FINAL

WORK PLANS FOR THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)
FORMER CAMP CROFT, SPARTANBURG, SOUTH CAROLINA

Contract: W912DY-10-D-0028
Task Order: 0005

Prepared for:

US Army Engineering and Support Center, Huntsville

by:

ZAPATA
TRUST • INTEGRITY • QUALITY

6302 Fairview Road, Suite 600
Charlotte, NC 28210

SEPTEMBER 9, 2011

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ACRONYMS AND ABBREVIATIONS

°F	Fahrenheit
AIR	Analog instrument-assisted surface reconnaissance
AM	Action Memorandum
amsl	above mean sea level
AoPI	Areas of Potential Interest
APP	Accident Prevention Plan
AR	Administrative Report
ARARs	Applicable or Relevant and Appropriate Requirements
ASR	Archive Search Report
ATF	Alcohol, Tobacco and Firearms
B&V	Black & Veatch
BATF	Bureau of Alcohol, Tobacco and Firearms
BIP	Blow-in-place
BMP	best management practices
BRAC	Base Realignment and Closure
CAIS	chemical agent identification sets
CD	Compact Disk
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	chemicals of potential concern
CSM	Conceptual Site Model
CWM	Chemical Warfare Materiel
DA	Department of Army
DD	Decision Document

DDESB	Department of Defense Explosives Safety Board
DERP	Defense Environmental Restoration Program
DGM	Digital Geophysical Mapping
DHEC	SC Department of Health and Environmental Control
DIDs	Data Item Descriptions
DMM	Discarded Military Munitions
DNR	Department of Natural Resources
DoD	Department of Defense
DOT	Department of Transportation
DQCR	Data Quality Control Report
DQO	Data Quality Objective
EE/CA	Engineering Evaluation/Cost Analysis
ELAP	Environmental Laboratory Accreditation Program
EM	Engineering Manual
ER	Engineering Regulation
EOD	Explosive Ordnance Disposal
EP	Engineering Pamphlet
EM	electromagnetic
EM	Engineering Manual
ESS	Explosive Safety Submission
EZ	Exclusion Zone
ft.	foot/feet
FUDS	formerly used defense site
GIS	Geographic Information System
gpm	gallons per minute

GPS	Global Positioning System
GSV	Geophysical System Verification
HA	Hazard Assessment
HAZWOPER	Hazardous Waste Operations and Emergency Response
HE	High Explosives
HEAT	High-Explosive Anti-Tank
HFA	Human Factors Applications
HFD	hazard fragmentation distance
HHRA	Human Health Risk Assessment
HTRW	Hazardous, Toxic, and Radioactive Waste
HQ	Headquarters
HZ	Hertz
IAW	In Accordance With
ID	Identification
IDIQ	Indefinite Delivery, Indefinite Quantity
IDW	Investigative Derived Waste
IGD	Interim Guidance Document
in.	Inches
IRTC	Infantry Replacement Training Center
ISO/IEC	International Organization for Standardization and International Electrotechnical Commission
ISO	Industry Standard Objects
LTM	Long Term Monitoring
LUC	Land Use Controls
m	Meters
MC	Munitions Constituents

MDAS	Material Documented as Safe
MEC	Munitions of Explosive Concern
MEC HA	Munitions of Explosive Concern Hazard Assessment
MGFD	Munition with the greatest fragmentation distance
mm	millimeter
MMR	Military Munitions Response
MMRP	Military Munitions Response Program
MPPEH	Material Potentially Presenting an Explosive Hazard
MR	Munitions Response
MRSs	Munitions Response Sites
MRSPP	Munitions Response Site Prioritization Protocol
MSD	minimum separation distance
NC	No Contact
NCAR	Nonconformance and Corrective Action Reporting
NCP	National Contingency Plan
NCR	Non-conformance Report
NOAA	National Oceanic and Atmospheric Administration
NTCRA	Non-time Critical Removal Action
OE	Ordnance and Explosives
OSHA	Occupational Safety and Health Administration
PAO	Public Affairs Office
PDA	Personal Digital Assistant
PDT	Project Delivery Team
PETN	Pentaerythritol tetranitrate
PHT	Project Delivery Team

PIP	Public Involvement Plan
PIRS	Project Information Retrieval System
PM	Project Manager
POC	Point-of-Contact
PP	Proposed Plan
PPE	Personal Protective Equipment
PPK	Post Processed Kinematic
PWS	Performance Work Statement
OASD	Office of the Assistant Secretary of Defense for Public Affairs
OE-CW	Chemical Warfare Design Center
QA/QC	Quality Assurance/Quality Control
QCP	Quality Control Plan
RAGS	Risk Assessment Guidance for Superfund
RA-O	Remedial Action-Operation
RCWM	Recovered Chemical Warfare Material
RI/FS	Remedial Investigation/Feasibility Study
RMAC	Removal Action-Construction
ROE	Right-of-Entry
RSLs	Regular Screening Levels
RTK	Real Time Kinematic
SC	South Carolina
SDSFIE	Spatial Data Standards for Facilities Infrastructure and the Environment
SLERA	screening level ecological risk assessment
SNR	Signal to Noise Ration
SOPs	Standard Operation Procedures

SUXOS	Senior UXO Supervisor
TCRA	Time-Critical Removal Action
TEU	Technical Escort Unit
TM	Technical Manual
TP	Technical Paper
TPP	Technical Project Planning
UFP/QAPP	Uniform Federal Policy/Quality Assurance Project Plan
USACE	US Army Corps of Engineers
USAESCH	US Army Corps of Engineers, Engineering and Support Center, Huntsville
USEPA	United States Environmental Protection Agency
USFWS	US Fish and Wildlife Service
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
UXOSO	UXO Safety Officer
UXOQCS	UXO Quality Control Specialist
VSP	Visual Sample Plan
WAAS	wide area augmentation system
WERS	Worldwide Environmental Remediation Services
WGS 84	World Geodetic System 1984
WP	White phosphorous
WP	Work Plan
ZAPATA	Zapata Incorporated

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1.0 INTRODUCTION

Zapata Incorporated (ZAPATA) submits this plan in response to the Performance Work Statement (PWS; Appendix A) from the US Army Corps of Engineers, Engineering and Support Center, Huntsville (USAESCH) for the Remedial Investigation/Feasibility Study (RI/FS) at the Former Camp Croft in Spartanburg County, South Carolina (SC). The Former Camp Croft is a formerly used defense site (FUDS) within the US Army Corps of Engineers (USACE) Charleston District; the designated FUDS number is I04SC001603 (see Exhibit 1, Appendix B).

1.1 PROJECT AUTHORIZATION

1.1.1 The work required under this PWS falls under the Defense Environmental Restoration Program (DERP) – FUDS Program. All activities regarding personnel, equipment and procedures in areas potentially containing unexploded ordnance hazards will be conducted consistent with requirements of the USAESCH, USACE, Department of Army (DA) and Department of Defense (DoD). 29 Code of Federal Regulations (CFR) 1910.120 also applies to all actions taken at this site. This RI/FS is the Munitions Response (MR) selected for the project site. Work will be conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response action, in accordance with CERCLA and the National Contingency Plan (NCP) to the maximum extent practical, and pursuant to Engineering Regulation (ER) 200-3-1, dated 10 May 2004.

1.1.2 No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely onsite. It is the policy of the United States Environmental Protection Agency (USEPA) and the DA to assure all activities conducted on sites are protective of human health and the environment, and that the requirement to meet (or waive) the substantive provisions of permitting regulations that are Applicable or Relevant and Appropriate Requirements (ARARs) is addressed.

1.2 PURPOSE AND SCOPE

The PWS to conduct a RI/FS at the Former Camp Croft (hereafter referred to as Camp Croft) specifically identifies three Munitions Response Sites (MRSs) and 11 optional sites of varying sizes located within the FUDS boundary but outside of the three MRSs. The three MRSs include the Gas Chamber (MRS 1), the Grenade Court (MRS 2), and the Land Range Complex (MRS 3). Of the 11 optional sites, 10 are defined in the PWS as "Areas of Potential Interest" (AoPI), and one appears to be associated with MRS 3, that being the Lake Craig and Lake Johnson Range Complex. The MRSs and AoPIs were established based on historical range locations at Camp Croft (see Exhibit 2, Appendix B). The AoPIs correspond to areas previously referred to as Ordnance Operable Units (OOUs); those areas include AoPIs 3, 5, 8, 9E, 9G, 10A, 10B, 11B, 11C, and 11D. Eighteen previously defined OOUs exist within or partially within MRS 3; those include OOUs 1A, 1B, 2, 4, 6A, 6B, 7, 9A, 9B, 9C, 9D, 9F, 9H, 10C, 10D, 11A, 12A, and 12B (see Exhibit 3, Appendix B).

1.3 WORK PLAN ORGANIZATION

1.3.1 This work plan is prepared consistent with Data Item Descriptions (DIDs) approved for the Worldwide Environmental Remediation Services (WERS) contract, along with various USACE guidance documents. Specific guidance documents used to develop this work plan and various components of ZAPATA's project-specific operations include;

- DID WERS-001.01 – Work Plans (USAESCH, 2010),
- DID WERS-002.01 – Explosives Management Plan (USAESCH, 2010),
- DID WERS-004.01 – Geophysics (USAESCH, 2010),
- DID WERS-005.01 – Accident Prevention Plan (USAESCH, 2010),
- DID WERS-007.01 – Geospatial Information and Electronic Submittals (USAESCH, 2010),
- DID WERS-009.01 – Munitions Constituents Chemical Data Quality Deliverables (USAESCH, 2010),
- DID WERS-011.01 – Accident/Incident Reports (USAESCH, 2010),
- DID WERS-012.01 – Personnel Qualifications Certification Letter (USAESCH, 2010),
- DID WERS-014.01 – Report/Minutes, Record of Meeting (USAESCH, 2010),
- DID WERS-015.01 – Telephone Conversations/Correspondence Records (USAESCH, 2010),
- DID WERS-016.02 – Periodic Status Reports (USAESCH, 2010),
- DID WERS-017.01 – Institutional Analysis and Institutional Control Plan (USAESCH, 2010),
- DID WERS-018 – Project Management Plan (USAESCH, 2010),
- Engineering Manual (EM) 200-1-2 – Technical Project Planning (USACE, 1998),
- EM 200-1-3 – Requirements for the Preparation of Sampling and Analysis Plans (USACE, 2001),
- EM 200-1-4 – Risk Assessment Handbook: Volume I – Human Health Evaluation (USACE, 1999),
- EM 200-1-4 – Risk Assessment Handbook: Volume II – Environmental Evaluation (USACE, 2010),
- EM 385-1-1 – Safety and Health Requirements (USACE, 2008),
- EM 1110-1-1200 – Conceptual Site Models for Ordnance and Explosives and Hazardous, Toxic, and Radioactive Waste Projects (USACE, 2003),
- EM 1110-1-4009 – Military Munitions Response Actions (USACE, 2007),
- Engineering Pamphlet (EP) 1110-1-18 – Ordnance and Explosives Response (USACE, 2007), and
- EP 1110-1-24 – Establishing and Maintaining Institutional Controls for Ordnance and Explosives Projects (USACE, 2007).

1.3.2 ZAPATA has reviewed DID WERS-001.01 and EM 1110-1-4009 and included interpreted applicable sections in the format listed below. Subsections in the Field Investigation Plan have been grouped into common or specific operational categories and organized to present required elements of work in an approximate chronological order to facilitate communication of the planned work flow.

- Chapter 1 – Introduction
- Chapter 2 – Technical Management Plan
- Chapter 3 – Field Investigation Plan
- Chapter 4 – Quality Control Plan
- Chapter 5 – Explosives Management Plan
- Chapter 6 – Environmental Protection Plan
- Chapter 7 – References

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  - Appendix O – Explosives Siting Plan and Explosive Safety Submission
  - Appendix P – Visual Sample Plan Input/Output
  - Appendix Q – Risk Assessment Work Plan

1.3.3 The following sections referenced in DID WERS-001.01 have been excluded from these work plans; the rationale is provided below.

- Property Management Plan – No Government furnished property will be used for this project.
- Interim Holding Facility Siting Plan for Recovered Chemical Warfare Materiel (RCWM) Projects – This section is only applicable to projects with known RCWM. No RCWM is anticipated at this site.
- Physical Security Plan for RCWM Projects – This section is only applicable to projects with known RCWM. No RCWM is anticipated at this site.

1.4 PROJECT LOCATION

The project site is located in the upstate of South Carolina, less than 10 miles southeast of downtown Spartanburg, SC. The site is roughly bound to the north SC Highway 295, to the east by US Highway 176, to the south by SC Highway 150 and to the west by SC Highway 56. The site can be accessed by taking US Highway 176 south at Exit 72 along US Interstate 85.

1.5 PROJECT PROPERTY DESCRIPTION

1.5.1 The surrounding landscape is consistent with the Piedmont physiographic province, with rolling hills, many tributary channels, and iron-rich clay overburden soils. The FUDS property occupies approximately 19,044 acres, the majority of which includes Croft State Natural Area. Much of the land surface is wooded. The highest elevation is approximately 800 ft above mean sea level. Topography varies only by several hundred feet. There are two man-made lakes within Croft State Natural Area; Lake Johnson and Lake Craig. These lakes total 186 acres and were constructed after the FUDS was transferred to state ownership. The earthen dams constructed to create the lakes used soil from onsite. In addition, Lake Johnson was drained approximately two years ago but, is currently being filled by natural precipitation. It is estimated the lake now only contains about seven acres of water and has a maximum depth of approximately five feet. In contrast, Lake Craig is full and is approximately 30 ft deep at its deepest point.

1.5.2 The Long Range Planning/Growth Monitoring Division of the Spartanburg County Planning and Development Department developed the Spartanburg County Comprehensive Plan in 1998. Information in the following subsections have been taken from that document and supplemented, when necessary.

1.5.3 Topography

Spartanburg County is located in the northwestern part of the state, in what has come to be known as the "Piedmont Crescent". The county lies just southeast of the Blue Ridge Mountains in the piedmont plateau, which is characterized by subdued topographic features and moderate relief. The land surface is inclined to elevations exceeding 1,000 feet in the northwest section of the county to less than 600 feet in the southeast. Hills have a well rounded appearance with no conspicuously prominent ridges or peaks. Valley floors are generally about 100 feet deep with well developed water courses. There are few swamp-like areas. The general slope of the county is southeastward, which is the general direction of the main drainage features. The land ranges from nearly level to steep, but most areas are gently sloping to moderately steep. The highest point in the county, about 1,480 feet above mean sea level (amsl), is on Bird Mountain in the northwestern part. In the central portion of the county, elevation ranges from 750 to 900 feet amsl. In the northern part of the county, a series of hills rises about 200 feet above the surrounding land and does not conform to the general pattern of relief. The lowest elevation is on the Enoree River in the extreme southeastern part of the county near the Union County line (Spartanburg County, 1998).

1.5.4 Geology

1.5.4.1 Thirteen geologic formations are found in Spartanburg County, but over 95 percent of the county is in five major formations. These formations are made up of alluvium, fine-grained rocks, medium-grained rocks, fine-grained to coarse-grained rocks, and coarse-grained rocks. Alluvium consists of material recently deposited on flood plains. The fine-grained rocks are quartzite, diabase, taluca quartz monzonite, and sericite schist. The medium-grained rocks are granite, biotite gneiss, and migmatite. The fine-grained to coarse-grained rocks are biotite schist, Yorkville quartz monzonite, and hornblende schist. The coarse-grained rocks are hornblende gneiss, coarse-grained granite, and muscovite pegmatite dikes (Spartanburg County, 1998).

1.5.4.2 Nearly all of Spartanburg County, except for some small areas in the southeastern part bordering Union County, lies within the Inner Piedmont belt, a major subdivision of crystalline rocks in the Piedmont province. The small area in the southeastern part of the county contains rocks typical of the Kings Mountain belt. In much of the county, the hard crystalline rock has weathered to a soft clayey or sandy material (saprolite), which maintains many of the original rock structures and extends from ground surface to depths of as much as 140 feet (Spartanburg County, 1998).

1.5.5 Climate

1.5.5.1 The county is characterized by a humid, temperate climate. Spartanburg County is located on the lee side of the Appalachian Mountains, which provide protection from the cold air masses that move southeastward during the winter. At Spartanburg, temperatures usually are between 32 degrees Fahrenheit (°F) and 90 °F for eight months of the year; the average daily temperature for the county is about 60 °F.

1.5.5.2 Average annual rainfall is about 50 inches (in.), an amount that exceeds the national average by 20 in. Rainfall is usually well distributed throughout the year. Depending upon location, accumulations may vary from 30 in. in a dry year to over 80 in. in a wet year. Prevailing winds are from the southwest most of the year, but are from the northeast late in summer and early fall. Average relative humidity ranges from 57 percent in winter to 47 percent in April and May. The average relative humidity for the year is approximately 70 percent. Warm weather generally lasts from May into September with few breaks from the heat during midsummer. Temperatures of 90 °F or higher are recorded on an average of 50 days. About 25 percent of the annual rainfall occurs in summer, chiefly in local thundershowers. Fall generally is the most pleasant season, especially from late September to early November. During this period, rainfall is light, the percentage of sunshine is high, and the temperature is generally moderate. About 23 percent of the total annual rainfall is in fall. Winters are mild and relatively short, though about 60 days have temperatures at freezing or below. About 26 percent of the annual rainfall occurs in winter, mainly in steady rains. Spring is the most changeable season. March is frequently cold and windy, but May is generally warm and pleasant. Severe thunderstorms and tornadoes are most likely in spring. About 26 percent of the total annual rainfall occurs in spring (Spartanburg County, 1998).

1.5.5.3 The Southeast Regional Climate Center (http://www.sercc.com), affiliated with the National Oceanic and Atmospheric Administration (NOAA), maintains a database of historic climate information. Based on data collected between November 1962 and December 2010 at the station GRNVL SPART WSO AP (Station No. 383747), a nearby climate monitoring station, the following annual averages are report;

- Maximum Temperature – 71.0 °F
- Minimum Temperature – 49.7 °F
- Total Precipitation – 49.21 in.
- Total Snowfall – 5.2 in.
- Snow Depth – 0 in.

15.5.4 We anticipate fieldwork will be conducted between the months of September and March; average monthly maximums temperatures range from 81.4 °F to 51.0 °F, average monthly minimum temperatures range from 61.5 °F to 31.1 °F, and average monthly precipitation ranges from 3.62 in. to 5.11 in. Snowfall is minimal; the majority of any accumulation occurs in January (2.1 in.) and February (1.6 in.).

1.5.6 Hydrology

Spartanburg County considers water perhaps the single most important natural resource in the county. Abundant supplies of water for industrial and domestic use, as well as relatively easy access to water supplies have allowed the county to sustain population growth.

1.5.6.1 Surface Water

About 40 percent of the average rainfall in Spartanburg County becomes streamflow, or surface water, having excellent quality for domestic, industrial, and agricultural uses. The water is soft and has low concentrations of individual dissolved substances. Some streams in the central part of the county, however, receive waste discharges that increase dissolved solids content and deplete dissolved oxygen. The effect of these wastes is pronounced on the North, Middle, and South Tyger Rivers and on Fairforest Creek (which drains the Croft State Natural Area), particularly at low flow. Temperatures of surface water throughout the county are fairly uniform; changes in temperature at most locations are in response to seasonal weather conditions (Spartanburg County, 1998).

1.5.6.2 Wetlands

The term wetlands means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, bogs, and similar areas. In the northern portion of the FUDS boundary, there are numerous small wetlands and riparian areas identified; those types include Freshwater Emergent, Freshwater Forested/Shrub, Freshwater Pond, Riparian Forested/Shrub (http://www.fws.gov/wetlands/data). Those areas range in size from a 4.79-acre Freshwater Forested/Shrub located south of AoPI 3 to a 0.10-acre Freshwater Pond located north of AoPI 11D, near the FUDS boundary. The southern portion of the FUDS boundary is dominated by numerous larger wetlands, primarily the Freshwater Forested/Shrub type, along Fairforest Creek. The largest wetland in southern portion of the FUDS is 82.85 acres and is located southwest of Lake Craig.

1.5.6.3 Groundwater

Groundwater is the principal source of water for rural homes and farms, some small to medium sized industries, and some supplemental irrigation across the county. The quantity of water available from ground sources is usually less than that which may be obtained from surface water sources. However, the importance of ground water lies in the fact that it is generally of good quality and available in most parts of the county. ZAPATA found no conclusive existing information regarding groundwater quality within the former Camp Croft boundary during the development of this work plan. As a result, groundwater can satisfy the requirements for most domestic, agricultural, and small industrial uses. The consistency of groundwater quality and temperature are additional factors that enhance its utility and economic value. On average, groundwater is soft, slightly acidic, and low in dissolved solids. Well yields range from 1 to 250 gallons per minute (gpm) and average 20 gpm. The average well yield is 53 gpm. Wells in topographically low areas, such as draws and gentle slopes, generally have the highest yields. Wells located on topographically high areas or on steep slopes generally have the lowest yields.

1.5.7 Cultural Sites

There are no known historical/archeological cultural sites within the project property.

1.5.8 Demographics

Demographic data were obtained in May 2011 from the US Census Bureau Quickfacts website (http://www.quickfacts.census.gov). According to that website, the data were derived from Population Estimates, Census of Population and Housing, Small Area Income and Poverty

Estimates, State and County Housing Unit Estimates, County Business Patterns, Nonemployer Statistics, Economic Census, Survey of Business Owners, Building Permits, and Consolidated Federal Funds Reports. Highlights over those data are provided below.

- Population;
  - Population, 2009 estimate – 286,822
  - Population, percent change, April 1, 2000 to July 1, 2009 – 13.0%
  - White persons, percent, 2009 (a) – 75.9%
  - Black persons, percent, 2009 (a) – 20.8%
  - American Indian and Alaska Native persons, percent, 2009 (a) – 0.3%
  - Asian persons, percent, 2009 (a) – 2.0%
  - Persons reporting two or more races, percent, 2009 – 1.0%
- Education and Other
  - High school graduates, percent of persons age 25+, 2000 – 73.1%
  - Bachelor's degree or higher, pct of persons age 25+, 2000 – 18.2%
  - Persons with a disability, age 5+, 2000 – 53,655
- Housing and Income
  - Housing units, 2009 – 123,499
  - Median value of owner-occupied housing units, 2000 – $91,100
  - Median household income, 2008 – $45,000
- Business
  - Private nonfarm establishments, 2008 – 6,605
  - Private nonfarm employment, 2008 – 120,639
  - Manufacturers' shipments, 2002 ($1,000) – 9,831,728
  - Wholesale trade sales, 2002 ($1,000) – 3,127,193
  - Retail sales, 2002 ($1,000) – 2,724,038
  - Accommodation and foodservices sales, 2002 ($1,000) – 299,561
- Geographic
  - Land area, 2000 (square miles) – 810.93
  - Persons per square mile, 2000 – 312.9

1.6 PROJECT PROPERTY HISTORY

1.6.1 On November 4, 1940, the War Department announced that a new training center would be located in Spartanburg County, South Carolina. Camp Croft Infantry Replacement Training Center (IRTC) was officially activated on January 10, 1941, with housing for 20,000 trainees and support personnel. Camp Croft IRTC consisted of two general areas: a series of firing ranges and a troop housing area with attached administrative headquarters. Camp Croft IRTC served as one of the Army's principal IRTCs; approximately 250,000 soldiers were trained. Camp Croft was also a prisoner of war camp during World War II. The installation was declared surplus to the Army's needs in November 1946 and excessed to the War Assets Administration in 1947.

1.6.2 The Former Camp Croft was used for a variety of purposes. It had at least eleven live ammunition-training ranges used for small arms ammunition, anti-tank rockets, anti-aircraft artillery, 60-millimeter (mm) infantry mortars, and 81mm infantry mortars. The training range impact areas comprised a total of 16,929 acres. The camp also had a grenade court (approximately 175 acres).

1.7 CURRENT AND PROJECTED LAND USE

1.7.1 During the development of the Comprehensive Plan, Spartanburg County categorized land uses by major type, i.e., residential, commercial, industrial, agricultural, woodland, etc. As of the late 1990's, over one-half of the county was in woodlands of various ownerships. Approximately one-quarter of the county was in farmland, and nearly one-quarter in urban/built up land. The South Carolina Department of Natural Resources (DNR) prepared in 1992 a digital land cover map of the state, including Spartanburg County. Land cover in Spartanburg County generally is divided on the map into four broad categories; those include Agricultural/Cropland, Urban/Built up land, Mixed Forest (woodland), and Deciduous Forest (woodland). From an aerial perspective, these four land use groups present a physical form. The urban/built up land form represents a continually changing land mass, running into agricultural, grasslands and forested areas, continually altering its boundaries in response to changes wrought by growth and development (Spartanburg County, 1998).

1.7.2 Croft State Natural Area occupies 7,054 acres of the 19,044-acre FUDS property. The majority of the park is open to the public although access is controlled by maintaining various roads and trails and restricting off-trail activities. The primary activities conducted at the park include hiking, mountain biking, fishing, boating, and equestrian. The park hosts a horse shows on the third Saturday of each month between February and November. Bow hunting is allowed during three two-day sessions between September and November. It is not anticipated that site usage at Croft State Natural Area would change unless RI/FS findings indicated an immediate need to do so. Land used for the remainder of the FUDS property (approximately 11,990 acres) is composed of industrial, agricultural, commercial, residential and private ownership. It is likely those types of land use will continue in the future.

1.8 PREVIOUS INVESTIGATIONS OF THE PROJECT PROPERTY

Since the early 1990's, many investigations and removal actions have been conducted at various locations within the former Camp Croft property. ZAPATA reviewed the documents listed under the Reference section herein to support our proposed approach. Highlights of the previous site activities are provided below.

- The USACE verified that the property was FUDS-eligible in a November 1991 Findings of Fact Memorandum.
- The USACE, Rock Island District prepared an Archives Search Report in 1993.
- Two Engineering Evaluation/Cost Analysis (EE/CA) Reports were completed by various contractors; one in 1996 and another in 1998. The Phase I EE/CA investigation included OOUs 1A, 1B, 2, 3, 4, 5, 6, 7, and 8. The Phase II EE/CA investigation included OOUs 9 (A – H), 10 (A – D), 11 (A – D), 12 (A and B), and an expanded area of OOU 3.
- OOU3 was the location of the grenade court. Environmental Science & Engineering, Inc. completed two Engineering Evaluation/Cost Analysis (EE/CA) reports (Phase I and Phase II) for various portions of the former Camp Croft. OOU3 (Wedgewood subdivision) was previously investigated as part of the Phase I EE/CA and expanded to include additional areas (OOU3 Buffer Parcels) during the Phase II EE/CA after discovery of MKII hand grenades during a March 1997 removal action.
- OOU3 is located in the former cantonment area, north of the current Croft State Natural Area. Munitions debris including practice grenades, and 2.36-inch rocket fragments were found in OOU3 during the Phase I EE/CA. During a removal action conducted in March

1997, seven MKII fragmentation grenades were recovered, as well as numerous practice hand grenades and grenade parts.

- UXB International and ZAPATAENGINEERING (later Zapata Incorporated, ZAPATA) have previously cleared ordnance from portions of OOU3 under separate contracts. UXB cleared the original set of OOU3 grids with the exception of several pits in two of the grids. ZAPATA later cleared these pits plus several Buffer Parcels.
- ZAPATA's field operations within OOU3 occurred during January 2005 and January 2006. The investigation included clearing three small pits in Grid 17 and one small pit in Grid 40. Clearance activities were also conducted in select OOU3 Buffer Grids/Parcels (40P, GC2, 35P1, 35P2, 35P3, 35P4, 33P, 32P, 31P, and 29P). The January 2005 and January 2006 fieldwork resulted in unearthing and disposal of 24 M15 white phosphorous grenades, one M15 fuze, eight MKII practice grenades, and four MKII fragmentation grenades. Prior to the January 2005 and January 2006 field efforts, 12 M15 white phosphorous grenades were excavated from one of the pits in Grid 17 and 150 pounds of smoke canisters were excavated from the pit in Grid 40.
- OOU10 includes 210 acres of Croft State Natural Area where munitions debris was found during the Phase II EE/CA Investigation. Munitions debris found within the park that were indicative of high order detonations include grenade, mortar, and rocket parts. OOU10 is subdivided into four sectors based on their physical location. Sector 10A includes approximately 157 acres in the northwest corner of the Croft State Natural Area; Sector 10B includes approximately 37 acres in the northeast corner of Croft State Natural Area. Sector 10C includes approximately 11 acres along the entrance road to the park on the east side of Croft State Natural Area. Sector 10D includes 5 acres located near Dairy Ridge Road on the western side of the site. The property within OOU10 is administered by the South Carolina Parks Department.
- OOU11 includes 87 acres outside of Croft State Natural Area where munitions debris was found during the Phase II EE/CA investigation. Munitions debris found in OOU11 includes grenade, mortar, and rocket parts. OOU11 is subdivided into four sectors based on physical location. Sector 11A includes approximately 25 acres west of Croft State Natural Area on the west side of Whitestone Road. Sector 11B includes approximately 31 acres north of Croft State Natural Area and southeast of the intersection between Route 295 and Henningston Road. OOU11C includes approximately 17 acres and is located west of Cedar Springs Drive, due northwest of OOU3. OOU11C is partly residential and partly undeveloped, wooded property, where M9 rifle grenade fragments have been found at depths of 13 inches below ground surface. OOU11D includes 14 acres and is located between Keltner Avenue and East Croft Circle, north of OOU3. The area is privately owned and developed for use as a golf course. The area is a suspected former grenade range. Some of the outlining area around OOU11D is wooded and may require some brush clearing. Practice grenades at depths of three inches have been recovered in OOU11D.
- OOU12 includes 94 acres outside of Croft State Natural Area where live UXO was found during the Phase II EE/CA investigation. OOU12 is subdivided into two sectors based on physical location. Sector 12A, includes approximately 78 acres north of the Croft State Natural Area on the southeast of the intersection between Dairy Ridge Road and State Route 295. Sector 12B includes approximately 16 acres located south of Croft State Natural Area and west of Forest Mill Road.

- ZAPATA established and maintains the project website (http://www.campcroft.net), a toll-free telephone number for the community, an electronic document repository, and the Information Repository at the Spartanburg County Public Library.
- ZAPATA conducted a MEC clearance at OOU6 (now referred to as AoPI 6) in 2002. This effort involved coordination with a US Air Force research team from Tyndall Air Force Base; a robotic bulldozer and mechanical sifter were used to clear approximately four acres of sloped landscape.
- Over the last two years, ZAPATA has conducted digital geophysical mapping in OOU3 (AoPI 3) and OOU 11C (AoPI 11C). ZAPATA supported the USACE efforts to obtain rights-of-entry (ROE), which included participating in numerous meetings/discussions to minimize the financial impact to The Creek Golf Club.
- In 2010, ZAPATA conducted a MEC clearance at OOU 11C (AoPI 11C); results of that work are not yet published. ZAPATA recently conducted a MEC removal of priority anomalies in the expanded OOU 3 (southwest of the AoPI 3); that work was conducted in January 2011.

1.9 INITIAL SUMMARY OF MEC RISK

An Archives Search Report (ASR) was completed by the USACE, Rock Island District in September 1993. The ASR documents previous site investigations; those include a Site Survey of Camp Croft conducted in 1984, a Site Screening Investigation performed in 1990, and a Preliminary Assessment completed in 1991. An ASR Supplement was completed by the USACE, Rock Island District in November 2004. The ASR Supplement documented the type, size, configuration, location, munitions used, and preliminary risk (among other details) at numerous ranges at Camp Croft. The ASR and ASR Supplement indicate that, in addition to various small arms, a variety of MEC was used at Camp Croft. No evidence of contamination by Chemical Warfare Materiel (CWM) or CWM components has been confirmed. Reported encounters with MEC at the site confirm that a variety of munitions were used at Camp Croft and that some MEC does not match documented use at some ranges. The following list includes, but is not limited to, MEC items of concern that have been identified as likely to be present at Camp Croft. Each of the items listed poses a potential explosive hazard to the public and RI/FS personnel.

