Military Munitions and Explosives of Concern:

A Handbook for Federal Land Managers, with Emphasis on Unexploded Ordnance

February 2006

BLM Handbook [H-1703-2]
FWS Handbook
2006

The U.S. Department of the Interior's Bureau of Land Management and U.S. Fish and Wildlife Service present an overview of unexploded ordnance and its management on Federal lands under their jurisdiction.

We extend our thanks to the Department of the Army and the U.S. Army Corps of Engineers for their assistance with the preparation of this handbook.

Suggested citation:

Bureau of Land Management Protection and Response Group. 2005. Military Munitions and Explosives of Concern: A Handbook for Federal Land Managers, with Emphasis on Unexploded Ordnance, BLM Handbook H-1703-2. Washington, DC. *****. 96 pages. *Release number 1-1697

Unless noted otherwise, BLM and FWS provided all the photographs.

Cover Photo – Nomans Land Island National Wildlife Refuge, Massachusetts, the results of many years of practice bombing.

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Bureau of Land Management
U.S. Fish and Wildlife Service

U.S. Department of the Interior
Washington, DC

Unexploded ordnance comes in all shapes and sizes.
This World War II-era sea mine washed ashore in the Aleutian Islands,
Alaska Maritime National Wildlife Refuge.

How to Get Help if You Encounter Unexploded Ordnance

First: Call local law enforcement or the nearest military installation.
Next: Call the appropriate personnel for your agency:

- **BLM employee**—Call the BLM ranger or call the hazardous materials coordinator at the BLM office, or BLM State office, that has jurisdiction for the site. If you cannot reach the hazardous materials coordinator, call the BLM State law enforcement office emergency number or the BLM national law enforcement office at (208) 387-5126.

- **FWS employee**—Call the regional environmental compliance engineer or regional safety officer.

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PRIMARY DEFINITIONS

Note: Additional definitions are given in the glossary.

Discarded military munitions (DMM). Military munitions that have been abandoned without proper disposal or have been 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))

Fuzes. Devices that initiate the detonation sequence in munitions. Fuzes are typically associated with munitions (e.g., mortars and bombs), but they are occasionally found separately. They may contain a charge large enough to cause injury. Magnetic and proximity fuzes are the most sensitive and, depending on other factors (e.g., fuze location and arming), greatly influence the likelihood of detonation. When separated from the munitions, a fuze may not look like an explosive munitions item.

The terms *fuse* and *fuze* mean different things. For this handbook, a *fuze* is a mechanical or electrical device with explosive or non-explosive components designed to initiate a train of fire or detonation in ordnance (e.g., hand grenade). A *fuse* is a cord of readily combustible material that can be lit at one end to carry a flame along the length of the fuse to detonate an explosive at the other end (e.g., firecracker).

Military munitions. Ammunition products and components produced for or used by the armed forces for national defense and security. The term *military munitions* includes ammunition products or components under the control of the Department of Defense, the U.S. 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; bulk explosives; chemical 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.

Military munitions do not include wholly inert items, improvised explosive devices, or nuclear weapons, nuclear devices, or nuclear components. However, military munitions do 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))

Munitions constituents (MC). Any materials originating from unexploded ordnance, discarded military munitions, or other military munitions, including explosive and non-explosive materials. MC also includes emission, degradation, or breakdown elements of such ordnance or munitions. (10 U.S.C. §2710(e)(3)) Note: Munitions constituents are MEC when explosive compounds of the munitions, such as TNT, RDX, and HMX, are in sufficient concentration as to pose an explosive hazard. This situation arises when concentration levels are 10 percent or more. Non-explosive munitions constituents and explosive concentrations less than 10 percent are not considered MEC.

Munitions and explosives of concern (MEC). Specific categories of military munitions that may pose unique explosive risks, including:

(a) unexploded ordnance (UXO), as defined in 10 U.S.C. §101(e)(5);
(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 10 U.S.C. §2710(e)(3), present in high enough concentrations to pose an explosive hazard. (See "Munitions constituents")

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

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 whether by malfunction, design, or any other cause.
(10 U.S.C. §101(e)(5)(A) through (C))

P.L. 106-65, section 3031 (c)(5)(A), provides a more detailed description.

ACRONYMS

ADNT	Aminodinitrotoluene
AEC	Army Environmental Center
BIP	Blow-in-place
BLM	Bureau of Land Management
BRAC	Base Realignment and Closure
CB	Citizens band
CCP	Comprehensive conservation plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CSM	Conceptual site model
CTT	Closed, transferring, and transferred [ranges]
DDESB	Department of Defense Explosives Safety Board
DERP	Defense Environmental Restoration Program
DMM	Discarded military munitions
DNA	Dinitroaniline
DNB	Dinitrobenzene
DoD	Department of Defense
DOI	Department of the Interior
EM	Engineering Manual
EMI	Electromagnetic induction
EOD	Explosive ordnance disposal
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FACA	Federal Advisory Committee Act
FFCA	Federal Facility Compliance Act
FLPMA	Federal Land Policy and Management Act of 1976
FORSCOM	Forces Command (U.S. Army)
FUDS	Formerly used defense sites
FWS	U.S. Fish and Wildlife Service
GPR	Ground penetrating radar
GPS	Global positioning system
HMX	Her Majesty's explosive [high explosive] and high melting explosive
IR	Infrared
IRP	Installation Restoration Program
ITRC	Interstate Technology and Regulatory Council
JUXOCO	Joint Unexploded Ordnance Coordination Office
MC	Munitions constituents
MEC	Munitions and explosives of concern
MRA	Munitions response area
MRS	Munitions response site
MTADS	Multisensor Towed Array Detection System
NAVFAC	Naval Facilities Engineering Command
NEPA	National Environmental Policy Act

OB/OD	Open burning/open detonation
OE	Ordnance and explosives
OEW	Ordnance and explosives waste
OMB	Office of Management and Budget
PDA	Personal digital assistant
P.L.	Public Law
RAB	Restoration Advisory Board
RAC	Resource Advisory Council
RCRA	Resource Conservation and Recovery Act
RDX	Royal demolition explosive [high explosive]
SAR	Synthetic aperture radar
SARA	Superfund Amendments and Reauthorization Act
TNB	Trinitrobenzene
TNT	Trinitrotoluene
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
UXO	Unexploded ordnance

PREFACE

Approximately 40 national wildlife refuges managed by the U.S. Fish and Wildlife Service (FWS), and between 200 and 300 formerly used defense sites (FUDS) managed by the Bureau of Land Management (BLM), still have munitions and explosives of concern (MEC) on-site. Therefore, land managers must be prepared for the possibility that personnel, authorized users (i.e., oil gas operator, farmer, rancher, etc.), or visitors will encounter unexploded ordnance (UXO) or discarded military munitions (DMM) on certain public lands and refuges. UXO and DMM encounters that cause injury or death have been rare. However, public use of BLM and FWS lands is increasing, along with the potential for exposure to UXO and DMM. The BLM and FWS developed this handbook to provide managers with important information on what to do when UXO and DMM are encountered and how to minimize the likelihood of an incident leading to injury or death.

The BLM is responsible for managing over 261 million acres of America's public lands and resources for multiple use and sustained yield. As part of this management effort, the BLM accepts into its inventory lands that were formerly used by the military services (Army, Navy, Air Force, and Marine Corps). Accepting lands that have been returned to the public domain and opening former military ranges for public use present unique challenges. More than 5 million acres of BLM-managed land that is open to public access may contain MEC. The BLM is collaborating with the Department of Defense (DoD) and the U.S. Army Corps of Engineers (USACE) to address MEC-contaminated lands currently in BLM's inventory and the possible transfer of additional military lands to BLM management.

The FWS works in partnership with other Federal agencies, State and local governments, tribal governments, international organizations, private organizations, and individuals to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. Under a wide range of Federal laws and executive orders, the FWS has principal responsibility for the protection and conservation of migratory birds, threatened and endangered species, certain marine mammals, and interjurisdictional fisheries. The FWS accomplishes its mission through the management of the National Wildlife Refuge System, Ecological Services Field Stations, National Fish Hatcheries, Wetlands Management Districts with Waterfowl Production Areas, and Coordination Areas, encompassing about 96 million acres in all. The National Wildlife Refuge System includes public lands that were formerly, and in some cases are currently, held and used by the military services. Congress sometimes legislatively directs the BLM and FWS to take lands from the military services. Often these lands contain MEC.

In addition, the FWS manages lands in the Aleutian Islands and the Pacific islands that were battlegrounds during World War II. The islands have MEC remnants from the war.

The BLM and FWS follow several basic principles for managing lands containing MEC, including the following:

- The BLM and FWS have been delegated response authorities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) on lands subject to its jurisdiction, custody, or control (Executive Order 12580).

- The military service is responsible for developing an inventory of the MEC sites on BLM- and FWS-managed lands, with the cooperation of the BLM and FWS. The BLM and FWS will provide the inventory to field offices and field stations, which will be responsible for making the inventories available to local law enforcement and firefighting personnel.
- The responsible military service and the BLM or FWS will jointly implement access controls and other risk reduction actions, as necessary and appropriate.
- The BLM and FWS normally do not accept the transfer of lands until the lands have been properly cleared of MEC to a level that safely supports the intended land use.

Where MEC removal and remedial actions may destroy important habitat, the BLM and FWS may decide to leave some MEC in place and restrict public access to reduce the risk to the public and protect the habitat.

The military service's primary responsibilities include the following:

- Maintain an inventory of sites containing MEC.
- Provide site characterization and risk assessment.
- Assist Federal land managers with risk management.
- Coordinate with the BLM or FWS to obtain the necessary approvals for response actions to ensure that proposed actions are compatible with the agencies' resource management goals.
- Take appropriate removal and remedial actions, with the concurrence of the BLM or FWS.

BLM and FWS managers and personnel do not touch, move, or remove MEC on the Federal lands under their control. The military services retain liability and responsibility for MEC removal and remedial actions on all lands transferred or transferring from the military to the BLM or FWS. Through a partnership with the military services, the BLM and FWS ensure that MEC removal and remedial actions are consistent with the intended land use, protect the environment, and reduce the risk to the public and employees. The BLM and FWS, as land managers, provide oversight for actions performed by the military services.

This handbook will provide Federal land managers and personnel with a fundamental understanding of MEC and of their risk management options for sites with MEC. The handbook presents answers to the following:

- What is MEC and what does MEC look like?
- What should we do if we find MEC?
- What should we tell personnel and the public about MEC?
- What types of sites may contain MEC?
- How do we use a historical records search to learn what types of UXO may be encountered?
- What are the BLM's and FWS's policies and options for managing lands transferred from the military services?
- What technologies are available for detecting and removing UXO and DMM?
- What are the statutes, policies, and references associated with MEC?

Actual injuries and deaths due to contact with UXO and DMM are rare, but the consequences of encountering UXO and DMM are too severe to ignore. Proper UXO and DMM management reduces the

risk to the public and to BLM and FWS employees. It is the responsibility of BLM and FWS managers to educate themselves and their personnel regarding these risk reduction measures.

This handbook does not address commercial explosives.

Chapter 1
Introduction

Acronym List	
BLM	Bureau of Land Management
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DMM	Discarded military munitions
DoD	Department of Defense
FWS	U.S. Fish and Wildlife Service
MC	Munitions constituents
MEC	Munitions and explosives of concern
UXO	Unexploded ordnance

1.1 BACKGROUND

Since World War II, the military services have returned more than 5 million acres of land used as military ranges to the Bureau of Land Management (BLM). In addition, some U.S. Fish and Wildlife Service (FWS) national wildlife refuges are former military lands or lands that are currently held by the military and are managed by the FWS as overlay refuges. The military used these sites to conduct research and development, testing and evaluation, and training exercises that involved dropping, firing, and placing various ordnance items.

Under the 1988 Base Realignment and Closure (BRAC) Act, subsequent BRAC laws, and other authorities, the military services have transferred or are transferring additional DoD properties to the BLM and FWS. Those lands are both withdrawn public lands and real property that are no longer needed by the military services.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires that, before transferring lands from the military, the military service must search for and remove munitions and explosives of concern (MEC) to accommodate reasonably anticipated future land use. These range cleanup operations, especially before 1986, were typically surface removals and frequently did not remove all MEC on and beneath the surface of the land and water. However, in recent years, technological advances in ordnance detection and increasing public interest in environmental issues have prompted more thorough cleanup efforts.

Today, a military service or installation that is transferring its land prepares detailed surveys to identify and quantify MEC that remains on the site. MEC includes unexploded ordnance (UXO), discarded military munitions (DMM), and munitions constituents (MC) when MC is present in high enough concentrations to pose an explosive hazard. The surveys include physical searches, record searches, and interviews with people who worked on the site. Federal, State, and local environmental regulators; citizens; and representatives of land management agencies typically have a role in planning the survey, witnessing the cleanup of identified hazards, and ensuring that risks are reduced to an acceptable level. However, no existing method or combination of methods can ensure 100 percent removal of MEC (see Section 5.1, “Safety Issues Related to MEC”). This handbook refers to the cleanup effort as a *response operation* and the overall

remedial or removal action as a *munitions response*.

1.2 THE NEED FOR SAFE MANAGEMENT OF TRANSFERRED DOD LANDS

Projections for the next decade indicate that the population in the West will increase more than in other regions of the United States. According to the U.S. Census Bureau, Nevada, the State with the highest proportion of Federal lands, has one of the highest rates of population growth, followed closely by Utah and Arizona.

The growing cities of the West have helped create unprecedented demand for outdoor recreation. Although national parks and national forests continue to attract tourists, the BLM's public lands attract a growing number of Americans who seek a more rugged or remote outdoor experience. In 2001, nearly 52 million people visited the public lands for recreation. Specially designated areas, such as wild and scenic rivers, wilderness areas, national monuments, and backcountry byways, are attracting record numbers of visitors. People are also visiting BLM-managed lands to see archeological, paleontological, and historical sites. The increased use of the public lands for recreational purposes, and in particular the use of off-highway vehicles, increases the risk that the public will be exposed to UXO and DMM.

In 2003, nearly 40 million people visited national wildlife refuges across the nation. Many visitors come to the refuges to get closer to the natural world, such as to visit a favorite fishing hole, watch birds at sunrise, or enjoy an environmental education program. Many refuge visitors participate in structured educational programs, but a significant number of visitors are also interested in just "getting away from it all" and exploring areas removed from visitor centers and trails. In the future, as the nation's population grows and urban areas expand, increased demand for outdoor recreation will lead to the need to protect people who are likely to visit Federal lands that are known or likely to contain MEC.

1.3 HANDBOOK LAYOUT

This handbook introduces basic MEC guidance and risk management options for BLM and FWS lands that were formerly, or are currently, used by the military.

Chapter 2, "BLM and FWS Principles for Managing MEC," provides an overview of the agencies' policies and guidance related to MEC on lands managed by those agencies.

Chapter 3, "Risk from Munitions and Explosives of Concern," describes the risk posed by MEC and MEC encounters.

Chapter 4, "MEC Risk Management," considers the risk of exposure to MEC in the context of BLM and FWS land management.

Chapter 5, "Safety and Reporting Procedures," gives an overview of safety guidelines and reporting procedures.

Chapter 6, "MEC Site Characterization and Munitions Response Operations," describes the site characterization process and current technologies available for identification and removal of MEC.

Chapter 7, "MEC-Related Statutes, Policies, and References," gives an overview of the laws and guidelines relating to the management of MEC-contaminated lands.

The **glossary** provides additional definitions of munitions-related concepts and terms.

Appendix 1, "Military Munitions," describes and illustrates the various classes of munitions.

Appendix 2, "Additional Information," lists useful Internet sites with additional information concerning MEC, UXO, DMM, and MC.

Appendix 3, "Points of Contact," lists the departments and officials of the BLM and FWS.

Appendix 4, "Sample Liability Waiver," shows the form given to recreational users at an installation that allows hunting and fishing in an area that may contain MEC.

Appendix 5, "Site Safety and Health Plan," shows the information necessary to minimize potential exposure, accidents, or injuries that could occur.

Chapter 2

BLM and FWS Principles for Managing MEC

Acronym List	
BLM	Bureau of Land Management
CCP	Comprehensive Conservation Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DDESB	Department of Defense Explosives Safety Board
DMM	Discarded military munitions
DOI	Department of the Interior
EOD	Explosive ordnance disposal
EPA	Environmental Protection Agency
FLPMA	Federal Land Policy and Management Act
FUDS	Formerly used defense sites
FWS	U.S. Fish and Wildlife Service
MEC	Munitions and explosives of concern
NEPA	National Environmental Policy Act
OMB	Office of Management and Budget
USACE	U.S. Army Corps of Engineers
UXO	Unexploded ordnance

The Department of the Interior (DOI) addresses the management of munitions and explosives of concern on BLM and FWS sites in its Departmental Manual, Part 602, Chapter 2, "Real Property Pre-Acquisition Environmental Site Assessment" (see Section 2.2 of this handbook). Until specific policy is established, the BLM and FWS are operating under a set of principles for the management of lands containing MEC.

Lands transferred to the BLM or FWS by the military services may contain MEC and may require additional munitions response actions. The ultimate goal of the BLM and FWS is to have unrestricted use of the lands they manage by ensuring the removal of MEC or the remediation of MEC sites by the military services that used the lands. Until that goal is achieved, interim goals should be established that limit risk by considering potential exposure, impacts on the environment, proposed land use, technology limitations, and cost-effectiveness. Current technologies are unable to achieve 100 percent removal of UXO or DMM at a MEC site, refuge, or public lands. Therefore, managers should assume that all MEC sites contain a residual amount of UXO or DMM until proven otherwise.

2.1 GENERAL STATEMENTS OF BLM AND FWS PRINCIPLES

The BLM and FWS, as the Federal agencies responsible for administration of the Federal lands, and DOI, as the department of jurisdiction, work with the military services to limit exposure to MEC for the public and employees. The BLM and FWS have been delegated the CERCLA response authorities on lands subject to its jurisdiction, custody, or control under Executive Order 12580.

2.1.1 BLM

The BLM administers public lands within a framework of numerous laws. The most comprehensive of those laws is the Federal Land Policy and Management Act of 1976 (FLPMA). All BLM policies, procedures, and management actions must be consistent with the act and with other laws that govern the use of public lands.

