakeholders (as needed)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(name/title/signature/date)

1. List plans and reports from previous investigations relevant to this project

# QAPP 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 agencies. Two examples follow. Figure 3-1 provides an example of the structure for the organization performing advanced geophysical classification, and Figure 3-2 provides an example of the structure for the Explosives Safety Operations organization. [Note: Although this template does not address explosives safety per se, including a copy of the organizational structure for the Explosives Safety Operations organization is useful for facilitating project communications.] 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 also can be used to document recipients of controlled copies of the QAPP. The draft QAPP, final QAPP, and any changes/revisions must be provided to all QAPP recipients shown on this chart. Use asterisks or other symbols to designate QAPP recipients. [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.

Lines of Authority Lines of Communication

## Figure 3-1: Advanced Geophysical Classification Organizational Structure

Regulators/

Stakeholders

DoD Remedial Project Manager

DoD QA, Safety, Geophysicist

Project Manager

(Prime Contractor)

Corporate Safety Manager

(Prime Contractor)

UXO ExpertiseA

Data Processor

GIS Manager

Field Team Leader

Project Geophysicist

Corporate QA Manager

(Prime Contractor)

Quality Control (QC) Geophysicist

A 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.

Lines of Authority Lines of Communication

## Figure 3-2: Explosives Safety Operations Organizational Structure

QC Geophysicist

Regulators/

Stakeholders

DoD Remedial Project Manager

DoD QA, Explosive, Safety, Geophysicist

Corporate QA Manager

(Prime Contractor)

Project Manager

(Prime Contractor)

QC Specialist

Corporate Safety Manager

(Prime Contractor)

UXO Safety Officer

(UXOSO)

Senior UXO Supervisor

(SUXOS)

UXO Team Leader

# QAPP 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: Advanced Geophysical Classification Organization | | | | | |
| **Name/**  **Contact Information** | **Project Title/Role** | **Education/Experience[[1]](#footnote-1)** | **Specialized Training** | **Required Licenses/Certifications[[2]](#footnote-2)** | **Signature/Date** |
|  | Project Manager | M.S. Chemistry  \_\_ years Managing munitions response projects  PM for \_\_ advanced geophysical classification projects |  |  |  |
|  | Corporate QA Manager | B.S. Civil Engineering  Corporate Quality Control (QC) manager for \_\_ years  Oversight of \_\_ munitions response projects |  |  |  |
|  | Corporate Safety Manager | M.S. Industrial Engineering |  | Certified Industrial Hygienist |  |
|  | Project Geophysicist | M.S. Physics  Project Geophysicist on ESTCP Geophysical Classification demonstration at \_\_ | Oasis Montaj Geophysical Data Processing for UXO 3-day UX-Analyze instruction by ESTCP |  |  |
|  | QC Geophysicist | M.S. Physics  Project Geophysicist on ESTCP Geophysical Classification demonstration at \_\_ | Oasis Montaj Geophysical Data Processing for UXO 3-day UX-Analyze instruction by ESTCP |  |  |
|  | Field Team Leader | B.S. Engineering  Field Geophysicist on ESTCP Geophysical Classification demonstration at \_\_ | Oasis Montaj Geophysical Data Processing for UXO Working with UX-Analyze |  |  |
|  | Data Processor | B.S. Physics  Project Geophysicist on ESTCP Geophysical Classification demonstration at \_\_ | Oasis Montaj Geophysical Data Processing for UXO  3-day UX-Analyze instruction by ESTCP |  |  |
|  | Geographic Information System (GIS) Manager | M.S. in Geoinformatics and Geospatial Intelligence |  |  |  |

| Table 4-2: Explosive Operations Organization | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Name/**  **Contact Information** | **Project title/Role** | **Education/Experience[[3]](#footnote-3)** | **Specialized Training** | **Required Licenses/Certifications[[4]](#footnote-4)** | **Signature/Date** |
|  | Project Manager | M.S. Geology  \_\_ years managing munitions response projects  PM for \_\_ advanced geophysical classification projects | Project Management Professional |  |  |
|  | Corporate QC Manager | B.S. Civil Engineering  Corporate QC manager for \_\_ Years  Oversight of \_\_ munitions response projects |  |  |  |
|  | Corporate Safety Manager | M.S. Industrial Engineering |  | Certified Industrial Hygienist |  |
|  | Senior UXO Supervisor (SUXOS) | Graduate Naval EOD School  Qualified Senior UXO Supervisor i/a/w  Department of Defense Explosives Safety Board (DDESB)  TP-18 | Emergency Response (HAZWOPER) |  |  |
|  | Unexploded Ordnance QC Specialist  (UXOQCS) | B.S. Civil Engineering  Qualified UXOQCS i/a/w  DDESB TP-18 | HAZWOPER |  |  |
|  | QC Geophysicist | M.S. Physics  Project Geophysicist on ESTCP Geophysical Classification demonstration at \_\_ | Oasis Montaj Geophysical Data Processing for UXO 3-day UX-Analyze instruction by ESTCP |  |  |
|  | UXO Safety Officer | B.S. Civil Engineering  Qualified Unexploded Ordnance Safety Officer (UXOSO) i/a/w DDESB TP-18 | HAZWOPER |  |  |
|  | UXO Team Leader | Qualified UXO III i/a/w  DDESB TP-18 | HAZWOPER |  |  |

# QAPP 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 Definable Feature of Work (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.

| Table 6-1: Communication Pathways and Procedures | | | |
| --- | --- | --- | --- |
| **Communication Driver** | **Initiator**  **(name, project title** | **Recipient**  **(name, project title** | **Procedure**  **(timing, pathway, documentation)** |
| Regulatory agency interface | Name, DoD RPM | Name, Regulatory Organization | DoD RPM provides weekly project update memorandum to Regulator via email |
| Stop work due to safety issues | Name, Contractor SUXOS | Name, Contractor PM | As soon as possible following discovery, the SUXOS informs Contractor PM by phone of critical safety issues and generates follow-up Stop Work Memorandum |
| Minor QAPP changes during project execution[[5]](#footnote-5) | Name, QC Geophysicist | Name, Corporate QC Manager and 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 |
| Major QAPP changes during project execution | Name, Contractor PM | Name, DoD RPM  Name, Contractor QA manager | Within 24 hours, Contractor PM submits field change request form to Corporate QA Manager and DoD RPM for approval. Following approval, DoD RPM informs regulator via email. |
| Mobilization and surface clearance activities are complete | Name, Contractor SUXOS | Name, Contractor PM | Upon completion of surface clearance activities, the SUXOS informs the Contractor PM via Surface Clearance Memorandum. |
| Daily and weekly QC reports | Name, Contractor PM | Name, DoD RPM | At end of each day/week of field work, Contractor PM provides daily/weekly QC reports to the DoD RPM via email |
| Geophysical QC variances | Name, Contractor QC Geophysicist | Name, Project Geophysicist and Name, Corporate QC Manager | QC Geophysicist generates Corrective Action Request (CAR) form and transmits to Project Geophysicist and Corporate QC Manager. Project Geophysicist notifies PM by email. |

# QAPP Worksheet #9: Project Planning Session Summary

**(UFP-QAPP Manual Section 2.5.1)**

The GCMR-QAPP worksheets will be completed in a series of project planning sessions, and a copy of this worksheet should be completed for each session, whether the session involves internal project teams (contractor and lead organization only) or includes regulators and other stakeholders. It is used to provide a concise record of participants, key decisions or agreements reached, and action items. Multiple planning sessions typically are required to complete the QAPP, and sessions should involve key technical personnel and decision-makers needed for that specific stage of planning and documentation. If a planning session occurs after the QAPP has been finalized, and the session results in a change to the QAPP, the QAPP and this worksheet should be amended accordingly.