- Grenade, CN-1, ABC-M25A1
- Grenade, Hand, MK II
- Grenade, Practice Hand, M21
- Projectile, 60 millimeter (mm), High Explosive (HE), M49
- Projectile, 60mm, Illumination, M83
- Projectile, 60mm, Smoke, WP, 302
- Projectile, 60mm, Practice, M50A2
- Projectile, 81mm, HE, M43
- Projectile, 81mm, HE, M56
- Projectile, 81mm, Illumination, M301A2
- Projectile, 81mm, Smoke, WP, M57
- Rifle Grenade, Anti-Tank, M9A1
- Rifle Grenade, Practice, M11A2
- Rocket, HEAT, 2.36-inch, M6A1

- Rocket, HEAT, 2.36-inch, M6A3
- Rocket, Practice, 2.36-inch, M7A1
- Rocket, Practice, 2.36-inch, M7A3
- Other (Items encountered during investigations subsequent to ASR/ASR Supplement
  - Mortar, 4.2-inch
  - Projectile, 37mm, APT
  - Projectile, 57mm
  - Projectile, 105mm, M84
  - Projectile, 155mm

1.10 POTENTIAL FOR PRESENCE OR ABSENCE OF MC

1.10.1 ZAPATA examined the information documenting previous investigations and removal actions available on the Camp Croft website, along with our own investigation results. Through that process, it has become apparent that MC has not been assessed during previous activities at Camp Croft. Limited MC sampling is prudent for a defensible RI/FS and may be necessary to satisfy CERCLA requirements.

1.10.2 Based on the potential MEC items listed in the initial summary of MEC Risk (Section 1.9), explosives constituents, including Pentaerythritol tetranitrate (PETN) and Nitroglycerine, selected metals (antimony, copper, lead, and zinc), and/or white phosphorus (WP) may be present at locations within the project site. Explosives constituents and WP typically degrade when exposed to the environment for considerable lengths of time. We do not anticipate these constituents will be measured at concentrations that exceed selected screening levels. However, we intend to collect discrete samples at locations where high concentrations of explosives constituents (and selected metals) may likely exist; i.e., target areas, if those areas are encountered. We do not intend to collect samples for WP analysis and will only collect samples for analysis for WP if findings indicate the high likelihood that WP exists (e.g., if we encounter a cache of 81mm, Smoke, WP, M57). If such events occur, ZAPATA will issue a field change request to add sampling and analysis procedures to this work plan.

1.10.3 The presence of chemical of potential concern is unknown. Thus, ZAPATA will perform a human health risk screening and a screening level ecological risk assessment. Further human health and ecological risk assessment details are provided in Sections 3.4.12.2 and 3.4.12.3, respectively.

1.11 CHEMICAL WARFARE MATERIEL (CWM)

There is no documented use of chemical warfare materiel (CWM) at Camp Croft and no evidence of use has been encountered during previous investigations. If CWM are encountered, ZAPATA will temporarily stop work, notify the USAESCH, and respond as directed by the USAESCH contracting officer.

1.12 CONCEPTUAL SITE MODEL

1.12.1 Fifteen Military Munitions Response (MMR) areas have been identified in the Archive Search Report (ASR; USACE, 1993) and ASR Supplement (USACE, 2004). Three of those areas correspond to the three designated MRSs (i.e., the Gas Chamber, Grenade Court, and the Range Complex). The Range Complex (MRS 3) is composed of Lake Johnson and Lake Craig and 12 sub-ranges. Those sub-ranges are generally referred to in the ASR Supplement as Rifle, Landscape, Anti-aircraft Miniature, Pistol, Machine Gun, Mortar, Anti-tank, Moving Target, and Combat Ranges. For 10 of the 12 sub-ranges, documented ordnance use was limited to small arms ammunition. Documented use at two ranges situated near the intersection of Dairy Ridge Road and SC Highway 56 (Ranges 9 and 11) included all types of 60mm and 81mm mortars, 37mm and 57mm projectiles, rifle grenades and 2.36-inch rockets. ZAPATA reviewed investigation and removal action documents and compared findings in those documents with the information provided in the ASR and ASR Supplement. ZAPATA identified discrepancies between documented ordnance types and actual findings in numerous locations, examples include the following:

- Sub-range 8 (Machine Gun Range; small arms, general and 0.50 caliber) – Grenade fragments, rifle grenades, 2.36-in. rocket motors, 37mm projectiles, and 60mm and 81mm mortars have been found at various locations;
- Sub-range 9 (Mortar Range; 60mm and 81mm mortars) – 37mm and 57mm projectiles and grenade fragments have been found at various locations;
- Sub-range 10 (1000” Anti-tank; small arms, general) – 37mm and 57mm projectiles have been found at various locations;
- Sub-range 11 (Moving Target; 2.36” HEAT and rifle grenade) – 37mm and 57mm projectiles have been found at various locations; and
- Sub-range 15 (Combat Range; small arms, general) – Grenade fragments, 60mm and 81mm mortars, and 105mm hexachlorethane smoke rounds were recovered at OOU6.

1.12.2 These discrepancies represent a potentially serious misunderstanding of how the former ranges may have been used or the exact extent of the range fans and thus, these areas should be more closely evaluated. Furthermore, MD and MEC have been found at areas outside of range fans (e.g., OOU9H, OOU10B, and OOU11B). Anecdotal information provided through the existing Restoration Advisory Board (RAB) from local residents, supports the notion that munitions-related items may be found beyond range fans and close to the FUDS boundary; two residents have independently indicated that items may be located along Fairforest Creek where that creek intersects South Carolina Highway 150. ZAPATA developed a preliminary Conceptual Site Model (CSM) to better understand the historical range usage (see Table 1). The preliminary CSM represents a summary of recent site findings/information used to design our approach.

2.0 TECHNICAL MANAGEMENT PLAN

2.1 PROJECT OBJECTIVES

2.1.1 The objective of this task order is to achieve acceptance of Decision Documents (DD) at the Gas Chamber MRS (FUDS Project No. I04SC0016-03R01), Grenade Court MRS (FUDS Project No. I04SC0016-03R02), and Land Range Complex MRS (FUDS Project No. I04SC0016-03R03) at Camp Croft by 31 January 2013 in compliance with factors listed in 40 CFR 300.430(d)(2), the CERCLA, DoD, U.S. Army and USACE regulations. The outcome of the RI may indicate additional MRSs which will require DDs for each. ZAPATA will meet this objective by designing and completing a RI, evaluating those results and reporting that evaluation in a FS, and documenting decisions made by stakeholders in a DD.

2.1.2 The RI for Camp Croft is an iterative process comprised of Scoping, Site Characterization, and Alternative Analysis. ZAPATA will accomplish this process by executing the following activities.

- First, ZAPATA will focus on analyzing existing data, confirming the specifics related to current land use, reviewing regulatory ARARs, developing MEC and MC comprehensive CSMs, establishing data quality objectives (DQOs) and preparing project plans.
- Then, ZAPATA will collect sufficient data to characterize MEC and MC as defined by the DoD in the Final Munitions Response RI/FS Guidance.
- Finally, ZAPATA will evaluate data (those collected under this RI along with previously collected data), identify ARARs, perform a baseline risk/hazard assessment, and report those finding.

2.1.3 Through the course of ZAPATA's investigations, if contamination (munitions or chemical) is discovered in soil, sediment, surface water, or groundwater and that contamination is determined to be attributable to the Department of Defense through activities conducted on the property during ownership, ZAPATA will attempt to determine the source, nature and extent of that contamination to the extent required under CERCLA for remedial investigations.

2.2 MANAGEMENT STRUCTURE AND ORGANIZATION

The project delivery team (PDT) assembled to facilitate the completion of the RI/FS process for the former Camp Croft project includes the USACE, Charleston District, the USAESCH, ZAPATA, and representatives from the South Carolina Department of Health and Environmental Control (DHEC) and Croft State Natural Area. The roles and responsibilities of USACE, USAESCH and ZAPATA team members are provided below.

2.2.1 United States Army Corps of Engineers, Charleston District

The USACE, Charleston District is the Geographic Project Manager for the RI/FS. Responsibilities include coordination for site access; review of project work plans and documents, communication with the news media and public, and coordination with state and local regulatory agencies.

2.2.2 United States Army Engineering and Support Center, Huntsville

USAESCH is the implementing agency and has approval authority for project execution. The USAESCH will provide expertise for MEC-related activities whose responsibilities include direction of the contractor, control of the budget and schedule, and coordination of document reviews.

2.2.3 Zapata Incorporated

2.2.3.1 ZAPATA will perform project management activities necessary to maintain project control, including the maintenance of a Project Schedule in Microsoft Project. The schedule will be adjusted and refined during the Technical Project Planning (TPP) process and updated accordingly. Monthly progress reports will be submitted to the USACE Project Manager in accordance with DID WERS-016.02, Periodic Status Report. Project documentation will consist of, but not be limited to, all project correspondence both formal and email, contracts, modifications, and deliverables of all types. Upon completing all task elements, ZAPATA will prepare and submit a letter signed by an officer of the company certifying, on behalf of ZAPATA, that the requirements of the awarded task order have been met.

2.2.3.2 The Project Manager will be responsible for developing project schedules and budgets and ensuring that all deliverables satisfy project requirements and are conducted in accordance with applicable guidance. Adherence to our standard procedures (SOPs) will ensure quality deliverables. In addition, the Project Manager will coordinate appropriate activities to ensure mitigation measures are implemented to minimize project risk. Field Personnel will be comprised of UXO-qualified individuals and environmental scientists and technicians. All UXO personnel meet requirements established in DDESB TP 18 (DDESB, 2004). All ZAPATA site personnel will have OSHA 40-Hour or 24-Hour HAZWOPER training. Subcontractors will 24-Hour HAZWOPER training, unless escort by those individuals with 40-Hour HAZWOPER training is deemed acceptable by the USAESCH.

2.2.3.3 Black & Veatch (B&V), our teaming partner, will conduct the human health and ecological risk assessment. Accutest Laboratories, TestAmerica, SAEDACCO, Summit Engineering, and Clean Management will support ZAPATA by providing data analysis, monitoring well installation and soil boring (if required), surveying, and investigative derived waste (IDW) disposal services.

2.3 PROJECT PERSONNEL

The following paragraphs list key positions deemed essential in the successful execution of this project along with the experience of individuals filling these positions; an organizational chart is provide in Figure 1. If an individual selected for a key position is not available due to other operational commitments, ZAPATA will submit a request for approval of an alternate, equally-qualified individual to the USACE. Those key personnel listed below were also key contributors to the development of these work plans.

2.3.1 Project Manager

Mr. Jason Shiflet, P.G., is a Professional Geologist that has worked on a wide variety of environmental and Military Munitions Response Program (MMRP) projects since 1998, including RI's, RI/FSs, EE/CAs and Removal Actions. ***Mr. Shiflet will serve as the single point-of-contact (POC)*** and will participate in all TPP meetings and will be available to meet with key decision-makers at Camp Croft in coordination with the USACE for oversight of fieldwork. He has managed MMRP projects under DERP-FUDS, CERCLA, and other State/Federal regulatory guidelines. His experience includes environmental, MEC, and geophysical data collection and analysis, risk assessment, knowledge of regulatory requirements, technical report preparation and submittal, and regulatory interface. He has participated in site investigation and removal actions at Camp Croft and is currently the Project Manager for the RI/FS at the former Opa Locka Army Airfield in Miami, Florida. Mr. Shiflet earned his B.S. and M.S. in Geology from Clemson University and the University of Georgia, respectively, and is currently a Ph.D. Candidate at the University of North Carolina at Charlotte.

2.3.2 Munitions and Explosives of Concern Program Manager

Mr. Michael Winningham is ZAPATA's Vice President and Program Manager of Munitions Response Services and will serve as our team's MEC Technical Advisor. Mr. Winningham has more than 22 years of experience in field actions and MEC project management. Mr. Winningham's expertise in methods for remediating MEC and full knowledge of Army regulations for MEC/CWM operations will ensure the achievement of the Department of Defense cleanup goals. As the Program Manager, ***Mr. Winningham will serve as the alternate POC*** and oversee contract compliance for cost, schedule, and quality. He will also be available to review deliverables and coordinate with USACE on issue resolution in coordination with ZAPATA's PM.

2.3.3 Geographic Information Systems Manager

Mr. Tim Burkett, GISP, has over 15 years experience providing GIS, database, and mapping support and services for a wide range of projects. Mr. Burkett has extensive knowledge with GIS software and technologies and has managed numerous IT based projects to include web-based, database development and integration.

2.3.4 Senior Geophysicist

Mr. James F. Hild, P.G., has provided project management for more than 120 MEC geophysical surveys including at OOU3 and OOU11C. He has over 28 years of experience in the planning, implementation, and interpretation of geophysical, geological, and geotechnical programs. Mr. Hild earned his M.S. and B.S. in Geology, from Rensselear Polytechnic Institute in Troy, New York.

2.3.5 Senior Risk Assessor

Mr. James Eldridge with B&V has over 25 years of experience in environmental and natural resources management. He has managed or participated in a variety of projects, including ecological evaluations, human health and ecological risk assessments, and biological sampling at numerous sites including five RI/FS projects in support of ZAPATA at MEC sites throughout the United States under this IDIQ contract for USACE. Mr. Eldridge has extensive knowledge of heavy metal ecotoxicology and bioavailibility to aquatic and terrestrial receptors and is very familiar with fate transport mechanisms of a variety of contaminants. Mr. Eldridge earned his M.S. in Environmental Science from the Washington State University, and holds a B.A. in Biology. Mr. Eldridge will participate in the TPP meetings and be available to discuss past findings with key decision-makers at Camp Croft and the USACE.

2.3.6 Senior Unexploded Ordnance Supervisor (SUXOS)

Mr. Jeffery (Jeff) Schwalm (UXO Database #0052) will be ZAPATA's SUXOS and Field Operations Manager. Mr. Schwalm is a retired Air Force Master EOD Technician, a graduate of the Basic Explosive Ordnance Disposal Course, and has more than 37 years experience, with 17 years as a SUXOS. He has held numerous UXO field management positions on munitions response (or related) projects for the USACE, including the Former Camp Croft.

2.3.7 Unexploded Ordnance Quality Control Specialist (UXOQCS)

Mr. Terry Farmer (UXO Database # 0759) will be ZAPATA's UXOQCS. Mr. Farmer has served in that capacity for all of the clearance activity at Camp Croft since 2005. Mr. Farmer served as an active duty Master EOD technician for 18 years, graduated from the Basic Explosive Ordnance Disposal Course, and has more than 35 years experience in the EOD/UXO field, with eight years as a SUXOS, UXOQCS, or UXOSO. Mr. Farmer has participated in and managed all aspects of MMRP projects for the USACE, including Camp Croft.

2.3.8 Unexploded Ordnance Safety Officer (UXOSO)

Mr. Timothy (Tim) Hendrix (UXO Database #0105) will be ZAPATA's UXOSO. Mr. Hendrix is a US Air Force EOD retiree, a graduate of the Basic Explosive Ordnance Disposal Course, and has more than 30 years experience, with 17 years as a Senior UXO Supervisor. Mr. Hendrix has served as SUXOS, UXOSO, and UXOQCS on numerous munitions response projects for the USACE across the United States, including multiple projects at the Former Camp Croft.

2.4 COMMUNICATION AND REPORTING

ZAPATA will communicate with USACE and USAESCH personnel using various media, including email, telephone and hard-copy letter. Unless otherwise directed, ZAPATA will not communicate directly with persons outside the USACE and USAESCH. Two exceptions include current members of the project delivery team; i.e., Susan Byrd of SC DHEC and John Moon of the Croft State Natural Area. The USACE and/or USAESCH will be copied on all communication with either Ms. Byrd or Mr. Moon. Direct and conference telephone calls that include substantive information will be documented in accordance with DID WERS-015.01, Telephone Conversations/Correspondence Records (USAESCH, 2010). Meetings will be documented in accordance with DID WERS-014.01, Report/Minutes, Record of Meeting (USAESCH, 2010). All communication documents are stored electronically on ZAPATA servers and provided to the USAESCH at the conclusion of the project, or earlier if requested.

2.5 DELIVERABLES

Specific deliverables under this task order are identified in the General Requirements presented in Section 3.0 and listed in the PWS (Appendix A). These documents will undergo technical and compliance reviews, which will be documented on the Document Review Form (Appendix F). Unless otherwise directed, ZAPATA will ship hard copies of the deliverables to directly to the USACE, Charleston District and USAESCH, to be dispersed accordingly to PDT members and others, as appropriate.

2.5.1 Task Deliverables

The following major deliverables will be tracked by ZAPATA during execution of the project. The calendar dates associated with these deliverables are subject to change; the tentative scheduled due dates are presented in the Project Schedule (Appendix M).

- TPP Documents – Draft and Final TPP Memorandums and Addendums (I & II)
- RI/FS Work Plans – Draft, Draft-Final, and Final
- RI Reports – Draft, Draft-Final, and Final
- FS Reports – Draft, Draft-Final, and Final

- Proposed Plan – Draft, Draft-Final, and Final
- Responsiveness Summary
- Decision Document – Draft, Draft-Final, and Final
- Public Involvement Plan – Draft, Draft-Final, and Final

2.6 PROJECT SCHEDULE

ZAPATA uses Microsoft Project to compile and track scheduled project activities. The ZAPATA Project Manager will monitor and report all tracking information to the USAESCH Project Manager. Appendix M contains the project schedule.

2.7 PERIODIC REPORTING

Prior to and after active fieldwork operations, ZAPATA will prepare monthly status reports consistent with DID WERS-016.02, Periodic Status Reports (USAESCH, 2010). These will include exposure data and describe the accomplishments and significant findings for the reporting period, work currently underway and anticipated, and any challenges encountered with recommended solutions. Monthly reports will generally be submitted to the USAESCH by the 10th working day of each month. When actively conducting field operations, ZAPATA will prepare progress reports on a weekly basis. Weekly reports will be submitted electronically to USAESCH for the duration of fieldwork. When actively conducting MC sampling of environmental media during field operations, ZAPATA will prepare daily Data Quality Control Reports (DQCRs) per DID WERS-009.01. Those DQCRs will be transmitted daily in electronic format to the USAESCH PM, TM and designated chemist and to the USACE, Charleston District PM. Project data and progress reports will be posted on a secure SharePoint® site for access by the PDT.

2.8 COSTING AND BILLING

2.8.1 Costing

ZAPATA's project delivery system, Microsoft Dynamics, is designed to facilitate control of costs and schedules based on real-time budget, cost and schedule data. The ZAPATA Project Manager reviews this information on a regular basis to anticipate and prevent cost overruns and schedule delays. By frequent review of actual costs and performance progress in comparison with budgets and schedules, potential costs and/or schedule variances can be identified early and corrective action can be implemented. These monitoring procedures will be applied to this contract on a weekly basis to ensure accurate internal reporting and cost controls. This reporting is for internal use, and billing based on Government acceptance upon milestone completion.

2.8.2 Billing

ZAPATA also uses the Microsoft Dynamics cost accounting system to manage financial information for its clients. Subcontractor invoices and employee work records are input daily to maintain a real-time snapshot of the project's budget. ZAPATA Project Managers are well versed in the data analysis functions of Microsoft Dynamics for management and billing activities.

2.9 PUBLIC RELATIONS SUPPORT

ZAPATA will participate in stakeholder meetings to execute the TPP process. The ZAPATA project team's participation will include delivery of presentations, plus development and production of TPP worksheets and handout materials. Specific deliverables under this task are identified in Appendix A (Task Order PWS).

2.10 SUBCONTRACTOR MANAGEMENT PROCEDURES

Sound monitoring procedures, specific deliverables, and fixed schedules will be specified in our relationships with our subcontractors. ZAPATA's Quality Management program provides for subcontractor site evaluations, supplier ratings, and inspections by ZAPATA, as appropriate. Our Quality Management program also ensures the flow-down of contract requirements to all subcontractors.

2.11 FIELD OPERATIONS MANAGEMENT PROCEDURES

The ZAPATA project manager (PM) will oversee all aspects of the project, including field operations. The SUXOS and/or Senior Geophysicist will oversee various phases of the fieldwork, as appropriate. There will be daily communication between field staff (including subcontractors) and the ZAPATA PM during field operations. The SUXOS will address any unexpected issues or concerns that arise during UXO-related field operations. Thus, the SUXOS will be involved in issue resolution and will be aware of any changes in site conditions or planned modification to field procedures. The ZAPATA PM will involve the USAESCH PM in the decision-making process as necessary. The ZAPATA PM will notify the USAESCH PM of any changes in site conditions or planned modification to field procedures for consideration and concurrence prior to initiation of the modification. Agreed to changes will be documented on a Field Change Request Form (Appendix F).

2.12 GENERAL SITE PRACTICES

2.12.1 Safety is paramount during execution of all ZAPATA's projects. ZAPATA places the highest priority on the safety of our employees and subcontractors, both in the field and in the office. Safety and health compliance is one of the critical performance metrics (directly linking to Quality) that is measured on every task order. Field personnel will be briefed daily on all aspects of safety. The UXOSO will monitor the safety of all site activities, conduct safety audits, and implement the Site Safety and Health Plan in the field. It is ZAPATA's policy that all personnel have the authority to stop work at any time if an unsafe operation and/or procedure is noted.

2.12.2 Throughout operations, ZAPATA will strictly adhere to the following general practices. Detailed safety precautions and procedures are in the Accident Prevention Plan (APP) (Appendix D). The SUXOS and UXO Safety Officer (UXOSO) will verify that the area around the operating site is clear of all non-UXO and non-essential personnel, and will verify that advance notification has been made (see Appendix D).

2.12.3 Site-Specific Training

As part of the mobilization process, ZAPATA will perform site-specific training for personnel assigned to this project and site visitors, as appropriate. The purpose of this training is to ensure that all personnel fully understand the procedures and methods ZAPATA will use to perform operations, their individual duties and responsibilities, and any and all safety and environmental practices/procedures associated with operations. Personnel will be trained as they arrive on-site. Training material/issues covered in the training sessions and training responsibilities include the topics listed below.

- Operational briefings for the SUXOS on his duties and responsibilities, including review of the work and safety plans.
- Ordnance recognition and UXO safety for field personnel and subcontractors. The UXO Safety Officer will perform this training.
- All personnel will receive training on the individual equipment they will operate while on-site.
- Environmental awareness will be discussed.
- Prior to mobilization, all UXO personnel will have received Hazardous Waste Operations and Emergency Response (HAZWOPER) 40 hours (and eight-hour refresher) training, as required.

2.12.4 Work Hours

Field operations will be conducted during daylight hours only. All UXO personnel involved in MEC-related activities will work no more than 40 hours of UXO-related work and not exceed 50 hours per week, with 48 hours rest between work weeks.

2.12.5 Site Access

ZAPATA will control access into work areas and will limit access to only those personnel necessary to accomplish the specific operations or who have a specific purpose and authorization to be on the site.

2.12.6 Handling of Munitions and Explosives of Concern

Should a MEC item be encountered, only UXO-qualified personnel (UXO Technician II or higher) will perform identification of the item and ascertain its condition. Similarly, MD will not be handled or touched unless first inspected by UXO-qualified personnel. <u>THIS POLICY WILL BE STRICTLY FOLLOWED.</u> As indicated in Section 3.4.9.11, MEC Identification, a minimum of two UXO Technicians, one of which will be a UXO Tech III, must be in agreement on the nature and condition of a live item before any action is taken. If the nature of an item remains in question after field evaluation by UXO Technicians, digital images of the item will be forwarded to the USAESCH and ZAPATA's offices for consultation.

2.12.7 Safety Training/Briefing

ZAPATA safety officers will conduct daily safety meetings before daily operations commence. The UXO Tech III may hold a safety stand-down at any time he notes any potential degradation of safety or a safety issue that warrants a review.

2.12.8 Daily General Briefing

ZAPATA's supervisor, quality control and safety officers will jointly conduct daily general briefings before daily operations commence; these will coincide with the daily safety meetings. The daily general briefing will be conducted for all site personnel prior to beginning work. The briefing will cover general site activities, personnel expectations and teaming arrangements, coordination requirements, data management requirements, and any relevant topic identified since the last briefing.

2.12.9 Visitor Briefing

2.12.9.1 Site visitors must receive a safety briefing prior to entering any portion of the project site where field activities are being performed. In addition, site visitors will be escorted at all times by UXO-qualified personnel, preferably the SUXOS or UXOSO. All visitors entering the respective Exclusion Zone specified for each MRS must have the proper Occupational Safety and Health Administration (OSHA) qualifications and be in the required Personal Protective Equipment (PPE).

2.12.9.2 Essential personnel and authorized visitors may visit the exclusion zone (EZ) while MEC procedures are being conducted. All requests for approval as an authorized visitor for entry into the EZ during MEC operations must be submitted through the USAESCH for approval. The request shall:

- Describe the purpose of the visit and the tasks to be performed;
- Explain why the tasks must be performed during MEC procedures;
- Specify whether the visit will be a single visit or one in a series of visits; and
- State the frequency of the visits and the time required to perform the task.

2.12.10 Work Clothing and Sanitation

PPE and field sanitation practices are addressed in Accident Prevention Plan (Appendix D).

2.12.11 Compliance with Plans and Procedures

All field operations will be conducted in a systematic manner using proven operating methods and techniques. All UXO-related activities will be conducted under the direction, supervision, and observation of the SUXOS or UXO Technician III. All personnel will strictly adhere to approved plans and established procedures. When operational parameters change and there is a corresponding requirement to change procedures or routines, careful evaluation of such changes will be conducted by on-site supervisory personnel in close liaison with the ZAPATA Project Manager. Any new course of action or desired change in procedures will be submitted with justification on a Field Change Request (Appendix F) to the USAESCH PM, as required.

2.13 DATA MANAGEMENT PROCEDURES

2.13.1 Field Data Records

Field team members will record data and field measurements in non-erasable format in field notebooks and on requisite forms. Types of information and data to be recorded are discussed within the context of field operations throughout the Work Plan.

2.13.2 Site Safety Records

The site safety record documents safety aspects of the project, including training, inspections, and accident and incident reports. The UXOSO will maintain these records on-site. Copies may be posted on a secure SharePoint® site, if necessary.

2.13.3 Site Activity Records

All site personnel / work teams will be required to maintain Site Activity Records. Site activity records include field data and field activity information. All data is to be delivered as described herein, per DID WERS-001.01, and includes maps illustrating the locations of geophysical anomalies, dig sheet information, and QC results. Information pertaining to accountability documentation for MEC and MD recovered and explosives used to detonate MEC are discussed in detail in Section 5.0 and Appendix L, Scrap Management.

2.13.4 Data Reduction and Evaluation

2.13.4.1 Digital Geophysical Data

ZAPATA's Project Geophysicist will evaluate digital geophysical data for completeness at the end of each field day. The data will be electronically transferred to ZAPATA's Golden, Colorado office for processing, reduction and interpretation. Original copies of all raw data will be maintained at ZAPATA's Colorado office. Determination of the anomalies representing potential MEC items will be based on the results of the geophysical system verification and our rationale for anomaly selection. This geophysical information will be depicted on a map (hardcopy or electronic format) that will be provided to the USAESCH and USACE.

2.13.4.2 Chemical Analytical Data

Chemical analytical data generated at the primary and quality assurance laboratories will be submitted to ZAPATA in electronic format. ZAPATA will maintain copies of all raw chemical analytical data at its Charlotte office. ZAPATA will reduce the chemical analytical data reported in the RI by developing "hits only" tables; these analytical tables will show only those constituents that were detected in at least one sample.

2.14 DEVELOPMENT OF MEC DATA QUALITY OBJECTIVES

2.14.1 Stakeholders must agree on the type, quantity, and quality of data required to achieve an adequate characterization of the nature and extent of MEC/MC; this is often done by establishing hypothetical tests during the investigation design. Because of uncertainties that result from sampling variations, decisions made using hypothetical tests will be subject to error; commonly referred to as false positives (α) or false negatives (β). The acceptable level of decision error associated with hypothesis testing is defined by the confidence level and statistical power; these two parameters are closely related to the two types of probability error, α and β. The USEPA recommends minimum performance measures of both confidence level and power. The key is to balance the confidence level and power such that the likelihood of making an erroneous decision can be minimized.

2.14.2 ZAPATA has made several assumptions about the type, quantity and quality of data required for determining probability and accuracy levels, based on existing site information and data requirements for the Visual Sample Plan (VSP). VSP is a software tool that supports the development of a defensible sampling plan based on statistical sampling theory and the statistical analysis of sample results to support confident decision making. Using a somewhat conservative approach but, balancing that risk mitigation with achievable project goals, ZAPATA chose a low-to-moderate target density and a high probability of target detection (90%) based on the analysis of existing data and the likelihood that HE munitions may be present within MRSs (see Appendix P). The approach will provide a statistically-based confidence, which allows for the identification of contaminated areas that are distinctly different than the background, and will also allow for the determination of the extent of that contamination with a probability error that is acceptable to the USACE.

2.14.3 A formalized method of conducting the process described above is described in EM 200-1-2, Technical Project Planning (TPP) Process (USACE, 1998). In a phased approach similar to the RI process, the TPP process generally includes identifying the MRS project, determining data needs, developing data collection options and finalizing the data collection program necessary to achieve established project DQOs. The TPP process allows the DoD to manage the uncertainties associated with this project by ensuring the distribution and quantity of MEC/MC is determined using acceptable detection methodology and technologies, even in light of potentially unknown site-specific historical information.

3.0 FIELD INVESTIGATION PLAN

3.1 OVERALL APPROACH TO MUNITIONS RESPONSE ACTIVITIES

3.1.1 Our team will perform all necessary field activities to meet the overall objective of this PWS and the data quality objectives (DQOs) established for this project. ZAPATA will characterize the nature and extent of MEC/MC, per agreed upon requirements developed during the TPP, and perform an ecological and human health risk assessment for the purpose of developing and evaluating effective remedial alternatives. Based on the site characteristics, ZAPATA will conduct a combination of analog instrument-assisted intrusive investigations (hereafter referred to as mag-and-dig), analog instrument-assisted surface reconnaissance (AIR), and DGM to characterize nature, density, and extent of MEC as described in the CSM (see Exhibit 3, Appendix B).

3.1.2 The transect spacings selected for this investigation are based on a MKII grenade, 37mm projectile, rifle grenade or 60mm mortar, depending upon the specific range use and findings from previous site characterizations/removals. Transect investigation will include either mag-and-dig or AIR. Anomaly density maps developed following transect investigations will be used to place grids at high, medium and low anomaly density locations. Grid investigation to refine our understanding of the nature of MEC will either be conducted using DGM or mag-and-dig; grids placed in areas where mag-and-dig was performed will be evaluated using DGM and grids placed in areas where AIR was performed will be evaluated using mag-and-dig. If dense anomalous areas indicate a potential burial pit, trenching may be used to supplement intrusive investigations. In the event MEC is discovered at the outer boundary of any of the AoPIs or MRSs, ZAPATA will coordinate with the Project Delivery Team (PDT) to determine an acceptable approach for expanding the characterization.

3.1.3 ZAPATA will collect ten discrete surface soil samples (0 to 2” bgs) to evaluate MC (i.e., explosives and select metals) at each of the MRSs and AoPIs, except for MRS 1 and Lakes Johnson and Craig. Prior to detonating a MEC in-place, ZAPATA will collect discrete surface soil samples for analysis of explosives and metals; following each detonation, ZAPATA will collect surface soil samples for explosives and metals using the 7-Point “wheel composite” method. The following parameters will be analyzed in soil to characterize the nature and extent of potential contaminants and to develop a health and ecological risk assessment for the RI/FS:

- Explosives, plus nitroglycerin and PETN using USEPA Method 8330A; and
- Selected metals (antimony, copper, lead, and zinc) using USEPA Methods 6020A.

3.1.4 MC sample locations will be placed in/around suspected source areas and receptors based on document review and MEC investigation results. ZAPATA will also conduct MC sampling in areas determined to represent background locations; background samples would be submitted for metals analysis only. If evidence of white phosphorus is discovered, discrete soil samples may be collected and submitted for chemical analysis. Based on TPP team concurrence, sediment and surface water will not be evaluated during this RI unless site conditions indicate a need to evaluate those media; those indicators include visible sediment staining, large quantities of visible material potentially presenting an explosive hazard (MPPEH) at a sediment/surface-water interface, or drainage features emanating from areas containing large quantities of MPPEH. ZAPATA will use the results of the intrusive investigations, geophysics, multi-media sampling, as well as data collected during the previously completed investigations and removal actions to define the nature and extent of MEC and MC contamination.

3.1.5 Remedial Investigation Goals

The site characterization goals are to collect sufficient data to determine if MEC or MC pose a threat to human health, public safety, or the environment and to determine if removal action, remedial action, or no action are appropriate for the MRSs under investigation. Additionally, the RI/FS will further define the areas of suspected MEC occurrence and generate sufficient data to allow for risk assessment development and analysis of remedial alternatives, and preparation of a Proposed Plan (PP) and DD for each MRS.

3.1.6 Data Quality Objectives

3.1.6.1 Data Quality Objectives (DQOs) are statements defining the quality, quantity, and type of data required, and the acceptance criteria for those data, necessary to provide an adequate database to support project decisions. To generate data that will meet the project objectives, it is necessary to define the types of decisions that will be made and identify the intended use of the data in an effort to characterize the residual risk remaining at the project site. Table 2 through Table 15 presents the DQOs for conducting the RI at Camp Croft for all project subtasks except MC DQOs; which are provided in Appendix E.