2.1.2 FWS

The FWS manages the National Wildlife Refuge System under the authority of the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997. The refuge system is managed according to the principles of sound management of fish and wildlife and the administration of fishing, hunting, wildlife observation, and environmental education programs.

2.1.3 Department of Defense

DoD is responsible for the control of military munitions under 10 U.S.C. §172 and responsible for MEC removal or remedial actions under 10 U.S.C. §2701. Therefore, the military retains responsibility and liability for MEC on transferring lands and for MEC that remains on lands already transferred to the BLM or FWS. At sites for which DoD maintains administrative control, it retains complete responsibility related to MEC.

2.2 ACQUISITION OF LANDS CONTAINING MEC

The DOI Departmental Manual, Part 602, Chapter 2, states: "It is the Departmental policy to minimize the potential liability of the Department and its bureaus by acquiring real property that is not contaminated unless directed by the Congress, court mandate, or as determined by the Secretary." The DOI policy requires a bureau that is acquiring real property to ascertain the nature and extent of any potential liability from hazardous substances or other environmental problems, including potential liabilities associated with MEC. The DOI allows bureaus to acquire property with liability only when Congress or the court mandates the acquisition, or when the bureau determines that the acquisition benefits the bureau's programs and when the appropriate authority in the bureau or the Secretary of the Interior approves the acquisition. This latter situation generally is limited to properties for which substantial natural or cultural resource values override the associated environmental liability.

The BLM or FWS will work with the military service responsible for the munitions response actions at a site to balance the need to reduce the risk from MEC with the natural resource values of the site that the agency intends to protect. In some circumstances in which a property has high resource value but is still an active range or otherwise contains MEC, the FWS and the military service can enter into an agreement by which the FWS manages the land as an overlay refuge. In some cases, the FWS might accept the transfer of such properties after military action has ceased and the military service or installation has completed munitions response actions for MEC and other environmental contamination to acceptable levels. The BLM does not have a property management option that is comparable to an overlay refuge.

2.3 EXPLOSIVES SAFETY

The military service is responsible for explosives safety at a MEC site. The regulations and policies of the Department of Defense Explosives Safety Board (DDESB) and military service apply. The BLM and FWS personnel must never ask the military service to disregard explosives safety regulations and policies.

It is the responsibility of the Military Service (not BLM or FWS) land manager to determine if it is likely that a site contains MEC that may pose a hazard to users. Prior to authorizing access to such a site, the land manager should coordinate with DoD and request an analysis of any safety issues that may be associated with access to the site. The preparation by DoD of a safety plan will ensure that such access is accomplished in a manner consistent with DDESB standards. At a minimum the safety plan must state whether visitors entering the site must have an escort who is a specially trained UXO technician.

BLM and FWS employees must report all observed or suspected MEC to appropriate authorities for elimination of the risk. Employees with the potential to encounter MEC must receive safety training so they can (a) recognize potential MEC, (b) identify the location so the UXO or bomb squad personnel can find the UXO or DMM item, (c) safely leave the area, and (d) report the encounter to the proper authorities.

2.4 INVENTORY OF SITES CONTAINING MEC

The U.S. Congress has mandated that the military service is responsible for MEC and for explosives safety and must maintain an inventory of sites containing UXO (P.L. 107-107, section 311). The BLM and FWS will assist the military service with reviewing inventory data for lands they manage.

BLM managers will establish priorities for munitions response actions on their sites that contain MEC. The BLM will provide the prioritized list to the U.S. Army Corps of Engineers (USACE) for its national priorities list of formerly used defense sites (FUDS) response actions.

2.5 RISK MANAGEMENT

2.5.1 Responsibility for Risk Assessment

The military service is responsible for assessing the risk associated with MEC at DoD sites and will provide that information to the BLM or FWS. The BLM or FWS will assist the military with this assessment as it relates to the future intended use of the lands, public visitor use, and employee visits to accomplish the agencies' management objectives. (See USACE Engineer Manual 1110-1-4009, June 23, 2000, Chapter 10, and *Management Guidance for Defense Environment Restoration Program*, September 2001, page 4, paragraph 5.)

2.5.2 Risk Management Planning

As soon as possible after identifying a MEC site, the military service, along with the BLM or FWS, will develop and implement a risk management plan. The plan should protect human health and the environment, including natural and cultural resources. The plan will include a detailed statement concerning the risk at the site, identify institutional and engineering land use controls to be implemented, where appropriate, and establish funding responsibilities for the initial implementation and maintenance of land use controls. The plan should also include a discussion of the long-term management of the land use controls, possible changes in land use, site inspections to ensure that the remedy is working, and the use of new technologies when they become available to reduce or eliminate the need for land use controls.

2.5.3 Risk Management When Archeological Sites, Traditional Cultural Properties, or Historic Properties Are Present

The values associated with archeological sites, traditional cultural properties, and historic properties should be preserved during munitions response actions. The military service should have cultural inventories for sites transferred after 1990 and should be able to provide these reports upon request.

People may be drawn to these sites for ceremonies, curiosity, or other reasons. If the site contains UXO and access cannot be controlled, the munitions response must be adequate to safely accommodate these visits and activities.

During munitions response actions at or near archeological, cultural, or historic properties, measures will be used to minimize the impact on those resources. If there will be unavoidable impacts on the resource, the site will be documented and mitigated by the appropriate specialist prior to the munitions response action, if the documentation and mitigation actions can be conducted safely.

2.6 LAND USE PLANS

Land use plans for lands that include sites containing MEC must address the risk posed by the MEC. The plan will include access closures or restrictions on subsurface activities, if appropriate, and disposal of the lands out of Federal ownership. BLM managers should refer to the *Land Use Planning Handbook* (H-1601-1).

2.7 MUNITIONS RESPONSE ACTIONS AT SITES CONTAINING MEC

2.7.1 Responsible Party

Congress provides the military with funds for munitions response actions at MEC sites. The military retains the liability and responsibility for MEC. If the U.S. Environmental Protection Agency (EPA) or a State regulatory agency directs the BLM or FWS to clean up a site containing MEC, the BLM or FWS will forward that notice to the appropriate military service and advise EPA of the military service's responsibility for the site. The military services have the knowledge, technical expertise, funding, and responsibility to clean up MEC sites.

2.7.2 Remedy Selection

The BLM or FWS is an equal partner with DoD on the munitions response team that selects the cleanup level and methodology. The BLM or FWS manager should be concerned with balancing risk reduction with the safety of visitors, employees, and natural resources. The munitions response plan must protect human health and the environment, including natural and cultural resources.

2.7.3 Site Access

The BLM or FWS will provide DoD, including its contractors, with adequate access to the property containing MEC, as may be reasonably required for DoD to meet its obligations. Before entering the property, DoD will notify the BLM or FWS to allow coordination between response actions and the agency's land management activities. In emergencies, DoD must notify the BLM or FWS as soon as practicable, but no later than 24 hours after entry.

2.7.4 Responses Involving Land Use Controls

The BLM or FWS will coordinate decisions with DoD regarding response actions and land management. Both parties must agree on the remedy selection for any response actions. DoD may act as a cooperating agency for the development of the National Environmental Policy Act (NEPA) documentation for land use planning. Consistent with applicable law, DoD must notify the Office of Management and Budget (OMB) as early as possible about any land use proposal that will affect DoD's budget. This notice may be contained in a refuge comprehensive conservation plan (CCP), any other land use planning process, legislative proposal, or court judgment. To the extent permitted by law, the OMB will review and determine any unresolved budgetary issues between DoD and the BLM or FWS that might result from the land use planning processes or response actions.

2.7.5 Additional Removal and Remedial Actions at a MEC Site

2.7.5.1 Circumstances Under Which BLM or FWS May Request Additional Munitions Response Actions

The BLM or FWS and the military service will jointly decide when the military service will return to a site to conduct additional removal or remedial response actions. BLM and FWS land managers might request the military to return to a site under the following circumstances:

- The initial cleanup level does not adequately protect human health and the environment for the land use.

- EPA or State environmental cleanup standards have become more stringent than those imposed in earlier cleanup actions.
- New technology has become available that would reduce risk and therefore reduce the need for land use controls.
- The land use has changed as a result of events beyond the control of the BLM or FWS and the military service.
- A major natural event, such as a landslide, flood, or wildfire, has exposed MEC that had been buried.

2.7.5.2 Third-Party Use of Federal Lands

Sometimes a third party (e.g., lessee, permit holder, right-of-way grantee) chooses to use lands containing MEC when other options are available. In such cases, the BLM or FWS document authorizing use must include a MEC hazard warning notice and a requirement that the third party complete the MEC removal or remedial action to a level appropriate for the intended use. The third party will bear all costs associated with the additional MEC removal or remedial action and will assume all liability for its actions, including injuries to authorized users of the MEC hazard area.

2.8 MUNITIONS RESPONSE SITE PRIORITIZATION PROTOCOL

The DoD published the Munitions Response Site Prioritization Protocol in the Federal Register on October 5, 2005 (70 FR 58016). The purpose of the protocol is to assign each defense site a relative priority for response activities related to MEC based on the overall conditions at the defense site.

The relative priority is based on an analysis of site conditions by a project team, which includes stakeholders, such as the land owner/manager. The BLM or FWS are participating stakeholders for munitions response sites on public lands or refuge lands, respectively.

The site conditions analysis is primarily a hazard/risk analysis which leads to the site being placed in one of eight priority categories or three "Alternative Priorities". "Sequencing" within each of the eight priority categories is influenced by other factors, including proposed land management and land use changes, and other factors which may be known to the land manger, but not specifically addressed in the hazard analysis. It is in the sequencing part of the process where the BLM, FWS, and DOI will have the opportunity to influence timeliness of cleanup of munitions response sites on lands managed by the BLM or FWS.

Chapter 3

Risk from Munitions and Explosives of Concern

Acronym List	
DMM	Discarded military munitions
EOD	Explosive ordnance disposal
HMX	Her Majesty's explosive (high explosive) and high melting explosive
ITRC	Interstate Technology and Regulatory Council
MEC	Munitions and explosives of concern
OB/OD	Open burn/open detonation
RDX	Royal demolition explosive
TNT	Trinitrotoluene
USACE	U.S. Army Corps of Engineers
UXO	Unexploded ordnance

3.1 POTENTIAL MUNITIONS ON BLM AND FWS SITES

A simple definition of risk is "the probability of loss or injury." Risks can be differentiated from hazards by thinking of a hazard as a source of danger, or something that exists, such as MEC on a site, that may bring about risk if encountered. A more complex definition states that risk can be characterized as the probability of a negative event occurring and the severity of the event's effect should it occur. This chapter describes the four factors associated with risk incurred from an encounter with MEC and discusses how to manage those factors.

Munitions and explosives of concern consist of the following categories of military munitions that may pose unique explosive risks:

- Unexploded ordnance (UXO) is the most dangerous category of munitions because it has been readied for use, used, and malfunctioned (i.e., it has not yet functioned as planned). However, the fuze has been activated. Therefore, the explosive condition of munitions that have been readied is unknown. Munitions that have survived an attempt to destroy them by open burning/open detonation (OB/OD) are also considered to be UXO, as the condition of the fuze is unknown.
- Discarded military munitions (DMM) are complete munitions that have not been readied for use and have not been used. They are munitions that were abandoned by troops at a firing range (e.g., buried near the firing line) or tossed aside by maneuvering troops to lighten their load. Given that untrained persons cannot consistently distinguish between DMM and UXO, all BLM and FWS personnel must treat DMM as if it is UXO.
- Munitions constituents are MEC when explosive compounds of the munitions, such as TNT, RDX, and HMX, are in sufficient concentration as to pose an explosive hazard. This situation arises when concentration levels are 10 percent or more. Non-explosive munitions constituents and explosive concentrations less than 10 percent are not considered MEC.

As public use of BLM- and FWS-managed lands increases, more agency personnel will be on those lands. As a result, BLM and FWS managers need to take an active risk management position to ensure the safety of the public and employees. The information in this chapter is provided to increase the managers' understand-

ing of the factors that influence risk associated with MEC on their sites.

3.2 MEC RISK FACTORS

Land managers need to understand risk factors to effectively mitigate MEC hazards on their lands. These factors form a progression of conditions—a chain of events—that lead to a detonation. Eliminating any one step in the chain of events can eliminate the acute consequence of a detonation. Land managers can reduce the risk of exposure posed by MEC by managing all of the following elements of a MEC chain of events:

- Presence of MEC—The determination is made that MEC is present or likely to be found.
- Likelihood of a MEC encounter—The likelihood that a person will have a MEC encounter is based on site accessibility, activity of that individual, and location of the MEC.
- Likelihood of detonation—The likelihood that MEC will detonate as a result of the encounter will depend on the type and condition of the MEC and the type of disturbance.
- Consequences of detonation—The range of possible outcomes or results includes injury or death.

3.2.1 PRESENCE OF MEC

Numerous factors affect whether MEC will be present on public lands and refuges. The primary factor is whether the military used the land for testing, training, or munitions storage or manufacture. Managers should assume that all lands used by the military and its munitions contractors and suppliers contain MEC until proven otherwise. If the lands were never used for testing, training, munitions storage, or munitions manufacturing, the presence of MEC is unlikely. MEC that is found in "clean" portions of an installation generally consists of small items that were perhaps inappropriately removed from training ranges and later hidden or buried to avoid detection.

Transferred lands that were testing and training ranges will probably always have residual surface, and probably subsurface, MEC, even after the military response team conducts response efforts. Also, areas that were used for the manufacture, transport, or storage of munitions may contain authorized munitions burial sites and MEC. Until the mid-1960s, the burial of obsolete, damaged, or otherwise unserviceable munitions was an accepted practice. Most former military lands that were transferred before 1987 were given only a surface clearance. Such "surface sweeps" are generally limited to a visual inspection by military personnel walking the site. Even thorough surface sweeps will not find all the munitions on the surface and will usually not find any subsurface UXO or DMM. If the military response team has conducted a subsurface response, residual UXO and possibly DMM will remain, because the best current technology can find only about 90 percent of subsurface UXO and DMM. Older technologies detected as little as 30 percent. Also, the freeze and thaw cycles of soil moisture, and other soil mechanics, can cause residual UXO and DMM to rise to the soil surface.

To learn about past activity on a transferred site, BLM and FWS personnel can read the military installation's historical records review, also known as the archive search report, which is prepared by the U.S. Army Corps of Engineers (USACE) or the responsible military service. The report gives historical background on MEC and chemical warfare materiel used on a site and is essential for identifying where potential and residual UXO munitions may be located. The Interstate Technology and Regulatory Council's (ITRC) *Munitions Response Historical Records Review* is an excellent source that describes how historical records reviews are prepared by the military and factors that affect their adequacy. The document can be ordered through the ITRC web site at http://www.itrcweb.org.

3.2.2 Likelihood of a MEC Encounter

The likelihood of encountering MEC depends on various factors related to the types and locations of residual MEC at a known or suspected MEC site. An analysis of the potential risk of encountering MEC at a given location should consider the following factors:

- Effectiveness of prior response actions
- Amount of UXO or DMM
- Depth of UXO or DMM
- Size of UXO or DMM
- Shapes of UXO and DMM
- Current and potential land use
- Accessibility of the land
- Topography
- Vegetation and ground cover
- Water cover
- Soil type
- Climate
- Other site features

3.2.2.1 Effectiveness of Prior Response Actions

All MEC sites managed by the BLM and FWS received some level of MEC removal before they were transferred from the military service. The likelihood of encountering MEC is directly related to the effectiveness of prior response actions. It is important for BLM and FWS managers to learn the nature and extent of the response action and, if possible, obtain the associated records from the military, because the residual MEC presents a risk to the public and employees (see ***Figure 1***). Those records include the archive search report or historical records review, which contains the history of the use of the lands, including dates of use of the range, types of activity and munitions used on the range, and types of munitions contained in the storage facility or manufactured on the site.

Figure 1 – Range residue, including fins from a 60 mm mortar, fins from a 3.5-inch rocket-propelled antitank round, and shrapnel.

Reports of the removal actions will indicate the level of removal, the technical tools used, and the location and nature of materials found. That documentation also will indicate the effectiveness of the surface removal and the occurrence and depth of any subsurface clearance. It is unlikely that the military did any subsurface clearance before 1986. Documentation of the types and locations of previously detected MEC will be very helpful in determining the types and locations of residual MEC.

3.2.2.2 Amount of UXO or DMM

The likelihood of an encounter increases as the amount of UXO or DMM increases. Although this sounds very basic, it is important to note that the amount of UXO or DMM varies across a military installation and across military ranges. At a military installation, most MEC occurs on former ranges and maneuver areas. However, other sites, including former storage, disposal, or housing areas, may also contain UXO or DMM.

On a typical range, the amount of UXO will be greatest in the target area, in a pattern similar to that shown in ***Figure 2***. The primary impact area of all rounds, and therefore of UXO, is in an elliptical pattern with the target in the center. The long axis is in the direction of fire and results from rounds landing short or long of the target

(firing axis), and the short axis lies to the left and right of the firing axis (deflection axis). Beyond this target area, rounds also could have landed anywhere within the safety fan, with the likelihood of encountering UXO decreasing as the distance from the target area increases. Any area in front of the firing point (down range) could have UXO.

Figure 2 depicts a single firing point, target, and safety fan. Most ranges consist of multiple firing points and multiple ranges. Multiple ranges may be in a line with all weapons firing in the same general direction. If the range area is large enough, the multiple ranges may be located inside a perimeter road with all weapons firing into the center. ***Figure 3*** is a drawing of the overlapping ranges at Siskiyou Rocket and Bombing Range, California. Note that the three safety fans overlap and use the same target. This will affect the density and distribution of UXO.

