Final
MRS-16 Munitions and Explosives of Concern
Remedial Action Report
Former Fort Ord, California

Total Environmental Restoration Contract
Contract No. DACW05-96-D-0011
Task Order No. 016

Submitted to:
U.S. Department of the Army
Corps of Engineers
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Revision 1
July 2009

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Table of Contents

Table of Contents (cont)

List of Tables

List of Figures

List of Photographs

List of Appendices

Acronym List

ARAR	Applicable or Relevant and Appropriate Requirements
Army	United States Department of the Army
ASCII	American Standard Code for Information Interchange
BLL	Black Legless Lizard
BLM	Bureau of Land Management
BRA	Basewide Range Assessment
BRAC	Base Realignment and Closure
CAR	Corrective Action Request
CD	compact disk
cm	centimeter
CMC	central maritime chaparral
CSM	Conceptual Site Model
CTS	California Tiger Salamander
DGM	digital geophysical mapping
DID	data item description
DMM	discarded military munitions
DTSC	Department of Toxic Substances Control
EM	electro-magnetic
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FS	feasibility study
FWV	Field Work Variances
GPO	geophysical prove-out
GPS	global positioning system
HA	Historical Area
HE	high explosives
HEAT	high explosive anti-tank
HLA	Harding Lawson Associates (now known as Mactec)
HMP	Habitat Management Plan
IA	Interim Action
lbs	pounds
MD	munitions debris
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
mm	millimeter
MMRP	Military Munitions Response Program
MPPEH	materials potentially presenting an explosive hazard
MQO	measurement quality objective
MR	munitions response
MRA	munitions response area
MRS	munitions response site
mV	milliVolt
ODDS	Ordnance Detection and Discrimination Study

OE	ordnance and explosives
OE SS	ordnance and explosives safety specialist
PDA	personal digital assistant
POMFD	Presidio of Monterey Fire Department
QA	quality assurance
QC	quality control
RA	Remedial Action
RI	Remedial Investigation
ROD	record of decision
RRD	range related debris
RTK	real time kinematic
SPK	Sacramento District U S Army Corps of Engineers
SSWP	site specific work plan
SUXOS	Senior Unexploded Ordnance Supervisor
TCRA	Time Critical Removal Action
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
UXO	unexploded ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
WiFi	wireless transmitter
WWII	World War II

Definitions[1]

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

Military Munitions - Military munitions means all ammunition products and components produced for or used by the armed forces for national defense and security, including ammunition products or components under the control of the Department of Defense, the Coast Guard, the Department of Energy, and the National Guard. The term includes confined gaseous, liquid, and solid propellants, explosives, pyrotechnics, chemical and riot control agents, smokes, and incendiaries, including bulk explosives and chemical warfare agents, chemical munitions, rockets, guided and ballistic missiles, bombs, warheads, mortar rounds, artillery ammunition, small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges, and devices and components thereof.

The term does not include wholly inert items, improvised explosive devices, and nuclear weapons, nuclear devices, and nuclear components, except that the term does include non-nuclear components of nuclear devices that are managed under the nuclear weapons program of the Department of Energy after all required sanitization operations under the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) have been completed. 10 U.S.C 101(e)(4)(A)

Munitions Constituents (MC) – Any materials originating from unexploded ordnance (UXO), discarded military munitions (DMM), or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions. (10 U.S.C. 2710 (e)(3))

Munitions Debris – Remnants of munitions (e.g. fragments, penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization or disposal)

Munitions and Explosives of Concern (MEC)[2]– This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks, means: (A) Unexploded Ordnance (UXO), as defined in 10 U.S.C. 101 (e) (5);

1 Official definitions provided in the April 21, 2005 memorandum from the Office of the Assistant Secretary of the Army (Installations and Environment), "Munitions Response Terminology"

2 For the purposes of the basewide Military Munitions Response Program (MMRP) being conducted for the former Fort Ord, MEC [DMM, UXO] does not include small arms ammunition .50 caliber and below.

(B) Discarded military munitions (DMM), as defined in 10 U.S.C. 2710 (e) (2); or (C) Munitions constituents (e.g., TNT, RDX) as defined in U.S.C. 2710 (e)(3), present in high enough concentrations to pose an explosive hazard

Munitions Response – Response actions, including investigation, removal and remedial actions to address the explosives safety, human health, or environmental risks presented by unexploded ordnance (UXO), discarded military munitions (DMM), or by munitions constituents (MC) or to support a determination that no removal or remedial action is required

Material Potentially Presenting an Explosive Hazard (MPPEH) - Material potentially containing explosives or munitions (e.g., munitions containers and packaging material; munitions debris remaining after munitions use, demilitarization, or disposal; and range-related debris); or material potentially containing a high enough concentration of explosives such that the material presents an explosive hazard (e.g., equipment, drainage systems, holding tanks, piping, or ventilation ducts that were associated with munitions production, demilitarization or disposal operations). Excluded from MPPEH are munitions within DoD's established munitions management system and other hazardous items that may present explosion hazards (e.g., gasoline cans, compressed gas cylinders) that are not munitions and are not intended for use as munitions.

Munitions Response Area (MRA) – Any area on a defense site that is known or suspected to contain UXO, DMM, or MC. Examples include former ranges and munitions burial areas. A munitions response area is comprised of one or more munitions response sites

Munitions Response Site (MRS) - A discrete location within a MRA that is known to require a munitions response

Range-related Debris – Debris, other than munitions debris, collected from operational ranges or from former ranges (e.g. target debris, military munitions packaging and crating material).

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

1.0 Introduction

This Remedial Action Report (RA Report) describes the work elements and results for the munitions and explosives of concern (MEC) remedial action conducted at Munitions Response Site 16 (MRS-16) at the former Fort Ord, California. The work was performed by Shaw Environmental (Shaw) for the United States Army Corps of Engineers (USACE) – Sacramento District Contract No. No. DACW05-96-D-0011., Task Order No. 0016. This work has been completed in accordance with the USACE Statement of Work (Appendix A), the *Final Work Plan, MRS-16 Munitions and Explosives of Concern Removal, Former Fort Ord (Final Work Plan,* Shaw, 2006a*),* and the *Record of Decision, Interim Action for Ordnance and Explosives at Ranges 43-48, Range 30A, and Site OE-16, Former Fort Ord, California* (*IA ROD*, Army, 2002).

1.1 Purpose and Scope

The scope of this task order was to complete the munitions response in approximately 80 acres of former Fort Ord land known as MRS-16.

This RA Report details the work completed as part of the Fort Ord MRS-16 MEC remedial action and provides discussion of the following tasks:

- MEC removal area boundary survey.
- Anomaly reacquisition and investigation using digital geophysical mapping (DGM) data.
- MEC detection and removal activities using mag & dig surveys.
- Quality and safety oversight.
- Explosives management.
- Munitions debris management.
- Project documentation and reporting.

The RA Report describes work conducted by Shaw plus work conducted by other contractors prior to the Shaw remedial action.

1.2 Approval Documents

The work was conducted in accordance with the *Final Work Plan* (Shaw, 2006a), which was developed in accordance with Huntsville MCX Data Item Description (DID) OE-005-1.01, Type II Work Plan. The *Final Work Plan* (Shaw, 2006a) incorporated the Safety and Health Plan.

As the work progressed, the work plan was amended by field work variances (FWV) as follows:

FWV TII-0016	approval to perform a magnetometer assisted removal in selected grids prior to DGM
FWV TII-0017	defined procedures for real time electro-magnetic (EM)61 surveys in areas where global positioning system (GPS) coverage was impeded by tree canopy
FWV TII-0019	confirmed procedures that excavations would be checked with EM61 and not magnetometer following target removal
FWV TII-0020	defined procedures for real time EM61 surveys in areas where GPS coverage was impeded by tree canopy
FWV TII-0021	defined procedures for interpreting EM data in "noisy area"
FWV TII-0024	defined procedures for completing the grid surveys following shut down due to funding shortage

Field Work Variances are included as Appendix B and are further discussed as appropriate in following sections of the report.

1.3 Project Personnel and Subcontractors

Shaw conducted the work with qualified unexploded ordnance (UXO) technicians who met or exceeded the requirements of DID OE-025.01. The key UXO personnel were:

- Senior Unexploded Ordnance Supervisor (SUXOS): Tim Mathisen/Jack Tortolano
- UXO Quality Control Specialist (UXOQCS): Jack Tortolano/Bruce Tincknell/ Al Grant/Charlie Hutchison
- UXO Safety Officer: Jack Tortolano/Bruce Tincknell/Al Grant/Charlie Hutchison
- Project Geophysicist: Marty Miele

The Task Manager was Kevin Siemann. The Project Manager was Peter Kelsall.

Shaw performed the work detailed in this report with UXO qualified individuals. Staffing included: Jeffrey Steinwand, Tara Volpe, Jimmy Drake, Harley Davidson, John Honer, Josh Jenkins, John Sparks, Tim Herron, Val Valdez, and John Kandcer. Not all listed personnel were on-site at the same time.

Most of the personnel used on the task order were Shaw employees, including all UXO Technicians. The following tasks were subcontracted:

- Vegetation Clearance for Fuel Breaks prior to the Prescribed Burn (Firestop, Bowman-Miller, Inc.)
- Vegetation Clearance following the Prescribed Burn (Firestop, Bowman-Miller, Inc.)
- Disposal of Munitions Debris (FACT International)

1.4 Health and Safety

One recordable safety incident occurred during the MRS-16 project; this was a poison oak exposure that required a clinic visit. One non-recordable safety incident occurred during the project; this incident was carpal tunnel syndrome due to a repetitive motion injury (swinging a Schonstedt). There was one non-reportable vehicle incident that resulted in property damage during the project; this incident involved a General Services Administration vehicle impacting a gate at the entrance to MRS-16.

1.5 Report Organization

This RA Report was prepared in accordance with the preparation instructions outlined in *MR-030, Site Specific Final Report* (USACE DID). The report also incorporates elements of U.S. Environmental Protection Agency (EPA) guidance for a RA Report.

Sections of this RA Report are organized as follows:

Section 1: Introduction

Section 2: Site Background

Section 3: Overview of RA

Section 4: Site Preparation

Section 5: Analog Removal

Section 6: DGM Operations

Section 7: Quality Assurance (QA)/Quality Control (QC)

Section 8: MEC and munitions debris (MD) Removal

Section 9: Environmental Protection

Section 10: Protectiveness Assessment

Section 11: References

Appendix A: Task Order Statement of Objectives

Appendix B: Field Work Variances

Appendix C: MRS-16 Technical Letter for Preparatory Action

Appendix D: White Paper Regarding Noisy Area

Appendix E: DD Form 1348-1A (MD and Metal Debris Documentation)

Appendix F: EM61 Surveys of Trenches Within Saturated Area

Appendix G: DGM Data Forms [found on separate compact disk (CD)]

Appendix H: Daily QC, Safety, SUXOS forms

Appendix I: USACE Form 948

Appendix J: Corrective Action Request (CARs)

Appendix K: Target List (found on separate CD)

Appendix L: Explosives Accountability

Appendix M: MEC Risk Assessment for MRS-16

Appendix N: DGM QA Approval and Discussion

Appendix O: DGM QC Plan Addendum

Appendix P: Single Grid DGM Maps and Grid Tracking Sheets (available upon request)

Appendix Q: Response to Comments

1.6 Applicable or Relevant and Appropriate Requirements

Applicable or Relevant and Appropriate Requirements (ARARs) were outlined in the *IA ROD* (Army, 2002). The performance of this interim remedial action was in compliance with the ARARs outlined in that document.

2.0 Site Background

2.1 Site Location

Fort Ord is a former military installation that comprises approximately 46 square miles in northwestern Monterey County, California, and is located approximately 120 miles south of San Francisco. Monterey Bay forms the western boundary of the former Fort Ord, and the Santa Lucia Range bounds the former Fort Ord to the south. The cities of Marina and Seaside, and the Salinas Valley are northwest, southwest, and east of the former Fort Ord, respectively. MRS-16 is located roughly in the center of the former Fort Ord (Figure 2-1).

Munitions Response Site-16 is bounded by the former Fort Ord Impact Area and Eucalyptus Road to the south, and by Parker Flats Road and Watkins Gate Road to the north and east (Figure 2-2).

2.1.1 Population, Proximity, and Access

Prior to the RA, MRS-16 was enclosed by a 6-foot high chain link fence and access was restricted to authorized personnel only. The fence was maintained through an inter-service support agreement with the Bureau of Land Management (BLM) and security was governed by the MRS Security Program (Army, 2005) implemented by the United States Department of the Army (Army).

