Pond 16 Impact Area MRA
Geophysical Anomaly Investigation
Technical Information Paper
Former Fort Ord, California

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Prepared for

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List of Acronyms

AGCMR	Advanced Geophysical Classification for Munitions Response
AR	Administrative Record
Army	United States Department of the Army
BLM	United States Bureau of Land Management
DGM	Digital Geophysical Mapping
FP	False Positive
FWV	Field Work Variance
KEMRON	KEMRON Environmental Services, Inc.
MEC	Munitions and Explosives of Concern
MD	Munitions Debris
MM2x2	MetalMapper 2x2
MPPEH	Material Potentially Presenting an Explosive Hazard
MRA	Munitions Response Area
MRS	Munitions Response Site
mV	millivolt
OD	Other Debris
OESS	Ordnance and Explosives Safety Specialist
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action
RD	Remedial Design
ROD	Record of Decision
SSWP	Site-Specific Work Plan
SUXOS	Senior Unexploded Ordnance Supervisor
TIP	Technical Information Paper
TOI	Targets of Interest
USACE	United States Army Corps of Engineers
UXO	Unexploded Ordnance

1.0 Introduction

This Technical Information Paper (TIP) describes the Geophysical Anomaly Investigation of Vernal Pond 16 performed by KEMRON Environmental Services, Inc. (KEMRON), with Gilbane as a subcontractor. This work was performed in October 2018. Vernal Pond 16 lies in Munitions Response Site (MRS)-Bureau of Land Management (BLM) Unit 13 (Unit 13), which is located within the Impact Area Munitions Response Area (MRA) at the former Fort Ord, California. Figure 1 shows the location of Vernal Pond 16 in the Impact Area MRA.

1.1 Purpose and Scope

This document presents the results of a MetalMapper 2x2 (MM2x2) evaluation of selected targets located within the footprint of Vernal Pond 16, and subsequent intrusive investigation of selected anomalies. Anomalies that potentially represented Munitions and Explosives of Concern (MEC) items within the footprints of Vernal Pond 16 were removed to allow safe access during biological surveys. Wetland monitoring requires that biologists enter the inundated areas when the visibility of the surface is obstructed by water and there is a potential for subsurface disturbance. The *Final Record of Decision Impact Area Munitions Response Area Track 3 Munitions Response Site Former Fort Ord, California* [Track 3 ROD; United States Department of the Army (Army), 2008] requires construction support for ground-disturbing or intrusive activities. Construction support and anomaly avoidance are impractical to support access to Vernal Pond 16. To make Vernal Pond 16 safe for biological surveys, the decision was made to conduct subsurface removal of MEC within the pond boundaries.

Any negative impact to this vernal pond could affect the habitat value for endangered species that might use the pond. To minimize impacts to the sensitive habitat within Vernal Pond 16, advanced geophysical classification techniques were utilized to reduce the number of intrusive investigations. Procedures for intrusive investigations were developed and implemented to maintain the integrity of the vernal pool. Anomaly investigations were minimized and standard procedures followed to maintain the integrity of Vernal Pond 16. Section 3.3 and Appendix A provide further detail regarding these procedures.

1.2 Approval Documents

The Investigation within Vernal Pond 16 occurred under the following:

- Track 3 ROD (Army, 2008),
- *Final Work Plan, Remedial Design (RD)/Remedial Action (RA) Track 3 Impact Area Munitions Response Area (MRA) Munitions and Explosives of Concern (MEC) Removal Former Fort Ord, California* [Final RD/RA Work Plan; United States Army Corps of Engineers (USACE), 2009],
- *Final Site-Specific Work Plan Munitions and Explosives of Concern Remedial Action Non-Burn Areas Former Fort Ord, California* [Final Non-Burn SSWP; Shaw Environmental, Inc., (Shaw) 2010], and
- *Field Work Variance 022 to the Final Site-Specific Work Plan Munitions and Explosives of Concern Remedial Action Non-Burn Areas Former Fort Ord, California* (FWV 022; KEMRON, 2018), which is included in Appendix A.

2.0 Site Background

2.1 Background

The Impact Area MRA at the former Fort Ord, California contains vernal ponds that frequently fill with water during the winter months. Vernal ponds on the former Fort Ord provide breeding habitat for the California fairy shrimp and the federally and state threatened California tiger salamander. Monitoring for these species and other biological resources requires that biologists enter the inundated areas when the visibility of the surface is obstructed by water and there is a potential for subsurface disturbance. To make Vernal Pond 16 safe for biological surveys, the decision was made to conduct subsurface removal of MEC within the pond boundaries. Removal of MEC is not feasible when water is present in the ponds. Vernal ponds generally retain water throughout much of the year; however, 2016 was a particularly dry year. To take advantage of dry conditions in 2016, a Digital Geophysical Mapping (DGM) survey occurred in Pond 16 using an EM61. The EM61 data was used to select anomalies for a limited-scope subsurface MEC removal in the fall of 2018 when the pond was sufficiently dry. Due to the sensitive nature of these resources and the

habitat they provide, a person-portable EM61 was used to collect DGM data in order to minimize impacts on the vernal pond environments. Data collection was completed in accordance with standards outlined in the *Final Quality Assurance Project Plan Former Fort Ord, California Volume II Appendix A Munitions and Explosives of Concern Remedial Action* (KEMRON, 2016a).

2.2 Site Location

Vernal Pond 16 is located within Unit 13 in the southeastern portion of the Impact Area MRA, east of Impossible Canyon Road. Figure 1 shows the location of Vernal Pond 16.

3.0 Overview of Investigation

3.1 Geophysical Approach

DGM survey of Vernal Pond 16 was conducted with an EM61 in the fall of 2016. This time period was specifically selected in order to maximize the amount of DGM coverage when Vernal Pond 16 was expected to be dry. The investigation area was delineated by the project biologist based upon the types of vegetation known to be present within vernal ponds. The DGM survey utilized a person-portable single-coil EM61 to minimize disturbance to the vernal pond habitat. A determination was made by the Senior Unexploded Ordnance Supervisor (SUXOS) and Ordnance and Explosives Safety Specialist (OESS) that the survey of the investigation area could proceed prior to surface MEC removal. The project geophysicist verified that data collected during the DGM survey met the Category A DGM data standard. The Category A DGM data standard must be met for performance of DGM-based subsurface MEC removal. Following completion of the DGM survey, a target list based on a 14-millivolt (mV) threshold was developed.

In order to reduce impact to the vernal pond habitat, anomalies detected with the single-coil EM61 were further evaluated with the MM2x2 advanced electromagnetic induction (EMI) system to discern potential targets of interest (TOI) prior to intrusive investigation. This phase of work was conducted in accordance with the *Quality Assurance Project Plan Superfund Response Actions Former Fort Ord, California Volume II Munitions Response Appendix B Advanced Geophysical Classification for Munitions Response Quality Assurance Project Plan* (AGCMR-QAPP;

KEMRON, 2016b). The MM2x2 classification survey was conducted in the fall of 2018 by placing the MM2x2 directly over each EM61 detected anomaly location and acquiring static data. The acquired data was processed through an inversion modeling routine to estimate the intrinsic parameters of each anomaly source, and the results were compared to the known parameters of MEC items in the classification library. Each anomaly was ranked according to its likelihood of being a TOI.

Category 0: Cannot Analyze
Category 1: High-confidence TOI
Category 2: Inconclusive
Category 3: High-confidence Non-TOI

As outlined in the Final Non-Burn SSWP (Shaw, 2010), classified targets were selected for intrusive investigation as follows:

Category	Level of Investigation
Category 0 (Cannot analyze)	Target remained on dig list. These locations were checked with a handheld metal detector prior to intrusive investigation. If a signal of appropriate strength was detected, the target was dug to a depth of up to 18 inches. If no signal was detected or an insufficient signal was present, the target was identified as false positive.
Category 1 (High-confidence TOI)	Intrusively investigated (no maximum depth of investigation).
Category 2 (Inconclusive)	Targets were intrusively investigated up to a depth of 18 inches.
Category 3 (High-confidence Non-TOI)	Not investigated.

Some low-amplitude targets from the EM61 data were not detected with the MM2x2. Although the sources of these detected anomalies may have been removed between the EM61 DGM survey conducted in the fall of 2016 and the MM2x2 classification survey in the fall of 2018, these items

remained on the dig list for investigation. It is likely that the low-amplitude targets from the EM61 data had been removed from the surface during a surface MEC sweep that occurred following the EM61 DGM Survey and prior to the MM2x2 classification survey. In order to verify that the anomaly source was no longer remaining, it was determined that the intrusive investigation team would first check these locations with a handheld metal detector. If no subsurface metal was detected, anomaly source removal was considered confirmed and the investigation was considered complete at the location in question. Verification of anomaly resolution for all these anomalies was completed by the Quality Control (QC) Geophysicist with a person-portable EM61. These anomalies are notated as False Positives (FP) in Table 1. Intrusive investigation of MM2x2 Category 0 and Category 2 targets continued until the anomaly source was recovered or the excavation reached a depth of 18 inches below ground surface. Category 1 targets were investigated below 18 inches. For Category 0 and Category 2 TOIs, a maximum investigation depth of 18 inches was considered more than adequate to allow for the expected shallow soil disturbance during biological surveys.

The results of the digs are included in Table 1. A total of five Category 1 targets were investigated below 18 inches. The determination to excavate these targets below 18 inches was made based on the concentration and types of MEC items removed during surface removal activities. A total of four targets where the excavation ended when the depth of 18 inches below ground surface was reached are annotated as Unknown. Additionally, five targets were determined to be from another anomaly in the dig list. These anomalies are notated as Same Anomaly in Table 1. Figure 2 shows the results of the intrusive investigation performed at Vernal Pond 16.

3.2 MEC/MD/OD Removed During the Investigation

During the course of the investigation at Vernal Pond 16, a total of seven material potentially presenting an explosive hazard (MPPEH) items were removed from the subsurface. Two of the items were ultimately determined to be MEC (UXO). A total of 75.5 pounds of munitions debris (MD) and a total of 142.25 pounds of other debris (OD) were removed during the course of the investigation. MD and metallic OD were stockpiled onsite for ultimate recycling. Non-metallic OD was disposed of at the local municipal landfill. The results of intrusive activities performed during the investigation are included in Table 1.

3.3 Maintaining Clay Layer During Investigation

The *Wetland Monitoring and Restoration Plan for Munitions and Contaminated Soil Remedial Activities at Former Fort Ord* (Burleson Consulting, Inc., 2006) describes the requirements to mitigate impacts on wetland habitats associated with remedial activities. The extent of disturbance to wetland soils and hydrology resulting from MEC removal depends on both the depth to which soils are removed and the water-holding properties of the soils. An investigation was conducted to map the subsurface structure of a subset of the vernal ponds, which determined the depth to confining clay layers and estimated heterogeneity of soil layering that promotes retention of the water in the ponds [*Ground-Penetrating Radar Investigation of Vernal Ponds in BLM Area B at Former Fort Ord, Monterey, California* (USACE, 2019)]. If the properties of water retention were to be altered as a result of loss of the bedding properties of the ponds, this would have adverse effects on the wetland function. In order to cause the least disturbance of the confining clay layers, anomaly investigations were minimized in lateral dimension. Procedures outlined in detail in Appendix A were followed with the exception of excavating Category 1 targets past 18 inches as described in Section 3.1.

4.0 Quality Control/Quality Assurance

Quality standards for MM2x2 data collection and classification were met and are described in the AGCMR-QAPP (KEMRON, 2016b). The intrusive investigations of selected targets were conducted in accordance with *SOP AGCMR-09, Anomaly Reacquisition and Intrusive Investigation*, as modified by the SOP attached to FWV 022 (KEMRON, 2018) included in Appendix A.

One QC seed was placed, located and removed from Vernal Pond 16 during this investigation. All quality standards for the geophysical anomaly investigation at Vernal Pond 16 were met.

5.0 Environmental Protection

During MEC removal activities at Vernal Pond 16, specific habitat avoidance and minimization measures were followed. Specific measures included; 1) conducting MEC removal work as

described in Attachment 1 to FWV 022 (KEMRON, 2018) included in Appendix A, and 2) avoiding work while the pond was inundated, Prior to the start of MEC removal activities the project biologist flagged the boundaries of the pond to exclude masticators and other heavy equipment from working within 50 feet of the investigation area. Only small mechanical equipment such as a bobcat or manual equipment was used to remove vegetation when necessary.