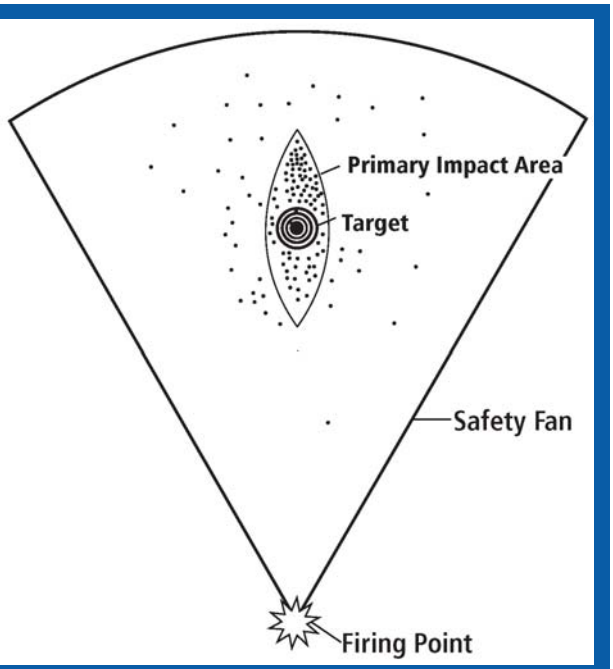

Figure 2 – *Illustration of UXO density in a target area on a typical range.*

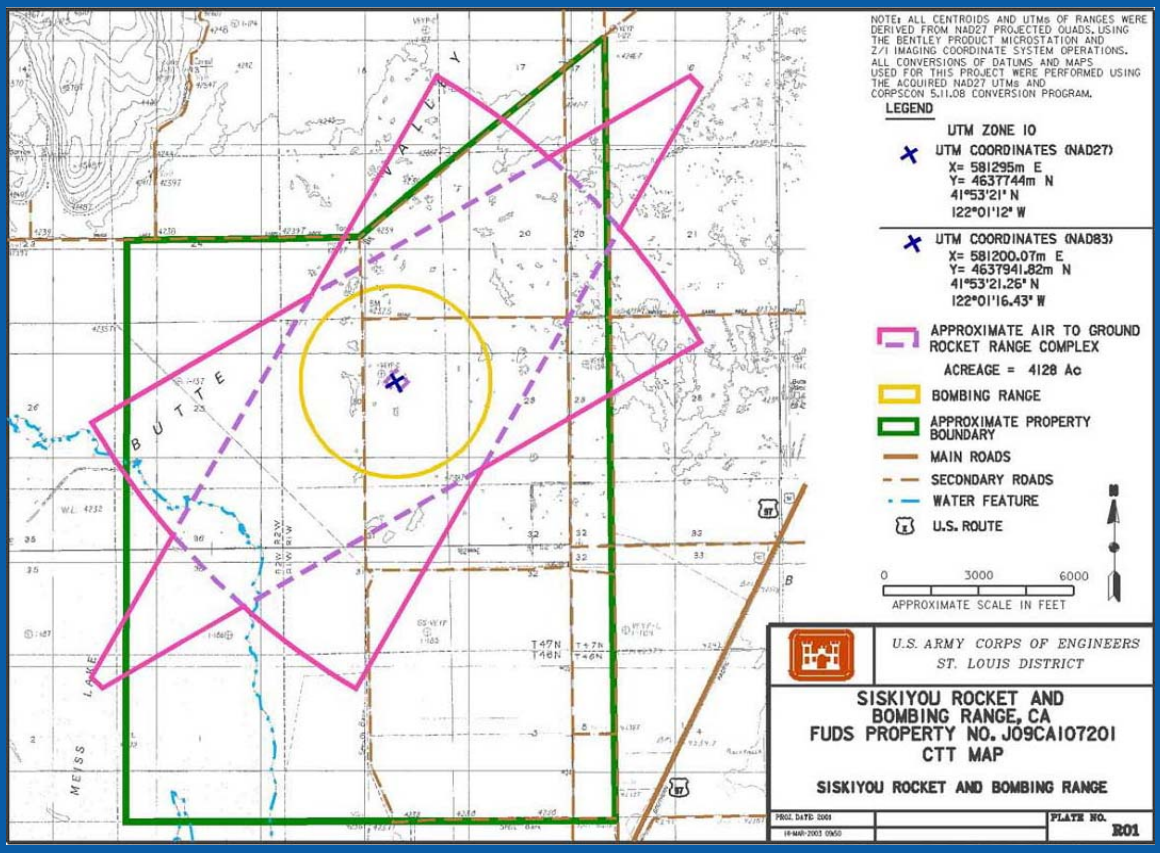

Figure 3 – *Maps of a multi-range area showing overlapping range fans with a single impact area. In this case, the density pattern is more complicated than Figure 2 as it reflects the flight paths of the rockets and the circle within which all bombs impacted.*

In addition, full rounds of DMM may be buried near a firing point. Until recently, military personnel could not return rounds from an opened case to the ammunition supply point. Although burial was never an approved practice, personnel sometimes buried unused rounds instead of firing the rounds down range. DMM also may be found along "routes of march," at dug-in positions (foxholes), and in bivouac (camping) areas within maneuver areas. Soldiers would lighten their load by tossing rounds aside or leaving rounds behind when they were given the order to move out. A high amount of UXO also is likely to remain in the vicinity of an OB/OD crater. The amount of UXO decreases as the distance from the crater increases.

BLM or FWS managers and personnel should avoid areas that indicate high amounts of UXO; otherwise, they must have a qualified UXO escort when entering areas of suspected or known high amounts of UXO.

3.2.2.3 Depth of UXO or DMM

An encounter is more likely if the MEC is exposed on the surface than if it is buried in the subsurface. On typical Army and Marine Corps ranges, more than 90 percent of UXO and DMM are found within the top 2 feet of soil. Larger, more powerful munitions, such as bombs and artillery projectiles, are heavier than grenades and small arms munitions and therefore are more likely to penetrate the ground to greater depths (see ***Figure 4***). In addition, munitions and projectiles will generally penetrate hard clay soils more deeply than soft soils or sandy soils (see ***Table 1***).

Activities such as walking, driving, digging, trenching, plowing, doing construction, and building campfires may disturb MEC in the subsurface, moving it closer to the surface and thereby increasing the risk of an encounter. Many activities that frequently occur on BLM and FWS lands have the potential to create such a risk, including digging for fence installation, trenching in utility corridors, road building, and maintenance activities.

Figure 4 *– Large ordnance can easily penetrate soils.*

Weather and climate can also affect the depth of MEC. Over time, buried UXO or DMM may become exposed through weather or wind erosion or may migrate to the surface as a result of the freeze and thaw cycles of soil. Conversely, surface UXO and DMM may become buried by vegetative matter or deposition of wind- or water-borne soil material (see Section 3.2.2.12).

3.2.2.4 Size of UXO or DMM

Large UXO or DMM items on the surface of the ground are more likely to be seen and are therefore easier to avoid than small UXO or DMM (see ***Figure 5***). Easily seen surface UXO or DMM includes large bombs, rockets, and guided

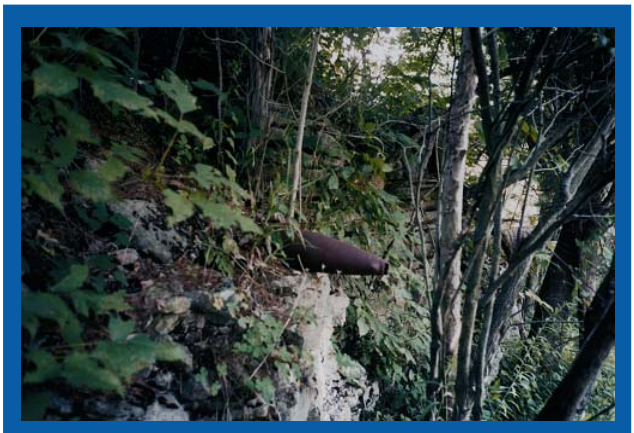

Figure 5 *– This 155 mm round is quite noticeable even partially concealed by vegetation.*

Table 1. Penetration of Bombs and Projectiles into the Earth

Weight of Bomb or Projectile (in pounds)	Depth of Penetration (in feet)*									
	Sandstone		Sand and Gravel		Chalk		Clay		Offset**	
	Avg.	Prob. Max.	Avg.	Prob. Max.	Avg.	Prob. Max.	Avg.	Prob. Max.	Avg.	Prob. Max.
0.25 (20 mm)	0.2	0.5	0.3	0.6	0.3	0.6	0.5	1	–	–
2 (37 mm)	0.3	0.6	0.4	0.8	0.5	0.9	0.8	1.5	–	–
16 (75 mm)	1	2	1	3	2	4	4	6	–	–
30 (105 mm)	2	3	4	6	6	9	10	13	–	–
90 (155 mm)	4	9	8	11	10	13	12	17	–	–
100	8	17	9	19	11	19	14	25	3	18
500	11	23	13	28	16	29	20	35	4	20
1,000	14	29	17	33	20	34	24	43	5	20
2,000	17	34	20	40	24	41	29	52	7	26

*Depth below surface is based on tests designed to maximize the depth of penetration. The depth below surface is provided to show the difference in depths when the same weight bomb or projectile is sent into different soil types. Specific maximum depths of MEC items will be determined site-specifically based on a variety of factors.
**Offset is the distance laterally from the point of entry that a bomb may travel after penetrating the surface of the ground.
Avg. = average
Prob. Max. = probable maximum
– = Not applicable
Source: Range Clearance Technology Assessment (Revision 1), March 1990, Final Report, prepared by Naval Explosive Ordnance Technology Center, Indian Head, MD, pp. 2-14.

missiles. Small arms munitions, grenades, and projected grenades, which are much smaller, are more difficult to avoid. Unfortunately, because of their size, small UXO or DMM items are often picked up and kept as souvenirs.

3.2.2.5 Shapes of UXO and DMM

Many people can readily identify and thus avoid UXO or DMM items that they have seen in movies or on television (e.g., hand grenades and bombs). Nevertheless, some people will pick up such items without thinking. Submunitions, fuzes, and many other small items do not look like military munitions to the untrained eye; therefore, people may be more likely to pick up and examine such items (see Appendix 1). In addition, children may be attracted to smaller munitions because these munitions have enticing shapes and colors.

Another shape-related factor is that munitions may corrode over time and look more like scrap metal (shrapnel) than like a munitions item. Many people assume that old, rusted munitions can no longer be explosive. That assumption can be a fatal mistake.

3.2.2.6 Current and Potential Land Use

Land uses allowed on a MEC site directly affect the exposure of individuals to the MEC hazard. The likelihood that an individual will encounter a MEC item on a munitions response site is directly related to the number of persons who are on the munitions site, the duration of their presence, and their activities during that time. For example, MEC encounters are more likely on lands used for general recreational purposes (e.g., hiking, hunting, off-highway vehicle use, and camping) than on lands used for grazing or in areas without public access simply because

more individuals for a longer period of time have an opportunity to encounter a MEC item.

Any management change in land use that may increase the likelihood that users or personnel will encounter MEC (e.g., from grazing to recreation) requires an understanding of the MEC hazard present. This understanding is developed through review of the work already accomplished by the military at the site, for example a preliminary assessment, site inspection, or other documentation; a hazard assessment or application of other risk methodology; and an understanding of the exposure risk of surface and subsurface intrusive activity. Public use of public lands and refuges where MEC is present should be appropriate to the hazard associated with the MEC and the risk of an encounter. Access controls and education are tools that may be used to reduce the likelihood of a MEC encounter.

When considering land use at or near MEC sites, the adjacent land uses which might bring people within the maximum horizontal fragmentation distance of an explosive event at the site should also be considered. The military service responsible for the site can provide that information.

Before approving intrusive activity into the subsurface where MEC may be located (e.g., installing fences, building roads, or excavating a foundation), the land manager should request the appropriate military service to provide MEC avoidance or construction support so MEC in the subsurface may be avoided or remediated prior to the intrusive activity (see Sections 6.1 and 6.2).

3.2.2.7 Accessibility of the Land

An area's accessibility contributes to the number of people likely to go on the land and encounter MEC (see ***Figure 6***). An unfenced area near a road is more accessible than a remote fenced area. In addition, the use of off-highway vehicles, such as all-terrain vehicles, has made some rugged, remote areas more accessible.

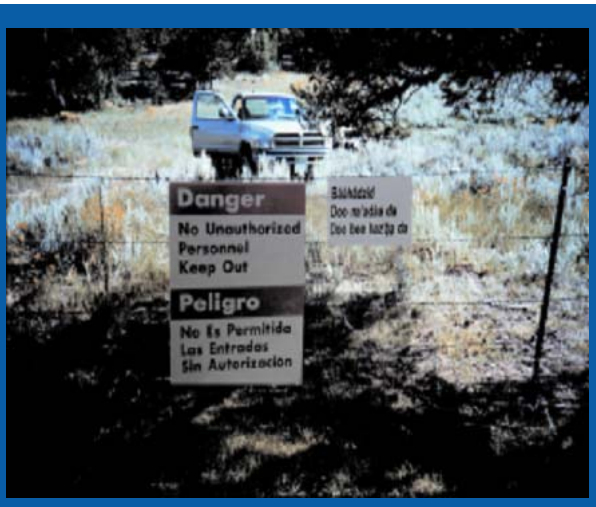

Figure 6 *– A way to limit access is to fence areas and post sign.*

Land managers may need to increase the number of warning signs, install fences, or use other access restrictions, and enforce those restrictions, in areas of concern.

3.2.2.8 Topography

Topography can influence the number of people likely to enter a site, the amount and type of MEC found, and potential land use (see ***Figure 7***). In general, the public is more likely to enter flat land near populated areas than remote land with rugged terrain. Topography also influences where MEC may be concentrated. MEC is more likely to migrate to valleys and depressions

Figure 7 *– Land with a flat or rolling topography is much more accessible and more likely to attract visitors than land with mountainous or rugged terrain.*

through surface water movement, soil erosion, landslides, and avalanches.

3.2.2.9 Vegetation and Ground Cover

Surface MEC may be seen more easily on barren desert lands (see ***Figure 8***). Conversely, heavy vegetation and ground cover may conceal even large MEC items. However, heavy vegetation and ground cover can limit access to an area, thus reducing potential encounters with MEC.

Figure 8 *– Surface UXO or DMM may be more easily seen on barren desert lands; however, UXO or DMM may also be concealed by the scrub growth and shifting soils.*

3.2.2.10 Water Cover

MEC can also be found in groundwater, surface water, and marine environments. Water may increase or limit visibility, depending on the water's depth and turbidity. Water may restrict access to UXO and DMM. Some activities, such as dropping an anchor, could lead to MEC encounters.

3.2.2.11 Soil Type

Soil type influences the depth to which munitions penetrate the ground and can affect whether the fuze activates. Some fuze types require a substantial impact before they will activate. If the munitions item lands in mud or fine soil, the fuze may not activate as designed. With such site conditions, the likelihood and amount of UXO increases. In addition, munitions penetrate hard clay soils deeper than soft soils.

3.2.2.12 Climate

Climate affects the surface and subsurface movement of UXO and DMM in several ways. Heavy rainfall and high winds cause surface water movement and soil erosion, thus causing UXO and DMM to migrate. The depth of the frost line and the frequency of the freeze/thaw cycle in different climates also affect the movement of UXO and DMM to the surface. Generally, colder climates have deeper frost lines, thus contributing to a greater number of UXO and DMM items migrating to the surface. Colder climates with more snow cover also may conceal surface UXO and DMM.

3.2.2.13 Other Site Features

Impact craters indicate a high potential for UXO. Jagged pieces of metal, mortar fins, and other debris from munitions that functioned properly are good indicators that numerous large UXO may also be present. BLM and FWS managers should ensure that personnel and visitors are not permitted to enter these areas without an EOD escort. All persons entering these areas must use extreme caution.

3.2.3 Likelihood of Detonation

The likelihood of a MEC encounter that leads to an accidental detonation depends on three primary factors: (a) the actions of the individual encountering the UXO or DMM, (b) the location of the MEC, and (c) the condition of the UXO or DMM.

Following the safety guidelines presented in Chapter 5 will greatly reduce the likelihood of detonation:

- Do not move any closer to the UXO or DMM after observing it.

- Do not touch, move, disturb, or attempt to pick up the UXO or DMM.
- Do not attempt to mark or remove an object on, attached to, or near the UXO or DMM.
- When reporting the UXO or DMM, do not use any electronic communication devices, such as cell phones, near the UXO or DMM.

The location of the UXO or DMM (i.e., surface, subsurface, or partially buried) also affects the likelihood of detonation (see ***Figure 9***). Subsurface UXO or DMM is less likely to be disturbed by someone walking or driving over it than UXO or DMM that is lying on the surface. The risk of encountering UXO or DMM decreases as the depth of the UXO or DMM increases. Partially buried UXO or DMM is most susceptible to being disturbed by someone tripping over it or kicking it or by a vehicle driving over it and radically changing its position. An item on the surface is most easily seen and avoided.

The condition of the UXO, especially the fuze, is a critical variable in the likelihood of an unintentional detonation. When the fuze of a UXO has been armed, but has not functioned as intended, the damaged fuze may be further sensitized. Even professional EOD personnel cannot determine with certainty the condition of the fuze. For those reasons, anyone encountering munitions on a site should never approach, touch, or otherwise disturb it, because it could be UXO.

Figure 9 *– Not all UXO is on or under the ground. This tank-fired antitank round may be overlooked, although it is a danger and an attractive risk.*

3.2.4 Consequences of Detonation

The BLM's and FWS's goal is to avoid the accidental detonation of MEC. The consequences of detonation can range from limited injuries (e.g., loss of fingers or a hand caused by a spotting charge in practice munitions) to massive injury or loss of life. In any case, detonations are instantaneous. Although in most cases the risk from MEC cannot be completely eliminated, reducing the risk is essential to the safe reuse of former ranges as public lands and refuges.

Chapter 4

MEC Risk Management

Acronym List	
AEC	Army Environmental Center
CSM	Conceptual site model
CTT	Closed, transferring, and transferred
DMM	Discarded military munitions
DoD	Department of Defense
EM	Engineering Manual
EOD	Explosive ordnance disposal
EPA	Environmental Protection Agency
FACA	Federal Advisory Committee Act
ITRC	Interstate Technology and Regulatory Council
MEC	Munitions and explosives of concern
NAVFAC	Naval Facilities Engineering Command
OB/OD	Open burning/open detonation
RAB	Restoration Advisory Board
RAC	Resource Advisory Council
USACE	U.S. Army Corps of Engineers
UXO	Unexploded ordnance

4.1 ELEMENTS OF RISK MANAGEMENT

This section provides information to help BLM and FWS land managers apply risk management practices to MEC-contaminated lands. Managers should use professional risk managers to develop a risk management plan for the MEC site.