Regardless of planning session format (e.g., phone conference, web-conferencing, or face-to-face meeting), all project planning sessions should be documented. Meeting minutes can be included as attachments if necessary, or referenced. Project teams will find it helpful to have a copy of the entire draft AGC-QAPP template on hand for all planning sessions, in whatever state of completion it may be. The following table may be modified to suit project-specific documentation requirements.

Date of planning session:

Location:

Purpose:

Participants:

| **Name** | **Organization** | **Title/Role** | **Email/Phone** |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Notes/Comments:

Consensus decisions made:

Action Items:

| **Action** | **Responsible Party** | **Due Date** |
| --- | --- | --- |
|  |  |  |
|  |  |  |

# QAPP 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 (CSM) as it relates to the proposed investigation. The CSM is a working, iterative model of site conditions used to assist in the visualization and communication of available information and development of DQOs. The CSM may include text, figures, and tables to depict the current understanding of site conditions. [Note: In August 2015, the ITRC published its guidance document, “Geophysical Classification for Munitions Response” which provides additional information users should find helpful in the development of the CSM.]

At a minimum, the CSM for the RA phase of investigation should include the following information:

* Site history and uses;
* Description of any known or suspected soil movement (e.g., scraping, filling, digging) or possible future soil movement that may be required in association with the site’s reuse.
* Types and quantities of MEC known or suspected to be present;
* Expected distribution of MEC present (area, expected maximum depth, depth distribution, anomaly density, etc.);
* Any geophysical data collected to date and interpretations of the data;
* The basis for dividing the site into survey units and delivery units[[6]](#footnote-6)
* Hydrology;
* Topography, geology, vegetation;
* Land use considerations;
* Detailed information on reasonably anticipated future uses;
* Current and future receptors;
* Exposure pathways;
* Access restrictions or other obstacles to investigation;
* Endangered species, sensitive habitats, and historic or cultural resources that could be affected by traffic or other disturbances occurring during the advanced geophysical classification process; and
* Data gaps and uncertainties associated with any information.

# QAPP Worksheet #11: Data Quality Objectives

**(UFP-QAPP Manual Section 2.6.1)**

This worksheet is used to document DQOs, which are developed during project planning sessions using an SPP. Examples of SPP include: 1) the DQO Process[[7]](#footnote-7), and 2) the U.S. Army Corps of Engineers’ Technical Project Planning (TPP)[[8]](#footnote-8) process. A well-developed, up-to-date CSM is essential to the development of appropriate DQOs. Regardless of the type of SPP applied, the QAPP must document the environmental decisions that need to be made, the type and quantity of data, and level of data quality needed to ensure decisions are based on sound scientific data. The following guidelines are based on EPA’s 7-step DQO process. The example is based on the RA phase. DQOs can be presented in tabular format.

**Step 1: State the Problem.** Define the problem that necessitates the study. Examine budget and schedule issues.

Site-specific problem statement: (Example) Previous investigations (list) have indicated that MEC in the form of DMM and UXO including (x, y, and z) are present at site \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, resulting from its use between (years) \_\_\_\_\_\_\_\_and\_\_\_\_\_\_\_\_ as a (describe the type of facility and its uses). As shown in the CSM these materials present an unacceptable risk from explosive hazards to (describe current receptors and potential future receptors based on anticipated land use.)

Advanced geophysical classification uses advanced sensors and geophysical classifiers to estimate physical properties of the item (e.g., depth, size, aspect ratio, wall thickness, symmetry) and determine whether the item is a TOI (i.e., highly likely to be MEC) or non-TOI (i.e., highly unlikely to be MEC). Using this information in a structured decision-making process, project teams will be able to make informed decisions about whether an item should be excavated or can be left in place.

**Step 2: Identify the goals of the data collection.** State how data will be used in meeting objectives and solving the problem. Identify study questions, including RA objectives. Define alternative outcomes.

Identify the principal study question: (Example) Based on current and anticipated future land use scenarios, which detected buried metal objects must be removed, and which ones may be left it place?

Identify alternative outcomes: (Example) To classify an object as a TOI and remove it, or to classify it as non-TOI and leave it in place.

State how the data will be used in solving the problem: (Example) Advanced geophysical classification will be used to 1) detect anomalies resulting from DMM, UXO, and other metallic debris and 2) classify anomalies so that informed decisions can be made as to whether the anomaly results from a TOI that should be removed, or a non-TOI that may be left in place. Geophysical data collected using advanced EMI sensors in a dynamic mode will be used to initially detect and document the locations of subsurface anomalies. Geophysical data collected using advanced EMI sensors in a cued (static) mode will then be used to classify each anomaly as follows: 1) TOI, i.e., highly likely to be DMM or UXO; 2) Non-TOI, i.e., highly unlikely to be DMM or UXO; or 3) Inconclusive. Detected items classified as “TOI” and “inconclusive” will be targeted for removal. Items classified as non-TOI will be left in place. The results of geophysical detection and classification and the subsequent intrusive investigation must meet established DQOs to allow the anticipated land reuse to take place after the removal of TOI.

**Step 3: Identify information inputs**. Identify data and information needed to answer the study questions.

(Example)

* Up-to-date CSM summarizing site conditions based on previous studies (e.g., Preliminary Assessment (PA), Site Inspection (SI) and Remedial Investigation/Feasibility Study (RI/FS)). [See Worksheet #10]:
* Detection survey results, including:
  + Areas covered
  + System QC test results
  + Instrument Verification Strip (IVS) results
  + Surveyed validation seed and QC seed locations
  + Anomaly detections and responses
  + Data analysis results, including
    - Anomaly locations
    - Unique anomaly identification numbers
    - Z-component amplitude and dipole response for each anomaly
    - Detection survey data validation report
    - Detection survey data usability evaluation
    - Updated CSM
* Cued survey results, including:
  + System QC results
  + IVS results
  + Background data
  + Surveyed validation seed and QC seed locations and types
  + Unique anomaly identification numbers and locations
  + Site-specific munitions library
  + Definition of items representing unacceptable explosive hazard
  + Classification of anomalies with confidence metric
  + Cued survey data validation report
  + Cued survey data usability evaluation
  + Updated CSM
* Intrusive investigation results, including
  + Excavation results (database)
  + Photos
  + Disposal records
  + Stop-Dig Threshold verification
  + Comparison of excavated “classification validation targets” to predictions
  + Final data usability evaluation
  + Final CSM

**Step 4: Define the boundaries of the project.** Specify the target population and characteristics of interest. Define spatial and temporal boundaries. [Discuss NAOC Comment 129]

Target population: (Example) The target population for this study includes the following MEC confirmed or suspected to exist in the study area:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 11-1: Target Population | | | | |
| **Confirmed Munitions (including nomenclature, if known)** | **MEC Type**  **(UXO, DMM, or both)** | **Munition Length** | **Observed Depth of Penetration (to center of mass)** | **Expected Detection Threshold** |
| 37mm (unknown mark/mod) | UXO |  |  |  |
| 75mm (unknown mark/mod) | UXO |  |  |  |
| **Suspected Munitions (including nomenclature, if known)** | **MEC Type**  **(UXO, DMM, or both)** |  |  |  |
| 60 mm mortar, M49A3 | UXO |  |  |  |
| 155mm, M107 | UXO |  |  |  |

Characteristics of interest: (Example) The characteristics of interest are those characteristics (e.g., size, symmetry, aspect ratio, object density, and wall thickness) that will allow classifiers to determine whether an anomaly is a TOI or non-TOI.