Munitions Response Site-16 is approximately one mile from a residential neighborhood (Fitch Park) on the former Fort Ord. MRS-16 is also located adjacent to the Impact Area and land that has been transferred to BLM. The immediately adjacent BLM land is open to the public for activities such as hiking, biking, jogging, and horseback riding.

As a result of completing the RA, the boundary fence around MRS-16 has been removed.

2.1.2 Reuse

The land that includes MRS-16 is intended to be transferred to BLM (USACE, 1995) and will be maintained as undeveloped habitat reserve under the *Installation-Wide Multispecies Habitat Management Plan* (HMP) *for former Fort Ord* (USACE, 1997), which describes special land restrictions and habitat management requirements within habitat reserve areas. Habitat reserve areas support plant and animal species protected under the Endangered Species Act that require implementation of mitigation measures identified in the HMP to minimize potential adverse impacts to listed species.

2.1.3 Vegetation and Habitat Type

Baseline vegetation conditions for MRS-16 have been previously documented in the 1996 Annual Monitoring Report (Harding ESE, 1996), and in the 2007 MRS-16 Fuel Breaks Baseline Biological Monitoring Report (Shaw, 2007a). The MRS-16 vegetation type consists primarily of intermediate-aged to mature central maritime chaparral (CMC) with some grassland areas and coast live oak areas. CMC is a key habitat at Fort Ord and is an extremely rare plant community. Approximately 50 to 85 percent of the worldwide distribution of rare and endangered plants in CMC habitat occur at Fort Ord and these species are designated as protected under the HMP (USACE, 1997).

Along the southern edge of MRS-16, portions of the site contain grassland habitat. The dominant shrub species observed at MRS-16 include shaggy-barked manzanita, chamise, Monterey and tooth-leafed ceanothus, black sage, and sandmat manzanita. These species contribute approximately 63 percent of the overall vegetative cover. Prior to the prescribed burn, dense CMC vegetation obscured the presence of MEC.

Surveys for HMP herbaceous annual species conducted at MRS-16 in 1996 identified low densities of Monterey spineflower along the south side of the site at the edges of coast live oak woodland, in grasslands and in openings in coastal scrub and chaparral. Surveys also identified several patches of sand gilia on the southern side of the site (Harding ESE, 1996; Shaw, 2007a).

The land that includes MRS-16 is intended to be transferred to the BLM and will remain undeveloped as habitat reserve. Chapter 3 of the HMP (USACE, 1997) describes mitigation measures that must be implemented during MEC investigation and remediation. In addition, there are three biological opinions that contain terms and conditions and reasonable and prudent measures that need to be implemented during MEC activities to minimize and reduce impacts to listed species. Habitat management activities required by the HMP, with the exception of future requirements, have been completed for MRS-16.

2.2 Regulatory Status

After it was established in 1917, Fort Ord primarily served as a training and staging facility for infantry troops. From 1947 to 1975, Fort Ord was a basic training center. After 1975, the 7th Infantry Division was based at Fort Ord. Fort Ord was selected for closure in 1991. The majority of the soldiers were reassigned to other Army posts in 1993. There is no longer an active Army division stationed at the former Fort Ord.

Fort Ord was placed on the National Priorities List of Superfund sites by EPA on February 21, 1990, due to evidence of contaminated soil and groundwater. A Federal Facility Agreement (FFA) was signed by the EPA, Department of Toxic Substances Control (DTSC), and Regional Water Quality Control Board, a part of the California EPA. The FFA established procedures and schedules for conducting remedial investigations (RIs) and feasibility studies (FSs) and requires remedial actions be completed as expeditiously as possible. The former Fort Ord was selected in 1991 for base realignment and closure (BRAC), and the base was officially closed in September 1994. The Army began investigating and removing MEC at the former Fort Ord after the BRAC listing and a munitions response (MR) RI/FS began in 1998. In April 2000, an agreement was signed between the Army, EPA and DTSC to evaluate MEC at the former Fort Ord subject to the provisions of the FFA. The April 2000 agreement also formalized the regulatory agencies' roles in the Military Munitions Response Program (MMRP) at Fort Ord.

The Army, as the lead agency, determined that an interim action (IA) was appropriate for three sites including MRS-16 [formerly ordnance and explosives (OE) Site-16] at the former Fort Ord. The remedial alternatives were evaluated in the *Final Interim Action OE Remedial Investigation/Feasibility Study for Ranges 43-48, Range 30A, Site OE-16* (Harding ESE, 2002). The rationale for taking an IA and the selected remedies are documented in the *Record of Decision, Interim Action for Ordnance and Explosives at Ranges 43-48, Range 30A, and Site OE-16, Former Fort Ord, California* (Army, 2002). The selected remedies for the IA sites including MRS-16 are: (1) vegetation clearance via prescribed burning, (2) MEC remedial action via surface and subsurface MEC removal, and (3) detonation of MEC with engineering controls.

2.3 Site Features and History of Military Munitions Use

Munitions Response Site-16 includes approximately 80 acres located immediately north of the former Fort Ord munitions response area (MRA), between Eucalyptus and Parker Flats roads and bounded by Watkins Gate Road to the east. The boundaries for MRS-16 were established at existing paved roads, where they existed, for administrative purposes in the *IA ROD* (Army, 2002). Prior to the signature of the ROD described above, the site boundaries were smaller and encompassed only the immediate extent of the "bazooka practice" area shown on former Fort Ord training maps. This site will become habitat reserve and will remain undeveloped. The BLM land (immediately adjacent) is open to the public for hiking, biking, jogging, and horseback riding. Prior to implementation of the remedial action the site was surrounded by a temporary 6-foot high chain link fence and was posted with signs warning of the dangers associated with unexploded ordnance. The vegetation at MRS-16 mainly consists of CMC with some grassland areas.

The site is a World War II (WWII) era rocket range, and is identified as a "bazooka practice" area on Fort Ord Training Facilities maps dating from 1945 and 1946. Available training maps after 1946 do not identify the bazooka training area. According to Fort Ord Range Control, this range was probably used as an antitank rocket range during and shortly after WWII. Available information indicates that MRS-16 had been used for training and live fire exercises from approximately the 1940s until the time the base was officially closed in 1994. Practice and high explosive anti-tank (HEAT) rockets and rifle grenades were used in the 1940s and possibly in the 1950s. The site was later used for a portion of time as an anti-armor training area. Evidence from the site indicates that both practice and HEAT 2.36-inch rockets were used.

2.4 Summary of MEC-Related Activities and Data Collected Prior to the Remedial Action

Various MEC cleanup, site characterization, and limited MEC sampling and removal activities were performed at MRS-16 prior to the removal action described in this report.

- In 1991, during a controlled burn of land immediately adjacent (to the northeast) of MRS-16, numerous 2.36-inch rockets and rifle grenades were found, some of which contained high explosive filler. On the basis of this discovery, a recommendation was made to perform a MEC removal over the burned area. Approximately 1,000 rockets were removed as a result of this action. This report is not documented in an After Action Report, but is based on interviews with range control personnel employed at Fort Ord at the time.

- In 1998, a 30-foot wide fuel break composed of contiguous 30 by 110-foot grids placed around the perimeter of the "bazooka training" area were subjected to a complete removal to a depth of four feet over each grid. Numerous MEC were found during this removal activity, including high explosives (HE) and practice 2.36-inch rockets; practice anti-tank mines; HEAT, practice, and smoke projectiles, 37 millimeter (mm) projectiles, rifle grenades, grenade fuzes; and illumination signals (USA, 2001).

- A portion of MRS-16 was investigated as part of the Field Trial Sites phase of the Ordnance Detection and Discrimination Study (ODDS) (Parsons, 2002a)

- Site characterization data was presented in the IA RI/FS that included a literature review and evaluation of previous MR work (Harding ESE, 2002);

- A Time Critical Removal Action (TCRA) of surface MEC in accessible areas was conducted (Parsons, 2002b) as the first phase of implementing the IA MEC removals described in the IA RI/FS (Harding ESE, 2002). GPS tracking points were recorded to determine areas covered during the TCRA. The MEC surface removal was initially conducted over the trails, paths, and accessible areas within an 18-acre portion of MRS-16 within the previously established fuel break. When MEC was found near the site boundary, the surface removal operations extended outside the site boundary in 200-foot increments from the MEC that was found near the site boundary. The operations continued until no MEC was found within a 200-foot extension or until the operations reached approximately 1,200 feet from the MRS-16 firing line. The operations did not extend into the Impact Area. A total of seven suspected MEC items were encountered during the limited surface removal. Of the seven suspected MEC items, five were determined to be MEC items and were detonated; two of the items were X-rayed and then determined to be MD. In addition, 514 pounds of MD were collected (not including the two suspected MEC items that were determined to be inert/expended after demolition operations were completed). The MD that was encountered was comprised primarily of 2.36-inch M7 practice rockets.

A list of the MEC items discovered and removed prior to the work detailed in this report is provided in Table 2-1. There are 81 UXO or discarded military munitions (DMM) items listed in Table 2-1, including "insufficient data items" assumed to be UXO to be conservative. Insufficient data items are items that are suspected to be UXO or DMM, but, due to a lack of records or complete consumption during detonation operations, cannot be confirmed to be either UXO or DMM. In addition, over 8,600 MD items were found during these activities. The locations of MEC items found prior to the Shaw work are shown on Figure 2-3.

3.0 Overview of Remedial Action

3.1 Remedial Action Objectives

The *IA ROD* (Army, 2002) was signed in August, 2002. The Interim RA Objectives were to reduce risks to human health and the environment associated with MEC and to comply with federal and state ARAR. IA alternatives for IA site MRS-16 included the following components:

- Vegetation Clearance Alternatives
- MEC RA Alternatives
- MEC Detonation Alternatives

Prescribed burning was chosen as the vegetation clearance RA alternative. Prescribed burning is the use of fire under a specific set of conditions to burn vegetation. Prescribed burning is used in a large number of plant communities in California to achieve a range of objectives. The most common uses of prescribed burning are: fuel hazard reduction and control; range improvement; agricultural land clearing; commercial forest stand improvements; slash reduction or removal (tree cutting operations); and habitat maintenance or enhancement. The CMC community that occurs at the former Fort Ord is similar to other California chaparral associations, having herbaceous and shrub plant species which are considered dependent on fire for reproduction. Reproductive strategies that relate to the occurrence of fire include the release of dormancy by heating and the reduction or alteration of chemicals either on the seed coat or in the soil, which inhibit reproduction. Several of these plant species are either uncommon or endemic to the Monterey Peninsula, and include federally endangered and threatened species. These species are subject to management provisions of the HMP (USACE, 1997) that include the use of prescribed burning for habitat maintenance or enhancement.

Surface and subsurface MEC[3] removal was chosen as the MEC RA Alternative. Surface and subsurface MEC removal consists of identification of MEC (conduct a visual search and operate MEC detection equipment), and remediation of any MEC found/detected on the ground surface and in the subsurface to depths determined in each site-specific work plan. Subsurface MEC removal depths were determined based on: 1) the type and amount of MEC; 2) the typical depth at which the type of MEC is found: 3) planned reuse of specific areas within the IA site: and 4) the capabilities of the geophysical detection equipment selected as best suited for site conditions by the MEC site geophysicist.

Detonation with Engineering Controls was chosen as the MEC Detonation Alternative. The Detonation with Engineering Controls Alternative consisted of applying explosive charges to

3 The term "OE" was used in the ROD, but is replaced here by the more current acronym, "MEC"

single or consolidated MEC items, and applying engineering controls (covering the MEC with tamped dirt, sandbags, contained water, or other materials) prior to detonation. These controls reduce the blast, fragmentation, emissions or noise that are associated with the detonation. This method is applicable and well suited for detonations at the IA site because it can be performed in any location MEC is found during remediation of MEC.

The *Final Work Plan* (Shaw, 2006a) for MRS-16 outlined the surface removal approach and planned subsurface MEC removal depths. During the formulation of the Final Work Plan, it was determined that subsurface OE removal would be to depth of detection. Any MEC encountered at the site was to be removed regardless of the depth. The Final Work Plan was developed with input from the regulatory agencies and public, and was approved by the regulatory agencies.

3.2 MEC Remedial Action

3.2.1 Remedial Action Chronology

The following field activities were conducted to implement the MEC RA at MRS-16:

- Fuel Break Habitat monitoring
- Fuel Break Vegetation Clearance
- Debris Removal
- Geophysical prove-out (GPO) and Report
- Prescribed Burn and Support Activities
- Vegetation Clearance following Prescribed Burn
- Site Set Up and Survey
- Surface Removal
- Digital Geophysical Survey
- Reacquisition of Digital Anomalies
- Excavation of Digital Anomalies
- Real Time EM61 Survey
- MEC Detonation
- Munitions Debris Disposal
- Removal of Site Fence

The prescribed burn for MRS-16 was conducted on October 19 & 20, 2006. The MEC RA at MRS-16 followed in three phases due to funding and environmental constraints:

1. The first phase of MEC field work started in December, 2006, and was temporarily stopped in July, 2007, due to funding constraints.

