FINAL
FEASIBILITY STUDY REPORT

for:

FORMER WITHLACOOCHEE CWS FIELD TRIALS & ATG BOMBING & GUNNERY RANGE

Sumter & Hernando Counties, Florida

prepared for

U.S. ARMY ENGINEERING AND SUPPORT CENTER HUNTSVILLE
and
U.S. ARMY CORPS OF ENGINEERS, JACKSONVILLE DISTRICT

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

A Remedial Investigation was conducted at the former Withlacoochee Chemical Warfare Service Chemical Warfare Service Field Trials and Air-to-Ground Bombing and Gunnery Range (hereafter the Withlacoochee Site) to gather the data required to determine the nature and extent of Munitions and Explosives of Concern and Munitions Constituents for the purpose of developing and evaluating effective remedial alternatives as presented in this Feasibility Study Report. The purpose of the Feasibility Study is not to select the remedy but to provide decision makers with the necessary data to select the final remedy for the site.

ES.2 REMEDIAL INVESTIGATION

ES.2.1 The Remedial Investigation was designed to assess the nature and extent of Munitions and Explosives of Concern and Munitions Constituents contamination within the site. The nature and extent of munitions hazards was characterized using a combination of digital geophysical mapping and intrusive investigation of geophysical anomalies. During the Remedial Investigation, two unexploded chemical munitions were found, one had a mustard agent filler and the other had no liquid filler. Munitions debris was also found within six former test locations within the site. Soil samples were collected to gauge the nature and extent of munitions constituents contamination. Background samples for soil, surface water, and sediment were also collected.

ES.2.2 The Remedial Investigation Report noted that a potential for a complete exposure pathway for hazardous munitions exists at five areas within Chemical Use Area #1 and one area within Chemical Use Area #2 (approximately 249 acres), but no significant risk exists for the munitions constituents. The RI recommended these six hazardous areas to be broken out from the Munitions Response Area into the "Test Areas", separate from the "Remaining Lands" for which no risks were identified for Munitions and Explosives of Concern and Munitions Constituents. A Feasibility Study was recommended for the site because of the Test Areas portion of the site.

ES.3 FEASIBILITY STUDY

ES.3.1 Development of Alternatives

Four alternatives were developed and assessed for managing hazards associated with Munitions and Explosives of Concern potentially remaining within the Test Areas MRS. This process is described in Chapter 3. The overall remedial action objective is to prevent interaction between human and ecological receptors and residual Munitions and Explosives of Concern. The four alternatives initially developed and screened consist of the following:

- Alternative 1 – No Action: No action is conducted under this alternative.
- Alternative 2 – Land Use Controls (Education Program): Development of a site-specific educational awareness program consisting of preparation, installation of warning signs, and distribution of educational tools and materials.
- Alternative 3 –Remedial Action (Munitions and Explosives of Concern Removal from Surface); Land Use Controls (Education Program): A munitions removal will be con-

ducted on the surface only within the identified areas of munitions hazard. An education program will be conducted to provide continuing protection and education.

- Alternative 4 – Remedial Action (Munitions and Explosives of Concern Removal): A munitions removal will be conducted to the depth to which Munitions and Explosives of Concern or Munitions Debris were discovered in each of the six areas, or to the maximum depth of land use activities, which is estimated to be 36 inches. Advanced geophysical anomaly classification technology will be used if possible. This alternative would remove the munitions sources from those areas identified during the Remedial Investigation as having munitions hazards. The implementation of this alternative would allow unlimited use and unrestricted exposure.

ES.3.2 Initial Screening of Alternatives

The four alternatives were initially screened for effectiveness, cost, and implementability to determine which alternatives should be carried forward to a detailed analysis. Alternative 3 was dismissed from detailed analysis because it would not provide a reduction in hazards posed by subsurface Munitions and Explosives of Concern. Alternatives 1, 2, and 4 were carried forward for detailed analysis in Chapter 5.

ES.3.3 Detailed Analysis of Alternatives.

A detailed analysis was completed for the three remaining alternatives using nine evaluation criteria, as defined by the Comprehensive Environmental Response, Compensation, and Liability Act. The following conclusions were derived from a comparative analysis of the alternatives:

- Alternative 1 – No Action - is ineffective in reducing risk to human health and the environment and has no long-term permanence. This alternative was considered as required by the NCP to provide a baseline for comparing the other alternatives.
- Alternative 2 – Land Use Controls (Education Program) – site-specific education program consisting of information provided to the Florida Forest Service and Florida Fish and Wildlife Commission with the objective of modifying behavior in the event munitions and explosives of concern are found. The Florida Forest Service and Florida Fish and Wildlife Commission would provide the information to site workers and the recreational users of the forest. Warning signs will be installed around the six “Test Areas” noting the potential presence of Munitions and Explosives of Concern. The program includes an initial public meeting and updating the existing Public Involvement Plan into a Community Relations Plan. Due to the many hiking trails and campgrounds throughout the Withlacoochee Site, extra emphasis will be put on making the information easily available to recreational users of the forest. This alternative does not reduce the toxicity, mobility, or volume of munitions and explosives of concern but it does minimize risks by potentially modifying behavior of visitors and workers.
- Alternative 4 – Remedial Action (Munitions and Explosives of Concern Removal). The objective of the removal is to identify and remove munitions and explosives of concern on the ground surface and in the subsurface to the depth based on the deepest occurrence of Munitions and Explosives of Concern or Munitions Debris at each of the six sites. Detection and identification of anomalies attributable to munitions would be conducted using geophysical methods and advanced geophysical anomaly classification technology. Locations to be excavated would be based on anomalies from geophysical data and on ar-

eas that are flagged using analog instruments. This alternative is strong in the balancing factors of long-term effectiveness, permanence, and reduction of toxicity, mobility, and volume through treatment due to the finding and destruction of munitions and explosives of concern.

ES.3.4 Comparative Analysis of Alternatives

Based upon the analysis of the remaining alternatives, Alternative 2 tends to be the favorable alternative due to its protection of human health through the installation of Land Use Controls and an education program, its effectiveness over a long term, a lower potential of short-term hazards during installation of signs, its ability to be readily implemented, and its lower overall cost.

ES.3.5 Site-Specific Summaries

The site risks and candidate alternatives are summarized in Table ES-1.

Table ES-1: MRS Summary- Feasibility Study Evaluation Data and Candidate Alternatives

MRS Areas	Acreage	Historical Usage of Site	Current Usage of Site	Current and Future Activities and Associated Depths (feet)	Munitions and Explosives of Concern (MEC) and Munitions Constituents (MC) Hazards Identified during Remedial Investigation (RI)	Candidate Alternatives
TEST AREAS	249 acres	**A and B Forests** (74 acres) - CWS Field Trials (Jan. 1944 – Jan. 1945. Mortars (4.2 inch), various bombs, and Comings Candles were used against simulated Japanese defensive positions built on two test grids (A Forest and B Forest).	Owned and maintained by the Florida Forest Service for forestry and recreational activities.	• Forestry: 1-2 • Recreation: <1 • Road maintenance: 1-2 • Utility installation: 1-3	• MEC/MD: ○ MD: unidentified munitions fragmentation found during RI. ○ Depth Range; MD found surface to 14 inches • MC: ○ Risk assessment did not identify an unacceptable MC risk	**Alternative 2 – Land Use Controls (Education Program)** • Provide letter and fact sheets notifying site workers and recreational users of the potential for MEC to remain and steps to take if potential MEC is found • Install warning signs around hazard areas. • Provide updates on a periodic basis **Alternative 4 - Remedial Action (MEC Removal)** • Removal of MEC to a depth corresponding to the maximum depth of MEC or MD discovered during the RI, or to a maximum of 36 inches below ground surface (bgs)—specific for each the six identified MEC hazard areas (totaling 249 acres)
		D Meadow (14 acres) - CWS Field Trials (Sept. 44 – Jan 1945) - Tests conducted using M47A2 bombs (filled with HN1 and H). Three tests used HN1 or H poured directly on the ground. One test fired 200 4.2-inch mortars filled with HT into the test grid.			• MEC/MD: ○ MD: 4.2-inch mortar debris found during RI. ○ Depth Range; MD found 4 to 13 inches • MC: ○ Risk assessment did not identify an unacceptable MC risk	
		F Meadow (61 acres) - CWS Field Trials (Sept 1944 – May 1945) - Tests included over 1,000 4.2-inch mortars being fired into the grid			• MEC/MD: ○ Chemical Warfare Materiel (CWM): EK-4 10-lb chemical bomblet (14 inches bgs) ○ MD: 4.2-inch mortar debris found during RI. ○ Depth Range; MD found 4 to 16 inches • MC: ○ Risk assessment did not identify an unacceptable MC risk	
		ATG Range (35 acres) - Air-to-ground training range (1943-1945) - Munitions used: practice bombs, practice rockets, small arms			• MEC/MD: ○ MD: MD from AN-M47 100-pound bombs found during RI. ○ Depth Range; MD found 36-40 inches • MC: ○ Risk assessment did not identify an unacceptable MC risk	
		NP Forest (46 acres) - CWS Field Trials (Nov. 1943 – Aug 1944) - First test area established for the testing of munitions with non-persistent agents, persistent agents, and stimulants. Test grid approx. 500 yds by 500 yds.			• MEC/MD: ○ MD: aerial bombs (EK-4 or M74 10-lb chemical bombs, 500-lb chemical bombs), 4.2-inch mortar debris found during RI. ○ Depth Range; MD found surface to 20 inches • MC: ○ Risk assessment did not identify an unacceptable MC risk	