6.0 Conclusion

The investigation performed in Vernal Pond 16 was consistent with the Track 3 RD/RA Work Plan (USACE, 2009), the Track 3 ROD (Army, 2008), the Final Non-Burn SSWP (Shaw, 2010), and FWV 022 (KEMRON, 2018), which is included in Appendix A. No conditions contrary to these documents were encountered at the site.

Figure 3 shows the DGM survey area for Vernal Pond 16 and the pond inundation area of Vernal Pond 16 in 2017, which was a relatively wet year with the inundation area larger than the survey area. Figure 3 also shows inundation of Pond 16 in a below normal water year. Vernal Pond 16 is determined to be safe for biological surveys to the extent of the investigation footprint shown on Figure 3. If biological surveys are planned outside the investigation footprint during wet conditions, the USACE Ordnance and Explosives Safety Specialist and UXO Safety Officer should be consulted for site specific best practices before undertaking field work.

The anomaly investigation for the project area is complete. All subsurface MEC investigation areas passed QC/QA.

Anomalies that potentially represented MEC items within the investigation footprint of Vernal Pond 16 were removed to allow safe access during biological surveys. Biological surveys in Vernal Pond 16 within the investigation footprint may occur without construction support or anomaly avoidance.

7.0 References

Burleson Consulting Inc., 2006. *Wetland Monitoring and Restoration Plan for Munitions and Contaminated Soil Remedial Activities at Former Fort Ord.* (Administrative Record [AR]# BW-2453)

KEMRON Environmental Services, Inc. (KEMRON), 2016a. *Final Quality Assurance Project Plan Former Fort Ord, California Volume II Appendix A Munitions and Explosives of Concern Remedial Action.* (AR# OE-0884A)

KEMRON, 2016b. *Quality Assurance Project Plan Superfund Response Actions Former Fort Ord, California Volume II Munitions Response Appendix B Advanced Geophysical Classification for Munitions Response Quality Assurance Project Plan.* (AR# OE-0868B)

KEMRON, 2018. *Field Work Variance 022 to the Final Site-Specific Work Plan, Munitions and Explosives of Concern Remedial Action, Non-Burn Areas, Former Fort Ord, California.* (AR# OE-0685D.15)

Shaw Environmental, Inc. (Shaw), 2010. *Final Site-Specific Work Plan Munitions and Explosives of Concern Remedial Action Non-Burn Areas Former Fort Ord, California*. (AR# OE-0685D)

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

USACE, 2019. *Ground-Penetrating Radar Investigation of Vernal Ponds in BLM Area B at Former Fort Ord, Monterey, California.* (AR# BW-2864)

The United States Department of the Army (Army), 2008. *Final Record of Decision Impact Area Munitions Response Area Track 3 Munitions Response Site Former Fort Ord, California*. (AR# OE-0647)

Tables

Table 1

Pond 16 Investigation Dig Results

Operation Type	Unit ID	Date	Item Type	Grid ID	MM2x2 Category	Local Target ID	Expected Depth (inches)	Actual Depth (inches)	MD/UXO weight (lbs)	MD/UXO Description	OD (lbs)	OD Description
MetalMapper Cued DigEx	13	10/24/2018	OD	Pond16	2	1001	8.01	2	0	None	40	Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	OD	Pond16	1	1002	15.74	12	0	None	2	Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	SameAnom	Pond16	2	1002.1	16.55	11	0	None	0	None
MetalMapper Cued DigEx	13	10/23/2018	OD	Pond16	2	1003	10.93	11	0	None	40	Scrap Metal
MetalMapper Cued DigEx	13	10/22/2018	OD	Pond16	2	1004	8.73	6	0	None	5	Sign Post
MetalMapper Cued DigEx	13	10/24/2018	OD	Pond16	1	1006	10.77	11	0	None	25	Metal Pipe
MetalMapper Cued DigEx	13	10/24/2018	SameAnom	Pond16	2	1006.1	13.30	11	0	None	0	None
MetalMapper Cued DigEx	13	10/22/2018	OD	Pond16	1	1010	8.15	6	0	None	5	Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	1	1011	10.87	10	5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	OD	Pond16	2	1013	7.00	7	0	None	7	Scrap Metal
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	1	1017	6.53	6	1	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	2	1019	4.31	2	5	projo, 81mm	0	None
MetalMapper Cued DigEx	13	10/24/2018	QC Seed	Pond16	1	1021	3.88	1	0	None	0.5	Small ISO
MetalMapper Cued DigEx	13	10/23/2018	SameAnom	Pond16	2	1023	12.36	11	0	None	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	1	1024	11.55	7	6	projo, 60mm mortar	0	None
MetalMapper Cued DigEx	13	10/23/2018	SameAnom	Pond16	2	1024.1	7.45	7	6	None	0	None
MetalMapper Cued DigEx	13	10/24/2018	UXO	Pond16	1	1025	24.31	29	25	projo, 4.2inch, mortar, HE, M329 series	0	None
MetalMapper Cued DigEx	13	10/24/2018	UXO	Pond16	1	1026	6.46	6	1.5	signal, illum, ground, M125 series	0	None
MetalMapper Cued DigEx	13	10/23/2018	OD	Pond16	2	1027	9.22	7	0	None	2	Scrap Metal
MetalMapper Cued DigEx	13	10/22/2018	OD	Pond16	2	1028	10.33	12	0	None	5	Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	1	1030	19.84	13	10	projo, 81mm, mortar, HE, M43 series	0	None
MetalMapper Cued DigEx	13	10/23/2018	OD	Pond16	2	1033	15.56	16	0	None	1	Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	OD	Pond16	2	1034	14.19	6	0	None	0.5	Scrap Metal
MetalMapper Cued DigEx	13	10/22/2018	OD	Pond16	2	1035	5.07	4	0	None	1	Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1036	1.48	19	3	projo, 81mm, mortar, prac, M43 series	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	1	1037	20.34	19	10	projo, 81mm	0	None
MetalMapper Cued DigEx	13	10/22/2018	MD	Pond16	2	1038	7.31	6	0.5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	1	1039	22.21	24	10	projo, 81mm, mortar, HE, M43 series	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	2	1040	18.23	18	2	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/22/2018	MD	Pond16	2	1041	10.49	10	3	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1042	11.10	12	5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	1	1044	24.60	21	10	projo, 81mm, mortar, HE, M43 series	0	None
MetalMapper Cued DigEx	13	10/23/2018	OD	Pond16	2	1045	15.79	14	0	None	2	Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	1	1046	9.35	5	2	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/22/2018	OD	Pond16	2	1047	7.70	11	0	None	1	Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	OD	Pond16	2	1049	12.22	9	0	None	1	Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1051	10.26	6	0.5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	1	1052	8.23	5	1	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	OD	Pond16	2	1054	16.93	8	0	None	0.25	Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	OD	Pond16	2	1056	6.85	7	0	None	0.5	Scrap Metal
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	2	1057	9.55	4	0.25	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1058	9.34	3	0.25	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	2	1059	3.06	3	1	projo, 40mm	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	1	1062	28.85	25	10	projo, 81mm, mortar, HE, M43 series	0	None
MetalMapper Cued DigEx	13	10/22/2018	Unknown	Pond16	2	1063	4.18	18	0	None	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	2	1064	3.48	2	1	projo, 40mm	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1066	11.37	8	2	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1069	2.28	5	1	projo, 40mm	0	None
MetalMapper Cued DigEx	13	10/24/2018	OD	Pond16	2	1070	9.64	8	0	None	0.25	Aluminum Scrap Metal
MetalMapper Cued DigEx	13	10/22/2018	MD	Pond16	2	1072	1.14	5	0.25	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/22/2018	MD	Pond16	2	1075	13.18	14	2	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/22/2018	MD	Pond16	2	1076	3.29	2	0.5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/22/2018	MD	Pond16	2	1078	5.04	6	2	projo, 60mm mortar	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1079	7.68	2	0.25	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1082	11.64	8	0.25	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1082.1	16.42	8	0.25	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1084	13.00	7	0.5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	1	1085	8.94	11	1	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/22/2018	MD	Pond16	1	1086	8.63	8	1	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	1	1087	14.79	12	4	projo, 81mm	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1095	7.40	9	0.5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	2	1095.1	14.52	9	0.5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	0	1096	4.28	3	0.25	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	Unknown	Pond16	0	1100	4.81	18	0	None	0	None
MetalMapper Cued DigEx	13	10/22/2018	MD	Pond16	2	1104	11.77	5	0.25	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1106	1.96	6	0.5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1108	11.02	10	1	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	OD	Pond16	2	1110	7.41	5	0	None	0.25	Wire
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	1	1111	10.04	12	1	Assorted MD Components	0	None

Table 1

Pond 16 Investigation Dig Results

Operation Type	Unit ID	Date	Item Type	Grid ID	MM2x2 Category	Local Target ID	Expected Depth (inches)	Actual Depth (inches)	MD/UXO weight (lbs)	MD/UXO Description	OD (lbs)	OD Description
MetalMapper Cued DigEx	13	10/22/2018	OD	Pond16	0	1113	7.78	5	0	None	0.25	Aluminum Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	1	1115	10.74	8	0.5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	1	1117	11.81	12	0.5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1120	12.47	11	0.5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	2	1121	1.36	5	5	projo, 81mm	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	0	1122	6.57	6	0.25	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	0	1124	6.56	5	0.25	Assorted MD Components	0	Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1128	8.25	6	0.25	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/22/2018	FP	Pond16	0	1129	10.98	0	0	None	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	0	1133	7.01	6	1	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1135	14.18	10	0.25	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	OD	Pond16	0	1136	15.94	14	0	None	0.25	Aluminum Scrap Metal
MetalMapper Cued DigEx	13	10/23/2018	MD	Pond16	2	1140	13.50	14	1.5	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	FP	Pond16	0	1143	6.28	0	0	None	0	None
MetalMapper Cued DigEx	13	10/24/2018	OD	Pond16	0	1147	4.56	11	0	None	2	Scrap Metal
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	0	1148	6.95	11	1	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/23/2018	Unknown	Pond16	2	1153	17.00	18	0	None	0	None
MetalMapper Cued DigEx	13	10/22/2018	FP	Pond16	0	1155	7.34	0	0	None	0	None
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MetalMapper Cued DigEx	13	10/22/2018	FP	Pond16	0	1163	0.02	0	0	None	0	None
MetalMapper Cued DigEx	13	10/24/2018	Unknown	Pond16	0	1164	16.87	18	0	None	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	2	1168	10.81	12	1	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/22/2018	FP	Pond16	0	1171	4.41	0	0	None	0	None
MetalMapper Cued DigEx	13	10/24/2018	MD	Pond16	2	1172	12.57	11	1	Assorted MD Components	0	None
MetalMapper Cued DigEx	13	10/24/2018	SameAnom	Pond16	2	1173	13.18	0	0	None	0	None
MetalMapper Cued DigEx	13	10/24/2018	FP	Pond16	0	1174	15.83	0	0	None	0	None
MetalMapper Cued DigEx	13	10/22/2018	FP	Pond16	0	1176	1.98	0	0	None	0	None
MetalMapper Cued DigEx	13	10/24/2018	FP	Pond16	0	1181	-3.67	0	0	None	0	None

Figures

Pond Location

Unit 13

Impact Area MRA Boundary

Former Fort Ord Boundary

Pond 16

Impact Area MRA

Former Fort Ord

Medford

Sacramento

Carson City

San Francisco

San Jose

Fresno

Mt Whitney

Las Vega

Los Angeles

San Diego

Mexicali

SIERRA NEVADA MOUNTAINS

GREAT BASIN

NEVADA

COAST RANGE

CALIFORNIA

N

0 100 200 Miles

Marina

Marina State Beach

Locke Paddon Park

Marina Municipal Airport

Reindollar Ave

Imjin Pkwy

Imjin Rd

2nd Ave

Cabrillo Hwy

Inter-Garrison Rd

California State University - Monterey Bay

Light Fighter Dr

Fort Ord

Gen Jim Moore Blvd

Monterey Rd

Bayonet Black Horse Golf Course

Cooper Rd

Castroville Rd

183

N Davis Rd

W Market St

E Market St

Hartnell College

W Alisal St

Salinas

John St

Front St

Abbott St

S Main St

S Sanborn Rd

E Blanco Rd

W Blanco Rd

S Davis Rd

Reservation Rd

Salinas River

Spreckels Blvd

Harris Rd

River Rd

Toro Regional Park

Monterey Rd

Fort Ord National Monument

Mazda Raceway Laguna Seca

Nicklaus Club Monterey

Monterey-Salinas Hwy

Aguajito Rd

Jacks Peak

Pacific Grove

Lighthouse Ave

Prescott Ave

Presidio of Monterey

Pacific St

Munras Ave

Del Monte Ave

Monterey

Naval Postgraduate School

Seaside

Del Monte Blvd

Fremont Blvd

Noche Buena St

Broadway Ave

Hilby Ave

Fremont St

Del Rey Oaks

Monterey Regional Airport

218

68

1

N

0 1 2 Miles

Pond 16 - Impact Area MRA
Geophysical Anomaly Investigation
Technical Information Paper
Former Fort Ord, California