Risk management on Federal lands will involve the following three phases (see ***Figure 10***):

- **Risk perception** — Perception of risk, that is, awareness of a hazard that has an associated risk, may come from land use inventories performed by the military services, BLM, or FWS; from MEC site inventories; or from reports by the public or employees who encounter MEC. Once it is known that MEC may be present and pose a risk to the public and employees, the next step is to determine the magnitude and extent of the problem.
- **Risk assessment** — The second phase involves the analysis of the risk factors discussed in Section 3.2. This analysis provides information on the MEC hazard, its location, the amount or degree of risk, and the consequences of an encounter with the hazard.
- **Risk management** — The third phase involves developing a risk management plan and managing the site to reduce or eliminate an encounter with the hazard.

4.2 OBJECTIVE OF RISK MANAGEMENT

The objective of risk management is to reduce or eliminate the opportunity for an encounter with

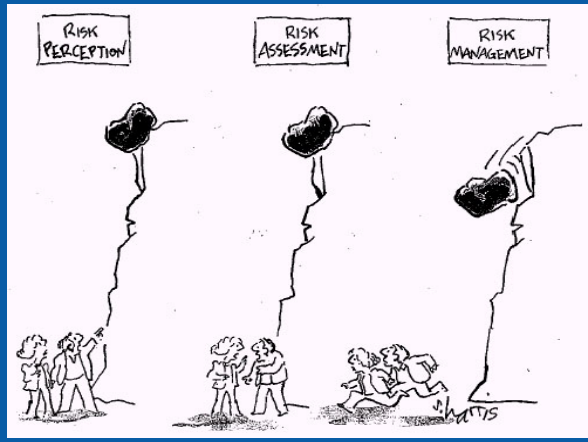

Figure 10 – Risk Cartoon

the hazard. That is done by analyzing the risk at each step of the potential chain of events, as shown in Section 3.2, and by either breaking the chain of events or reducing the likelihood of an event occurring. The following steps are involved in managing risk:

- Manage the source of the risk (the presence of MEC)
- Manage the likelihood of an encounter
- Educate people to recognize and avoid MEC

Although the likelihood of detonation and consequences of detonation are beyond a land manager's control, eliminating or reducing the likelihood of an encounter through management actions reduces the risk of detonation.

4.3 USE OF A CONCEPTUAL SITE MODEL TO IDENTIFY AND ASSESS RISK

The conceptual site model (CSM) is a description of a site and its environment that is based on existing knowledge and is updated regularly. It describes sources of MEC at a site; actual, potentially complete, or incomplete exposure pathways; current or reasonably anticipated future land use; and potential receptors. The source-receptor interaction is one descriptive output of a CSM. The CSM serves as a planning instrument, a modeling and data interpretation aid, and a communication device among the response team members.

4.4 METHODS FOR ELIMINATING OR MINIMIZING SOURCES OF RISK

Section 3.2.1 outlines the factors affecting the presence of MEC on lands used for military training and testing or for manufacturing and storing munitions. The BLM and FWS manage the source of the risk by working with the military services to have MEC eliminated from the site. If all MEC is eliminated from the site, the potential chain of events is broken, and the risk management action can stop.

Currently, eliminating 100 percent of MEC from a site is generally not technically feasible, unless the soils are excavated and sifted. Therefore, MEC sites will almost always have a residual risk that must be managed. The land manager's objective is to work with the responsible military service to determine a balance among residual risk, the proposed land uses, environmental damage caused by the munitions response action, and cost. The management goal is to reduce the amount of residual MEC to a level appropriate for the proposed land uses, without destroying important habitats. This is not an easy balancing act, given limited funding, and should involve input from the BLM's public Resource Advisory Council (RAC) or the military installation's Restoration Advisory Board (RAB), or some other public input. Although the FWS does not have a RAC, the FWS manager should assign an interdisciplinary team composed of refuge personnel, biologists, real estate specialists, outdoor recreation specialists, environmental engineers, and environmental contaminants specialists to work with the military service. (Note: The BLM RAC is a Federal Advisory Committee Act [FACA] group. It is a public body and is not the same as the FWS interdisciplinary internal team.)

Personnel could encounter MEC on almost any former military installation. For example, controlled burns or wildland fires can expose previously hidden UXO or DMM, soil erosion from heavy precipitation or high winds can uncover subsurface UXO or DMM, and normal freeze/thaw cycles can cause munitions to migrate to the surface. When significant land-altering events occur on previous munitions response areas, BLM or FWS managers should request the military service to return to the site to do a surface survey for newly exposed MEC.

4.4.1 Emergency Munitions Response Action

Whenever a discrete UXO or DMM item is discovered on a site, BLM and FWS managers must contact explosive ordnance disposal (EOD)

or bomb squad personnel to have them immediately remove the item from the site. This type of removal action is referred to as an *emergency munitions response* action because it expeditiously addresses a known, specific, exposed UXO or DMM hazard.

The likelihood of additional persons encountering the UXO or DMM decreases as the thoroughness of the munitions response action increases. The EOD team or bomb squad conducting the emergency removal should also check the immediate vicinity for other UXO or DMM. The local BLM or FWS office should retain a copy of the EOD or bomb squad report and periodically review reports to determine if the reports reflect any pattern indicating that a specific area warrants further investigation.

4.4.2 Non-emergency Munitions Response Action

A non-emergency munitions response action is generally long term. The BLM or FWS land manager should request a non-emergency munitions response action when (a) MEC are known or suspected in an area, but the nature and extent of the contamination have not yet been defined, or (b) multiple emergency munitions response actions have been required at the same location, indicating a concentration of UXO or DMM items near the surface that are becoming exposed. In such cases, an appropriate risk reduction measure would be a subsurface non-emergency munitions response action to remove the UXO or DMM before it becomes exposed. This non-emergency munitions response action would reduce the frequency of emergency munitions response actions by EOD teams and would eliminate the possibility that the UXO or DMM would later be exposed and result in a public encounter.

4.5 METHODS FOR PREVENTING OR MINIMIZING MEC ENCOUNTERS

In addition to using emergency and non-emergency response actions to minimize the MEC at a site, the BLM and FWS land managers must evaluate ways to minimize encounters by the public or agency personnel with any remaining MEC. If there is no encounter, there will be no risk from a detonation.

4.5.1 Land Use Controls

BLM and FWS managers can minimize unintended encounters with MEC by implementing land use controls (where appropriate), which consist of institutional controls and engineering controls. In certain situations the military may maintain administrative control of parcels of land within properties controlled by the BLM or FWS. In these situations the military will be responsible for implementing and maintaining the appropriate land use controls.

4.5.1.1 Institutional Controls

Institutional controls are the legal and administrative tools that ensure that the continuing and future use of the site is compatible with any residual MEC contamination. For the BLM and FWS such tools normally include: governmental controls (e.g., permits), access restrictions established through resource and refuge management plans, and informational tools (e.g., signs). The following are examples of ways that managers can establish institutional controls:

- BLM and FWS land managers can transcribe information indicating locations of hazardous areas to master title plats (BLM) and land records (FWS).
- BLM resource management plans and FWS refuge management plans should consider MEC hazards when analyzing access, land use, and information (educational) requirements.
- The BLM may close the area to incompatible activities by withdrawing from operation of some or all of the public land laws (e.g., withdrawal and reservation for public safety).
- The FWS may limit public access to part of a refuge.

All refuge and public lands personnel must have access to hazard information in order to support management decisions that minimize encounters with MEC. The BLM plats and FWS records should provide a source of information that agency personnel can check before doing field-work to ensure that the proposed work area contains no hazards. Also, agency personnel can check the records for hazards so that future authorized land use activities remain compatible with land use restrictions that have been imposed because of the residual risk from MEC.

4.5.1.2 Engineering Controls

Engineering controls are used to limit access to MEC sites by posting a warning, such as signage, or by erecting a physical barrier, such as fencing. If signage is used, signs must be posted in the languages used most commonly in the area, such as English and Spanish, but may also include local Native American languages (see ***Figure 11***). Fencing must convey the message, along with signage, that an area is off limits to the public. In some cases barbed wire will be sufficient; in other areas chain-link fencing may be required. Other less frequently used measures include closing roads to make reaching an area more difficult, or capping burial sites or open burning/open detonation (OB/OD) areas.

Engineering controls require maintenance; therefore, either the military service or the BLM or FWS must provide funding to maintain the engineering controls. This responsibility is often shared. Details of the relationship are described in a memorandum of agreement.

4.5.2 Training and Education to Minimize Inappropriate Actions by Persons Encountering MEC

BLM and FWS personnel and the public have encountered and will continue to encounter MEC on lands transferred from the military services. How they react to an encounter is determined in part by the safety training they have received. The land manager is responsible for ensuring that safety training is provided to all personnel who may be working in or transiting potential MEC hazard areas. The amount and types of training needed depend on the duties of the individual.

Training is available through the following entities:

- **DoD** — Web site at http://www.denix.osd.mil/denix/Public/Library/Explosives/UXOSafety/uxosafety.html
- **Interstate Technology and Regulatory Council (ITRC)** — UXO Basic Training at http://www.itrcweb.org
- **EPA** — Planning and Management of Munitions Response Actions
- **BLM and FWS** — This handbook and other printed sources

Figure 11 – Examples of warning signs. The first two signs are in two languages: English and Spanish.

The USACE and Naval Facilities Engineering Command (NAVFAC) also have more advanced courses available for employees working on munitions response project teams. Those agencies also can help with the design of signage and may be able to provide it.

Managers of sites with MEC-contaminated lands that are open to public access and use should show a short safety video and provide safety cards similar to the one shown in ***Figure 12***. Safety videos are available from USACE and the Army Environmental Center (AEC). The BLM is developing a short safety video for its public lands. Appendix 2 provides a list of sources for safety information and videos.

The basic training for the public and employees should be simple, such as repetition of slogans and some basic recognition factors. Slogans such as the following are very effective in MEC areas: "Remember the three R's of UXO – Recognize, Retreat, and Report," and "If You Did not Drop It, Do not Pick It Up."

Safety training must include a discussion of the likelihood and consequences of a detonation. If a person is behaving in an unsafe manner, such as carrying a MEC item they have picked up, it is too late to do anything other than clear the area and request the person to stop the inappropriate behavior. After securing the area, call the EOD unit or bomb squad to assess the situation.

4.6 THE SPECIAL CASE OF WILDLAND FIREFIGHTING AND REHABILITATION OF BURN AREAS

Wildfires may be hot enough to cause munitions to detonate. Wildfires will also expose munitions on the surface. Wildland firefighting and fire rehabilitation activities penetrate the ground surface and expose firefighters and equipment operators to significant risk.

Land use plans and fire management plans should note areas of potential MEC so that managers do not send BLM and FWS personnel into such areas to fight fires. Heat from the fire and impact from equipment could detonate explosives, thereby making the fighting of fires in such areas too risky.

Land managers should also avoid fire rehabilitation in areas with potential MEC, or they should file a request with DoD for assistance from properly trained EOD personnel. Trained personnel will investigate areas where ground-disturbing activity may take place. They also will locate and mark potential MEC and the hazard area ingress and egress routes. BLM and FWS rehabilitation personnel must avoid marked locations, unless properly trained EOD or UXO personnel have removed the MEC.

Front

Back

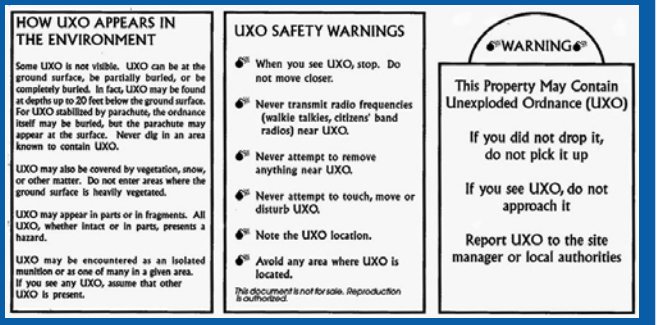

Figure 12 – Example of a double-sided, trifold UXO safety card.

Chapter 5

Safety and Reporting Procedures

Acronym List	
AEC	Army Environmental Center
BRAC	Base Realignment and Closure
CB	Citizens band
DMM	Discarded military munitions
DoD	Department of Defense
EOD	Explosive ordnance disposal
FORSCOM	U.S. Army Forces Command
FUDS	Formerly used defense site
GPS	Global positioning system
IRP	Installation Restoration Program
MEC	Munitions and explosives of concern
NAVFAC	Naval Facilities Engineering Command
PDA	Personal digital assistant
USACE	U.S. Army Corps of Engineers
UXO	Unexploded ordnance

This chapter provides a summary of safety guidelines and reporting procedures that are essential to the proper management of MEC and lands that contain MEC.

5.1 SAFETY ISSUES RELATED TO MEC

Although the military services retain liability for MEC cleanup, DoD munitions response operations typically cannot remove every item of MEC given the current technological limitations. BLM and FWS personnel should assume that residual munitions remain on-site after a response operation is completed. All lands known to contain or suspected of containing MEC, including lands where a removal action has been completed, must be managed as if the risk of encountering MEC will continue. Residual UXO and DMM may migrate to the surface long after response operations are completed; thus, land managers must plan for long-term risk management at all MEC sites.

All site personnel must treat any UXO and DMM they encounter, including practice ordnance, with great caution. Practice ordnance can contain a spotting charge that could cause injury or death.

5.2 SAFETY GUIDELINES TO FOLLOW WHEN ENCOUNTERING UXO AND DMM

The first and most important rule of UXO and DMM safety is to remember:

If you did not drop it, DO NOT pick it up!

Second, memorize the three R's of UXO and DMM:

Recognize, Retreat, and Report.

Other important considerations include the following:

- Treat all MEC found on a site as UXO, the most hazardous of the MEC categories. Only qualified EOD personnel can tell the difference between UXO and DMM.
- Do not move any closer to a MEC item after recognizing it as potential UXO or DMM. Some types of ordnance have magnetic, or motion-sensitive, proximity fuzes that may detonate when a target is sensed. Others have built-in self-destruct timers. Even casting a shadow on a certain type of fuze (piezoelectric) may cause an abrupt change in temperature that is sufficient to cause a detonation. In

most cases, if you can see a UXO or DMM item, you are already within its kill radius.

- Do not move or disturb UXO or DMM, because the motion could activate the fuze, causing the munition to explode. If the fuze has malfunctioned, there is no way to know its condition, and any movement could cause it to function. Also, some munitions have antidisturbance fuzing.
- Do not attempt to remove any object on, attached to, or near UXO or DMM. Some fuzes are motion-sensitive or might have trip wires that could cause the UXO or DMM to explode.
- Do not mark the location of a UXO or DMM in a way that would attract the attention of someone just passing by.
- Document and unobtrusively mark the location of a UXO or DMM item to help ordnance experts locate the item.
- Leave the UXO or DMM hazard area.
- Restrict visitor access.
- Report the UXO or DMM to the appropriate authority (see Section 5.3).
- Do not transmit from walkie-talkies, shortwave radios, citizens band (CB) radios, cellular telephones, wireless PDAs (personal digital assistants) that transmit to the Internet, or other communication and navigation devices. The transmission signal may detonate the munition. You *can* use a global positioning system (GPS) receiver because it is a receive-only device.

The best way to prevent an encounter with UXO or DMM is to stay away from areas known to contain or suspected of containing MEC. However, if you must enter an area with known or suspected UXO or DMM, request a military EOD specialist escort. And remember:

All UXO or suspected UXO is fuzed, armed, and extremely dangerous!

5.3 PROCESS FOR REPORTING MEC AND REQUESTING DOD SUPPORT

The two types of requests for military service support are the emergency response request and the non-emergency response request. A munitions emergency occurs when a known, observed munition is discovered on a site and presents a hazard that must be dealt with immediately to prevent a MEC encounter. A non-emergency situation occurs when munitions are known to be or are suspected in an area, but there are no visible munitions that pose an immediate threat. In non-emergency situations, the military service has time to characterize the site and, if necessary, investigate and remove any suspect items.

5.3.1 Emergency Response Procedures for Reporting UXO or DMM Encounters

MEC encounters should be reported as soon as it is possible to do so safely. Private citizens who discover MEC should, after leaving the area, call 911 or immediately notify a BLM or FWS authority. Instructions for notifying authorities should be posted, along with instructions about safe reporting and other safety procedures. BLM and FWS personnel and law enforcement officers should contact the following offices.

BLM personnel: Call the local law enforcement office (bomb squad), 911, or the nearest military installation's EOD unit. Also notify the BLM ranger or call the hazardous materials coordinator at the BLM office, or BLM State office, that has jurisdiction for the site. If you cannot reach the hazardous materials coordinator, call the BLM State law enforcement office emergency number or the BLM national law enforcement office at (208) 387-5126.

FWS personnel: Call the local law enforcement office (bomb squad), 911, or the nearest military installation's EOD unit. Also, call the regional environmental compliance engineer or regional safety officer.

Both BLM and FWS hazardous materials staff should have a point of contact at the local military EOD unit for emergency response actions.

5.3.2 Details to Include in Reports on UXO or DMM Encounters

Remember, all observations should be made as far away as possible from the MEC.

The report should include as much of the following information as possible:

- Location of the MEC using a map, GPS coordinates, or landmarks (use of a GPS receiver is acceptable because it is a receive-only device)
- Who discovered the MEC and how they can be contacted
- Condition of the MEC (e.g., buried, partially exposed, fully exposed, corroded, punctured)
- Type of MEC (e.g., bomb, rocket, grenade, mortar)
- Number of MEC items visible
- Estimated size of MEC (e.g., length and diameter)
- Distinctive features of MEC (e.g., shape, color, markings)
- Nearby structures, if any (so inhabitants can be contacted and evacuated if necessary)
- Public access to the vicinity (i.e., open, closed)

5.3.3 Procedures for Requesting an Emergency Response

An emergency response may be undertaken at sites where the explosives or munitions pose an immediate danger. An emergency response is usually a short-term action that involves a local bomb squad or a military EOD unit responding to a specific observed item of ordnance.