Spatial and temporal boundaries: Spatial boundaries include both the horizontal area and vertical depth of the study. Establishing the vertical boundary considers the maximum expected depth that objects 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 meaningful data for specific munitions. Establishing spatial boundaries should consider any areas that will be inaccessible to investigation for any reason (e.g., presence of power lines, structures, ponds, sensitive habitats, historic sites, and forested areas). Establishing temporal boundaries should consider seasonal conditions that could limit site access (e.g., periods of high rainfall, nesting seasons, etc.) Spatial and temporal boundaries should be depicted in the CSM (Worksheet #10).

(Example) This study is designed to detect and correctly classify all TOI exceeding the detection threshold and meeting measurement criteria within the established spatial boundaries. The detection threshold is a horizontal 37 mm projectile at 0.3 m below ground surface (bgs), which has been determined to be in the range of \_\_ to \_\_ millivolt (mV)/Ampere (A). This represents an anticipated minimum signal to noise ratio (SNR) of \_\_.

The horizontal boundaries of the project are defined by the boundary of the 7-acre treatability study area shown on Figure \_, excluding [list any areas excluded from the investigation]. The vertical boundary for each munition is the munition-specific maximum depth of detection based on the detection threshold discussed above. Vertical boundaries for each munition are shown on Figure \_.

**Step 5: Develop the Project Data Collection and Analysis Approach.** Define the parameter of interest, specify the type of inference (i.e., what criteria define anomaly detection and what criteria will distinguish between TOI and non-TOI), and develop the logic (decision rules) for drawing conclusions from findings.

(Example) This project will use the results from advanced geophysical sensors (polarizability decay curves or EMI signatures) and specialized geophysical modeling to classify target anomalies detected during the geophysical detection survey. Geophysical data from advanced sensors will be interpreted with physics-based models to estimate the physical attributes of the anomalies, and classifier models will be used to evaluate the likelihood that the anomalies are intact munitions. Anomalies will be classified into one of three categories described in Step 2 above. The final product will be a “ranked anomaly list” that classifies each anomaly, justifies the classification, and identifies whether a detected object will be removed or left in place. Anomalies on the list will be ranked in order of greatest likelihood to be a TOI to greatest likelihood to be a non-TOI, based on their confidence metrics.

**Detection Phase**

Parameters of interest: (Example) Measurements with an amplitude ≥\_\_ and a SNR ≥ \_\_.

Type of inference: (Example) Measurements meeting the criteria noted above will be considered to be potential TOI and selected as anomalies for further evaluation during the Cued Phase.

Decision rules: (Examples)

* If a response amplitude of ≥\_\_ mV/A is present in the detection data, and the signal to noise ratio is ≥\_\_, the anomaly will be selected and placed on the Amplitude Response Anomaly List

**Cued Phase**

Parameters of interest: (Example) Spatial extent of detected anomaly, cued measurement SNR, inversion fit coherence, and inversion outputs of β1, β 2, β3, x, y, and z.

Type of inference: (Example) If any of the following three criteria are met, the anomaly will be selected as a TOI: 1) the polarizability matches (within specifications established on Worksheet #22) that of an item in the project-specific TOI library, 2) estimates of the size, shape, symmetry, and wall thickness calculated from the polarizability, indicates the item is long, cylindrical, and thick-walled, or 3) there is a group (cluster) of x or more anomalies having similar polarizabilities that, after investigation, are discovered to be TOI. Anomalies with poor inversion fit coherence that, after considering all available information, cannot be ruled as non-TOI (i.e., the data are inconclusive) will be added to the TOI list.

Decision rules: (Examples)

* If all or a portion of the study area is determined to have an anomaly density too high for cued analysis, then an alternative approach will be developed (factors for evaluating anomaly density are discussed in Worksheet #17).
* If the object is classified as TOI (highly likely to be a munition), then the object will be excavated.
* If the object is classified as non-TOI (highly unlikely to be a munition), then the object will be left in place.
* If the object is classified as inconclusive, then the object will be excavated.

**Step 6: Specify Project-specific Measurement Performance Criteria (MPC).** Considering Steps 1-5, derive project-specific MPCs that collected data will need to achieve to minimize the possibility of making erroneous decisions (i.e., concluding that a TOI is a non-TOI, or concluding that a non-TOI is a TOI). 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. MPCs guide the development of the advanced geophysical classification survey 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. Project-specific MPCs are presented in Worksheet #12.

(Example) Project-specific MPCs are presented in Worksheet #12. Project-specific MPCs are the criteria that collected data must meet to satisfy the DQOs. Failure to achieve the MPCs may have an impact on end uses of the data, which will be discussed in the DUA Report.

**Step 7: Survey Design and Project Work Flow.** 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, which should describe the advanced geophysical classification process design and work flow in detail.

(Example) The MPCs established during Step 6 of the DQO process (documented in Worksheet #12) were used to develop the sample design, which is described in Worksheet #17. The sample design is broken down into a series of specific processes and data collection steps, termed DFW. Figure 17-1 provides a decision tree that will be used in the execution of the sample design, to evaluate the conformance of specific DFW to established MPC.

# QAPP Worksheet #12: Measurement Performance Criteria

**(UFP-QAPP Manual Section 2.6.2)**

This worksheet documents the project-specific MPC in terms of data quality indicators (DQI) (i.e., accuracy, sensitivity, representativeness, completeness, and comparability) for advanced geophysical classification projects.[[9]](#footnote-9) MPCs are the minimum performance specifications that the advanced geophysical classification survey design, including instruments and procedures, 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 detection survey, cued survey, and final DUAs will be conducted as documented on 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. The project-specific QAPP must explain and justify any changes to black text. An appendix may be used for this purpose.

| Table 12-1: Measurement Performance Criteria | | | |
| --- | --- | --- | --- |
| **Measurement Performance Activity (or DFW)** | **Data Quality Indicator** | **Specification** | **Activity Used to Assess Performance** |
| QC Seeding | Representativeness | Blind QC seeds will be placed at the site by the contractor. Blind QC seeds must be detectable as defined by the DQOs and located throughout the horizontal and vertical survey boundaries defined in the DQOs. [The blind seed plan should describe the number and types of blind QC seeds.] Blind QC seeds will be distributed such that the field team can be expected to encounter between one and three seeds per day per team. | Review of Production Area QC Seeding Report |
| Detection Survey | Completeness | 100% of the site is sampled. | Verification of conformance to measurement quality objectives (MQOs) for in-line spacing and cross-line spacing (see Worksheet #22) |
| Detection survey | Sensitivity | This worksheet must describe the project-specific detection threshold. (Example) A detection threshold of ≥1.7 mV/A and SNR ≥ 5 is required to detect a [37 mm projectile] lying horizontally at a depth of [0.3 m]. | Initial and ongoing Instrument Verification strip (IVS) surveys  Blind QC and validation seed detection  Analysis of background variability across the site |
| Detection survey | Accuracy/  Completeness | 100% of validation seeds must be detected. | Review of validation seed detection results per survey unit |
| Detection survey | Completeness/  Comparability | Complete project-specific databases and target lists delivered. | Data verification/data validation |
| Classification survey | Completeness/  Comparability | Library must include signatures for all munitions known or suspected to be present at the site, as listed in the CSM. | Verification of site-specific library |
| Classification survey | Representativeness/  Accuracy | Background data will be collected at least once every two hours of cued survey data collection. Background locations will be selected such that background data will be representative of the various subsurface conditions expected to be encountered within each survey unit at the site. | Data verification/data validation |
| Classification survey | Completeness | All detected anomalies classified as:   1. TOI 2. Non-TOI 3. Inconclusive | Data verification |
| Classification survey | Accuracy/  Completeness | Cued survey must correctly classify 100% of all validation seeds. | Review of validation seed classification results |
| Classification survey | Accuracy | 100% of predicted non-TOI that are intrusively investigated are confirmed to be non-TOI. | Visual inspection of recovered items from classification validation |
| Intrusive Investigation  (classification validation) | 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). | Visual inspection and qualitative evaluation of items recovered during classification validation |
| Intrusive Investigation | Completeness/  Comparability | Complete project-specific database including records reconciling inversion results to the physical properties of the recovered items. | Data verification  Data validation |