Figure 1
Location

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EM61-MK2A Readings

19.2
18.5
17.7
16.9
16.2
15.4
14.6
13.8
13.1
12.3
11.5
10.8
10.0
9.2
8.5
7.7
6.9
6.2
5.4
4.6
3.8
3.1
2.3
1.5
0.8
0.0
-0.8
-1.5
-2.3
-3.1
-3.8
-4.6
-5.4
-6.2
-6.9
-7.7
-8.5
-9.2

mV
CH Sum

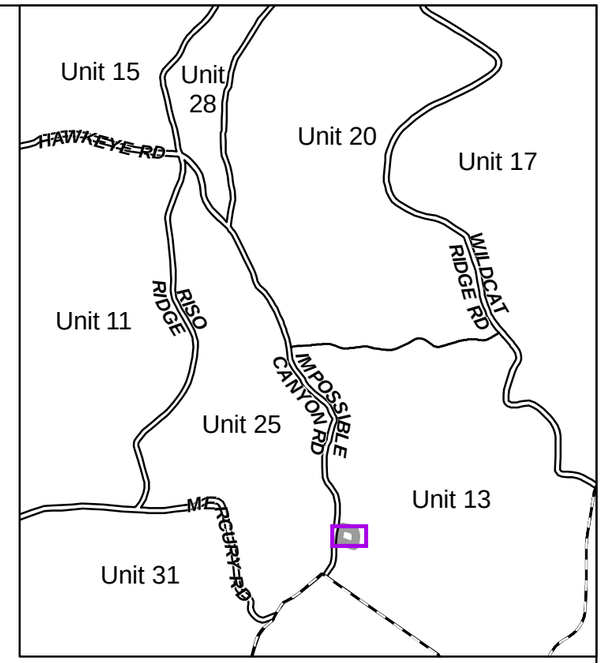
IMPOSSIBLE CANYON RD

projectile, 4.2inch, mortar, HE, M329 series

signal, illum, ground, M125 series

N

0 50 Feet



Unit 13

DGM Pond Survey Area

Unit Boundaries

Anomaly Investigation Results

- UXO (2 targets/items)
- MD (54 targets; 124.5 pounds)
- RRD/OD (22 targets; 141.3 pounds)
- Unknown Target (4 targets)
- QC Seed (1 target; 0.5 pounds)
- Same Anomaly (5 targets)
- False Positive (11 targets)

Pond 16 - Impact Area MRA
Geophysical Anomaly Investigation
Technical Information Paper
Former Fort Ord, California

Figure 2
Pond 16
DGM and Dig Results

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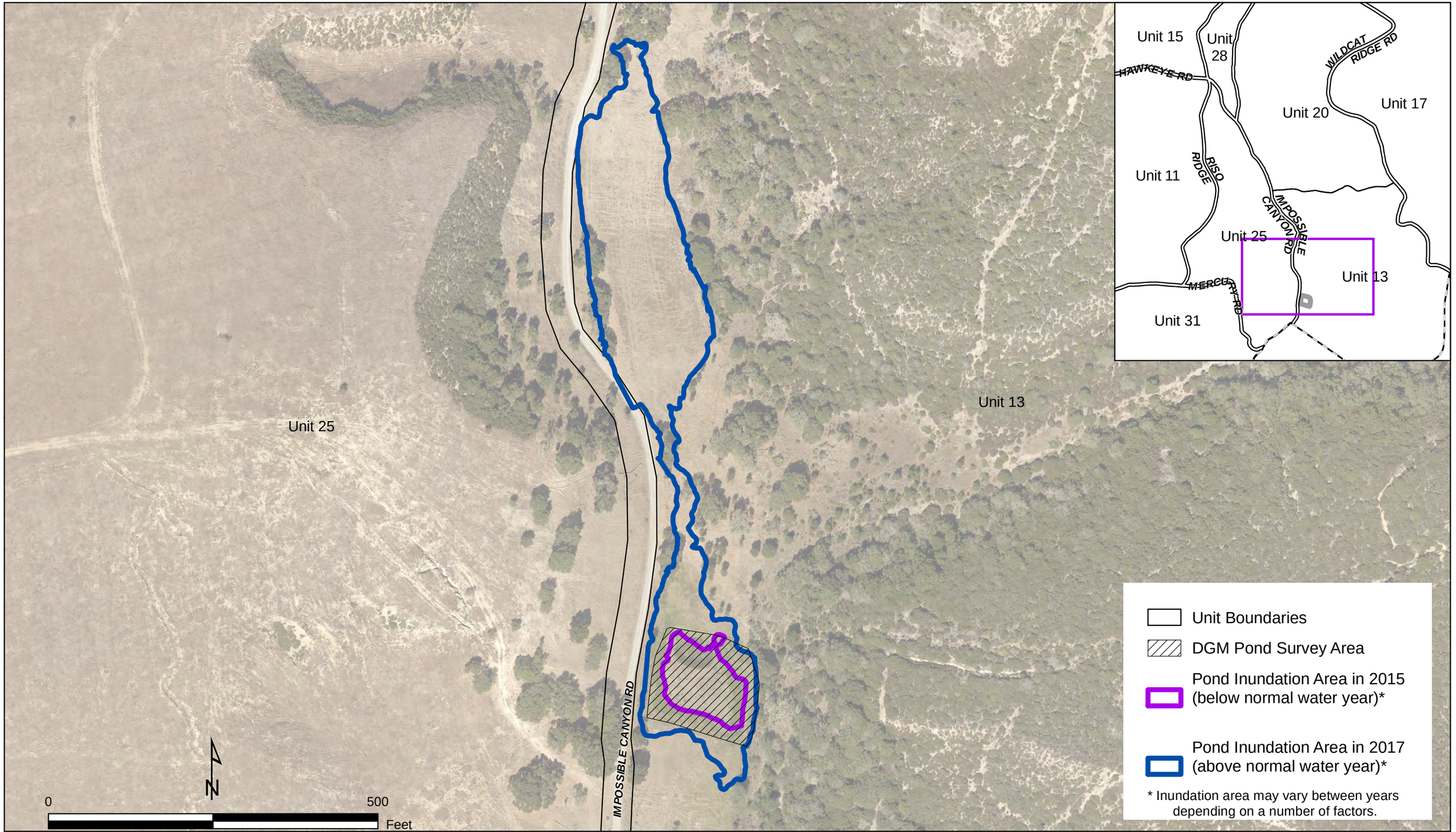

KEMRON ENVIRONMENTAL SERVICES

Gilbane

Pond 16 - Impact Area MRA
Geophysical Anomaly Investigation
Technical Information Paper
Former Fort Ord, California

Figure 3
Pond 16
Inundation Area

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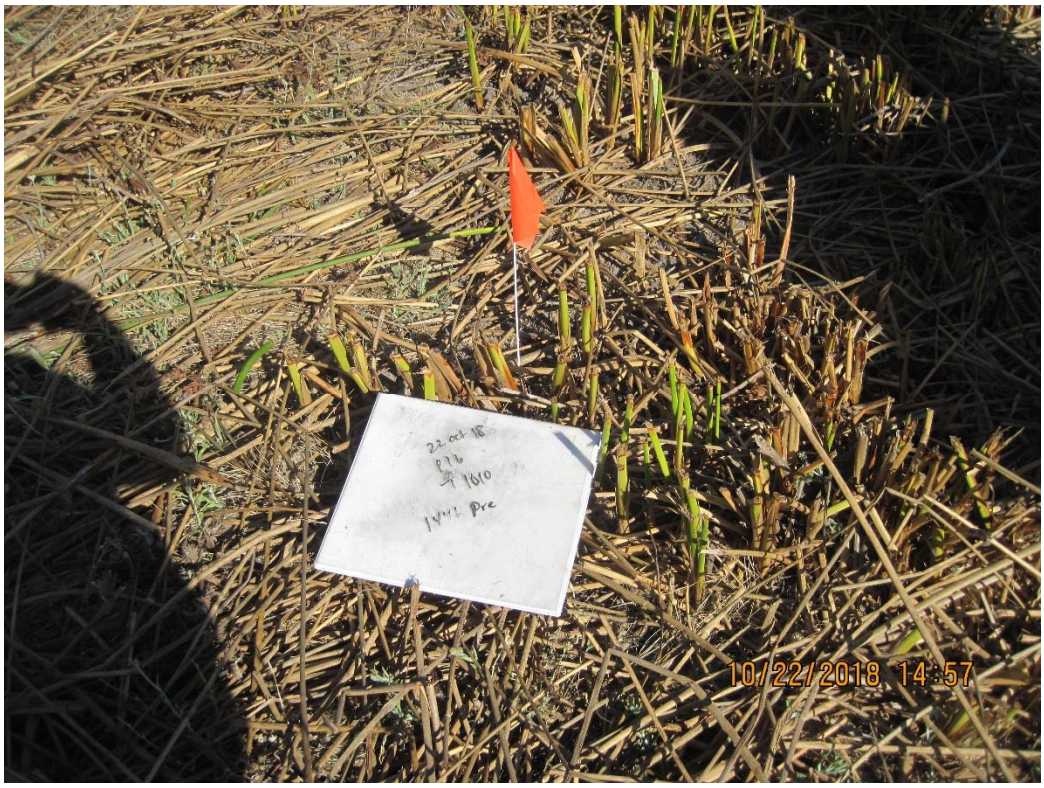
Photographs



Photograph 1 – Anomaly 1010 Prior to Excavation

Photograph 2 - Anomaly 1010 During Excavation

Photograph 3 - Anomaly 1010 After Excavation

Photograph 4 - Anomaly 1046 Prior to Excavation

Photograph 5 - Anomaly 1046 During Excavation

Photograph 6 - Anomaly 1046 After Excavation

Photograph 7 - Anomaly 1026 Prior to Excavation

Photograph 8 - Anomaly 1026 During Excavation

Photograph 9 - Anomaly 1026 After Excavation

Appendix A

Field Work Variance 022

FIELD WORK VARIANCE

Project Name/Number	Fort Ord	**WP**	17
Applicable Document	Final, Site-Specific Work Plan, Munitions and Explosives of Concern Remedial Action, Non-Burn Areas, Former Fort Ord, California (Shaw, 2010) (OE-0685D)	**Date**	October 15, 2018

Background: The Impact Area Munitions Response Area (MRA) at the former Fort Ord, CA contains vernal ponds that are frequently filled with water. Digital Geophysical Mapping (DGM) and removal of Munitions and Explosives of Concern (MEC) is not feasible when water is present in the ponds. Vernal ponds generally retain water throughout much of the year; however, 2016 was a particularly dry year. To take advantage of dry conditions, a DGM survey occurred in accessible (dry) portions of Pond 16 using an EM61-MK2A in 2016 and anomalies were identified within the data. Due to the sensitive nature of these resources and the habitat they provide, a person-portable EM-61MK2A was used to collect DGM data in order to minimize impacts on the vernal pond environments. Data collection was completed in accordance with standards outlined in the *Final Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, Volume II, Munitions Response, Appendix A* (KEMRON, 2016). DGM data collected within the footprint of this vernal pond is shown on the attached Figure 1.

Problem Description: Anomalies within the footprints of Pond 16 should be removed to allow safe access during biological surveys. The potential exists to negatively impact the ability of the vernal pond to retain water if anomaly investigation techniques do not maintain the integrity of the clay soil layer at the bottom of the vernal pond. This negative impact could affect the planned long-term reuse of the property by BLM. Anomaly investigations should be minimized and standard procedures followed to maintain the integrity of Pond 16.

Recommended solution:

Use MetalMapper 2x2 to further evaluate selected targets located within the footprint of the vernal pools. Conduct a limited subsurface removal that addresses the anomalies that potentially represent MEC items in the shallow subsurface. Follow standard operating procedures outlined in Attachment 1. Standards for MetalMapper 2x2 data collection and classification are described in the *Final Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, Volume II, Munitions Response, Appendix B* (KEMRON, 2016). Intrusive investigation of selected targets will be conducted in accordance with *SOP AGCMR-09, Anomaly Reacquisition and Intrusive Investigation*, as modified by Attachment 1 and as detailed below. The width of excavation will be limited to what is needed to acquire the target.