When UXO or DMM has been observed and reported to the local law enforcement authority, BLM ranger, or FWS refuge officer, those authorities should evacuate and restrict access to the area. The law enforcement authority should contact the nearest EOD unit or military installation through existing local procedures for military support.

If the local law enforcement authority does not know which military unit to contact, then the local law enforcement authority should contact the U.S. Army Forces Command (FORSCOM), 52nd Ordnance Group (EOD), at its 24-hour emergency response number, (404) 469-3333. In the event the operations center cannot be contacted, the 52nd Ordnance Group S-3 (Operations) can be notified during normal duty hours (Eastern time zone) at (404) 469-3325. For Alaska and Hawaii, the contact is (808) 287-1524 (24-hour pager). This applies to the United States and its territories.

For BLM employees, if the local law enforcement authority does not respond, contact the BLM national law enforcement office at (208) 387-5127. The national office will ask the national interagency fire center's emergency response center to request military support.

A local bomb squad may respond at the request of the local law enforcement authority. The use of the civilian bomb squad depends on its level of training for military munitions and on existing protocols between the military service and the local government.

If responding military EOD personnel determine that the response action is not an emergency or is not within their capability, they will contact the appropriate authority to respond to the incident. If a MEC risk remains after the EOD unit's emergency response is completed, the Federal land manager should follow the procedures for a non-emergency MEC munitions response action.

5.3.4 Reporting Procedure for Requesting a Non-emergency Response

The military services will conduct a non-emergency munitions response at sites where an

emergency response has been completed and follow-up work is necessary, or at sites where MEC generally is known or suspected because of prior military use. In either case, a non-emergency response generally is a long-term action involving a site survey, site characterization, MEC removal, land use controls, risk management measures, and periodic evaluation to determine if additional munitions response actions are necessary.

Most sites with MEC will fall under one of three DoD-funded programs, depending on the date lands were or will be transferred to BLM or FWS management and on the method of transfer.

5.3.4.1 Formerly Used Defense Sites (FUDS) Program

The FUDS program is managed by USACE. Every USACE District Office has a FUDS coordinator. FUDS lands generally include any lands that were used by the military services or their contractors and that were transferred to BLM or FWS management on or before October 16, 1986. However, the FUDS program does not include former battlefields (e.g., Aleutian Islands), cemeteries, and certain sites.

5.3.4.2 Installation Restoration Program (IRP)

The individual military services are responsible for their bases' IRPs. All lands transferred to BLM or FWS management on or after October 17, 1986, fall within this program, unless they are listed as a Base Realignment and Closure (BRAC) Act site. The USACE FUDS coordinator should know which service and installation to contact. Also, a check of the historical index of BLM's master title plats or FWS's land records should indicate which military service and military organization used the lands. Generally, although the military service is responsible for munitions response actions, Air Force and Army installations will contract with USACE to accomplish MEC removal. Navy installations contract with Naval Facilities Engineering Command (NAVFAC) to accomplish MEC removal.

5.3.4.3 Base Realignment and Closure (BRAC) Program

The BRAC program started in 1988 with the passage of the first Base Realignment and Closure Act. As of 2005, five BRAC rounds are in progress. The military uses only BRAC funds to remove MEC from installations closed by those laws. Again, the military services are responsible for their own installations, but they normally contract with USACE or NAVFAC to perform MEC removal.

5.4 ROLE OF THE BLM AND FWS LAND MANAGER

BLM and FWS land managers are responsible for actions taken by all parties on the lands they manage. The military service personnel have expertise relating to explosives and munitions response operations. The BLM or FWS manager's responsibility is to ensure that the military's proposed actions are compatible with the agency's goals for land and resources management while they meet risk reduction goals.

For an emergency munitions response, the land manager's role is to ensure that no one enters the site without authorization until the EOD unit or bomb squad removes the hazard. Without delaying the emergency munitions response action, the Federal land manager should evaluate available information on important natural and cultural resources that might be affected by the action. All reasonable efforts should be made to protect those resources.

For a non-emergency munitions response, the BLM or FWS must authorize the proposed action before the bomb squad or EOD unit begins the munitions response action.

The BLM or FWS manager has oversight of land use controls used in the long-term risk management for the MEC site (see Chapter 4). The BLM or FWS may have responsibility for implementation and enforcement of land use controls, or those responsibilities may be retained by DoD.

5.5 INFORMATION FOR VISITORS AND AUTHORIZED USERS ABOUT UXO AND DMM

Public lands provide visitors with a vast array of recreational opportunities. These include hunting, fishing, camping, hiking, boating, hang gliding, off-highway vehicle driving, mountain biking, birding, and visiting natural and cultural heritage sites. A significant number of visitors are interested in "getting away from it all" and exploring areas removed from visitor facilities and trails. In the future, as the nation's population grows and urban areas expand, increasing demands for outdoor recreation will lead to the need to protect visitors in areas on public lands that are known or likely to contain MEC.

Land managers should provide UXO and DMM information to visitors and authorized users of public lands and refuges to ensure their safe access and use of the lands. The BLM or FWS can convey this information through written materials (e.g., brochures), briefings, videos, or a combination of these methods. Information should include site-specific access information, types of UXO or DMM that might be encountered at the site (with pictures), and the likelihood of an encounter.

Briefings are ideal opportunities for land managers to provide information to authorized visitors at controlled access locations. The briefing can be an entrance requirement at Federal lands that were former military ranges and would allow visitors to ask questions and plan or modify their activities based on the likelihood of potential MEC encounters. Short safety videos and written materials can be ordered from DoD, the Army Environmental Center (AEC), and USACE Huntsville (see Appendix 2).

5.5.1 Hold-Harmless Waiver

In most locations, Federal land managers require visitors and other authorized users to sign a statement acknowledging that they have read the safety material and hold the U.S. Government harmless for any MEC incidents. The required waiver (see Appendix 4) helps to emphasize the need to behave safely. The waiver demonstrates that the land manager has provided information about known and unknown risks to visitors.

5.5.2 Web Site

The following MEC safety web site provides samples of signage, informational material, video clips, and more: http://www.denix.osd.mil/denix/Public/Library/Explosives/UXOSafety/uxosafety.html.

Chapter 6

MEC Site Characterization and Munitions Response Operations

Acronym List

ADNT	Aminodinitrotoluene
AEC	Army Environmental Center
BIP	Blow-in-place
BRAC	Base Realignment and Closure
DNA	Dinitroaniline
DNB	Dinitrobenzene
EMI	Electromagnetic induction
EOD	Explosive ordnance disposal
EPA	Environmental Protection Agency
FUDS	Formerly used defense site
GPR	Ground penetrating radar
GPS	Global positioning system
HMX	Her Majesty's explosive or high melting explosive
IR	Infrared
JUXOCO	Joint Unexploded Ordnance Coordination Office
MTADS	Multisensor Towed Array Detection System
RDX	Royal demolition explosive
SAR	Synthetic aperture radar
TNB	Trinitrobenzene
TNT	Trinitrotoluene

MEC site characterization and munitions response operations are the responsibility of the military services. However, the BLM and FWS are responsible for identifying their agencies' priorities for the munitions response, for describing expected land use, and for concurring with and overseeing the military service's operations on BLM- and FWS-managed lands. Representatives of the BLM or FWS become part of a project team, which also consists of the military service project office, the EPA, and the State's environmental department.

6.1 PROCEDURE FOR REQUESTING TECHNICAL SUPPORT FROM DOD

Requests for technical support from DoD for munitions response, including site characterization and munitions response operations, will be submitted to different military organizations, depending on the type of munitions response site involved:

- For formerly used defense sites (FUDS) — Send requests to the supporting U.S. Army Corps of Engineers district office.
- For base realignment and closure (BRAC) lands — Send requests to the military installation or command that was responsible for remediation and transfer of the lands. If that office no longer exists, the BLM or FWS headquarters' point of contact will forward the request to the appropriate military office.
- For sites that are neither FUDS nor BRAC — Send requests to the appropriate BLM headquarters' military liaison or to the point of contact at the FWS headquarters' Division of Engineering, Environmental and Facility Compliance, who will forward the request to the appropriate military office.

The BLM or FWS headquarters staff will contact, as appropriate, Headquarters USACE, Headquarters Naval Facilities Engineering Command, Air Force Real Estate Agency, or the DoD office responsible for munitions response

policy to determine the appropriate munitions response organization.

The request for support should include the following information, if known:

- Site name
- Site location
- Type of support, such as the following:
  - Site characterization
  - Surface munitions response
  - Subsurface munitions response
- Narrative about site use (who, what, when, where, and how), such as the following:
  - Period of use by the military
  - Type of training (how site was used)
  - Types of munitions used
- BLM or FWS point of contact

6.2 SITE CHARACTERIZATION

Site characterization is the investigation of known or suspected MEC areas to determine the presence or absence of MEC and to gather other information such as type, density, depth, or lateral extent of the MEC. Former military properties are characterized to provide a baseline for determining whether the selected risk reduction measures will be adequate for the proposed land uses. Characterization of these former military properties requires searching for discrete metallic objectives on the surface or buried beneath the surface. The objects may be located in concentrated areas in association with a specific target, or distributed randomly in a wide variety of areas. Knowing where to look depends on historical knowledge of the munitions activities that took place at the site and a documented conceptual site model. DoD has conducted tests and demonstration projects and still finds that many UXO detection and discrimination systems or procedures are less reliable than desired. UXO discrimination systems are designed to differentiate a UXO explosive item from scrap metal. The military services sponsor research and development programs to improve UXO detection and discrimination. Current information is available from the DoD Joint Unexploded Ordnance Coordination Office (JUXOCO) at the web site http://www.denix.osd.mil.

The site characterization process should also include an environmental investigation to determine if the site is contaminated with chemical constituents from munitions. Some of the specific chemicals used in munitions are 2,4,6-trinitrotoluene (TNT); 1,3,5-trinitrobenzene (TNB); 1,3-dinitrobenzene (DNB); 3,5-dinitroaniline (DNA); 2-amino-4,6-dinitrotoluene (ADNT); 1,3,5-trinitro-1,3,5-triazine (RDX, or royal demolition explosive); HMX (Her Majesty's explosive or high melting explosive); perchlorate; and tetryl. If concentrations of these chemicals are sufficiently high (more than 10 percent), the soils are potentially explosive. In addition, ambient concentrations of these chemicals may be toxic to biota and contaminate surface and groundwater.

If MEC is found anywhere on the site, additional site characterization and remediation are required. BLM personnel should consult State or regional BLM environmental specialists for more specific environmental investigation information. FWS personnel should contact the environmental contaminants specialist in the Ecological Services Field Office and the Environmental and Facility Compliance Office in the Division of Engineering.

6.3 SITE CHARACTERIZATION TECHNOLOGIES

Two primary technologies are deployed on a number of different platforms to characterize sites and detect UXO and DMM: magnetometers and electromagnetic induction (EMI) sensors. They each have strengths and weak-

nesses depending on the specific munitions items for which they are searching, the manner in which the weapon system was deployed (and the resulting maximum depth of the munition), and the physical environment at the site being investigated.

This section describes these primary technologies, a variety of secondary technologies that may be helpful in specific circumstances, plus technology advancements.

6.3.1 Primary Technologies

This section describes the two primary technologies used to detect subsurface UXO and DMM: magnetometry and electromagnetic induction.

6.3.1.1 Magnetometry

Magnetometers measure variations in the magnetic field of the Earth. Iron (ferrous) objects or minerals on the surface or in the subsurface cause local distortions or anomalies in that field. Magnetometers locate buried iron objects, including UXO or DMM, by detecting those distortions.

A typical magnetometer consists of a detection sensor, power supply, computer data system, and means to record the locations of detected anomalies. More advanced magnetometers incorporate a navigational system, such as a differential global positioning system (GPS), to determine location.

The effectiveness of magnetometers depends on their sensitivity, distance between the sensor and UXO or DMM, amount of iron material in the UXO or DMM, background magnetic noise, and site-specific soil properties. Recent demonstrations show that newer systems detect 70 to 90 percent of the UXO or DMM. These systems generally are used with the sensor head only a few inches above the ground.

There are numerous types of magnetometers (see ***Figures 13-15***). Gradiometers, which are systems of two magnetometers configured to measure the spatial rate of change in the magnetic field, are widely used to detect UXO and DMM. Helicopter-borne systems fly 6 to 10 feet above the ground. However, at that height the system loses the ability to detect small- and medium-caliber projectiles. Other magnetometers are available that have improved detection sensitivity for specific soil conditions.

6.3.1.2 Electromagnetic Induction

Electromagnetic induction (EMI) sensors detect both ferrous and nonferrous metallic objects. EMI systems transmit electric current into the soil to detect metallic objects. The systems measure either the secondary magnetic field induced in metal objects or the difference between the electrical conductivity of the soil and the electrical conductivity of buried objects, such as UXO (see ***Figures 16-18***).

Figure 13 – *Multisensor Towed Array Detection System (MTADS) configured with cesium vapor magnetometers. Photo courtesy of Blackhawk Geometrics.*

Figure 14 – *Cart system configured with cesium vapor magnetometers. Photo courtesy of Blackhawk Geometrics.*

Figure 15 – *Helicopter configured with magnetometers for UXO and DMM detection. Photo courtesy of Oak Ridge National Laboratory.*

Figure 16 – *MTADS configured with EMI sensors. Photo courtesy of Blackhawk Geometrics.*

6.3.2 Secondary Technologies

The secondary technologies described below have a number of limitations, but they may be useful in selected site-specific circumstances.

6.3.2.1 Infrared Sensors

Infrared (IR) sensor technologies detect UXO and DMM by distinguishing between the temperature of the UXO or DMM and the surrounding soil. Metal objects heat and cool at a different rate than the surrounding soils. IR detectors locate UXO and DMM at or near ground surface by detecting those temperature differences. This technology is typically most effective on unvegetated or sparsely vegetated surfaces and when weather conditions and time of day provide the greatest temperature differential (see ***Figures 19-21***). IR technology has minimal capability to identify types or categories of UXO or DMM (e.g., mortar fins versus smooth artillery munitions).

Figure 18 – *EMI skirt configuration. Photo courtesy of Blackhawk Geometrics.*

Figure 17 – *EMI cart and backpack configuration. Photos courtesy of Blackhawk Geometrics.*

6.3.2.2 Ground Penetrating Radar

Ground penetrating radar (GPR) is a radar system designed to penetrate the earth and return signals that indicate the nature of subsurface items.

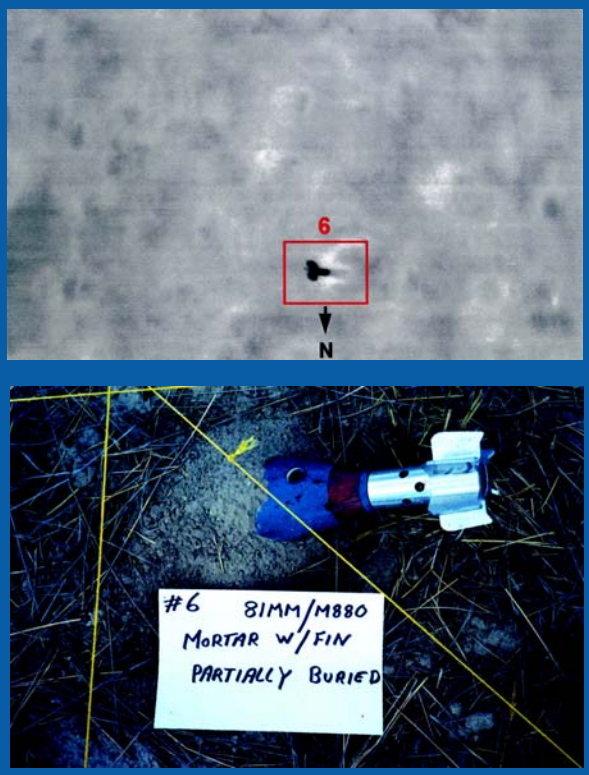

Figure 19 – *Airborne infrared and ground images of an 81 mm mortar. Photos courtesy of ORD-TECH.*

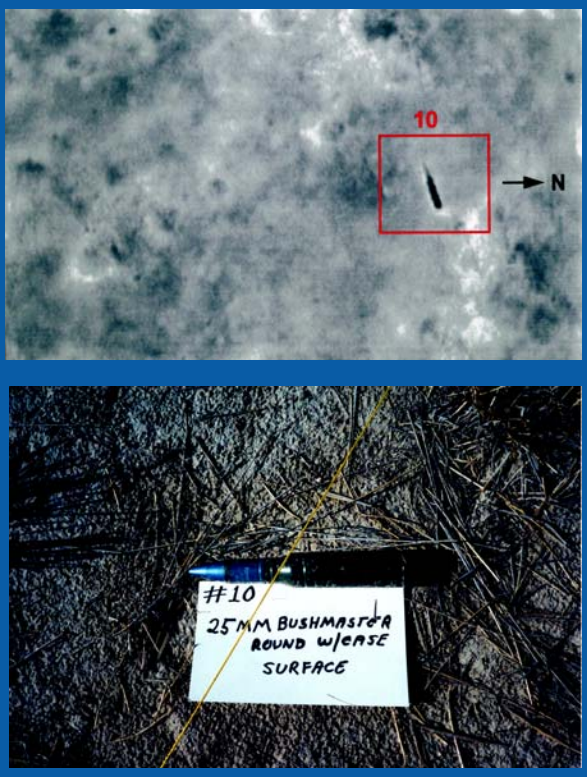

Figure 20 – *Airborne infrared and ground images of a 25 mm round. Photos courtesy of ORD-TECH.*

The main elements of any GPR system are the transmitter, receiver or antenna, controls, and display and recorder units. The transmitter directs short pulses of electromagnetic energy toward the ground. As the energy pulses travel into the ground, buried objects reflect signals back to the receiving unit. The processing and recording of these signals form an image.

Figure 21 – *ORD-TECH's helicopter with an advanced infrared detection system. Photo courtesy of ORD-TECH.*

Many environmental factors significantly affect the ability of GPR systems to produce accurate images. Important factors include the density and type of vegetative cover, water content of the vegetation and soil, and topography. In general, GPR is not effective in saturated soils and wet areas because water absorbs GPR energy.