MRS Areas	Acreage	Historical Usage of Site	Current Usage of Site	Current and Future Activities and Associated Depths (feet)	Munitions and Explosives of Concern (MEC) and Munitions Constituents (MC) Hazards Identified during Remedial Investigation (RI)	Candidate Alternatives
		G Forest (19 acres) - CWS Field Trials (Dec 1944 - Jun 1945) - Tests were conducted using rocket warheads, EK-4 bomblets, and M47A2 bombs. One test included dropping an E49 cluster bomb.			• MEC/MD: ○ MD: MD from EK4 10-pound bomblets found during RI. ○ Depth Range; MD found 1-16 inches • MC: ○ Risk assessment did not identify an unacceptable MC risk	
REMAINING LANDS	17,991 acres	CWS Field Trials (1944-1945) – Tests at various areas included air-dropping bombs, testing aerial spray tanks, static firing of munitions, and persistence testing of chemical agent on ground.	Forestry, Recreation, Fish Hatchery	• Forestry: 1-2 • Recreation: <1 • Utility installation: 1-3 • Road maintenance: 1-2 • Maintenance of fish ponds: 1-2	• MEC/MD: ○ No MEC hazards identified in this area. • MC: ○ Risk assessment did not identify an unacceptable MC risk	

1.0 INTRODUCTION

An FS at the former Withlacoochee CWS Field Trials & ATG Bombing & Gunnery Range (hereafter the Withlacoochee Site) has been conducted under the Military Munitions Response Program (MMRP), which was created by the fiscal year (FY)02 National Defense Authorization Act by modifying the Defense Environmental Restoration Program (DERP) to address MEC and/or MC contamination on inactive, non-operational military ranges. Under the MMRP, the U.S. Army Corps of Engineers (USACE) is conducting environmental response activities for the Army.

1.1 PURPOSE

1.1.1 The purpose of the FS is not to select the remedy but to provide decision-makers with the necessary data to select the final remedy for the site. The FS process is designed to:

- Develop an appropriate range of potential alternatives to manage hazards and risks;
- Analyze the alternatives against the nine National Oil and Hazardous Substance Pollution Contingency Plan (NCP) criteria defined below; and
- Compare the alternatives against each other.

1.1.2 The CERCLA contains several statutory provisions with which all remedies must comply. These include protection of human health and the environment, compliance with ARARs, cost effectiveness, and a preference for permanence and for treatment that reduces toxicity, mobility, or volume of the hazardous substances. To satisfy these CERCLA requirements, NCP Section 300.430 identifies nine criteria against which potential remedies are judged, as summarized in Table 1-1.

Table 1-1: Nine Criteria for Detailed Analysis of Remedial Alternatives

Threshold Criteria	1. Overall protection of human health and the environment
	2. Compliance with ARARs
Primary Balancing Criteria	3. Long-term effectiveness and permanence
	4. Reduction of toxicity, mobility, or volume through treatment
	5. Short-term effectiveness
	6. Implementability
	7. Cost
Modifying Criteria	8. State acceptance
	9. Community acceptance

1.2 SUMMARY OF REMEDIAL INVESTIGATION FINDINGS

1.2.1 The results of the RI are contained in the RI Report and summarized in Table 1-2 at the end of this section. Chapter 6 of the RI Report contains the baseline MC risk assessment and the MEC hazard analysis. The paragraphs below provide a brief summary of the RI findings for each MRS.

1.2.2 The RI for the Withlacoochee Site identified a potential for human receptors to come into contact with MEC in six areas collectively known as Test Areas. During the RI, one CWM munition, an unexploded liquid-filled EK-4 10-lb chemical bomblet, was found at a depth of 14 inches in grid CUA1-037 within the F Meadow Test Area. On August 28, 2013, the Materiel

Assessment Review Board (MARB) met to evaluate this item (Item WAF-13-001). As stated in the report, "A review of the x-rays determined the item contains a 90% liquid fill, an unarmed fuze, heel, and with energetic material present. Analysis of the PINS spectra revealed this item contains a high confidence mustard fill. The MARB recommendation for this item is Explosive System Demilitarization (ESD)." The MARB memo is included in Appendix D of the RI Report. In addition, MD and one unexploded EK-4 10-lb bomblet (UXO) with an intact burster but no liquid filler was found within the G Forest Test Area during the RI.

1.2.3 Based on the CWM/UXO and MD findings, the hazards are concentrated near the surface and decrease to a maximum depth of 40 inches. The MD and CWM were found within six limited areas known as the Test Areas, which correspond with previously identified historical munitions test areas. Since the potential for MEC is limited to specific areas, the total area with an identified risk of MEC exposure considered in this FS for the entire Withlacoochee Site MRA is conservatively estimated to cover approximately 249 acres (Chapter 7 of the RI Report). Investigated areas of the Withlacoochee Site MRA outside the 249-acre Test Areas do not have a risk of MEC identified. Because the Withlacoochee Site MRA is a CWM site, the USEPA MEC Hazard Assessment (MEC HA) is not applicable.

1.2.4 The MC Risk Assessment shows that unacceptable human health or ecological risks due to MC are not present at the Withlacoochee Site MRA.

Table 1-2: Remedial Investigation Summary

MRS Area	Acreage	Historical Usage of Site	Current Usage of Site	Current and Future Activities and Associated Depths (feet)	MEC and MC Hazards Identified
REMAINING LANDS	17,991		Forestry, Recreation, Fish Hatchery	• Forestry: 1-2 • Recreation: <1 • Road maintenance: 1-2 • Maintenance of fish ponds: 1-2	• No MEC or MC hazards identified in this MRS.

2.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES FOR MEC AND MC

The process used for developing and screening remedial technologies includes establishing RAOs and developing general response actions that describe areas or volumes of media to which response actions may be applied. The next step is to identify potential treatment and disposal technologies and to screen those technologies based on technical implementability. The following sections provide details regarding the RAOs, ARARs, general response actions, and remedial technologies.

2.1 REMEDIAL ACTION OBJECTIVES

2.1.1 Overview

2.1.1.1 RAOs address the goals for reducing the hazards associated with MEC to ensure protection of human health, safety, and the environment. The RAOs are intended to be as specific as possible but not so specific that the range of alternatives that can be developed is unduly limited.

2.1.1.2 Based on the findings of the RI and previous investigations, there is a potential for human receptors to come into contact with MEC at the Test Areas within the Withlacoochee Site MRA only. From the historical information about the CWS Field Trials, we understand that weapons testing and training was conducted in specific areas (see subchapter 1.3 of the RI Report). Any remaining MEC is assumed to be associated with those areas. The six areas associated with the Test Areas MRS had MD or MEC findings from the intrusive investigation of anomalies. The areas, which represent localized concentrated munitions usage areas, were grouped as a single MRS due to their similar terrain, similar land use, and similar munitions history and useage. The depths of the MEC or MD are reported in Table ES-1.An analysis of the RI results and the current and anticipated future land use concluded that no unacceptable human health or ecological risk due to MC has been identified at the Withlacoochee Site MRA. No MEC exposure risk has been identified and no unacceptable human health or ecological risk due to MC has been identified in the Remaining Lands portion of the Withlacoochee Site MRA, so a response action does not need to include those areas.

2.1.1.3 The Withlacoochee Site MRA is part of the Withlacoochee State Forest, with a fish hatchery included within the boundaries. Future land use is expected to remain the same. Typical activities within the forest include many types of outdoor recreational activities, like hiking, biking, hunting, and camping. These activities are not likely to expose visitors and workers to subsurface MEC. However, the Florida Forest Service employees grade and repair the roads and utility work is possible at ranger stations or the fish hatchery. These activities have the potential to expose subsurface MEC; therefore, both surface and subsurface exposure pathways are considered potentially complete for human receptors within the Test Areas.

2.1.2 RAOs

2.1.2.1 <u>MEC Hazards:</u> CWM/MEC hazards have been identified in the form of an unexploded liquid-filled EK-4 10-lb chemical bomblet in grid CUA1-037 and another EK-4 10-lb chemical bomblet (burster only, ruptured) located in grid CUA2-006. MD has been found at subsurface depths in six areas, as deep as 40 inches in one area. The MD discovered at 40 inches was from

an AN-M47 100-lb bomb in grid CUA1-075. Much of the MD found was from 4.2-inch mortars.

- Exposure Routes for MEC: Exposure pathways for MEC are considered potentially complete for human receptors conducting activities at the surface and subsurface. Potential human receptors include:
  - Current site visitors, construction workers, and commercial/industrial workers; and
  - Future site visitors, construction workers, and commercial/industrial workers.
- RAO for Human Exposure to MEC in Subsurface Soil: Reduce the potential for human receptors to be exposed to hazardous MEC to a depth consistent with the depths at which MEC or MD were discovered for each area (see Table ES-1), while conducting current and anticipated future land use activities (as described in paragraph 2.1.1.3).

2.1.2.2 Contaminants of Concern: No unacceptable risks to human health or the environment have been identified for MC for this MRA.

2.1.2.3 ARARs: The project will be designed and implemented in compliance with requirements associated with the Resource Conservation and Recovery Act (RCRA) 40 Code of Federal Regulations 264 Subpart X (Miscellaneous Units OB/OD) Subsection 264.601 (Environmental Performance Standards) as applicable to the management and treatment of military munitions through the detonation of munitions consolidated at another location, if detonations are conducted.