# QAPP Worksheet #13: Secondary Data Uses and Limitations

**(UFP-QAPP Manual Section 2.7)**

This worksheet should be used to identify sources of secondary data (i.e., data generated for purposes other than this specific project or data pertinent to this project generated under a separate QAPP) and summarize information relevant to their uses for the current project. This worksheet should describe specifically how all secondary data will be used. The project team needs to carefully evaluate the quality of secondary data (in terms of accuracy, sensitivity, representativeness, comparability, and completeness) to ensure they are of the type and quality necessary to support their intended uses. Examples of secondary data include the following: sampling and testing data collected during previous investigations, historical data, background information, interviews, modeling data, photographs, aerial photographs, topographic maps, and published literature. When evaluating the reliability of secondary data and determining limitations on their uses, consider the source of the data, the time period during which they were collected, data collection methods, potential sources of uncertainty, the type of supporting documentation available, and the comparability of data collection methods to the currently proposed methods. Examples are provided below.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 13-1: Secondary Data Uses and Limitations | | | |
| **Data type** | **Source** | **Data uses relative to current project** | **Factors affecting the reliability of data and limitations on data use** |
|  |  |  |  |
|  |  |  |  |
| Infrastructure locations |  |  |  |
| Range history |  |  |  |
| Munitions use and disposal |  |  |  |

# QAPP Worksheet #14/16: Project Tasks & Schedule

**(UFP-QAPP Manual Section 2.8.2)**

The QAPP should include a project schedule showing specific tasks, the person or group responsible for their execution, and planned start and end dates. The following template may be used or a Gantt chart can be attached and referenced. Examples of activities that should be listed include key on-site and off-site activities. Any critical steps and dates should be highlighted.

| Table 14-1: Project Tasks and Schedule | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **DFW** | **Activity** | **Responsible party** | **Planned start date** | **Planned completion date** | **Deliverable(s)** | **Deliverable due date** |
| 1 | Site Preparation |  |  |  |  |  |
| 2 | Seeding & IVS Construction |  |  |  |  |  |
| 3 & 4 | Detection Survey |  |  |  |  |  |
| 5 | Data Processing (Detection Phase) |  |  |  |  |  |
| 5 | Data Verification and Validation (Detection Phase) |  |  |  |  |  |
| 5 | Data Usability Assessment (Detection Phase) |  |  |  |  |  |
| 6 & 7 | Cued Survey |  |  |  |  |  |
| 8 | Validate Advanced Sensor Data |  |  |  |  |  |
| 9 | Conduct Data Processing |  |  |  |  |  |
| 10 | Anomaly Classification |  |  |  |  |  |
| 10 | Data Usability Assessment (Cued Phase) & Dig/no-Dig Decisions |  |  |  |  |  |
| 11 | Intrusive Investigation |  |  |  |  |  |
| 12 | Threshold Verification |  |  |  |  |  |
| 12 | Classification Validation |  |  |  |  |  |
| 13 | Data Usability Assessment (Final) |  |  |  |  |  |
| 13 | Final Report Preparation |  |  |  |  |  |

# QAPP Worksheet #17: Survey Design and Project Work Flow

**(UFP-QAPP Manual Section 3.1.1)**

This worksheet describes and justifies the design for both the detection and cued surveys. 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 work flow must include the following:

1. A map showing physical boundaries for the area(s) under study.
2. The basis for dividing the site into survey units.
3. A decision-logic diagram (See Figure 17-1 for an example)
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 Work Flow: This section should provide concise descriptions for each DFW and highlight 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. (In all cases, SOPs must be provided in an appendix to the project-specific QAPP.) Project teams may modify this work flow description to consolidate DFW or provide further break-down of DFW, as necessary to accommodate project-specific specifications.

DFW 1: Conduct site preparation (contractor and lead organization): Describe activities that must be completed prior to conducting site work (e.g., surface clearance, 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.

Documentation: Surface Sweep Technical Memorandum

[Example] Contractor: The contractor will conduct site preparation activities in the survey area as well as any areas needed for equipment ingress/egress. The contractor will conduct a surface sweep to remove all exposed or partially exposed metallic objects that are equal to or greater than 5.0 cm in length in any direction. The contractor will document the type, quantity, and estimated mass of objects removed. Following the lead organization’s inspection and acceptance 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 the Surface Sweep Technical Memorandum and visually inspect the site.

DFW 2: Conduct validation seeding, Quality Control (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 constructing the IVS, including the number, descriptions, depths, and orientation of targets. This step should reference the draft Verification and Validation Plan, which should be referenced on Worksheet #36 and provided as an appendix to the QAPP.

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

Documentation: QC Seeding Plan, IVS Plan, Draft Verification and Validation Plan

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.

Documentation: Instrument Assembly QC Checklist; IVS Memorandum

Decision point: Have MQOs been achieved?

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).

Documentation: Daily IVS Summaries; Daily QC Reports

DFW 5: Conduct data processing and document locations of anomalies (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. If using an advanced sensor for the detection survey and informed source selection (IFS), describe the procedure and criteria for eliminating anomalies from further consideration (e.g., evaluating dipole fit coherence and thresholds for size and decay rates). To verify the size and decay rate thresholds, identify an additional 200 anomalies below these thresholds to be included on the list of anomalies selected for cued data collection.

Lead organization: Because the cued data collection will be performed only at the locations of anomalies selected during this step, it is critical that the detection survey data validation be accepted by the lead organization, before the cued data collection begins. (Data validation is discussed in Worksheet #35). Once the lead organization has accepted the data validation report, the project team should conduct a detection survey DUA before proceeding to the cued phase. The DUA is discussed in Worksheet #37.

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, and Detection Survey DUA Report

Decision point: Is anomaly density acceptable for cued survey? Have MQO’s been achieved

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.

Documentation: Instrument Assembly Checklist; Cued Survey IVS Memorandum

Decision point: Have MQOs been achieved?

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.

Documentation: Daily IVS Summaries; Daily QC Reports

Decision point: Have MQOs been achieved?

DFW 8: Validate advanced sensor data (contractor and lead organization): Contractor: Describe the procedures for validating cued survey data prior to inversion. If using advanced anomaly selection, this would include the process for verifying the size and decay rate thresholds. The contractor typically conducts validation each day of data collection and generates a weekly QC report for review by the lead organization.

Lead organization: Review and accept weekly QC reports

Documentation: Database (raw data and metadata), Weekly QC Reports

Decision point: Have MQOs been achieved?