- All category 1 targets will be intrusively investigated.
- Category 2 targets less than 18 inches depth will be intrusively investigated. If no target is contacted, intrusive investigations will terminate at 18 inches depth.
- Category 3 targets will not be intrusively investigated.

Category 0 target locations will be checked by UXO dig teams using an EM61 all metals detector. If an anomaly greater than 4.2 mV (channel 2) is still present, the anomaly will be intrusively investigated and cleared in accordance with UXO SOP 3. If no target is contacted, intrusive investigations will be terminated at 18 inches. If no anomaly greater than 4.2 mV is present, the flagged location will not be intrusively investigated.

Impact on present and completed work:

No impact on current or completed work.

Recommended solution/disposition:

Incorporate this FWV as an appendix to the existing Final Work Plan.

Clarification ☐ Minor Change ☐ Major Change ☒

Affects Budget Yes ☒ No ☐
Affects Schedule Yes ☒ No ☐

Signature Kevin Siemann Digitally signed by Kevin Siemann DN: C=US, E=ksiemann@gilbaneco.com, O=Gilbane Company, OU=KEMRON/Gilbane, CN=Kevin Siemann Date: 2018.10.15 10:01:16-07'00' Date
Task Manager

Signature Bradley J. Olson Digitally signed by Bradley J. Olson Date: 2018.10.16 09:22:10 -07'00' Date
SUXOS

Signature cclyde@gilbaneco.com Digitally signed by cclyde@gilbaneco.com DN: cn=cclyde@gilbaneco.com Date: 2018.10.15 14:00:54 -07'00' Date
CQCSM

Signature Bruce McClain Digitally signed by Bruce McClain Date: 2018.10.15 16:08:46 -07'00' Date
UXOQCS

Signature Steve Crane Date 10/16/18
Project Manager

Signature Erin K. Caruso Digitally signed by Erin K. Caruso DN: C=US, E=ecaruso@gilbaneco.com, O=Gilbane, OU=Federal Services, CN=Erin K. Caruso Reason: I am approving this document Date: 2018.10.16 14:13:32-07'00' Date
Deputy Project Manager

USACE Approval: If Major Change:

Signature BRITT.JAMES.CLIFTON.1056168920 Digitally signed by BRITT.JAMES.CLIFTON.1056168920 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=BRITT.JAMES.CLIFTON.1056168920 Date: 2018.10.18 16:27:31 -07'00' Date
OE Safety Specialist

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USACE COR or TM

Signature LINDSAY.KYLE.M.1529297226 Digitally signed by LINDSAY.KYLE.M.1529297226 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=LINDSAY.KYLE.M.1529297226 Date: 2018.10.19 11:08:37 -07'00' Date
USACE Project Geophysicist

Standard Operating Procedure for Soil and Vegetation Handling In Vernal Pools

PURPOSE:

The purpose of this standard operating procedure (SOP) is to describe the process that will be protective of biotic constituents of vernal pools affected by manual soil investigation activities in support of Munitions and Explosives of Concern (MEC) remedial investigations located in the BLM Area B and the Impact Area. Handling of soil and vegetation in aquatic features should be conducted under the guidance of the Wetland Monitoring and Restoration Plan for Munitions and Contaminated Soil Remedial Activities at Former Fort Ord (Burleson 2006); and in accordance with the Installation-Wide Multispecies Habitat Management Plan (HMP; USACE 1997). The work falls under the Programmatic Biological Opinion (PBO; USFWS 2017) issued to the United States Department of the Army to enable compliance with the federal Endangered Species Act and to avoid or minimize, to the extent feasible, take of listed species as well as protecting other species of concern and their habitats.

GEOLOGIC CONDITIONS:

Core sampling and GPR analysis were conducted across eight vernal pools in BLM Area B Subunits A and B. Core sampling identified clay layers with varying sand content present in all vernal pools sampled that became difficult to auger at depths around 10 inches and deeper. Three vernal pools had a second layer of clay around 12 inches that differed in color and texture. Based on the profiles of the cores and GPR results it is expected that most of the target digs will occur within clay layers, and that the excavations will not penetrate past them.

PROCEDURE:

MEC remedial investigation activities in identified vernal pools is required to make the vernal pools safe for entry when they are inundated with water. Targets will be acquired down to 18 inches. For each excavated target, soil will be stockpiled separately to allow for replacement that mirrors preexisting conditions after operations are complete, to the extent feasible. Soil disturbance activities will be conducted when the vernal pools are dry, as determined by the project biologist. Each excavated target will be backfilled with stockpiled soil immediately after the target is acquired.

The soil and vegetation handling process for each anomaly investigation shall be conducted as follows:

1. For each target, prior to any work, a digital photograph should be taken of the target location with an engineer's ruler (Photo 1), and a whiteboard with the following information:

   Date
   Pond number
   Unique target ID

2. In case that the location of the target is overgrown with vegetation, vegetation will be cut around the target and set aside in a pile.

3. During anomaly excavation the top 6 inches of topsoil layer should be removed first and set aside. Subsequent soil layers will be removed at 6 inch intervals down to the target item, but not further than 18 inches. Soils should be separated into piles at 6 inch intervals and managed for easy transfer back into to the excavated area.

4. After acquisition of the target item is complete, a digital photograph should be taken of the excavated area with an engineer's ruler placed in the X and Y axis for estimation of the excavated area. The photograph should also include a whiteboard with the following information:

   Date
   Pond number
   Unique target ID
   Depth of excavation

5. A digital photograph should be taken of the separate soil piles or their samples for each target.

6. The excavated area should be backfilled using soils in the reverse order that were excavated and were set aside. Each layer should be returned to its original position. During backfilling, the soil should be compacted at 6-inch intervals to help preserve the impermeability of the disturbed soil. Use enough water to moisten the soil, but not saturate it to ensure even compaction. Placement of hard chips may require breaking the large fragments of clay into smaller, more readily compacted pieces before placement. Use a compaction and breaker bar to compact the filled area uniformly, by dropping the bar 20 times from 1 foot height across the excavated area with the flat end (Photo 2). The final layer must be the top 6 inches saved from the surface. If vegetation was removed the clippings should be placed back on top of the excavation area.

7. After backfilling of the excavated area is complete, a digital photograph should be taken of the backfilled area with an engineer's ruler placed approximately in the same position as in No. 4 above. The photograph should also include a whiteboard with the following information:

   Date
   Pond number
   Unique target ID
   Depth of excavation

Photograph 1. Suggested example of an engineer's ruler.

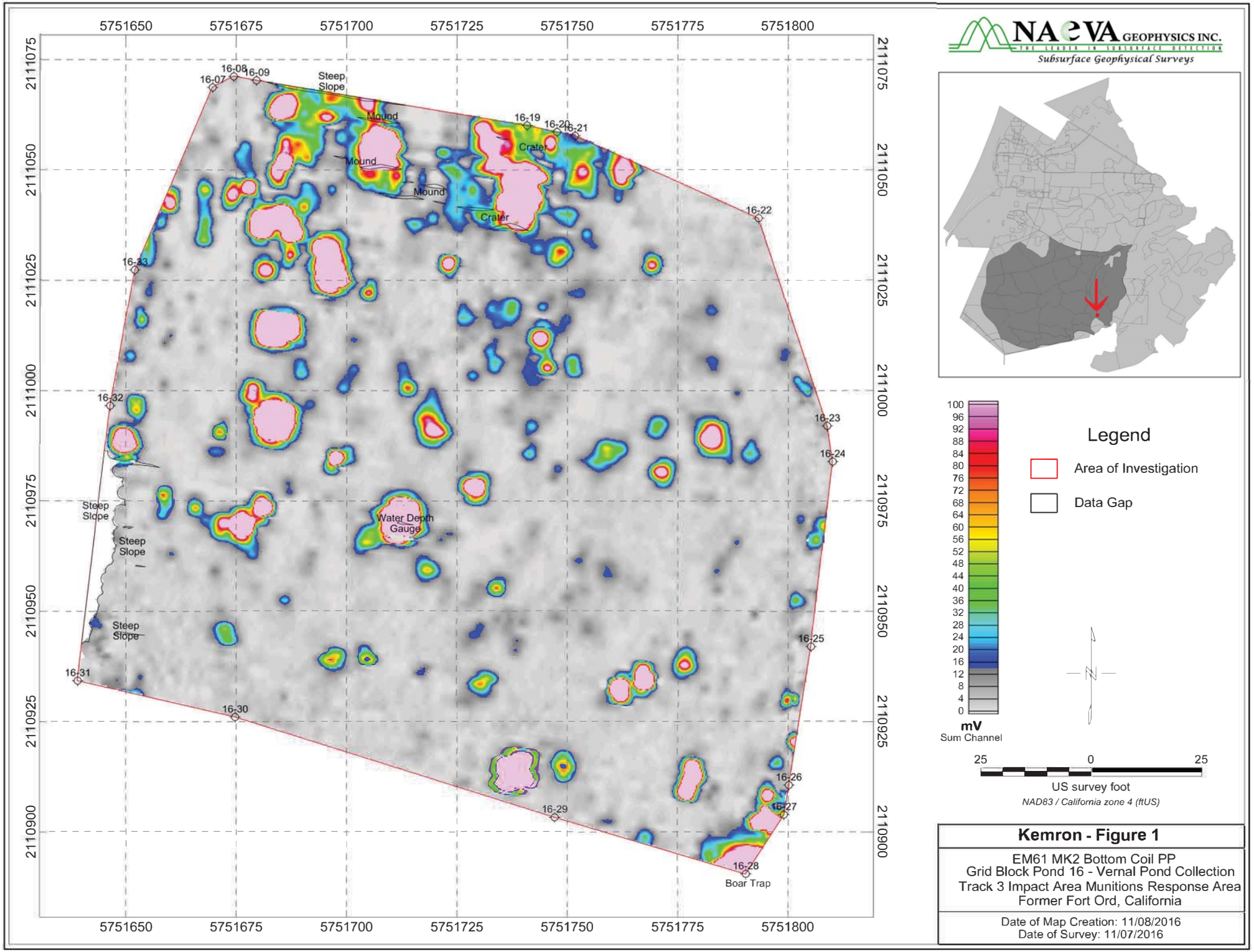
Photograph 2. Suggested example of a compaction and breaker bar.

REFERENCES:

[Burleson] Burleson Consulting, Inc. 2006. Wetland monitoring and restoration plan for munitions and contaminated soil remedial activities at former Fort Ord, California.

[USACE] U.S. Army Corps of Engineers. 1997. Installation-wide multi-species habitat management plan for former Fort Ord, California. April. Sacramento, California.

[USFWS] U.S. Fish and Wildlife Service. 2017. Reinitiation of Formal Consultation for Cleanup and Property Transfer Actions Conducted at the Former Fort Ord, Monterey County, California (Original Consultation #8-8-09-F-74, 81440-2009-F-0334).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16-25
16-26
16-27
16-28
16-29
16-30
16-31
16-32
16-33
Steep Slope
Mound
Crater
Water Depth Gauge
Boar Trap
NAEVA GEOPHYSICS INC.
Subsurface Geophysical Surveys
Legend
Area of Investigation
Data Gap
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
12
8
4
0
mV
Sum Channel
25
0
25
US survey foot
NAD83 / California zone 4 (ftUS)
Kemron - Figure 1
EM61 MK2 Bottom Coil PP
Grid Block Pond 16 - Vernal Pond Collection
Track 3 Impact Area Munitions Response Area
Former Fort Ord, California
Date of Map Creation: 11/08/2016
Date of Survey: 11/07/2016

Distribution List: FWV 022, Final Site-Specific Work Plan Munitions and Explosives of Concern Remedial Action, Non-Burn Areas, Former Fort Ord, California

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1		Ms. Chieko Nozaki	Chenega Corporation	4463 Gigling Road	Seaside, CA	93955
1		Ms. Betsy Hibbits	Chenega Corporation	4463 Gigling Road	Seaside, CA	93955
1		Mr. Tom Ghigliotto	Chenega Corporation	4463 Gigling Road	Seaside, CA	93955
1	1	Mr. Eric Morgan	Bureau of Land Management, Fort Ord National Monument	940 2nd Avenue	Marina, CA	93933
1		Mr. Robert Young	Tech Law, Inc.	235 Montgomery Street, Suite 717	San Francisco, CA	94104
1		Mr. Tom Hall	Tech Law, Inc.	7 Shore Point Road	North Little Rock, AR	72116
1	1	Mr. Vlado Arsov	California Department of Toxic Substances Control (DTSC)	8800 California Center Drive	Sacramento, CA	95826
1	1	Ms. Maeve Clancy	U.S. Environmental Protection Agency, Region IX	75 Hawthorne Street, Mail SFD-8-3	San Francisco, CA	94105
	1	Mr. Mike Weaver	Fort Ord Community Advisory Group (FOCAG)	52 Corral De Tierra Road	Salinas, CA	93908
1		Mr. Steve Crane	KEMRON Environmental Services	4522 Joe Lloyd Way	Monterey, CA	93944
1	1	Ms. Audrey Johnson	KEMRON Environmental Services	4522 Joe Lloyd Way	Monterey, CA	93944
1		Ms. LeVonne Stone	Fort Ord Environmental Justice Network (FOEJN)	P.O. Box 361	Marina, CA	93933
2	2	Admin Record	Fort Ord BRAC	4463 Gigling Road	Seaside, CA	93955