Most GPR systems are on sleds that are pulled across the ground (see ***Figure 22***). Sensor heads, which are essentially in contact with the ground, provide deeper penetration of the ground and less surface-signal-return clutter. Signal penetration into the soil decreases with increasing distance between the sensor head and the ground, thus lowering the equipment's ability to discriminate small objects.

Figure 22 – Ground penetrating radar sled in towed configuration. Photo courtesy of Blackhawk Geometrics.

6.3.2.3 Synthetic Aperture Radar

Synthetic aperture radar (SAR) is an airborne system that provides a radar image of the land surface and objects on the surface. Metallic objects have a stronger radar signal return than nonmetallic objects. This allows for identification of metallic objects, both munitions-related and non-munitions-related. The synthetic aperture provides a high degree of surface image resolution even though the aircraft is flying at thousands of feet above the ground. This system can cover large areas at relatively low cost. SAR is effective at finding surface indicators of UXO and DMM as well as the actual munitions, thereby allowing more efficient and focused use of ground systems. SAR is not good at differentiating between sizes of metallic objects.

6.3.3 Technological Advancements

Industry continues to make significant technological advancements in UXO detection and in the ability to differentiate between UXO or DMM and non-UXO/DMM items. Use of these technologies increases UXO and DMM detection rates and reduces the number of false alarms (signal responses that indicate a possible UXO or DMM item when none is present, such as non-UXO/DMM ferrous metal or naturally occurring ferrous elements). False alarms are a major cost for munitions response operations. Reductions in false alarm rates increase efficiency and significantly decrease the cost of the munitions response operation. Technology advancements in UXO and DMM discrimination sciences are evolving rapidly. The U.S. Army Environmental Center (AEC) has information regarding the latest detection and discrimination technologies.

The combination of EMI and magnetometer sensors on a single platform appears to hold the highest promise for improving detection systems. Ongoing research and development efforts focus on the analysis of magnetometer and EMI signals to discriminate between ordnance and non-ordnance items. Although GPR is not as good as magnetometers or EMI at detecting UXO and DMM, GPR systems show promise for discrimination of detected objects.

Finally, recent demonstrations by the DoD Environmental Security and Technology Certification Program (ESTCP) suggest that data from high airborne light detection and ranging (LiDAR) systems and orthophotography offer promise in identifying potential munitions-related features in large, open range areas such as those frequently found in the West.

6.4 MUNITIONS RESPONSE OPERATIONS

Response operations at former military sites typically include the remediation of many different types of hazards, such as MEC, range debris, and possibly radioactive contaminants associated with range debris. Munitions response actions often entail actual destruction of the MEC on-site (sometimes referred to as “blow-in-place,” or BIP). Destroying the MEC on-site is the preferred method of disposal, as it involves less risk to the EOD team; however, it may leave some explosives residue. When MEC removal is deemed necessary, such as the discovery of MEC in a residential area, specially trained and certified EOD professionals must perform the removal action or the *render safe* procedure. Render safe usually means removing the fuze or

disrupting the fuze train of the UXO or DMM so that it will not explode.

The emergency contacts listed at the beginning of this handbook will call the military ordnance experts to evaluate and remove or neutralize (destroy or render safe) any MEC found on BLM or FWS sites. In some areas, a local police unit or the hazardous materials response squad from the fire department may respond to a MEC discovery. For large-scale, non-emergency MEC removal operations, DoD will hire UXO contractors to conduct the munitions response operations. These types of operations typically will involve the formation of a project team.

6.5 SELECTION OF A RESPONSE ACTION

Munitions response actions reduce risk from exposure to MEC by removing some or all MEC from an area in response operations. The BLM or FWS and the military jointly determine the extent of a response action by considering the following:

- Reasonably anticipated future land use
- Boundaries of the areas to be investigated and remediated
- Effectiveness of risk reduction
- Environmental impact from response operations
- Cost

Evaluation of these factors is embodied in the analysis conducted under the remedy selection process associated with the Comprehensive Environmental Response, Compensation, and Liability Act (see Chapter 7).

Using the military installation's historical records and current information provided by the BLM or FWS, the military services will do the following:

- Research all archival material to determine when, where, and how the military used the lands
- Determine the types of known or suspected MEC
- Define the locations and depths of MEC
- Develop a conceptual site model of the munitions response area
- Remove or neutralize the MEC
- Document the process
- Provide continued surveillance of areas where MEC is to remain above the frost line but below the removal depth

It is the position of the BLM and FWS that the military services are obligated to perform a new MEC site characterization or additional munitions response operations when changes in land use are proposed. The military services sometimes do not agree with this position and maintain that they will return to do additional munitions response only if Congress or a court order mandates the land use change. The BLM and FWS manager should consider the cost and risk to EOD personnel and alternatives available before proposing a land use change on lands containing MEC. This is an unresolved principle that the DoD and DOI are still discussing.

The BLM and FWS have no established standards for describing the depth of munitions removal at a munitions response site. The depth of removal will be developed at each munitions response site by the site's project team. The project team should consider current and future management actions that are likely to occur on-site and the depth to which the response actions will penetrate the subsurface. Examples of typical actions in which depth will be a consideration include fence construction to the depth of the post holes; road or pipeline construction because of excavation; intrusive wildland firefighting actions such as construction of firebreaks and associated restoration activities; activities associated with prescribed burning; and vegetation management actions such as seeding,

invasive species removal and eradication, and habitat modification.

6.6 MEC EXCAVATION TECHNOLOGIES

MEC removal may cause the detonation of explosives or the release of hazardous or toxic materials. EOD specialists or UXO technicians must perform all removal operations. The project munitions response team will determine the site-specific procedures for MEC removal. Although a detailed discussion of the excavation procedures associated with removal of MEC is beyond the scope of this handbook, the following sections provide a general overview of available excavation technologies.

Historically, MEC excavation primarily involved labor-intensive manual methods. Since the 1980s, research and development efforts have focused on increased mechanization to improve efficiency and enhance operator safety. The major categories of excavation technologies are manual methods, mechanized systems, and remote-controlled systems.

6.6.1 Manual Methods

Standard manual excavation involves the use of shovels and other digging tools to excavate soil and expose potential MEC. Manual methods work best for MEC in the near-surface and shallow subsurface (not more than 24 inches deep). Manual methods present significant safety risks to workers.

6.6.2 Mechanized Systems

Mechanized MEC excavation systems include excavators, bulldozers, front-end loaders, and other heavy construction equipment. Historically, backhoe-type excavators were the most commonly used mechanized system. Vacuum excavators, another kind of mechanized system, use a high-pressure jet of air to penetrate and dislodge soil, then use a vacuum to extract the dislodged soil (to expose the MEC), and finally transport the soil away using a conveyor belt.

6.6.3 Remote-Controlled Systems

Remote-controlled MEC excavation systems include telerobotic and autonomous systems. In general, the capabilities, effectiveness, and use of remote-controlled systems are the same as for mechanized systems. The primary difference is that the operator of a remote-controlled system remains outside the immediate hazard area. Of the three categories of MEC excavation methods, remote-controlled systems offer the highest degree of safety, but they may also be the slowest and most expensive.

Chapter 7

MEC-Related Statutes, Policies, and References

Acronym List

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DMM	Discarded military munitions
DOI	Department of the Interior
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FUDS	Formerly used defense site
MC	Munitions constituents
MEC	Munitions and explosives of concern
NEPA	National Environmental Policy Act
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
UXO	Unexploded ordnance

This chapter contains an overview of MEC-related statutes, policies, and references. For additional information, consult the applicable reference.

7.1 NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

NEPA (42 U.S.C. §4231 *et seq.*) requires the BLM and FWS to ensure that environmental considerations are given appropriate weight during the decision-making process. It also requires Federal departments and agencies to perform an environmental evaluation of proposed actions that considers all alternatives in order to minimize potential environmental damage. The act requires the preparation of environmental documentation (environmental assessments and environmental impact statements) to evaluate the potential environmental effects of a proposed action and any unavoidable adverse environmental effects.

The selection of cleanup alternatives under CERCLA does not require a NEPA assessment, as CERCLA is considered to be the functional equivalent of NEPA, and the CERCLA remedy selection process (either removal or remedial) stands in place of a NEPA assessment.

7.2 RESOURCE CONSERVATION AND RECOVERY ACT OF 1976

RCRA (42 U.S.C. §6901 *et seq.*) provides the comprehensive Federal regulation for the collection, treatment, storage, and disposal of solid waste, including hazardous waste.

Munitions, used for their intended purpose, at some point become solid waste potentially subject to RCRA and also may include hazardous substances, pollutants or contaminants subject to CERCLA. It is EPA's position that munitions become a statutory solid waste when EPA or a state determines they have been left in the environment long enough to be considered "discarded" within the statutory definition of "solid waste." UXO and DMM are not listed as hazardous waste under RCRA; however, when managed, they will become hazardous waste if they fail the RCRA hazardous waste characteristics tests (e.g., toxicity, ignitability, reactivity, and corrosivity). MC may in some instances be listed as hazardous waste, or it may become a

regulated waste if it fails one of the RCRA hazardous waste characteristics tests.

RCRA also contains corrective action requirements that apply to the cleanup of old hazardous waste units. Depending upon State preferences, a munitions response action may be conducted under RCRA or CERCLA but must be consistent with both.

7.3 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA; 42 U.S.C. §9601 *et seq*.), prescribes reporting and investigation requirements for hazardous substance releases and for cleanup of sites. CERCLA imposes potential liability for owners or operators (including Federal agencies) of land containing hazardous substances. The National Contingency Plan contains the implementing regulations for CERCLA (40 CFR §300). CERCLA is the primary authority directing the military's munitions response activities. The DoD has asserted a preference for conducting response actions under CERCLA rather than RCRA.

7.4 ENDANGERED SPECIES ACT OF 1973

The Endangered Species Act (ESA) of 1973 (16 U.S.C. §1531 *et seq*.) protects plant and animal species formally listed as threatened or endangered by the Secretary of the Interior (terrestrial and freshwater species and some marine species) or the Secretary of Commerce (other marine species). The act calls for the listing of species to be based solely on scientific data. As of September 2003, 1,263 U.S. species and 558 foreign species were listed as threatened or endangered. Once a species is listed, section 7 of the ESA directs Federal agencies to consult with the FWS or the National Maritime Fisheries Service to ensure that any actions the Federal agencies authorize, fund, or carry out do not jeopardize the continued existence of any listed species or destroy critical habitat.

7.5 DEPARTMENT OF THE INTERIOR MANUAL

The DOI Departmental Manual, Part 602, Chapter 2 ("Real Property Pre-Acquisition Environmental Site Assessment" in the Public Lands Series on Land Acquisition, Exchange, and Disposal) describes departmental policy, responsibilities, and functions regarding liability and risk. Before real property is acquired (including withdrawn public lands that are returning to the jurisdiction of the Secretary of the Interior), the DOI agency acquiring the property is required to determine if hazardous material, including MEC, are present. If hazardous materials are present, the extent of DOI's exposure to cleanup liability and other associated risks must be evaluated.

7.6 DEPARTMENT OF THE ARMY TECHNICAL MANUAL, AMMUNITION, GENERAL

The Technical Manual, Ammunition, General, was published by the Department of the Army in 1969 (TM 9-1300-200) and reprinted in 1993. The manual provides a comprehensive report of U.S. military munitions, munitions data, illustrations, munitions packaging information, and labeling and marking of munitions.

7.7 UNEXPLODED ORDNANCE (UXO) PROCEDURES FIELD MANUAL

The *Unexploded Ordnance (UXO) Procedures* field manual was published by the Department of the Army in 1981 (FM 21-16) and reprinted in 1994. This document is designed for military identification and removal operations for UXO resulting from battlefield operations. This manual provides very good background on UXO identification, munitions photographs, and removal techniques.

Glossary

Active range: A military range that is currently in service and is being regularly used for range activities.

Anomaly avoidance: Techniques employed on property known or suspected to contain UXO, other munitions that may have experienced abnormal environments (e.g., DMM), munitions constituents in high enough concentrations to pose an explosive hazard, or chemical agent (CA), regardless of configuration, to avoid contact with potential surface or subsurface explosive or CA hazards, to allow entry to the area for the performance of required operations.

Arming device: A device designed to perform the electrical and/or mechanical alignment necessary to initiate an explosive train.

Base Realignment and Closure (BRAC): BRAC is a process DoD has used to reorganize its installation infrastructure to more efficiently and effectively support its forces, increase operational readiness, and facilitate new ways of doing business.

Blow-in-place: The method used to destroy UXO or DMM, by use of explosives, in the location the item is encountered.

Caliber: The diameter of a projectile or the bore of a gun or launching tube expressed in millimeters or inches. When caliber is given only as a number, such as .50, it is in inches. A caliber given in millimeters will always have "mm" after the number.

Chemical agent (CA): A chemical compound (including experimental compounds) that is intended for use in military operations to kill, seriously injure, or incapacitate persons through its chemical properties that produce lethal or other damaging effects on human beings. Excluded are research, development, testing, and evaluation (RDTE) solutions; riot control agents; chemical defoliants and herbicides; smoke and other obscuration materials; flame and incendiary materials; and industrial chemicals.

Clearance: The removal of UXO or DMM from the surface and subsurface at operational ranges.

Closed range: A military range that has been taken out of service and either has been put to new uses that are incompatible with range activities or a range that is not considered by the military to be a potential range area. A closed range is still under the control of a military service.

Construction support: Assistance provided by EOD- or UXO-qualified DoD personnel or personnel trained and qualified for operations involving chemical agent (CA), regardless of configuration, to ensure the safety of personnel or resources from any potential explosive or CA hazards during intrusive construction activities on property known or suspected to contain UXO, other munitions that may have experienced abnormal environments (e.g., DMM), munitions constituents in high enough concentrations to pose an explosive hazard, or CA, regardless of configuration.

Defense sites: Locations that are or were owned by, leased to, or otherwise possessed or used by the Department of Defense. The term does not include any operational range, operating storage or manufacturing facility, or facility that is used for or was permitted for the treatment or disposal of military munitions. (10 U.S.C. §2710(e)(1))

Detonation: A violent chemical reaction within a chemical compound or mechanical mixture evolving heat and pressure. The result of the chemical reaction is exertion of extremely high pressure on the surrounding medium.

Discarded military munitions (DMM): Military munitions that have been abandoned without proper disposal or have been 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))

Electromagnetic induction (EMI): The transfer of an electrical field from one item to another, causing a magnetic field resonance in the object that can be detected by sensors.

Engineering controls (land use): Any physical barriers or actions that are designed to limit access to locations where MEC is believed to exist, such as fencing, signage, and cap and cover systems.

Explosion: A chemical reaction of any chemical compound or mechanical mixture that, when initiated, undergoes a very rapid combustion or decomposition, releasing large volumes of highly heated gases that exert pressure on the surrounding medium. Also, a mechanical reaction in which failure of the container causes sudden release of pressure from within a pressure vessel.

Explosive: A substance or mixture of substances that can undergo a rapid chemical change, generating large quantities of energy generally accompanied by hot gases.

Explosive hazard: A condition where danger exists because explosives are present that may react (e.g., detonate, deflagrate) and result in death or injury of people or damage to property, operational capability, or the environment.

Explosive ordnance disposal (EOD): The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of unexploded ordnance and of other munitions that have become an imposing danger, for example, by damage or deterioration.

Explosive ordnance disposal incident: The suspected or detected presence of UXO or damaged military munitions that constitute a hazard to operations, installations, personnel, or material. Each EOD response to reported UXO or DMM is an EOD incident.

Explosive ordnance disposal personnel: Military personnel who have graduated from the Naval School, Explosive Ordnance Disposal; are assigned to a military unit with a service-defined EOD mission; and meet service and assigned unit requirements to perform EOD duties. EOD personnel have received specialized training to address explosive and certain chemical hazards during both peacetime and wartime. EOD personnel are trained and equipped to perform render-safe procedures on nuclear, biological, chemical, and conventional munitions, and on improvised explosive devices.

Explosive ordnance disposal response: The safe recovery and final disposal of UXO or munitions. An EOD response may also include actions to render-safe or dispose of explosive ordnance that has become hazardous by damage or deterioration, when the disposal of such items is beyond the capabilities of the personnel normally assigned the responsibilities for routine disposal.

Explosive ordnance disposal unit: A military organization constituted by proper authority, manned with EOD personnel, outfitted with equipment required to perform EOD functions, and assigned an EOD mission.

Explosive soil: Any mixture of explosives with soil, sand, clay, or other solid media at concentrations that cause the mixture itself to be reactive or ignitable. Defined by the USACE as soil that is composed of more than 10 percent reactive or ignitable material.

Explosive train: The arrangement of different explosives in a sequence in which (1) a small quantity of an initiating compound or mixture, such as lead azide, is used to detonate a larger quantity of (2) a booster compound, such as tetryl, which results in (3) RDX, TNT, or other compounds detonating.

Explosives or munitions emergency response: All immediate response activities by an explosives and munitions emergency response specialist to control, mitigate, or eliminate the actual or potential threat encountered during an explosives or munitions emergency. An explosives or munitions emergency response may include in-place render-safe procedures, treatment or destruction of the explosives or munitions, and/or transporting of those items to another location to be rendered safe, treated, or destroyed. Any reasonable delay in the completion of an explosives or munitions emergency response caused by a necessary, unforeseen, or uncontrolled circumstance will not terminate the explosives or munitions emergency. Explosives and munitions emergency responses can occur on either public or private lands and are not limited to responses at RCRA facilities. (Military Munitions Rule, 40 CFR §260.10)

Flares: Devices that are dropped or fired as a projectile. They normally consist of a magnesium compound that burns at very high temperatures, a fuze that initiates the burning process, and possibly a parachute, all contained in a canister. Flares as UXO will normally be found on or near the ground surface. The danger from a flare is both from the fuze used to ignite the flare and the intense heat from the burning flare.

Fragmentation: Characteristic of ordnance that is primarily intended to produce many small fragments (shrapnel) for the purpose of killing personnel or damaging soft targets.

Fuse: A cord of readily combustible material that is lit at one end to carry a flame along its length to detonate an explosive at the other end (e.g., firecracker).

Fuze: A mechanical or electrical device with explosive or non-explosive components designed to initiate a train of fire or detonation in ordnance.

Fuze, delay: Any impact fuze incorporating a means of delaying its action after contact with the target. The delay duration classifies the fuze. A chemical or timing device can cause the delay.