DFW 9: Conduct data processing (contractor): 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 inverting the data to generate polarizability decay curves that will be the basis for 1) library matching, 2) identifying clusters, and 3) predicting the size, shape, and wall thickness of buried objects.

Documentation: Database (Inversion Results)

Decision point: Have MQOs been achieved?

DFW 10: Classify anomalies and make dig/no-dig decisions (contractor and lead organization) Contractor: Describe procedures and factors considered in classifying anomalies. The classification process considers how well the signature matches the library data (Worksheet #22 contains specifications for library fit coherence). In cases where the signature does not match library data but appears to either 1) fit that of a cluster (i.e., numerous similar signatures consistent with a potential TOI not contained in the library) or 2) predict properties consistent with those of a munition, the contractor will use information in the CSM (e.g., site history and uses, and known types and distribution of munitions) to assist with the classification process.

Objects will be classified into one of the following three categories, and the project team will make a dig/no-dig decision on each:

1. TOI (Highly likely to be MEC);
2. Non-TOI (Highly unlikely to be MEC);
3. Inconclusive (Data cannot be analyzed).

Classified objects will be placed on a ranked anomaly list, arranged in order from highest likelihood the object is a TOI to highest likelihood the object is a non-TOI. Objects classified as inconclusive will be included on the ranked anomaly list as potential TOI, and therefore, they will be included on the Dig List.

The contractor identifies the threshold between TOI and non-TOI (i.e., the last TOI on the Dig List), and an additional 200 “threshold verification” targets to add to the Dig List. [Note: threshold verification targets are selected sequentially below the TOI/non-TOI threshold].

Lead organization: The lead organization reviews and accepts the classification results.

Project team: The project team conducts the cued survey DUA, selects the 200 classification validation targets, reviews the draft Verification and Validation Plan and makes changes as necessary. [Note: selection of the classification validation targets can be either random or judgmental.]

Documentation: TOI/non-TOI classification spreadsheet; library match results, figures and maps, Dig List, Cued Survey DUA Report, Final Verification and Validation Plan

Decision point: Are all QC seeds on the dig list? Are all validation seeds on the dig list correctly classified? Have MPCs been achieved?

DFW 11: 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 and the classification validation targets.

Documentation: Database of excavation results, photographs, weekly QC reports, disposal reports

DFW 12: Verify the threshold and verify recovered non-TOI validation targets are consistent with predictions based on advanced sensor data (contractor and project team): Describe procedures for comparing excavated objects against the classification spreadsheet. If necessary, adjust the TOI/non-TOI threshold. If necessary identify additional threshold verification and classification validation targets such that all 400 targets represent non-TOI targets on the ranked anomaly list below the final threshold.

Documentation: Comparison results

Decision point: Was the stop-dig threshold correct? Are all excavated objects consistent with predictions?

DFW 13: Conduct Final DUA: Briefly describe procedures to conduct the final DUA. (Refer to Worksheet #37 for detailed procedures.

Documentation: Updated CSM, Final DUA, Final Report

## Figure 17-1: Advanced Geophysical Classification Decision Tree







# QAPP 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. References to the applicable definable feature of work (DFW) and standard operating procedures must be included. Failure response must include a root cause analysis (RCA) to determine the appropriate CA. Examples are provided in blue text. Minimum recommended specifications are provided in black text. The rational for any changes to black text must be specifically identified, documented and concurred upon by the project team. An appendix may be used for this purpose.

| **Table 22-1**: Detection Survey (instrument: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Measurement Quality Objective** | **DFW/SOP Reference** | **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 Assembly checklist | RCA/CA: Make necessary adjustments, and re-verify |
| Initial Instrument Function Test  (TEMTADS)  (Instrument response amplitudes) |  | Once following assembly | Field Geophysicist/ Initial IVS Memorandum/ Project Geophysicist | Response (mean static spike minus mean static background) within 20% of predicted response for all transmit/receive (Tx/Rx) combinations | RCA/CA: Make necessary adjustments, and re-verify |
| Initial Instrument Function Test (MetalMapper) (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. |  | 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  (EM61) |  | Once following assembly | Field Geophysicist/ Initial IVS Memorandum/ Project Geophysicist | Response (mean static spike minus mean static background) within 20% of predicted response for all channels | RCA/CA: Make necessary adjustments, and re-verify |
| Initial detection survey positioning accuracy (IVS) [NAOC 101) |  | Once prior to start of detection survey data acquisition | Project Geophysicist/ IVS Memorandum/QC Geophysicist | Derived positions of IVS target(s) are within 25cm of the ground truth  locations | RCA/CA: Make necessary adjustments, and re-verify |
| Ongoing Instrument Function Test (Instrument response amplitudes)  (TEMTADS) |  | Beginning and end of each day and each time instrument is turned on | Field Team Leader/ running QC summary (Excel/Geosoft) /Project or QC Geophysicist | 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 |
| Ongoing Instrument Function Test (MetalMapper) |  | Beginning and end of each day and each time instrument is turned on | Field Team Leader/ running QC summary/Project or QC Geophysicist | 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 |
| Ongoing Instrument Function Test  (EM61) |  | Beginning and end of each day and each time instrument is turned on | Field Team Leader/ running QC summary/Project or QC Geophysicist | Response (mean static spike minus mean static background) within 20% of predicted response for all channels | RCA/CA: Make necessary repairs and re-verify |
| Ongoing detection survey positioning precision (IVS) |  | Beginning and end of each day | Project Geophysicist / running QC summary/QC Geophysicist | Derived positions of IVS target(s) within 25 cm of the average locations | RCA/CA |
| In-line measurement spacing  (TEMTADS) |  | Verified for each survey unit using [describe tool to be used] based upon monostatic Z coil data positions | Project Geophysicist/ running QC summary/ QC Geophysicist | 100% ≤ 0.20m between successive measurements | RCA/CA  CA assumption: data set fails, (recollect portions that fail) |
| In-line measurement spacing  (MetalMapper) |  | Verified for each survey unit using [describe tool to be used] based upon monostatic Z coil data positions | Project Geophysicist/ running QC summary/ QC Geophysicist | 100% ≤ 0.25m between successive measurements | RCA/CA |
| In-line measurement spacing  (EM61) |  | Verified for each survey unit using [describe tool to be used] based upon monostatic Z coil data positions | Project Geophysicist/ running QC summary/ QC Geophysicist | 100% ≤ 0.25m between successive measurements | RCA/CA |
| Coverage  (TEMTADS) |  | Verified for each survey unit using [describe tool to be used] based upon monostatic Z coil data | Project Geophysicist/running QC summary and survey unit validation report/QC Geophysicist | 100% at ≤0.7m cross-track measurement spacing (excluding site specific access limitations, e.g., obstacles, unsafe terrain) | RCA/CA |
| Coverage (MetalMapper) |  | Verified for each survey unit using [describe tool to be used] based upon monostatic Z coil data | Project Geophysicist/running QC summary and survey unit validation report/QC Geophysicist | 100% at ≤0.7m cross-track measurement spacing (excluding site specific access limitations, e.g., obstacles, unsafe terrain) | RCA/CA |
| Coverage  (EM61 using electronic positioning) |  | Verified for each survey unit using [describe tool to be used] based upon monostatic Z coil data | Project Geophysicist/running QC summary and survey unit validation report/QC Geophysicist | 100% at project design cross-track measurement spacing (excluding site specific access limitations, e.g., obstacles, unsafe terrain) | RCA/CA |
| Sensor Tx current (TEMTADS) |  | Per measurement | Field Team Leader/running QC summary/Project Geophysicist | Current must be ≥5.5A | RCA/CA: out of spec data rejected |
| Sensor Tx current (MetalMapper) |  | Per measurement | Field Team Leader/running QC summary/Project Geophysicist | Current must be ≥3.5A | RCA/CA: out of spec data rejected |
| Detection survey repeatability  (EM61) |  | Evaluated by survey unit | Project Geophysicist/running QC summary and survey unit validation report/QC Geophysicist | QC seed response must be >75% of minimum predicted response at geometric center of anomaly | RCA/CA |
| Detection survey performance |  | Evaluated by survey unit | QC Geophysicist/ survey unit validation report/ lead organization QA Geophysicist | All blind QC seeds must be detected and positioned within 40 cm radius of ground truth | RCA/CA |
| Valid position data |  | Per measurement | Field Team Leader/running QC summary/Project Geophysicist | GPS status flag indicates real-time kinematic (RTK) fix and dilution of precision (DOP) less than 4.0 | RCA/CA: Out-of-spec data rejected |
| Valid orientation data |  | Per measurement | Field Team Leader/running QC summary/Project Geophysicist | Orientation data reviewed and appear reasonable within bounds appropriate to site | RCA/CA: Unreasonable data rejected |
| Size and decay rate threshold verification  (when informed source selection is used) |  | Collect cued data from an additional 200 anomalies excluded on the basis of advanced anomaly selection | QC Geophysicist | Cued data analysis confirms100% of excluded anomalies are non-TOI | RCA/CA |