Approved: PAYTON.R.CURTIS.II.1231979707

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Date: 2018.10.26 09:26:57 -07'00'

R. Curtis Payton, II, PG
Project Manager
U.S. Army Corps of Engineers

Appendix B

Pond 16 Quality Assurance Report: Digital Geophysical Operations

FORMER FORT ORD, CALIFORNIA
POND 16
QUALITY ASSURANCE REPORT:
DIGITAL GEOPHYSICAL OPERATIONS

PREPARED BY
GEOLOGY SECTION
SACRAMENTO DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PREPARED FOR
FORT ORD BASE REALIGNMENT AND CLOSURE (BRAC) OFFICE

APRIL 2019

1.0 INTRODUCTION

This report covers the Quality Assurance (QA) processes conducted by the U.S. Army Corps of Engineers (USACE) with respect to the collection, processing, and evaluation of digital geophysical data collected by KEMRON Environmental Services, Inc (KEMRON). The field work was performed in Vernal Pond 16, located within Unit 13 of the Impact Area MRA. Work was performed under WERS contract No. W912DY-10-D-0027, Site-Specific Work Plan for Non-Burn Areas, Impact Area MRA (Shaw, 2010) and Field Work Variance (FWV) 022 (KEMRON, 2018b). The field protocols, database management, and QA reviews were based on a combination of methods previously used in other units and described in the UFP-QAPP Volume II Appendix A, along with additional procedures necessary for ensuring compliance with the WERS MMRP contract and the standard operating procedures performed by KEMRON's subcontractors GILBANE and NAEVA. USACE QA verified that KEMRON had an adequate Quality Control (QC) program in place and that data collected in Vernal Pond 16 were in accordance with project Data Quality Objectives (DQOs) and Measurement Quality Objectives (MQOs), as established in the UFP-QAPP (KEMRON, 2016a) with modification by FWV 022 (KEMRON, 2018b) and the AGCMR-QAPP (KEMRON, 2016b) with modification by FWV 012 (KEMRON, 2018a). Vernal Pond 16 included areas recommended for subsurface removal and were collected in their entirety to meet Category A data.

1.1 Site Details

Vernal Pond 16 is located in the southwestern corner of Unit 13, as depicted in Figure 1. Vernal Pond 16 encompasses a total of approximately 0.53 acres and is bounded by Impossible Canyon Road to the west.

The vernal ponds located at the Former Fort Ord provide breeding habitat to federally and state threatened species, and are considered biologically sensitive habitat. The decision was made to remove MEC from the vernal ponds to allow biologists to safely monitor these species.

DGM was conducted with a person-portable EM61 during October-December of 2016 to take advantage of the dry conditions in the ponds. The narrow window of opportunity to survey the dry ponds before the onset of the rainy season required immediate survey with DGM instruments. Due to the urgency of the survey, the DGM surveys of the vernal ponds occurred prior to surface sweep activities in the ponds.

To minimize disturbance to vernal pond habitat, anomalies detected with the EM61 were cued with the MetalMapper 2x2 (MM2x2) to identify Targets of Interest (TOI) that required intrusive investigation. Cued measurements were collected in August of 2018.

2.0 QA ACTIVITES

2.1 Data Collection Methods

Dynamic geophysical data were collected using Geonics EM-61MKII electromagnetic sensors in person-portable mode throughout most of the site. The EM-61MKII is a time-domain electromagnetic sensor that generates an electromagnetic pulse, inducing eddy currents within the subsurface. During the off period of the EM pulse, the eddy current decay produces secondary electromagnetic fields within both ferrous and non-ferrous metallic objects. These secondary electromagnetic fields are received and recorded over four averaged time gates per data collection interval (10Hz).

Data were collected as individual transects grouped by vernal pond number. Data collected within Vernal Pond 16 met Category A line spacing requirements, with 95% not to exceed a lane spacing of 2 ft. and 100% not to exceed a lane spacing of 3 ft. As stated in the MEC Procedures Supplement, the purpose and objective for the Category A DGM surveys is to obtain high quality DGM data in order to pick targets for subsurface removal.

Obstacles and issues with terrain precluded 100% coverage and approximately 0.0046 acres of Vernal Pond 16 were inaccessible due to the presence of vegetation or terrain/cultural features (mounds, craters, and water gauge staff). All data gaps were appropriately documented in the obstacle files submitted with DGM packages. Figure 2 of this QA report depicts the full DGM dataset for Vernal Pond 16.

A total of 185 targets were selected from the dynamic EM61 DGM survey (Figure 2) for cued measurement with the MM2x2. Classification data from each measured anomaly was processed, modeled, and classified to determine if the item was safe to leave in place or was a potential TOI to be intrusively investigated and removed. Each anomaly was ranked according to its likelihood of being a TOI: Category 0 – Cannot Analyze, Category 1 – High-Confidence TOI, Category 2 – Inconclusive, and Category 3 – High-Confidence Non-TOI.

2.2 Field Oversight

Field oversight was performed intermittently throughout the project by both the USACE QA Geophysicist and the OESS. Appropriate field procedures were reviewed and found to be in compliance. Under the WERS Contract No. W912DY-10-D-0027, NAEVA is subcontracted to collect the geophysical data.

2.3 Geophysical System Verification

Under the WERS contract, USACE and KEMRON fully incorporated the physics based Geophysical System Verification (GSV) approach as described in the July 2009 ESTCP report (ESTCP, 2009) and supported by EM 200-1-15. GSV includes two methods for providing QA/QC: blind seeding and the instrument verification strip (IVS). IVS data results were

recorded on daily QC submittals attached as PDF files to the grid blocks. Data were reviewed by the QA Geophysicist to ensure all MQOs were achieved. The QA data review process is described in section 2.4 and a summary of MQOs for person-portable DGM operations and MM2x2 AGC cued measurements are given in Tables 1 and 2, respectively. Daily IVS test results for person-portable DGM in Vernal Pond 16 are shown in Figures 3-4. Daily IVS test results for MM2x2 AGC cued measurements are shown in Figure 5. Further details regarding MQOs are provided in the UFP-QAPP (KEMRON, 2016a) and AGCMR-QAPP (KEMRON, 2016b).

Production data required the GSV blind seeds placed throughout the Vernal Ponds, as documented in the UFP-QAPP. By placing blind seeds at an average rate of one per day, the instrument functionality can be tested on a daily basis. Any failures to detect a blind seed could be indicative of an issue with data collection. All blind seeds were small industry standard objects. Due to the sensitive status of the vernal ponds, QC seeds were not planted at their standard 6-inch depth. Rather, QC seeds were lain horizontal on the ground surface and then pushed into the ground to a depth of two inches. The blind seeds were placed by the QC Geophysicist. All blind QC seeds were detected and both the responses and positioning were within the requirements of the MQOs and SOPs. Table 3 summarizes the QC seed results for Vernal Pond 16.

2.4 Digital Data Review

A review of digital geophysics data by the USACE was performed to monitor the effectiveness of data processing and consistency of data delivery. Issues that were reviewed in these data included:

1) Missing survey lines within a grid (interline gaps)
2) Point-to-point data gaps along survey lines
3) Bowing out of survey lines beyond 50% of survey line spacing, unless otherwise collected
4) Unreasonable data “spikes”
5) Data incongruity across survey grids (Data levels in one grid are not reasonably compatible with data levels in neighboring grids)
6) Inadequate data density along survey traverse
7) Lack of accurate, precise locations; survey line orientation
8) Inadequate/incomplete site survey coverage
9) Missing, incomplete, or noncompliant instrument standardization checks
10) Completeness of file header information and supporting documentation
11) Consistent IVS and GSV results supporting the data quality objectives

To accomplish this, all raw and processed data files were checked by the USACE to ensure that KEMRON followed an appropriate and informative naming convention reflecting the grids surveyed as outlined in the EM 200-1-15. The USACE checked that KEMRON managed the field and processed data in a professional manner, including organization, daily

maintenance, and complete documentation. This focused on a review of header files on the pre-processed data (data that has been merged into a single file and synchronized with the GPS data) and processed data to verify that dates were consistent, systems and system sampling parameters were identified, project name and contractor was listed, and all column headers were included and defined. KEMRON also delivered supporting summary sheets that further documented field parameters and processing. All of the summary sheets were reviewed for completeness, verification of calibration data, and consistency to the electronic data file headers.

In order to make the above process more efficient, a grid tracking spreadsheet located in the Vernal Ponds folder on the FTP site was updated weekly and allowed for the QC Geophysicist and USACE QA Geophysicist to document their verification of each deliverable. Minor issues such as corrupt or incomplete zip files were addressed within the table and via QC report deliverables. The final excel file will be maintained within the Final Data Submittal QC folder on the Fort Ord server.

The procedure for reprocessing and projecting the pseudo-color maps of the DGM Category A data included starting with a 100% review of the data in Geosoft Oasis Montaj to include re-leveling and re-gridding. These digital data were imported into Geosoft for the generation of pseudo-color maps that were then exported as a georeferenced geotif.

Overall, the general QA digital data review consisted at a minimum of:

1) Creating a processed database
2) Importing XYZ data
3) Calculation of sum channel
4) Generating a grid (0.25 ft. cell size and blanking distance of 2 ft.) of sum channel
5) Plotting the sum channel
6) Plotting a symbol cover for the track lines (view coverage)
7) Exporting the plots to geotifs
8) Importing the geotifs into a GIS

2.5 Data Validation

In addition to verifying and validating the data processing and QC procedures as described above, data validation will typically include validation seeding and the selection and intrusive investigation of validation digs from anomalies classified as non-TOI. To minimize disturbance to the sensitive habitat of the vernal ponds, no validation seeds were placed in the ground and no validation digs were selected.

2.6 Corrective Action Request

No corrective action requests were issued for data collected in Vernal Pond 16, however one item is worth discussion. An atypically high number of low-amplitude targets picked from the EM61 data were not detected with the MM2x2, resulting in the target being assigned to Category 0: Cannot Analyze. The QC Geophysicist and QA Geophysicist agreed that the unusually high number of Category 0 targets was likely caused by the source of the EM61 anomaly being removed by surface sweep operations prior to the cued AGC survey with the MM2x2. Typically these targets are automatically placed on the dig list for intrusive investigation. To minimize disturbance to the vernal pond habitat, an alternative approach was developed and is documented in FWV 022 (KEMRON, 2018b).

3.0 CONCLUSIONS

QA activities by the Government verified KEMRON had an adequate QC program in place and that data collected within Vernal Pond 16 are sufficient and in accordance with the project DQOs and MQOs. All dynamic DGM data in Vernal Pond 16 meet Category A standards. Furthermore, removal of anomalies identified as TOI were removed to allow safe access for biological surveys within the investigation footprint of Vernal Pond 16.

4.0 REFERENCES

ESTCP, 2009. *Geophysical System Verification (GSV): A Physics-Based Alternative to Geophysical Prove-Outs for Munitions Response.* July.