2. The second phase of MEC field work started in March, 2008, and was temporarily stopped in May, 2008, due to environmental constraints, specifically to minimize impacts during Sand Gilia and Monterey Spineflower germination.

3. The final phase of MEC field work was completed in June, 2008, following completion of Sand Gilia and Monterey Spineflower germination.

Table 3-1 provides a summary of major events associated with the RA at MRS-16.

3.2.2 Variations from the Site Specific Work Plan

The *Final Work Plan* (Shaw, 2006a) called for the following remedial methods to be as applied to the entire site following the prescribed burn:

- Surface removal
- Subsurface removal by means of DGM and reacquisition and excavation of anomalies.

The surface removal was conducted as planned. The methods used for subsurface removal were revised by FWVs (Appendix B) to account for site conditions for several reasons as described below:

- The DGM mapping phase revealed an area in the western portion of the site with a high density of anomalies (referred to as the "saturated area"). Shaw and the USACE jointly determined that "mag and dig" would be performed for subsurface removal for a portion of this area, with reacquisition and excavation based on DGM performed for the remaining part of the saturated area. These areas are shown in Figure 3-1. Production costs for the "mag and dig" and DGM portions would then be compared to document subsurface removal costs for future sites. FWV TII-016 addressed this change to the procedures established in the *Final Work Plan,* (Shaw, 2006a). "Mag and dig" operations were completed but significant anomalies remained following these operations.

- Based on work conducted in the saturated area (Section 5.3), Shaw and the USACE determined that the area shown on Figure 3-1 could not be completed by conventional analog or DGM methods. This area was addressed in FWV TII-016 (Appendix B). An evaluation determined that the only feasible method that could be used in this area would be sifting. The Army then determined that the subsurface removal would not be completed in this area.

- Most of the site was mapped using a towed array, but this equipment could not be used in locations near the perimeter fence while the fence was in place, and in areas close to trees. The subsurface removal in these areas was completed using a "real-time EM61" method in which mapping was performed with a personnel towed EM61 magnetometer and anomalies were immediately flagged and excavated. FWVs TII-017, TII-020 and TII-024 addressed these changes to the procedures established in the *Final Work Plan,* (Shaw, 2006a). FWV TII-020 superseded FWV TII-017.

- A portion of the northern area at MRS-16 was characterized by unexplained and unusual noisy data. The "noisy area" consisted of 86 grids extending across the northern boundary of the site (some were partial grids). The noise consisted of data "spikes" from an external source that generated anomalies. The project geophysicist and the USACE QA geophysicist tried to assess the source of the noise but nothing was discovered. The effect of the noisy area was an increased number of false positives. The false positive percent within the noisy area (approximately 20 percent) was approximately double that of the remainder of MRS-16 (less than 10 percent). Shaw produced a white paper in March, 2007 which addressed the problem (Appendix D). Several different types of alternative processing and filtering routines were tested, but alternative processing techniques did not solve the problem. The problem was resolved during reacquisition within the noisy area. If an anomaly could not be reacquired (hence no significant milliVolt (mV) values above background) the anomaly was not excavated since there was obviously no source. The number of QC digs was increased within the noisy area. FWV TII-021 addressed these changes to the procedures established in the *Final Work Plan,* (Shaw, 2006a). This area is further discussed in Section 6.0.

3.2.3 Summary of Remedial Action Methods

The MRS-16 area included 406 full or partial 100 by 100-foot grids within the approximate 80-acre site defined by the original fence. As a result of varying methods to account for site conditions the work was completed as follows:

Table 3-2: Types of Removal Methods and Grid Counts

Removal method	Number of grids	% of total grids
Surface removal	406	100%
Subsurface removal (total of all methods)	382	94%
Subsurface removal – Analog "mag and dig")	23 6	%
Subsurface removal – combination of DGM towed array and EM61 real time	359 88	%
Subsurface removal not completed ("saturated area")	24 6	%

There were 109 grids completed using real time EM61 alone. DGM grids were completed mostly with equipment towed by a tractor, with a personnel-towed EM61 used to fill in data gaps mostly adjacent to trees.

3.3 Munitions Constituents Investigation

Soil sampling activities conducted as part of the Basewide Range Assessment (BRA) are summarized in this section. Characterization of the soil at MRS-16 occurred during the MEC RA work. The BRA Program includes sites that require additional evaluation for possible presence of chemicals of concern in soil related to military munitions training as presented in the *Basewide Range Assessment Work Plan and Contractor Quality Control Plan, Small Arms and Multi-Use Ranges, Fort Ord, California (IT/Harding ESE, 2001).*

Appendix I of the *Final Sampling and Analysis Plan, Characterization of Small Arms and Multi-Use Ranges, Fort Ord, California* (MACTEC/Shaw, 2003) presents the sampling and analytical requirements for collecting samples from MRS-16. MRS-16 is designated as Historical Area (HA) -119 in the BRA Program.

A separate technical memorandum will be prepared documenting the data and decisions reached by the BRAC Cleanup Team.

3.3.1 Previous Investigation

Previous investigations at MRS-16 (HA-119) were conducted under the *Draft Final Data Summary and Work Plan Site 39 – Inland Ranges, Fort Ord, California* (HLA, 1994). MRS-16 was sampled as part of the Basewide Range Investigation/Feasibility Study for Site 39. Based on the available information at that time, samples were collected from five random locations at various depths and analyzed for metals and explosives. Lead was detected below background levels with a maximum concentration of 15.5 milligram per kilogram (mg/kg). Pentaerythritol tetranitrate, a component of the high explosive antitank 2.36-inch rocket and M9 series HEAT rifle grenade was detected at a concentration of 1.5 mg/kg in one sample. No other explosives were detected. Table 3-3 lists the analytical results of samples collected in 1994. Figure 3-2 shows the location of the samples.

3.3.2 Site Characterization Approach

The sampling approach conducted at MRS-16 included biased and step-out sampling. Sample locations were selected based on visual observations during MEC remedial action activities. Sample locations were selected based on observations that suggested a potential source of soil contamination from previous site use. Table 3-4 presents the analytical results. Figure 3-2 shows the location of soil samples collected from MRS-16.

4.0 Site Preparation

4.1 Fuel Break Site Preparation

Shaw conducted a 150 feet wide vegetation clearance around the perimeter of the site to serve as a primary containment line for the prescribed burn. The total area cut was approximately 28 acres (Figure 4-1). This included 22.6 acres within the boundary of MRS-16 and 5.4 acres on the west side outside the boundary. This work was completed prior to the submission of the *Final Work Plan* (Shaw, 2006a). Site preparation activities, including fuel break preparation, were detailed in the *MRS-16 Technical Letter for Preparatory Action* (Appendix C). Mechanical vegetation clearance equipment was used to cut the vegetation. Photographs of mechanical vegetation clearance equipment are included as Photographs 1 and 2. Manual tools such as chain saws and trimmers were used in areas where the mechanical cutter could not gain access, or to trim tree branches. Photographs of manual vegetation clearance activities are included as Photographs 3 and 4. In areas with heavy vegetation that obscured visual inspection of the ground surface, a first cut was made to a height between 18 and 24 inches above the ground. After visual inspection for MEC, a second cut was made to a height of no more than 6 inches above ground. In areas with medium to light vegetation where the ground surface could be observed before cutting, the vegetation was cut in one stage to a height of no more than 6 inches above ground. Vegetation cut manually from the fuel breaks was placed in the burn area as directed by the Presidio of Monterey Fire Department (POMFD). During fuel break preparation, debris that could be safely removed form the site was removed. This debris included general trash, metallic debris, and telephone poles that were present from previous Army operations. Photographs of debris removal operations are included as Photographs 5 and 6.

Two Shaw UXO personnel provided construction support during vegetation clearance. If MD or suspected MEC was encountered, vegetation clearance personnel would stop operations until Shaw UXO personnel could determine if any hazard was associated with the item. MEC and MD items removed during this phase of work were tracked as part of the surface removal operation.

4.2 Prescribed Burn

The prescribed burn for MRS-16 was conducted on October 19 & 20, 2006. The POMFD conducted the prescribed burn, with Shaw personnel supporting as required. Complete information concerning the prescribed burn is presented in the *Prescribed Burn, 2006, MRS-16 After Action Report, former Fort Ord, Monterey County, California* (*2006 Prescribed Burn*, POMFD, 2007). Photographs of prescribed burn operations are included as Photographs 7 through 10.

4.3 Vegetation Clearance following Prescribed Burn

Following the prescribed burn, Shaw UXO escort personnel conducted a survey to determine that it was safe to enter areas that required vegetation clearance, and then provided construction support during all vegetation clearance. After burning, remnant stems and branches were removed to allow operation of DGM equipment. Photographs 11 and 12 display vegetation clearance activities following the prescribed burn.

Remnant vegetation that did not burn was cut with a combination of mechanical and hand held brush cutting equipment. These areas are detailed in the *2006 Prescribed Burn* (POMFD, 2007). Brush was cut as close to ground surface as possible, but no taller than 6 inches above ground surface to permit proper use of the EM61 geophysical equipment. Oak trees were not removed but branches were trimmed. Manually-cut vegetation was removed from the area. MEC and MD items removed during this phase of work were tracked as part of the surface removal operation.

4.4 Debris Removal

During and after vegetation clearance following the prescribed burn, remaining metal and other debris was removed from MRS-16. Metal debris was recycled at a local recycler, and other debris was disposed of at a local municipal landfill. Documentation for recycling of metal debris is included in Appendix E.

4.5 Vernal Pool Sampling

Water samples were collected from the vernal pool north east of the MRS-16 site, before and after the prescribed burn per the requirements of Appendix N of the MRS-16 Work Plan, *Draft Final Sampling and Analysis Plan, Vernal Pool Sampling and Monitoring, Munitions Response Site 16, Former Fort Ord, CA, Revision 0* (Shaw, 2006b). Two samples were collected; one sample prior to the burn (03/06/2006), and one sample after the burn (2/4/2008). Samples were collected to monitor the potential impacrts of foam retardants used during the burn.

Both 2007 and 2008 were with below average rainfall. Due to the low levels of precipitation in 2007, the vernal pool never ponded sufficiently to provide sufficient water to sample. Sufficient rain occurred in February, 2008, that resulted in ponding and thus a sample was collected at that time. Although there was standing water at a sufficient quantity to sample during 2008, the size of the vernal pool was smaller than during original sampling in 2006. The event in February 2008 was the only time when the pool could have been sampled because it dried up shortly thereafter and has not had standing water since (as of late 2008).

Analytical measurements were needed to verify the concentrations of ammonium and total phosphate (primary constituents Fire-Trol® LCA-F fire retardant), alpha-olefin sulfonate (primary constituent of Phos-Chek® WD881 foam retardant), along with pH and turbidity.

Samples were analyzed in the laboratory for ammonium using EPA 350.2, Nitrogen, Ammonia (Colorimetric, Titrimetric, Potentiometric Distillation Procedure), total phosphate using EPA 365.2, Phosphorous, All Forms (Colorimetric, Ascorbic Acid, Single Reagent), alpha-olefin sulfonate using EPA 425.1, Methylene Blue Active Substances, pH using EPA 150.1, pH (Electrometric), and turbidity using EPA 180.1, Determination of Turbidity by Nephelometry. The following table presents the results of the pre and post burn samples:

Table 4-1
Pre and Post Burn Sample Results

Constituent Method		Pre-Burn Sample Results	Post-Burn Sample Results
		MRS16-001	MRS16-002
		3/6/2006	2/4/2008
Ammonia as N	EPA 350.2	0.20J mg/L	0.341 mg/L
pH EPA	150.1	6.84	6.36
Phosphorous (total)	EPA 365.2	0.11 mg/L	0.152
Surfactants (MBAS)	EPA 425.1	<0.1 mg/L	<0.25 mg/L
Turbidity	EPA 180.1	98.6 NTU	85.4 NTU

Pre-burn water and post-burn water results were compared to assess any potential impact. There are no significant differences between the two results collected from the vernal pool. The slight increase in some concentrations (though not all, as the turbidity values actually decreased) may have been caused by the drought conditions described above resulting in the vernal pool containing less water (and therefore more concentrated constituents) when sampled post-prescribed burn as compared to the pre-prescribed burn sampling. It is concluded that the prescribed burn activities had no effect on the water quality of the pool.

5.0 Analog Removal

Analog methods using magnetometers were used for surface clearance of the whole site. As described in Section 3.2.2, analog methods were also used for subsurface removal in 23 grids.