3.1.6.2 Data needs specific to this RI have been identified by evaluating existing data and through discussions of project requirements with the PDT. The process by which data needs were developed is documented in the TPP Memorandum (Appendix I) and Worksheet #10 of the UFP-QAPP (Appendix E). The DQOs developed for MC, as well as the analytical data quality level requirements, are provided in Worksheet #11 of the UFP-QAPP.

3.1.6.3 Chemical analytical data collected during this program will be validated by an independent chemist to ensure the procedures defined in the QAPP have been followed and that the quantity of data adequately supports the intended use of the data as described in USEPA's Data Quality Objectives Process (G-4) (August 2000) and Data Quality Objectives Process for Hazardous Waste Sites (G-4HW) (January 2000). The Quality Assurance/Quality Control (QA/QC) evaluation will determine whether the data meet the requirements of the UFP-QAPP and will include validation of the laboratory data. Accutest Laboratories Southeast, Inc. at 4405 Vineland Road, Suite C-15, Orlando, Florida 32811 is accredited to DoD Environmental Laboratory Accreditation Program (ELAP) and the International Organization for Standardization and International Electrotechnical Commission (ISO/IEC) 17025:2005 through December 15, 2012. Their certification number is L2229.

3.1.6.4 The overall objective of the field effort is to provide an accurate, precise and representative assessment of the soil in areas identified during historical research and geophysical surveys. The collected samples and data generated from those samples are intended to provide the information necessary to assess future remediation options for Camp Croft, if necessary. ZAPATA will compare analytical results to numeric criteria to determine if the basic DQOs were met. This includes reviewing laboratory reporting limits to confirm they did not diverge from those specified in this Work Plan and, if so, whether this was due to laboratory dilution or some other cause. Further comparisons include analytical soil samples for explosives (plus nitroglycerin and PETN) and selected metals to the USEPA Regional Screening Levels

(RSLs). Measurement performance criteria for laboratory analyses are listed in Worksheet #12 and Worksheet #37 of the UFP-QAPP (Appendix E).
3.1.6.5 To support the RI/FS objective of characterizing the nature and extent of potential MEC at the site, ZAPATA plans the following QC measures to meet DQOs of detecting munitions items at site-specific depths of detection. The specific geophysical DQOs and quality control requirements were derived from the PWS and TPP discussions.

3.1.7 Data Incorporation in the Remedial Investigation/Feasibility Study

Historical data, AIR, mag-and-dig, DGM, intrusive investigation data, and chemical analytical data will be maintained in the project GIS database. This database will be managed and updated as additional data are provided or generated. The GIS database will be designed such that specific queries, tables, and reports can be generated for analysis and presentation of the existing MEC hazards within each MRS and AoPI. A database dictionary will be developed for the acquisition of field data to ensure data integrity and reduce/eliminate data transcription errors.

3.1.8 Munitions and Explosives of Concern Exposure Analysis

The initial summary of MEC risk is provided in Section 1.9. All relevant data acquired during the RI fieldwork will be migrated to and analyzed within the GIS. Once the nature and extent of MEC contamination at the site are characterized, the potential risk due to exposure to MEC/MC contamination will be assessed. The potential risk posed by MEC/MC contamination may be characterized by evaluating the ordnance, site characteristics, human and ecological exposure pathways (see Table 16 and Table 17). The ordnance category includes the type of MEC identified, the level of sensitivity (i.e., the potential adverse health effects associated with exposure to the specified MEC), the density of MEC in a specified area, and the depth of the MEC.

3.1.9 Munitions Constituents Investigation Plan

Environmental field sampling for the RI/FS will be conducted after the MEC investigation and will include surface soil sample collection. Environmental field sampling rationale, methods, and activities are described in detail in the UFP-QAPP (Appendix E), herein.

3.1.10 Use of Time Critical Removal Actions

3.1.10.1 Time-Critical Removal Actions (TCRAs) are removal actions intended to address the imminent safety hazard posed by the presence of MEC/MC, where cleanup or stabilization actions must be initiated within six months to reduce the risk to public health or the environment. Once the imminent threat at a site is addressed through the TCRA, additional work that is necessary is completed through the non-TCRA process. During the course of the RI/FS process, if an area is discovered that poses an imminent danger, the USACE and USAESCH will be notified for the purpose of reevaluating the area for a TCRA.

3.1.10.2 If an evaluation of the hazards warrants a TCRA, an Action Memorandum (AM) will be prepared and submitted. This document will contain a location and description of the site, a description of existing MEC/MC hazards, current land use activities, and previous actions that have taken place to address the MEC/MC hazard. The AM will also include an endangerment determination with the following statement: "There is a significant possibility that an individual may encounter MEC/MC hazards at this site, and that these hazards may cause injury or death to individuals who encounter the hazards if not addressed through the response action described in the Action Memorandum."

3.1.11 Follow-on Activities

ZAPATA's task order includes completion of various munitions response activities under CERCLA from the RI through the DD. If the DD requires follow-on activities, those activities will be completed under a separate task order.

3.2 IDENTIFICATION AND EVALUATION OF AREAS OF CONCERN

ZAPATA performed an in depth review of available site-related documents and summarized site information from the three MRSs and 11 optional areas included in the PWS in a preliminary CSM (see Exhibit 3, Appendix B). The CSM describes the area size, suspected past DoD activities, potential MEC/MD, previous investigation/removal activities (if any), current and future land use, and our field investigation approach. Field activities are based on the refined CSM, and outcome of the TPP. The investigative approach can be conceptually categorized into three types of investigation; those approaches are summarized in the following subsections.

3.2.1 Gas Chambers (MRS 1)

The Gas Chambers Area is an approximate 24-acre area that was used to train soldiers on the effects of gas munitions; CS smoke pots/grenades are believed to be the primary training item used at this site (see Exhibit 4, Appendix B). Based on the review of historical documentation, the use of chemical agent identification sets (CAIS) kits or chemical warfare materiel (CWM) is not anticipated at this MRS. Information in the historic photographic analysis indicates the primary building used as a gas chamber may actually be located south of the designated location indicated in the PWS. However, the exact location of the gas chamber remains unknown. ZAPATA will investigate this MRS by conducting AIR along one meter-wide transects spaced 36m (northern portion) and 16.24m (southern portion) apart on center, followed by DGM and intrusive investigation of 50 ft by 50 ft grids. In the event that the location of the former gas chamber is determined or suspected based on AIR results, one or more 50 x 50 ft grids will be mapped in the vicinity of the suspected location. No intrusive investigation will occur during AIR operations along transects. If the former gas chamber area is identified, the 50 ft by 50 ft-equivalent grids will be placed surrounding that location. If a burial pit is discovered, ZAPATA will dig a test trench through the pit. Actual grid placement will be refined later if the PDT determines the MRS boundary should be adjusted. Blow-in-place (BIP) disposal applies to conventional MEC items only. If chemical agent is discovered, ZAPATA will implement our procedures specified in Section 3.4.9.16.

3.2.2 Grenade Court (MRS 2) and all AoPIs

3.2.2.1 These areas are composed of various range types and size. The majority of these areas, except for AoPI 10B and 11B, are found north of the primary firing line, which existed immediately south of and along Dairy Ridge Road. ZAPATA will mag-and-dig 100% of anomalies along transects of varying spacings (either based on the MKII grenade, rifle grenade, or 60mm projectile) and then place grids in areas of high, medium, and low anomaly density. A minimum of 10% of the transect acreage in each area will be evaluated with DGM and intrusive investigation of MEC-like anomalies in the grids.

3.2.2.2 ZAPATA identified two AoPIs (AoPI 3 and 11C) where existing data indicate that the boundary may different than that described in the PWS. Based on our investigation and removal activities within and around the Wedgewood neighborhood, MEC contamination may extend beyond the AoPI 3 boundary as defined in the PWS. ZAPATA will conduct an investigation beyond the boundaries of AoPI 3 defined in the PWS. Based on the historic photographic analysis and ZAPATA's removal action findings from 2010 (e.g., MEC beyond the eastern AoPI 11C boundary and foxholes between the AoPI 11C boundary and the ball fields), the likely location of the MEC-impacted area is east of AoPI 11C as defined in the PWS. ZAPATA will perform additional DGM within the ball fields east of AoPI 11C. Those data will be collected over 100% of the ball fields. The proposed investigations are shown on Exhibits 5 through 11 in Appendix B.

3.2.3 Range Complex (MRS 3)

3.2.3.1 The Range Complex is a 12,102-acre area composed of 15 ranges and two lakes. Documented munitions used within this complex included small arms, rifle grenades, 2.36-inch rockets, and 60mm and 81mm mortars. Numerous other munitions have been discovered within the range complex; those items include the 37mm, 57mm, 105mm and 155mm. Several areas within this range complex have been cleared during previous removal actions, although these areas equate to only a fraction of the total size of the MRS. It should be noted that some removals were Time-Critical Removal Actions (TCRAs); those locations may have been cleared of munitions but, according to documents, those clearance depths may have been less than or equal to one foot (ft) below ground surface.

3.2.3.2 ZAPATA has divided MRS 3 into two sub-areas (see Exhibit 12, Appendix B). Sub-area 1 represents all areas within former range fans where MK II grenades, 37mm, rifle grenades or 60mm mortars have been found. ZAPATA will mag-and-dig 100% of anomalies along approximate parallel one meter-wide transects with various spacings, as described below:

- The areas previously identified as OOU 10C and OOU 10D, along with a portion of the area previously identified as OOU 12A, and AoPI 11B will be investigated along transects spaced 36m apart on center;
- The area previously identified as OOU 1A, which fully encompasses the areas previously identified as OOU 1B and OOU 9C (but excluding OOU 10C and a portion of OOU 10D) will be investigated along transects spaced 73m apart on center; and
- The remainder of Sub-area 1 and the area previously identified as AoPI 10B will be investigated along transects spaced 135m apart on center.

Following that mag-and-dig investigation, ZAPATA will place grids designated for DGM in a portion of those areas; MEC-like anomalies will be intrusively investigated in the grids. Sub-area 2 represents all remaining portions of MRS 3 and areas beyond documented range fans (i.e., the areas previously identified as OOU 9A, OOU 9F, OOU 9H, and OOU 11A), where only sporadic and small quantities of munitions have been found. ZAPATA will perform AIR of this sub-area along one meter-wide transects spaced 135m apart to identify areas of potential munitions contamination.

3.2.3.3 Lake Craig and Lake Johnson total 186 acres (see Exhibit 13, Appendix B). ZAPATA will perform mag-and-dig west of the lakes and AIR east of the lakes along one meter-wide transects spaced 135m apart on center. When transects reach the shoreline, the field crews will turn and follow the shoreline until the transect turns away from the lakes. Anomalies encountered during the mag-and-dig and AIR operations will be used to evaluate anomaly density only.

3.2.4 Basis for the Investigation Approach

As indicated above, ZAPATA will primarily utilize three general approaches to define the nature and extent of MEC at the former Camp Croft. These approaches include variations of both transect (mag-and-dig or AIR) and grid-based investigation.

1. Transects will be investigated across each area to outline the general distribution of potential MEC items. Specifically, this method will allow ZAPATA to identify ground target areas and other areas of high MEC density. The transect spacing (sampling density) for each area will be based on the documented activity that reportedly took place within the respective area and munitions recovered during previous investigations and removal actions. The historical range use, ordnance type, and range size was used to determine probable target size; these data are detailed in the CSM (Table 1). ZAPATA then incorporated empirical data into the VSP to calculate the probability that a given target would be detected. ZAPATA determined the target distribution would be bivariant normal, set the decision rule that there be 95% confidence that the target area has a density greater than background, and required a 90% probability of target detection.
    a. ZAPATA will perform mag-and-dig operations using Minelab metal detectors along transects paths (nominal width of one meter) in all MRSs and AoPIs except MRS 1 and sub-area 2 of MRS 3. Anomaly count data and MEC finds will be recorded and used to generate anomaly density maps.
    b. ZAPATA will perform AIR using Minelab metal detectors in MRS 1 and sub-area 2 of MRS 3 to identify potential munitions contamination. Transect spacing was determined as indicated above. Anomaly count data and MEC items found on the surface will be recorded and used to generate anomaly density maps. Based on the findings of the AIR and discussions with the PDT, additional characterization (mag-and-dig or grids) may be required to verify the extent of residual MEC.
2. Grids will be placed across the areas based on the transect data to refine the extent of the MEC and determine its nature. The grids will generally be 50 ft by 50 ft but, may be of various sizes depending on the anomaly density of the "target" areas in which they are located.
    a. Grids placed in areas where mag-and-dig was performed will be digitally geophysically mapped. From those DGM grids, all MEC-like anomalies and 10% of the remaining anomalies will be investigated. MEC-like anomalies will be based on results determined at the IVS; those selections will be discussed with the PDT prior to intrusive investigation.
    b. Grids placed in areas where AIR was performed will be investigated using mag-and-dig methods. All anomalies identified within the mag-and-dig grids will be intrusively investigated by UXO-qualified technicians.

3.2.4.1 Target Size Determination

The assumed "target areas" within each MRS and AoPI used in the VSP analysis were determined based on an assumed target type and probable munitions used. We assumed a target radius to be 1.5 times the hazardous fragmentation distance for the specific munitions. The munitions and specific target size used in the VSP calculations and the transect spacing derived from the VSP are provided in Appendix P.

3.2.4.2 Visual Sampling Plan Methodology

Our approach combines the standards established in EM 1110-1-4009 for the recommended minimum area investigated for each area with the application of VSP to determine the target detection probability for a selected number of anomalies above background. Initial transect spacing is determined by applying Table 7-1 (EM 1110-1-4009) to the area sector size then selecting the proper basic minimum area to be investigated. A target size for a particular range/bombing area depends on each area's probable ordnance fragmentation distance, ballistic dispersion, scatter variance, and distribution overlap. Based on previous survey experience, we estimate a background number of anomalies, a detection instrument false negative percentage, and target anomaly distribution. Our decision rule implemented a 95% confidence that the target area has a density greater than background density, a background response of 15 anomalies per acre, with a 5% false negative instrument response. We choose a bivariate normal distribution to represent the target, 350 anomalies per acre for the target density, and required a 90% probability of detecting the target. In our experience, this anomaly density is at the low to moderate end of average target densities and 90% probability of target detection is an accepted industry standard, serving as a strong starting point for target identification. The resulting spacing between parallel transects for a MKII grenade, Rifle Grenade (M9A1), and 60mm projectile (M49A5) are provided in Appendix P.

3.3 COMMON OPERATIONAL ELEMENTS

The MRSs and AoPIs to be characterized at Camp Croft have been established through land use evaluation and various project meetings with stakeholders; these MRSs are illustrated on Exhibit 3 in Appendix B. Some parts of the definable features of work to be conducted onsite contain common operational elements; those operational elements include equipment, positional awareness, site challenges, and geophysical seed items.

3.3.1 Equipment

3.3.1.1 Positional data will be collected using a Real-Time Kinematic (RTK) Global Positioning System (GPS) within DGM grids using a Trimble GeoXH or equivalent system capable of sub-decimeter accuracy. The GPS data may also be corrected using the wide area augmentation system (WAAS). Should poor quality GPS data be recorded, questionable data will be removed and the data gaps may be reacquired by the data acquisition team. Data may be linearly interpolated between "fixed" GPS values where possible. Positional data will be recorded in World Geodetic System 1984 (WGS 84) Longitude and Latitude. The data point coordinates will be converted to local UTM Zone 17 North coordinates for input onto the general survey database. DGM electromagnetic (EM) and GPS data will be recorded simultaneously.

3.3.1.2 During DGM data collection, data will be collected with a 1.0 m x 1.0 m transmitter/receiver coil MK2 system in cart-mounted configuration. The GPS antenna will be mounted to the coil. Positioning instrumentation will consist of Trimble GPS units utilizing post-processed kinematic (PPK) procedures for survey accuracy.

3.3.1.3 Standard equipment tests will be performed as described in Appendix K: "Instrument Standardization QC Requirements for Ordnance and Explosives (OE) Digital Geophysical

Mapping." The tests ensure that the geophysical system is functioning properly and optimized for the DGM objectives. The frequency at which the tests are run is listed in Table K-1. The results of each test will be recorded with applicable items entered in the Access database specified in Attachment B of DID WERS-004.01. No site calibration or standardization will be made to the MK2 instrument as it is calibrated prior to leaving the factory. However, the daily equipment tests, specifically the static/standard test and the latency test, ensure instruments are performing as designed.

3.3.2 Location, Surveying and Mapping

3.3.2.1 Data positioning, including reacquisition, will be performed using either a 1.0 m-accuracy Wide Area Augmentation System (WAAS)-corrected GPS or with survey tapes (linear interpolation between hubs). The data positioning method used will depend on the availability of quality GPS data. The equipment operator will monitor GPS quality on the Trimble GeoXH. If there is no satellite connectivity (WAAS correction) while acquiring DGM data or during reacquisition, the instrument operator will stand on the hub for one minute in an attempt to regain WAAS-corrected GPS positioning, prior to using survey tapes.

3.3.2.2 During data collection within the grids, survey line locations will be determined using measuring tapes laid out along the north and south grid edges along with additional east-west orientated survey tapes placed at intermediate positions within the grid. Distance along the line will be measured using the wheel encoder and adjusted via tie-points as determined by the east-west oriented measuring tapes. Using this positional information, the geophysical data will be converted to UTM Zone 17 North coordinates.

3.3.3 Site Challenges

3.3.3.1 Geophysical Background Noise

The survey areas are located on areas with varying thicknesses of saprolite; saprolites in the Piedmont of SC often contain appreciable amounts of oxidized iron. These iron-rich soils may cause some noise in the EM61 MK2 EM data. Such noise, however, should be relatively minor in magnitude and is not expected to significantly affect overall data quality.

3.3.3.2 Man-Made Features

Man-made features may interfere with the geophysical data interpretation. If these features are encountered during the field activities, the locations will be documented for inclusion on site figures along with known man-made features (i.e., power lines). The MK2 is relatively insensitive to lateral cultural interferences such as buildings, power lines, and fences. In the event that an area of the geophysical survey contains power lines, all efforts will be made in both data collection and data processing (by the use of filtration and methods as power of anomaly) to minimize the effects of the overhead power lines and maximize the quality of the data collected. There are other man-made features that may affect geophysical investigations. They may include, but are not limited to:

- Underground utilities;
- Sewer covers, and culverts, reinforced steel in storm drains; and
- Roads and curbing.

3.3.3.3 Site Accessibility

ZAPATA's field schedule is not limited local climate. However, dynamic events that may affect geophysical investigations include weather (precipitation, wind, and extreme temperatures); radio, and other EM spectrum transmissions; and solar activity (e.g., if a single sensor magnetometer is employed). It is the responsibility of the Site Geophysicist to evaluate these events/conditions during acquisition to determine their effect, if any, on the geophysical data quality. If it is determined that these events/conditions are adversely affecting data quality, then data acquisition will cease until the event/condition concludes. ZAPATA will investigate property parcels when Rights-of-entry (ROEs) have been obtained.

3.3.3.4 Evacuations

3.3.3.4.1 ZAPATA will provide for evacuations when residences are within the defined safety exclusion zone during intrusive operations. We will ensure that individuals and businesses whose property may be affected by intrusive investigations are informed throughout the process through face-to-face meetings, mailings, and telephone contact. The Camp Croft website will be updated weekly showing progress and areas identified for work the following week. ZAPATA will not publicize specific addresses that will be evacuated, to ensure safety and security of the residents. Outreach activities will be coordinated through the USACE. Meetings may be conducted specifically for affected residents and business owners to discuss the project, describe the impacts to their daily routines and to answer questions. We will leave flyers (and/or door hangers) at each residence approximately two to three days prior to evacuation, which will include contact information should a situation arise that impacts the pending evacuation.

3.3.3.4.2 ZAPATA will visit potentially affected residents and business owners to coordinate upcoming schedules and explain government reimbursement procedures, in coordination with the USACE. We will coordinate logistics for individuals requiring temporary lodging (a hospitality area or individual hotel rooms), when necessary, and provide information to the community via the local media, in direct coordination with the USACE. Kennel services will be provided for outdoor pets and for residents who do not wish to leave their pets unattended for the day. ZAPATA is aware that there are numerous small farms along Dairy Ridge Road and in the northeastern portion of MRS 3. We will coordinate directly with the property owner for site access and management of livestock, as necessary.

3.3.3.4.3 To ensure safety of the public, we will have road-guards posted to notify field teams of traffic in order to stop work to allow traffic to pass. If possible, and acceptable to the Police Department, temporary road blocks may be erected to maintain efficiencies in fieldwork, thereby reducing the impact to local residents/businesses.

3.3.3.4.4 As the majority of Croft State Natural Area is occupied by MRS 3, we will meet with the Park Superintendent to review park access and usage and how best to schedule and conduct field investigations to minimize impacts to recreational users.

3.3.4 QC/QA Seed Items

ZAPATA's blind seed program verifies that data collection, processing, and reacquisition methodologies meet requirements set forth by the USACE, the project WP, and ZAPATA's Blind Seed standard operating procedure (SOP) (Appendix J). Blind seeds provide an opportunity for Government personnel and ZAPATA personnel to monitor geophysical teams and to perform root-cause analyses to remedy performance deficiencies, while teams are mobilized. Specific details regarding seed items and the use/emplacement of those items are described in the GSV (Appendix J).

3.3.4.1 Blind Seed Approval and Composition

All seed items will be approved by Government and contractor geophysical personnel assigned to the project or management not directly involved with data collection, processing, or reacquisition. ZAPATA will employ Industry Standard Objects (ISO), (small surrogates) as the blind seed items.

3.3.4.2 Placement of Blind Seeds

One blind seed, on average, will be placed in each grid, though some grids may have two while others will have none. Seeds will be emplaced by a UXO technician only. The potential seed location must be in an area that has been deemed clear of all native in-situ anomalies within a 0.5 m radius (~1.64 ft) about the emplacement point. This area must be cleared with an approved metal detector (i.e., All Metals detector, Schonstedt, etc.) If the area is not deemed clean, a new location must be chosen, and the above step repeated. The seeding must be performed in such a way as to be "blind" or unknown to personnel performing data collection, processing, and intrusive investigations. The person emplacing the seeds must be an UXO technician with experience operating GPS equipment. QC/QA seeds will be oriented horizontally and at a depth of 25.4mm (5x the diameter of a small surrogate) in the grids.

3.3.4.3 Coordinate Acquisition of a Blind Seed

When seeding, the data concerning the blind seeds must be recorded in the project field book and sent via email only to the QA Manager (see Appendix F for documentation requirements). This will include, but will not be limited to, recording the location of the seed on a map as well as supplying the coordinates, seed identification (ID), and other identifying attributes of the item.

- In areas of reliable GPS data acquisition, coordinates of the blind seeds should be recorded with GPS. (Handheld GPS devices will not be employed due to their limited accuracy).
- If GPS is not available, the seed location will be determined in local coordinates. When establishing a local coordinate system, the southwest grid corner will be designated as the origin (i.e., X = 0, Y = 0) point. It is not acceptable to approximate blind seed locations. In order to determine the location of the seed item, a minimum of three separate tape measurements are required. To accomplish this, the following method is used.
    - Establish the southern and northern (or eastern and western) grid edges by placing two measuring tapes along opposite grid edges.
    - Use a third measuring tape stretched between the grid edges to measure the distance along the perpendicular measuring tape to the grid edges (i.e., the other two tapes); this configuration forms an "H" with the bar of the "H" passing through the seed location. All angles between measuring tapes should equal 90 degrees.

3.3.4.4 Seed Identification

Unique descriptive ID codes will be to be used for the blind seed items. This naming convention will be developed by QC or management. If possible, all seeds will be engraved with the ID code or otherwise marked with a permanent or semi-permanent medium. This will allow the blind seed to be tracked throughout the duration of the project. If an inert ordnance item is to be used as a blind seed item, it will be painted blue per industry requirements.

3.4 SPECIFIC OPERATIONAL ELEMENTS

The field tasks to be performed on site, along with the following reporting and data management tasks are described in the following sections. While these sections are loosely arranged in a manner similar to the expected general project work flow, one should refer to the project schedule for the specific planned timing of these work features (Appendix M).

3.4.1 Site Preparation

ZAPATA will establish a field office trailer north of Dairy Ridge Road (see Exhibit 7, Appendix B) in an existing fenced area near former ammunition bunkers. ZAPATA does not anticipate siting an explosives magazine on site; demolition explosives will be ordered on an on-call basis. However, in the event an onsite magazine is required, we will site the magazine according to the existing ESS. ZAPATA is aware that the former ammunition bunkers are not suitable for storage of explosives and, thus, would install chain-link fencing in a small area and place an Alcohol, Tobacco, and Firearms (ATF)-approved Type II portable magazine within that fenced area.

3.4.2 Site Geodetic Control

ZAPATA will self perform all surveying of transects and grid corners using GPS instrumentation (Trimble GeoXH) with sub-foot accuracy, in accordance with EM 1110-1-4009, DID WERS-007.01, the PWS, and the approved Work Plan.

3.4.3 Vegetation Clearance

ZAPATA recognizes that limited brush clearing will be required and we will attempt to conduct site activities in a manner such that brush clearing is minimal. We are aware that Croft State Natural Area has expressed concerns that transect paths cut through wooded areas may promote off-trail hiking. When transect pathway clearance is required, pathways will be limited to a nominal width of one meter. Brush clearing will be accomplished by ZAPATA's two six-man brush clearing teams consisting of one UXO Technician II and five laborers each, using mechanized and powered equipment. Brush clearing personnel will don appropriate PPE. We will clear brush immediately prior to geophysical investigation within grids. During brush clearing, any surface MEC items will be documented for inclusion in the RI report and disposed of as described in latter sections.

3.4.4 Transect Establishment

Following vegetation clearance, ZAPATA will install hubs within those transects using, or supported by, a UXO Technician II. Generally, hubs will be spaced 100 ft apart; shorter hub lengths may be necessary where transects turn corners. During hub installation, field personnel will annotate in the field logbook any portions of the site that may present specific site challenges (e.g., steep terrain) that may result in data gaps. These transect segments will be documented in the field log book and communicated to the ZAPATA PM.

3.4.5 Geophysical System Verification and Report

3.4.5.1 Geophysical System Verification (GSV) is a process combining twice-daily instrument testing and a blind seeding program to ensure quality production survey results. EM61 MK2 physics-based models are used to verify that the instrument's responses are within instrument specifications. The blind seed program verifies that data collection, processing, and reacquisition methodologies meet requirements set forth by the USACE and ZAPATA's internal set of Standard Operating Procedures (SOPs). Blind seed items will consist of a small Industry Standard Object (ISO) (one inch diameter by four inches long; part #44615K466) placed just below the ground surface within the grids. The seed items will be emplaced. The USACE, at their discretion, may place blind seed items in the Instrument Verification Strip (IVS), transects, or grids. The geophysical data will also be evaluated to ensure that the blind seed items were detected and accurately positioned. Any problems will be documented and resolved by the QC Geophysicist in accordance with the QCP. The QC Geophysicist will review dig results for consistency.

3.4.5.2 ZAPATA will construct an IVS consisting of six ISOs and background response lane. The selected location will be checked for background anomalies prior to any seed item emplacement. If necessary, the IVS will be relocated, or extended to avoid background anomalies. The field team will survey the IVS twice daily and prior to commencement of production surveying. The geophysicist will plot target responses on standard anomaly response curves (Geosoft's UX-Analyze), and target locations on polar plots in order to evaluate the consistency of the EM61 MK2 instrument response throughout the project duration. All production survey equipment combinations will collect IVS data sets prior to field survey commencement. After processing and delivery, datasets will be made available to the USACE representative for acceptance before production data collection.

3.4.5.3 Site-specific detection depths can vary based on site-specific conditions. The typical anticipated detection depths will be established during the GSV (described in Appendix J) based on site noise and the known response as outlined in NRL/MR/6110-09-983, "EM61-MK2 Response of Three Surrogates" dated March 12, 2009. The GSV will test the responses of some of the ISOs at 11x diameter in the least favorable orientation, which is the most stringent test possible. The results of the GSV will be detailed in the GSV Letter Report. During data production, the DQO for MEC targets and burial depths will be detection of the smallest target, the MKII grenade, at the site-specific detection depth determined by the GSV. At a minimum, the DQO of depth of detection for the MKII grenade is 7x the diameter, which is the depth to which MKII grenades have typically been detected at munitions sites. Detection of MKII grenades at depths deeper than 7x diameter using the EM61-MK2, although possible in some environments, has been challenging.

3.4.6 Geophysical Investigation Plan

3.4.6.1 Data Acquisition Methodology Over Transects

3.4.6.1.1 The transect line spacing, number of transect miles, and equivalent acres planned for each are contained in Table 2 through Table 15 and Exhibits 3 through 13 in Appendix B. ZAPATA will use a hand-held metal detector (i.e., Minelab) to locate anomalies along the transects. The Minelab metal detector was selected due to the extremely responsive and naturally-occurring magnetic conditions at this project site. A wooden stake will be placed at the start of the transect and at the beginning and end of each 100-ft segment. The stakes will be labeled with the transect number and the distance along the respective transect. The individual staked positions will be surveyed during geophysical data collection using Post-Processed

Kinematic (PPK) surveying with a Trimble XH GPS system, or equivalent. PPK GPS has an advantage over RTK GPS in wooded areas because a radio link is not required between the base station GPS unit and the rover GPS unit, and only four GPS satellites are required to obtain a solution. The accuracy of the GPS positioning of the transect stakes may be limited by the brush and tree cover. There will be a sufficient number of stakes that can be surveyed to allow accurate positioning of the transect. In the data collection process, a non-metallic tape will be pulled out along the transect and a labeled stake placed every 100 feet. Intrusive investigation of anomalies along the mag-and-dig transects will occur soon after hub installation.

3.4.6.1.2 Along mag-and-dig transects, crews will dig all anomalies encountered with the transect path (nominal width of one meter), and paths will go around any large obstacles (such a trees, wetlands, large rocks, etc.). UXO personnel will tally the number of anomalies encountered within each 100-ft segment, the type of material removed, the weight of the material and survey coordinates of all MEC with the GPS. If transects that contain a high number of anomalies (i.e., more than 50 anomalies per 100 ft segment, as defined by the PDT) are encountered during mag-and-dig operations, a statistically-derived subsample of anomalies within those transects may be intrusively investigated, if determined necessary by the USAESCH.

3.4.6.1.3 Along AIR transects, crews will count anomalies based on the audible signal of the Minelab. They will record the position of MEC and any other forensic evidence of HE use (e.g., HE craters). In the event that any anomalies appear to be "clustered" (i.e., a majority of anomalies are tightly bunched within a small portion of the transect segment), the UXO field teams will annotate those findings in the field log book and communicate that information to the ZAPATA PM.

3.4.6.2 Data Acquisition Methodology over Grids

3.4.6.2.1 ZAPATA will use DGM data and mag-and-dig results acquired in grids and DGM data acquired across ball fields to refine the extent and determine the nature of MEC. Investigations in grids provide higher density of data and higher positioning precision resulting in better evaluation of the anomalies identified. This information can be used to provide additional insight into the transect data. Grids will be placed in high and medium anomaly density areas, where possible, to characterize the nature of the MEC distribution. The grid sizes will vary depending on their intended location and purpose. The grids may also be used in "transect-like" configurations (e.g., 20 ft by 200 ft), centered on the boundary of the target as determined from the mag-and-dig or AIR operations along transects. The locations and distribution of grid types will be determined in consultation with the PDT. In order to meet the DQO for reacquired DGM data of 0.35m plus one-half of the line spacing used during data collection, grid data will be positioned using an RTK GPS. Using the RTKGPS system the nature and extent of MEC within the sample grids will be defined with a high degree of accuracy. Using the grid and transect data, the interpolation of MEC extent (boundary) will be on the order of tens of meters. We anticipate performing DGM within grids using a cart-mounted geophysical instrument, e.g., the EM61-MK2 time-domain electromagnetic (TDEM) metal detection system in conjunction with an RTK GPS. Upon completion of data collection and preliminary data analysis, the VSP software will be used to assess the degree of confidence in identifying the location and extent of UXO targets for each of the investigated sites.