Fuze, impact: A fuze in which the force of impact initiates detonation. This fuze may activate instantaneously or after a short delay.

Fuze, proximity: A fuze that is activated when it remotely senses the presence, distance, or direction of the target through the characteristics of the target itself or its environment. Noise, vibration, movement, magnetic signature, or radio signal may cause activation.

Gradiometer: Magnetometer for measuring the rate of change of a magnetic field.

Ground penetrating radar (GPR): A system that uses pulsed radar waves to penetrate the ground and measure the distance and direction of subsurface targets through radar waves that are reflected back to the system.

Hazardous substance: (A) any substance designated pursuant to section 311(b)(2)(A) of the Federal Water Pollution Control Act [33 U.S.C. §1321 (b)(2)(A)]; (B) any element, compound, mixture, solution, or substance designated pursuant to section 9602 of this title; (C) any hazardous waste having the characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act [42 U.S.C. §6921] (but not including any waste the regulation of which under the Solid Waste Disposal Act [42 U.S.C. §6901 *et seq*.] has been suspended by Act of Congress); (D) any toxic pollutant listed under section 307(a) of the Federal Water Pollution Control Act [33 U.S.C. §1317 (a)]; (E) any hazardous air pollutant listed under section 112 of the Clean Air Act [42 U.S.C. §7412]; and (F) any imminently hazardous chemical substance or mixture with respect to which the Administrator has taken action pursuant to section 7 of the Toxic Substances Control Act [15 U.S.C. §2606]. The term does not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of this paragraph, and the term does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas). (42 U.S.C. §9601(14))

Illumination: A term applied to ordnance indicating its ability to produce high-intensity light. The ordnance usually contains a magnesium flare and may contain a parachute for suspension in the air.

Inactive range: A military range that is not currently being used but is still under military control, is considered by the military to be a potential range area, and has not been put to a new use that is not compatible with range activities.

Incendiary: Any flammable material used as filler in ordnance intended to destroy a target by fire, such as napalm and white phosphorus.

Inert: The state of some types of ordnance that (1) when used as designed leave only a harmless carrier, or (2) are manufactured without explosive, propellant, or pyrotechnic content. Inert ordnance poses no explosive hazard to personnel or material.

Installation: A grouping of facilities, located in the same vicinity, that support particular functions. Installations may be elements of a base.

Institutional controls (land use): Non-engineering measures designed to prevent or limit human exposure to hazardous substances left in place at a site or to ensure the effectiveness of the chosen remedy. Institutional controls are usually, but not always, legal controls, such as public access closures, withdrawal and reservation of lands for public safety purposes, and notations on official land records.

Land use controls: Any type of physical, legal, or administrative mechanism that restricts the use of, or limits access to, property to prevent or reduce risks to human health and the environment.

Magnetometer: An instrument for measuring the intensity and direction of magnetic fields.

Material potentially presenting an explosive hazard: 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 operation). Excluded from this definition are munitions within DoD's established munitions management system and other hazardous items that may present explosion hazards (e.g., gasoline cans or compressed gas cylinders that are not munitions and are not intended for use as munitions).

Military munitions: Ammunition products and components produced for or used by the armed forces for national defense and security. The term *military munitions* includes ammunition products or components under the control of the Department of Defense, the U.S. 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; bulk explosives; chemical 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.

Military munitions do not include wholly inert items, improvised explosive devices, or nuclear weapons, nuclear devices, or nuclear components. However, military munitions do 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) through (C))

Military munitions burial site: A site, regardless of location, where military munitions or CA, regardless of configuration, was intentionally buried, with the intent to abandon or discard in a manner consistent with applicable environmental laws and regulations or the national practice at the time of burial. It does not include sites where munitions were intentionally covered with earth during authorized destruction by detonation, or where in-situ capping is implemented as an engineered remedy under an authorized response action.

Military range: See "Operational Range" and "Range."

Munitions constituents (MC): Any materials originating from unexploded ordnance, discarded military munitions, or other military munitions, including explosive and non-explosive materials. MC also includes emission, degradation, or breakdown elements of such ordnance or munitions. (10 U.S.C. §2710(e)(4)) [NOTE: Explosive munitions constituents in sufficient concentration to be explosive are included in the definition of "Munitions and Explosives of Concern".]

Munitions and explosives of concern (MEC): Specific categories of military munitions that may pose unique explosive risks, including:

(a) Unexploded ordnance (UXO), as defined in 10 U.S.C. §101(e)(5);
(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 10 U.S.C. §2710(e)(3), present in high enough concentrations to pose an explosive hazard. (Note: See "Munitions Constituents"). (Munitions constituents are MEC when explosive compounds of the munitions, such as TNT, RDX, and HMX, are in sufficient concentration as to pose an explosive hazard. This situation arises when concentration levels are 10 percent or more. Non-explosive munitions constituents and explosive concentrations less than 10 percent are not considered MEC.)

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

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

Munitions response area: 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 consists of one or more munitions response sites.

Munitions response site: A discrete location within a munitions response area that is known to require a munitions response.

Obscurant: Man-made or naturally occurring particles suspended in the air that block or weaken the transmission of a particular part or parts of the electromagnetic spectrum.

Open burning (OB): An open-air combustion process by which excess, unserviceable, or obsolete munitions are destroyed to eliminate their inherent explosive hazards. The combustion of any material without (1) control of combustion air, (2) containment of the combustion reaction in an enclosed device, (3) mixing for complete combustion, and (4) control of emission of the gaseous combustion products.

Open detonation (OD): An open-air process used for the treatment of excess, unserviceable, or obsolete munitions whereby an explosive donor charge initiates the munitions being treated.

Operational range: A range that is under the jurisdiction, custody, or control of the Secretary of Defense and that is used for range activities, or, although not currently being used for range activities, that is still considered by the Secretary to be a range and has not been put to a new use that is incompatible with range activities (10 U.S.C. §101(e)(3)(A) and (B)). Also includes "military range," "active range," and "inactive range" as those terms are defined in 40 CFR §266.201.

Ordnance: Military weapons collectively, including ammunition and the equipment to keep them in good repair; also includes explosives, chemicals, pyrotechnics, and similar materials (e.g., bombs, guns, ammunition, flares, smoke, and napalm).

Ordnance and explosives (OE) and ordnance and explosives waste: Formerly used terms that have been replaced by the term munitions and explosives of concern (MEC).

Pollutant or contaminant: The term *pollutant or contaminant* shall include, but not be limited to, any element, substance, compound, or mixture, including disease-causing agents, which, after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction), or physical deformations in such organisms or their offspring. The term *pollutant or contaminant* shall not include petroleum, including crude oil or any fraction thereof, which is not otherwise specifically listed or designated as a hazardous substance (42 U.S.C. §9601 (14)) and shall not include natural gas, liquefied natural gas, or synthetic gas of pipeline quality (or mixtures of natural gas and such synthetic gas).

Practice ordnance: Ordnance manufactured to serve a training purpose. Practice ordnance generally does not carry a full payload, but it may still contain explosive components such as spotting charges, bursters, and propulsion charges.

Projectile: An object launched by an applied force and continuing in motion by its own inertia, such as a bullet, bomb, shell, mortar, or grenade.

Propellant: An agent such as an explosive powder or fuel made to provide the necessary energy for propelling ordnance.

Range: When used in a geographic sense, a designated land or water area that is set aside, managed, and used by the Department of Defense for range activities. Ranges include the following areas:

(a) Firing lines and positions, maneuver areas, firing lanes, test pads, detonation pads,

impact areas, electronic scoring sites, buffer zones with restricted access, and exclusionary areas.

(b) Airspace areas designated for military use in accordance with regulations and procedures prescribed by the administrator of the Federal Aviation Administration.

(10 U.S.C. §101(e)(1)(A) and (B))

Real property: Any land or an interest therein, and all buildings, structures, and improvements affixed to the land acquired by any Federal agency (such as the BLM or FWS), that is managed pursuant to the Federal Property and Administrative Services Act of 1949. Real property does not include lands withdrawn or reserved, from the public domain but does include lands or portions of lands withdrawn or reserved by the Secretary of the Interior, with the concurrence of the Administrator of General Services, if those lands are determined to be not suitable for return to the public domain for disposition under the general public land laws.

Real property acquisition: Real property obtained either through discretionary acts or by law—whether by way of condemnation, donation, escheat, right-of-entry, escrow, exchange, lapses, purchase, or transfer—that will be under the jurisdiction or control of any Federal agency (such as the BLM or FWS) and will be managed pursuant to the Federal Property and Administrative Services Act of 1949.

Remedial action: A type of response action under CERCLA. Remedial actions are those actions consistent with a permanent remedy, instead of or in addition to removal actions, to prevent or minimize the release of hazardous substances into the environment.

Removal action: Short-term response actions under CERCLA that address immediate threats to public health and the environment.

Render-safe procedures: The portion of EOD procedures involving the application of special EOD methods and tools to provide for the interruption of functions or separation of essential components of UXO to prevent an unacceptable detonation.

Response action: As defined in section 101 of CERCLA, "remove, removal, remedy, or remedial action, including enforcement activities related thereto." As used in this handbook, the term *response action* incorporates cleanup activities undertaken under any statutory authority.

Returning lands: Lands relinquished by the military service and returned to DOI when public lands that were withdrawn for military use are no longer needed for military purposes. When returning lands, DoD files a notice of intent to relinquish the lands with BLM (43 CFR §2372).

Small arms ammunition: Ammunition, without projectiles that contain explosives (other than tracers), that is .50 caliber or smaller, or for shotguns.

Smoke: A chemical filler for ordnance such as bombs, projectiles, and grenades that produces a cloud of smoke to mark a position or obscure a battlefield. The term is applied to ordnance to indicate that it is primarily intended to produce smoke to mark a position or obscure a battlefield.

Technical escort unit: A DoD organization of specially trained personnel that provide verification, sampling, detection, mitigation, rendering safe, decontamination, packaging, escort, and remediation of chemical, biological, and industrial devices or hazardous material.

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

Time-critical removal action: Removal action where, based on the site evaluation, a determination is made that a removal is appropriate, and that less than 6 months exists before on-site removal activity must begin. (40 CFR §300.5)

Transferred range: A military range that has been released from military control. Transferred ranges have been transferred from DoD control to other Federal agencies, State or local agencies, tribes, or private entities.

Transferring range: Ranges in the process of being transferred from DoD control (e.g., sites that are at facilities closing under the Base Realignment and Closure Act or other authorities). The term also refers to a military range that is proposed to be leased, transferred, or returned from the Department of Defense to another entity, including Federal entities.

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 whether by malfunction, design, or any other cause.

(10 U.S.C. §101(e)(5)(A) through (C))
P.L. 106-65, section 3031 (c)(5)(A) provides a more detailed description.

UXO technicians: Personnel who are qualified for and filling contractor positions of UXO Technician I, UXO Technician II, and UXO Technician III, as defined by the Department of Labor, Service Contract Act, Directory of Occupations.

Warhead: The part of a missile, projectile, rocket, or other munition that contains the explosive system, chemical or biological agents, or inert materials intended to inflict damage.

White phosphorus: A chemical that, when exposed to air, burns spontaneously, producing dense clouds of white smoke.

Wildland fire: Any nonstructure fire that occurs in the wildland, other than prescribed fire.

Withdrawn public lands: Public lands that are removed from the operation of the public land laws and reserved for a specific Federal Government purpose.

Appendix 1

Military Munitions

This appendix describes military munitions commonly found as UXO on FUDS, BRAC, and other transferred properties. Being able to identify UXO is an important step in the UXO risk management process.

TYPES OF ORDNANCE

The following categories of ordnance are the most common types found in the field and are discussed in more detail in the following sections:

1. Small Arms Munitions
2. Hand Grenades
3. Rifle Grenades
4. Projected Grenades
5. Projectiles
6. Mortars
7. Rockets
8. Guided Missiles
9. Bombs
10. Submunitions
11. Land Mines
12. Flares
13. Fuzes

1. Small Arms Munitions

A small arms munition, normally called a *round*, is a single unit consisting of a cartridge for holding the propellant (explosive) charge, with the projectile (bullet) inserted in one end and the primer (initiating) charge in the other end. Small arms munitions can be fired from pistols, rifles, shotguns, and machine guns. Small arms munitions include projectiles of .50 caliber and smaller without an explosive warhead (see glossary). Photos of the 20 mm round and 20 mm projectile, which are considered medium-caliber munitions and may contain explosive projectiles, are included for size comparison (see ***Figure 23***). Although the hazards associated with small arms UXO are relatively minor, small arms munitions may explode if thrown into a fire or if the primer is struck with a sharp object such as a nail.

2. Hand Grenades

Hand grenades are small hand-thrown devices that contain explosive or chemical filler. A grenade has three main parts: a body, a fuze with

Figure 23 *–Left to right: a 20 mm round (medium caliber) compared with a 20 mm projectile; a .50-caliber round compared with a .50-caliber projectile; and a .50-caliber round compared with a .223-caliber round (used in an M-16 rifle).*

Figure 24 *–Left to right, hand-thrown grenades: a World War II "pineapple" grenade, a fragmentation (practice) grenade, and a canister-style grenade used for smoke and riot-control agents, e.g., tear gas. (Red top indicates a red smoke grenade.)*

a pull ring and safety clip, and a filler. Classes of grenades that can be encountered as UXO include fragmentation, smoke, chemical, and illumination grenades. The traditional "pineapple" fragmentation variety was used in World War II and the Korean War. The Vietnam-era and current fragmentation varieties look like a baseball. The smoke, chemical, and illumination grenades look like and are about the size of a soft drink can (see ***Figure 24***).

3. Rifle Grenades

Rifle grenades are grenades attached to a tube that fits over a rifle barrel. They range in length from about 9 to 17 inches. Special ammunition is used in the rifle to provide the force necessary to propel the grenade to the target. Rifle grenades typically contain high explosives, white phosphorus, riot-control agents, illumination flares, or chemicals that produce colored or screening smoke. Rifle grenades typically have impact fuzes either on the nose or behind the warhead.

4. Projected Grenades

Projected grenades replaced the rifle grenade in the early 1960s. The 40 mm grenade is about the size and shape of a goose egg and contains a high-explosive charge and a sensitive internal impact fuzing system. When the grenade is fired, the fuze is armed. If the fuze does not activate upon impact, the resulting UXO item is extremely dangerous and likely to explode if moved or handled. The small size, quantity of explosive, and fragmentation make this the most likely munition to cause death or injury to the public and employees on the public lands and refuges (see ***Figure 25***).

5. Projectiles

Projectiles range from approximately .223 to 16 inches in diameter and from 1 inch to 4 feet in length. Munitions that are .50 caliber and smaller do not contain an explosive charge. Munitions from 20 mm through 30 mm may contain a fuze and an explosive charge. All munitions larger than 30 mm should be assumed to have a fuze and an explosive charge, white phosphorus, or chemical agent. In general, the larger the munition, the larger the explosive charge or amount of chemical agent it will contain. Also, the larger the projectile, the greater the force of impact and, therefore, the deeper the projectile may penetrate into the soil (see ***Figure 26***).

Figure 25 *– The projected grenade's small size and appealing shape and color make it most likely to cause death or injury on public lands and refuges.*

Figure 26 – *Milt Williams, public information officer for the Idaho State Department of Lands, looks over some of the artillery shells on an old gunnery range in the Boise Foothills. Wildfire made the surface more visible and led to the discovery of these rounds. Reprinted with permission of the Idaho Statesman, photograph ©Tom Shanahan, September 20, 1996.*

6. Mortars

A mortar is a type of projectile that has a very steep angle of impact. Mortars range from approximately 1 inch to 11 inches in diameter and are filled with explosives, toxic chemicals, white phosphorus, or illumination flares. The mortar fuze is normally in the nose (front) of the round, which is activated only after the round leaves the firing tube. The round normally has a tube with stabilizing fins behind the explosive warhead (see ***Figure 27***). Mortars, being fairly lightweight when compared with other larger projectiles, are generally found at or near the ground surface.

7. Rockets

Figure 27 – *81 mm high-explosive mortar.*

Rockets generally look like a metal tube with the warhead at one end and stabilizing fins and rocket motor at the other end (see ***Figure 28***). Rockets can range from 1.5 inches to more than 15 inches in diameter and can vary from 1 foot to more than 9 feet in length. Rocket warheads contain explosives, toxic chemicals, white phosphorus, submunitions, riot-control agents, or illumination flares. Fuzes can be located in the nose of the rocket warhead or at the base of the warhead in front of the rocket motor. Both the warhead and residual propellant in the motor can cause injury or death.

8. Guided Missiles

Guided missiles differ from rockets in that guided missiles have internal electronics that direct the missile to its target while in flight. Spent (fired) guided missiles can still contain residual propellant that could ignite and burn violently. Many forces, such as pressure, radio and sound waves, and electrostatic and photoelectric energy, can activate guided missile fuzes. Guided missiles are extremely dangerous because they can contain fuzes that detonate even without human contact.

Figure 28 – *Rocket, 2.75-inch practice.*

9. Bombs

Bombs are considered to be dropped munitions. Bombs range from 1 pound to 3,000

Figure 29 *–Left and center: Practice bomb (BDU-33) and a cutaway of the bomb. This practice bomb is approximately 2 feet long. The central channel in the bomb contains an explosive spotting charge large enough to cause serious injury. (Note: Practice munitions are painted blue, but not all blue munitions are necessarily inert.) Right: Bomb found on public lands north of Chocolate Mountains Gunnery Range, California.*

(or more) pounds and from 2 to 10 feet in length. Newer bombs (e.g., smart bombs) can have a guidance device to guide the bomb to its intended target. Generally, all bombs have the same components: a metal container, a fuze, and a stabilizing device (see ***Figure 29***). The metal container, or bomb body, holds the explosive or chemical filler and may consist of one or more pieces. Bombs use either internal or external mechanical or electrical fuzes, which are typically located in the nose or tail section. Some type of arming vane generally arms mechanical fuzes. The arming vane operates like a propeller to line up all the fuze parts and arm the fuze. Fins or parachute assemblies attached to the rear section of the bomb stabilize it during flight. These assemblies often detach from the bomb after impact. As UXO, bombs may be broken into components (e.g., body components and a fuze) and may not appear to be bombs, but they remain hazardous.