5.1 Surface MEC Removal

Following the prescribed burn and vegetation clearance, the UXO team performed a magnetometer-assisted surface removal of MEC and other metallic debris. The objective was to remove MEC and any metallic items that would impede geophysical surveys. MEC items removed as part of this operation were the following:

Table 5-1: MEC Items Found in Surface Removal

Description	Number of items
M1 practice Anti-tank Mines	27
M1 practice Anti-tank Mine Fuzes	3
M49 series Surface Trip Flares	4
M125 series ground illumination signals	2
M22 Launching Anti-tank Missile Simulators	2
MKII practice Hand Grenades	2
MKI Low-explosive 37mm Projectile	1
M6 High-Explosive Anti-Tank 2.36" Rocket	1
Total items	42

Munitions and explosives of concern items recovered as part of this operation are included in Table 5-2. The estimated total weight of MD recovered as part of this operation was 2,338 pounds. MD weights associated with this operation are included in Table 5-3.

5.2 Subsurface MEC Removal

Analog methods were used for subsurface removal in grids which were found to have a high anomaly density using DGM. These grids are shown on Figure 3-1. The description below details the process for subsurface removal using analog methods at MRS-16:

The SUXOS assigned mag & dig grids to the UXO Team leaders during the daily morning project brief. Once the UXO Team located the mag & dig area a series of sweep lanes up to 5-foot wide were established using flagging or rope. These lanes acted as guidelines for the UXO technicians during the mag & dig removal and ensured full removal coverage within the grids.

Schonstedt GA-52Cx magnetometers were used for the mag & dig removal. When this process was initiated, two UXO teams were assigned to individual analog removal grids shown on Figure 3-1. As more grids were completed and it became impossible to separate teams by a minimum 200 ft as required in the *Final Work Plan* (Shaw, 2006a), the two UXO teams were combined into one team.

During the course of the project, the mag & dig process in high anomaly density areas was further evaluated to increase efficiency and quality. To support high anomaly density area clearance activities, DGM data was used to identify large anomalies or clusters of anomalies where UXO Teams could initially focus intrusive activities. These larger anomalous areas were reacquired by reacquisition teams and marked with a non-metallic pin flag. The UXO Teams started intrusive activities at the flag location and radiated outward while collecting MEC, MD, and cultural debris. The process was performed as necessary based on the discretion of the UXO Team leader, SUXOS and USACE Ordnance and Explosives Safety Specialist (OE SS).

Schonstedt magnetometers were field tested daily at the QC function test plot. A similar process of testing instrument functionality and sensitivity performed on the EM61-MK2 was used for the Schonstedt. If it was determined that the equipment was not functioning to meet project objectives during this daily check, the instrument was taken out of service until repaired.

Anomaly excavation was performed in accordance with the *Final Work Plan* (Shaw, 2006a). If MEC was identified during excavation, the item was surveyed with GPS and a determination was made by the SUXOS and USACE OE SS as to whether it was safe to move. If the item was not safe to move it was later detonated in place. If it was safe to move it was moved to a safe holding area for future detonation. If the subsurface contact was determined to be MD or cultural debris, the visible metal was removed. After removal of the object(s) believed to be causing the anomaly, the excavation was rechecked by the UXO Team to verify the area had been cleared. The vicinity around the excavation was also checked to ensure other anomalies were not masked by the recovered item. If the excavation was determined to be clear of anomalies, the hole was backfilled. The excavation recheck process described above was performed following the detonation and removal of remaining MD.

If an anomaly was identified to exist below 4-ft depth, the USACE OE SS was consulted prior to continuing excavation.

MEC items removed as part of this operation were the following:

Description	Number of items
M22 Launching Anti-Tank Missile Simulators	7
M49 series Surface Trip Flare	1

Description	Number of items
MKI Low-explosive 37mm Projectile	1
M49 series High-explosive 60mm Mortar Projectile	1
M6 High-Explosive Anti-Tank 2.36" Rocket,	1
M9 series Anti-tank Rifle Grenade	1
Total items	12

The M49 series HE 60mm Mortar Projectile was the only MEC item classified as DMM during this operation. MEC items recovered as part of this operation are included in Table 5-2. The estimated weight of MD recovered as part of this operation was 1,815 pounds. MD weights associated with this operation are included in Table 5-3.

5.3 Burial Pits

Excavation of magnetic anomalies revealed three pits in which substantial amounts of expended 2.36-inch rockets had been buried. The most likely explanation for the presence of these burial pits is that they resulted from range cleanup activities performed by the Army prior to base closure. It appears that large pits were excavated and expended 2.36-inch rockets were bulldozed into the excavated pits. The pits were then backfilled and training activities were resumed. The approximate areal extents of these burial pits are shown on Figure 5-1. Excavation of these pits occurred using a backhoe and excavator, with subsequent inspection by UXO teams to determine classification. No MEC items were associated with these pit excavations, but 48,971 pounds of MD were removed from the pits and ultimately recycled. The areal extents of pits were determined through excavation to the edges of each pit, but not all items located within all three pits were excavated. The decision to stop excavating within the boundaries of the pits was made following a determination that MD extended well below four feet in depth. During investigation, depths of nine feet were reached in the pit in grid C3A2F3 with no indication of an end to the expended 2.36-inch rockets. Photos 13 through 15 document the excavation of these burial pits.

5.4 Trenching in Saturated Area

In order to determine the depth and makeup of metallic debris within the saturated area shown on Figure 3-1, several trenches were excavated for investigation purposes. These trench locations are shown on Figure 5-2. General metallic debris and MD were encountered during the trench operations; no MEC items were found. The density of MD and general metallic debris tapered off significantly below 1 foot in depth. For the first phase of trenching operations conducted in 2007, trenches were excavated to show Army and regulatory agency personnel the typical depth and makeup of metallic debris within the saturated area. For the second phase of the trenching operation conducted in 2008, soil was first removed in a 6-inch lift and an EM61 survey was conducted both at the bottom of the trench and over the excavation spoils placed on a plywood sheet. Following completion of the surveys, a second 6-inch lift was removed and the process was repeated to a depth of 12 inches. EM61 surveys of the original ground surface, the bottom of each trench and the excavation spoils placed on a plywood sheet are included as Appendix F. Photographs 16 through 19 document trenching activities and items recovered as part of the operation. The 6-inch surveys indicated that the density of MD and general metallic debris tapered off significantly below 1 foot in depth.

6.0 Digital Geophysical Mapping (DGM) Operations

Digital Geophysical Mapping operations were carried out at MRS-16 from January 2007 to July 2008. The DGM surveys were conducted with both a newly designed towed array consisting of three EM61 MK2 sensors, as well as single EM61 MK2 units. The towed array was utilized as the primary DGM data collection system. It was used to obtain data over all accessible areas within MRS-16 (accessible to the equipment towed by a tractor). The single EM61 MK2 units were used for fill-in DGM data in areas where the towed array could not access (tree canopy, close proximity to fence-line, tree stumps, etc.). Photographs 20 and 21 show the towed array and single EM61 MK2 unit, respectively. In all, DGM and real-time EM61 operations were conducted in 359 grids out of 406 total grids. Real time operations were conducted in 237 grids. In all, 182 grids had both real-time and DGM operations. Figure 6-1 shows the results of towed array mapping. The remaining grids or portions of grids were surveyed with either Schonstedts (mag and dig operations) or single EM61 MK2 systems used in real time mode. The DGM surveys are discussed in the following sections.

6.1 Geophysical Prove Out

Prior to the DGM surveys, a GPO was conducted over four of the Ft Ord prove out test plots at Badger Flats (ODDS Plot). The towed array of EM61 MK2 sensors and G858G magnetometers (assembled on hand carts) were tested on four 100 x 180 foot test plots containing various simulated MEC items at different depths and orientations. The type, location, depth, and orientation of seed items in two of the plots were known and the same information for the seed items in the remaining two plots were unknown.

The objective of the GPO was to evaluate the EM and MAG sensors, their deployment platforms, and operating techniques. As with any GPO, the results were used to determine the best sensor, determine the best survey approach, determine the best data processing techniques, and determine the most appropriate target selection criteria for the specific items and local soil conditions. The results of the GPO were then applied to the DGM surveys at MRS-16. The results of the GPO are published in the *Draft Final MRS-16 Geophysical Prove-Out Report, Former Fort Ord, California* (Shaw, 2007b).

6.2 DGM Surveys

Digital Geophysical Mapping surveys were used as the primary method to locate subsurface anomalies. 359 grids or portions of grids were surveyed with DGM or real-time EM61 within MRS-16. A total of 12,306 anomalies were selected from the DGM data using the anomaly selection criteria derived from the GPO. Subsequent to data collection, processing, and target selection 8,029 geophysical anomalies were intrusively investigated. This number included all geophysical anomalies successfully reacquired, and some geophysical anomalies unsuccessfully reacquired, but excavated as part of the site QC process.

6.2.1 Instrumentation

As described in previous sections EM61 MK2 sensors (towed array and single units) were utilized to obtain DGM data at MRS-16. A Leica real time kinematic (RTK) GPS was used in conjunction with the EM61 MK2 sensors for navigation data. All data was streamed into the same file. Hence, geophysical data and RTK GPS data were merged into the same file.

Data collection on the towed array was controlled remotely by a wireless transmitter (WiFi) from a remote computer. This allowed the tractor driver to concentrate on coverage. The remote computer controlled operations on the field computer attached to the towed array. The remote control computer was used by the field geophysicist who monitored and controlled all operating systems related to data collection in real time.

6.2.1.1 EM61 MKII

The EM61-MK2 is a four-channel, high-sensitivity time delay EM sensor designed to detect shallow ferrous and nonferrous metallic objects with good spatial resolution and minimal interference from adjacent metallic features. The EM61-MK2 consists of two 1- by 0.5-meter rectangular coils stacked 40 centimeters (cm) apart with the source/receiver coil located below a second receiver coil. A square wave EM pulse is generated with "time on" (positive and negative) and "time off" cycles. This induces subsurface eddy currents with an associated secondary magnetic field. The decay of the secondary magnetic fields is measured during "time off" cycles and stored as a mV response. By measuring the decay at "late times" the system can distinguish between natural earth materials and buried metal (ferrous and nonferrous) as the secondary field in metallic objects decays at a much slower rate than earth materials. Although the EM61-MK2 is capable of measuring a differential, calculated as the voltage difference between the top and bottom coils, for this project, data were recorded at four time gates from the bottom coil. The responses at these four specified time gates are recorded and displayed by an integrated system data logger.

6.2.1.2 Leica SR530 - GPS

Real-time kinematic GPS uses a base station that is set up based on a known position. Once the base station is established, it determines its location using satellites and then applies a correction based on the offset from the known coordinates at the location. This correction is then used by a rover that is in direct communication with the base station through a radio link. The rover must be within 4 miles of the base station. At distances near 4 miles, line of sight is required; at shorter distances (as in this survey); line of sight is not required. If the base station is less than 2 miles away the system can operate on low power. High power is required for larger distances. The base station was approximately 0.9 miles away from the center of MRS-16. RTK GPS is capable of taking survey-grade measurements in real time and providing immediate accuracy to within 1 to 4 cm.

A permanent base station located within ranges 43-48 and maintained by the USACE was used for MRS-16 operations. The base station was periodically serviced by the Shaw team in order to keep it operational during the field surveys.

6.2.2 Data Collection Procedures

EM61 MK2 surveys utilized the 4 time gate readings from the bottom coil. All surveys were conducted at a 2 foot line spacing as per the measurement quality objective (MQOs). Readings were sampled at a minimum rate of 10 readings per second. GPS readings were logged at a rate of 1 reading per second. All data collection activities were recorded in field personal digital assistant (PDAs) and later downloaded into the project database. The field notes were monitored by data processors and the quality control geophysicist and are included in the data delivery forms. As discussed above a combination of three different data collection modes were employed at MRS-16 using the EM61 MK2 coils. These include the towed array, single unit manual systems, and real time data collection procedures.

6.2.2.1 Towed Array

The towed array system consisted of three EM61 MK2 coils mounted on a wheeled platform. The three units were mounted in parallel, wide end forward, such that the center-to-center coil spacing was 2.0 feet and the bottoms of the coils were set at the standard Geonics height of 40 cm above the ground. The wheeled platform was pulled with a tractor. Survey lanes were marked using a biodegradable foam marking system mounted to the tractor. The EM61 MK2 and GPS data were streamed together and recorded using Geometrics MagLogNT software. Data collection on the towed array was controlled remotely by a WiFi from a remote computer. This allowed the tractor driver to concentrate on coverage. The remote computer was operated by a field geophysicist. The remote computer controlled the functions of the field computer mounted to the towed array system. The remote computer operator monitored the data collection. A total of 359 grids were surveyed with DGM.