3.4.6.2.2 Grids will be established in a north-south configuration, if practical. A wooden stake (hub) will be securely embedded in the ground at each corner of each grid. The hubs will be labeled with a grid number and corner identifier (i.e., SW, SE, NE, or NW). The hub position will be surveyed using a GPS device (if satellite coverage is available) or measured with measuring tape and/or wheel from an adjacent hub with a known geodetic coordinate point. The grid areas will be brush cleared approximately five ft beyond each side of the grid, allowing turnaround room for the geophysical instrument array. All vegetation above six inches in height and less than three inches in diameter will be removed from the grid areas where DGM will be conducted; vegetation removal in mag-and-dig grids may be limited. The data will be collected along lines nominally spaced 2.5 ft apart to ensure 100% coverage of unobstructed areas. Data will be positioned in DGM grids using the RTK GPS system, except in areas where satellite reception is disrupted by overhead canopy or heavy vegetation. In grids where RTK GPS positioning is not possible, EM61 data will be collected either in wheel mode with a 0.6 ft (20 centimeter) data point spacing along the survey line, or in auto mode. In both cases, data positions will be interpolated and/or refined between fiducial markers located every 25 ft along each survey line. Data will be logged using an Allegro recorder.

3.4.6.2.3 Sampling Rates

3.4.6.2.3.1 The proposed data acquisition parameters for the geophysical equipment are listed below. As each project site requires unique data collection criterion, these parameters will be used as a baseline during the GSV, and associated QA tests. The parameters may be modified slightly (as needed) to ensure that data are collected with the optimal sampling rates for each site. Optimal rates will be verified during the GSV. Detail of the QC checks and parameters are provided in Table 18.

3.4.6.2.3.2 The data acquisition parameters for non-GPS-positioned geophysical data are;

- Sampling Swath – 1.0 m (~3.3 ft),
- Separation between survey lines (for grids) – 0.75 m (~2.5 ft),
- Sensor Height – 42 centimeters (cm),
- Geophysical Data Acquisition rate with wheel mode – ~0.6 ft intervals, and
- Nominal along-line geophysical sensor data point – 98% ≤ 25cm data spacing. Sensor and positional data recording is controlled by wheel distance encoder, which is calibrated before data collection.

3.4.6.2.3.3 The data acquisition parameters for the GPS-positioned geophysical data are;

- Sampling Swath – 1.0 m (~3.3 ft),
- Separation between array passes – 0.75 m (~2.5 ft),
- Sensor Height – 42 cm,
- Geophysical Data Acquisition rate – 10 hertz (Hz),
- GPS Data Acquisition rate – 1.0 Hz,
- Maximum Array Speed – >95% of data will be collected at or below 3.5 miles per hour (mph) (or speed determined at the IVS), and
- Along-line geophysical sensor data point – 98% ≤ 25 cm data spacing.

3.4.6.2.4 Data Spatial Density

3.4.6.2.4.1 The density of data acquired over the survey areas using a single-coil system is nominally 20 cm along survey lines with survey lines, spaced 0.75 m apart (for grid data). This is sufficient to map objects with minimum dimensions of MKII grenade. The spatial sample density required to detect a target at a specific depth is an important consideration in survey planning.

3.4.6.2.4.2 Based on past experience, it is anticipated that a nominal single-coil sampling swath of 1.0 m (~3.3 ft) and an instrument-recording interval of at least 10 times per second will be sufficient to detect small, shallow targets. In accordance with DID WERS-004.01, a survey line spacing of 0.60 m (1.96 ft) will be used in areas where 37mm projectiles are suspected; a line spacing of 0.80 (2.62 ft) or smaller will be used in all other areas. Typical traverse speeds are between two and four miles per hour. At these speeds and with 10 readings per second, data are collected approximately every 7.5 to 18 cm along survey lines. Refinement of these specifications may be required during the GSV.

3.4.6.2.5 Digital Geophysical Mapping Quality Control

3.4.6.2.5.1 The data collection and processing steps will be monitored to ensure high-quality geophysical data. QC will consist of, but not be limited to those procedures outlined in DID WERS-004.01 and our standard operating procedures. These procedures include daily verification of sensor operation along with a check of the sensor positioning system used in data acquisition. Daily QC checks will include;

- Shake Test,
- Twice daily Static/Standard instrument responses,
- IVS background noise,
- IVS item magnitude response, and
- IVS item position verification.

3.4.6.2.5.2 In addition to data acquisition QC, a documented and reviewed QC will be performed on the data processing and interpretation. If any significant discrepancies exist in the positioning or repeatability of the data, the problem will be identified and corrected. Our QC Geophysicist will carefully evaluate the geophysical data for any potential problems such as latency correction, abnormal data spikes or inconsistent background values. The QC geophysicist will also evaluate geophysical data to determine if the "blind" seed items were detected and that their positioning is accurate. The QC Geophysicist will be documented and resolve any problems in accordance with the QCP.

3.4.7 Data Processing, Analysis, and Evaluation

3.4.7.1 The geophysical data from the grids and ball fields will be electronically transmitted to Golden, Colorado for processing. ZAPATA field personnel will complete a Field Data Sheet (Appendix F). This will be provided to the processors to use during the processing portion of the project and will be provided to the client in electronic form with the data submittal. Minimal field editing is expected. Generally, the data are directly exported in American Standard Code for Information Interchange (ASCII) format. Our geophysicists will oversee processing, interpretation, analysis, classification, and geophysical data presentation using a combination of software packages including Geosoft Oasis UX Detect®, MagMap®, Corel Draw®, and the proprietary MakeXYZ and TD3D software developed by ZAPATA. Digital data will be processed on DELL Optiplex 745 systems or equivalent. A cut sheet of the specifications of this system can be provided upon request. The majority of the data processing described herein will be done using Geosoft Oasis Montaj® v. 7.1.1 YW or 7.2 (Oasis) software.

3.4.7.2 Data processing, corrections, and advanced analysis will be done IAW EM 1110-1-4009 (USACE, 2007) and DID WERS-004.01, including the use of the USACE prescribed Access data base. For the processed data, all corrections, editing, and filters will be applied and all corrections will be documented. The following steps are used during data processing.

- For data collection using Trimble GeoXH, raw geophysical data files will be merged with the positioning data in raw *.XYZ files using ZAPATA's MakeXYZ program. Wheel positioned data will be corrected spatially and exported as *.XYZ files using either MakeXYZ or Geonics Dat61.
- Data are imported into Oasis.
- For grid data, a demedian filter will be applied, for transect data a non-linear instrument drift correction will be used. (The demedian filter may be applied in the MakeXYZ program in lieu of Oasis if the MakeXYZ program is employed.)
- A latency correction will be applied to GPS supported positioned data and a lag correction will be applied to non-GPS supported wheel encoded positioned data.
- If necessary, a non-linear noise filter may be applied to the data.

3.4.7.3 Once DGM and AIR data are collected and processed, ZAPATA will develop a preliminary anomaly target list for reacquisition and investigation, as well as a conceptual plan for grid placement. This information will be presented to the PDT for evaluation and consensus. The determination for which anomalies to investigate and grid location will be based on the DQOs, taking into consideration performance criteria and expectations, including the number of anomalies identified, anomalous clusters, terrain, and threshold for anomaly selection.

3.4.8 Anomaly Selection and Reacquisition

3.4.8.1 Selection of Anomalies from Digital Geophysical Mapping Data

3.4.8.1.1 Anomalies will be selected for intrusive investigation. Preliminary target lists will be developed based on the threshold value determined by the GSV. If it is determined that background noise within an area is greater than that measured during the GSV and thus exceeds the threshold value, the target selections will then be based on three standard deviations of the background response. Priority 1 and Priority 2 anomalies will be selected for intrusive investigation in the grids/ball fields. Priority 1 anomalies are defined as those "MEC-like" anomalies that exceed the anomaly selection threshold established during the IVS; anomalies that do not meet all anomaly characteristics (e.g., time constant, signal-to-noise ratio, etc.) are considered Priority 2 anomalies. Initial target selection will be accomplished using the Blakely Method algorithm of the Oasis program. Each of the targets will then be assigned a ranking based on additional target properties that may include, but may not be limited to:

- Signal Strength;
- Size (foot print); and
- Time constants (Tau).

3.4.8.1.2 This ranking system will be determined and refined during the GSV and described in the GSV letter report, however, the ranking may be changed slightly if the production data dictates. Each target will then be scrutinized by the project geophysicists, and evaluated as to its validity and position. Targets that are found to be invalid or misplaced will be removed or moved. Anomalies that are not selected by the algorithm, yet are deemed to represent a target, will be picked manually. The rankings of anomalies may be overwritten by the geophysicist, if deemed necessary.

3.4.8.2 Selection of Analog Anomalies in High Density Transect Segments

3.4.8.2.1 The potential exists for some mag-and-dig transect segments to contain an inordinate number of subsurface anomalies. During mag-and-dig operations, it may become apparent that high density areas are composed of cultural debris rather than MEC or MD. Furthermore, the objective of this work is to determine the natural and extent of potential MEC contamination; not complete a removal action. If ZAPATA encounters greater than 50 anomalies per 100 ft transect segment, they will complete mag-and-dig operations along that transect. The following 100-ft transect segment will be evaluated using AIR; those results will be recorded in the field logbooks and reported to the ZAPATA PM. The ZAPATA field teams will continue AIR operations along the transect segments until the anomaly density falls below 50 anomalies per 100 ft segment, at which time the field teams will begin mag-and-dig operations. ZAPATA will confer with the PDT to during how to adequately investigate high anomaly density transect segments; this may involve investigating a statistically-derived subsample of the recorded anomalies along those segments.

3.4.9 Intrusive Investigation

3.4.9.1 ZAPATA will intrusively investigate subsurface anomalies along mag-and-dig transects or within a grid. A list of anomalies identified for intrusive investigation of DGM anomalies will be provided to the reacquisition team using anomaly dig sheets, who will relocate targets on the ground using the EM61 MK2 system. Use of the EM61 MK2 helps ensure that the target identified on the ground is the target mapped by the original survey. In addition, the magnitude of the target anomaly will be listed in the data sheet. The technician operating the EM61 will first verify that the location has an anomaly approximating the magnitude reported on the dig sheet, and then locate the central peak of the anomaly by doing a sweep at right angles to the survey line with the EM61. The true location of the metal object will be marked on the ground with a labeled plastic pin flag. Reacquisition of selected anomalies is considered acceptable if actual anomaly locations are within 0.5m ± ½ line spacing within grids of the suspected location. In the event that the anomaly cannot be reacquired within 1m, ZAPATA will document the occurrence as a "no contact" and maintain a tally of those “no contacts” versus anomalies reacquired. If a “no contact” is encountered, the field team will follow the procedures listed below.

- When a NC is observed, field crews will document in detail all steps taken to remedy the anomaly.
- Initially, the NC will be double-checked against geophysical data. If a possible reason is apparent for the NC reading, the field crew will document their findings (e.g. large rock, possible coil bump, obstacle, survey path unclear, etc.).
- If no explanation for the anomaly is found, the NC will be re-examined with a MK2 to verify if an anomaly is detectable.

- The results of the NC will be reported to the QC Geophysicist who will investigate additional possibilities for "NC" such as secondary responses from nearby items, or noise. If no explanation can be found, the item will once again be investigated using a handheld device.
- If an anomaly still exists, another attempt will be made to intrusively investigate the item.

3.4.9.2 Reacquisition location will be converted to real-world coordinates for reporting purposes. If characterization results show the potential for MEC to extend beyond a currently defined MRS (or AoPI) footprint, ZAPATA will request direction from the USACE to continue to characterize the nature and extent beyond that boundary.

3.4.9.3 Multiple teams, each consisting of a UXO Technicians meeting the standards of DDESB TP-18 for their respective assigned positions, will intrusively investigate mag-and-dig or DGM reacquired anomalies. Our SUXOS, UXOQCS, and UXOSO will be on site at all times. ZAPATA will maintain a detailed record of the items including amounts of MEC, proper nomenclature and condition, location, depth and disposition. The record will include classification of the item (i.e., DMM, UXO or MC with enough explosives to present an explosive hazard) and the mark/model number of the item. Digital photographs will be taken for reporting purposes. Dig sheets and photographs will be linked to the project GIS. QC checks of the cleared designated anomaly locations will be accomplished by the UXOQCS by the next working day. UXO-qualified technicians will backfill excavations and restore the ground surface to its original condition. The UXO Technician III will document each MEC item and note its final disposition.

3.4.9.4 Once anomaly selections are made and the items are removed, the actual items will be compared to the selections to verify that the reported findings for each anomaly are consistent, meaningful, and defensible. The anomaly feedback process is essential to verify that dig results are consistent with the anomaly response. The comparison results will be used to refine instrument settings or selection thresholds, with concurrence from USAESCH, to reduce the number of false positives.

3.4.9.5 MEC Accountability and Record Management

A detailed accounting of all MEC items/components encountered will be maintained. ZAPATA will also account for all demolition materials utilized to detonate UXO on-site. Appendix L – Scrap Management, describes the procedures for inspection, certification, and verification of MD. A computer network project folder will be used to store all project data for the geophysical survey. Digital processing/interpretation folders will be maintained for the survey so the processing/interpretation sequence can be reproduced at a future date, if necessary. ZAPATA will preserve the integrity of the raw geophysical sensor and position data and ensure that the data are provided to a client representative. Raw data and processed data will be provided on compact disk (CD) with the completion report. Processed data will be presented as Geosoft *.GDBs databases and ASCII files. All pertinent geophysical data will be transferred to an independent / external hard drive or other computer media and stored at the centralized processing lab. ZAPATA will maintain the original or a copy of all records produced during the life of the contract. Reference information that may be recorded and stored for each survey area includes, but is not limited to:

- Site identification (file name and survey coordinates);
- Survey area conditions;
- Acquisition personnel;
- Weather conditions; and
- Instrument serial number(s).

3.4.9.6 UXO Personnel and Qualifications

3.4.9.6.1 Personnel Qualifications

All UXO personnel meet the requirements of DDESB Technical Paper (TP) 18 (DDESB, 2004).

3.4.9.6.2 Anomaly Avoidance Escort

Field activities will be under the direct supervision of a UXO-qualified anomaly avoidance escort.

3.4.9.6.3 Intrusive Investigation Teams

Intrusive investigation will be under the direct supervision of the SUXOS. The intrusive investigation team will be responsible for:

- Operating all metal detectors;
- Marking, plotting location and recording of all MEC, MD and cultural debris encountered;
- Intrusively investigating anomalies;
- Identifying and classifying MEC and munitions components;
- Photographing MEC;
- Conducting explosive disposal procedures of UXO, if necessary;
- Segregating, and removing all MD from each grid; and
- Performing other MEC operations when directed by the SUXOS.

3.4.9.6.4 Team Makeup

While the size of the UXO team(s) will be determined in the field, the maximum team size is seven persons. Resumes of key personnel are included in Appendix H.

3.4.9.6.5 Personnel Records

The UXOSO will maintain personnel files on each employee. All UXO personnel will meet the requirements of DDESB TP 18. Prior to beginning work on site, all employees at this job site will have completed a training program that complies with OSHA Regulation 29 CFR 1910.120e(9). Management and supervisors receive an additional eight hours training on program supervision. Each employee annually receives eight hours of OSHA refresher training.

3.4.9.6.6 Records Check

The SUXOS and/or UXOQCS/SO will conduct training. Records of attendance (and student performance, when applicable) are recorded. Prior to assignment to a duty position or change in duty position, the UXOQCS/SO performs a check of the individual's site personnel record to ensure that the employee is qualified to fill the position.

3.4.9.7 MEC Sampling Locations

Anomaly locations will be recorded during intrusive operations using standard field forms (Appendix F).

3.4.9.8 MEC Sampling Procedures

The anomaly investigation operation will start after the designated targets have been located during mag-and-dig operations or following reacquisition within grids. Each hole will be cleared, and signed off as such in the digital dig sheet. If the hole cannot be cleared (e.g. concrete culvert with rebar), that should be noted in the comments. All marked anomalies will be excavated using hand tools (i.e., shovels, picks, spades, etc.).

3.4.9.9 Munition with the Greatest Fragmentation Distance

The munition with the greatest fragmentation distance (MGFD) varies across MRSs and AoPIs. The munition we're most likely to encounter in MRS 1, AoPI 11B, and AoPI 11D are the 40mm M651 CS grenades, M83 60mm Illuminating projectile, and the 81mm Practice M879, respectively; these items do not have published horizontal maximum fragmentation distance (MFD-H) values as they are non-fragmenting. Thus, we have reported overpressure distances for inhabited building (i.e., K40) in place of instead of MFD-H values. AoPI 8 and AoPI 9E were reportedly used as small arms ranges only and, therefore, do not have MFD-H buffer zones associated with those areas. For all other MRSs and AoPIs, ZAPATA has assumed an MGFD (the MGFD differs from the munitions item used to develop the investigation report in some cases). The MGFDs and buffer zones are summarized in Table 19 and provided on Exhibits 5 through 12 in Appendix B; Fragmentation Data Review Forms are provided in Appendix G.

3.4.9.10 Minimum Separation Distances and Hazard Fragmentation Distance

The USACE has intrusively investigated millions of surface MEC items and subsurface anomalies that have the potential to be unexploded ordnance over the past 15 years on more than 1,000 project locations for FUDS, Base Realignment and Closure (BRAC), and active installations. These are extremely conservative estimates. On one project alone, USACE investigated over 3,000,000 anomalies, of which approximately 1.67% was UXO, with no accidents or unintentional detonations. For these reasons, the probability of an unintentional detonation, due to project activities, is assessed to be "Extremely Low", and the use of the hazard fragmentation distance (HFD) for the minimum separation distance (MSD) for non-essential personnel for unintentional detonations is warranted and authorized. The HFD and MSD (sandbag mitigated) are summarized in Table 19 and provided on Exhibits 5 through 12 in Appendix B; Fragmentation Data Review Forms are provided in Appendix G and the ESP in Appendix O. In some cases, the anticipated munitions are non-fragmenting and do not have published HFDs; in those cases, we have reported the overpressure distances for inhabited buildings (i.e., K40). Several areas scheduled for investigation are near primary roadways, such as SC Highways 56, 295 and 9 and US Highway 176. ZAPATA has established a buffer zone along those corridors equal to the greater of the HFD or the Sandbag Mitigation Distance (SMD). No intrusive operations will be conducted in those buffer zones.

3.4.9.11 MEC Identification

Prior to initiation of fieldwork, data on individual types of expected MPPEH (based on archival data available to ZAPATA) will be printed for use in the field by UXO Technicians. These data will include nomenclature, dimensions, general appearance, fillers, and any unique features useful in identification of MPPEH items. The field team will consult this information basing identification of each item on a list of features unique to the item in question. If MEC items are located, they will be documented in the GPS, photographed with a digital camera, and entered into the daily field log using a unique numerical identifier. The locations of the MD and cultural debris will be recorded as per guidelines set forth in DID MR-005-05.01. A minimum of two UXO Technicians II, one of which will be a UXO Technician III, must be in agreement on the nature and condition of a live item before any action is taken. If the nature of an item remains in question after field evaluation by UXO Technicians, digital data and images of the item will be forwarded to the USAESCH and ZAPATA's offices for consultation.

3.4.9.12 MEC Removal

All marked target anomalies will be excavated using hand tools (i.e., shovels, picks, spades, etc.). Items recovered during excavation will be inspected by the UXO Technicians, and then treated in the following manner: items including all MD and cultural debris will be visually inspected to ensure they are free of explosive hazards; collected; then transported to the storage area.

3.4.9.13 MEC Storage

MEC items requiring detonation will be destroyed on the day of discovery. Thus, ZAPATA will not store MEC items.

3.4.9.14 MEC Disposal Procedures

All MEC will be disposed of by detonation utilizing standard demolition procedures as outlined in Technical Manual (TM) 60A-1-1-31. The following paragraphs describe in general the procedures ZAPATA will use to detonate MEC items at Camp Croft.

3.4.9.14.1 Unexploded Ordnance

The SUXOS will make the final determination if an MPPEH item is acceptable to move, after the minimum of one UXO Technician II and one UXO Technician III have agreed on the nature and condition of a live item. If concurrence of the condition of the MPPEH cannot be reached, the item will be disposed of in place.

3.4.9.14.2 Acceptable- to-Move Items

The preferred means of MEC disposal will be (blow-in-place) BIP; however, to reduce the number of times personnel must handle explosive demolition materials, those items identified as being unfuzed and acceptable to move may be collected and consolidated for disposal within the individual respective grids.

3.4.9.14.2.1 Transport

After determining an item is acceptable to move, the UXO Tech III will determine the most expeditious route for safe movement of the MEC item to the in-grid consolidation point. MEC items safe to move for consolidation will not be transported on public roads; thus, conferring with state transportation officials is not required.

3.4.9.14.2.2 Items Unacceptable to Move

BIP operations will be conducted for all MEC items that are deemed unacceptable to move. BIP disposal operations will begin at the work site only after all non-essential and non-UXO personnel are out of the MSD of the ordnance being detonated. Demolition safety and operations will be conducted IAW the standard practices and procedures outlined in TM 60A-1-1-31, and MEC will only be detonated after positive identification. Electrical demolition procedures will be employed as the method of choice for all detonations, and all demolition shots will be tamped. All detonation/access holes will be backfilled. Demolition operations, if required, will take place at the end of the workday, weather permitting. The SUXOS is responsible for determining whether minimum safe conditions to conduct demolition operations are met. If an event such as inclement weather prevents the destruction of any UXO, arrangements will be made to provide security for the site. Team personnel will provide perimeter security during demolition operations. Personnel safe separation distance for demolition operations will be IAW DDESB TP 16. The following paragraphs describe the procedures that will be used to detonate UXO items at Camp Croft.

3.4.9.14.2.3 Site Control, Evacuation, and Establishment of Exclusion Area

All roads/trails that provide access to the disposal location will have roadblocks established during demolition operations. The SUXOS and the UXOQCS/SO will be on-site at all times during demolition operations. The operation is performed under the direction and supervision of the SUXOS, who is charged with the responsibility to ensure that procedures contained in this WP and referenced documents are followed. The UXOQCS/SO monitors compliance with the safety measures contained in the WP and associated documents and, in the event of non-compliance, is vested with the authority to stop or suspend operations. Prior to initiation of demolition operations, all non-essential personnel will be evacuated to a minimum of the MSD from the demolition area, as determined by consultation of DDESB guidance for the MEC item in question. The SUXOS and UXOQCS/SO will verify that the exclusion zone is clear of all non-essential personnel and verify that all required notifications have been made. Personnel remaining on-site will be limited to those needed to safely and efficiently prepare the item(s) for destruction. Prior to priming the demolition charges, all avenues of ingress will be physically blocked by guard personnel. Radio communications are maintained between all involved parties at all times. Avenues of ingress are not opened without the express permission of the UXOSO. A constant state of vigilance is maintained by all personnel to detect any intrusion into the fragmentation zone or over flights of aircraft. Evacuations are not anticipated as there are no businesses or inhabited buildings in or adjacent to the exclusion zone (EZ) of the MRS'. Every effort will be made to minimize disruption to construction and mining traffic during intrusive operations.

3.4.9.14.2.3.1 Road Closures

Roads entering the EZ may be blocked during intrusive investigation to ensure that unsuspecting individuals are not placed in jeopardy. The intrusive team will assure the area is clear of unauthorized personnel and equipment prior to intrusive investigation activities. It will be the responsibility of the intrusive team to suspend intrusive activities if any aircraft, vehicle, or personnel are sighted approaching the site. Roads entering the EZ will be blocked during explosive operations traffic observers will be stationed at locations along affected roads where there is a good view of the air and surface approaches to the demolition site. Reflective high-visibility barricades will be used at check points along roads which are to be closed. These will be manned by traffic observers in constant radio contact with the SUXOS and UXOSO. It will be the responsibility of the traffic observers to notify the SUXOS by hand-held radio to suspend operations if any aircraft, vehicle, or personnel are sighted approaching the EZ.

3.4.9.14.2.4 Engineering Controls

If necessary, engineering controls in the form of sandbag enclosures will be used. These will be in accordance with USACE Huntsville Center Publication HNC-ED-CS-S-98-7, "Use of Sandbags for Mitigation of Fragmentation and Blast Effects due to Intentional Detonation of Munitions." In the event that overhead power lines are located within the calculated vertical fragmentation range for the MGFD as listed in DDESB TP-16, intrusive activities will not proceed without the use of engineering controls. Demolition activities will be in compliance with:

- USAESCH's "Basic Safety Concepts and Considerations for Ordnance and Explosives Operations" (USACE 2001);
- DoD's 6055.9 Std., "DoD Ammunition and Explosive Safety Standards"; and
- TM 60A-1-1-31, "Explosive Ordnance Disposal Procedures."

3.4.9.14.2.5 Equipment

Standard electric and non-electric demolition equipment will be used. Procedures to be used will follow the guidelines dictated by TM 60A-1-1-31. Although use of electrical disposal procedures are anticipated, non-electrical procedures are included to provide procedural guidance should a circumstance arise where non-electrical firing procedures are the most prudent means of initiating a demolition shot.

3.4.9.14.2.6 Use of Cellular Phones and the Proximity of Cellular Telephone Service Towers

As noted in EM 385-1-97, the use of cellular phones and the proximity of blasting operations to a cellular service tower could present an electromagnetic radiation hazard. The cellular telephone is considered a low-power device, but there are concerns about their use in the proximity of blasting caps.

- Cell phones with less than one watt must be kept at least eight feet from a blasting circuit;
- Contact should not be made between the blasting circuit and the cellular telephone antenna and charging jack. As an added precaution, the charging jack may be covered with non-conductive tape;
- Restrict the use of cellular phones during blasting operations to only those who have the approval of the person in charge and are operated in accordance with approved procedures; and
- If it is suspected that a blasting circuit is at approximately the same elevation as a nearby cellular telephone service tower's cluster antenna, then the radio frequency field strength measurements should be made at the location of the blasting circuit and competent expert advice sought.

3.4.9.14.3 Demolition Procedures

The following policies are not all inclusive nor are they applicable in all situations. This section is not a stand-alone document and is to be used together with other parts of the WP including the APP and Explosives Management Plan, applicable Federal, State, and local regulations and contract restrictions and guidance.

3.4.9.14.3.1 General Demolition Operations

The following demolition procedures are not all inclusive. Additional safety and procedures information are found in the references cited above. The following is a general guide for disposal operations:

- Analyze explosive operations with a view towards reducing the number of personnel and quantity of explosive material subject to an accident. However, never allow one person to work alone.
- Prohibit tasks not necessary to the explosive operation in the fragmentation zone of such operations.
- Use sufficient warning signals and maintain a restricted/exclusion area when explosive operations are conducted. Cease operations when non-UXO personnel are present.
- Comply with the authorized explosive limits and safe separation distances.
- Discontinue explosive operations when unforeseen hazard conditions develop and do not resume until the condition is corrected.
- Smoke only in designated areas.
- Plan for, provide for, and know the emergency procedures in the event of an accident.
- Use special care in handling and disposal of damaged or deteriorated explosives, munitions items, and other hazardous materials.
- Disperse explosives awaiting destruction, in small quantities at safe distances, and protect them from unintentional initiation.
- Protect explosives and MEC items from the elements and static electricity.
- Provide an emergency vehicle outside the fragmentation zone for response in the event of an accident.
- Perform disposal operations only during daylight hours.
- Carry blasting caps in an approved container and handle them carefully.
- Do not use UXO for donor charges in demolition operations. They may be in an extremely sensitive and hazardous condition.
- Use caution when investigating post demolition shots. Search the area after each shot for any remaining explosives or explosive components.

3.4.9.14.3.2 Safety

ZAPATA will perform demolition operations in a manner consistent with industry standards and safe practices. The following procedures and safety precautions will be adhered to at all times.

3.4.9.14.4 Basic and General Munitions Safety Precautions

These basic safety precautions are the minimum munitions and ordnance safety requirements required of all personnel on site.

3.4.9.14.4.1 Basic Considerations

The following should be taken into consideration when planning or conducting UXO operations:

- SAFETY IS PARAMOUNT;
- The method of disposal for all recovered UXO items that are not acceptable to move will be BIP;
- Do not move or disturb unidentified items;
- All UXO will be identified independently by two UXO technicians;

- Do not collect souvenirs;
- Do not smoke except in designated areas;
- Do not carry fire or spark producing devices into the site;
- All UXO operations will use the "Buddy" system;
- Prohibit unnecessary personnel from visiting the site; and
- Demolition operations will be conducted in accordance with TM 60A-1-1-31.

3.4.9.14.4.2 Basic Safety Precautions

The following safety precautions are applicable to all UXO operations:

- Suspend all operations immediately upon approach of an electrical storm;
- Observe the hazards of electromagnetic radiation (EMR) precautions and grounding procedures when working with, or on, electrically initiated or susceptible MEC;
- Do not dismantle, strip, or handle any UXO unnecessarily;
- Avoid inhalation and skin contact with smoke, fumes, dust, and vapors of detonations and MC residue;
- Do not attempt to extinguish burning explosives or any fire which might involve explosive materials;
- Do not manipulate external features of ordnance items;
- Incorporate appropriate property and personnel protective measures for shock and fragmentation when conducting MEC operations;
- Do not subject MEC to rough handling during transportation - sand bag, chock, and block appropriately;
- Carry explosives in an appropriate container;
- Hand carry no more than two items (one in each hand) at a time and then only as required by the operation being performed;
- Destroy shaped charge munitions by counter charging the cone to prevent formation of the explosive jet;
- The preferred method for disposing of white phosphorous is to blow the munition in a manner that disperses the white phosphorus into the air versus down into the ground;
- Do not transport damaged white phosphorus munitions unless fully submerged in water;
- Avoid unnecessary movement of armed or damaged UXO;
- Avoid the forward portions of munitions employing proximity fuzing; and
- Assume unknown fuzes contain cocked strikers or anti-disturbance features.

3.4.9.14.4.3 General Safety Precautions

The following sub-paragraphs describe safety precautions for various types of munitions/disposal operations:

3.4.9.14.4.3.1 Projectiles

- Determine if the projectile has been fired and if so consider it armed;
- Check for the presence of unburned tracers;
- Avoid the rear and front of rocket assisted projectiles;
- Handle projectile components such as powder increments, cartridges, and primers with caution; and

- Seal the open ends of projectiles or sheared projectile components with tape or other suitable material before transporting.

3.4.9.14.4.3.2 Rockets

- Approach and work on rockets from the side;
- Do not dismantle or strip dud fired rockets or rocket motors;
- Do not expose electrically fired munitions to radio transmissions within 25 ft;
- Do not transport an unfired rocket motor until having shielded the motor igniter from EMR; and
- Dispose of unfired rocket motors, with or without warheads, in such a manner as to prevent them from becoming propulsive.

3.4.9.14.5 Demolition Procedures for Electric and Non-Electric Demolition Operations

The following sub-paragraphs outline the procedures that will be used to perform either electric or non-electric demolition operations:

- The method that provides the most positive control over the specific time of detonation is electric. However, situations may occur, such as an area with a high EMR hazard, where non-electric firing may be the only option.
- Cut the fuse long enough when initiating a non-electric charge to reach a safe distance by walking at a normal pace. Use a minimum of five minutes safe separation time on all shots.
- A minimum of 30 seconds separation time will be observed between multiple non-electric shots initiated simultaneously.
- Wait a mandatory 60 minutes plus the burn time of the fuse in the event of a misfire.
- For all buried charges use a dual priming system and detonating cord, DO NOT BURY CAPS.
- The demolition UXO Technician III will investigate all misfires.
- A "Fire in the hole" warning will be sounded three times, verbally, and on the radio prior to firing a shot.

3.4.9.14.5.1 Non-Electric Demolition Procedures

The following safety and operating procedures will be used to assemble and detonate explosive charges using non-electric firing trains:

- Do all demolition cap preparation procedures a safe distance (minimum 50 ft downwind) from the item(s) to be destroyed and demolition charges. Observe the following safety considerations;
- Do not strike, roughly handle, tamper with or attempt to remove or investigate the contents of a blasting cap;
- Handle caps only by their open end except during attachment to time fuse or detonating cord;
- Maintain positive control of caps;
- Do not force time fuse or detonating cord into caps;
- Always point explosive end of caps away from your body and other personnel during handling and crimping;
- Handle primed safety fuse and sensitized detonating cord with care. Avoid contact between caps and/or between caps and other hard objects; and

- Do not allow time fuse to coil up on itself, other time fuse, or explosives.

3.4.9.14.5.1.1 Procedures

- Assemble all equipment and explosives. Keep blasting caps away from explosives until priming the shot.
- Test burn time fuse.
- Cut, and dispose of the first 0.6 in of fuse. This will preclude an inaccurate burn rate or misfire due to moisture.
- Cut and test burn an appropriate length of fuse (no less than 3.0 ft) to determine the burn rate.
- These procedures will be accomplished at least 25 ft from explosives.
- Compute and cut time fuse to length (minimum 5 minutes) required for safe separation time.
- Inspect cap for foreign matter. Do not blow into cap to clear. Holding cap by the open end, lightly tap wrists together. If the foreign matter remains in the cap dispose of it on the shot and use a new cap.
- Crimp cap on time fuse, crimp 1/8 to 1/4 in from the base of the cap and attach the fuse lighter.
- Lay out and weight down time fuse.
- Prime explosive charge, sound the warning, initiate the fuse, and return to the safe area.