2.2 GENERAL RESPONSE ACTIONS

2.2.1 General response actions are selected to satisfy the RAOs for the MRS. The general response actions include the following:

- **Land Use Controls.** RAOs may be met by restricting access to the MEC through the use of administrative controls on land use or by education of those accessing the site; and
- **Clearance/Removal**. RAOs may be met by removing MEC. Removal of MEC is accomplished through detection surveys to identify anomalies, investigation of each anomaly, and removal or destruction of MEC, as required.

2.2.2 The general response actions identified above may be separated or combined in developing remedial action alternatives that are appropriate for a particular MRS.

2.2.3 The U.S. Environmental Protection Agency (USEPA) has established guidelines for the types of remedial alternatives that should be developed during the detailed analysis stage; they are listed in the NCP (40 CFR 300.430(a)(1)) and are summarized as follows:

- Use treatment to address the principal threats posed by a site, wherever practicable.
- Use engineering controls for low, long-term threats or where treatment is impracticable.
- Use a combination of methods, as appropriate, to achieve protection of human health and the environment.
- Use institutional controls to supplement engineering controls to prevent or limit exposure to hazardous substances, pollutants, or contaminants. The use of institutional controls

shall not substitute for active response measures as the sole remedy unless such active measures are determined not to be practicable.

- Consider using innovative technologies.

2.2.4 The NCP guidance further states that "the development and evaluation of alternatives shall reflect the scope and complexity of the remedial action under consideration" (40 CFR 300.430(e)). Land use is also a consideration in developing alternatives. Due to these factors, only a limited number of alternatives are considered for this FS. In addition to institutional controls (a subset of land use controls which includes education programs), remedial technologies associated with MEC potentially remaining at the MRS include: detection, removal, and disposal. The following sections discuss available and applicable processes for detection, removal, and disposal.

2.3 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

This section provides an overview of the technologies available for remedial actions followed by an evaluation of those technologies. Remedial technologies are grouped as detection technologies, removal technologies, and disposal technologies.

2.3.1 Detection Technologies

Methods for detecting munitions in the subsurface consist primarily of using geophysical instruments such as metal detectors and magnetometers combined with expert knowledge on the characteristics of anomalies produced by subsurface munitions. As shown during the RI, munitions are readily detected at the site using geophysical techniques. Although these geophysical instruments can be successful in finding MEC, only a small percentage of the anomalies identified during the RI resulted in finding actual MEC or CWM (less than 0.4%). Geophysics as a detection technology is very effective for covering large areas of open field and even wooded areas if the vegetation is cleared enough to allow access for the instruments; however, the method is ineffective under structures and in areas where there is significant interference from metal in adjacent structures. Digital Geophysical Mapping (DGM) techniques are described in Chapter 4 of the RI Report and are outlined briefly below.

- A Geometrics G-858 magnetometer was successfully used for DGM during the RI. The Geometrics G-858 magnetometer was operated as a vertical gradiometer with two sensors collecting magnetic field intensity data. The G-858 has been tested on geophysical proveouts (GPOs) and is supported by a database collected over known munitions at known orientations and depths. Although highly suited to the terrain of the Withlacoochee Site and found to be responsive over subsurface munitions, the G-858 also detected a number of false positive anomalies attributed to soil or rocks with a magnetized iron content (known as "hot rock" or "hot soil"). The number of such false positives could potentially be reduced through the use of an instrument with an electromagnetic induction sensor.
- Time-domain electromagnetic induction metal detectors (i.e., Geonics EM61-MK2) are also used for DGM. These instruments are used in combination with GPS systems to provide accurate locations of anomalies or are used fiducially on lanes in grids, where tree canopy blocks GPS coverage. The EM61-MK2 has been tested on geophysical proveouts (GPOs) and is supported by a database of data collected over known munitions

at known orientations and depths. This database allows the use of geophysical system verification (GSV) rather than GPOs and allows the application of more advanced processing. These instruments may be less prone to "hot rock" type false positive anomalies.

- In addition to DGM instruments, analog handheld flux-gate magnetometers (i.e., Schonstedt GA-52CX magnetic locators) and other similar instruments have been used as an investigative instrument for mag-and-dig operations in areas where DGM is ineffective such as adjacent to buildings and other cultural features. Although it can be used closer to surface metal objects and in more rugged terrain than DGM, the analog surveys are also limited by metal in structures and the instrumentation is not as effective as DGM for identifying anomalies for MEC removal in most terrain. The Schonstedt has also been used as part of the intrusive investigation process to help pinpoint metallic anomalies and for anomaly avoidance. Use of an analog handheld instrument that functions through electromagnetic induction that has a ground balancing feature could potentially reduce the number of "hot rock" digs.
- Advanced classification involves collecting and analyzing advanced EMI sensor geophysical data to determine if a detected anomaly represents a potential MEC-like item. These sensors are specifically designed to collect data to determine the size, shape, and electrical properties of buried metal objects. These advanced sensors use a multi-component, three-axis polarizability measurement. Inversion algorithms and software use the advanced sensor data to support physics-based decisions about whether a detected subsurface object needs to be excavated due to a potential explosive risk (MEC-like item) or can be safely left in the ground (non-MEC-like items). Approximately 90% of excavation costs on most MMRP projects are related to characterizing or removing scrap metal that does not represent an explosive hazard. The new generation of geophysical sensors and advanced classification methods has demonstrated ability to reduce the number of excavations of clutter (non-MEC items) by 50% to 90% while still removing the explosive hazards (MEC) from sites. Avoiding unnecessary removal of scrap metal increases the efficiency of MEC removal projects and allows sites to be remediated at a lower cost.

2.3.2 Removal and Treatment Technologies

Removal technologies for MEC include hand excavation supported by mechanical excavation, and mass excavation and sifting (using heavy equipment). The use of heavy equipment for mass excavation and sifting is usually not considered viable because of the level of disturbance to the land (wetland environment) it imposes and its relative cost. With mass excavation, there is also a greater potential for inappropriately contacting a buried munition and causing an unintentional detonation thereby posing a greater safety hazard to site workers. Hand excavation supported by mechanical excavation is considered the industry standard for UXO recovery and can be done very thoroughly and safely. Hand excavation was conducted during the RI. Hand and mechanical excavation is used in combination with a detection technology as described above. Hand or mechanical excavation requires specially trained personnel, who are experienced and qualified to handle and assess military munitions, particularly UXO. Mechanical excavation using equipment such as a backhoe or excavator is used to remove the upper layer of soil allowing access for hand excavation closer to the subsurface anomaly.

2.3.3 Disposal Technologies

Disposal technologies for non-CWM UXO include blow in place (BIP) and 'consolidate and blow', and the use of DoD-approved detonation chambers or explosive destruction systems to destroy munitions with liquid fills. For BIP, each munition is individually destroyed where found; whereas, the consolidated shot can be used for munitions that are "acceptable to move" and are collectively destroyed at one location. Several explosive destruction systems and technologies that offer total containment of blast effects are available for use or are under development. The systems may be mobile or fixed and differ in the processes used to access the munition, to destroy chemical agent, and for off-gas treatment. Three of the technologies are described in detail below:

- The Explosive Destruction System (EDS) is a trailer-mounted mobile system used to destroy explosively configured conventional and chemical munitions that are deemed unsafe to transport and fully contain all effects. The system has been used to destroy conventional and chemical munitions with or without explosive components. The EDS uses explosive linear shaped charges to access the agent cavity and to destroy any energetic materials in the munition. After detonation of the shaped charges, reagents appropriate to the agent to be neutralized are pumped into the vessel and the vessel contents are mixed until the treatment goal has been attained. After the concentration of chemical agent falls below the treatment goal, as determined by sampling the contents of the chamber, the liquid waste solution is transferred out of the chamber into a waste drum. The drummed EDS liquid waste is normally treated further at a commercial hazardous waste treatment, storage, and disposal facility (DDESB, 2010).
- The T-60 is a mobile detonation chamber that can be used with conventional and chemical munitions. The T-60 has three main components: a detonation chamber, an expansion chamber, and an emissions control system. A munition wrapped in explosive is mounted in the detonation chamber. Bags containing water are suspended near the projectile to help absorb blast energy and to produce steam. After the explosive is detonated, the gases are vented to an expansion chamber, then to the emissions control system. A catalytic oxidation unit oxidizes hydrogen, carbon monoxide, and organic vapors from the gas stream before the stream is vented through a carbon adsorption bed and released to the atmosphere (www.defenseindustrydaily.com, 09-Feb-2010). The level of emissions control system required and used will be dependent on the munitions type. The T-60 detonation chamber has the capability to process up to twenty 75mm projectiles and ten 155mm projectiles per 10-hour work day. Secondary waste from the T-60 detonation chamber generally includes non-hazardous metal scrap.
- The D-100 is a fixed detonation chamber and is designed for use with conventional munitions. The D-100 detonation chamber has internal dimensions of 14 feet wide by 16 feet high by 20 feet long, designed to control the heat, pressure, and shock of repeated detonations. Water bags are suspended from the ceiling of the detonation chamber to reduce the heat and pressure inside the chamber. The detonation chamber is connected to a cylindrical expansion tank made of mild steel. Ventilation doors at the rear of the chamber open immediately after detonations to evacuate emissions through the expansion chamber into the air pollution control unit. The air pollution control system consists of a cartridge-type particulate filter with pulsed jet cleaning, followed by an exhaust fan.