6.2.2.2 Single Unit/Manual

A single EM61 MK2 mounted on standard wheels and manually pulled was used in areas that were inaccessible to the towed array and in habitat sensitive areas. This did not include areas characterized by tree canopy (no GPS coverage). Single units were primarily used for filling in data gaps caused by surface obstructions (tree stumps, logs etc.). Data was recorded and/or observed using a standard field data logger controlled by the operator and RTK GPS was used for navigation. These data were then appended to the proper data set in order to fill in the dataset to fulfill the MQO requirements.

6.2.2.3 Real-time Data Collection

Many grids within MRS-16 were characterized by areas where RTK GPS data could not be obtained and/or would not work properly. In addition, grids adjacent to the fenceline were characterized by interference from the metallic content of the fence for approximately 15 feet into the MRS-16 field area. It was decided by the project team that these areas would be surveyed by the EM61 MK2 in real-time mode. This process was documented and procedures were established in FWVs TII-20 and TII-24 (Appendix B). The procedures in the FWV to conduct clearance under the tree canopy at MRS-16 are discussed below. Site personnel marked the boundary where the DGM data using RTK GPS started to falter around the tree canopy at a given site using pin flags. These navigational data were obtained from the DGM data base. Assurances were made that the boundary lies at least 5 feet within good GPS coverage. Once the tree canopy area was delineated, a geophysicist (or in some cases UXO technicians) used the EM61 MK2 in real time to locate anomalies for excavation under the tree canopy. The procedure for this operation is outlined below along with the general and pertinent MQOs that apply.

1. Delineate the edge of coverage using the DGM GPS data. The marked location was just inside (approximately 5 feet) good GPS coverage to ensure overlap of detections.
2. The clearance was conducted on a grid by grid basis (or partial grid basis).
3. Straight ropes were used for guidance of each "lane of detection". The ropes were positioned such that the lanes were parallel and did not exceed 2 feet between lanes (2 foot centers).
4. The lanes were numbered in increasing order from west to east (or south to north) and the orientation of the parallel lanes were recorded.
5. The EM61 MK2 operator used the instrument in real time at the maximum frequency (10 hertz or greater) and used the data logger to monitor anomaly magnitude.
6. The operator walked with the EM61 MK2 at a velocity less than 3 miles per hour. The operator walked along each lane and progressed along the lanes in a sequential manner (from one parallel lane to the next).
7. The operator centered the EM61 Mk2 over the rope and maintained this position along the extent of the lane.
8. The operator monitored the data logger and each anomaly that was detected at 14 mV and above (Sum of 4 channels) was flagged in the field.
9. When an anomaly was located the operator precisely located the position by running short, orthogonal transects and placed a pin flag over the anomaly peak. Once the pin was located, the operator relocated the EM61 over the line marking the lane and resumed the transect.

10. After all of the flags were located in a given grid (after conducting the lane detections) each anomaly was excavated and all pertinent information was recorded as per the "normal excavations" from reacquisition anomalies.

11. The approximate location of each anomaly was measured and recorded (along each numbered lane).

In general, the grids were surveyed in manner similar to a "mag and dig" field effort. In all 237 "real-time" grids or portions of grids were surveyed in this mode and 110 "fence-line" grids were surveyed in this mode. The results were entered into the database.

6.2.2.4 Daily Functional Quality Control Checks

Instrument tests were performed on a daily basis to ensure the instruments met the project QC requirements. As described in DID MR-005-05, the following instrument tests were performed:

- Static Background Test
- Static Spike Test
- Personnel Test
- Cable Shake Test
- Repeat Data/Lag Line
- Static GPS Location Test
- Dynamic GPS Location Test (added)

These tests were performed at the beginning and end of each day the instruments were in use. If one of the instruments was not working properly, the field crew would resolve the issue before beginning the survey. If it was determined that an instrument was not working properly at the end of the day, the field teams notified the QC geophysicist and proper steps were taken to verify that the survey data met project quality control standards.

In addition to the first six standard tests, two dynamic GPS location tests were conducted. One test consisted of placing a hitch-ball in the field area that was to be surveyed. The location of the hitch-ball was measured with GPS prior to obtaining data. The hitch-ball was run over by the EM61 MK2 system several times in one day. After the data was processed the location was checked to verify that the location was within specification (2 feet).

6.2.3 Data Processing and Anomaly Selection

All Geophysical data was processed using Geosoft's Oasis Montaj and vendor supplied software. Oasis Montaj processing and anomaly selection included several steps:

1. Transforming raw data to American Standard Code for Information Interchange (ASCII) xyz files: Using vendor supplied software, data was converted from the native file format to ASCII data files suitable for import into Oasis Montaj.

2. Initial data review: Once raw xyz files were imported into Oasis Montaj, the coordinates were converted to the project coordinate system. Data coverage and quality was assessed by the data processors. If it was determined that data quality and coverage were acceptable, the data was further processed and anomalies were selected. If coverage and/or data quality objectives were not met, field teams were sent to either fill in data gaps or re-collect data where necessary.

3. Correcting for instrument latency: Using the results of the daily repeat data test, geophysical data was shifted to account for the time lag inherent in the data logging system.

4. Leveling data: Data were then leveled to the same background values removing the effects of instrument drift. The leveled data were added together to create the 4 channel sum and the decay rate was calculated between time gates 1 and 2.

5. Creating a target lists: Once leveled and corrected for instrument latency, data was gridded using a minimum curvature gridding routine in Oasis Montaj. Targets were initially selected using an automated picking routine on the gridded data. Data processors then refined the target list by adding, removing, and moving targets.

Data processing procedures remained consistent for MRS-16. Anomalies were selected using a 4 channel sum of 14 mV. Additional filtering was applied to targets using the instrument decay. Data processing activities were logged in data processing forms. A detailed description of the processing steps is outlined in the *Final Work Plan* (Shaw, 2006a).

6.2.4 Noisy Area

A portion of the northern area at MRS-16 was characterized by unexplained and unusual noisy data. The noise consisted of data "spikes" that generated anomalies which truly did not exist. The "noisy area" consisted of 86 grids extending across the northern boundary of the site that runs northwest-southeast parallel to Parker Flats Road (some were partial grids). The Project geophysicist and the USACE QA geophysicist tried to assess the source of the noise but nothing was discovered. There were no visible power lines or anything that looked like a source of interference.

The effect of the noisy area was an increased number of false positives. The false positive percent within the noisy area was approximately double that in the main part of MRS-16. Shaw produced a white paper which addressed the problem and is included in Appendix D. Figure 6-1 delineates the noisy area at MRS-16.

The following bullets outline the logic, sequence of events, and general approach to assessing the noisy area solution.

- At first the project team believed it to be an equipment issue. Therefore, the team decided to resurvey a portion of one of the noisy area grids with the towed array. The resulting data showed the same pattern in the data. Because of this, and because it was localized, the team determined that outside factors were causing the spikes and higher readings.
- The project team also tested a single unit in grid-block C3A3A6. The team noticed the high background when reacquiring targets in grid C3A3C6 and had difficulty nulling the EM61 MK2 because the background was changing so rapidly. The team reacquired the first 9 targets and they were all false positives. At this point Shaw decided to survey a few lines to demonstrate the background issue. The results of the survey were the same and showed EM61 readings increasing as you go north in C3A3C6.
- Shaw then ran a static test inside the noisy area. An EM61 MK2 within the noisy area was allowed to run for two hours in the morning and two hours in the afternoon. The purpose was to determine if there was any outside interference. There was no spiking (or unusual readings) evident in the data, however the drift was high for all channels. The drift was as much as 20 mV for Channel 1 and 10 mV for Channel 3.
- Because the background was higher in these areas, the team tried leveling the data using different parameters within Geosoft's UX-Drift correction. The team accounted for the higher readings by including a larger percentage of high readings for the average background. This provided some improvement, but there were still signals created that were false targets. For example, in grid-block C3A3A6, changing the leveling eliminated 6 of 9 false positives.

Looking at the raw and leveled data for gridblock C3A3A6 (which contains grids C3A3A6, C3A3B6, and C3A3C6) the changes in EM61 MK2 readings can be observed (Appendix D). There is both an increase in long wavelength readings and short wavelength readings. There is a sharp drop in C3A3C6 at the last 4 peaks (marked with M) which is due to a mound in the grid. During reacquisition the background jumped from 20 mV to 0 mV on channel 1 on top of the mound. This is evidenced by the data included in Appendix D.

6.2.4.1 Processing and Testing

Shaw conducted a comparison in processing routines for Grid C3A3C6 (noisy grid). Channel 3 was the least affected channel on the EM61 Mk2 data. Therefore, the channel 3 data was processed with the improved fore-mentioned leveling routine and processed the channel 3 data. This routine was chosen because "normal" processing routines for the MRS-16 data generated too many false positives. It was thought that using channel 3 data (least affected by the noise and background phenomena) would generate less false positives. Shaw also reprocessed the same grid using Sum 4 data and the improved leveling routine. Both methods generated approximately the same number of "false positives". The Channel 3 processed data actually exhibited more false positives because the threshold value was lowered to gain maximum detection.

It should be noted that there is a low false positive percentage across MRS-16 outside of the noisy area (approximately 8 percent).

6.2.4.2 Field Testing

Shaw conducted reacquisition of the anomalies from both processing methods in Grid C3A3C6. Most of these anomalies were false positives (Sum 4) as they did not register an EM61 MK2 reacquisition value above background. In general 27 anomalies were generated; 16 of them had reacquisition values well below 14 mV (Sum 4 values of 0 to 8 mV). These were all excavated to a depth of 2 feet and nothing was found. Therefore, these anomalies were considered to be caused by external noise. Ten anomalies were reacquired close to the 14 mV threshold value. These anomalies were excavated and most of the anomalies were characterized by rusty soil or soil that had some small mV response. Only one anomaly exhibited a small metal object (small piece of fence). One anomaly was reacquired at a 60 mV value and some range related debris was excavated. No other anomalies existed. The original values of all anomalies within this grid ranged from 15 to 401 mV. Based on this testing process it is concluded that most of the anomalies were generated by noise of some kind that was not MEC or MD related. Some of the noise was probably natural background due to weathering of the Santa Margarita Formation.

6.2.4.3 Remedy Derived from Test Data

Since processing did not totally solve the problem (data is improved with different leveling scheme in the "noisy area"), Shaw suggested that the problem be minimized by a reacquisition approach. Any anomaly with a reacquisition value significantly less than 14 mV was not to be excavated. As referenced above, anomalies from 0 to 8 mV yielded no source. Therefore, any anomaly reacquired at 8 mV or less was not excavated. As a QC measure, ten percent of the anomalies reacquired from 8 to 11 mV were excavated. Although none of the anomalies in this range during the field testing yielded sources, they were considered QC excavations. For a conservative approach, all anomalies above 11 mV were excavated. This approach cut down on the time and money spent with anomalies caused by external noise. It was also consistent with the processing and other logistics used over the remainder of the site and was a conservative approach.

6.2.5 Saturated Area

During the DGM surveys an area of 24 grids on the western side of MRS-16 exhibited dense anomalies and "saturated" conditions. The area was characterized by grids that virtually exhibited one large anomaly or a few large anomalies that covered entire grids. This area was referred to as the saturated area. It was impossible to resolve single point source anomalies within the saturated area. Mag and dig efforts were tested in the saturated area which resulted in inefficient operations and were deemed not practical to continue those operations. The project team made the decision to delineate that area (as the saturated area) and treat that area with a different approach. In the beginning the cause of the saturated area was not clearly understood. It was obvious that there were numerous dense clustered objects, however, it became evident after time that other conditions existed.

A DGM test was conducted within the saturated area. First, a single EM61 MK2 unit was used to record data over an area that was saturated. The soil along that traverse was then removed to a depth of 6 inches and the soil was placed on a sheet of plywood. The EM61 MK2 then recorded data over the soil and plywood to assess the response. The EM61 MK2 was then used along the same traverse and recorded data over the area that was excavated to a depth of 6 inches. The same process was then repeated. The trench was excavated to a depth of 12 inches and the soil was placed on another sheet of plywood and data was recorded over that soil. The EM61 MK2 was then used to record data in the trench that was excavated to a depth of 12 inches. This process is further discussed in Section 5.4. These results are documented in Appendix F.

Findings from this process revealed that there were few remaining anomalies below a depth of 12 inches. Therefore, it was concluded that the top 12 inches of soil was the main cause of the saturated response within the saturated area. The trench was logged and the soil was inspected. Other than a few objects that were excavated the soil conditions exhibited tiny rust or metallic sediment with the upper 12 inches. This concentration of metallic "sediment" was assumed to be the cause of the saturated area characteristics.