3.4.9.14.5.2 Non-Electric Misfire Procedures

- Upon misfire, WAIT A MINIMUM OF 60 MINUTES, PLUS BURNING TIME OF THE FUSE, AFTER THE MAXIMUM DELAY COMPUTED FOR ANY PART OF THE DISPOSAL SHOT TO ELAPSE BEFORE PROCEEDING DOWN RANGE.
- Up range, prepare a new non-electric firing system to include a new donor charge.
- After the required wait time has elapsed, proceed down range. Place a new charge close enough to the original charge to ensure detonation of both charges. When employing a detonating cord firing system use the following procedure: after the wait time, proceed down range, cut the detonating cord between the cap and the charge, and attach a new firing system to the end of the detonating cord going to the original charge. Destroy the cut detonating cord and cap with the newly primed shot.
- Sound the warning, initiate the new firing system, and return to the safe area.

3.4.9.14.6 Electric Demolition Procedures

Personnel performing electrically initiated demolition operations will strictly adhere to the following safety and operating procedures.

3.4.9.14.6.1 Safety Considerations

Do all demolition preparation procedures a safe distance (minimum 50 ft downwind) from the item(s) to be destroyed. Observe the following safety considerations:

- Never hook up caps to un-shunted wire;
- Never leave caps un-shunted unless actually testing or hooking to firing wire; and
- Observe explosive safety (e.g., do not strike, handle roughly, tamper with, or attempt to investigate the contents of the blasting cap.

3.4.9.14.6.2 Procedures

The following procedures will be used to assemble, test, and function electric firing trains:

- Prior to going down range, gather all equipment and explosives;
- Lay out (from the site to the safe area) the test firing wire;
- Ground yourself prior to breaking out caps. Keep explosive end of cap pointed away from your body and other personnel;
- Grip the cap lead wires 0.3 to 0.6 in behind the base of the cap, pull an initial arm's length of wire off the wire coil;
- Barricade the cap at least 50 ft downwind from other explosives;
- Un-shunt and test blasting cap(s);
- Splice the cap leads to the firing wire in a parallel circuit and insulate connections;
- Prime the shot;
- Return to the safe area and test the circuit for continuity; and
- Hook up the firing machine, sound the warning, and fire the shot.

3.4.9.14.6.3 Electric Misfires

- In order to prevent misfires, ensure that:
- All blasting caps are included in the firing circuit;
- All connections between blasting cap wires, connecting wires, and firing wires are properly made.
- Short circuits are avoided;
- Grounds are avoided; and
- The number of blasting caps in any circuit does not exceed rated capacity of power source on hand.

Common specific causes of electric misfires include:

- Inoperative or weak blasting machine or power source;
- Improperly operated blasting machine or power source;
- Defective and damaged connections, causing either a short circuit, a break in the circuit, or high resistance with resulting low current;
- Faulty blasting caps;
- The use in the same circuit of blasting caps made by different manufacturers or of different design; and
- The use of more blasting caps than power source rating permits.

3.4.9.14.6.4 Clearing Electric Misfires

If charge is electrically primed, proceed as follows:

- Make three successive attempts to fire.
- If unsuccessful, remove firing wires from blasting machine and check continuity of firing circuit.
- If continuity is good, reattach firing wires to blasting machine and make three more successive attempts to fire.
- Check connections of firing wires to blasting machine and make three more successive attempts to fire.
- Change blasting machine after third unsuccessful attempt with original blasting machine.

- If still unsuccessful, disconnect firing wire ends from blasting machine and shunt by twisting firing wire ends together.
- Wait 30 minutes after an electric blasting misfire. A malfunctioned electric cap may have initiated a burning explosive charge.
- Remove and disconnect old blasting caps and shunt wires.
- Connect wires of new blasting caps(s) to firing circuit and re-prime the charge(s).
- Reconnect firing wire ends to blasting machine and fire charge(s).

3.4.9.14.7 Discarded Military Munitions

The preferred means of DMM disposal at Camp Croft is BIP; however, to reduce the number of times personnel must handle explosive demolition materials, those items identified as being unfuzed and acceptable to move may be collected and consolidated for disposal.

3.4.9.14.8 Munitions Constituents

If the presence of munitions constituents is suspected in high enough concentration to pose an explosive hazard, the USACE will be immediately consulted. After appropriate notifications, the MC will be destroyed, in coordination with the USACE.

3.4.9.14.9 DD Form 1348-1A

3.4.9.14.9.1 The Senior UXO Supervisor will certify and the USACE OE Safety Specialist will verify that the debris is free of explosive hazards. The DD form 1348-1A will be used as certification / verification documentation. All DD 1348-1A will clearly show the typed or printed names of the contractor's Senior UXO Supervisor and the USACE OE Safety Specialist, organization, signature, and contractor's home office and field office phone number(s) of the persons certifying and verifying the debris as free of explosive hazards. The form will state the following:

"This certifies and verifies that the Material Documented as Safe (MDAS) listed has been 100% inspected and to the best of our knowledge and belief, is free of explosive hazards."

3.4.9.14.9.2 All material will be accounted for in the daily and weekly reports. Disposal documentation receipts will be generated identifying the day of off-site removal, approximate scrap weight and signature of the recipient. Turn-in documentation will be submitted as an appendix to the final RI/FS report.

3.4.9.15 MEC Disposal Alternatives

ZAPATA may request that the Spartanburg County Sheriff's Office respond to an identified MEC item. In that case, the item will be guarded following its discovery, while the field team awaits the response of local authorities.

3.4.9.16 Chemical Warfare Materiel

3.4.9.16.1 This site is not suspected of containing CWM. However, during conventional MEC operations, if ZAPATA identifies or suspects unknown liquid-filled munitions, all personnel shall immediately withdraw upwind from the work area and contact the contracting officer and the appropriate point of contact in their Work Plan (WP)/Accident Prevention Plan (APP). ZAPATA shall secure the area and provide two personnel located upwind of the suspect item(s) to secure the site until relieved by the Department of the Army emergency response personnel. Additional support may be required by the emergency response personnel, such as, construction of blast mitigation controls. Additional reporting instructions are contained in Notification Procedures for Discovery of Recovered Chemical Warfare Materiel (RCWM) During USACE Projects, USACE Interim Guidance, CEMP-CE Memorandum 200-1a dated 23 April 2004.

3.4.10 Geographic Information System Management

3.4.10.1 ZAPATA will use, build upon, and manage the existing GIS package IAW DID WERS-007.01, EM 200-1-2, EM 1110-1-4009 and other applicable interim guidance documents to develop the CSM and monitor project progress. Since 1995, ZAPATA has compiled Camp Croft GIS data and developed a comprehensive GeoDatabase, including such site vector data as color aerial imagery, State Natural Area boundaries, parcels, transportation feature centerlines, place names, wetlands, flood hazard zones, soils and buildings. ZAPATA maintains current ESRI software and will maintain our existing database in the ArcGIS 9.x environment. We will integrate new environmental data into the GIS as necessary, including well locations, sample locations, lab results, location of sensitive habitat and potential receptors, such as newly discovered drinking water wells, and rights-of-entry.

3.4.10.2 ZAPATA will create two separate GIS GeoDatabases, including respective pre and post-project response action geospatial data analyses. The Pre-RI GeoDatabase will be built from existing GIS data, with data refreshed as new data become available. Social, economic, and/or environmental entities that may be or will be affected by response actions will be selected and incorporated into GIS "layers" within the Pre-RI GeoDatabase. As the project is executed, the Post-RI GeoDatabase will serve as the comprehensive project GeoDatabase, incorporating entities impacted by RI/FS activities and impacts of future response action activities (if applicable). Layers will be incorporated that overlay on the maps of the site that identify physical features, and MPPEH/MD and Range-Related Debris found during previous investigations. By creating this living GeoDatabase, the Project Manager and technical staff will have an accurate grasp of potential issues.

3.4.10.3 All data will be delivered in the local UTM coordinate system. We will take the GIS data, manual, file, and GeoDatabase structure from the Huntsville Center standard and the previously developed ArcGIS GeoDatabase and layer files and expand on the development through the RI/FS processes. The post RI and FS analysis will detail entities impacted by the RI/FS activities and impacts of future response actions. We will post this map to the internet providing stakeholders immediate access to site data. Map layers will be developed in conformance with the Spatial Data Standards for Facilities Infrastructure and the Environment (SDSFIE) for Installation Mapping and Geospatial data. This will allow the GIS data to be queried, retrieved, and disseminated via password to the USACE and team members, and to stakeholders authorized by the USACE. At the project conclusion, the GIS will be submitted to the USACE on a CD or DVD. Information about archaeological and culturally sensitive areas and property owner information will not be published in the GIS.

3.4.11 Munitions Constituents Sampling

Environmental field sampling for the RI/FS will be conducted after the MEC investigation and will include discrete surface soil sample collection. MC samples will be collected in areas with high anomaly densities. Tentatively, those high density areas are defined as those areas where the anomaly density count is > the 97th percentile of all anomaly densities. Environmental field sampling activities are described in detail in the UFP-QAPP (Appendix E), herein. Upon approval of the final WP, the USAESCH PM will authorize ZAPATA to initiate the site investigation activities; environmental sampling will be scheduled accordingly. Discrete background surface soil samples will be collected geographically close to the MRSs and AoPIs and shall have similar lithologic characteristics to those of the site. Soil samples collected from background locations will be analyzed for selected metals, only.

3.4.12 Risk Assessment

ZAPATA will use the data from the RI field activities to prepare new or update existing Munitions Response Site Prioritization Protocol (MRSPP) forms for each MRS, and compile the evaluation as a stand-alone document for insertion as an appendix into the RI Report.

3.4.12.1 Munitions and Explosives of Concern Hazard Analysis

3.4.12.1.1 ZAPATA will complete the MEC Risk Assessment in accordance with the guidance provided in the MEC Hazard Assessment (HA) Methodology, Interim (US EPA, 2008). The MEC HA methodology provides guidance assessing explosive hazards to human receptors at MRS and reflects the fundamental difference between assessing the chronic chemical exposure risk and assessing the acute MEC explosive hazards. The MEC HA is structured around three components of potential explosive hazard incidents:

- Severity, which is the potential consequences (e.g., death, severe injury, property damage, etc.) of an MEC item functioning;
- Accessibility, which is the likelihood that a receptor will be able to come in contact with an MEC item; and
- Sensitivity, which is the likelihood that a receptor will be able to interact with a MEC item such that it will detonate.

3.4.12.1.2 Each of these components is assessed in the MEC HA by input factors. Each input factor has two or more categories associated with a numeric score that reflects the relative contributions of the different input factors to the MEC hazard assessment. The sum of the input factor scores falls within one of four defined ranges, called hazard levels. Each of the four levels reflects site attributes that describe groups of sites and site conditions ranging from the highest to lowest hazards.

3.4.12.1.3 For the RI, the MEC HA is used to assess explosive hazards of current (baseline) conditions. During the FS analysis of remedial alternatives, the MEC HA assists in the analysis of the four balancing criteria: long-term effectiveness, short-term effectiveness, implementability, and reduction of toxicity, mobility, or volume through treatment.

3.4.12.2 Human Health Risk Assessment

ZAPATA assumes that a comprehensive human health risk assessment will not be conducted. The presence of chemicals of potential concern (COPCs) for human health is unknown given that there are no existing chemical analytical data from previous investigations. Pending the results of the geophysical surveys, and supplemental discrete sampling to determine the presence or absence of munitions constituents (MC), a human health risk screening will be performed that compares the maximum site constituent concentration to EPA RSLs dated June 2011 to identify COPCs. These can be found at http://www.epa.gov/region9/superfund/prg/. Identified COPCs will be evaluated further in the HHRA. Private land owners and recreational visitors are anticipated to be the primary exposure receptors, even though access to portions of MSR 3 is limited. Upon review of existing information from TPP meetings, land use conditions, etc., a more detailed discussion of site conditions and potential exposure scenarios will be developed. A toxicity assessment and a risk characterization will also be included in the HHRA. The principal guidance documents for use in conducting the human health risk assessment include: Risk Assessment Guidance for Superfund (RAGS) (Parts A through E) (US EPA, 1989, 1991, 2001, and 2004) and EM 200-1-4, Volume I Human Health Evaluation (USACE, 1999).

3.4.12.3 Ecological Risk Assessment

The presence of COPCs for ecological receptors is unknown given that there are no existing chemical analytical data from previous investigations. A screening level ecological risk assessment (SLERA) will be developed based on the existing data and all subsequent data collected from the various MRSs to determine the presence/absence of MC. Once any contamination is delineated to the RSL table, EPA Region IV Ecological Screening Values (Eco-SSLs) will be used for ecological risk assessment purposes. These can be found at http://www.epa.gov/region4/waste/ots/epatab4.pdf. A review of existing information as to the potential for sensitive or habitats in the affected areas will be included. It is assumed that the ERA process will not continue beyond step 3A of the SLERA. The principal guidance documents that will be used in conducting the ecological risk assessment include, but are not limited to: EM 200-1-4, Volume II Environmental Evaluation (USACE, 1996), Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (US EPA, 1997), and SC DHEC guidance. A baseline risk assessment will be conducted.

3.4.13 Reporting

3.4.13.1 Remedial Investigation Report

3.4.13.1.1 ZAPATA will prepare an RI Report in accordance with the DID WERS-010.01, US Army MMRP RI/FS guidance (US Army, 2009), EP 1110-1-18 (USACE, 2000), and IGD 06-04 (USACE, 2006) in Draft, Draft-Final, and Final versions. Major components of the RI Report pertinent to Camp Croft include Site Characterization, MRS Characterization for MEC, MC Characterization, Data Evaluation, Human Health and Ecological Risk Assessments, Assessment of Required Interim Measures, and Remedial Investigation Reporting. ZAPATA will incorporate all relevant previously collected Camp Croft data into our RI Report. If warranted, ZAPATA will recommend MRS and/or AoPI boundary changes within the RI Report. The following paragraphs detail some of the key aspects of these assessments.

3.4.13.1.2 ZAPATA will document the physical characteristics of the property, environmental media, the types, quantity and concentration of UXO and DMM, the extent of observations, actual and potential exposure routes, and other factors that may affect characterization.

3.4.13.1.3 ZAPATA will describe the technology selected for MEC characterization, the survey design implanted, analysis of the geophysical data, anomaly discrimination and interpretation and results of the intrusive investigation.

3.4.13.1.4 ZAPATA will describe the sample location and interval selection information, analytical methods used to obtain data, the analytical results, and validation processes incorporated to ensure data representativeness and accuracy.

3.4.13.1.5 The risk assessments will be prepared as an appendix to the RI report and summarized in the main body of the RI report. All usable data from the other relevant previous investigations will be included. The risk assessments will be structured per the guidance materials to include an exposure evaluation that addresses chemical fate and transport to the receptors and the factors that may affect potential bioavailability, persistence, and bioaccumulation potential. Toxicity evaluations and characterization of risks will also be described. Output from software used during the risk assessment will be included in the appendix to the RI report.

3.4.13.2 Feasibility Study Report

The purpose of the FS is to provide the project decision makers with the necessary data to select a response alternative and to develop, screen and evaluate a range of potential response alternatives to manage the MEC and MC hazards to human health and the environment and risks at the site. ZAPATA will prepare an FS Report in accordance with DID WERS-010.01, EP 1110-1-18 (USACE, 2000), and IGD 06-04 (USACE, 2006) in Draft, Draft-Final and Final versions.

3.4.13.2.1 Preliminary ARARs Identification Technical Memorandum

Efforts to identify site-specific, chemical-specific, and applicable or relevant and appropriate requirements (ARARs) will be conducted throughout the RI process. ZAPATA will identify and submit ARARs to the PDT in a Preliminary ARARs Identification Technical Memorandum in a format appropriate for direct incorporation into the FS report.

3.4.13.2.2 Remedial Action Alternatives Screening Memorandum

We will formulate remedial-action alternatives throughout the RI process, and will separately consider MEC and MC. Development of potential alternatives will include long-term management of waste or residuals, containment with little or no treatment, and/or no-action. The memorandum will include remedial action objectives, preliminary remediation goals, general response actions, identification of applicable technologies, and development of alternatives. The memorandum will include screening alternatives for effectiveness, implementability, and cost. The memorandum will be presented in a format appropriate for direct incorporation into the FS report.

3.4.13.2.3 Remedial Alternatives Evaluation Memorandum

We will describe each alternative, outlining the strategy and ARARs associated with each, including a discussion of the performance of each alternative with respect to selection criteria, while summarizing and tabulating the results. We will provide a detailed analysis of remedial alternatives addressing evaluated environmental media. We will use EPA's three-tiered approach in determining remedial alternatives. The evaluation criteria include 1) Threshold Criteria, 2) Modifying Criteria, and 3) Primary Balancing Criteria. Threshold Criteria includes a) Overall protection of human health and the environment and b) Compliance with identified ARARs. Modifying Criteria includes a) State regulatory acceptance and b) Community acceptance. Primary Balancing Criteria includes a) Long term effectiveness and permanence, b)

Reduction of toxicity, mobility, and volume through treatment, c) Short term effectiveness, d) Implementability, and e) Cost.

3.4.13.3 Proposed Plan

ZAPATA will prepare a Proposed Plan (PP) written in non-technical language that is understandable by the general public. ZAPATA will prepare the PP in accordance with CERCLA, ER 200-3-1 (USACE, 2004b) and Errata Sheet #1 dated 4 December 2007, EP 1110-1-18 (USACE, 2000), and IGD 06-04 (USACE, 2006), and will include a brief summary description of the remedial alternatives evaluated in the FS. We will clearly outline the decision-making process, presenting the results of the data collections, rationale for interpreting analytical results, outcome of the risk assessments, and how all of these data relate to a remedial alternative. We will include a summary of formal comments received from regulators; a summary explanation of any proposed ARAR waiver(s), and will identify and provide a discussion of the rationale that supports the preferred remedial alternative. ZAPATA will submit a Draft PP to the USACE only within 14 days of the acceptance of the FS Report. ZAPATA will submit a Draft-Final PP 14 days after receipt of comments on the Draft PP. Following a 30-day public review period of the Revised Draft-Final PP, ZAPATA will conduct a public meeting to discuss the PP with interested stakeholders. ZAPATA will submit a Final PP that incorporates and/or addresses public comments along with meeting minutes documenting the public discussions within 14 days following the public meeting.

3.4.13.4 Decision Document

We will prepare a Decision Document (DD) for each MRS in accordance with CERCLA, ER 200-3-1 (USACE, 2004b), EP 1110-1-18 (USACE, 2000), IGD 06-04 (USACE, 2006), and Appendix C of the PWS. ZAPATA will submit Draft, Draft-Final, and Final DD(s). The Final DD will include a Responsive Summary. The DD will include;

1. Title, including project name and project number, date DD (or AM) was signed and by whom,
2. Brief description of the respective Munitions Response Site (MRS), covered by the decision,
3. Brief description of selected response action and its relationship to other cleanup actions,
4. Degree of risk reduction,
5. Present worth cost of selected response action, and the contribution to the cost-to-complete of all remedies for the FUDS Property,
6. Funding amounts and fiscal year(s) that funds are required for remedial/removal action design and construction,
7. Duration of any remedial action-operation (RA-O), removal action-construction (RmA-C) and/or Long Term Monitoring (LTM) actions,
8. Land use controls (LUC) required and means of maintaining them,
9. Other potential response actions considered, and
10. Expected result of the action.

3.4.13.5 Public Involvement Plan

ZAPATA will update and maintain the existing Public Involvement Plan (PIP) that was drafted by ZAPATA in October 2009 in accordance with the provisions of the NCP, ER 200-3-1 (USACE, 2004b), EP 1110-3-8 (USACE, 2004a), and IGD 06-04 (USACE, 2006). The PIP is an organized approach for keeping community leaders, local government officials, and affected citizens informed about the project. More importantly, it details how stakeholders may become involved and provide feedback to the USACE. The PIP will be continually updated to provide the most current, complete information. We will submit a Draft PIP at a time to be determined over the course of the project. A Draft-Final PIP will be submitted 14 days after receipt of Draft PIP comments, and a Final version of the PIP will be submitted seven days after receipt of Draft-Final PIP comments.

3.4.14 Community Relations Support

3.4.14.1 ZAPATA will provide community relations support throughout the project life to accomplish project requirements and objectives. Our Team will attend and participate in three public meetings, tentatively scheduled to be held in Spartanburg, SC. Tasks include delivery of presentations, graphics and development and production of handout materials. In the past, RAB meetings have been held at the Marriott Renaissance in downtown Spartanburg; unless a change is preferred, we would likely continue to hold meetings at that location. We will submit all presentation materials to USACE for approval not later than 21 days prior to the meetings and make them available to the public seven days prior to the meeting. We will provide all logistical support for these meetings. Specifically, ZAPATA will:

- Notify the community of each scheduled meeting via mailed meeting reminder cards and advertisements in the local newspapers, including contact information;
- Continually update the mailing list with addresses of meeting attendees and notifications of interested parties;
- Coordinate all meeting logistics, including development of an agenda, with the USACE;
- Ensure the meeting facility is handicapped-accessible and satisfies all audio-visual requirements;
- Participate in question and answer dialog;
- Develop and distribute handout materials, fact sheets and/or brochures describing the history of the site, objectives of RI/FS, and safety information;
- Provide for transcription services, place transcripts in the local information repository, post transcripts on the website, and provide copies to the USACE; and
- Submit a meeting summary within seven days of each public meeting.

3.4.14.2 Community communication will be important during execution of field activities. To ensure the safety of persons and property, we will:

- Present safety requirements and an explanation of exclusion zones at both the TPP and public meetings; and
- Control traffic flow using field personnel, and stop approaching persons or vehicles outside of the exclusion zone.

3.4.15 Administrative Record

ZAPATA will establish and maintain a project repository and Administrative Record (AR) for the Camp Croft site IAW the guidance given in Chapter 4 (Establishing and Maintaining Administrative Records) of EP 1110-3-8 (USACE, 2004a) and Standard Operating Procedure for Formerly Used Defense Sites (FUDS) Records Management, Revision 5, dated January 2008. The documents available for public review will be housed at the Spartanburg County Public Library located at 151 South Church Street, Spartanburg, SC 29306. We will closely coordinate with the USACE to secure all required documents necessary to support the Administrative

Record. Electronic AR files will be maintained on the electronic information repository currently managed by ZAPATA under a separate task order. Final electronic document files will be in text-searchable (*.pdf) format. Final documents in the Administrative Record suitable for placement on the Project Information Retrieval System (PIRS) website will be provided on CD/DVD to appropriate entities, including USACE, at the end of the project.

3.4.16 Geospatial Information and Electronic Submittals

At the completion of the project, all project information will be saved to DVD/CD and submitted to the USAESCH. These data will include all plans, reports, and communication records, along with all data generated during investigation operations. The GIS database will be managed and submitted as described in Section 3.4.10.

3.4.17 Investigation Derived Waste Plan

3.4.17.1 During MC sampling, ZAPATA will generate IDW; this waste includes personal protective equipment used during sample collection (e.g., nitrile gloves) and liquids generated during decontamination processes. If the monitoring well installation is required, soil cuttings and development/purge water will also be considered IDW. Hazardous wastes other than RCWM will be disposed of IAW applicable regulations. This may include disposal in a Class II Hazardous Waste Facility. All IDW will be packaged in accordance with state and Federal laws and regulations. Packaging will ensure segregation of materiel (if necessary) for transportation and ultimate disposal of the IDW. IDW will be disposed by a facility that operates as a Treatment, Storage, and Disposal Facility (TSDF) under Resource Conservation and Recovery Act (RCRA) regulations.

3.4.17.2 The personnel and equipment necessary to package, label, manifest, transport, and dispose the IDW will be provided by ZAPATA, as necessary. The USACE or USAESCH will designate the point of contact for signature of the hazardous waste manifest.

3.4.17.3 All licenses and permits required to comply with applicable Federal, state, and local laws, codes, and regulations will be obtained prior to collections and containerization of IDW. All work will be accomplished in strict accordance with such licenses and permits.

3.4.17.4 All methods used to ship or transport IDW will be in accordance with Department of Transportation (DOT) Hazardous Material Regulation 49 CFR 100-199. All required hazardous waste manifests will be prepared by an appropriately trained and certified shipping agent or specialist. The manifests will include a correct, complete, and legible description of all wastes to be shipped.

3.4.18 Risk Characterization and Analysis

The EPA/DoD MEC HA model will be used for MEC risk assessment and analysis as described in Section 3.4.12.1. MC risk assessment and analysis is described in Sections 3.4.12.2 and 3.4.12.3.

3.4.19 Analysis of Land Use Controls

3.4.19.1 An Institutional Analysis and an Institutional Control Plan are not part of ZAPATA's PWS. However, ZAPATA will perform an institutional analysis to develop and evaluate potentially effective institutional controls as a part of the RI/FS process. For each institution selected for review, the following information will be provided:

- Name of Agency
- Origin of Institution
- Basis of Authority
- Sunset Provisions (refers to the periodic review of government agencies in order to continue their existence).
- Geographic Jurisdiction
- Public Safety Function
- Land Use Control Function
- Financial Capability (in general terms only; not detailed accounting)
- Desire to participate in the institutional control program
- Constraints to Institutional Effectiveness.

3.4.19.2 Institutional controls alternatives for detailed analysis may consist of single or combined strategies, as appropriate. These alternatives will be completely formulated. All management, execution, and support roles will be identified and costs to participating institutions will be estimated.

3.4.20 Preparation of the Five-year Review Plan

The preparation of the Five-year Review Plan is not part of ZAPATA's PWS.

4.0 QUALITY CONTROL PLAN

ZAPATA has a Corporate Quality Assurance (QA) Program that results in an aggressive project-level QC program. Our Nonconformance and Corrective Action Reporting (NCAR) program applies to every aspect of project fieldwork. The program contains a form that addresses the description of nonconformance, the probable cause, a recommended corrective action, and allows for the Project Manager to review and either concur with, or recommend a different action. Once the corrective action is completed, the work is re-inspected to ensure compliance. Our QA Program enforces a Deliverable/Document Review Process that requires all documents to be reviewed by knowledgeable personnel, other than the author. The document is ultimately reviewed by the Vice President of Program Compliance for completeness, accuracy, grammar, and compliance with contract/scope requirements.

4.1 COMMITMENT TO QUALITY

Our quality of work is managed from task order award through acceptance of the final deliverables, as described in our Corporate Quality Program, reviewed and accepted by the USACE. Ms. Suzy Cantor-McKinney, Vice President of Program Compliance and previously the Program Manager of our MMRP program for more than ten years, will conduct quality reviews and oversight to ensure that the PWS objectives are met. She reports outside of the project chain of command. All quality control personnel report to Ms. Cantor-McKinney, which eliminates the possibility of QC personnel being subordinate to the Project Manager.

4.2 ZAPATA PERSONNEL RESPONSIBILITIES

4.2.1 Project Manager

Mr. Jason Shiflet, P.G., the PM, is responsible for all aspects of the project including the quality of all products and services provided as part of this PWS. He will ensure that all deliverables satisfy project requirements and are conducted in accordance with applicable DIDs and the ZAPATA Quality Manual. As PM, Mr. Shiflet performs the following:

- Maintains the nonconformance, corrective and preventive action systems;
- Responds to QC inspections;
- Coordinates improvements to the QC plan based on suitability reviews;
- Obtains and communicates client requirements to the appropriate personnel;
- Ensures that qualified, skilled and trained personnel and other resources are available to implement the QC plan;
- Ensures that products and services satisfy client requirements including quality, safety, cost, schedule, performance, reliability, durability, accuracy and maintainability; and
- Ensures that personnel comply with applicable standards, regulations, specifications and documentation procedures.

4.2.2 Project Geophysicist

Mr. Jim Hild, the Project Geophysicist, is responsible for ensuring the soundness of geophysical plans, the quality of geophysical data collection, processing and anomaly selection. The Project Geophysicist, fulfills the following duties:

- Verifies that the data is of acceptable quality prior to submittal to the client. He/she will visually inspect all data (raw and processed), performing QC tests on the data (blind seeds, coverage, speed, sample separation, background noise, repeatability, and

positioning repeatability), review field notes, verify all daily field tests pass, and reprocess 10% of the data. If any of the above fails, the field crew and/or processors are notified and a solution is implemented.
- Resolves issues related to the quality of geophysical data.
- Knowledgeable of QC data requirements and ensures they are implemented correctly. Develops survey/test designs that will accomplish these goals, while also providing education and guidance to the field crews and processors as to the latest requirements.

4.2.3 Senior Unexploded Ordnance Supervisor

Mr. Jeff Schwalm, the Senior UXO Supervisor, is responsible for the day-to-day on-site management of UXO services. His responsibilities include direction of all UXO site operations and coordination with the ZAPATA UXOSO and UXOQCS. He is authorized to stop work in progress or make appropriate notifications when unsafe conditions exist or requirements are not being met.

4.2.4 Unexploded Ordnance Quality Control Specialist

Mr. Terry Farmer, the UXO Quality Control Specialist, fulfills the following duties:
- Contributes to the QC plan;
- Implements the QC plan in the field; and
- Conducts QC field inspections.

4.2.5 Project Quality Manager

Ms. Suzy Cantor-McKinney, the Project Quality Manager, is responsible for implementation of the QC Plan and UFP-QAPP. She will review field reports/logs and project deliverables, and verify correction of non-conforming work, in consultation with the ZAPATA Project Manager.

4.3 SUBCONTRACTOR CORRECTIVE ACTION

ZAPATA's subcontract documents require subcontractors to promptly identify report and correct any conditions adverse to quality or safety. All personnel are authorized to stop work immediately for situations indicating imminent danger to personnel or property. Budget and schedule considerations will not override safety.
- Once an adverse safety or quality condition is identified, documentation of the cause and corrective actions to preclude reoccurrence are required. Subcontract agreements specify procedures for reporting significant conditions adverse to safety, health and quality.
- If a subcontractor problem is identified, the subcontractor will identify in writing to the ZAPATA PM a disciplined approach to solve the problem. Minimum procedures for corrective action include:
    - Effective handling of client and/or ZAPATA complaints;
    - Investigation of the cause of the problem relating to work effort and quality system checks and forward a record of the results of the investigation;
    - Determine the corrective action needed to eliminate the problem;
    - Application of controls to ensure that corrective action is taken and that it is effective.
- Any corrective action taken to eliminate the causes of actual or potential problems will be appropriate to the magnitude of problems and commensurate with the risks encountered.

4.4 QUALITY CONTROL PROCEDURES

4.4.1 ZAPATA will conduct site-specific employee training prior to the start of operations and supplement this initial training, as necessary, throughout the project. At a minimum, personnel will have:

- OSHA: Current certification in accordance with 29 CFR 1910-120 (e);
- Safety: Review of the Site-Specific Safety and Health Plan;
- Equipment Operator Training: Tailored to operator experience level and project objectives; and
- Daily Safety Training: Tailgate briefings outlining the day's activities, unique hazards and safety precautions, and other operational issues related to the project.

4.4.2 Quality control checks of every aspect of work are conducted routinely. Our procedures will be used for all phases of fieldwork. Our UXOQCS reports directly to the Corporate Quality Manager, who reports to the Company President. QC processes and procedures are associated with personnel, data collection/analysis, instruments / sensors and other equipment, data deliverables and for measuring the effectiveness of MEC removal actions. Our QC processes provide for;

- Testing and calibrating equipment used to perform work,
- Monitoring/measuring the effectiveness of work performed,
- Inspecting the maintenance and accuracy of site records,
- Determining compliance with site safety, environmental, and operational plans,
- Ensuring the accuracy, timeliness, and completeness of data deliverables, and
- Placement of "blind" seed items to verify positioning control and detection.

4.4.3 Work progress and field data will be presented in weekly and monthly progress reports with accompanying maps, in accordance with applicable DIDs, QCP, and specific requirements of the PWS. ZAPATA will maintain a project GIS. The database will be updated daily during field activities and current maps will be provided with the weekly progress report. We will apply the OEGIS standard for the creation of datasets that identify grid/transect coordinates and identification numbers, dates of field activities, dates of QC and QA inspections, and locations that contain MEC, MPPEH/MD, and/or UXO.

4.4.4 Quality Control Summary

4.4.4.1 Table 18 provides a summary of ZAPATA's QC methods and documentation requirements for the project site. Table 20 provides specific tests and procedures for DGM, mag-and-dig and AIR data collection activities. The QC requirements for MC/environmental sampling are included in Appendix E.