KEMRON, 2016a. *Final, Quality Assurance Project Plan, Former Fort Ord, California, Volume II, Appendix A, Munitions and Explosives of Concern Remedial Action.* December. (OE-0884A)

KEMRON, 2016b. *Final, Quality Assurance Project Plan Superfund Response Actions, Former Fort Ord, California, Volume II, Appendix B, Advanced Geophysical Classification for Munitions Response Quality Assurance Project Plan.* August. (OE-0868B)

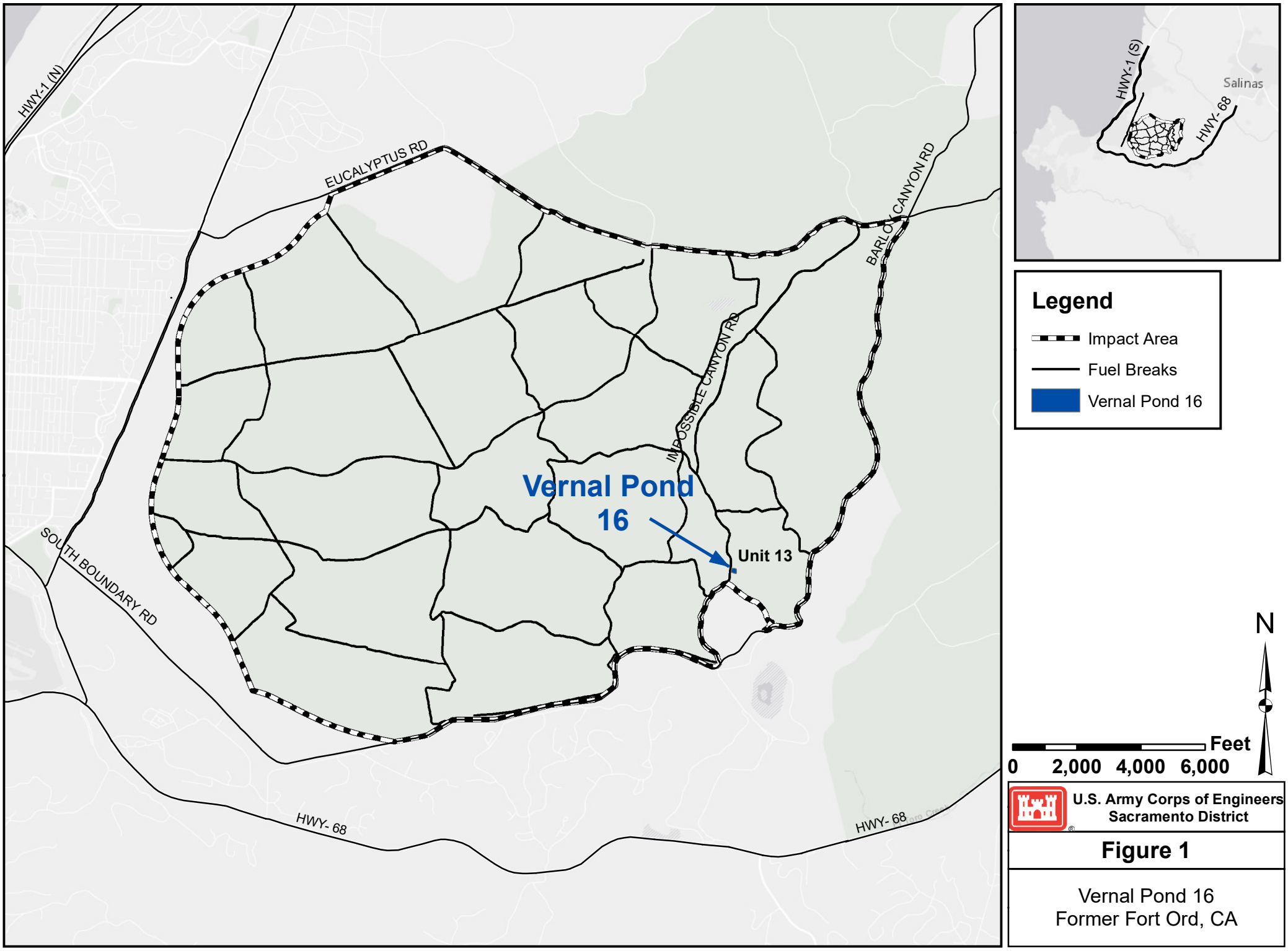
KEMRON, 2018a. *Field Work Variance 012* to the *Final, Quality Assurance Project Plan Superfund Response Actions, Former Fort Ord, California, Volume II, Appendix B, Advanced Geophysical Classification for Munitions Response Quality Assurance Project Plan.* January. (OE-0888B.2)

KEMRON, 2018b. *Field Work Variance 022* to the *Final Site-Specific Work Plan, Munitions and Explosives of Concern Remedial Action, Non-Burn Areas, Former Fort Ord, California.* October. (OE-0685D.15)

Shaw Environmental, Inc, 2010. *Final Site-Specific Work Plan Munitions and Explosives of Concern Remedial Action Non-Burn Areas Former Fort Ord, California.* (OE-0685D)

USACE, 1997. *Installation-Wide Multispecies Habitat Management Plan for Former Fort Ord, California (HMP).* April. With technical assistance from Jones and Stokes, Sacramento, California. (BW-1787)

5.0 FIGURES



U.S. Army Corps of Engineers
Sacramento District

Figure 1

Vernal Pond 16
Former Fort Ord, CA

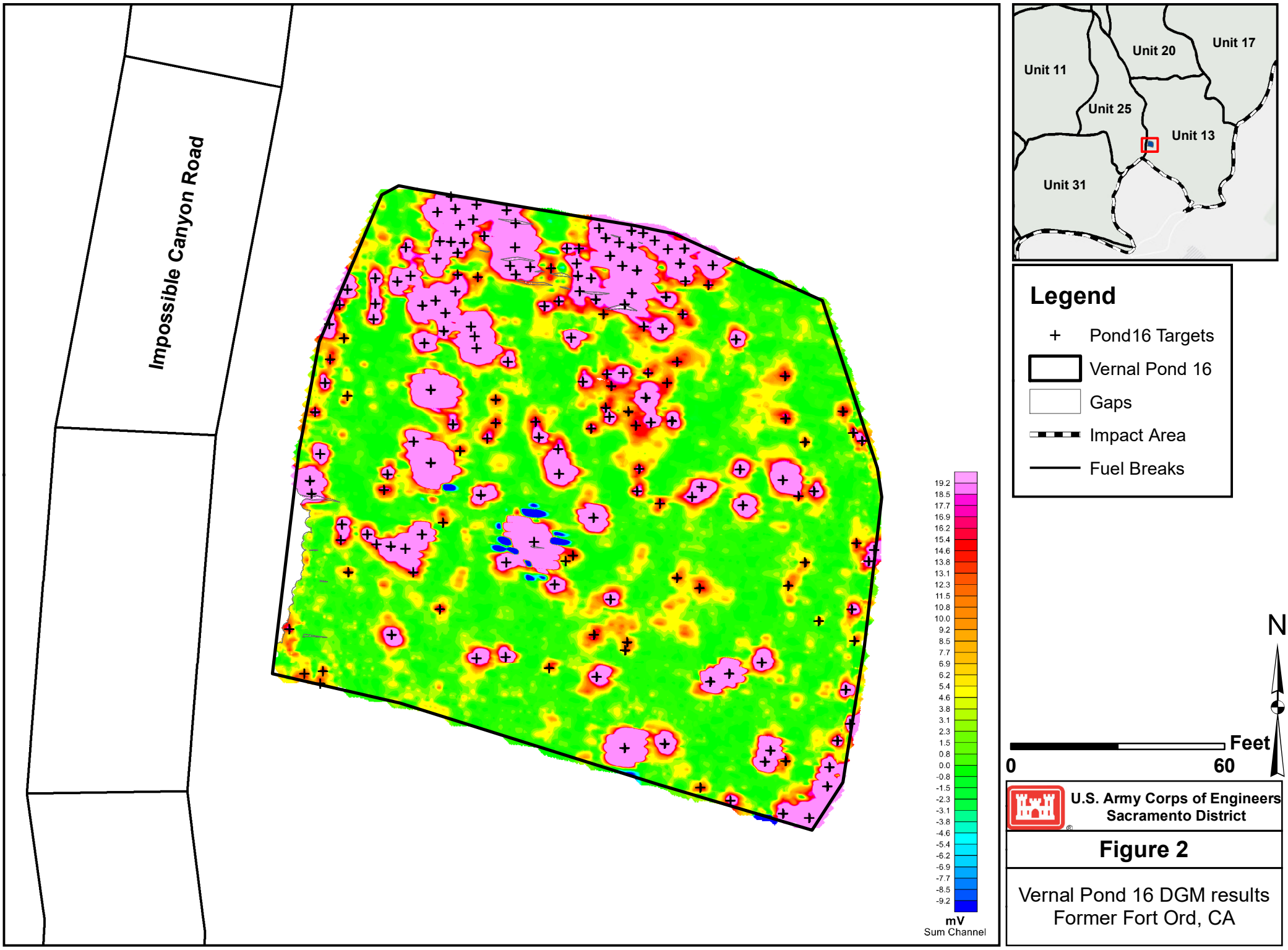


Figure 2

Vernal Pond 16 DGM results
Former Fort Ord, CA

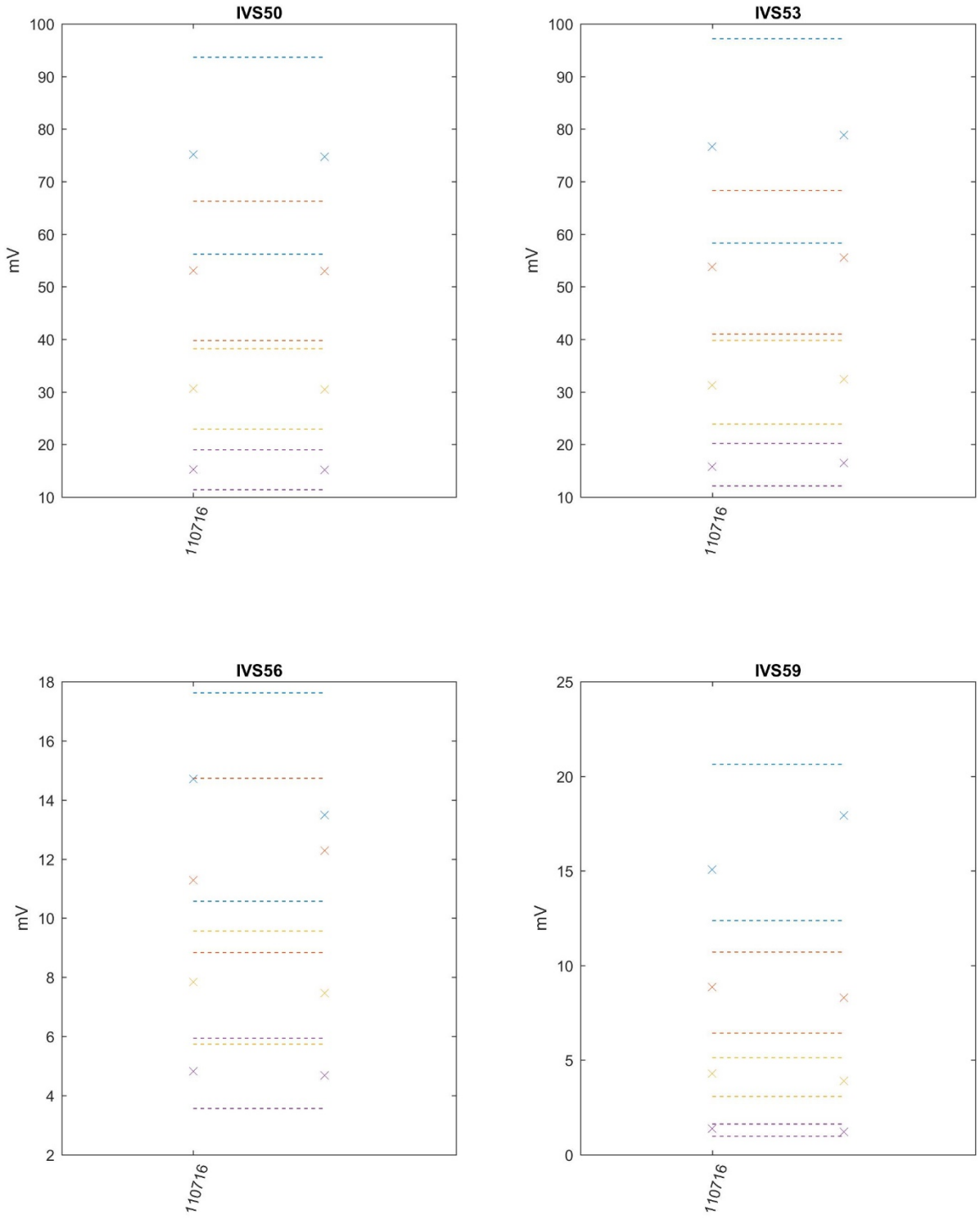


Figure 3. DGM response of IVS items for Vernal Pond 16 for each survey day. X symbols represent peak anomaly response for Channel 1 (blue), Channel 2 (red), Channel 3 (yellow), and Channel 4 (purple) for each IVS item. Dashed lines represent the allowable variability (+/- 25% of predicted response) established in WS #22.