| **Table 22-2**: Cued Survey (instrument: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_; classification tool: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Measurement Quality Objective** | **DFW/SOP Reference** | **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 instrument assembly checklist | RCA/CA: Make necessary adjustments, and re-verify |
| Initial sensor function test (TEMTADS) |  | Once following assembly | Field Team Leader/ instrument assembly checklist/Project Geophysicist | Response (mean static spike minus mean static background) within 20% of predicted response for all Tx/Rx combinations | RCA/CA: make necessary repairs/ adjustments and re-verify |
| Initial instrument function test (MetalMapper) (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 |  | 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 repairs/ adjustments and re-verify |
| Initial IVS background measurement and background verification (five background measurements, one centered at the flag and one offset at least ½ sensor spacing in each cardinal direction) |  | Once during initial system IVS test | Field Team Leader/ Initial IVS memorandum/ Project Geophysicist | All five measurements (decay amplitude) within the noise level of each other and library match from all four offset measurements >0.9 | RCA/CA: reject/replace BG location |
| Initial derived polarizabilities accuracy (IVS) |  | Once during initial system IVS test | Project Geophysicist/ Initial IVS memorandum/ QC Geophysicist | Library Match metric ≥ 0.9 for each set of inverted polarizabilities | RCA/CA |
| Derived target position accuracy (IVS) |  | Once during initial system IVS test | Project Geophysicist/ Initial IVS Memorandum/QC Geophysicist | All IVS item fit locations within 0.25m of ground truth locations | RCA/CA |
| Ongoing derived polarizabilities precision (IVS) |  | Beginning and end of each day as part of IVS testing | Project Geophysicist/ tracking summary/QC Geophysicist | Library Match to initial polarizabilities metric ≥ 0.9 for each set of three inverted polarizabilities | RCA/CA |
| Ongoing derived target position precision (IVS) |  | Beginning and end of each day as part of IVS testing | Project Geophysicist/ tracking summary/QC Geophysicist | All IVS items fit locations within 0.25m of average of derived fit locations | RCA/CA |
| Initial measurement of production area background locations and background verification (five background measurements: one centered at the flag and one offset at least ½ sensor spacing in each cardinal direction) |  | Once per background location | Field Team Leader/ background location report/Project Geophysicist | All five measurements (decay amplitude) within the noise level of each other and library match from all four offset measurements >0.9 | RCA/CA: reject BG location and find alternate |
| Ongoing production area background measurements |  | Background data collected a minimum of every two hours during production | Field Team Leader/failures noted in field log and tracking summary/Project Geophysicist | Original and ongoing measurements at each location differ by a factor of five or less. | RCA/CA: document environmental changes. Project Geophysicist must approve before proceeding. |
| Ongoing instrument function test  (TEMTADS) |  | Each time instrument is restarted | Field Team Leader/tracking summary/Project Geophysicist | 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 |
| Ongoing instrument function test (MetalMapper) |  | Each time instrument is turned on | Field Team Leader/ tracking summary/ Project Geophysicist | Response within 20% of predicted response | RCA/CA: Make necessary repairs and re-verify |
| Transmit current levels (TEMTADS) |  | Evaluated for each sensor measurement | Field Team Leader/ tracking summary/ Project Geophysicist | Current must be ≥5.5A | RCA/CA: stop data acquisition activities until condition corrected |
| Transmit current levels (MetalMapper) |  | Evaluated for each sensor measurement | Field Team Leader/ tracking summary/ Project Geophysicist | Current must be ≥3.5A | RCA/CA: stop data acquisition activities until condition corrected |
| Confirm all background measurements are valid |  | Evaluated for each background measurement | Project Geophysicist/ Background summary/ QC Geophysicist | Ensure background variation does not impact ability to classify correctly | RCA/CA: BG measurement rejected and removed from active BG measurements |
| Confirm adequate spacing between units (TEMTADS) |  | Evaluated at start of each day (or grid) | Field Team Leader/ Field Logbook/  Project Geophysicist | Minimum separation of 50m | RCA/CA: Recollect all coincident measurements |
| Confirm adequate spacing between units (MetalMapper) |  | Evaluated at start of each day (or grid) | Field Team Leader/ Field Logbook/  Project Geophysicist | Minimum separation of 25m | RCA/CA: Recollect all coincident measurements |
| Confirm inversion model supports classification (1 of 3) |  | Evaluated for all models derived from a measurement (i.e. single item and multi-item models) | Project Geophysicist/ Measurement  QC summary/  QC Geophysicist | Derived model response must fit the observed data with a fit coherence ≥ 0.8[[10]](#footnote-10) | Follow procedure in SOP or RCA/CA |
| Confirm inversion model supports classification (2 of 3) |  | Evaluated for derived target | Project Geophysicist/ Measurement  QC summary/  QC Geophysicist | Fit location estimate of item ≤ 0.4m from center of sensor | Follow procedure in SOP or RCA/CA |
| Confirm inversion model supports classification (3 of 3) |  | Evaluated for all seeds | QC Geophysicist/ Measurement  Inversion model QC summary/lead organization QA Geophysicist | 100% of predicted seed positions ≤ 0.25m radially from known position (x, y). Z ≤ .15m). | RCA/CA |
| Confirm reacquisition GPS precision |  | Daily | UXO tech or field tech/ Daily QC Report/ Project Geophysicist | Benchmark positions repeatable to within 10cm | RCA/CA |
| Classification performance |  | Evaluated for all seeds | QC Geophysicist; USACE QA Geophysicist/  Ranked Dig List/  USACE QA Geophysicist | 100% of QC and validation seeds placed on dig list | RCA/CA |

| **Table 22-3**: Intrusive Investigation | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Measurement Quality Objective** | **DFW/SOP Reference** | **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 | Project Geophysicist/  Measurement QC Summary or intrusive database/QC Geophysicist | 100% of recovered (excluding inconclusive category) item positions ≤ 0.25m from predicted position (x, y). | RCA/CA |
| Confirm derived features match ground truth (2 of 2) |  | Evaluated for all recovered items | UXO Dig Team/ Dig List and intrusive database/  Project or QC Geophysicist | 100% of recovered object size estimates (excluding inconclusive category) qualitatively match predicted size | RCA/CA |
| Verification of TOI/non-TOI threshold |  | Dig 200 anomalies beyond last TOI on Dig List | Project Geophysicist/ Verification and Validation Report/QC Geophysicist | 100% of predicted non-TOI intrusively investigated are non-TOI | RCA/CA. Adjust threshold |
| Classification validation |  | Random selection of 200 non-TOI | Project Geophysicist/  Verification and Validation Report/ QC Geophysicist | 100% of predicted non-TOI qualitatively matches predicted size/shape | RCA/CA. Document in DUA |

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

**(UFP-QAPP Manual Section 3.5.1)**

This worksheet provides 1) minimum specifications for all data management tasks and deliverables, and 2) procedures for controlling project documents, records, and databases. Where applicable, specific versions or dates of software used should be documented. Its purpose is to ensure data completeness, data integrity, traceability and ease of retrieval.