4.4.4.2 Each definable feature of work will be monitored and documented, either in a bound field logbook, on prescribed forms (i.e., dig sheets), or digitally in a PDA. Non-conformance reports will be issued when an activity is not performed in accordance with the WP or when results are not within a specified tolerance. In these situations, the PM and QC personnel will conduct a root cause analysis and develop a corrective measure for implementation. Acceptable tolerances may be adjusted based on the outcome of the QC process and unexpected field conditions. These "adjustments" will be submitted to the USACE for concurrence, and documented, as necessary on a Field Change Request (Appendix F).

4.4.5 Quality Control Inspection

4.4.5.1 QC inspections may be performed periodically to ensure systems are functioning as planned. By or under direction of the Quality Manager, management surveillance of the QC program ensures that operations are performed in accordance with approved work plans. The inspections include a review of procedures, logs, records, etc. Management reviews help determine discrepancies in information collected or if conditions and practices create the potential for QC problems, so that corrections can be implemented before problems occur.

4.4.5.2 Listed below are QC processes and procedures associated with personnel, data collection/analysis, instruments/sensors and other equipment, data deliverables, and for measuring the effectiveness of MEC investigations. ZAPATA QC processes provide for:

- Testing and calibrating equipment used to perform work
    - Each geophysical component will be noted according to make, model, and serial number in the field logbooks and/or in the digital data logger for the respective instruments.
    - Functional instrument tests for the system will be digitally recorded and available for review by QA personnel.
    - All instruments and equipment that require calibration will be checked prior to the start of each workday.
    - Batteries will be replaced as needed, and the instruments will be checked against a known source.
    - Instrument-specific functional testing procedures will be performed IAW methods described in Appendix J (Geophysical System Verification) and Appendix K (Instrument Standardization Quality Control Requirements).
- QC procedures will be implemented to ensure data acquisition, data processing, and interpretation methods are monitored at a sufficient level to meet the overall program objectives.
- Monitoring/measuring the effectiveness of work performed
    - The UXOQCS is responsible for ensuring that personnel accomplish all QC checks and that the appropriate log entries are made. The UXOQCS performs random, unscheduled checks to ensure that personnel accomplish all work specified in the WP and submits a report of their findings to the SUXOS.
    - Project deliverables, such as the WP and RI/FS documents, will be prepared by the PM and reviewed by the Quality Manager prior to submittal to USAESCH. Documentation of internal reviews (Appendix F) will be maintained in the project file.
    - QC Journals and digital dig sheet data will be submitted to the SUXOS on a daily basis. These records include descriptions of the areas checked and the results of the QC checks. Non-conformance reports will be submitted to the Project Manager and QC Manager. Records of these daily inspections will be consolidated and submitted at the end of the project.

4.4.6 Digital Geophysical Data Process Modification

The QC geophysicist will document whether collection or interpretation processes need to be modified, if corrective actions are necessary, or if the processes are being performed to their optimal capabilities. If it is found that the interpretation processes need modifying or corrective actions are identified, the geophysicist will notify the ZAPATA PM and USAESCH geophysicist of proposed modifications to correct deficiencies; all data processed previously will be re-evaluated under these new guidelines.

4.5 CORRECTIVE/PREVENTATIVE ACTION PROCEDURES

Guidelines have been established to assure conditions adverse to quality such as malfunctions, deficiencies, deviations and errors are promptly investigated, documented, evaluated, and corrected. When an activity is identified to be in nonconformance - i.e., not being performed to required specifications, not within specified tolerance, not adhering to a specific scope of work or is in violation of the Safety and Health Plan - it will be recorded on the Nonconformance and Corrective Action Report (NCAR; see Appendix F). Each nonconforming activity must have a probable cause identified. Condition identification, cause, reference documents, and corrective action planned will be documented and reported to the UXOQCS, the ZAPATA PM, Quality Manager, and involved subcontractor management, as applicable. Implementation of corrective actions will be verified by documented follow-up action. All project personnel have the continuing responsibility to identify problem areas promptly, solicit approved corrective actions, and report any condition adverse to quality. In general terms, corrective/preventive actions will be initiated at a minimum:

- When predetermined acceptance standards are not attained,
- When procedures or data compiled are determined to be faulty,
- When equipment or instrumentation is found faulty,
- When quality assurance requirements are violated,
- As a result of system and performance inspections, and/or
- As a result of management assessment.

4.6 DATA MANAGEMENT

Data generated during the project will be stored in hard copy and electronic form by ZAPATA. Data deemed critically important will have multiple electronic versions archived. Following completion of each deliverable, data will be transferred to the USAESCH. Data deemed critically important will have multiple electronic versions archived. Following completion of each deliverable, data will be transferred to the USAESCH. Further management of the DGM data is discussed in Section 2.13.

4.7 DIGITAL GEOPHYSICAL MAPPING

4.7.1 The QC plan of the DGM has been developed based upon DID WERS-004.01, requirements identified in the PWS, and Chapter 9 of EM 1110-1-4009 “Quality Control of Geophysical Systems and Related Operations” (USACE, 2007). Additional ZAPATA QC steps are also included. QC checks will be performed on both the geophysical collection procedures and on their results. This QC will be done to ensure all data and results are of high quality and will be performed by the UXOQCS and the QC geophysicist independent of the daily processing. The key procedures and systems that that will be to be monitored for quality are:

- The geophysical instruments;
- The operators;
- Positioning systems;
- Site preparation procedures;
- Data acquisition procedures;

- Data processing procedures;
- Anomaly selection processes;
- Anomaly reacquisition and marking procedures; and
- Anomaly excavation and resolution procedures.

4.7.2 QC tests have been designed to test these procedures and systems to ensure quality. These tests are summarized in Table 20 as are the root-cause analyses and corrective actions that will take place should a failure occur. The instrument standardization tests are described in Appendix K.

4.7.3 In addition to the checks described above, the QC geophysicist will review field data sheets and log forms for completeness. The results of all applicable QC checks will be entered into the Access database. ZAPATA has the final decision-making responsibility on all quality-control issues. If a QC procedure shows a potential problem, the ZAPATA UXOQCS and PM will oversee the appropriate corrective actions.

4.8 FIELD OPERATIONS

The ZAPATA SUXOS and UXOQCS will oversee all field operations and be in daily communication with the PM.

4.9 EQUIPMENT CALIBRATION/MAINTENANCE PROGRAM

All equipment used on-site will be calibrated, if calibration is applicable to that instrument, and used and maintained in accordance with manufacturer's specifications. Records of any repairs performed on equipment will be included in the final report with an explanation of problem diagnosis and repair.

4.9.1 General Equipment Calibration/Maintenance Requirements

Equipment requiring calibration will be calibrated daily or as required by the operation manual. The instruments and general equipment will receive proper maintenance and care to ensure quality performance. Measurement equipment used on-site will be checked at the time of use for operational reliability. If equipment field checks indicate equipment is not operating properly and field repairs cannot be made, the equipment will be tagged and removed from service, and the PM will be notified. If equipment calibration fails or the equipment does not function properly, replacement equipment will be shipped overnight, or by the fastest possible means, so that fieldwork is not delayed. Replacement equipment will meet the same manufacturer's requirements for accuracy and sensitivity as the originally specified equipment.

4.9.1.1 Geophysical Instruments

Geophysical instruments will arrive on-site in a ready state. Specific QC operational procedures for digital and analog geophysical instruments are explained in Table 18 and Appendix K. Analog geophysical instruments will be operationally tested on the IVS to ensure that adequate settings for their tasks are achieved. Analog geophysical instruments will be field checked daily to ensure they are functioning properly and instrument sensitivity is adequate to detect MEC items of interest. Following these checks, settings (i.e., sensitivity) for each applicable analog instrument will be recorded in the field logbook and any equipment that is found unsuitable will be immediately removed from service. The UXOQCS will conduct unannounced instrument checks in the field to verify the settings on an instrument agree with the results from the daily operational tests. If an instrument is found to exhibit improper settings, all work accomplished since the last check will be repeated. The ZAPATA QC Geophysicist, or designated geophysicist, in conjunction with the USAESCH Project Geophysicist and with possible input from the UXOQCS, Technical Manager and USAESCH OE Safety Specialist, will conduct an investigation to determine the impact of failure on completed work and the possible need to rework previously worked areas.

4.9.1.2 Communication Equipment

On-site and off-site communications equipment will be checked daily to ensure that communications can be established with off-site responders using non-emergency numbers, and that batteries are in good condition and fully charged. If on-site or off-site communications cannot be established, no intrusive work will be done until communications have been re-established.

4.9.1.3 Vehicles and Machinery

Vehicles and machinery will be used correctly, per manufacturer's warranty. All vehicles and machinery operation will be checked daily.

4.9.1.4 Personal Protective Equipment

The UXOSO will be responsible for checking to make sure each employee has appropriate PPE. However, any employee may inform the UXOQCS or the PM of PPE deficiencies.

4.9.1.5 Post-Operational Checks

Daily, upon completion of field operations, all equipment will be inspected to ensure it is complete and serviceable and is shut down in accordance with the procedures identified by the manufacturer. Operators will report any damaged equipment, unusual wear or missing components. Batteries will be removed from battery-powered equipment and charged (if rechargeable). Equipment, instruments, tools, gauges, and other items requiring preventative maintenance will be serviced in accordance with the manufacturer's recommendations. If daily operational checks fall outside the specified range, the check measurement will be performed again. Any additional checks or calibrations will be noted in the logbook. If the operational checks continue to fall outside the specified range, the equipment will be removed from service and a non-conformance report (NCR) will be initiated (Appendix F). The device in question will be noted as removed from service in the check log for that piece of equipment. If the equipment is removed from service due to failure of re-calibration, the date of removal and the operator's initials will be recorded in the log for that piece of equipment.

4.9.2 Maintenance Procedures

The manufacturer's written maintenance schedule will be followed to minimize downtime of the equipment. It will be the operator's responsibility to adhere to this maintenance schedule and to arrange promptly any necessary service. At a minimum, equipment used on a daily basis will be cleaned at the end of each workday and kept in good operating condition. Service to the equipment, instruments, tools, etc. will be performed by qualified personnel.

4.9.3 Maintenance Records

Logs will be established to record and control maintenance and service procedures and schedules. All maintenance records will be documented and traceable to the specific equipment, instruments, tools and gauges. Records produced will be reviewed, maintained and filed by the geophysical equipment operators and/or UXO technicians when this equipment is used at the site. The UXOQCS will audit these records to verify complete adherence to these procedures.

4.9.4 Equipment Spare Parts

An extra battery pack for each type of geophysical instrument will be on-site at all times. Because of cost considerations, a back-up geophysical instrument will not be kept on-site. However, arrangements will be made with an equipment vendor so that replacement equipment or any spare parts can be delivered to the site by the fastest possible means.

4.10 NON-CONFORMANCE CRITERIA FOR QUALITY INSPECTIONS

Any nonconformance to the work or to contractual requirements will be documented. Nonconformance may include, but is not limited to the following:

- Delivery of items or services that do not meet the contractual requirements of ZAPATA or any of its subcontractors.
- Errors made in following work instructions, or improper work instructions.
- Unforeseeable or unplanned circumstances, which result in items or services that do not meet quality, contractual, and/or technical requirements.
- Technical modifications to the project by individuals without the requisite responsibility and authority.

Non-conformance will be deemed to have occurred if delivery of items or services has not passed ZAPATA's QC pass/fail metrics and a root cause analysis and corrective action assessment have not been performed (see Tables 18 and 20).

4.11 RECORDS GENERATED

Bound field logbooks with consecutively numbered pages will be used by the Team Leaders, SUXOS, and UXOQCS/UXOSO. Field logbooks will be maintained on-site for the duration of the fieldwork.

4.11.1 Daily Logs

- Date and recorder of field information
- Start and end time of work activities including breaks, lunch and down-time
- Visitors
- Weather conditions
- Relevant events
- Changes from approved or planned work instructions
- Signature of the SUXOS or UXOQCS

4.11.2 Safety Logs

- Date and recorder of field information
- Daily general and tailgate safety briefings (time conducted and by whom)
- Weather conditions
- Significant site events relating to safety
- Accidents
- Stop work because of a safety hazard or deficiency. Documentation will include the hazard or deficiency found, the action taken to correct it and the time lost (if any).

- Safety inspections
- Signature of the SUXOS or UXOSO

4.11.3 Site Training Logs

- Date and recorder of log
- Nature of training
- Visitor training
- Signature of the ZAPATA UXOQCS

4.11.4 Quality Control Activity Log

- Date and recorder of log
- Equipment calibration/testing
- Equipment monitoring results
- QC inspections
- Nonconformance reports
- Signature of the ZAPATA UXOQCS

4.11.5 Meeting Minutes

ZAPATA will provide a record of the proceedings of any specified meeting. The minutes will include the purpose of the meeting, information covered during the meeting, specific statements relating to changes or modifications of the project, any actions to be carried out and the names all meeting attendees.

4.11.6 Inventory Forms

If Government property is to be used, the PM will maintain a government property log on-site and the ZAPATA Property System Manager will maintain the log in the home office. No Government property is anticipated to be used for this project.

4.11.7 Inspection Forms

4.11.7.1 DD Form 1348-1A

The Senior UXO Supervisor will certify and the USACE OE Safety Specialist will verify that the debris is free of explosive hazards and document that decision using DD form 1348-1A. All DD 1348-1A forms will clearly show the typed or printed names of the contractor's Senior UXO Supervisor and the USACE OE Safety Specialist, organization, signature, and contractor's home office and field office phone number(s) of the persons certifying and verifying the debris as free of explosive hazards. The form will state the following:

"This certifies and verifies that the Material Documented as Safe (MDAS) listed has been 100 percent inspected and to the best of our knowledge and belief, is free of explosive hazards."

4.11.7.2 Disposal Documentation

All material will be accounted for in the daily and weekly reports. Disposal documentation receipts will be generated identifying the day of off-site removal, approximate scrap weight, and signature of the recipient. Turn-in documentation will be submitted as an appendix to the final RI/FS report.

4.11.8 Photographic Records

ZAPATA's SUXOS and UXOQCS will maintain photographic records of site work. Significant activities will be documented using a digital camera. Photographic records will be used to supplement information recorded in the daily activity logs, including photographs of equipment before use, typical ordnance items and the condition of sites before, during and after activity. All MEC items and representative samples of MD will be photographed. Photographs will also be maintained in the Project GIS.

4.12 DELIVERABLE MILESTONES

Deliverable milestones for Government QA and acceptance are provided in Table 21.

4.13 LESSONS LEARNED

The UXOQCS in his daily report will note any lessons learned. This information will be given to the PM and included in daily logs as appropriate. Lessons learned will be included in the final RI/FS report. Any lessons learned of an emergency nature will be brought to the immediate attention of the USACE, USAESCH OE Safety Office and PM, and the ZAPATA Program Manager.

4.14 CONTRACT SUBMITTALS

4.14.1 Document Distribution

Documents will be shipped directly to the USACE and USAESCH to be distributed to those recipients per the quantities noted in the PWS. The shipping address, phone number, and number of copies are listed in that table; however, it should be noted Mr. Shawn Boone is in the USACE, Charleston District.

4.14.2 Format and Contents of Reports

Computer files and electronic deliverables will be furnished to the Government in the formats and standards described in the PWS (Appendix A).

4.14.3 Data Presentation

Project data will be arranged and presented in a clear and logical format IAW with scientifically accepted standards. Figures, charts, tables, and other visual displays will be used for organizing, evaluating, and presenting data and for highlighting relationships of data. Data displays are necessary for documenting results and aiding the decision-making process during an investigation. Graphical methods of data presentation may be used when appropriate to illustrate data trends and patterns as a supplement to information presented in data tables.

4.14.4 Communications

A record of telephone conversations and written correspondence affecting decisions relating to the performance of this task order will be documented with date and time recorded. The records will be maintained in the project files.

4.14.5 Project File Management

ZAPATA will maintain project documentation in project-specific files. The files will provide a record of all background information, previous investigation reports, and data and information generated during the project. Requirements for hard copy files are provided below. Hard copy documents of a confidential nature will be stored in lockable filing cabinets that can be accessed only by designated personnel.

4.14.5.1 Hard Copy Files

4.14.5.1.1 For this project, a hard copy file must be established as a permanent record of project plans, activities, and results. Each of these files will be tracked using a unique project number (i.e., task number). Minimum documentation to be included in the project file includes:

- Work Authorization;
- Project PWS;
- Deliverables (by task);
- Quality Assurance Records (by task);
- Background Material (by task);
- Correspondence;
- Contact Reports;
- Subcontracting Documentation;
- Invoice Transmittal Letters;
- Project Management Forms;
- Field Activity Logbooks;
- Field Data Sheets;
- Survey Results; and
- Maps, and Site Drawings.

4.14.5.1.2 In order to serve the function for which they are intended, documents must be distributed to the appropriate ZAPATA and subcontractor personnel. At a minimum, the personnel whose signatures represent approval of the document and the project file will be supplied with a copy of the final document. In addition, key project personnel, including subcontractors (if applicable), will receive a copy of planning documents (e.g., Work Plan, APP/SSHP, UFP-QAPP).

4.14.5.2 Storage Procedures of Electronic Data

4.14.5.2.1 Historical documents, deliverables, and electronic data (i.e. chemical and geophysical data) are maintained on a central Network Attached Storage (NAS) server, in a project-specific directory. The server employs a RAID5+1 array. The file system has daily snapshots taken to preserve the data. Snapshots are backed up to tape weekly, and taken offsite for storage.

4.14.5.2.2 For the transfer of data to and from the field to the Golden, Colorado office, a secured, internal File Transfer Protocol (*.FTP) site will be used. This site will allow for the dissemination of both raw and processed data to be shared quickly and effectively with ZAPATA personnel and clients.

4.14.5.2.3 All digital data will be stored in the Golden, Colorado office. The computer network at this centralized processing lab will be used to store all project data for the geophysical survey. Digital processing/interpretation folders will be maintained for the survey so the processing/interpretation sequence can be reproduced at a future date, if necessary.

4.14.5.2.4 All pertinent geophysical data will transferred to an independent / external hard drive or other computer media and stored at the centralized processing lab with data backups performed regularly to ensure no data are irrecoverable.

4.14.5.2.5 ZAPATA will preserve the integrity of all DGM data, including:

- Native formats of all raw and geophysical sensor and positional data;
- Processed digital geophysical data;
- Processed data;
- Subsequent classified target lists; and
- Final production graphics.

4.14.6.1.1.6 All data and graphics will be compatible with the existing project database protocols (ASCII ADF space delimited *.XYZ file formats) and Access database requirements, as set forth in DID MR-0005-05.01.

4.15 PROJECT SUMMARY REPORTS

4.15.1 Weekly Progress Reports

Each week during fieldwork, ZAPATA's PM will submit a status report per DID WERS-016.02.

4.15.2 Monthly Progress Reports

Each month, ZAPATA's PM will submit a status reports, IAW DID WERS-016.02, to the USAESCH identifying accomplishments, noting deficiencies and describing corrective actions associated with the project and a monthly status/exposure report. During field operations, information from the Weekly Progress Reports will be summarized in the Monthly Progress Reports. In case of schedule changes, an updated schedule (in bar chart form) will be included. ZAPATA will submit weekly progress reports, when conducting active field operations.

4.15.3 Daily Quality Control Reports

Daily QC Reports will be maintained during field activities and will document field measurements, calibration, and maintenance of field instruments and management procedures. Corrective actions taken will be documented in the Daily QC Reports and the ZAPATA PM will be notified immediately.

4.15.4 Quality Control Summary Reports

After field activities are completed, Daily QC Reports, including data validation, will be compiled and summarized in the Quality Control Summary Report (QCSR). The report will include a discussion of any data points that may have been influenced or compromised, their impact on DQOs or remedial decisions, problems encountered, and any corrective actions implemented.

4.16 TRAINING PLAN

4.16.1 Records of Training

The PM will maintain personnel files on each employee. All UXO personnel will meet the requirements of DDESB TP-18. All employees at this job site will have completed a training program, prior to beginning work on site, which complies with OSHA Regulation 29 CFR 1910.120e(9). All employees who work on hazardous sites receive training, which includes an equivalent of 40 hours of training off-site and three days of actual field experience under the direct supervision of a trained, experienced supervisor. Management and supervisors receive an additional eight hours training on program supervision. Each employee annually receives eight hours of OSHA refresher training.

4.16.2 Site-Specific Training

Employee training is an integral part of producing quality products. Site-specific employee training will be conducted prior to the start of operations and supplemented, as necessary, throughout the remainder of the project. At a minimum, UXO personnel receive the following types of training:

- Safety: Review of the SSHP with specific emphasis on the hazards known to exist on-site.
- Equipment Operators Training: Tailored to the experience level of the operator and objectives of the project.
- Environmental and archaeological awareness training.
- Daily Safety Training: General and tailgate briefings outlining the day's activities, unique hazards and safety precautions, and other operational issues related to the project.

4.16.3 Training Attendance

The UXOSO will conduct safety training; the SUXOS or UXOQCS will conduct site specific training and visitors training. Records of attendance (and student performance when applicable) are recorded. Prior to assignment to a duty position or change in duty position, the UXOSO performs a check of the individual's site personnel record to ensure that the employee is qualified to fill the position.

4.17 CHEMICAL DATA QUALITY MANAGEMENT

Quality control requirements for MC sampling are documented in the UFP-QAPP (Appendix E).

4.18 CONCLUSION

These QC procedures are designed to ensure the critical components of the process are inspected before, during, and after operations are performed. Application of these procedures will ensure the work performed is of high quality and meets the objectives of this study. All QC records and documentation will be kept on-site and made available for Government inspection.

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5.0 EXPLOSIVES MANAGEMENT PLAN

5.1 GENERAL

This plan, consistent with DID WERS-002.01, outlines the procedures that will be used to perform MEC identification and disposal operations at the project site. ZAPATA will acquire all required federal and state permits. Licenses or permits issued under this Section or a copy of a license or permit will be posted and available for inspection on each project site location where explosives materials are used. The procedures are in accordance with the following:

- FAR 45.5;
- ATFP 5400.7;
- DoD 6055.9-STD;
- AR 190-11; and
- DOT Regulations.

5.2 LICENSES/PERMITS

5.2.1 Bureau of Alcohol Tobacco and Firearms (BATF)

ZAPATA has a BATF permit and related permit extension to purchase and use explosives, (see Figure 2). This permit will be posted on site and will be available for local, state, or federal inspection. Accountability and use of the explosives will remain with ZAPATA unless custody is transferred to the Government or other agency with a current BATF explosive license. Fieldwork at the project site may extend beyond expiration date of the permit (01 February 2012); we will renew the permit and replace the expired permit if field activities extend beyond that date.

5.3 ACQUISITION

5.3.1 Order Quantity

ZAPATA will order the appropriate amount of demolition explosives from Halliburton Jet Research (HJR) of Alvardo, Texas or other ATF approved commercial explosive suppliers.

5.3.2 Acquisition Source and Method of Delivery

Explosives and explosives services procured from HJR, located at:

Halliburton Jet Research
Alvardo, TX 76009-9775

ZAPATA will store the explosives in a Type II storage magazine. The SUXOS will be authorized to request and receive explosives from the commercial suppliers.

5.3.3 Proposed Explosives

Class 1.4 explosives will be used whenever possible, because they are safer to handle, easier and less expensive to ship and store and more readily available. The demolition materials anticipated for use on this project are listed in Table 22 and will be purchased on as needed basis (on-call delivery) from HJR.

5.4 INITIAL RECEIPT

Shipments of explosives will be by the explosives supplier. The explosive supplier is responsible for all permits and documentation required by Federal, state, and local regulations. Only individuals listed on the Explosives Authorization List may sign for explosives from the shipper. Upon initial receipt of a shipment of explosives, each container of material will be inspected and inventoried by two ZAPATA personnel. The contents of the shipment will be verified based on the quantity and type of material ordered, as indicated on the invoice, shipping documents, or bills of lading.

5.4.1 Receipt of Explosives

The original receipt documents and an inventory will be maintained on file by the SUXOS. Upon receipt of the explosive materials shipment, copies of the supplier's Bill of Lading documentation will be sent to ZAPATA's Charlotte office within three working days. At the completion of the project, the original documents will be sent to ZAPATA's Charlotte office, where they will be maintained for a period of five years. Copies of the documentation will be included in the final report. Two magazine data cards will be established for each type and lot of explosives received. One copy will be kept in the magazine with the explosives and the second identical copy maintained in the site admin files.

5.4.2 Reconciling Discrepancies

The SUXOS, UXOQCS, or the Demo Supervisor will conduct a 100 percent inventory of the incoming explosives. The quantities annotated on the receipt documentation should match the quantities reflected in the inventory. If these quantities do not match, the Senior UXO Supervisor will contact the originator of the receipt documentation. ZAPATA personnel will only sign for the actual quantity of material received, as reflected by the inventory. Receipt documentation will be changed to reflect the proper quantities. Actual quantities will be properly annotated on the shipping documentation prior to ZAPATA accepting delivery. These procedures will be conducted for each receipt of explosives materials (Appendix F).

5.5 STORAGE OF DEMOLITION EXPLOSIVES

ZAPATA will utilize a BATF-approved Type 2 portable magazine for storage of demolition materials. A dual magazine (for example) consisting of a 4' x 4' x 4' compartment with an attached integral 18" x 18" x 18" detonator box (see Exhibit 14, Appendix B) will be used. While the net explosive weight (NEW) of the demolition material magazine will not exceed 100 pounds, ZAPATA will utilize 1.4 explosives, further reducing the explosive hazard. The perforators (Class 1.4S, compatibility group D) and detonating cord (Class 1.4D, compatibility group C) will be stored in the larger magazine, and the electric detonators (Class 1.4B, compatibility group B) will be stored in the smaller, attached cap box. The fenced enclosure is approximately 12' x 12' and located at 800 Dairy Ridge Road within the Croft State Natural Area. Smoking, matches, open flames, spark-producing devices, and firearms will not be permitted inside of or within 50 feet of demolition explosives.

5.6 TRANSPORTATION

The explosives vendor will deliver explosives to the site or ship explosives to the site by standard shipping methods. The rendezvous location will typically be at the entrance to the project site. From the rendezvous location, the transporter of the demolition explosives will transport explosives on-site by the least populated and safest route.

5.6.1 On-Site Transportation

Blasting caps and high explosives will be transported on-site in a Type 3 portable magazine (day-box) meeting Federal Explosives Storage Requirements, mounted in bed of a pickup truck.

5.6.2 Vehicle Safety Requirements

5.6.2.1 Transport Checklist

Transportation of MEC and explosives will comply with all Federal, state, and local regulations. Prior to movement, the driver will visually inspect the explosive-laden vehicle to ensure the load is properly secured and acceptable to move. The cargo will be checked to ensure containers are loaded, blocked, braced, tied down, or otherwise secured to the vehicle body to prevent movement. If using a vehicle with an open body, a closed container to contain the explosives will be secured to the bed of the vehicle. For transportation of MEC and explosives on site, the transporter will comply with the following:

- The load will be well braced and, except when in closed vans, covered with a fire-resistant tarpaulin or in an appropriate shipping container.
- Vehicles transporting explosives or MEC will be inspected daily using DD Form 626, Motor Vehicle Inspection, and will be properly placarded;
- Explosives will be transported in closed vehicles whenever possible. When using an open vehicle, explosives will be covered with a flame resistant tarpaulin (except when loading/unloading);
- Vehicle engine will not be running when loading/unloading explosives and will be attended while loaded with explosives or detonators;
- Beds of vehicles will have either a wooden bed liner, dunnage, or sand bags to protect the explosives from contact with the metal bed and fittings;
- Vehicles transporting explosives will have a first aid kit, one 20-BC rated fire extinguisher (at a minimum), and communications capability;
- Vehicles used to transport explosives will have substantially constructed bodies with no sparking metal exposed in the cargo space, and will be equipped with suitable sides and tail gates;
- During transportation, explosives will not be piled higher than the sides or end of the truck bed;
- Vehicles containing explosives or detonators will display the proper warning signs, be maintained in good condition and operated at a safe speed, in accordance with all safe operating practices;
- Other materials or supplies will not be placed on or in the cargo space of a conveyance containing explosives, detonating cord, or detonators, except for safety fuze and properly secured non-sparking equipment, used only for handling explosives, detonating cord, or detonators;
- Explosives or detonators will be transported promptly without delays in transit;
- Explosives or detonators will be transported at times and over routes that expose a minimum number of persons. Only the necessary attendants will ride on or in vehicles containing explosives or detonators;
- When vehicles containing explosives or detonators are parked, the brakes will be set, the vehicle will be choked and the motor shut off;

- After the vehicle has been secured, the Institute of Makers of Explosives (IME) Specification 22 cap-box and the containers containing the explosives will be removed from the bed of the truck and placed on the ground, prior to any explosives being removed from the containers;
- Maps indicating route to be traveled will be within the vehicle;
- Compatibility requirements will be observed;
- Only UXO Technicians II and above may be issued and transport explosive materials;
- Operators transporting explosives will have a valid drivers license;
- Drivers will comply with posted speed limits but will not exceed a safe and reasonable for conditions. Vehicles transporting explosives off-road will not exceed 25 MPH;
- Personnel will not ride in the cargo compartment with explosives or MEC.

5.6.2.2 General Precautions

The SUXOS will ensure that the following general safety precautions are observed during transport operations:

- Explosives will not be transported in the passenger compartment of a vehicle;
- Explosive laden vehicles will not be left unattended;
- No person is permitted to ride on or in the cargo compartment;
- Smoking in and around vehicles transporting explosives is prohibited;
- Refueling of vehicles will be accomplished without the explosive cargo.

5.6.3 Authorized Individuals

ZAPATA is required to provide commercial suppliers with documentation of individuals authorized to request and receipt for explosives. The individual authorized to receipt and issue explosives is the SUXOS and if the SUXOS is not available, an identified and authorized UXO technician or manager. The SUXOS will designate in writing the UXO personnel who are authorized to transport and use explosives, and the list of authorized individuals will be maintained on site.

5.6.4 Certification

The SUXOS and UXO Technician III team leader performing demolition will sign and date the Explosives Consumption Certificate (see Appendix F) certifying that the explosives were used for their intended purpose.

5.6.5 Procedures for Reconciling Receipt Documents

The SUXOS will reconcile the delivery shipping documentation with the requested amounts ordered and received. Any shortages or overages will be reported to the explosives supplier to reconcile any differences.

5.7 INVENTORY

When explosives are received on-site, the SUXOS will perform and document the inventory. The SUXOS will strictly control access to all explosives and will review all requests for explosives for the site.

5.8 REPORTING LOSS OR THEFT OF EXPLOSIVE MATERIALS

If it is confirmed that ordnance or explosives are missing, the ZAPATA PM and the USACE OE Safety Specialist will be notified, and the SUXOS will immediately notify the Contracting Officer by telephone, followed up by a written report within 24 hours. ZAPATA also will notify BATF (800-800-3855) within 24 hours of discovery, and complete ATF Form 5400.5, "Report of Theft or Loss -Explosive Materials," and mail to the nearest ATF office. Theft or loss of explosives will be reported as required in 27 CFR 55.30. A Report of Theft or Loss – Explosive Materials, ATFP Form 5400.5, will be completed and forwarded within 24 hours to the ATF, with a copy to the ZAPATA PM and the USAESCH COR. The following persons will be notified immediately upon discovery of theft or loss of explosive materials:

- The Bureau of Alcohol, Tobacco and Firearms at 1-800-800-3855;
- Local law enforcement via 911 (from local landline);
- The USAESCH Contracting Officer, Ms. Janice Jamar at 1-256-895-1343; and
- ZAPATA'S PM, Mr. Jason Shiflet, P.G. at 1-704-358-8240.

5.9 PROCEDURES FOR RETURN TO STORAGE OF EXPLOSIVES NOT EXPENDED

The UXOSO or UXOQCS along with the Demolition Supervisor will return unexpended explosives to storage at the end of the workday and record the transaction as a return on the appropriate Magazine Data Cards.

5.9.1 Physical Inventory Procedure of the Returned Demolition Materials

Each item of explosive will be counted. All containers will be opened and counted. Any discrepancies will be noted. The original receipt document will be adjusted to reflect the returned material and will be signed by the individual returning the explosives and a second authorized ZAPATA UXO Technician. The SUXOS will indicate in the daily journal the fact that an inventory was conducted that day and the results.

5.10 PROCEDURES FOR DISPOSAL OF REMAINING EXPLOSIVES

During operations, ZAPATA will minimize the explosives inventory. At the end of site activities, ZAPATA will perform an economic analysis to determine the most cost-effective method to manage the remaining explosives. This information will be forwarded to the ZAPATA Program Manager and the USAESCH Project Manager for authorization. The available alternatives include:

- Transfer of stocks to another ZAPATA project;
- Transfer of stocks to a local law enforcement bomb squad;
- Destroy by detonation

Prior to transferring the explosives to another ZAPATA project or to the local law enforcement bomb squad, ZAPATA will obtain a letter from the USACE Contracting Officer authorizing the transfer. The certification letter from the Contracting Officer will be attached to the Final Work Plan.