2.3.4 Evaluation of Remedial Technologies

The technologies described above have been selected based on their technical implementability. The advantages and disadvantages of the various remedial technologies are described in Table 2-1, along with an evaluation of the applicability of these technologies.

Table 2-1: Evaluation of Remediation Technologies

Technology	Summary	Advantages	Disadvantages	Applicability of the Technology
Detection Technologies				
MEC Detection - DGM using G-858 Magnetometer	• Used for DGM over the survey area using either GPS or fiducials for location control • Identify anomalies consistent with target munitions based on GPO data • Maps of data collected and anomaly selections are available for review • Effectiveness demonstrated at the Withlacoochee site	• Proven and routinely used • Anomaly selection can be tuned to site-specific targets • More portable than EM61-MK2; can be used in a wider variety of terrain • Accepted by regulators	• Brush and understory vegetation may need clearing • Less effective near surface metal or structures including • More prone to detecting magnetized rocks or soil (“hot rocks” or “hot soil”) • Not supported by GSV database and some advanced processing techniques	• Primary detection technology in rough terrain
MEC Detection - DGM using EM61-MK2 Metal Detector	• EM61-MK2 metal detectors used for DGM the entire survey area using either GPS or fiducials for location control • Processing of data to identify anomalies consistent with target munitions based on GPO or GSV data • Maps of data collected and anomaly selections are available for review	• Proven and routinely used technology • Anomaly selection can be tuned to site specific targets, thereby reducing the number of digs (compared to analog methods) • Less prone to detecting magnetized rocks or soil (“hot rocks” or “hot soil”) • Accepted by regulators	• Brush and understory vegetation must be cleared • Not effective near surface metal or structures • Difficult to use on slopes, ditches, and rough terrain	• Primary anomaly detection method (recommended for all areas it can cover effectively)
MEC Detection - Analog Surveys	• Schonstedt GA-52Cx handheld magnetic locator or equivalent instrument including electromagnetic induction instruments • Instrument operators place flags to mark anomalies based on audio output of the instruments, or dig anomalies immediately.	• Proven and routinely used • May be used along ditches, in rough terrain, and closer to structures • Low to moderate cost • Accepted by regulators	• Brush and understory vegetation may need clearing • Effectiveness dependent on the skill and experience of the instrument operator • No record of anomaly locations is available for review • Large number of potential digs produced	• Recommend limiting this technology to areas where G-858 or EM61-MK2 cannot reach (such as close to structures and in rough terrain) and as a support instrument for intrusive investigation and for anomaly avoidance • Use of an analog electromagnetic induction instrument can reduce the number of “hot rock” false positives identified by other methods
MEC Detection - Advanced Detection and Processing Techniques	• EM61-MK2 used for DGM with additional data collection requirements. • MetalMapper or TEMTADS used to evaluate individual anomalies • Advanced processing of geophysical data. • Maps of data collected and anomaly selections are available for review	• Results in fewer false positive anomalies that standard DGM and far fewer than analog methods • Reduced number of digs (offsets higher cost of collecting data)	• Recently developed technology • Brush and understory vegetation must be cleared • Hindered by same restrictions as EM61-MK2 • More costly, requires experience and expertise on the part of the data processors	• The technology is applicable in areas with limited range of munition targets (such as sites with 4.2-inch mortars and EK-4 bomblets) and where there are a sufficient number of anomalies to justify the additional cost of data gathering and processing
Removal and Treatment Technologies				
MEC Removal – Hand Excavation	• Excavation of identified anomalies using hand tools by UXO-qualified technicians to specified depth of investigation • Mechanical excavation may be used to get close to the anomalies but the final distance must be dug by hand. • Individual excavations backfilled and restored to grade	• Proven and routinely used • Good safety record • Soil disturbance limited to anomaly locations only • Accepted by regulators	• Requires specially trained personnel • Safety risk to workers • Costly • No guarantee that all MEC has been removed	• Primary removal technology (recommended for all MEC removal areas at the Withlacoochee Site)

Technology	Summary	Advantages	Disadvantages	Applicability of the Technology
MEC Removal – Mass/Mechanical Excavation	• Excavation of the entire area using armored excavation equipment operated or supervised by UXO-qualified personnel (supervisor Tech II or above) to specified depth of investigation • Soil is typically removed in layers, usually one foot at a time • Soil may be sifted to identify all MEC and MD present • All vegetation must be removed • Soil is backfilled or replaced, and compacted	• Proven and routinely used • All MEC is removed to depth of investigation • Good safety record • Accepted by regulators	• Requires specially trained personnel • Safety risk to workers • All soil must be removed to depth of investigation • Greater environmental impact due to vegetation and soil removal • Not likely to be accepted by landowner • Costly	• Applicability limited to areas of high MEC anomaly density and where terrain is dry and firm enough to support the heavy equipment
Disposal Technologies				
Blow-in-Place (BIP)	• Detonation of UXO in place (where found) using donor explosives and engineering controls such as sand bags; work conducted by UXO-qualified personnel • UXO is guarded until destroyed • Each location has its own detonation	• Proven and routinely used • Hazard is eliminated quickly (in a few days) • Good safety record • Relatively inexpensive • Accepted by regulators	• Requires specially trained personnel • Safety risk to workers • Blast may cause disturbance to the public • MC contamination may be produced by the detonation and left at the ground surface	• Applicable to any non-liquid-filled UXO. (Recommended for munitions that are not acceptable to move or individual munitions that are isolated at a site)
Consolidate and Blow	• Detonation of UXO using donor explosives and engineering controls such as sand bags; work conducted by UXO-qualified personnel • UXO is guarded until destroyed • "acceptable to move" munitions may be consolidated for a single shot	• Proven and routinely used • Hazard is eliminated quickly (in a few days) • Fewer detonations than BIP • Good safety record • Relatively inexpensive • Accepted by regulators	• Triggers RCRA Subpart X • Requires specially trained personnel • Safety risk to workers • Blast may cause disturbance to the public • MC contamination may be produced by the detonation and left at the ground surface	• Applicable to all non-liquid-filled UXO that are "acceptable to move" (in preference to BIP)
Controlled Detonation	• "Acceptable to move" liquid-filled munitions are stored in an Interim Holding Facility until destruction can be arranged (typically at the end of the project) • Munition is placed inside a sealed detonation chamber and either pierced by explosives (shape charges or wrapped in explosives depending on the chamber type). The liquid fill is treated within the sealed container.	• Proven and routinely used • Good safety record • Accepted by regulators • Total containment of blast • May be used for conventional munitions or CWM • Off-gas treatment system, if necessary • Scrap metal is recyclable	• Requires specially trained personnel • Safety risk to workers • Rounds must be guarded and safely stored until destruction can be arranged • Potential for liquid waste • Space requirements • Very expensive • Limited availability • Poor mobility of the equipment	• Applicable to UXO and CWM (including liquid-filled) that are "acceptable to move."

3.0 DEVELOPMENT AND INTITIAL SCREENING OF REMEDIAL ACTION ALTERNATIVES

3.1 DEVELOPMENT OF ALTERNATIVES

3.1.1 Based on the RAOs, the general response actions, and available detection, removal, and disposal technologies for MEC, the following alternatives were developed for consideration:

- Alternative 1: No Action
- Alternative 2: Land Use Controls (Education Program)
- Alternative 3: Remedial Action (MEC Removal on Surface); Land Use Controls (Education Program)
- Alternative 4: Remedial Action (MEC Removal)

3.1.2 The MEC removal depth identified for the six MEC hazard areas in the MRS in Alternative 4 is based on the depth at which MEC or MD were found in each area, or a maximum depth of intrusive land use (36 inches). The alternatives are summarized in Table 3-1 and include the proposed MEC detection, removal, and disposal methods resulting from the screening and evaluation of technologies presented in Chapter 3. Other aspects of remedial alternatives such as preparing education materials, distributing education materials, signs and performing five-year reviews are also listed. Detailed explanations of each alternative and rationale for consideration are presented in the following sections.

Table 3-1: Initial Identification of Response Alternatives for the Test Areas MRS

Alternative	MEC Detection Technologies	MEC Removal Technologies	MEC Disposal Technologies	Munitions Constituents	Other
1 - No Action	N/A	N/A	N/A	N/A	N/A
2 – Land Use Controls (Education Program)	N/A	N/A	N/A	N/A	• Educational Awareness
3 – Remedial Action (MEC Removal at Surface); Land Use Controls (Education Program)	DGM using G-858 or EM61-MK2 Metal Detector	Hand Clearance	• BIP • Consolidate and Blow • Controlled Detonation	N/A	• Educational Awareness
4 – Remedial Action (MEC Removal)	DGM using G-858 or EM61-MK2 Metal Detector with Advanced	Hand Excavation	• BIP • Consolidate and Blow • Controlled	N/A	N/A

Alternative	MEC Detection Technologies	MEC Removal Technologies	MEC Disposal Technologies	Munitions Constituents	Other
	Classification		Detonation		

N/A – not applicable

3.1.3 Five-year reviews, as outlined in Section 121(c) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA), and Section 300.430 (f) (ii) of the NCP, are required for sites (at least every five years) where hazardous substances, pollutants, or contaminants remain at a site above levels that allow unlimited use and unrestricted exposure following the completion of a remedy. Five-year reviews are conducted to 1) ensure that public health, safety, and the environment are being protected by the response actions implemented; 2) verify the integrity of any site controls; 3) determine if new information has become available that may warrant further action; 4) determine if there is an immediate threat to the public or environment that may require an accelerated response; and 5) review decisions for technical impracticability to determine if new technology will address potential MEC safety risk. Data gathered during the review process is used to determine if further action needs to be taken to protect public safety and the environment. If no changes have taken place, the site would continue to be monitored at the specified intervals. At the completion of the review, a Five-Year Review Report is prepared and a public notice is placed in the local newspaper concerning the continued effectiveness of the remedy. In some cases 5-yr reviews are not part of the remedy, but the cost of the 5-yr review—if required—has to be taken into consideration.