6.2.6 Phase II DGM Surveys

On the western side of MRS-16 there were 42 grids surrounding the saturated area were characterized by dense clustered anomalies. These grids are shown in Figure 6-2. These grids were processed and excavated in the first round of DGM and excavation. However, due to the dense and clustered anomalies (not saturated), some anomalies were unresolved and remained unexcavated following the first phase DGM survey because they do not display a separate peak value. In many instances, distinct anomalies were not able to be selected due to the close proximity of adjacent anomalies. Therefore, a second round of DGM data was obtained and the second round of anomalies were excavated after the first round of excavations. This approach assured that all of the anomalies that matched the selection criteria within the grids were detected and excavated. These grids are referred to as Phase 2 grids. They were selected collaboratively by the Project geophysicist and the USACE QA Geophysicist. Phase 2 grids are documented in the table below and shown in Figure 6-2.

Phase 2 Grids					
C3A2H2	C3A2I7	C3A2G8	C3A2C1	C3A2B3	C3A2A3
C3A2H3	C3A2G1	C3A2F7	C3A2C2	C3A2B4	C3A2A4
C3A2H4	C3A2G2	C3A2F8	C3A2C8	C3A2B5	C3A2A5
C3A2H5	C3A2G4	C3A2E8	C3A2C9	C3A2B6	C3A2A6
C3A2H6	C3A2G5	C3A2D1	C3A2B0	C3A2B7	C3A2A7
C3A2H7	C3A2G6	C3A2D2	C3A2B1	C3A2B8	C3A2A8
C3A2I6	C3A2G7	C3A2D3	C3A2B2	C3A2B9	C3A2A9

6.2.7 Data Delivery

Survey data was broken down into separate grids and/or grid blocks prior to delivery. The delivery schedule was consistently met throughout the project. Exceptions were cleared with the QA Geophysicist beforehand. Raw data were due within three days of completion and processed data were submitted within 5 days of completion. Raw data deliveries included the raw data in binary format, raw data in ASCII xyz format, and the field notes saved in PDF form. Processed data included the processed data in ASCII xyz format, the final targets lists, and the appropriate data processing forms. Examples of the data and forms are contained in Appendix G. In all, a total of 323 whole or partial grids were processed and delivered from the DGM data.

6.3 Measurement Quality Objectives (MQOs)

As part of the MQOs specified in the site specific work plan (SSWP), the following items were monitored throughout the project:

- Background noise
- Mean speed
- Along track spacing
- Across track spacing
- Instrument latency corrections
- Data leveling
- Systematic noise

- Anomaly selection
- Positioning errors
- Known location qc items
- Blind seed/qc items
- Reacquisition

The geophysical QC plan called for the QC Geophysicist to monitor all of the MQOs. The QC Geophysicist monitored every grid and if there were any aberrations to the MQOs actions were taken to assure that the specific metric was corrected before passing the grid. These actions were documented in weekly QC reports to the USACE Project Geophysicist. During the MRS-16 survey the USACE QA geophysicist monitored grids after they passed geophysical QC. Any comments or questions were addressed for specific grids and the issues were resolved between the Project Geophysicist and USACE QA Geophysicist. The appropriate action was then initiated.

6.4 Anomaly Reacquisition

State coordinates for geophysical target lists were exported to comma separated files suitable for import into the Leica GPS rovers and field PDAs. Targets were then relocated in waypoint mode and flagged in the field at each target coordinates. Once flagged, the field teams moved a single EM61 MK2 (in real time) over the flagged location in different directions to locate the anomaly peak. Once located, the flag was moved to the peak location and the offset from the original target list location was recorded in field PDAs. The final instrument readings (in mV) were also recorded in field PDAs to assure that the correct anomaly was relocated. All reacquisition activities were downloaded into the project database on a daily bases. In some instances, anomalies were not reacquired in the field and were considered false positives.

Greater than 96 percent of all reacquisitions were within the metric required in the MQOs (within one meter). Any outliers were rechecked to assure that the correct anomaly was reacquired. The aberrations were found to be due to unusual conditions (sloping ground surface causing GPS antenna to lean, interference from fence, etc.) and they were all resolved to assure the correct anomaly was reacquired.

6.5 Anomaly Excavation

After each anomaly was excavated, a field QC check of each excavation was conducted. The EM61 MK2 was utilized by a member of the excavation team to assess the final mV reading in and around the excavation. An area consisting of a 3-foot radius was inspected around the excavation itself. If the highest value in the area was below 14 mV (threshold for excavation) the value was recorded in the PDA and the excavation was refilled. More than 95 percent of the excavations were significantly below 14 mV; exceptions were usually an un-moveable source that would generate a higher value (known utility, known metal structure, large amounts of rust, etc.). In those cases the source was recorded in the PDA. However, in all of those cases the original anomaly value was reduced by removing the original buried item. FWV TII-019 addressed these changes to the procedures established in the *Final Work Plan,* (Shaw, 2006a).

During the excavation field activities, numerous excavations had to go through some iterations of this process which acted as a good QC measure. In other words, after the first excavation attempt, if values were above or even close to 14 mV the excavation was continued until the value was significantly lower than 14 mV. The only exceptions were when there were un-moveable sources. Ultimately, all of that information was recorded. In all, 8,029 excavations were conducted. Approximately 1,300 excavations yielded significant multiple items.

6.6 MEC Removal

Munitions and explosives of concern items removed as part of DGM and reacquisition/excavation were the following:

Description	Number of items
M1 practice Anti-Tank Mines	104
M1 practice Anti-Tank Mine Fuzes	3
M49 series Surface Trip Flares	7
M213 hand grenade fuzes	3
M125 series ground illumination signals	2
MKI Low-explosive 37mm Projectiles	5
High-explosive 37mm Projectile	1
M6 High-Explosive Anti-Tank 2.36" Rocket	26
M9 series Anti-tank Rifle Grenades	5
M28 High-Explosive Anti-Tank Rifle Grenade	1
M73 Practice 35mm Subcaliber Rocket	1
MKI 75mm Shrapnel Projectile	1
Total items	159

The three M213 hand grenade fuzes and one M125 series ground illumination signal were classified as DMM. MEC items recovered as part of this operation are included in Table 5-2. The estimated weight of MD recovered as part of this operation was 3,753 pounds. MD weights associated with this operation are included in Table 5-3.

MEC items removed as part of real time EM61 operations were the following:

Description	Number of items
M1 practice Anti-tank Mines	8
M49 series Surface Trip Flares	2
M205 series practice hand grenade fuzes	30
M125 series ground illumination signal	1
MKI Low-explosive 37mm Projectile	1
M6 High-Explosive Anti-Tank 2.36” Rocket	1
M18 series Smoke Hand Grenade	1
M17 series Rifle Ground Signal	1
3-inch Unfired Stokes Mortars	13
Total items	58

All hand grenades and hand grenade fuzes, the M125 series ground illumination signal, M17 series Rifle Ground Signal and 13 3-inch unfired Stokes mortars were classified as DMM. Three of the M205 hand grenade fuzes and 13 3-inch unfired Stokes mortars were stored in a safe holding area and were detonated on May 19, 2009. Final nomenclature of these fuzes and mortars were entered in the MEC database following the detonation operation. The distinction of the hand grenade fuzes as DMM is important, and no indications that MRS-16 was used for hand grenade training were encountered. MEC items recovered as part of this operation are included in Table 5-2. The estimated total weight of MD recovered as part of this operation was 597 pounds. MD weights associated with this operation are included in Table 5-3.

7.0 Quality Assurance/Quality Control

This section discusses the QC and QA procedures that were used at MRS-16.

7.1 Quality Control

Quality control is conducted by the contractor. Several QC measures were conducted by the UXOQCS and by the QC Geophysicist. A discussion of the pertinent QC measures and procedures is included in the following sections.

7.1.1 Analog Quality Control

7.1.1.1 Field Activities

Daily QC, Safety, and SUXOS forms are included in Appendix H. During surface removal operations at MRS-16, the UXOQCS was responsible for visually observing teams and conducting periodic spot checks to ensure grids were receiving complete coverage during the surface removal phase. During "mag and dig" subsurface removal, the UXOQCS visually observed teams in the field and conducted additional spot checks to verify subsurface items were being removed. The UXOQCS also conducted a 10 percent QC Check of completed "mag and dig" grids.

7.1.1.2 Analog Quality Control During DGM Operations

Once DGM excavations were initiated, the UXOQCS visually observed teams on a random basis to verify field QC actions described in Section 6.5 were being implemented. During the EM61 real-time survey of both fence grids and other grids that were not included as part of the DGM survey, the UXOQC conducted periodic spot checks of teams in the field to verify proper procedures were being followed, and conducted 10 percent Schonstedt QC checks of completed grids in conjunction with the USACE QA check described below. USACE Form 948s for Analog QA approved grids are included in Appendix I.

7.1.1.3 Database Activities

The UXOQCS reviewed every entry received from personnel in the field during each phase of work prior to entry in the database. Each entry was reviewed for completion of field QC (to confirm final EM61 reading was below 14 mV), MEC and MD nomenclature, completion of targets/digs within a given grid, and ultimate disposition of MEC items.

7.1.2 DGM Quality Control

The QC standards and procedures were outlined in the *DGM QC Plan Addendum, MRS-16 Munitions and Explosives of Concern Removal* (Appendix O). The QC Geophysicist was responsible for planning and executing QC oversight of geophysical activities and ensuring compliance with geophysical QC requirements. Specifically, the QC Geophysicist was responsible for the following:

- Reviewing and approving the qualifications of geophysical staff;
- Planning and insuring the acceptable performance and completion of all geophysical QC activities;
- Reviewing the geophysical QC and DGM data, target lists, and dig results as specified in the SSWP Geophysical Investigation Plan;
- Establishing the known and blind seed item and location control program;
- Identifying quality problems and verifying that appropriate corrective actions were implemented for geophysical activities;
- Ensuring that the requisite geophysical QC records, including submittals, were generated and retained as prescribed.

In order to keep track of all of this information and report weekly events and statistics, a weekly QC report was delivered to the project geophysicist and the QA geophysicist. This included all pertinent information for the week as well as cumulative information about the project including, but not limited to, information such as grids surveyed, targets picked, personnel, average acreage per day, and QC blind seeds located.

A total of 41 blind seeds were emplaced prior to the start of field operations by the QC geophysicist and all but one of these items were detected by the geophysics surveys. The one item that was not detected was located over the top of a large metal waterline and was not evident in the data. An additional 20 items were emplaced prior to real-time field operations by the QC geophysicist and all but one of these items were located by the real-time geophysics surveys. This item that was missed was due to placement too close to a subsurface cable that masked the signature of the item.

The QC Geophysicist had daily access to all geophysical QC and DGM data and was on-site intermittently as needed after the completion of the initial inspections for geophysical activities, and on site approximately 2 days every 2 weeks for unannounced field and procedure checks. The QC Geophysicist reported to the Project Geophysicist and supported the UXOQCS.

7.2 Quality Assurance

Quality assurance is conducted by the USACE OE SS and the USACE QA Geophysicist.

7.2.1 Analog Quality Assurance

Analog Quality Assurance has been completed for MRS-16. USACE Form 948s are provided in Appendix I.

7.2.2 DGM Quality Assurance

Digital geophysical mapping Quality Assurance approval and discussion is provided as Appendix N of this report.

7.2.3 Corrective Action Requests

During the course of MRS-16 field operations, Shaw received 7 CARs from USACE. CARs are included as Appendix J. It should be noted that corrective actions were implemented and grids were eventually accepted by USACE. Resolution of each CAR is summarized below:

- CAR CESPK-ED-GG-FY07-001: This CAR resulted from not detecting a QA seed item buried directly beneath another QA seed item. The deeper item was not found during QC check of the excavation using the EM61. Discussion centered on whether excavations should be checked with the Schonstedt. Ultimately, the determination was made that no field change was needed and excavations would continue to be checked with the instrument which initially detected the anomaly (EM61 in the case of DGM).

- CAR CESPK-ED-GG-FY07-002: This CAR resulted from not finding and reporting a QA seed during DGM excavation. Three possible causes for lack of QA seed recovery were posited prior to field testing: 1) EM61 Mk2 check of excavation did not extend to 1.3 ft radius from excavation which would have resulted in detection of QA seed. 2) QA seed may have settled or been masked by munitions debris encountered nearby. 3) Malfunction of EM61 Mk2 resulting in false response of 0 mV. After field testing, it was determined that EM61 Mk2 check of excavation did not extend to 1.3 ft radius from excavation which would have resulted in detection of QA seed. Changes were implemented to establish that QC checks of excavations were a full 1.3 ft radius from excavation center.