5.11 FORMS

ZAPATA will use internal forms for explosives receipt, inventory, and vehicle inspections (Appendix F).

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6.0 ENVIRONMENTAL PROTECTION PLAN

The following section describes procedures and methods that ZAPATA will implement during project activities to minimize pollution, protect and conserve natural resources, restore damage to the property, and minimize noise and dust within reasonable limits.

6.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

6.1.1 Section 121 of CERCLA specifies that on-site Superfund remedial actions must attain federal standards, requirements, criteria, limitations, or more stringent state standards determined to be legally applicable or relevant and appropriate to the circumstances at a given site. Under CERCLA Section 121(d)(2), the federal ARARs for remedial action could include requirements under any of the federal environmental laws (i.e., Clean Air Act [CAA], Clean Water Act [CWA], and Safe Drinking Water Act [SDWA]). Such applicable or relevant and appropriate requirements (ARARs) are identified during the RI/FS process. Development and evaluation of ARARs is an iterative process that will be performed throughout the life of the project.

6.1.2 Applicable requirements are identified on a site-specific basis by determination of whether the jurisdictional prerequisites of a requirement fully address the circumstances at the site or the proposed remedial activity. All pertinent jurisdictional prerequisites must be met for the requirement to be applicable. These jurisdictional prerequisites are as follows:

- The party must be subject to the law
- The substances or activities must fall under the authority of the law
- The law must be in effect at the time the activities occur
- The statute or regulation requires, limits, or protects the types of activities

6.1.3 In a letter dated 19 February 1992, The Office of Emergency and Remedial Response noted that CERCLA response actions are exempted by law from the requirement to obtain Federal, state or local permits related to any activities conducted completely on-site. It is the policy of the USEPA (and the Department of the Army) to assure all activities conducted on-site are protective of human health and the environment. ZAPATA will obtain permits related to work activities, if required by regulatory agencies.

6.2 POLLUTION MINIMIZATION METHODS

Based on the nature of the site work to be conducted, ZAPATA anticipates little, if any, environmental impact to land, air, or water. No storm water impacts are anticipated. Hand-dug excavations will be on a very limited scale, not requiring runoff controls. Other than during the possible disposal of a UXO item by detonation, noise is not anticipated to be a concern. If ZAPATA personnel recognize an increase in pollution potential, the work will be stopped temporarily, and the ZAPATA and USAESCH PMs will evaluate and, if necessary, take the appropriate steps to mitigate the situation. If necessary, WPs will be modified.

6.3 IDENTIFICATION AND LOCATION OF KNOWN NATURAL RESOURCES

ZAPATA was not scoped to complete an environmental survey prior to conducting operations at the project site. The follow subsections describe natural resources identified at the project site based on information obtained through Spartanburg County and the US Fish and Wildlife Service (USFWS) at the time this document was developed. If additional natural resources not described below are discovered during site operations, this section may be amended, as appropriate.

6.3.1 Endangered, Threatened, or Listed Species

Wildlife habitats contribute greatly to the overall environmental and economic health of the county. They provide cover for animals and recreational opportunity to resident and nonresident hunters and outdoor enthusiasts. Wildlife habitats display natural beauty and provide educational opportunities and places for scientific research. Habitats also provide other important benefits, such as water and air filtration and serve to harbor many rare and unique plants and animals. The number, quality, and geographic extent of game, fish, and plant species is directly related to the extent and quality of their habitats. Habitats are impacted by agriculture, forestry, industrial development and urban expansion. These activities over time have taken a toll on certain plants and animals in Spartanburg County. From various reports of occurrences in Spartanburg County, the South Carolina Department of Natural Resources (DNR) has compiled a list of indigenous plants and animals considered to be rare, threatened or endangered. To most current list of Rare, Threatened, and Endangered Species and Communities Known to Occur in Spartanburg County dated 22 September 2009 was obtained from the SC DNR and is provided in Table 23 (http://www.dnr.sc.gov/species/pdf/spartanburg.pdf). Of the different species of endangered plants, only the Dwarf-flowered Heartleaf is classified as federally threatened, according to the Heritage Trust Program. The only animal on the endangered list is the Meadow Vole, a small field mouse. While rare in the county, this species is secure in the state. The list of species and occurrences identified herein is derived from an existing data base, which the Department of Natural Resources does not assume to be complete. There are areas not yet inventoried which may contain significant species or occurrences. As a result, care should be exercised in developing natural areas where such information is not available, particularly south of Spartanburg, where there is little evidence of documented occurrences (Spartanburg County, 1998).

6.3.2 Wetlands

The USFWS has documented wetlands that exist within the project area (see Exhibit 3, Appendix B). If is not safe to conduct intrusive investigations in areas of standing water. Thus, these wetlands, and others if discovered during the performance of work under this task, will not be intrusively investigated. If site features or observed MEC evidence indicate investigation of these areas is necessary, ZAPATA will communicate that information to the USAESCH and request direction. If site activities are conducted within or near any of these areas, ZAPATA will make every effort to minimize any disturbance.

6.3.3 Cultural and Archaeological Sites

There are no known historical/archeological cultural sites within the project property. However, should any artifacts or remains be encountered during field activities, ZAPATA will record the location, notify the USAESCH via telephone and email, and cease work in the immediate area, until guidance is provided. ZAPATA will continue work in another area of the MRS while awaiting response from the USAESCH on how to proceed at the location where the artifact/remains were located. Project personnel, including subcontractors, will not remove or disturb any archeological items within the site. Avoidance of impact to archeological or cultural resources is a primary concern and ZAPATA will take every precaution to protect these important resources, should they be discovered.

6.3.4 Water Resources

The project site contains several water bodies and wetlands. Storm water impacts are not anticipated, since excavations will be hand-dug, and on a very limited scale not requiring runoff controls. In adherence to generalized best management practices (BMP) for the protection and management of wetland and riparian areas, ZAPATA will not place transects or grids within 100 feet of these features, with exception of Lakes Craig and Johnson; transects will be placed along a portion of the shorelines of these lakes.

6.3.5 Forests

Approximately 52 percent of all land in Spartanburg County is forested. Loblolly, oak, pine and hickory trees make up the majority of forested lands in the county, followed by elm, ash and cottonwood forest, gum and cypress forest, in that order. Most large forested stands are found south and east of Spartanburg. Also, some areas north of Lake Bowen and Blalock have large stands of mixed and deciduous forest. The forest industry is not as heavily vested in Spartanburg as in many other counties in the state. In fact, forest lands owned by the timber industry declined substantially during the late 1990's, from over 20,000 acres to less than 10,000. Farmer-owned forest land also has declined, while corporate and individual ownership have increased. These ownership trends point to development speculation and investment in forest lands (Spartanburg County, 1998).

6.3.6 Identified Existing Impacted Sites

Aside from potential DoD impacts associated with the former Camp Croft, there are no known impacted sites that existing the project property.

6.4 SITE-SPECIFIC MITIGATION PROCEDURES

6.4.1 Manifesting, Storage, Transportation and Disposal of Wastes

Environmental sampling may generate several waste streams requiring disposal. Investigative Derived Waste (IDW) may include PPE, solid waste, and decontamination water. IDW associated with environmental sampling is addressed in the UFP-QAPP (Appendix E), herein. In addition, scrap metal may be generated as a result of investigation of metallic geophysical anomalies. Based on the nature of the site and existing data, it is expected that only nonhazardous IDW will be generated during the field sampling event. Nonhazardous IDW such as decontamination fluids from the washing and rinsing of sampling equipment will be disposed of on the ground at the site or to a wastewater treatment plant via a sanitary sewer. ZAPATA will seek approval for disposal via the sanitary sewer in advance by contacting the wastewater treatment facility directly. It is expected that solid IDW (e.g., Tyvek suits, PPE, and other plastics) will be collected separately in trash bags and disposed of as municipal solid waste.

6.4.2 Burning Activities

We do not anticipate any purposeful burning activities.

6.4.3 Dust and Emission Control

Site operations will be conducted in a manner that produces minimal disturbance. Dust should be limited to that generated by vehicular traffic. If necessary, areas requiring dust control will be watered down. Prevailing wind directions will be determined prior to the start of daily fieldwork, and will be considered in planning fieldwork.

6.4.4 Spill Control and Prevention

All drums will be sealed prior to leaving the site. If a drum containing liquids is punctured, the liquid will be absorbed and disposed of as potentially contaminated waste. Storage of diesel, lubricants or automotive gasoline will be appropriately bermed, diked and/or contained to prevent spillage. Releases will be reported to SC DHEC. A spill of over one gallon is required to be reported to the USAESCH on-site representative. If human health or the environment is threatened, the National Response Center and the state will be notified as soon as possible. In areas where spills or leaks occur, the Site Safety and Health Officer will oversee the use of salvage drums or containers and absorbent materials. Moving of drums or containers will be kept to a minimum, and procedures will be implemented to contain and isolate the materials being transferred into drums or containers. Safety cans or other approved portable service containers of flammable liquids having a flash point at or below 73°F will be painted red with a yellow band around the can and the name of the contents conspicuously painted or stenciled on the container in yellow. Drums, barrels, and flammable-liquid containers will be tightly capped.

6.4.5 Storage Areas and Temporary Facilities

6.4.5.1 Storage Areas

The project storage and staging area will be located on property owned by the Croft State Natural Area. If field activities occur at multiple MRSs simultaneously, the staging area will be established at a central location. All storage facilities and equipment will remain locked during non-working periods.

6.4.5.1.1 Donor Explosives

Explosives will be provided by HJR, as described in Section 5.0.

6.4.5.1.2 Vehicles and Equipment

Vehicles will be used to transport personnel on a daily basis to and from the job site, and will be locked during non-work hours. The all-terrain utility vehicle will be trailered to and from the work site daily.

6.4.5.1.3 Investigative Derived Waste (IDW)

IDW will be stored as indicated in Section 3.4.17 and Appendix E.

6.4.5.1.4 Munitions Debris (MD)

MD will be stored as indicated in Appendix L.

6.4.5.2 Temporary Facilities

ZAPATA will establish a temporary office trailer and Port-a-John facilities to support operations required during this project. Upon project completion, ZAPATA will remove all temporary facilities, portable toilets, and debris from the site.

6.4.6 Access Routes

Vehicle traffic off of existing roads will be kept to a minimum.

6.4.7 Vegetation Protection and Restoration

Croft State Natural Area has expressed concern that clearing transects through wooded areas may promote off-trail hiking. However, limited brush clearing may be required. To the extent practical, we will attempt to conduct site activities in a manner such that brush clearing is minimal. When vegetation clearing is required in the Croft State Natural Area, we will attempt to leave a natural buffer area around the cleared areas to conceal those areas from the general public. Cut brush will be placed beyond the cleared areas; field teams will attempt to place the material in neat piles.

6.4.8 Control of Water Run-on and Run-off

ZAPATA will conduct work associated with this site investigation in a manner that prevents the discharge of pollutants into adjacent waterways within and outside the project area. Such impacts are not anticipated since excavations will be dug by hand.

6.4.9 Decontamination and Disposal of Equipment

Non-disposable PPE and equipment will be decontaminated prior to reuse as indicated in Appendix E. The disposition of disposable PPE and disposable equipment is addressed in Section 3.4.17.

6.4.10 Minimizing Areas of Disturbance

ZAPATA will conduct field activities in a manner that produces the fewest number of impacts to the smallest area possible.

6.5 POST-PROJECT CLEAN-UP ACTIVITIES

Prior to departing the location, ZAPATA will restore the site to its approximate pre-project condition. As directed in the PWS, all access/excavation/detonation holes will be backfilled by ZAPATA.

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7.0 REFERENCES

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APPENDIX A
PERFORMANCE WORK STATEMENT

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Performance Work Statement
Remedial Investigation / Feasibility Study
Former Camp Croft
Spartanburg, Spartanburg County, South Carolina
I04SC001603
~~**22 November 2010**~~
02 December 2010
Revision: 1

The purpose of Revision 1 is to affect the following changes: (Changes are italicized and in bold)
-Addition of paragraphs 3.4.14 Task 4n and 3.12.14 Task 12n.
-Corrections were made to task numbers in paragraphs 3.12.4-3.12.13.
-Corrections were made to the Unit Cost column in Attachment D, 12d-12m.
-Correction was made to Task 12d in Attachment D, the task was changed to FFP.

1.0 OBJECTIVE: The objective of this task order is to achieve acceptance of Decision Document(s) in compliance with CERCLA and Department of Defense, Army, and USACE Regulations and Guidance to include Interim Guidance and Data Item Descriptions (DID) at the referenced Munitions Response Sites.

2.0 BACKGROUND

2.1 Work under this Performance Work Statement (PWS) falls within the Military Munitions Response Program (MMRP) for Former Camp Croft, a Formerly Used Defense Site (FUDS). The Contractor shall perform all work in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP), 40 CFR Part 300. All activities involving work in areas potentially containing explosive hazards shall be conducted in full compliance with United States Army Corps of Engineers (USACE), Department of the Army (DA), and Department of Defense (DOD) regulations.

2.2 Available Site Specific information will be provided with the request for proposal for contractor review and use via either a designated Internet site or delivery of recorded data on CD/DVD. This information may include but is not limited to general site history, previous investigations and other documentation.

3.0 General Requirements:

3.0.1 Contractor Methods: This is a performance based task order. The performance objectives and standards included herein are the basis of the task order requirements. The technical approach and level of effort expended to achieve task order objectives and standards are solely up to the contractor to select and adjust as necessary through the life of the task order. Government recognizes the contractor's right to change the technical approach and level of effort from that proposed with the understanding that the contractor shall still meet all project objectives and gain government Quality Assurance acceptance in order to receive payment. Given the short time available during the pre-award phase to evaluate the site it is possible that after award and refinement of the conceptual site model and data needs that the contractor will wish to adjust the investigation strategy. If after the TPP but before the field work begins an adjustment in the quantities or types field investigations are required to achieve the performance standard or the Government determines that the performance standard must be adjusted the Government at its discretion may choose to modify the contract with the price adjustment based upon the prorated unit prices proposed in the accepted offer. Once these adjustments are complete the contractor shall be obligated to deliver the required performance standard making adjustments in the field strategy as may be necessary to achieve the standard without a change in price.

3.0.2 Quality monitoring and measurement: The contractor will be evaluated periodically during performance of this task order to ensure compliance with the proposed and accepted performance goals, regulations, guidance and DIDs, and to document that acceptance criteria (AC), delivery schedule, and the overall completion date are being met. This evaluation will be performed according to a Quality Assurance Surveillance Plan (QASP). A programmatic QASP will be provided by the government as a starting point for the contractor prepared Draft QASP per Task 2. The government will finalize the contractor's Draft QASP. This final QASP will be supplied to the contractor and used by the government to evaluate the contractor's performance. Failure to adequately complete any service or submittal to at least a satisfactory level of quality or timeliness may result in a repeat of the work, or a poor performance evaluation, or both.

3.0.3 Performance Requirements. Performance requirements are addressed in each task and summarized in the Performance Requirements Summary (PRS) provided in Attachment A. Performance metrics are provided in Attachment B. If discrepancies or ambiguity exists between the documents, the order of precedence is 1) the Task; 2) Performance Requirements Summary; 3) Performance Metrics

3.0.4 Task pricing: A pricing schedule is provided in Attachment D which will be used as a basis for negotiation of price increase or decrease due to government changes in the specified performance objectives.

3.1 Task 1, Technical Project Planning (TPP): This is a Firm Fixed Price/Unit Price task.
Objective: Implement the four-phase TPP process in accordance with EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents.

Performance Standard: Achieve the objectives of each TPP phase as listed in EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents. Facilitate meetings in a professional and organized manner.

AC: Acceptance of TPP documents (meeting presentations, agenda, handouts, CSM and memorandums) with up to one (1) revision. Meetings held are organized; accomplish requirements of the TPP process; and professional in nature. Zero letters of reprimand, grievances, or formal complaints

Measurement / Monitoring: TPP checklist for each phase as provided in the guidance will be used to measure and document successful progress; guidance cited will be used to evaluate content of documents for acceptance / non-acceptance. Government will attend and evaluate organization and facilitation of the meetings, and professional nature of the meetings.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: The contractor shall utilize the TPP process to obtain consensus on specific Data Quality Objectives that the contractor intends to achieve in pursuit of the established RI performance requirement that were proposed and accepted as the basis for the RI task. The Contractor shall plan for meetings to occur as follows: first meeting, pre-Work Plan with resulting DQOs and conceptual site model (CSM), and TPP Memorandum; second meeting, to finalize Work Plan with resulting TPP addendum; third meeting, verify all data gaps have been filled and finalize Remedial Investigation Report with resulting TPP addendum. The contractor shall organize and coordinate all meetings; identify and involve all stakeholders, upon approval by the Government; and be responsible for the logistics of these meetings to include, but not limited to, providing a facilitator, obtaining meeting location, and sending invitation letters (pending government review and acceptance). The Contractor shall prepare, submit for review and gain acceptance of a TPP memorandum or addendum for each meeting. If a site visit is planned prior to acceptance of a Work Plan, the Contractor shall prepare and submit for acceptance an Abbreviated Accident Prevention Plan (AAPP). The Contractor shall utilize statistical methods to support the decision making processes used to characterize both UXO/DMM (such as Visual Sample Plan (VSP) software) and MC. The Contractor shall prepare a preliminary Munitions Response Prioritization Protocol for each Munitions Response Site covered under this task order.

3.2 Task 2, RIFS Work Plan (WP), Uniform Federal Policy for Quality Assurance Project Plan (UFP-QAPP) and QASP: This is a Firm Fixed Price task.
Objective: Prepare, submit and gain acceptance of a WP, munitions constituent (MC) UFP-QAPP and QASP that are detailed and comprehensive plans covering all aspects of site characterization, risk assessment and methodology, and project execution. UFP-QAPP applies only to environmental sampling. It is the contractor's responsibility to review all provided historical documentation pertaining to Camp Croft and ensure that all areas in previous investigations are either covered under the existing MRS's or as an Area of Potential Interest.

Performance Standard: Prepare the WP in accordance with DID WERS-001 and EM 1110-1-4009, EM 385-1-1, and EP 75-1-3 as appropriate. Prepare the sampling and analysis plan, field sampling, and UFP-QAPP in accordance with EM 1110-1-4009, DID WERS-009.01, and UFP-QAPP, as appropriate. Prepare a risk assessment work plan incorporating implementation of the risk assessment and methodologies per EPA Risk Assessment Guidance (RAGS) and USACE EM 200-1-4, Volumes I and II, as appropriate. UFP-QAPP content shall also meet the requirements of DoD Quality Systems Manual for Environmental Laboratories (current version). Draft QASP includes requirements in regulations, guidance, DIDs and the Quality Control Plan in the WP.

AC: Acceptance of WP and UFP-QAPP with two revisions. Draft QASP reflects requirements and QCP with one revision required.

Measurement / Monitoring: Review of WP, UFP-QAPP and QASP per guidance to verify that the minimum acceptable content has been provided.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: Incorporate all decisions pursuant to the TPP process. The sampling and analysis plan (SAP) shall include the Contractor's phased approach and address contaminants of interest and sample media (soil/groundwater/sediment/surface water). The Contractor shall provide a discussion on data evaluation and fate and transport analysis. The potential for fate and transport will address all transport pathways, and it should also address future degradation products resulting from biodegradation, photolysis, and chemical reactions.

3.2.1 Optional, Task 2a, Explosive Siting Plan: This is a Firm Fixed Price task. If this optional task is not awarded, an Explosive Siting Plan will be provided by the government for inclusion in the WP.

Objective: Prepare, submit and gain acceptance of an Explosives Siting Plan.

Performance Standard: Prepare required submission in accordance with DoD 6055.09-Std, Chapter 12, Paragraph 12.5, EM 385-1-97, Errata Sheet #3,and DID WERS-003 as a stand alone document for inclusion after acceptance into the WP.

AC: Acceptance of submission with two revisions.

Measurement / Monitoring: Review by Government using guidance cited to determine acceptability.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: Allow eight (8) weeks in the schedule for DDESB approval after submission of final document to the CEHNC-CX.

3.2.2 Optional, Task 2b, Dive Plan: This is a Firm Fixed Price task.
Objective: Prepare, submit and gain acceptance of a Dive Plan.

Performance Standard: Prepare, submit and gain acceptance of a Dive Plan that is a detailed and comprehensive plan covering <u>all</u> aspects of dive operations in accordance with EM 385-1-1.

AC: Acceptance of submission with two revisions.

Measurement / Monitoring: Review by Government using guidance cited to determine acceptability.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: None.

3.3 Task 3, GeoSpatial Data: This is a Firm Fixed Price/Unit Price task.
Objective: Utilize GIS in the development of the Conceptual Site Model (CSM) and maintain and manage all project and geospatial data.

Performance Standard: Manage and maintain project data, and develop CSM in GIS IAW DID WERS-007.01, EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents.

AC: Acceptance of CSM and GeoSpatial Data submissions meets quality and formatting requirements.

Measurement / Monitoring: Review by Government using guidance cited to determine acceptability.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: The GeoSpatial Data shall include:
- A comprehensive CSM
- A pre and post-project response action geospatial data analysis will be performed using a GIS.
- All available existing data that is applicable to the project will be consolidated into the GeoDatabase and analyzed to relay pertinent information to the PDT. If an existing GIS database is available, it will be provide by the government.
- The analysis of data from the GIS shall support all conclusions of the CSM.
- The information attained through the pre-RI analysis will be documented in the work plan.
- The information attained in the post-RI and FS analysis will be documented in the RI and FS reports.
- The pre-RI analysis will encompass social, environmental and/or economic entities that will be or may be impacted by response-action activities.
- The post-RI and FS analysis will detail entities impacted by RI/FS activities and impacts of future response action activities (if applicable).
- The pre and post-RI and FS analysis may detail the fieldwork strategies, areas of concern, survey requirements, environmental concerns, milestones and/or other factors that affect product delivery and future action planning.
- Entities that may be affected by response actions include but are not limited to: landowners, homeowners, rental tenants, schools, utilities, roads, businesses, recreational areas, air traffic, water bodies and/or industries.
- The GeoDatabase shall be a living repository that is refined throughout the life of the project.
- Incorporate layers that overlay on maps of the site that identify physical features, and MPPEH/MD and Range-Related Debris found during the investigation. Examples include: streets, anomalies, MEC positively identified, identifiable MD, sampling location, cultural resources, environmental, biological, and socio-economic variables.
- Archeological site location(s) will not be released to the public without written permission from USACE.
- Perform civil surveys IAW EM 1110-1-4009 and DID WERS-007.01
- Property owner privacy will be preserved. Property owner names shall not be disseminated in any documents.
- Obtain and maintain property GIS data for all landowners with in the project boundaries.
- The Government will provide the contractor with a landowner data base.
- Maintain and update property GIS data for all landowners with in the project boundaries.
- Track and assist the District in obtaining property Right -of -Entry as needed.

3.4 Task 4, RI/FS Field Activities: This is a Firm Fixed Price/Unit Price task.
Objective: Conduct a remedial investigation in accordance with CERCLA, characterizing the nature and extent of MEC contamination at the required munitions response sites (MRS) and the Areas of Potential Interest (AOPI), meeting the project DQOs as defined during the TPP process. This task shall include all field activities necessary to execute this task except MC sampling. MC sampling requirements are covered under Task 12, Environmental Sampling & Analysis.

3.4.1 Task 4a, Gas Chambers, FUDS Project No. I04SC0016-03R01. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.2 Task 4b, Grenade Court, FUDS Project No. I04SC0016-03R02. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.3 Task 4c, Range Complex (Land), FUDS Project No. I04SC0016-03R03. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.4 Task 4d, Optional, Range Complex (Lake Craig and Lake Johnson), FUDS Project No. I04SC0016-03R03. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.5 Task 4e, Optional, Area of Potential Interest 3, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.6 Task 4f, Optional, Area of Potential Interest 5, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.7 Task 4g, Optional, Area of Potential Interest 8, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.8 Task 4h, Optional, Area of Potential Interest 9E, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.9 Task 4i, Optional, Area of Potential Interest 9G, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.10 Task 4j, Optional, Area of Potential Interest 10A, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.11 Task 4k, Optional, Area of Potential Interest 10B, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.12 Task 4l, Optional, Area of Potential Interest 11B, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.13 Task 4m, Optional, Area of Potential Interest 11C, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.4.14 Task 4n, Optional, Area of Potential Interest 11D, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

Performance Standard: Given the available historical information and the approved conceptual site model the field work, data quantity and quality, and analysis of said data (does not include area where Rights-of-entry were not obtained) provides the following results in the RI report:
- Demonstrate that the work was performed in accordance with the applicable laws, regulations, and guidance documents;
-Demonstrate with at least a 90 % confidence of detection that all MEC contaminated areas have been identified. (MEC contamination will be defined in accordance with the approved conceptual site model. The CSM for a suspected ground target area might define the character of a confirmed MEC contaminated area as one with elevated anomaly density plus evidence of concentrated munitions use. The CSM for a suspected disposal area might define the character of a confirmed MEC contaminated area as one with geophysical evidence of a burial pit.)
-Demonstrate that the boundaries of all identified MEC contaminated areas likely to contain MEC have been delineated to an accuracy of at least +/- half the transect spacing, maximum 250 feet.
-Demonstrate with at least 90 % confidence that all land outside the areas likely to contain MEC have less than or equal to (.1 when public use is significant, .5 when public use is moderate and 1 when public use is low) UXO per acre.

-Demonstrate that a 90 % confidence in the nature (type, density and potential depth) of MEC and MEC related debris, for each relatively homogeneous MEC contaminated area, has been achieved.
- Demonstrate that data inputs from the RI into the FS will enable remediation cost estimates with an accuracy of +50%/-30%. The work and reporting shall address the surface and sub-surface metallic anomaly density distribution (anomaly/acre) across identified MEC contaminated areas and other remediation cost drivers such as vegetation type and density, terrain conditions, soil type, exclusion zone evacuation costs, etc each to a level of accuracy within the range specified herein.
Additionally:
- Perform the RI field activities in accordance with the accepted Work Plan and UFP-QAPP.
- Proper processing and disposition of UXO, DMM and MC encountered in accordance with approved plan(s).
- All Material Potentially Presenting an Explosive Hazard (MPPEH) and munitions debris processed in accordance with Chapter 14, EM 1110-1-4009 and Errata Sheet No. 2.
- Meet the project DQOs as defined by the TPP process.
- All geophysics shall be IAW geophysics DID. For this task order 1 acre of transects equals 14,520 lf (2.75 miles) of transects 3 feet wide. One acre's worth of grids equals seventeen (17) 2500 sf grids or four (4) 10,000 sf grids.

AC: Conduct the RI in accordance with the accepted/approved WP, UFP-QAPP, and ESP. QC data submitted meets requirement described in DID WERS-004.01. No more than 3-4 CARs/948s for non-critical violations and/or 1 CAR/948 for critical violation. No unresolved Corrective action requests. All final data and QC tests/documentation submitted. Government QA acceptance QC tests/documentation gained. No Class "A" Safety, contractor at fault, violations during execution of work, <1 non-explosive related Class D, accidents, or <2 non-explosive Class C accidents IAW AR 385-40. Major safety violations, 1 non-explosive related safety violation. Minor safety violations, 2 safety violations. Zero letters of reprimand, grievances, or formal complaints.

Measurement / Monitoring: Period inspection/review of field work. Verify compliance with accepted WP, UFP-QAPP , Dive Plan and ESP . Quality control tests/documentation submitted per the QASP for government review. Additionally, statistical confidence will be calculated using the Visual Sampling Plan software or other approved statistical method. Boundary precision will be determined by evaluation of the sampling footprint as it relates to the reported contaminated/uncontaminated areas in question. Anomaly density profile and other remediation cost driver precision will be verified by QA of methods used.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements:
- Restore all areas to their original condition; all access/excavation/detonation holes shall be backfilled.
- Maintain a detailed accounting of all UXO, DMM, MD and range-related debris encountered per DID WERS-004.01. This accounting shall include: amounts of UXO, DMM and MD; nomenclature; location and depth of UXO/DMM; location of MD; and final disposition. The accounting system shall also account for all demolition materials utilized on site. Digital photographs of UXO and DMM and examples of MD found during the investigation are to be taken.
- All UXO, DMM and MC encountered during this munitions response shall be processed in accordance with the approved work and safety plans.
- The contractor is responsible for evacuations.

3.4.8 Task 4p, Evacuations: This is a Cost Plus Fixed Fee task.
Objective: Provide support for evacuation of residences displaced due to intrusive investigation exclusion zones.

Performance Standard: Support evacuation of residences in an efficient and timely manner so as not to cause delays in schedule and complains from the residences.

AC: Necessary voluntary evacuations accomplished in a courteous and professional manner with no contract a fault delay to project schedule.

Measurement / Monitoring: Government monitoring of evacuations, receipt of complaints from the public, unsolicited commendations.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating.

Specific Task requirements: ~~*The Contractor shall provide Bi-lingual support, English and Spanish on-site during field activities.*~~ The Contractor shall provide printing services and distribution of door hangers for evacuation reminders. The Contractor shall provide logistics for Hospitality Area (HosA), transportation to the HosA and support evacuation requirements; food and drink. The Contractor shall arrange for kenneling as necessary. The Contractor shall provide additional services for evacuation, as required, by the District. The following shall be used for price of evacuation:

- Sleeping Rooms	$77 at Government Per Diem
- Hospitality Suite	$175 plus taxes and gratuity per day of evacuations
- Food	$15 per person per day
- Transportation	$50 round trip per car load once per week of fieldwork
- Pet Boarding	$40 per pet per day

3.5 Task 5, Remedial Investigation (RI) Report:
Objective: Prepare, submit and gain acceptance of a RI report in accordance with EM CX Interim Guidance 06-04 and EPA Guidance.

Performance Standard: The RI report shall document the result of the RI and be in accordance with EP 1110-1-18, EM CX Interim Guidance 06-04 and EPA guidance.

AC: Acceptance of RI with two revisions.

Measurement / Monitoring: Review of RI against guidance to verify that the minimum acceptable content has been provided.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements:
- Prepare, submit and gain acceptance of a RI report in accordance with EP 1110-1-18 EM-CX Interim Guidance 06-04, and EPA guidance.
- Use EPA MEC Hazard Assessment, not Ordnance and Explosives Risk Impact Assessment.
- Incorporate all RI data and data from previous investigations, historical documents, PA/SI into this RI.
- Recommend changes in realignment of MRS dependent on RI finding.
- Prepare, as an appendix to this report, a new or update Munitions Response Site Prioritization Protocol (MRSPP) for each MRS dependent upon RI findings using the MRSPP worksheets, http://www.lab-data.com/MRSPP/ .

3.6 Task 6, Feasibility Study (FS) and Report: This task is a Firm Fixed Price task.

Objective: Conduct a feasibility study and prepare, submit and gain acceptance of a FS report in accordance with EM CX Interim Guidance 06-04.

Performance Standard: The FS report shall document the result of the feasibility study and be in accordance with EP 1110-1-18, EM CX Interim Guidance 06-04 and EPA guidance.

AC: Acceptance of FS with two revisions.

Measurement / Monitoring: Review of FS against guidance to verify that the minimum acceptable content has been provided.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: None.

3.7 Task 7, Proposed Plan: This task is a Firm Fixed Price task.

Objective: Prepare, submit and gain acceptance of a Proposed Plan (PP).

Performance Standard: Prepare the PP in accordance with CERCLA, ER 200-3-1, EP 1110-1-18 and EM-CX Interim Guidance 06-04.

AC: Acceptance of PP with two revisions.

Measurement / Monitoring: Review of PP against guidance to verify that the minimum acceptable content has been provided.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: After government & regulator review, the revised draft-final version of the Proposed Plan will be subject to a minimum 30-day public review. A public meeting shall be held to present the Proposed Plan to the public. This public meeting falls under Task 9, Community Relations Support.

3.8 Task 8, Decision Document: This task is a Firm Fixed Price task.

Objective: Prepare, submit and gain acceptance of a Decision Document (DDfor each MRS identified.

Performance Standard: Prepare the DDs in accordance with CERCLA, ER 200-3-1, EP 11101-1-18 and Appendix C, herein.

AQL: Acceptance of DDs with two revisions.

Measurement / Monitoring: Review of DD against guidance to verify that the minimum acceptable content has been provided.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: PWS Appendix C provides new formatting requirements for the Decision Document. For formatting of Decision Documents, Attachment C supersedes MM CX Interim Guidance 06-04.