3.2 ALTERNATIVE DESCRIPTIONS

3.2.1 Alternative 1: No Action

The No Action alternative means that no action will be taken to reduce the potential explosive hazards posed by MEC. This alternative, if implemented, would involve continued use of the site in its current condition. This alternative will be considered as required by the NCP to provide a baseline for comparing other alternatives.

3.2.2 Alternative 2: Land Use Controls (Education Program)

3.2.2.1 This alternative is comprised of an education program and will be considered for initial screening. The USACE conducted public outreach during the RI, and maintaining public awareness for the hazards that exist within the Test Areas MRS can be facilitated by continuing these methods that have already been proven. Public meetings for the Withlacoochee Site MRS generally have had a low attendance and there are no residences located within the Test Areas MRS, so other methods of distributing the information are recommended. An education program would focus on providing information on the areas containing the MEC hazards and the appropriate response if suspected MEC is encountered. The education program will also provide materials that target recreational users since the site is part of the Withlacoochee Forest and offers many outdoor recreational activities, like hiking, camping, and hunting. These preventive measures would include educational fact sheets that have the goal of modifying behavior to reduce the risk of encountering MEC, to reduce the impact if an MEC encounter occurs, and to ap-

propriately report the find. Letters and fact sheets would be sent to the FFS and FWC as property managers of the Withlacoochee Forest. They would then provide the information to site workers and recreational users of the forest. The fact sheets would contain information including which MEC hazards may remain at the site. Letters with updates would be provided on a periodic basis, corresponding with the five-year reviews. Warning signs would be placed at access points and around the perimeters of the six test areas (spaced approximately 200 ft). Signage is a feasible alternative when a small number of landowners are involved; in this case, the areas of concern are all under the control of the Florida Forest Service. The signs would warn visitors that particular areas may have hazardous munitions remaining. Maintenance would be conducted annually to replace missing or damaged signs.

3.2.2.2 The Public Involvement Plan (PIP) would also be updated to a Community Relations Plan (in accordance with new guidance) in conjunction with the five-year reviews. The PIP provides the framework for public outreach activities that the USACE will use to communicate with the community and address their concerns and expectations. Updating this document will include revising the project summary, updating fact sheets and brochures, updating stakeholder lists, media contacts, and information on the community. Five-year reviews will be conducted over the course of 30 years (six iterations) to analyze the effectiveness of this alternative.

3.2.3 Alternative 3: Remedial Action (MEC Removal at Surface); Land Use Controls (Education Program)

3.2.3.1 This alternative uses a combination of activities to achieve a reduction in the MEC hazards at the surface and also minimizes receptor interaction with MEC at the surface at the MRS. The activities consist of geophysics and intrusive investigations (MEC removal) for the Test Areas MRS (see Chapter 7 of the RI Report).

3.2.3.2 The overall process would begin by obtaining written ROE from the landowner to allow access for the field work. The site would then be prepared for the removal by clearing understory vegetation and brush to allow access for the surface MEC removal teams. Brush clearing may use mechanical brush clearing machines (e.g., bushhog), and hand clearing tools (cutters, chainsaws, mowers, etc.). Generally, trees larger than 6 inches in diameter and ornamental plants are not removed.

3.2.3.3 The objective of the MEC removal is to identify and remove visible MEC on the ground surface at the site. Surface MEC removal is conducted by UXO-qualified technicians using handheld metal detectors to aid the visual identification of UXO and MD. Depth of removal is surface-only regardless of the maximum depth of known receptor pathways or the maximum depth of the UXO and MD found during the RI. Munitions would be destroyed using BIP procedures, if possible, or applicable CWM removal and destruction procedures. Munitions that are acceptable to move could be moved to a nearby designated area for demolition. All MD would be inspected, certified as safe, containerized, and shipped to an offsite smelter for destruction. Because of the potential for CWM, the removal action would be conducted as a CWM operation, employing air monitoring equipment for chemical agents, PPE, personnel decontamination station, onsite medical support, rescue team, and the establishment of a secure Interim Holding Facility to store recovered CWM munitions until disposition of the CWM can be arranged.

3.2.3.4 Land use controls in the form of an education program, similar to that described under Alternative 2, would provide additional protection by providing information to the public con-

cerning MEC hazards at the site. In addition, notices would be published and meetings held to inform site users of MEC removal activities and to help plan for evacuations where needed. It is estimated that one meeting would be held prior to the removal work and one at the end of the field investigation. If the removal action lasts longer than one year, a public meeting will be held once a year until the action is complete. Additionally, five-year reviews will be conducted over the course of 10 years (two iterations) to analyze the effectiveness of this alternative. Reports, fact sheets, and other information would also be placed in the information repository.

3.2.3.5 Under this alternative, visible munitions will have been removed from the surface of accessible areas identified during the RI as containing MEC, potentially leaving MEC in subsurface soil. During the RI, only 1% of investigated anomalies were found at a depth of 1 inch or less, and no MEC were found on the surface. There is also the potential for MEC to remain in areas not investigated during the RI. The education program would help reduce the risk of human exposure to remaining MEC.

3.2.4 Alternative 4: Remedial Action (MEC Removal)

3.2.4.1 This alternative uses a combination of activities to achieve a reduction in the MEC hazards and also minimizes receptor interaction with MEC to maximum depth at the Test Areas MRS. The activities consist of geophysics and intrusive investigations (MEC removal) for the Test Areas MRS (see Chapter 7 of the RI Report).

3.2.4.2 The overall process would begin by obtaining written ROE from the landowner (FFS) to allow access for the field work. Detection and identification of anomalies attributable to MEC is conducted with DGM techniques using the EM61-MK2 or the G858, if needed due to the rough terrain throughout the site. The use of advanced classification DGM will reduce the number of anomalies to be excavated by identifying those anomalies that resemble MEC items. Use of this technology could result in a significantly lower MEC removal cost and provide more cost-effective hazard reduction. It is estimated that at least 75% of the dig list would be eliminated using advanced classification DGM, leading to significantly less intrusive work. DGM is usually combined with GPS in open field areas to obtain accurate locations and with fiducial grids established by surveyors for areas with poor GPS coverage. Geophysical data would be processed and anomalies selected will be based on previous data collected at the former Withlacoochee Site, standardized instrument response curves, GPO test plot data, and other data specific to the munitions being targeted.

3.2.4.3 The objective of the MEC removal is to identify and remove MEC on the ground surface and in the subsurface to a maximum depth based on the deepest potential depth of MEC and depths of potential intrusive activities at the site. As shown in Table 3-2, the depth of typical intrusive activities in the Test Areas (36 inches) is greater than the maximum depth that MEC and MD were found during the intrusive investigations in all areas except for the ATG Range, where MD were found at 40 inches. For this reason, the maximum depth of MEC removal should be based on the maximum depth at which MEC or MD were located in each area, or a maximum of 36 inches. Locations to be excavated would be based on anomalies from DGM data and on anomalies that are flagged using analog instruments. The MEC removal would not be conducted under bodies of water or structures. Munitions would be destroyed using BIP procedures, if possible, or applicable CWM removal and destruction procedures. Munitions that are acceptable to move could be moved to a nearby designated area for demolition. All MD would be inspected, certified as safe, containerized, and shipped to an offsite smelter for destruction. Because of the

potential for CWM, the removal action would be conducted as a CWM operation, employing air monitoring equipment for chemical agents, PPE, personnel decontamination station, onsite medical support, rescue team, and the establishment of a secure Interim Holding Facility to store recovered CWM munitions until disposition of the CWM can be arranged. This alternative would remove the munitions sources from those areas identified during the Remedial Investigation as having munitions hazards. The implementation of this alternative would allow unlimited use and unrestricted exposure.

Table 3-2: Recommended Depth of MEC Removal

MRS Area	Current and Potential Future Intrusive Land Use Activities and Associated Maximum Depths (inches)	Recommended Depth of MEC Removal (inches)
Test Areas	• Forestry: 12-24 • Recreation: <12 • Utility installation: 12-36 • Road maintenance: 12-24	• A and B Forests: 14 inches • D Meadow: 13 inches • F Meadow: 16 inches • ATG Range: 36 inches • NP Forest: 20 inches • G Forest: 16 inches

3.2.4.4 Land Use Controls in the form of an education program, similar to that described under Alternative 2, would provide additional protection by providing information to the public concerning MEC hazards at the site during the removal action. In addition, notices would be published and meetings held to inform site users of MEC removal activities and to help plan for evacuations where needed. It is estimated that one meeting would be held prior to the removal work and one at the end of the field investigation. If the removal action lasts longer than one year, a public meeting will be held once a year until the action is complete. Reports, fact sheets, and other information would also be placed in the information repository. Five-year reviews will not be conducted since the potential of encountering MEC hazards have been removed within accessible areas.

3.2.4.5 Under this alternative, munitions will have been removed from accessible areas identified during the RI as containing MEC, potentially leaving MEC in inaccessible areas covered by swamp. Inaccessible areas would include those areas that are flooded at the time of the removal action. There is also the potential for MEC to remain in areas not investigated during the RI.