- CAR CESPK-ED-GG-FY07-0003: This CAR resulted from seemingly not finding and reporting a QA seed during DGM excavation. Three possible causes for lack of QA seed recovery were posited prior to field testing: 1) EM61 Mk2 check of excavation did not extend to 1.3 ft radius from excavation which would have resulted in detection of QA seed. 2) QA seed may have settled or been masked by munitions debris encountered nearby. 3) Malfunction of EM61 Mk2 resulting in false response of 0 mV. After field testing, it was determined that CAR resulted from not reporting to the USACE QA Geophysicist that a QA seed that was located and recovered in the field. Changes were implemented to make certain that QA seeds recovered in the field are reported to the USACE QA Geophysicist.

- CAR CESPK-ED-GG-FY07-0004: This CAR resulted from MD, range related debris (RRD) and general clutter being left on site following initial demobilization due to funding constraints in July 2007 (see Appendix J for specific grids). Additional surface sweep and EM61 survey of affected grids were instituted following return to the site.

- CAR CESPK-ED-GG-FY08-0005: This CAR resulted from two items recovered during analog QA check of MRS-16 grids. The first item recovered was a piece of chrome that was detectable with a Schonstedt magnetometer, but not with an EM61. The second item was a grenade fuze that was likely below the 14 mV threshold established for MRS-16 remedial action. Recommendation was made to discuss use of Schonstedt magnetometer in future remediation areas where grenade fuzes are known or suspected.
- CAR CESPK-ED-GG-FY08-0006: This CAR resulted from several items recovered during DGM QA check of MRS-16 grids. It was later determined that GPS lock was lost for a small subsection of MRS-16, which resulted in these items being missed. All areas that experienced the loss of GPS lock were subsequently resurveyed and checked regarding GPS coverage.
- CAR CESPK-ED-GG-FY08-0007: This CAR resulted from an item recovered during DGM QA check of MRS-16 grids. The item was recovered from outside the fence line of MRS-16, an area that was not surveyed during EM61 real-time work in accordance with FWV TII-024. No change to procedures was implemented.

8.0 MEC and MD Removal

This section provides tabular and graphical summaries of the MEC and MD removed from MRS-16. Section 8.1 describes the Shaw removal action. Section 8.2 provides data for all removal actions conducted at the site.

8.1 Shaw Remedial Action

Statistical information for the MRS-16 MEC remedial action was recorded, tracked, and reported by removal grid, individual item, and date. The removal grid tracking database is provided in Appendix K and lists the investigation dates (reacquisition, QC, and QA), number of MEC items recovered, and total MD and cultural debris weight for each removal grid. Figure 8-1 shows the locations of all recovered MEC, and Figure 8-2 shows and the weight of MD removed from each removal grid. The cumulative statistical results for the remedial action are provided in the following table.

Cumulative Statistical Results

Parameter	Project Total
Total Remedial Area (acres)	80.7 acres
Final Analog QA Approved Grid Count	343
Final Digital QA Approved Grid Count	382
Mag & Dig Area (acres)	5.4 acres
DGM Anomalies Reacquired	9079
Anomaly Reacquisition QC Inspection Targets	297
Number of DGM Digs	8029
MEC Items	271
Estimated MD Weight (lbs)	57,500 pounds
Estimated non-MD Weight (lbs)	3500 pounds

The MRS-16 remedial action target list is provided in Appendix K and tabulates dig results for recovered material identified throughout the course of the project. The target list is sorted by removal grid ID and provides specific information for MEC and MD including type, condition, weight, recovery depth, and final disposition. The target list also provides the results of all QC investigation results. MEC and MD descriptions are provided in the following sections.

8.1.1 MEC Removal

Munitions and explosives of concern were recovered and treated during the course of the MRS-16 removal action. A total of 271 MEC items were identified within MRS-16. A summary of the type and quantity of MEC recovered during the removal action is provided in the following table. The recovery and treatment date, grid ID, and item depth of each MEC item identified is provided in Appendix K. Representative photographs of MEC items recovered during the remedial action are included as Photographs 22 through 33.

MEC Recovery Information

MEC Model Description	Quantity	Depth Range (inches)
MK I Projectile, 3 inch, trench mortar, (Stokes)	13	48
M49 Flare, surface, trip	14	0 - 21
M213 Fuze, grenade, hand	3	3
M205 Fuze, grenade, hand, practice	30	2 - 4
M1 Fuze, mine, antitank, practice	6	0 - 3
MK II Grenade, hand, practice	2	0
M18 Grenade, hand, smoke	1	4
M9 Grenade, rifle, antitank	6	3 - 24
M28 Grenade, rifle, high explosive antitank	1	20
M1 Mine, antitank, practice	139	0 - 36
Projectile, 37mm, high explosive	1	3
MK I Projectile, 37mm, low explosive	8	0 - 7
M49 Projectile, 60mm, mortar, high explosive	1	0
MK I Projectile, 75mm, Shrapnel	1	3
M6 Rocket, 2.36inch, high explosive antitank	29	0 - 48
M73 Rocket, 35mm, subcaliber, practice	1	3
M17 series Signal, ground, rifle, parachute	1	3
M125 series Signal, illumination, ground	5	0 - 6
M22 Simulator, launching, antitank guided missile and rocket	9	0
Total items	271	

MEC were recovered between 0 inches and 48 inches below ground surface. Most MEC items (84 percent) were recovered at depths of 12 inches or less. The distribution by depth is shown in the following table:

MEC Depth Information

Depth Found (inches)	Number of Items	Percent Distribution
Surface 55		20.3%
1 9		3.3%
2 56		20.7%
3 34		12.5%
4 18		6.6%
5 6		2.2%
6 24		8.9%
7 8		3.0%
8 6		2.2%
9 4		1.5%
10 3		1.1%
11 1		0.4%
12 5		1.8%
18 3		1.1%
20 2		0.7%
>20 37		13.7%
Total items	271	100.0%

8.1.2 MD Removal

Recovered MD and cultural debris were characterized by type, weight, and recovery depth. An estimated total of approximately 57,500 lbs of MD were recovered during the course of the removal action. A high proportion of the MD (85 percent) was recovered from several burial pits. Figure 8-2 shows the distribution of MD by grid across the site. Detailed information regarding MD and cultural debris finds are provided in the MRS-16 removal action target list in Appendix K. MD and cultural debris were tracked, certified by the SUXOS, UXOQCS, and USACE OE SS as free from explosive material, and stored in lockable roll-off containers. All MD was demilitarized as appropriate. MD, RRD and cultural debris were transported to a recycling facility. *DD Form 1348-1A* documentation accompanied the MD. *DD Forms 1348-1A* for this project are provided in Appendix E. SAA are awaiting transport to a recycling facility.

8.1.3 Detonation of Munitions or Explosives of Concern

A total of 271 MEC items required detonation. During the course of the Shaw MRS-16 remedial action, 271 MEC items were destroyed by detonation. Explosives Accountability forms are included in Appendix L.

8.1.4 Disposition of Munitions Debris

Shaw used a systematic approach for collecting and inspecting munitions debris. In accordance with the scope of work, items less than two inches maximum dimension were not collected. According to Department of Defense 4160.21-M, all debris collected is classified as Group 1b.

Munitions debris was transported to FACT International for smelting and eventual recycling. *DD Form 1348-1A* documentation accompanied the MD. *DD Forms 1348-1A* for this project are provided in Appendix E.

8.1.5 Production Rates

The approximate total man-hours (not including mobilization and demobilization) worked by all field personnel including UXO technicians, Geophysicists and support field personnel was 25,000. This number does not include office support hours such as project management, geographic information system and database support, project procurement, and cost and schedule support.

8.2 All Removal Actions

8.2.1 MEC

There were 352 MEC items recovered and reported from MRS-16 during all phases of work conducted at the site (Figure 8-3). The MEC items recovered prior to the remedial action discussed in this report are included in Table 2-1. The MEC items recovered during the remedial action discussed in this report are included in Table 5-1. All MEC items were detonated.

8.2.2 Munitions Debris

The weight of MD recovered during previous work at MRS-16 was not reported consistently. It is known that large numbers of expended rockets have been removed during previous activities.

8.3 Conceptual Site Model

Figure 8-4 presents a Conceptual Site Model (CSM) for the site. This shows the locations of the firing points for the bazooka rocket range and a typical safety fan for this type of range. Most rocket MEC items were found in this fan in the area behind the targets. The saturated area surrounds the former targets for the bazooka range. It is suggested that the high density of metallic debris in this area results from heavy equipment moving the soil during or after use of the range.

9.0 Environmental Protection

9.1 Description of Impacts and Mitigation Measures

Since the site is designated as future habitat reserve land, all work was conducted using the appropriate environmental protection measures for impacts associated with a MEC removal site. The main activities conducted on the site were: digging and excavations, vehicle use, walking around the site, tree and shrub pruning, debris removal, erosion control. Mitigation measures to reduce impacts to protected species are taken from the HMP and three Biological Opinions provided by the U.S. Fish and Wildlife Service to address Army clean-up activities (USFWS 1999, 2002, 2005). Mitigation measures that were applied during this project are summarized here:

- Maritime chaparral sites had a baseline survey for HMP species and habitat completed before the start of work. Follow-up monitoring will be conducted to document recovery of the species and habitat. (See Section 9.2 Biological Monitoring).
- Conduct employee training: a staff biologist provided biological training on rare, threatened and endangered species on the site, including a description of the species, their protected status, and a list of measures to be implemented to avoid and reduce impacts to these species or their habitat.
- Flag and map locations of rare plants to avoid and reduce unnecessary impacts: Several areas with sand gilia, or especially high densities of Monterey spineflower were flagged to alert crews to these high-sensitivity areas while in bloom. Work schedule in sand gilia areas was arranged to avoid the bloom season.
- Use existing roads wherever possible: Shaw limited all off-road vehicle use, except where necessary to access excavation sites or debris removal areas.
- Reduce the footprint of excavations as much as possible.
- Reduce impacts of digs on the seedbank of rare plants: Crews were instructed to backfill digs and replace topsoil on top of refilled digs.
- All Black Legless Lizard (BLL) and California Tiger Salamander (CTS) encounters are reported to a staff biologist. Biologist records encounters, maps locations with GPS, and relocate the animals to appropriate habitat, using the appropriate handling techniques. One BLL was encountered during the project. The individual was alive, and was relocated by the staff biologist to a safe area as close as possible to the discovery site. One juvenile CTS was encountered on the site. The individual was found under a log in January, 2007, after a rainfall event. The CTS was recovered by a biologist qualified to handle CTS, and relocated off-site to a ground squirrel burrow in the upland zone of the nearest vernal pond (Pond #8). Reports were submitted to the Army.

9.2 Biological Monitoring

Preliminary baseline vegetation surveys were conducted by Harding ESE (1996) and Shaw (2007a) before the work began. Baseline surveys are necessary so that potential impacts to protected species and maritime chaparral habitat can be accurately documented. Follow up vegetation surveys will be conducted in years 1, 3, 5, and 8 for HMP annual species, and in years 3, 5, 8 and 13 for shrubs. Follow-up monitoring may be conducted by Shaw or another contractor. At the end of the monitoring period, the data will be assessed to see whether success criteria have been met. Monitoring surveys are conducted according to the Protocol for Conducting Vegetation Monitoring in Compliance with the Installation-Wide Multispecies HMP at Former Fort Ord (Burleson, 2006).

As part of follow-up monitoring, the site will be surveyed regularly for invasive weeds, and weed removal will be conducted by the Army as needed.

9.3 Erosion Control

To reduce erosion concerns on bare mineral soils after the site burn, vehicle access was restricted to existing roads and trails, except for a few occasions where a backhoe was used for excavation, or a Polaris (ATV) was employed for debris removal. Shaw monitored the work site for potential erosion problems and a final inspection was conducted by a qualified biologist. Two pre-existing eroded gullies were treated with erosion control measures. Gullies were filled in with existing soil at the edges, waterbars were constructed, and straw wattles were applied in several locations.

10.0 Protectiveness Assessment

Between December 2006 and July 2008, Shaw completed a MEC removal action across approximately 80 acres at the MRS-16 site. This project involved the removal of MEC and other related items posing an explosive hazard down to instrument detection depth, to meet project objectives for BRAC land transfer. A total of 271 MEC items were recovered from the MRS-16 removal action operations. In addition, approximately 57,500 pounds of MD were demilitarized and transported offsite for recycling. Prior to Shaw's work, other contractors had removed 81 MEC items from the site. Considering all operations, a total of 352 MEC items have been removed from the MRS-16 site. The planned techniques, QC checks, and inspections subsequently implemented during the MRS-16 MEC removal action provided results necessary to achieve project performance standards.