**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 on CD-ROM or as specified by the DoD client. Data management and backup must be performed in accordance with the contractor’s documented quality system.

TOI Library: This worksheet must document the version (date) of the DoD TOI library used and describe or reference procedures to be used to update the library. The TOI library used must be included in data deliverables.

**Part 2: Control of Documents, Records, and Databases**

| Table 29-1: Minimum Required Documents and Records | | | |
| --- | --- | --- | --- |
| **Document/Record** | **Purpose** | **Completion/**  **Update Frequency** | **Format/**  **Storage Location/**  **Archive Requirements** |
| Site Manager Log |  |  |  |
| Quality Control (QC) Seed Plan |  |  |  |
| QC Firewall Plan |  |  |  |
|  |  |  |  |
| Daily QC Reports |  |  |  |
| Weekly Geophysical QC Report |  |  |  |
| Team Leader Log(s) |  |  |  |
| Field Change Request Form |  |  |  |
| Root Cause Analysis |  |  |  |
| Photograph Log |  |  |  |
| Production Area QC Seeding Report |  |  |  |
| Surface Sweep Technical Memorandum |  |  |  |
| Land Survey/Control Point Data Report |  |  |  |
| Instrument Verification Strip (IVS) Technical Memorandum |  |  |  |
| SOP Checklists |  |  |  |
| Seed Tracking Log |  |  |  |
| Data Usability Assessments (detection survey, cued survey and final DUA) |  |  |  |
| Target Selection Technical Memorandum |  |  |  |
| Final Ranked Dig List |  |  |  |
| Reacquisition Results |  |  |  |
| Intrusive Investigation Results |  |  |  |
| Anomaly Resolution Results |  |  |  |
| Digital Geophysical Mapping (DGM) Data Deliverable |  |  |  |
| DGM QC Deliverable |  |  |  |
| Supporting Classification Images |  |  |  |

# QAPP 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 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 (DFW 1-2)
2. Detection survey (DFW 3-5)
3. Cued survey (DFW 6-10)
4. Intrusive investigation (DFW 11-13)

[Example] For each group of related activities, assessment activities will occur during the following phases:

Preparatory Phase: Comprises the planning and design process leading up to field activities. The UXOQCS will perform a Preparatory Phase assessment before beginning each group of activities. The purpose of this assessment is to review applicable specifications and plans to verify that the necessary resources, conditions, and controls are in place and comply with specifications before field work begins.

Initial Phase: Occurs at the startup of field activities. The purpose of this phase is to check preliminary work for compliance with specifications, check for omissions, and resolve differences of interpretation.

Follow-up Phase: Covers the routine, day-to-day activities at the site. One or more follow-up assessments will be conducted during each related group of activities, depending on the duration of field activities, and the nature of any assessment findings.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 31-1**: Assessment Schedule | | | | | | | | | |
| **Assessment Type** | | **Responsible Party** | | **Schedule/Frequency** | | **Assessment Deliverable** | | **Deliverable due date** | |
| Site Preparation  Preparatory phase | |  | |  | | Preparatory Phase Inspection Checklist | |  | |
| Site Preparation  Initial phase | |  | |  | | Initial Phase Inspection Checklist | |  | |
| Site Preparation  Follow-up phase | |  | |  | | Follow-up Phase Inspection Checklist | |  | |
| Detection Survey  Preparatory phase | |  | |  | |  | |  | |
| Detection Survey  Initial phase | |  | |  | |  | |  | |
| Detection Survey  Follow-up phase | |  | |  | |  | |  | |
| Cued Survey  Preparatory phase | |  | |  | |  | |  | |
| Cued Survey  Initial phase | |  | |  | |  | |  | |
| Cued Survey  Follow-up phase | |  | |  | |  | |  | |
| Intrusive Investigation  Preparatory phase | |  | |  | |  | |  | |
| Intrusive Investigation  Initial phase | |  | |  | |  | |  | |
| Intrusive Investigation  Follow-up phase | |  | |  | |  | |  | |
| **Table 31-2**: Assessment Response and Corrective Action | | | | | | | | | | |
| **Assessment Type** | **Responsibility for responding to assessment findings** | | **Assessment Response Documentation** | | **Timeframe for Response** | | **Responsibility for Implementing Corrective Action** | | **Responsible for monitoring**  **Corrective Action implementation** | |
| Site Preparation  All phases |  | |  | |  | |  | |  | |
| Detection Survey  All phases |  | |  | |  | |  | |  | |
| Cued Survey  All phases |  | |  | |  | |  | |  | |
| Intrusive Investigation  All phases |  | |  | |  | |  | |  | |

# QAPP Worksheet #34: Data Verification, Validation, and Usability Inputs

**(UFP-QAPP Manual Section 5.2.1 and Table 9)**

This worksheet is used to list the inputs that will be used during data verification, validation, and usability assessment. Inputs include all requirements documents (e.g. contracts, SOPs, planning documents), field records (both hard-copy and electronic), and interim and final reports. Data verification is a completeness check that all specified activities involved in data collection and processing have been completed and documented and that the necessary records (objective evidence) are available to proceed to data validation. Data validation is a detailed evaluation of data for conformance to stated requirements, e.g., those contained in the contract, SOPs and Worksheet #22. The data usability assessment is an evaluation of the data set making up a delivery unit, to determine whether the data support their intended uses. It is an evaluation of conformance to the MPCs presented in Worksheet #12. Examples of requirements documents as well as records subject to verification and validation are listed below in blue text.