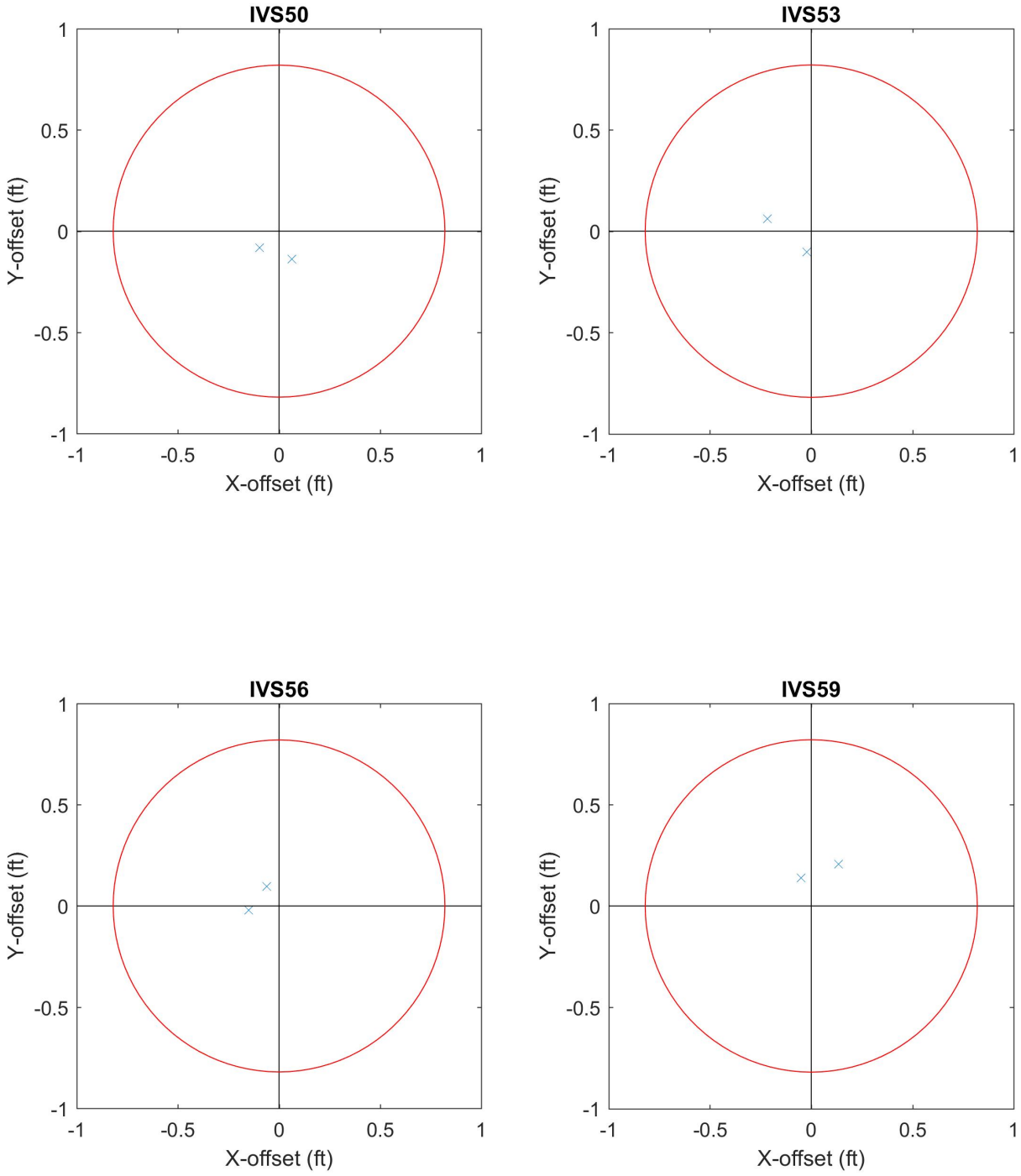


Figure 4. Daily IVS positioning results for Vernal Pond 16. Blue X's show the offset between picked DGM anomaly and the IVS ground truth. Red circle shows maximum acceptable offset (0.82 ft.) established in WS #22.

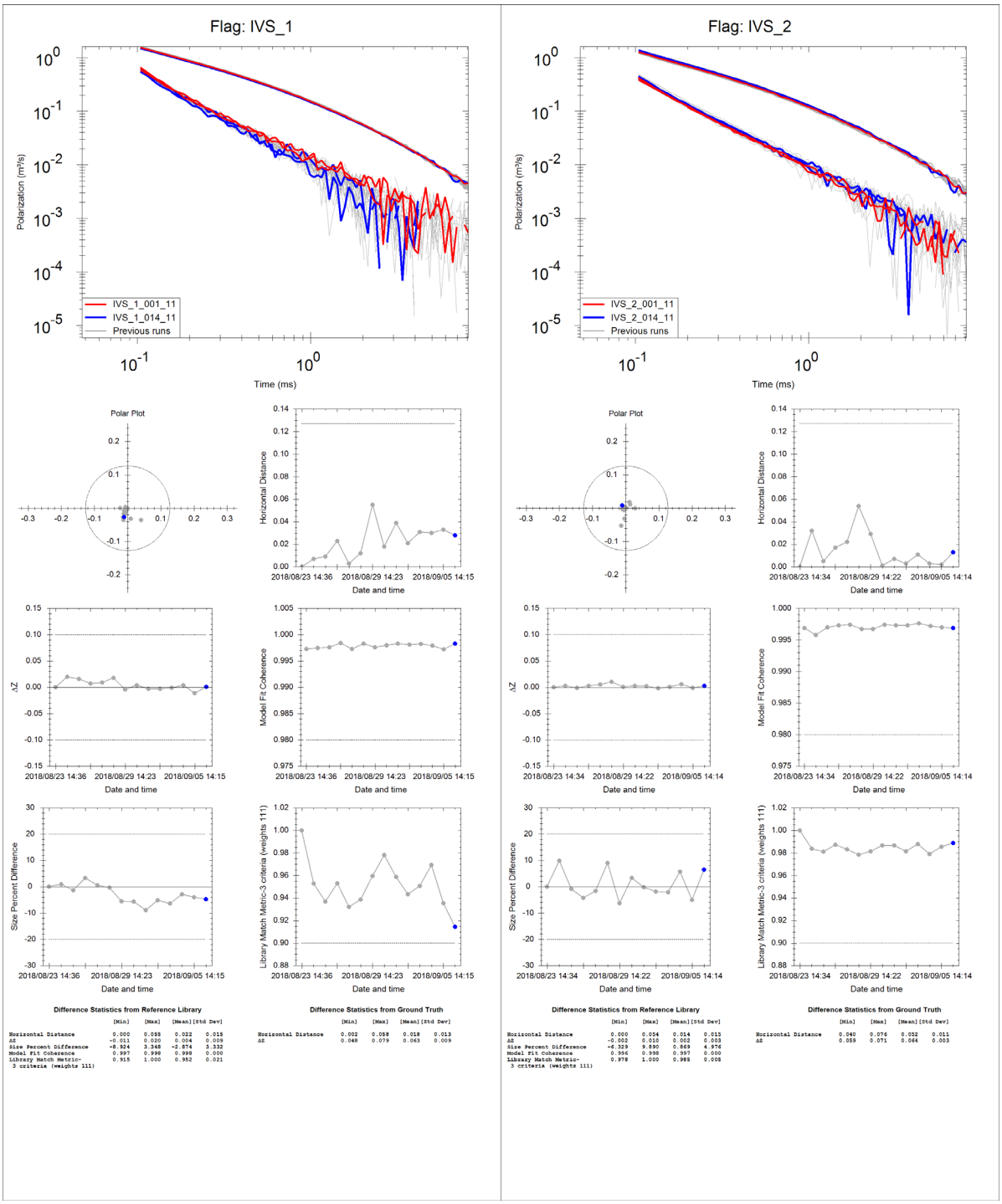


Figure 5. Daily MM2x2 QC tests for IVS items IVS_1 and IVS_2. Dashed lines show MQO acceptance criteria thresholds. MQOs are further discussed in FWV 012 to the AGCMR-QAPP.

6.0 TABLES

Data Type	Data Quality Indicator (DQI)	QC Sample and/or Activity to Assess Measurement Performance	Measurement Quality Objective (MQO)	Frequency	Consequence of Failure (a)
Cable Shake Test	Sensitivity	Instrument Response Tests at the IVS	Cable shake test: 98% of response values will not excseed +/- 2 mV when system cables are moved (for all EM61MK2 channels)	Once Daily (AM)	Do not proceed with DGM field activities until failure is resolved and cable shake test has passed.
Personnel Test	Sensitivity	Instrument Response Tests at the IVS	Personnel test (PP): 98% of response values (due to proximity of data collection personnel) will not exceed +/- 2 mV (for all EM61MK2 channels).	Once Daily (AM)	Do not proceed with DGM field activities until failure is resolved and personnel test has passed.
Tow Vehicle Test	Sensitivity	Instrument Response Tests at the IVS	Tow vehicle test (towed array): 98% of response values (due to elevated two vehicle RPM) will not exceed +/- 2 mV (for all EM61MK2 channels).	Once Daily (AM)	Do not proceed with DGM field activities until failure is resolved and tow vehicle test has passed.
Static repeatability (instrument functionality) (b)	Accuracy/Precision	Instrument Response Tests at the IVS	98% of the daily static background response values (no test object) will not exceed +/- 2 mV of expected baseline response (for all EM61MK2 channels). (d) 98% of the response values to the standard spike test item (a small ISO fixed at an orientation and distance from the sensor to provide an approximately 100 mV response on channel 2 of the EM61MK2) will not exceed +/- 10% of the expected baseline response (for all EM61MK2 channels). (d)	Twice Daily (AM/PM)	If failure occurs during the AM static test, do not proceed with DGM field activities until failure is resolved and AM static test(s) have passed. If failure occurs during PM static test, the day's data fails unless BSI is mapped that day with repeatable anomaly characteristics (see dynamic detection repeatability (GSV blind seeding)).

Along track sampling	Completeness	DGM Data Set or Grid	98% <= 0.65 ft. (20 cm)	By grid or dataset (c)	Submittal fails.
Coverage	Completeness	DGM using GPS Positioning: DGM Data Set or Grid	Category A (towed array): A lane spacing of 2 ft is to be used for the twoed array. 95% (or greater) of the lane spacing is to be at the project design lane spacing of 2 ft. 100% of the lane spacing is to be at 3 ft. No unexplained data gaps. Category B (towed array): A lane spacing of 2 ft is to be used for the towed array. 95% (or greater) of the lane spacing is to be at the project design lane spacing of 2 ft. 98% (or greater) of the lane spacing is to be at 3 ft.	By grid or dataset (c)	Data gaps must be filled in before submittal is accpted.
Dynamic detection repeatability (IVS)	Accuracy/Precision	Instrument Response Tests at the IVS	98% of the dynamic background response values during the daily IVS survey will not exceed +/- 3 mV of expected baseline response (for all EM61MK2 channels). (d) Instrument response to each IVS item will be within +/- 25% or +/- 2 mV(whichever is greater) of the expected baseline response (for all EM61MK2 channels). The baseline response for each IVS item will be the average of the instrument responses to that item measured during the first week of IVS surveys. (d)	Twice Daily (AM/PM)	If failure occurs during the AM IVS test, do not proceed with DGM field activities until failure is resolved and AM dynamic IVS test(s) have passed. If failure occurs during PM IVS test, the day's data fails unless BSI is mapped that day with repeatable anomaly characteristics (see Dynamic Detection Repeatability (GSV blind seeding)).
Dynamic detection repeatability (GSV blind seeding)	Sensitivity/Accuracy/Precision/Completeness	DGM Data Set or Grid	All BSIs must be located. Peak response >75% of maximum expected BSI response. (d)	1 per day per team (# per acre to be based on production rate)	Submittal fails.

Dynamic positioning repeatability (IVS)	Accuracy/Precision	Instrument Response Tests at the IVS	Position offset of IVS targets < 25 cm.	Twice Daily (AM/PM)	If failure occurs during the AM IVS test, do not proceed with DGM field activities until failure is resolved and AM dynamic IVS test(s) have passed. If failure occurs during PM IVS test, the day's data fails unless BSI is mapped that day with repeatable anomaly characteristics (see Dynamic Positioning Repeatability (GSV blind seeding)).
Dynamic positioning repeatability (GSV blind seeding)	Sensitivity/Accuracy/Precision/Completeness	DGM Data Set or Grid	90% positioning offset is <= 25 cm + 1/2 line/sensor spacing and 100% is <= 35 cm + 1/2 line/sensor spacing for digital positioning systems. For Towed Array DGM using 2 ft line spacing (Category A and Category B) and RTK-GPS: 90% <= 22 inches 100% <= 26 inches	1 per team per day (# per acre to be based on production rate - same as dynamic detection repeatability (GSV blind seeding)).	Submittal fails.
Velocity	Completeness	DGM Data Set or Grid	95% of all geophysical measurements with the EM61MK2 will be collected at a speed not to exceed 4 miles per hour (1.8 meters per second)	By grid or dataset (c)	Submittal fails.
Target Selection	Completeness	DGM Data Set or Grid	All dig list targets are selected according to project design as detailed in the SSWP	By grid or dataset (c)	Submittal fails.
Geodetic equipment functionality	Accuracy/Precision	GPS Function check at IVS	GPS position checks will not exceed +/- 3 inches (7.6 cm) from the established baseline position.	Once Daily (AM)	Do not proceed with DGM field activities until failure is resolved and positional check has passed.