3.3 SCREENING OF INDIVIDUAL ALTERNATIVES

3.3.0.1 This section discusses the performance of the four alternatives described in subchapter 3.2 relative to identified screening criteria. The screening criteria include the following:

- **Effectiveness** – the degree to which an alternative reduces the toxicity, mobility, or volume through treatment; minimizes residual risks; and affords long-term protection.
- **Implementability** – the technical and administrative feasibility of implementing the alternative.
- **Cost** – the costs of construction and any long-term costs to operate and maintain.

3.3.0.2 Table 3-3, at the end of this section, provides a summary of the initial screening of the four alternatives and identifies the alternatives that will undergo a detailed comparative analysis as presented in Chapter 4. Table 3-3 also provides the individual information for each of the six MEC hazard areas within the MRS. Detailed explanations of the initial screening of each alternative are presented in the following sections.

3.3.1 Alternative 1 - No Action

Alternative 1 does not provide protection of human health and the environment at the MRS, as it does not reduce potential risk or afford long-term protection. Thus, this alternative does not meet the effectiveness screening criterion. There would be no actions to implement and no costs associated with this alternative. Although this alternative does not meet the effectiveness screening requirement, it will be retained for further evaluation for comparative purposes.

3.3.2 Alternative 2 - Land Use Controls (Education Program)

The Education Program will provide a measure to mitigate potential residual risks to human health and environment. This alternative does not reduce the toxicity, mobility, or volume of potential MEC but it does minimize risks by potentially modifying behavior of visitors and workers. This alternative can readily be implemented within weeks of planning document approval. The cost for implementing the education program alternative for all six areas is $231,200 with an additional cost of $230,400 for five-year reviews over a period of thirty years. The Education Program alternative will be retained for further evaluation because of its ability to help reduce risks from interacting with MEC that may remain at the MRS, its ease of implementability, and low cost.

3.3.3 Alternative 3 – Remedial Action (MEC Removal at Surface); Land Use Controls (Education Program)

Alternative 3 would not meet the effectiveness criteria for residual MEC at the MRS. Because only 1% of the anomalies investigated during the RI were found at a depth of 1 inch or less, very little surface MEC is expected at the Test Areas MRS. Assuming that some surface MEC are discovered and removed as a result of this alternative, there will be a very small reduction in quantity of MEC through their removal. Implementation of MEC removal is technically and administratively feasible, and the skilled labor (i.e., UXO technicians) to implement such a remedy is generally available for the six identified areas of MEC hazard consisting of 249 acres (see Chapter 7 of the RI Report). Implementation of this alternative would provide long-term effectiveness for mitigating explosive hazards due to MEC that is found on the surface only. Workers and recreational users would be evacuated as needed to conduct the removal work, but very few persons would be affected in these undeveloped areas. The cost to implement this alternative for all six areas is $15,810,240 which includes an education program. The field task for this alternative would include site preparation (brush clearing) and surface clearance and would be conducted in approximately 19 months. The five-year reviews would be conducted at the five-year and 10 year mark, with an estimated cost of $230,400. This alternative would not adequately protect human health and the environment from unacceptable risks posed by subsurface MEC. Ninety-nine percent of MEC/MD found at the Withlacoochee Site during the RI was found in the subsurface; therefore, a surface removal action would have only a minimal effect on reducing the potential hazards to human health and the environment. Due to the minimal effectiveness ex-

pected and the high cost for such a small benefit, this alternative will not be retained for further evaluation.

3.3.4 Alternative 4 – Remedial Action (MEC Removal)

Alternative 4 would meet the effectiveness criteria for residual MEC at the MRS. Assuming that MEC are discovered and removed as a result of this alternative, there will be a reduction in quantity of MEC through their removal and destruction. Implementation of MEC removal is technically and administratively feasible, and the skilled labor (i.e., UXO technicians) to implement such a remedy is generally available for the six identified areas of MEC hazard consisting of 249 acres (see Chapter 7 of the RI Report). Implementation of this alternative would provide long-term effectiveness. Workers and recreational users would be evacuated as needed to conduct the removal work, but very few persons would be affected in this mostly undeveloped area. The cost to implement this alternative for all six areas is $37,201,700. The field time associated with this alternative includes field preparation time (brush clearing and digital geophysics mapping), and then the actual removal action, altogether lasting approximately 4.5 years. Alternative 4 will be retained for further evaluation based on the attainability of the effectiveness and implementability screening requirements.

Table 3-3: Summary of Alternatives Considered for Initial Screening

MRS Area	Criteria	Alternative 1* No Action	Alternative 2 LUCs (Education Program)	Alternative 3 Remedial Action (MEC Removal at Surface); LUCs (Education Program)	Alternative 4 Remedial Action (MEC Removal)
Test Areas – Total	**Effective**	No	Yes	No	Yes
	Implementable	Yes	Yes	Yes	Yes
	Cost	$0	$461,600	$15,810,240	$37,201,700
Test Areas – NP Forest Only	**Effective**	No	Yes	No	Yes
	Implementable	Yes	Yes	Yes	Yes
	Cost	$0	$402,200	$3,573,440	$11,178,140
Test Areas – A & B Forests Only	**Effective**	No	Yes	No	Yes
	Implementable	Yes	Yes	Yes	Yes
	Cost	$0	$405,200	$3,783,420	$6,069,120
Test Areas – D Meadow Only	**Effective**	No	Yes	No	Yes
	Implementable	Yes	Yes	Yes	Yes
	Cost	$0	$395,800	$1,873,420	$1,992,820

MRS Area	Criteria	Alternative 1* No Action	Alternative 2 LUCs (Education Program)	Alternative 3 Remedial Action (MEC Removal at Surface); LUCs (Education Program)	Alternative 4 Remedial Action (MEC Removal)
Test Areas – F Meadow Only	**Effective**	No	Yes	No	Yes
	Implementable	Yes	Yes	Yes	Yes
	Cost	$0	$403,000	$4,104,340	$16,536,440
Test Areas – ATG Range Only	**Effective**	No	Yes	No	Yes
	Implementable	Yes	Yes	Yes	Yes
	Cost	$0	$400,600	$2,511,740	$3,706,540
Test Areas – G Forest	**Effective**	No	Yes	No	Yes
	Implementable	Yes	Yes	Yes	Yes
	Cost	$0	$396,200	$2,085,760	$1,613,300

* For baseline comparison purposes only
Recommended for Detailed Analysis

4.0 DETAILED ANALYSIS OF ALTERNATIVES

4.1 INTRODUCTION

4.1.1 The purpose of the detailed analysis is to evaluate and compare those alternatives identified through the initial screening process as requiring further consideration. The alternatives identified for the detailed analysis include the following:

- Alternative 1: No Action
- Alternative 2: Land Use Controls (Education Program **)**
- Alternative 4: Remedial Action (MEC Removal)

A detailed description of each alternative was provided in Chapter 3.

4.1.2 The alternatives were compared and evaluated with respect to seven evaluation criteria developed to address the statutory requirements and preferences of CERCLA. The seven criteria are as follows:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume
5. Short-term effectiveness
6. Implementability
7. Cost

4.1.3 Additionally, two modifying criteria, state acceptance and community acceptance, will be considered. These modifying considerations cannot be fully evaluated and assessed until comments on the FS and the Proposed Plan are received.

4.1.4 Each of the four alternatives were analyzed individually against each criterion and then compared against one another by site to determine their respective strengths and weaknesses and to identify the key trade-offs. The following sections describe each of the evaluation criteria and the evaluation process used for performing the analysis.

4.2 EVALUATION CRITERIA

Alternatives were compared and evaluated using the NCP criteria, including threshold factors, balancing factors, and modifying considerations. The following sections describe the factors and each of the criteria.

4.2.1 Threshold Factors

Threshold factors are requirements that each alternative must meet or have specifically waived (ARARs only) to be eligible for selection.

4.2.1.1 Overall Protection of Human Health and the Environment

The selected alternative must adequately protect human health and the environment from unacceptable risks posed by MEC. In addition, the RAO needs to be achieved by the remedy. The overall protectiveness to human health and the environment was evaluated based on the effect each alternative has on the MEC exposure hazard and environment. Exposure involves three components: the MEC source characteristics, the receptor, and interaction between them. All three components are required for a safety threat from MEC to exist. The protectiveness factor also considers the environmental impact that implementation of an alternative has on the existing environmental/ecological factors at the MRS.

4.2.1.2 Compliance with ARARs

The NCP requires that all project sites comply with ARARs (or that an ARAR waiver be obtained), hence, the ability of an alternative to comply with ARARs is evaluated. The lack of alternative involvement with wetlands or threatened or endangered species habitat precludes the Clean Water Act (CWA) and the Endangered Species Act from being considered ARARs. The CWA is precluded because MEC under swampy terrain would not be removed and access will be limited. Wetland areas in general will be avoided. The ESA is precluded because no T&E species have been observed in or near the areas of MEC hazard and these areas do not contain T&E species habitat (See Chapter 2 of the RI for more details). The substantive requirements of RCRA 40 CFR 264, Subpart X would be an ARAR if munitions are consolidated from other locations rather than BIP. Use of BIP practice exclusively would eliminate the Subpart X requirements from consideration as ARARs; however, field operations require the ability to consolidate munitions for detonation in order to prevent the temporary closing of major public highways such as those adjacent to G Forest an F Meadow. Additionally, CWM will be either destroyed in a Detonation Chamber or if approved and safe to do so, will be transported by the government to an approved destruction facility. For the evaluated alternatives, compliance with ARARs will be required for alternatives that involve demolition of munitions encountered on site.