10. Submunitions

Submunitions are multiple bomblets, grenades, or mines housed in a canister-like or artillery projectile delivery system. When activated, the delivery system (e.g., dispenser, missile or rocket warhead, or artillery projectile) releases the submunitions (see ***Figure 30***). The delivery system disperses the submunitions while still airborne, scattering the submunitions over a wide area. After dispersal, submunition fuzing systems activate in a variety of ways, including impact, pressure, time-delay, magnetic, or movement. Overall, submunitions are among the most dangerous UXO because they are small (as small as a 35 mm film canister), contain an explosive charge, do not look like military munitions, and are easily picked up.

11. Land Mines

Land mines are explosive munitions placed in or on the ground. Land mines detonate when the fuze is activated by pressure, when a trip wire is pulled, or in the presence of a magnetic field. Land mines are generally of two types: small antipersonnel mines and larger antitank mines (see ***Figure 31***). The only confirmed incidence of land mines on BLM-managed public lands

Figure 30 *– A 155 mm artillery dispenser carries grenade-like submunitions to the target. This dispenser did not open properly to scatter the submunitions; the inert submunitions fell out when the round hit the ground. Submunitions are small and often do not look like military munitions.*

were practice antitank mines in the California desert that were left over from training during World War II. The same type of practice antitank mines may also be located in southern Arizona and southern Nevada, where similar training took place. These practice antitank mines contain a spotting charge equivalent to the explosive force of a shotgun shell.

Figure 31 – *Left: Antitank practice mine found on public lands, Chemehuevi Mountains, BLM Needles Field Office, California. Right: Antipersonnel mine.*

The FWS had an active World War II-era antipersonnel and antitank minefield on Adak Island, but the Navy removed the tank and minefield as part of the BRAC cleanup. The FWS may have additional minefields on national wildlife refuges in the Pacific islands.

12. Flares

Flares may be either dropped or fired as a projectile. They normally consist of a magnesium compound that burns at very high temperatures; a fuze that initiates the burning process; and a canister that contains the magnesium compound, a fuze, and possibly a parachute. Flares as UXO will normally be found on or near the surface. The danger from a flare is both the fuze used to ignite the flare and the intense heat from the burning flare.

Figure 32 – The numbers in the "window" of this fuze for a 155 mm projectile indicate an internal timing mechanism to allow for an airburst of the projectile.

13. Fuzes

A fuze may be an integral part of a complete munition or a separate component that is attached to the remainder of the munition prior to firing (see ***Figure 32***). If a fuze fails to function properly, it will have undergone significant stress and may or may not still be attached to the munition. Fuzes come in a large variety of shapes and sizes and, therefore, are some of the most difficult MEC items to identify.

Appendix 2

Additional Information

Web Address	Sponsor	Synopsis
http://www.acq.osd.mil	Under Secretary of Defense for Acquisition and Technology	Provides updates for DoD technology-related activities
http://www.defenselink.mil	Department of Defense	Provides entrance into DoD web site; includes a search engine
http://www.denix.osd.mil	Defense Environmental Network and Information Exchange (DENIX)	Environmental legislation, compliance, restoration, cleanup, and DoD guidance
http://www.denix.osd.mil/denix/Public/Library/Explosives/UXOSafety/uxosafety.html	DENIX UXO Safety URL	UXO safety messages, posters, video clips, etc.
http://www.eglin.af.mil/navscleod	Naval School Explosive Ordnance Disposal	Navy EOD web site
http://www.frtr.gov/resources.htm	Federal Remediation Technologies Roundtable	Agency explosives, ranges, and EOD-UXO links to other web sites with UXO information
http://www.fws.gov	U.S. Fish and Wildlife Service	FWS web site
http://www.dtic.mil	Defense Technical Information Center	Provides access to a forum for the exchange of scientific and technical information
http://www.epa.gov	Environmental Protection Agency	EPA's web site information regarding EPA activities, policies, and regulations
http://www.estcp.org	Environmental Security Technology Certification Program	Promotes environmental technologies through demonstration and validation
http://www.doi.gov	Department of the Interior	DOI web site
http://www.blm.gov	Bureau of Land Management	BLM web site
http://www.serdp.org	Strategic Environmental Research and Development Program	Latest news and events, and information regarding new cleanup technologies, including UXO
http://www.atsdr.cdc.gov/toxfaq.html	Agency for Toxic Substances and Disease Registry	Fact sheets on various contaminants, including some explosive materials that may be found at hazardous waste sites

Appendix 3

Points of Contact (July 2005)

Bureau of Land Management	
Chief Ranger (BLM National Law Enforcement Office, Boise, ID)	(208) 387-5126
Protection and Response Group	(202) 557-3585
Lands and Realty	(202) 452-7773
BLM Safety Officer	(202) 501-2664
Military Liaison	(202) 452-7778
U.S. Fish and Wildlife Service	(303) 984-6867
Division of Engineering, Branch or Environmental and Facility Compliance	
Department of the Interior	
Office of Environmental Policy and Compliance	(202) 208-3891
DoD's Liaison to DOI	(202) 208-7211
Department of Defense	
DoD Explosives Safety Board, Chairman	(703) 325-0891

Appendix 4

Sample Liability Waiver

The following is an example of a waiver used at an installation that authorizes hunting and fishing in areas that may contain MEC. The recreational user must read or attend a safety briefing and sign this waiver before entering the property.

This is only a sample. Waivers must be approved by the regional solicitor or field solicitor that supports the local office.

CONDITION OF ENTRY AND LIABILITY WAIVER

I, the undersigned, hereby agree to observe all applicable regulations and circulars and all (State) Wildlife and Fish laws. I am fully aware that all activities are at my own risk, and in consideration for the permission to participate, I relieve the Government of all responsibility and liability for any damages or injuries that might occur.

I am fully aware that I may encounter hazards, including unexploded ordnance. I further agree not to enter any area except those that I have been authorized to enter. I will also follow the instructions provided for entry onto these lands. I certify that I have received a map and applicable regulations and/or instructions.

_____ _____

SIGNATURE DATE

_____

FULL ADDRESS INCLUDING ZIP CODE

Appendix 5

Site Safety and Health Plan

Instructions: Complete all blanks. If a response is not applicable, insert NA. Return to the Health and Safety Coordinator for review and approval.

Site Name:			
Prepared by:		Date	
Reviewed by:		Date	

A. INTRODUCTION

This health and safety plan establishes procedures and practices to protect employees and subcontractors from potential hazards posed by non-invasive field activities at the _____ site. In this health and safety plan, measures are provided to minimize potential exposure, accidents, and physical injuries that may occur during daily on-site activities and during normal working conditions. Contingencies are also provided for emergency situations. This plan should only be modified or amended by qualified BLM personnel or a contractor, assigned by BLM, qualified to make such modifications or amendments.

B. SITE DESCRIPTION

Site location or address:

Current site use:

Past site use:

Topography:

Name of and distance to nearest surface waters:

Surrounding land use and nearest population:

Site access [Provide directions to site]:

Nearest drinking water/sanitary facilities:

Nearest telephone:

Utilities located?

Site map attached?

C. PROJECT PERSONNEL

Role	Name	Training/Medical Monitoring Current? (Y/N)	Safety Briefing. Initials	Date
Team Leader				
Site Safety Officer				
Decontamination				
Sampler				

D. WORK PROPOSED

This plan was prepared for [describe specific tasks]:

Proposed work dates:

If visual inspection, will personnel be entering or contacting potentially hazardous areas? If yes, describe:

E. HAZARD EVALUATION AND ANALYSIS

Potentially hazardous agents known or suspected to be on-site (include preservatives and decontamination chemicals):

Substance	Concentration	Media	OSHA PEL	FP/LEL/VP	Odor Thresh	IP (ev)	Symptoms	First Aid
Heat	NA	NA	NA	NA	NA	NA	Flushed, hot or clammy skin, dizzy, nausea, disoriented	Provide water, electrolytes, rest, cool off in shade, sponge baths, seek medical attention

List any agents suspected to be at the site that cannot be detected by routine air monitoring equipment and plans made to detect them:

Potential chemical exposure routes [provide an "X"]:

Route	Known	Possible	Unlikely
Inhalation			
Ingestion			
Dermal			
Eye contact			

Chemical characteristics [provide an "X"]:

Hazard	Known	Possible	Unlikely
Toxic			
Ignitable			
Reactive			
Carcinogenic			
Volatile			
Radioactive			
Corrosive			
Particulate/fibers			

Possible physical hazards present during site investigation activities:

Hazard	Yes	No	Prevention
Terrain/tripping			
Heat/cold			
Electrical			
Drowning			
Falling objects			
Noise			
Venomous			
Other			

F. SITE CONTROL

Site control consists of measures taken to prevent human exposure to hazardous materials at the site. Such controls are defined as exclusion zones, contaminant reduction zones (CRZ), and support zone/ command post. If site control zones are needed for this site, they are shown on the attached map.

Site conditions and the work proposed under this plan (_____) do or do not require the establishment of exclusion zones that limit trained employee access. However, employees should minimize potential exposures and the raising of dust.

Regardless of the activities to be conducted, all site workers must use the buddy system, whereby each worker is paired with another worker or in communication (e.g., by radio under certain circumstances) with another worker. Under this system, each worker has the following responsibilities:

- Provide co-worker with assistance.
- Observe co-worker for evidence of chemical or heat exposure.
- Monitor the integrity of co-workers protective equipment.
- Notify the site safety officer or project manager if emergency help is needed.

G. CONFINED SPACES

A confined space is any space having limited means of egress that may be subject to the accumulation of toxic or flammable contaminants or an oxygen-deficient atmosphere. Confined spaces include tanks; process vessels; catch basins; boilers; bins; ducts; sewers; tunnels; pipelines; mine adits; and open-top spaces more than 4 ft deep, such as pits, vaults, and other vessels. **No confined spaces should be entered at the site for the work proposed under this plan.**

H. SPILL CONTAINMENT

No provisions are made within this plan for spill containment, as the information provided during the preparation of this plan did not identify any liquid wastes as being present at the site.

I. TASK DESCRIPTION AND PERSONAL PROTECTIVE EQUIPMENT

Based on the type of hazards identified in Section E, list the site tasks, level of protection, and protective clothing required for the each task:

Task	Level of Protection	Type of Coverall	Type of Bootie	Type of Glove

Only Level D tasks are approved for this site at this time. Workers performing these activities should minimize activities that raise dust. Level D: Safety boots, cotton clothing (no shorts). Upgrade may be to Tyvek or Saranex coveralls, safety glasses, surgical gloves, and overglove. **NOTE: Project personnel are not permitted to deviate from the specified level of protection without the prior approval of the site safety officer or BLM's health and safety officer.**

J. MEDICAL SURVEILLANCE

Employers are required by 29 CFR 1910.120 to provide a medical monitoring program for certain employees working with hazardous materials. The purpose of this program is to evaluate occupational exposures and to confirm that the employee is in satisfactory physical condition to wear the appropriate personal protective equipment. The employer must provide a medical surveillance program meeting the requirements of 29 CFR 1910.120 for the following personnel:

- All personnel who are or may be exposed to hazardous materials at or above the permissible exposure level at this and any other potential hazardous material site for more than 30 days a year regardless of the use of respiratory protection.
- Personnel who wear respirators more than 30 days a year.
- Personnel who develop injuries or symptoms of overexposure to hazardous substances.

The medical monitoring program must include the following elements:

- Physical examination prior to employment or assignment to a position necessitating contact with potentially hazardous materials.
- Yearly physical examination (the examination may be made at less frequent intervals at the direction of the physician).
- Physical examination at termination of employment or reassignment to a position that does not involve potential exposure to hazardous materials.
- Physical examination as soon as possible following an injury or the development of symptoms of overexposure to hazardous materials.

The medical examination must include the following elements:

- Determination and evaluation of the worker's employment and medical history.
- Description of the employee's duties.
- Estimate of the employee's potential exposure levels.
- Information from previous medical examinations, as needed.
- Diagnostic or analytical procedures as recommended by the physician.

The results of the medical surveillance program must be made available to the employee (including a written opinion from the physician regarding the fitness of the employee for the required task), and medical surveillance program records must be kept for the period of employment plus 30 years.

K. TRAINING

All employees working on-site that are exposed or potentially exposed to hazardous substances or general health and safety hazards shall receive training meeting the requirements of 29 CFR 1910.120 (e)(1) through (9), as appropriate. This includes the minimum 40-hour training for general site workers and additional 8-hour training for supervisors.

L. SAFETY EQUIPMENT

The following safety equipment will be on-site during the field investigation: first aid kit, eyewash, fire extinguisher, and wind tape.

M. AIR MONITORING

The following equipment will be used to monitor air quality in the breathing zone during work activities:

Instruments	Calibration	Parameter	Frequency
Dataram	None	Particulates	Continuous
Multirae	Daily per manual	Vapors/gases	Continuous
Multirae	Factory	O_2, combustible gas, H_2S	Varies
Monitor 4	Factory	Radiation	Varies
Detector tubes	None	Numerous; chemical-specific	Varies

If air contaminants are detected, continuous monitoring shall be employed. The following action levels have been established to determine the appropriate level of personal protection to be used during site investigation activities:

Hazard	Action Level	Action	Instrument
Particulates	> 5.0 mg/m^3	Vacate site	Dataram
Organic vapor	> 1 ppm[a]	Vacate site	Multirae
Detector tubes	> PEL	Vacate site	Draeger
Gamma radiation	> 2mrem/hr[b]	Vacate site	Survey instrument
Combustible gas/ O_2 level	> 20% LEL < 19.5%	Vacate hazard area	Multirae

[a] Above background in breathing zone
[b] Milliroentgen equivalent in man per hour
Comments: Assumes lead constitutes 1% of airborne dust. Background radiation is normally 0.01-0.02 mrem/hr.

Note: Source for radiation hazard information: *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, prepared by NIOSH/OSHA/USCG/EPA. 1985.

N. DECONTAMINATION

To prevent the distribution of contaminants outside the exclusion zone and to prevent cross-contamination, the following procedures will be used to decontaminate equipment: Dismantle to expose hidden contamination, wash with soap and water in a wash tub, rinse with water, rinse with clean water, and place equipment in a clean plastic bag. More delicate equipment or surfaces should be decontaminated by wiping with a clean, moist cloth. To prevent the distribution of contaminants outside the exclusion zone and to prevent personal exposure to chemicals, VEHICLES WILL NOT BE ALLOWED INSIDE THE EXCLUSION ZONE.

To minimize or prevent personal exposure to hazardous materials, all personnel working in the exclusion zone and contamination reduction zones will comply with the following decontamination procedures: Wash boots, rinse boots, remove duct tape (if used), remove coveralls, remove gloves. Decontamination may not be necessary if site control zones have not been identified and soils are not wet.

Decontamination equipment required on-site will include: Wash and rinse tubs, brushes, water storage, alconox. Decontamination wastewater and contaminated materials will be disposed of in the following manner: decontaminated PPE is expected to be of low hazard and should be placed in plastic bags for disposal at a landfill. Soapy water may be discharged on the ground.

O. SHIPMENT OF RESTRICTED ARTICLES

Federal laws and international guidelines place restrictions on certain materials shipped by passenger and cargo aircraft. No shipping of restricted materials is expected for the work proposed under this safety plan. This section may require revision in the future if the scope of work is modified (for example, to include shipment of environmental samples).

P. EMERGENCY RESPONSE PLAN

The site safety officer (SSO) is responsible for implementing this aspect of the plan. He will decide when to evacuate the site and notify local resources listed below. He will be alert for symptoms of chemical or heat exposure as listed in Section E. The SSO will maintain the first aid kit. He or other members of the team will provide decontamination and first aid in accordance with Section E (if needed) and immediately transport injured persons to the hospital.

Local Resources	Name	Telephone
Fire		
Police		
Ambulance		
Hospital		
Site phone		

Directions to the hospital: See attached map. [Provide directions]

[Hint: Try Mapquest.com]

BLM and other resources:

	Name/Location	Work Phone	Home Phone
Site Health and Safety Officer			
Health and Safety Coordinator			
Medical Consultant			

Q. DOCUMENTATION

Document	Attached (Y/N)	In File (Y/N)
Hospital Route Map		
Site Map		
Work Plan		
Material Safety Data Sheets		
Training Records		
Medical Clearance		
Equipment SOPs		
General Work Practices		
Accident Report Form		
Health and Safety Plan		

R. EQUIPMENT LIST

A. Health and Safety ___ Organic vapor detector ___ Dataram ___ Explosimeter ___ Oxygen level indicator ___ Radiation meter ___ Detector tubes ___ Other ___ Tyvek suits number ( ) ___ Saranex suits ( ) ___ Nitrile gloves ( ) ___ Surgical gloves ___ Booties ( ) ___ Hardhats ___ Safety boots ___ Respirators ___ Duct tape ___ Cell phone/radio ___ First aid kit ___ Eyewash ___ Vehicle fire extinguisher ___ ___ ___	C. Basic Sampling Equipment ___ Hand auger; number of auger heads: ___ Stainless steel bailer ___ Teflon bailer ___ Plastic scoop ___ Rope for bailer; feet ( ) ___ Shovel ___ Stainless steel spoons ( ) ___ Disposable plastic spoons ___ Ziploc bags ___ Sample bottles (number and type) ___ Preservatives ___ Water filtering apparatus ___ Disposable bags ___ Ice ___ Coolers ( ) ___ Strapping tape ___ Air bills ___ 100 ft. measuring tape ___ pH, temperature, conductance kit ___ Soil pH tester ___ Water level indicator ___ X-ray fluorescence (XRF)/field screening kits ___ Pin flags ___ Global Positioning System (GPS) unit
B. Decontamination ___ Alconox (detergent) ___ Decontamination tubs (2 minimum) ___ Brushes (bailer type) ___ Brushes (dairy type) ___ Brushes (auger type) ___ 10 gal tap water ___ Methanol (optional) ___ Squirt bottles (optional) ___ Foil ___ Garbage bags ___ Distilled water	D. Documentation ___ Field logbook ___ Chain-of-custody forms ___ Sample tags ___ Custody seals ___ Camera ___ Film ___ Wristwatch ___ ___ ___ ___