As part of the remedial action, a magnetometer-assisted surface clearance was conducted for the whole site. Subsurface clearance was completed for 382 grids or 94 percent of the total site. Subsurface removal was not completed in 24 grids identified from DGM as a high density or "saturated" area. Several trenches were dug in the saturated area revealing that the high density was caused by high concentrations of MD and disseminated ferrous metal debris (rust). No MEC items were found in the trenches within the saturated area. However, based on results from limited mag and dig within the area, as well as extrapolation from subsurface removals in adjacent grids, it is likely that subsurface MEC is present within the saturated area.

10.1 Protectiveness Assessment

The protectiveness achieved by the remedial action is discussed in this section through presenting the results and qualitatively assessing the probability that MEC remains. The results of applying the Fort Ord OE Risk Assessment Protocol (Protocol) (*Malcolm Pirnie, 2002*) are presented in Appendix M and summarized in Section 10.2. The revised risk code classification presented in Revised Explosive Hazard Risk Code Classification Document (*USACE, 2005*) was used instead of the codes included in the Protocol.

10.1.1 Proposed Reuse

Munitions response site-16 is undeveloped land in the inland portion of the former Fort Ord separated from the Impact Area by Eucalyptus Road. MRS-16 is primarily left in its natural state; support facilities associated with training that occurred at the site (e.g. access roads, observation towers, targets, trenches, bunkers, etc.) have been removed.

The land that includes MRS-16 is scheduled for transfer to BLM (USACE, 1995) and will be maintained as undeveloped habitat reserve under the *Installation-Wide Multispecies Habitat*

Management Plan (HMP) *for former Fort Ord* (USACE, 1997), which describes special land restrictions and habitat management requirements within habitat reserve areas. MRS-16 is located in Transfer Parcel F1.3, which the HMP identifies as a habitat reserve area that will be maintained as open space and will not be developed. Habitat reserve areas support plant and animal species that require implementation of mitigation measures identified in the HMP to ensure compliance with the Endangered Species Act and to minimize potential adverse impacts to listed species.

For purposes of this risk assessment the following activities are considered applicable to MRS-16:

- Route, road, and trail management and maintenance;
- Habitat enhancement;
- Species specific monitoring and habitat enhancement; and
- Recreational access on established routes.

10.1.2 Potential Receptors

Based on the proposed reuses described above for MRS-16, the following receptors were identified for evaluation in the risk assessment:

- Recreational User (using trails for hiking, bicycle riding, or horseback riding);
- Trespasser (in the area where subsurface removal was not completed)
- Outdoor Maintenance/Fire Fighter/Prescribed Burn Workers (planting, habitat monitoring or maintenance, firefighting, vegetation clearance, preparation of fire breaks)
- Construction Worker (small construction job).

10.1.3 Summary of Remedial Action

A surface removal was performed by Shaw over the entire site to remove MEC and surface debris. DGM was then conducted. Through a combination of towed array DGM and real time EM61 surveys, anomalies were identified and excavated in 359 grids. Subsurface removals were conducted in 23 additional grids using Schonstedt surveys. In total, subsurface removals were completed in 382 or 94 percent of the grids. Subsurface removal was not completed in 24 grids in the saturated area.

Over 8,000 anomalies were investigated at an average density of approximately 100 anomalies per acre. Considering all operations, a total of 352 MEC items have been removed from the MRS-16 site, corresponding to an average of 4.4 items per acre. Most of the MEC items were found in the western half of the site where the average is approximately 9 items per acre.

The table below lists the MEC quantities and types that have been recovered and treated during all MRS-16 removal operations.

MRS-16 MEC Items (All operations)

Quantity	MEC Item Description	Item Risk Code*
161	Mine, AT, Practice, M1	1
2	35mm Rocket, Subcal, Practice, M73	1
8	37mm Projectile, LE, MK1	3
2	37mm Projectile, HE	3
1	75mm Projectile, Shrapnel, MK1	3
15	Grenade, Rifle, AT, M9	3
1	Grenade, Rifle, HEAT, M28	3
1	Grenade, Rifle, Smoke, M22	1
1	Grenade, Hand, Smoke, HC, AN-M8	1
1	Grenade, Hand, Smoke, M18	1
2	Grenade, Hand, Practice, MKII	1
14	Flare, Surface, Trip, M49	1
1	Fuze, Grenade, Hand, Practice, M228	1
30	Fuze, Grenade, Hand, Practice, M205	1
3	Fuze, Grenade, Hand, M213	1
6	Fuze, Mine, Anti-Tank, Practice, M1	1
13	Projectile, 3-inch, trench mortar, MKI (Stokes)	1
11	Simulator, Launching, Anti-tank guided missile and rocket, M22	N/A
1	Simulator, Flash artillery, M110	1
1	Signal, Ground, Rifle, Parachute, M17	1
5	Signal, Illumination, Ground, M125	1
1	60mm Mortar, HE, M49	3
71	2.36-inch Rocket, HEAT, M6	3
Notes:		

* Item Risk Code based on *Fort Ord MMRP Database*

0 - Inert, will cause no injury.

1 - Will cause minor injury, in extreme cases could cause major injury or death to an individual if functioned by an individuals activities

2 - Will cause major injury, in extreme cases could cause death to an individual if function by an individuals activities

3 - Will kill an individual if functioned by an individuals activities

Munitions and explosives of concern were recovered between 0 inches and 48 inches below ground surface. Most MEC items were recovered at depths less than 12 inches. No detected and reacquired anomaly was left uninvestigated (with the exception of the burial pits discussed in Section 5.3).

The remedial action for MRS-16 was conducted according to work plans approved by the BRAC Cleanup Team (consisting of the Army, EPA, and DTSC). The data collection and management processes were subject to both contractor quality control and USACE quality assurance. Analog quality assurance documentation is included in Appendix I. The results of the USACE digital quality assurance review are included as Appendix N.

10.1.4 Evaluation of Remedial Action

For the post remedial action risks at MRS-16, two separate cases/areas are considered:

1. Areas where surface and subsurface MEC removals were completed. This includes the 80-acre site excluding the 5.4 acre saturated area.

2. Areas where surface MEC removal was completed, but subsurface MEC removal was not completed. This includes the 24 grids in the 5.4 acre saturated area.

10.1.4.1 Area with Completed Subsurface Removal

A surface removal was performed by Shaw over the entire MRS-16 site to remove MEC and surface debris. Prior to the surface removal, the vegetation was removed by burning or cutting with the objective of revealing the ground surface for inspection. The prescribed burn itself would be expected to detonate some MEC items.

The surface of the MRS-16 site has been evaluated through a sequence of activities involving observation by qualified UXO technicians:

- Vegetation cutting with UXO support prior to the prescribed burn
- Vegetation cutting with UXO support after the prescribed burn
- Systematic magnetometer-assisted surface clearance after vegetation removal
- DGM survey with UXO support
- Shaw QC inspections
- USACE QA inspections.

Following this sequence it is considered unlikely that MEC could remain on the surface at the MRS-16 site.

Considering the potential for subsurface MEC, the whole area evaluated in this section (i.e. the whole site excluding the saturated area) was surveyed with DGM and all targets that could be reacquired were investigated. This work was also subject to QC and QA in accordance with the approved work plan.

A total of 41 blind seeds were emplaced prior to DGM field operations by the QC geophysicist and all but one of these items were detected by the geophysics surveys. The one item that was not detected was located over the top of a large metal waterline and was not evident in the data. An additional 20 items were emplaced prior to real-time field operations by the QC geophysicist and all but one of these items were located by the real-time geophysics surveys. This item that was missed was due to placement too close to a subsurface cable that masked the signature of the item.

Based on the work conducted it is considered unlikely that subsurface MEC remains in areas where subsurface clearance was completed. It is possible that subsurface MEC does remain considering that the detection instruments are not 100 percent effective. This is especially true in areas where there is interference from metal debris.

In general, the types of MEC items removed at the site are consistent with the types of training and historical uses identified for the site, and the equipment used is capable of detecting the types of MEC items at the depths encountered during the remedial action. The one exception to this involves detection of grenade fuzes and is further detailed in CAR FY08-005 in Appendix J. All grenade fuzes were classified as DMM, and there was no evidence of grenade training encountered during field operations.

10.1.4.2 Saturated Area

During the course of MEC removal operations at MRS-16, an area exhibiting higher than expected anomaly density was delineated from DGM results. This MRS-16 saturated area consists of 24 grids equating to approximately 5.4 acres (Figure 3-1). The MRS-16 saturated area also contains three known rocket burial pits which have been horizontally delineated; however, vertical delineation has not been completed. No MEC was found in these pits, despite extensive investigation during excavation. Based on this extensive investigation, it is considered unlikely that any MEC remains within the confines of the burial pits, although expended 2.36” rockets (MD) remain within the confines of the pits.

Surface clearance was completed in the saturated area. In addition to the work conducted throughout the site (Section 10.1.4.1), the saturated area has been subjected to additional attention including excavation of several test trenches. Based on the work completed it is considered unlikely that MEC could remain on the surface at the MRS-16 site, including the saturated area. Subsurface MEC is evaluated in the following paragraphs.

The DGM of the saturated area generally showed a high uniform anomaly density (Figure 5-2). Discrete anomalies could not be identified to be added to the target dig list. Conventional mag and dig was tried but was too time consuming to continue. Other options were considered including excavation and sifting, and several trenches were dug to examine the soil to a depth of 12 to 18 inches. These trenches revealed that the primary cause of the anomalous electromagnetic signal was the presence of large amounts of fragments of ferrous metal. The evaluation of all the options discussed above was coordinated with regulatory agencies.

Information derived from the MRS-16 surface clearance, subsurface removal, and the test dig results within the saturated area were summarized to further evaluate the Saturated Area. Figure 10-1 shows MEC items found within or in the vicinity of the saturated area. Items are listed in Table 10-1.

- 33 MEC items were found in the saturated area by surface clearance or mag and dig. Of these, 17 were found on the surface and the remainder at depths up to 2 feet.
- 11 additional MEC items were found in the area extending one grid out from the edge of the saturated area. These items included 5 2.36-inch rockets found at depths ranging from 2 inch to 48 inches. These grids were evaluated because they provide the closest evidence of what might be found subsurface in the saturated area. Based on the CSM (Figure 8-4) rockets would be more expected behind the targets than in front.
- In the whole site, 42 MEC items were found at the surface and 229 items were subsurface.

From this evaluation, it is concluded that MEC are likely present in the subsurface of the saturated area. Some of the MEC likely to be recovered in the saturated area are considered to be sensitive.

Table 10-1 presents the Item Risk Code for MEC items identified in or near the saturated area. Some of these MEC items could be detonated by contact causing serious blast and fragmentation injuries, or death. The area is considered safe for its intended reuse because a surface removal has been conducted and recommended institutional controls at the site include UXO support for intrusive activities. The area has also been delineated with fencing, and will be delineated in transfer documents and the Fort Ord GIS.

10.2 Fort Ord Ordnance and Explosives Risk Assessment Protocol

An evaluation of the MRS-16 site using the Fort Ord OE Risk Assessment Protocol is presented in Appendix M.

Areas where surface and subsurface MEC removals were completed are scored as an A for all receptors based on the risk protocol. It should be noted that the detection efficiency of the geophysical equipment is not assumed to be 100 percent and that while not expected, based on the uncertainty analysis presented in Appendix M, it is possible that MEC may remain below the surface at the site.

Areas where subsurface MEC removals were not completed show a score of E (the highest risk score) for all receptors. Surface MEC removal was completed within this area, which resulted in reduction of risk. The subsurface condition of this area has also been investigated as described in Section 10.1.4.2. It should be noted that the risk score represents the highest risk level for the receptors and does not necessarily represent the expected risk.

10.3 Institutional Controls

Parcels such as MRS-16 designated as habitat management have specific management guidelines and restrictions prescribed by the HMP; these mitigations are designed to offset the habitat loss that would occur in designated development areas present outside the Impact Area MRA.

Based on the proposed reuse (Section 10.1.1) it is likely that BLM will place no restrictions on access to the MRS-16 site for activities that do not involve subsurface intrusion. Following the remedial action the perimeter fence has been removed. A two-strand barbed wire fence has been constructed around the saturated area along existing roads for convenience and government property signs have been placed. The purpose of this fence is to delineate the area in which subsurface removal was not completed. The fence location is shown on Figure 10-2. Any intrusive activities within the saturated area should be accompanied by UXO support. The saturated area location is also shown on Figure 10-2. The requirement for UXO support during intrusive activities has been coordinated with BLM and the regulatory agencies.

10.4 Operation and Maintenance

The MRS-16 remedy does not include any operating systems that require formal Operations and Maintenance Plan. It is recommended that the Army institute the following management practices:

- Maintain the fence that marks the boundary of the saturated area,
- Provide MEC recognition training for BLM personnel and report any possible MEC items that are found in accordance with the site security program,
- Require UXO construction support for any intrusive activities in the saturated area, and
- Evaluate the site via the five year review process.

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