4.2.2 Balancing Factors

Primary balancing criteria form the basis for comparison among alternatives that meet the threshold criteria. CERCLA requires that alternatives be developed for treating principal threats at the project site through reductions in toxicity, mobility, or volume. In addition, remedies are required to be permanent (e.g., removal of MEC) to the maximum extent practicable, and to be cost effective. The five balancing factors described below are weighed against each other to determine which remedies are cost effective and are “permanent” to the maximum extent practicable. The NCP explains that in general, preferential weight is given to alternatives that offer advantages in terms of the reduction of toxicity, mobility, or volume through treatment, and that achieve long-term effectiveness and permanence. Although the toxicity, mobility, and volume are not strictly relevant to MEC, the quantity and accessibility of MEC can be reduced.

4.2.2.1 Long-term Effectiveness and Permanence

The permanence criterion evaluates the degree to which an alternative permanently reduces or eliminates the potential for MEC exposure hazard. This criterion also evaluates the magnitude of residual MEC hazard with the alternative in place, and the effectiveness of controls to manage the residual hazard.

4.2.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion generally addresses the statutory preference for selecting remedies that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume (TMV) of hazardous substances, or in the case of the Test Areas MRS which has only MEC hazards, that permanently or significantly reduce the potential for exposure to explosives hazards associated with MEC (e.g, removal actions). This preference is satisfied when treatment is used to reduce the principal threats (e.g., explosives hazards) at a site through the removal of the MEC sources still present within the MRS. Non-removal alternatives have negligible impact in reducing sources or associated exposure hazards.

4.2.2.3 Short-term Effectiveness

The short-term effectiveness criterion addresses the potential consequences and risks of an alternative during the implementation phase. Alternatives were evaluated for their effects on human health and the environment prior to the remedy being completed. Short-term risks address adverse impacts to the workers and visitors during the construction and implementation phases of the remedy. Short-term effectiveness also looks at the time each remedy will take to reach remedial goals.

4.2.2.4 Technical and Administrative Implementability

The technical and administrative implementability criterion evaluates the difficulty of implementing a specific cleanup action alternative. The evaluation includes consideration of whether the alternative is technically possible; availability of necessary on-site and off-site facilities, services, and materials; administrative and regulatory requirements; and monitoring requirements.

4.2.2.5 Cost

The cost criterion evaluates the financial cost to implement the alternative. This includes direct, indirect, and long-term management costs (30-year duration). Direct costs are those costs associated with the implementation of the alternative. Indirect costs are those costs associated with administration, oversight, and contingencies. Cost estimates presented are order-of-magnitude level estimates based on a variety of information, including productivity estimates (based on site conditions), cost estimating guides, and prior experience at the site. The actual costs will depend on true labor rates, actual weather conditions, final project scope, and other variable factors.

4.2.3 Modifying Considerations

Modifying considerations are those considerations associated with state and community acceptance. The community and state acceptance criteria are based on the degree of assumed acceptance from the local public and from state agencies regarding the implementation of alternatives. The degree of community participation and specific concerns voiced during the RI provide an indication of community acceptance. These considerations cannot be fully evaluated and assessed until comments on the FS and the Proposed Plan are received.

4.3 INDIVIDUAL ANALYSIS OF ALTERNATIVES

4.3.1 Alternative 1 – No Action

4.3.1.1 Description

The No Action alternative does not implement any response or remedy.

4.3.1.2 Assessment

Threshold Factors

- Protectiveness. Alternative 1 would not be protective of human health and the environment. MEC was identified during the RI in the subsurface of the MRS. A No Action alternative would not eliminate, reduce, or control the threat of human exposure to MEC at the site.
- Compliance with ARARs. There are no ARARs associated with Alternative 1 that would restrict or modify its implementation.

Balancing Factors

- Long-term Effectiveness and Permanence. The No Action alternative includes no controls for exposure and no long-term management measures. All current and potential future hazards would remain under this alternative.
- Reduction of Toxicity, Mobility, and Volume through Treatment. This alternative provides no reduction in volume of MEC.
- Short-term Effectiveness. There would be no additional risks posed to workers or the environment as a result of this alternative being implemented, since no action would be taken.
- Implementability. There are no implementability concerns posed by this remedy, since no action would be taken.
- Cost. The cost of Alternative 1 is $0, since there would be no action. Project closeout costs are considered programmatic costs that are required for all projects, so no cost is included for closeout.

4.3.1.3 Summary

Alternative 1 does not reduce the potential exposure hazard. There would be no protection to human health or the environment as Alternative 1 does not implement a remedy to reduce potential future MEC exposure. No ARARs are associated with this alternative; therefore, Alternative 1 meets this threshold factor. In addition, there is no reduction in volume. Uncertainty exists about the long-term effectiveness of this approach for risk management. No costs are associated with this alternative.

4.3.2 Alternative 2 – Land Use Controls (Education Program)

4.3.2.1 Description

This alternative is comprised of an educational awareness program. An educational awareness program implemented by the USACE would continue to educate the public about the potential hazards (i.e., MEC) associated with the MRS. An educational awareness program would focus on providing information on the areas containing the MEC hazards and the appropriate response if suspected MEC is encountered, with an emphasis on making the information easily available to the many recreational users of the site (i.e., hikers, campers, hunters). Letters and fact sheets would be sent to landowners and site managers (FFS) within the MRS. Signs would be installed around the access points and perimeters of the six MEC hazard areas. The PIP would also be updated to a Community Relations Plan, and will include a revised project summary, updated fact sheets, stakeholder lists, media contacts, and information on the community. Though not part of the remedy, a five-year review would be required for Alternative 2 to monitor and ensure that the remedy is protective of human health and the environment.

4.3.2.2 Assessment

Threshold Factors

- Protectiveness: Since the MEC hazard evaluation concluded that there is potential for human receptors to come into contact with MEC, a complete exposure pathway is still possible if Alternative 2 is implemented. MEC hazards would not be managed by source removal but, instead, through controls to limit an exposure pathway (i.e., limiting interaction). The educational program would address the appropriate response to finding MEC but Alternative 2 cannot completely control behavior. There is also a risk associated with a person who may encounter MEC and has not had exposure to the educational awareness program. This alternative provides a reduced risk for the potential of humans coming into contact with MEC and therefore meets the RAO and the protectiveness criterion for the MRS.
- Compliance with ARARs: There are no ARARs associated with Alternative 2 that would restrict or modify its implementation.

Balancing Factors

- Long Term Effectiveness and Permanence. For Alternative 2, controls for exposure would include long-term management measures such as reassessment of the effectiveness of controls during five-year reviews.
- Reduction of Toxicity, Mobility, and Volume through Treatment. This alternative provides no reduction in toxicity, mobility, or volume of MEC.
- Short Term Effectiveness. There would be no additional risks posed to the community, the workers, or the environment as a result of this alternative being implemented.
- Implementability. There are no implementability concerns posed by this remedy; educational awareness is readily implemented through maintenance and update of the existing public outreach program.

- Cost. The 30-year total present worth cost of this alternative is estimated to be $231,200 which includes $118,400 to conduct the educational awareness program. In addition, a total budget of $230,400 is estimated to conduct recurring five-year reviews. The detailed cost estimate is provided in Appendix A.

4.3.2.3 Summary

Implementation of this alternative achieves the RAO since this alternative provides protection of human health through the reducing the risk of humans coming into contact with explosives hazards (MEC) through an education program. No ARARs are associated with this alternative; therefore, Alternative 2 meets this threshold factor. Although educational awareness can modify behavior to reduce the risk of exposure and long-term effectiveness will be monitored through five-year reviews, there is no source reduction of potential MEC. The cost associated with implementing this alternative is relatively low when compared to the other alternatives.

4.3.3 Alternative 4 – Remedial Action (MEC Removal)

4.3.3.1 Description

This alternative uses a combination of activities to achieve a reduction in the probability of encountering a MEC hazard. The activities consist of a MEC removal to the depth at which MEC or MD were discovered within each area, and implementation of an educational awareness program until the removal is complete. A detailed description of each of these components is included in Chapter 4. The evaluation is summarized in Table 4.1.

4.3.3.2 Assessment

Threshold Factors

- Protectiveness. Overall protectiveness of human health and the environment would be achieved with Alternative 4 through source removal of MEC and through implementation of the education program. A MEC removal would be conducted over the six identified MEC areas with the objective of identifying and removing MEC on the ground surface and in the subsurface. However, MEC removal would be limited to accessible areas. MEC within swampy inaccessible terrain would not be removed. Alternative 4 would reduce the probability of encountering a MEC hazard, thus meeting the RAO.
- Compliance with ARARs. RCRA 40 CFR 262.11, 264 Subpart X (Miscellaneous Units OB/OD) is the ARAR associated with this alternative and Alternative 4 will be compliant. .

Balancing Factors

- Long Term Effectiveness and Permanence. Alternative 4 would meet the long-term effectiveness and permanence criteria through source reduction of MEC.
- Reduction of Toxicity, Mobility, and Volume through Treatment. There would be a reduction of toxicity, mobility, or volume through destruction of MEC; however, munitions in areas inaccessible due to swampy terrain, would not be cleared.