**Requirements/Specifications:**

Contract No. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Quality Assurance Project Plan, (Title)

SOPs (see Appendix \_\_)

| Table 34-1 Data Verification, Validation and Usability Inputs | | | |
| --- | --- | --- | --- |
| **Description** | **Verification**  **(completeness)** | **Validation**  **(conformance to specifications)** | **Usability**  **(achievement of DQOs and MPCs)** |
| QC Seeding Records | **X** | **X** |  |
| Surface Sweep Seeding QC Checklist | **X** | **X** |  |
| Production Area Seeding QC Checklist | **X** | **X** |  |
| Field logbooks | **X** |  |  |
| Photographs | **X** |  |  |
| Instrument Assembly Checklist (Detection Survey) | **X** | **X** |  |
| Sensor Function Test Results (Detection Survey) | **X** | **X** |  |
| IVS Construction Details | **X** | **X** |  |
| IVS Checklists (Detection Survey) | **X** |  |  |
| Detection Survey Data Collection QC Checklist | **X** | **X** |  |
| Detection Survey Data Processing QC Checklist | **X** | **X** |  |
| Digital Field Notes | **X** |  |  |
| Daily QC Reports | **X** |  |  |
| Instrument Assembly Checklist (Cued Survey) | **X** | **X** |  |
| Sensor Function Test Results (Cued Survey) | **X** | **X** |  |
| IVS Checklists (Cued Survey) | **X** | **X** |  |
| Cued Data Collection QC Checklist | **X** | **X** |  |
| Cued Data Processing QC Checklist | **X** | **X** |  |
| Raw data files (EMI, GPS, and IMU) | **X** | **X** |  |
| Converted data files | **X** | **X** |  |
| Data Processing Log (Detection Survey) | **X** |  |  |
| Digital Field Notes | **X** |  |  |
| Mapped Detection Metric Data | **X** | **X** |  |
| Target Anomaly List | **X** | **X** |  |
| Final Data Archive (for each delivered area subset) | **X** | **X** |  |
| Cued Measurement Data (Target Measurement Data, Background Measurement Data, and Target Features Database) | **X** | **X** |  |
| Classification Images (pdf files) |  |  |  |
| Production Area Seed Report |  |  | **X** |
| IVS Memorandum (Detection Survey) |  |  | **X** |
| Detection Survey Data Processing Letter Report (data validation report) |  |  | **X** |
| IVS Memorandum (Cued Survey) |  |  | **X** |
| Site-specific library |  |  | **X** |
| Cued Survey QC Report (data validation report) |  |  | **X** |
| Prioritized Target List |  |  | **X** |
| Target Classification Report |  |  | **X** |
| Revised Validation Plan |  |  | **X** |
| Final Validation Plan |  |  | **X** |

# QAPP 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/electronic files | QAPP | 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 | SOP X | Instrument Assembly has completed according to SOP X. MQOs have been achieved, with any exceptions noted. If appropriate, corrective actions have been completed. Signatures and dates are present. | Project Geophysicist | SOP X Checklist  Daily QC Report |
| Initial IVS Survey | SOP X | Initial IVS Survey has been conducted according to SOP X. Checklist X 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 X Checklist  Daily QC Report |

# QAPP Worksheet #36: Advanced Geophysical Classification Validation

This worksheet documents procedures that will be used to validate the overall anomaly detection and classification approach as it is implemented at a specific site. The purpose of classification validation is to provide added confidence in the ability of the sample design to 1) select anomalies meeting the project-specific detection threshold for further investigation, and 2) correctly classify anomalies to distinguish between TOI and non-TOI. This worksheet can either include the draft Verification and Validation Plan, or reference it and include it in an appendix. The draft Verification and Validation Plan is finalized following cued data processing.

The validation approach involves testing the thresholds for both anomaly detection and anomaly classification in two ways: 1) Placing “blind” validation and QC seeds at the site before the project begins, to confirm that the seeds can be detected and correctly classified; 2) Conducting “threshold verification”, i.e., the excavation of additional targets (non-TOI) just beyond the thresholds used for detection and classification, to verify selection of the appropriate threshold; , and 3) Conducting classification validation, which involves a qualitative evaluation of how well the classification process predicted physical properties of the non-TOI. Classification validation is conducted at the end of the project, following the intrusive investigation. The results of classification validation will be considered during the data usability assessment described in Worksheet #37.

**Classification validation approach:**

[Example] The draft Verification and Validation Plan is included in Appendix \_ to this QAPP. The draft Verification and Validation Plan describes how each of the decision-making thresholds for detection and classification will be tested and identifies how anomalies will be selected for the threshold verification and classification validation. It addresses the contractor’s QC seeding plan, threshold verification, and classification validation. [Note: The placement of validation seeds is addressed in the lead organization’s Quality Assurance Surveillance Plan.] The number, type, and placement of QC seeds depend on project-specific DQOs. The final number and distribution of threshold verification targets and classification validation targets depends on the DQOs, as well as actual performance in the field against established MPCs. For that reason, the validation approach evolves as the project is implemented.

# QAPP Worksheet #37: Data Usability Assessment (DUA)

**(UFP-QAPP Manual Section 5.2.3 including Table 12)**

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 data collection activities for each phase of investigation (i.e., the detection survey, the cued survey, and the intrusive 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. Since payment may be tied to the completion of a delivery unit, the establishment of delivery units usually will be negotiated during contracting.] The DUA uses the outputs from data verification and data validation, including the Final Classification Validation Report).

The different phases of the DUA involves a qualitative and quantitative evaluation of environmental data for the detection phase, cued phase, and intrusive investigation, to determine if the project data are of the right type, quality, and quantity to support the MPCs and DQOs specific to that phase of the investigation. 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.

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.

DoD RPM

Project Manager

Project QA Manager

Project Geophysicist

QC Geophysicist

Field Geophysicist (Lead)

Identify documents used as input to each phase of the 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

Describe how the usability assessment will be documented: 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.

|  |  |
| --- | --- |
| **Step 1** | **Review the project’s objectives and sampling design**  *Review the data quality objectives. Are underlying assumptions valid? Were the project boundaries appropriate? Review the sampling design as implemented for consistency with stated objectives. Were sources of uncertainty accounted for and appropriately managed? Summarize any deviations from the planned sample design.* |
| **Step 2** | **Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12**  *Review the site-specific project library for completeness. 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. Evaluate conformance to MPCs documented on Worksheet #12. Summarize the impacts of non-conformances on data usability.* |
| **Step 3** | **Document data usability, update the CSM, and draw conclusions**  *Determine if the data can be used as intended, considering implications of deviations and corrective actions. Assess the performance of the sampling design and Identify any limitations on data use. For the detection survey and cued survey DUAs, determine whether the data are suitable for proceeding to the next phase. Update the conceptual site model and document conclusions.* |
| **Step 4** | **Document lessons learned and make recommendations**  *Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for future delivery units at the site, or future investigations. Prepare the data usability summary report.* |

1. Resumes should be included in an appendix. [↑](#footnote-ref-1)
2. This column should include any State-specific requirements. [↑](#footnote-ref-2)
3. Resumes should be included in an appendix [↑](#footnote-ref-3)
4. This column should include any State-specific requirements [↑](#footnote-ref-4)
5. Project teams should determine what constitutes minor and major QAPP changes during project planning. [↑](#footnote-ref-5)
6. A survey unit is a portion of the site for which geophysical survey data, including QC results and results for blind QC seeds and validation seeds, will be collected, verified, validated, and reported as a unit, for evaluation by the project team. (It is analogous to an analytical batch in chemical testing). The survey unit is not necessarily a geographically contiguous unit, and survey units for the detection phase may or may not be the same as those for the cued phase. The survey units should be designed such that data reporting and evaluation occurs at regular intervals as agreed upon during project planning.

   A delivery unit is a portion of the site, consisting of one or more survey units, for which data verification, data validation, and the data usability assessment have been conducted. Contracting documents normally will establish the specifications for delivery units. [↑](#footnote-ref-6)
7. Guidance on Systematic Planning Using the Data Quality Objectives Process, U.S. EPA, EPA QA/G-4, February 2006 [↑](#footnote-ref-7)
8. Technical Project Planning Process, U.S. Army Corps of Engineers, EM 200-1-2, August 1998 [↑](#footnote-ref-8)
9. See Glossary for definitions of the data quality indicators. [↑](#footnote-ref-9)
10. Fit coherence is defined as the square of the correlation coefficient between data and model [↑](#footnote-ref-10)