Geodetic accuracy	Accuracy/Precision	GPS Function Check of Positional monuments used for RTK-GPS base station(s)	Project control points that are used more than once must be repeatable to within 5 cm (e).	For points used more than once, occupation will be repeated (f) for each point used, either monthly (for frequently used points) or before re-use (if used infrequently) (g).	Reset points not located at original locations or resurvey point.
Verify Field Work Methods	Accuracy/Precision	QC Geophysicist will monitor field team work methods.	Verify work methods are being performed in accordance with MEC QAPP, SOPs, and SSWP.	Daily	Stop work. Generate an RCA, CAR, and CAP (as necessary). Implement corrective actions.
DGM Data Reprocessing	Sensitivity/Accuracy/Precision/Completeness	10% of DGM Data Set or Grid	DGM data will be reprocessed by the QC Geophysicist in accordance with GEO SOP 8 (Geophysical QC).	Daily	Stop work. Generate an RCA, CAR, and CAP (as necessary). Implement corrective actions.

Table 1. DGM MQO table for person-portable EM61 system.

(a) All failures require an RCA.

(b) Duration of data collection is 1 minute for background, 1 minute for spike and 1 minute for second background measurement. All static repeatability is to be compared to original readings to ensure instrument is consistent throughout the project.

(c) The terms grid and dataset refer to logical groupings of data or data collection event. Logical groupings of data are contiguous areas mapped by the same instrument and in the same relative timeframe. These can be grids, acres, or some other unit of area. A data collection event is similar to logical groupings of data but refers to data collected over a contiguous timeframe, such as morning, afternoon, battery life, or some other measure of contiguous time.

(d) For static background, the expected baseline mV response is to be based on an average of all the static background readings collected during the first four days (or first week). For static spike the expected baseline peak mV response is to be based on an average of all the static spike readings collected during the first four days (or first week). For the IVS background, the expected baseline mV response is to be based on an average of all the IVS background readings for the first four days (or first week). For the IVS spike, the expected baseline mV response is to be based on an average of all the IVS spike readings for the first four days (or first week). For GSV BSI items the baseline mV response will be determined by recording an additional survey line that is offset ½ of the planned survey line spacing (1 ft) from the center of the seeded IVS line. This offset line will be recorded twice daily (am/pm) during the first four days (or first week) of DGM operation with the PP system(s) and the baseline mV response to be used for BSIs (for PP and towed array systems) will then be calculated by averaging all of the peak readings for each ISO at this 1 ft offset. Note that separate baselines will be generated and used for the PP and towed-array system static and IVS tests.

(e) GPS base station coordinates that are currently being used are provided by USACE/BRAC.

(f) Repeat occupation means demonstrate the control points being used can be recovered and reoccupied and that they have not moved more than the requirement specification. This can be accomplished using the same methodology used to initially tie the local network to a HARN, CORS, OPUS, or other recognized network, or it can be accomplished by other means that achieve this requirement.

(g) An example of frequently used control points would be points used as RTK DGPS base stations. Infrequently used points could be those used during GPS operations where the control point was used during mapping and then again at some later time for reacquisition and QC statistical sampling. Infrequently used points also could include grid corners; they are used for line and fiducial positioning and then reused for reacquisition or QC statistical sampling.

Note: Although it is highly unlikely, should an area originally categorized and seeded for Category B (i.e. seeded for DGM at a rate of approximately 1 Blind Seed Item (BSI) for every 4 acres and not planned for intrusive investigation) then be upgraded to Category A after DGM has been completed (i.e. should be seeded at a rate of 1 BSI per dig team per day and planned for intrusive investigation), that if the dig team does not have 1 BSI per dig team per day that this would not constitute a QC failure because the density of BSIs installed would have been based on the original selection of this area as Category B. The rationale for stating this scenario is that once the DGM data has been collected, it is impossible to add additional BSIs (i.e. add additional anomalies to the previously collected DGM data). If this scenario does occur, it has been identified in the QAPP and discussed in relation to QC objectives and their pass/fail criteria.

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
QC seed item placement	Place Subsurface QC Seeds/ SOP AGCMR-03	Evaluated for each QC seed item	QC Geophysicist / Final Seed Report	Each seed item has been buried away from the immediate vicinity of strong anomalies, the burial parameters have been recorded with 1-inch precision for locations, 2-inch precision for depths, and 10° precision for inclinations and azimuths, and a photograph has been taken of the item in place.	CA: Replace the seed item, if necessary, or reacquire burial parameter information prior to commencement of data acquisition activities.
Verify correct MetalMapper 2x2 assembly	Cued Classification Survey/ SOP AGCMR-01	Once following assembly	Data Acquisition Geophysicist/Assembly Checklist	As specified in SOP AGCMR-01, Assembly Checklist	CA: Make necessary adjustments and re-verify
Initial sensor function test (five measurements over an emplaced IVS item, 1 with item directly under center of array and 1 each with item centered under each diagonal quadrant of the array). Derived polarizabilities for each measurement are compared to the classification library using UXA	Cued Classification Survey/ SOP AGCMR-01/ SOP AGCMR-08	Once following assembly	Data Acquisition Geophysicist/Assembly Checklist/Lead Data Processor	Library Match metric ≥ 0.95 for each of the five sets of inverted polarizabilities	CA: make necessary repairs/adjustments and re-verify
Initial sensor function test (five measurements over an emplaced IVS item, 1 with item directly under center of array and 1 each with item centered under each diagonal quadrant of the array). Modeled locations are compared to the known location of the schedule 80 small industry standard object (ISO 80) for each measurement.	Cued Classification Survey/ SOP AGCMR-01/ SOP AGCMR-08	Once following assembly	Data Acquisition Geophysicist/Assembly Checklist/Lead Data Processor	Modeled location of each measurement is under the correct quadrant of the TEMTADS sensor array	CA: make necessary repairs/adjustments and re-verify

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
Initial IVS background measurement (five background measurements – 1 centered at the flag and 1 offset 15 inches (40cm) in each cardinal direction)	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Once during initial system IVS test	Data Acquisition Geophysicist/Initial IVS Technical Memorandum/ Lead Data Processor	Decay amplitudes are below the selected background threshold at each offset background location	CA: reject/replace BG location
Initial derived polarizabilities accuracy (IVS)	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Once during initial system IVS test	Lead Data Processor and Gilbane Project Geophysicist/Initial IVS Technical Memorandum	Library Match metric ≥ 0.9 for each set of inverted polarizabilities	RCA/CA
Initial derived target position accuracy (IVS)	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Once during initial system IVS test	Lead Data Processor and Gilbane Project Geophysicist/Initial IVS Technical Memorandum	All IVS item fit locations within 5 inches of ground truth locations	RCA/CA
Ongoing IVS background measurements	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Twice daily as part of IVS testing	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	All decay amplitudes lower than project threshold and qualitatively agree with initial measurement	RCA/CA CA assumption: rejection of BG measurement (unless RCA indicates system failure)
Ongoing derived polarizabilities precision (IVS)	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Twice daily as part of IVS testing	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	Library match to initial polarizabilities metric ≥ 0.9 for each set of three inverted polarizabilities	RCA/CA
Ongoing derived target position precision (IVS)	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Twice daily as part of IVS testing	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	All IVS item fit locations within 5 inches of average of derived fit locations	RCA/CA
Initial measurement of production area background locations	Cued Classification Survey/ SOP AGCMR-04/ SOP AGCMR-08	Once per background location	Data Acquisition Geophysicist and Lead Data Processor/ tracking summary	All decay amplitudes lower than project threshold	CA: reject BG location and find alternate
Ongoing production area background measurement frequency	Cued Classification Survey/ SOP AGCMR-04/ SOP AGCMR-07	Evaluated for each background measurement	Data Acquisition Geophysicist/failures noted in field log and tracking summary	Time separation between background measurement and anomaly measurement < 2 hour	CA: reject data that does not have a corresponding background measurement recorded within acceptable time period
Ongoing production area background measurement	Cued Classification Survey/ SOP AGCMR-04/ SOP AGCMR-07/ SOP AGCMR-08	Evaluated for each background measurement	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	All decay amplitudes lower than project threshold and qualitatively agree with initial measurement	CA: background measurement rejected and reacquired

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
Transmit current levels	Cued Classification Survey/ SOP AGCMR-07	Evaluated for each sensor measurement	Data Acquisition Geophysicist/failures noted in field log and tracking summary	Peak transmit current ≥ 5.5 amps	CA: reject data acquired with current levels outside of the acceptable range
Initial anomaly (flag) location interrogated	Cued Classification Survey/ SOP AGCMR-07/ SOP AGCMR-08	Evaluated for each flag position	Data Acquisition Geophysicist/failures noted in field log and tracking summary	For each anomaly, a measurement must be acquired with the center of the array < 16 inches from the flag location.	CA: Reacquire measurement at flag location
Position data are valid (1 of 2)	Cued Classification Survey/ SOP AGCMR-07	Evaluated for each sensor measurement	Data Acquisition Geophysicist/failures noted in field log and tracking summary	GPS status flag indicates RTK fix	RCA/CA
Position data are valid (2 of 2)	Cued Classification Survey/ SOP AGCMR-07/ SOP AGCMR-08	Evaluated for each sensor measurement	Data Acquisition Geophysicist/Lead Data Processor/tracking summary	Orientation data valid Data input string checksum passes	RCA/CA
Confirm inversion model supports classification (1 of 2)	Cued Classification Survey/ SOP AGCMR-08	Evaluated for all models derived from a measurement (i.e., single item and multi-item models)	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	Derived model response must fit the observed data with a fit coherence > 0.8	CA: If no valid model is derived, classify as inconclusive
Confirm inversion model supports classification (2 of 2)	Cued Classification Survey/ SOP AGCMR-08	Evaluated for derived target	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	Fit location estimate of item ≤ 15 inches from center of sensor	CA: If no target within 15 inch radius using multi-solver inversion, classify as inconclusive
Confirm all anomalies classified	Cued Classification Survey/ SOP AGCMR-08	Evaluated for each anomaly (flag) location	Lead Data Processor and Gilbane Project Geophysicist/tracking summary	100% of anomalies are classified as: TOI/ Non-TOI/Inconclusive	Documentation required identifying reason for missing data with RCA/CA if necessary. If data cannot be acquired, classify as inconclusive.
Confirm reacquisition GPS accuracy and precision	Intrusive Investigation/ SOP AGCMR-09	Daily	Reacquisition Geophysicist/Daily Report	Benchmark positions repeatable to within 3 inches	CA: Make adjustments and re-verify
Confirm derived features match ground truth (1 of 2)	Intrusive Investigation/ SOP AGCMR-09	Evaluated for all recovered items	QC Geophysicist/QC reports	95% of recovered item positions < 10 inches from predicted position	RCA/CA
Confirm derived features match ground truth (2 of 2)	Intrusive Investigation/ SOP AGCMR-09	Evaluated for all recovered seed items	QC Geophysicist/QC reports	100% of predicted seed item positions < 10 inches from known position	RCA/CA

MQO	DFW/SOP Reference	Frequency	Responsible Person/Report Method	Acceptance Criteria	Failure Response
Classification performance	Intrusive Investigation/ SOP AGCMR-09	For each delivered dig list	QC Geophysicist/QC reports	100% of seed items classified as TOI	RCA/CA
Classification validation	Intrusive Investigation/ SOP AGCMR-09	For each delivered dig list	QC Geophysicist/QC reports	100% of predicted intrusively investigated non-TOI are confirmed to be non-TOI	RCA/CA

Table 2. MetalMapper 2x2 cued measurement MQO table

Seed ID	Grid	Reported Sum Response (mV)	Response Passes?	Total Offset (in)	Positioning Passes?
P16001G	Pond 16	369.28	Yes	3.40	Yes

Table 3. Blind QC seed response and positioning results in Vernal Pond 16.