- Short Term Effectiveness. Similar to the tasks undertaken in support of the RI field activities, there would be some danger posed to the field crew by implementing this alternative. The MEC removal would be performed by qualified UXO technicians; however, there is potential to cause an accidental detonation as part of the remedy. Non-essential personnel would be evacuated from the vicinity while digging or demolition operations are being conducted. The duration needed to conduct field activities for this alternative would be 4.5 years.
- Implementability. Alternative 4 would be readily implemented from a technical perspective. There are very few residents located in the MRS and those are state employees, so evacuations, if needed, should not be problematic. This type of remedy is effective and is similar to the RI intrusive investigation activities.
- Cost. The present worth cost of this alternative is estimated to be $40,613,900. These costs include DGM and MEC removal within the six identified areas of MEC hazard in the MRS. A detailed cost estimate is provided in Appendix A.

4.3.3.3 Summary

The RAO is achieved at the MRS through implementation of this alternative, and this alternative provides overall protection of human health and the environment. Compliance with RCRA 40 CFR 264, Subpart X would be required for consolidation of munitions for demolition. The balancing factors of long-term effectiveness, permanence, and reduction of toxicity, mobility, or volume would be achieved through MEC removal. Alternative 4 would be readily implemented from a technical perspective; however, there would be some safety risks posed to the field crew by implementing this alternative. The cost of this alternative would be the most expensive of the four alternatives to implement.

4.4 COMPARATIVE ANALYSIS OF ALTERNATIVES

In the following subchapters, the remedial alternatives for MEC are compared with each other with respect to each of the NCP evaluation criteria (Subchapter 4.2). The purpose of this evaluation is to identify the relative advantages and disadvantages of each alternative. Table 4–1 summarizes the comparative analyses for the MRS; the detailed cost summary is provided in Appendix A.

4.4.1 Overall Protection of Human Health and the Environment

All remedial alternatives identified to address MEC within the Test Areas MRS protect human health and the environment, with the exception of Alternatives 1 (No Further Action), which does not include any remedial technologies and is only included in the FS to provide a baseline for comparison. Remedial alternatives are either protective or not and therefore, no comparison of overall protectiveness is possible.

4.4.2 Compliance with ARARs

All remedial alternatives identified to address MEC at the Test Areas MRS comply with ARARs where applicable. Alternatives 1 (No Action) and 2 (Installation of LUCs) have no associated ARARs. Since MEC may be destroyed during the removal action conducted under Alternative 4, RCRA 40 CFR 264 Subpart X (Subsection 264.601) may apply. Remedial alternatives either comply with ARARs or not and, therefore, no comparison of ARAR compliance is possible.

4.4.3 Long-term Effectiveness and Permanence

Alternative 1 is not effective over the long-term because it does not involve implementing any remedial actions. Alternative 2 is more effective than Alternative MEC 1, but is less effective over the long-term than Alternative 4 because Alternative 2 is limited to the implementation and maintenance of the education program only. Alternative 4 is the most effective over the long-term and the most permanent because it involves removal of the source within areas accessible to the public.

4.4.4 Reduction of TMV

Alternatives 1 and 2 would not achieve any reduction in TMV of explosives hazards because they do not involve MEC removal. Alternative 4 achieves reduction in TMV because it involves MEC removal within accessible areas.

4.4.5 Short-term Effectiveness

Implementation of Alternative 1 would not result in any short-term hazards or other adverse affects to the workers and community because it does not involve any MEC removal; however, this does not account for the potential MEC hazards that might remain as a result of not implementing any remedies at the site. Implementation of Alternatives 2 and 4 would result in short-term hazards to workers involved with the MEC removal activities or the installation of signs because of the increased likelihood of exposure to explosive hazards. Alternative 4 would present the greatest short-term hazards to workers because it involves MEC removal, while Alternative 2 involves the implementation of LUCs only. In all cases, MEC hazards to workers would be managed using industry standard safety procedures (e.g., using qualified UXO personnel, enforcement of safe separation distances, engineering controls, etc.), which would also minimize any associated potential hazards to the surrounding community.

4.4.6 Implementability

Alternative 1 would be readily implementable as no special measures or approvals would be necessary for taking No Action at the site; however, this does not account for stakeholders being unlikely to approve No Action as a remedial alternative. While Alternative 2 and 4 would be more complex to implement than Alternative 1, they would both be more likely to be acceptable to stakeholders because they achieve the RAO established for MEC at the Test Areas MRS. Furthermore, all technologies and methods involved in implementing Alternative 4 are well established and would be readily implementable, assuming they were approved by the relevant stakeholders. Alternative 4 involves surface and subsurface MEC removal, and is more technically complex than Alternative 2, which only involves the implementation of LUCs. Of these three alternatives, Alternative 4 would be the most complex to implement because it involves MEC removal to a depth at which MEC or MD were found – specific to each area.

4.4.7 Cost

There would be no cost involved with implementing Alternative 1 at the Test Areas MRS. The TPV of implementing Alternative 2 (Implement LUCs and Education Program) would be $461,600, while the TPV of implementing Alternative 4 would be $37,201,700. Table 3-3 summarizes costs for all alternatives, and Appendix A provides additional cost information.

4.4.8 State Acceptance

State acceptance cannot be fully evaluated and assessed until comments on the FS and proposed plan are received. However, it is anticipated that Alternative 1 would not be acceptable to the state due to its lack of long-term effectiveness. Alternative 4 would significantly reduce the exposure to explosive hazards through the removal of MEC, but it is anticipated that since this would cause a disturbance to the forest it is least desirable. Alternative 2 is likely to be found acceptable due to the reduction of risk through the installation of LUCs and educational awareness.

4.4.9 Community Acceptance

Community acceptance cannot be evaluated until a proposed plan is prepared and submitted for public comment.

4.5 CONCLUSIONS

4.5.1 The remedial alternatives identified to address MEC within the Test Areas MRS were evaluated against the NCP evaluation criteria. The comparative analysis of alternatives was conducted using the current CSM for the Test Areas MRS, which is based on the present state of knowledge concerning potential contamination and both current and reasonably anticipated future land use. If new information arises concerning contamination conditions at the site or if land uses change beyond what has been assumed, the evaluation of these remedial alternatives may need to be revisited. The five-year reviews conducted for Alternatives 2 and 4 provide a formal mechanism to assess these possible changes, evaluate whether implemented remedies remain sufficiently protective of human health and the environment, and to recommend further steps to be taken if they are not.

4.5.2 The detailed analysis of remedial alternatives conducted in this FS is summarized in Table 4-1. This analysis suggests Alternative 2 would be the most effective and implementable to address MEC hazards within the Test Areas MRS due to its lower cost, implementability, protectiveness over human health, and both short- and long-term effectiveness.

4.5.3 Based on the analyses of remedial alternatives conducted in this FS, a proposed plan should be developed to recommend a preferred alternative for implementation. This preferred alternative should comprise the remedial alternatives favored by the project stakeholders to address MEC only within the Test Areas MRS.

Table 4-1
Comparative Analysis of Remedial Alternatives for Munitions and Explosives of Concern
Test Areas MRS, Withlacoochee Site

Remedial Action Alternative	Threshold Criteria		Primary Balancing Criteria				
	Overall Protection of Human Health and Environment	Compliance with ARARs	Long-Term Effectiveness	Reduction in TMV of Wastes	Short-Term Effectiveness	Implementability	Cost (1)
Alternative 1: No Action	Not protective of human health or environment	Not Applicable	Not effective over long-term	No reduction in TMV of wastes (*no MEC removal*)	No short-term hazards to workers or the surrounding area	Readily implementable (*no actions required*); however unlikely to gain approval	$0
Alternative 2: Land Use Controls (Education Program)	Protective of human health	Not Applicable	Effective over long-term	No reduction in TMV of wastes (*no MEC removal*)	Low short-term hazards to workers and surrounding area (*associated with sign installation*)	Readily implementable; more likely to gain approval than MEC removal	$461,600
Alternative 4: Remedial Action (MEC Removal)	Protective of human health and environment	Complies with applicable ARARs	Most effective over long-term due to the reduction in explosive hazards	Provides greatest reduction in TMV of wastes (*MEC removal*)	Greatest short-term hazards to workers and surrounding area (*MEC removal*)	Readily implementable (*uses well established technologies*) but less likely to gain approval due to impact to forest.	Test Areas Total: $37,201,700

(1) Details of the cost estimates are provided in Appendix A.

Shading shows alternative desirability with respect to that criterion:

Most desirable	Significantly desirable	Moderately desirable	Least desirable

5.0 REFERENCES

CWA (Clean Water Act) (Section 404, 33 CFR 320.4(r) and 40 CFR 230).

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 121(c), as amended by the Superfund Amendments and Reauthorization Act (SARA).

DDESB, 2010 Department of Defense Explosives Safety Board. Technical Paper No. 15, Revision 3, Approved Protective Construction, May 2010.

Endangered Species Act (USC Title 16 chapter 35§1536 (a)(2)).

Engineer Manual (EM) 1110-1-18, Military Munitions Response Process.

Engineer Regulation (ER) 200-3-1, Formerly Used Defense Sites (FUDS) Program Policy, USACE, 10 May 2004 and Errata 1 (4 Dec 2007).

NCP (National Oil and Hazardous Substances Pollution Contingency Plan), (40 CFR 300.430(a)(1)).

RCRA (Resource Conservation and Recovery Act; (40 Code of Federal Regulations (CFR) 262.11, and 264 Subparts I, L and X.

U.S. Army, Military Munitions Response Program (USAMMRP), 2009. Munitions Response, Remedial Investigation / Feasibility Study Guidance, Aug 2009.

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