3.9 Task 9, Community Relations Support: This task is a Firm Fixed Price/Unit Price, task.
Objective: Successfully complete public meetings and support the Savannah District with community relations.

Performance Standard: Contractor attends and participates in meetings. Meeting transcripts PP meeting are accurate. Meeting materials are accepted by the government as required.

AC: Acceptance of meeting materials with two revisions. Acceptance of PP meeting transcripts in one revision. Meetings held are organized; and professional in nature. Personnel are thoroughly familiar with the project. Zero letters of reprimand, grievances, or formal complaints

Measurement / Monitoring: Review of required materials for meetings. Government will attend and evaluate contractor's attendance, participation and professional demeanor.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating.

Specific Task Requirements: The Contractor shall attend and participate in Three (3) public meetings. These meetings are different and in addition to TPP meetings. These meetings will be held in Spartanburg, SC. The support shall include, but is not limited to: preparation and delivery of briefings, graphics, maps, posters, and support of question and answer sessions. The Contractor shall also obtain the meeting site, perform public notification and prepare any correspondence necessary to meeting the objectives of this task. The government shall approve all correspondence, public notices and all other materials prior to being presented/distributed to the public. These actions are independent of the field activities that involve interaction with the community. The meeting for the Proposed Plan shall be covered under this task. Transcripts of the public meeting for the Proposed Plan shall be prepared and submitted with the Final Proposed Plan.

3.10 Task 10, Public Involvement Plan (PIP): This task is a Firm Fixed Price task.
Objective: Update, submit and gain acceptance of a PIP in accordance with EP 1110-3-8, ER 200-3-1, EM-CX Interim Guidance 06-04, guidance provided in the FUDS Public Involvement Toolkit and DENIX website.

Performance Standard: Prepare the PIP in accordance with EP 1110-3-8, ER 200-3-1, EM-CX Interim Guidance 06-04, guidance provided in the FUDS Public Involvement Toolkit and DENIX website.

AQL: Acceptance of PIP with two revisions.

Measurement / Monitoring: Review of PIP against guidance to verify that the minimum acceptable content has been provided.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: None.

3.11 Task 11, Administrative Record: This task is a Firm Fixed Price task.
Objective: Maintain the Administrative Record for each MRS throughout the period of performance of this Task Order.

Performance Standard**:** Prepare in accordance with the guidance in EP 1110-3-8, Chapter 4 (Establishing and Maintaining Administrative Records) and Standard Operating Procedure for Formerly Used Defense Sites (FUDS) Records Management, Revision 5, dated January 2008 (or most recent version).

AC: Administrative record will be evaluated against guidance for compliance with requirements, accuracy and completeness of the record, with up to one uncorrected deficiencies remaining during the period of performance.

Measurement / Monitoring: The government will visit, at least once, the administrative record's location and check for completeness and compliance with referenced EP; electronic submissions will be evaluated randomly upon receipt as data is entered into the record.

Task specific Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: Secure a location such as a public library for a place to house the Administrative Record in the local city or community of each MRS. This task requires close coordination with the Savannah District (CESAS) and USAESCH to secure all required documents to support the Administrative Record. Provide copies of all final documents posted to the Administrative Record on CD/DVD to USAESCH and Savannah, 2 copies each. These files shall be suitable for placement on the PIRS web site.

3.12 Task 12, Environmental Sampling & Analysis: This task is a Firm Fixed Price/Unit Price, task

Objective: Collect sufficient data that meets the project DQOs as defined during the TPP process, of known quality and quantity to determine the nature and extent of munitions constituents (MC) to support and perform a human health and ecological baseline risk assessment.

3.12.1 Task 12a, Gas Chambers, FUDS Project No. I04SC0016-03R01. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.2 Task 12b, Grenade Court, FUDS Project No. I04SC0016-03R02. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.3 Task 12c, Range Complex (Land), FUDS Project No. I04SC0016-03R03. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.4 Task *12d*, Optional, Range Complex (Lake Craig and Lake Johnson), FUDS Project No. I04SC0016-03R03. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.5 Task *12e*, Optional, Area of Potential Interest 3, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.6 Task *12f*, Optional, Area of Potential Interest 5, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.7 Task *12g*, Optional, Area of Potential Interest 8, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.8 Task *12h*, Optional, Area of Potential Interest 9E, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.9 Task *12i*, Optional, Area of Potential Interest 9G, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.10 Task *12j*, Optional, Area of Potential Interest 10A, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.11 Task *12k*, Optional, Area of Potential Interest 10B, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.12 Task *12l*, Optional, Area of Potential Interest 11B, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.13 Task *12m*, Optional, Area of Potential Interest 11C, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

3.12.14 Task 12n, Optional, Area of Potential Interest 11D, FUDS Project No. I04SC0016-03. Refer to historical project documentation of site location, historical information, and boundaries.

Performance Standard: Perform field activities in accordance with the Work Plan and UFP-QAPP. MC analyses shall be performed in accordance with the requirements of the Department of Defense (DoD) Quality Assurance Manual (QAM), WERS-009.01 Munitions Constituents Chemical Data Quality Deliverables, and the approved project specific UFP-QAPP. The ecological and human health risk assessment shall be performed in accordance with the EPA Risk Assessment Guidance (RAGS) and USACE EM 200-1-4, Volumes I and II.

AC: Sampling field work and data meets established criteria within the accepted Uniform Federal UFP-QAPP, SAP, and Work Plan.

Measurement / Monitoring: Periodic inspection/review of field work, and data. Verify compliance with accepted WP, UFP-QAPP and ESP. Quality control tests/documentation submitted per the QASP for government review.

Incentive/Disincentive: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Task Specific Requirements: The contractor shall propose on the sampling rationale, and methods that will be utilized to ensure that data generated are of an acceptable quality for its intended use, propose a phased approach and address contaminants of interest and all sample media (soil/groundwater/sediment/surface water).. The contractor shall also propose on the quantity, quality and the methods used to verify adherence to the PARCCS parameters for sample collection, handling, laboratory analysis, verification and validation. Any deviations from the accepted SAP shall be documented in the Daily Quality Control Reports (DQCR) and conveyed to USAESCH personnel immediately. The contractor will provide an independent laboratory to analyze QA samples separate from the contractor's primary laboratory.

4.0 Submittals.

Even though draft and draft final submittals are requested, the term "draft" shall not reflect upon the quality of the submittal being provided by the Contractor. Submittals shall include all supporting materials including supporting data whether electronic or hardcopy. Submittals not meeting the requirements of referenced guidance or Data Item Descriptions or missing supporting data may be rejected and revised by the contractor at the contractor's own expense.

4.1 The Contractor shall deliver the specified number of copies shown in Table 4.2 of each report listed in Table 4-1 to the following addressees (addresses to be verified by Contractor):

US Army Engineering & Support Center, Huntsville
Attn: CEHNC-CT-E (Lydia Tadesse)
PO Box 1600
Huntsville, AL 35807-4301
4820 University Square
Huntsville, AL 35816-1822

US Army Engineering & Support Center, Huntsville
Attn: CEHNC (Spencer O'Neal) (COR)
PO Box 1600
Huntsville, AL 35807-4301
4820 University Square
Huntsville, AL 35816-1822

US Army Engineering & Support Center, Huntsville
Attn: CEHNC-OE-DC, Spencer O'Neal (PM)
PO Box 1600
Huntsville, AL 35807-4301
4820 University Square
Huntsville, AL 35816-1822

Commander
U.S. Army of Corps of Engineers. Savannah District
Attn: CE-SAC (Shawn Boone) (PM)

100 W. Oglethorpe Ave.
PO Box 899
Savannah, GA 31402-0889

Contractor to obtain and/or verify addresses.

4.2 Submittals and Due Dates.
The Contractor shall submit 1 copy of the entire submittal on a CD with each hard copy of a submittal (Reports, Plans, etc) in accordance with DID WERS-007.01. Hardcopies shall be printed on both sides of the paper whenever possible.

Table 4-1 List of Submittals

Submittal	**Due Date (Calendar Days)**
Meeting minutes for Kickoff phone conference	7 days after Kickoff phone conference
Proposed Schedule	7 days after kickoff conference call
Pre-TPP Meeting Materials	14 Days prior to TPP meetings
Conceptual Site Model (CSM)	With Pre-TPP materials
AAPP	7 days prior to site visit
Draft TPP Memorandum	14 days after first TPP meeting
Final TPP Memorandum	7 days after receipt of comments
Draft TPP Memorandum Addendum	7 days after second TPP meeting
Final TPP Memorandum Addendum	7 days after receipt of comments
Draft TPP Memorandum Addendum	7 days after third TPP meeting
Final TPP Memorandum Addendum	7 days after receipt of comments
Draft Public Involvement Plan	TBD
Draft-Final Public Involvement Plan	14 days after receipt of comments
Final Public Involvement Plan	7 days after receipt of comments
Pre-Public Meeting Materials	14 Days prior to public meetings
Final Public Meeting Materials	no later than day of Meeting
Draft Work Plan and Draft QASP	21 days after acceptance of TPP memorandum
Draft Final Work Plan	14 days after receipt of comments
Final Work Plan	14 days after receipt of comments and TPP meeting
Quality Control Documents	**As required by Regulation, guidance, DIDs, QCP, QASP, or agreed to in project schedule, to include the following**:
Daily QC Report for Environmental Sampling	Daily during Sampling Activities
Analytical Data Submittal for QA Evaluation	30-45 days after completion of fieldwork
Electronic Laboratory Data Submittal	45-60 days after completion of fieldwork
Draft RI Report	60-81 days after completion of field work
Draft Final RI Report	21 days after receipt of comments
Final RI Report	14 days after receipt of comments and TPP meeting
Draft FS Report	21 days after of acceptance of the RI Report
Draft Final FS Report	14 days after receipt of comments
Final FS Report	14 days after on board Review
Draft Proposed Plan	14 days after of acceptance of the FS Report
Draft Final Proposed Plan	14 days after receipt of comments
Final Proposed Plan	14 days after PP public meeting
PP Meeting Transcripts	with final Proposed Plan
Responsiveness Summary	with Decision Document Submittals
Draft Decision Document	14 days after acceptance of Proposed Plan
Draft Final Decision Document	7 days after receipt of comments
Final Decision Document	7 days after receipt of comments
Final Administrative Record (On CD/DVD)	Upon completion of the Record
Final GIS Files on CD	End of Project

4.3 Submittal Quantities

Provide the number of submittals shown in Table 4-2 to the addressees given in Section 4.2. No draft documents shall be released to the regulatory community until reviewed by the government.

Table 4-2 Submittal Guidance

	Draft Documents	Draft Final/Final Documents
KO/COR	1 each	1 each
USAESCH	4	4
Savannah	6	6

4.4 Period of Performance: The Completion Date for this Task Order is January 31, 2013.

5.0 Milestone Payments for firm fixed price tasks: Milestones will be considered met or completed when the required QC documentation has been submitted, QA completed and the submittal and/or product is accepted. Any payment vouchers submitted that do not coincide with the final accepted milestones or do not have the appropriate QC documentation will be rejected. All payments will be made utilizing an agreed upon Payment Milestone Schedule. The Contractor shall provide suggested milestones for payment. Milestones for payment shall be shown on the project schedule.

5.1 The following is a list of potential milestones for payment:
- Final Submittals: upon government acceptance, for example: Final WP
- Field Work: for defined units and activities completed and QA review and acceptance, for example: Final QC density data package.
- Meetings: after completion of meetings with government acceptance of meeting minutes, for example: Final PP meeting minutes.

6.0 REFERENCES:

6.1 Refer to "Base Contract."

6.2 Data Items Descriptions at the following website:
http://www.hnd.usace.army.mil/engr/WERS.aspx .

7.0 GENERAL CONDITIONS: See the Base Contract Section C, Section 10 General Conditions and the following addendums:

7.1 This is a performance based task order. The inclusion of unit prices in the proposal shall in no way be construed to mean that the Government is procuring a specified number of units of any given service.

7.2 Government acceptance of the proposed technical approach and/or price does not relieve the Contractor from full responsibility for the viability, productivity, and efficiency of the approach used to meet the performance requirements of the PWS at the price proposed. The task order is for the provision of services that ultimately meet the performance requirements of this task. If the contractor must adjust its technical approach or perform more field work than anticipated in order to achieve the proposed performance goal then the contractor will do so with no change in task order price.

7.3 If the Government at its sole discretion chooses to modify the performance standard the parties to this task order will assess the impact on the estimated amount of field work required to achieve the new performance standards and will negotiate a price adjustment based upon the unit prices providing as price proposal supporting documentation (See Attachment D).

7.4 The Contractor attests that it applied due diligence in the research and development of its proposal has priced reasonable estimates of the site conditions and the associated risks into the price. The Contractor accepts full and sole responsibility for identifying and considering all factors that may affect the cost to execute the work. The act of signing this task order signifies that the Contractor has been given ample opportunity to assess the conditions under which the work will be performed and the Contractor either fully understands those conditions or has factored the risk into the price.

7.5 The Government provided the Contractor with historical documents and documents from previous site activities. The Contractor attests it interpreted the data utilizing an experienced understanding of how the data of this type is collected, analyzed, interpreted, and presented.

8.0 ARMY CONTRACTOR MANPOWER REPORTING

8.1 Implementation.

8.1.1 The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains a secure Army data collection site where the contractor will report contractor manpower information (including subcontractor manpower information) required for performance of this contract. The contractor shall submit all the information required in the format specified at the following web address: **https://cmra.army.mil/default.aspx**

8.1.2 The Contractors shall fill in the required information on the website, fields are shown below:

- Contract Number
- Delivery Order Number (if applicable)
- Task Order Number (if applicable)
- Requiring Activity Unit Identification Code (UIC)
- Command
- Contractor Contact Information
- Federal Service Code (FSC)
- Direct Labor Hours
- Direct Labor Dollars
- Location Information (where contractor and subcontractors (if applicable) performed the services

8.1.3 Reporting period will be the period of performance not to exceed 12 months ending September 30 of each government fiscal year and must be reported by 15 October of each calendar year.

8.1.4 If your particular contract crosses fiscal years, 2 entries must be made to capture the data for the contract period; for example if the contract start date is 1 January 2007 and ends 31 December 2007, the data for the period from 1 January 2007 through 30 September 2007 shall be entered not later than 15 October 2007 and the period 1 October 2007 through 31 December 2007 shall be entered not later than 15 January 2008.

Attachment A
Performance Requirements Summary:

A.1 The Contractor shall meet the following performance requirements. Performance requirements are addressed in each task and summarized in the following Performance Requirements Summary. If discrepancies or ambiguity exists between the documents, the order of precedence is 1) the Task; 2) Performance Requirements Summary; 3) Performance Metrics

Table A-1 Performance Requirements Summary

Task Application	Objective	Performance Standard	Minimum Acceptable Criteria	Measurement / Monitoring	Incentive/ Disincentive
1	Implement the four-phase TPP process in accordance with EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents.	Achieve the objectives of each TPP phase as listed in EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents. Facilitate meetings in a professional and organized manner.	Acceptance of TPP documents (meeting presentations, agenda, handouts, CSM and memorandums) with up to one (1) revision. Meetings held are organized; accomplish requirements of the TPP process; and professional in nature. Zero letters of reprimand, grievances, or formal complaints.	TPP checklist for each phase as provided in the guidance will be used to measure and document successful progress; guidance cited will be used to evaluate content of documents for acceptance / non-acceptance. Government will attend and evaluate organization and facilitation of the meetings, and professional nature of the meetings.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
2	Prepare, submit and gain acceptance of a WP, munitions constituent (MC) UFP-QAPP and QASP that are detailed and comprehensive plans covering all aspects of site characterization, risk assessment methodology, and project execution.	Prepare the WP in accordance with DID WERS-001 and EM 1110-1-4009, EM 385-1-1, and EP 75-1-3 as appropriate. Prepare the sampling and analysis plan, field sampling, and UFP-QAPP in accordance with EM 1110-1-4009, DID WERS-009.01, and Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP), as appropriate. UFP-QAPP content shall also meet the requirements of DoD	Acceptance of WP and UFP-QAPP with two revisions. Draft QASP reflects requirements and QCP with one revision required.	Review of WP, UFP-QAPP and QASP per guidance to verify that the minimum acceptable content has been provided.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense

		Quality Systems Manual for Environmental Laboratories (current version).			
2a	Prepare, submit and gain acceptance of an Explosives Siting Plan	Prepare required submission in accordance with DoD 6055.09-Std, Chapter 12, Paragraph 12.5, EM 385-1-97, Errata Sheet #3,and DID WERS-003 as a stand alone document for inclusion after acceptance into the WP.	Acceptance of submission with two revisions.	Review by Government using guidance cited to determine acceptability.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense
2b	Prepare, submit and gain acceptance of a Dive Plan.	Prepare, submit and gain acceptance of a Dive Plan that is a detailed and comprehensive plan covering all aspects of dive operations in accordance with EM 385-1-1.	Acceptance of submission with two revisions.	Review by Government using guidance cited to determine acceptability.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
3	Utilize GIS in the development of the Conceptual Site Model (CSM) and maintain and manage all project and geospatial data.	Manage and maintain project data, and develop CSM in GIS IAW DID WERS-007.01, EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents.	Acceptance of CSM, and GeoSpatial Data submissions meet quality and formatting requirements.	Review by Government using guidance cited to determine acceptability.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
4	Contractor shall conduct a remedial investigation in accordance with CERCLA characterizing the nature and extent of MEC contamination at the required munitions response sites (MRS) meeting the project DQOs as defined during the TPP	Provide data and analysis that demonstrates proposed and accepted statistical confidence and accuracy levels have been met and that all MEC contaminated areas have been identified. Additionally: - Perform the RI field activities in accordance with the accepted Work Plan and UFP-QAPP. - Proper processing	Conduct the RI in accordance with the accepted/approved WP, UFP-QAPP , and ESP. QC data submitted meets requirement described in DID WERS-004.01. No unresolved Corrective action requests. All final data and QC tests/documentation submitted. Government QA acceptance QC tests/documentation	Period inspection/review of field work. Compliance with approved WP, UFP-QAPP and ESP. Quality control tests/documentation submitted per the QASP for government review. Additionally, Statistical Confidence will be calculated using the Visual	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

	process.	and disposition of UXO, DMM and MC encountered in accordance with - All Material Potentially Presenting an Explosive Hazard (MPPEH) and munitions debris processed in accordance with Chapter 14, EM 1110-1-4009 and Errata Sheet No. 2. - Meet the project DQOs as defined by the TPP process. -Restore all areas to their original condition; all access/excavation/detonation holes shall be backfilled. - All geophysics shall be IAW DID WERS-004.01. For this task order 1 acre of transects equals 14,520 lf (2.75 miles) of transects 3 feet wide. One acre's worth of grids equals seventeen (17) 2500 sf grids or four (4) 10,000 sf grids. approved plan(s).	gained. No Class "A" Safety, contractor at fault, violations during execution of work, <1 non-explosive related Class D, accidents, or <2 non-explosive Class C accidents IAW AR 385-40. Major safety violations, 1 non-explosive related safety violation. Minor safety violations, 2 safety violations. Zero letters of reprimand, grievances, or formal complaints.	Sampling Plan software or other approved statistical method. Boundary precision will be determined by evaluation of the sampling footprint as it relates to the reported contaminated/ uncontaminated areas in question. Anomaly density profile and other remediation cost driver precision will be verified by QA of methods used.	
5	Prepare, submit and gain acceptance of a RI report in accordance with EM CX Interim Guidance 06-04 and EPA Guidance.	The RI report shall document the result of the RI and be in accordance with EP 1110-1-18, EM CX Interim Guidance 06-04 and EPA guidance.	Review of FS against guidance to verify that the minimum acceptable content has been provided.	Review of RI against guidance to verify that the minimum acceptable content has been provided.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
6	Conduct a feasibility study and prepare, submit and gain acceptance of a FS report in accordance	The FS report shall document the result of the feasibility study and be in accordance with EP 1110-1-18, EM CX Interim Guidance 06-04 and EPA	Acceptance of FS with two revisions.	Review of FS against guidance to verify that the minimum acceptable content has been provided.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

	with EM CX Interim Guidance 06-04.	guidance.			
7	Prepare, submit and gain acceptance of a PP.	Prepare the PP in accordance with CERCLA, ER 200-3-1, EP 1110-1-18 and EM-CX Interim Guidance 06-04.	Acceptance of PP with two revisions.	Review of PP against guidance to verify that the minimum acceptable content has been provided.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
8	Prepare, submit and gain acceptance of a Decision Document (DD) for each MRS identified.	Prepare the DDs in accordance with CERCLA, ER 200-3-1, EP 11101-1-18 and Appendix C, herein.	Acceptance of DDs with two revisions.	Review of DD against guidance to verify that the minimum acceptable content has been provided.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
9	Support Jacksonville District with community relations, as needed.	Contractor attends and participates in meetings. Meeting transcripts are accurate. Meeting materials are accepted by the government and bilingual as required.	Acceptance of meeting materials with two revisions. Acceptance of transcripts in one revision. Contractor attendance and participation are provided in a professional manner. Personnel are thoroughly familiar with the project. Zero letters of reprimand, grievances, or formal complaints.	Acceptance of required materials for meetings. Government will attend and evaluate contractor's attendance, participation and professional demeanor.	Satisfactory or greater CPARS rating/poor CPARS rating.
10	Prepare, submit and gain acceptance of a PIP in accordance with EP 1110-3-8, ER 200-3-1, EM-CX Interim Guidance 06-04, guidance provided in the FUDS Public Involvement Toolkit and	Prepare the PIP in accordance with EP 1110-3-8, ER 200-3-1, EM-CX Interim Guidance 06-04, guidance provided in the FUDS Public Involvement Toolkit and DENIX website.	Acceptance of PIP with two revisions.	Review of PIP against guidance to verify that the minimum acceptable content has been provided.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

	DENIX website.				
11	Establish and maintain Administrative Record	Prepare in accordance with the guidance in EP 1110-3-8, Chapter 4 (Establishing and Maintaining Administrative Records) and Standard Operating Procedure for Formerly Used Defense Sites (FUDS) Records Management, Revision 5, dated January 2008 (or most recent version).	Administrative record will be evaluated against guidance for compliance with requirements, accuracy and completeness of the record, with up to 1 uncorrected deficiencies remaining during the period of performance.	The government will visit, at least once, the administrative record's location and check for completeness and compliance with referenced EP; electronic submissions will be evaluated randomly upon receipt as data is entered into the record.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
12	Collect data that meets the project DQOs as defined during the TPP process, of known quality and quantity, to determine the nature and extent of munitions constituents (MC) and perform a human health and ecological risk assessment.	Perform field activities in accordance with the Work Plan and UFP-QAPP. MC analyses shall be performed in accordance with the requirements of the Department of Defense (DoD) Quality Assurance Manual (QAM), WERS-009.01 Munitions Constituents Chemical Data Quality Deliverables, and the approved project specific UFP-QAPP. The ecological and human health risk assessment shall be performed in accordance with the EPA Risk Assessment Guidance (RAGS) and USACE EM 200-1-4, Volumes I and II.	Sampling field work and data meets established criteria within the accepted UFP-QAPP, SAP, and Work Plan.	Period inspection/review of field work, and data. Compliance with accepted WP, UFP-QAPP and ESP. Additionally, statistical confidence will be calculated using the Visual Sampling Plan software or other approved statistical method. Quality control tests/documentation submitted per the QASP for government review.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Attachment B
PERFORMANCE METRICS

B.1 Performance Metrics for Performance Assessment Record (PAR)

	Exceptional	Very Good	Satisfactory	Marginal	Unsatisfactory
PAR Category: Quality of Product or Service					
Performance indicator: Document reviews					
Draft Plans, Reports, and documents [Plans, documents and reports are considered draft until accepted as final by the Government]	All contract-milestone documents accepted as submitted	No substantive comments (i.e. limited to grammar, spelling, terminology) to any of the documents, but a few exceptions were noted and corrected	Contractor met Acceptance Criteria	One or more documents required revisions to be resubmitted for approval prior to proceeding. Two backchecks were required on one or more documents before original comments were resolved satisfactorily.	One or more documents did not comply with contract requirements, or one or more documents required more than two backchecks before original comments were resolved satisfactorily, or more than one document was rejected.
Performance indicator: Project Execution					
Process Compliance	Zero Corrective Action Requests (CAR) or 948s	{1-2} CARs/948s for non-critical violations to WP requirements	Contractor met Acceptance Criteria	{5-6} CARs/948s for non-critical violations and/or {2} CARs/948 for critical violations	{>6} CARS for non-critical violations and/or {>2} CARs/948s for critical violations, or any unresolved CARs
Project Execution	Zero letters of reprimand, grievances, or formal complaints AND one or more unsolicited letters of commendation		Contractor met Acceptance Criteria	{One} letter of reprimand, grievance or formal complaint that was resolved through negotiation	More than {one} letter of reprimand, grievance or formal complaint that were resolved through negotiation
Task Completion			Contractor met Acceptance Criteria		Final data and QC documentation submitted but not accepted
PAR Category: Schedule					
Performance indicator: Timely completion of tasks					
Final Plans and Reports, project	All document submittals and	Project closed out/final	Project closed out/final	Project closed out/final invoice	Project closed out/final

	Exceptional	**Very Good**	**Satisfactory**	**Marginal**	**Unsatisfactory**
milestones, T.O. invoices	task order milestones and invoices complete and accepted by T.O date, project closed out/final invoice approved ahead of schedule	invoice accepted ahead of schedule	invoice accepted on T.O. date	accepted within 30 calendar days after T.O. date.	invoice accepted more than 30 calendar days after T.O. date.
Project status reports accurate			Yes		No
Performance indicator: Impacts to schedule					
Impacts caused by Contractor or other causes identified, in writing to HNC CO/ PM, in a timely manner to apply acceptable corrective actions.			Yes		No
PAR Category: Cost Control (Not Applicable for Firm Fixed Price)					
Performance indicator: No unauthorized cost overruns					
Unauthorized cost overruns			No		Yes
Total Project Costs	Total contract invoices less than 98% of T.O. authorized amount	Total contract invoices greater than 98% but less than 99.99%of T.O. authorized amount	Total contract invoices between 99.99% and 100% of T.O. authorized amount	Total contract invoices greater than 100% but less than 105% of T.O. authorized amount	Total contract invoices greater than or equal to 105% of T.O. authorized amount
Performance indicator: Monthly cost report					
Monthly cost reports accurate			Yes		No
Performance indicator: Impacts to cost					
Impacts caused by Contractor or other causes identified, in writing to HNC CO/PM, in a timely manner to apply acceptable corrective actions.			Yes		No
PAR Category: Business Relations					
Performance indicator: Met contractual obligations					
Corrective Actions taken were timely and			Yes		No

	Exceptional	Very Good	Satisfactory	Marginal	Unsatisfactory
effective (Refer to CARs issued to Contractor)					
Performance indicator: Professional and Ethical Conduct					
Meetings and correspondences with Public, project delivery team and other stakeholders	Zero letters of reprimand, grievances, or formal complaints AND one or more unsolicited letters of commendation		Contractor met Acceptance Criteria	One letter of reprimand, grievance or formal complaint that was resolved through negotiation	More than one letter of reprimand, grievance or formal complaint that were resolved through negotiation OR removal of one or more project personnel as a results of a letter of reprimand, grievance or formal complaint.
Performance indicator: Customer has overall satisfaction with work performed					
Customer survey results for rating period	4.0-5.0	3.0-3.9	2.0-2.9	1.0-1.9	<1.0
Performance indicator: Personnel responsive and cooperative					
Key personnel responsive, and cooperative	Always		Most Times		Almost Never
PAR Category: Management of Key Personnel and Resources					
Performance indicator: Personnel knowledgeable and effective in their areas of responsibility					
Personnel assigned to tasks	All personnel proposed by Contractor were assigned to project, some personnel were substituted by higher qualified individuals.		All personnel proposed by Contractor were assigned to project, some personnel were substituted by equally qualified individuals.	All personnel proposed by Contractor were assigned to project, some personnel were substituted by equally qualified individuals, Letter of reprimand received for personnel conduct from HNC.	All personnel proposed by Contractor were assigned to project, some personnel were substituted by lesser qualified individuals or HNC requested, in writing, removal of assigned personnel for poor performance.
Performance indicator: Personnel able to manage resources efficiently					
Instances when resource management had negative impact	0	1-2	3-4	5-6	>6

	Exceptional	Very Good	Satisfactory	Marginal	Unsatisfactory
on project execution					
PAR Category: Safety					
Performance indicator: Accidents and Violations					
*No Class A Accidents, Contractor at fault	0 No class A accidents IAW AR 385-10	No class A accidents IAW AR 385-10	Contractor met Acceptance Criteria	{<2} non-explosive related Class C accidents, or {1} non-explosive Class B accident, IAW AR 385-10	{1} Any Class A accident IAW AR-385-10, or Any explosive related accident.
*Major safety violations	0 accidents/injuries No safety violations	0 accidents/injuries No safety violations		{2} non-explosive safety violations.	{>1} any violation of procedures for handling, storage, transportation, or use of explosives IAW the WP, and all Federal, State and local laws/ordinances.
*Minor safety violations	No safety violations	1 safety violation		{3} safety violations	{>3} safety violations

Classes of Accidents:

- **Class A:** Fatality or permanent total disability (Government Civilian, Military Personnel, and/or Contractor), or >$2,000,000 property damage.

- **Class B:** Permanent partial disability or impatient hospitalization of 3 or more persons (Government Civilian, Military Personnel, and/or Contractor), $500,000< $2,000,000 property damage.

- **Class C:** Lost Workday (Contractor) or Lost Time (Government Civilians), $50,000< $500,000 property damage.

- **Class D:** $2000 < $50,000 property damage.

* From Section C of Solicitation Number W912DY-08-R-0016, Amendment 0007 (may be included but are not limited to these).

The following guidelines are provided for issuing ratings that are subjective in nature, these ratings will be supported by the weight of evidence documented during the government's surveillance efforts:

<u>Exceptional:</u> Performance *meets* contractual requirements and *exceeds many* to the Government's benefit. The contractual performance of the element or sub-element being assessed was accomplished with *few minor problems* for which corrective actions taken by the Contractor were *highly effective*.

Very Good: Performance *meets* contractual requirements and *exceeds some* to the Government's benefit. The contractual performance of the element or sub-element being assessed was accomplished with *some minor problems* for which corrective actions taken by the Contractor were *effective*.

Satisfactory: Performance *meets* contractual requirements. The contractual performance of the element or sub-element contains *some minor problems* for which corrective actions taken by the Contractor *appear or were satisfactory*.

Marginal: Performance *does not meet all* contractual requirements. The contractual performance of the element or sub-element being assessed reflects a *serious problem* for which the Contractor has *not yet identified corrective actions*. The Contractor's proposed actions appear only *marginally effective or were not fully implemented*.

Unsatisfactory: Performance *does not meet most* contractual requirements and *recovery is not likely* in a timely manner. The contractual performance of the element or sub-element contains *serious problems* for which the Contractor's corrective actions *appear or were ineffective*

Attachment C

1. REQUIREMENTS AND PROCEDURES:

a. This interim guidance provides specific requirements for MMRP Decision Documents.

b. Format and content of ALL MMRP decision documents and action memoranda, regardless of signature authority shall be in accordance with Section 2. Each document will contain:

(1) A title page,

(2) A table of contents,

(3) Page numbers on each page indicating page number and total number of pages in the document, e.g., “1 of 25”.

(4) Header in the upper right-hand corner of each page including; document type (“Decision Document”, “Time Critical Removal Actions (TCRA) Action Memorandum”, or “Non-time Critical Removal Action (TCRA) Action Memorandum”), project name (“Sitka Naval Operating Base”), project location (“Sitka, Alaska”), and project number to include MRS number.

c. All decision documents or action memoranda, regardless of level of signature authority, will be accompanied by an Executive Summary that for Headquarters (HQ). USACE will forward to ACSIM-ISE and DASA (ESOH). The Executive Summary shall be kept to a single page, whenever possible, and will include:

(1) Title, including project name and project number, date DD (or AM) was signed and by whom,

(2) Brief description of the Munitions Response Sites (MRS), covered by the decision,

(3) Brief description of selected response action and its relationship to other cleanup actions,

(4) Degree of risk reduction,

(5) Present worth cost of selected response action, and the contribution to the cost-to-complete of all remedies for the FUDS Property,

(6) Amounts and fiscal year(s) that funds are required for remedial/removal action design and construction,

(7) Duration of any remedial action-operation (RA-O), removal action construction (RmA-C) and/or Long Term Monitoring (LTM) actions,

(8) Land use controls (LUC) required and means of maintaining them,

(9) Other potential response actions considered, and

(10) Expected result of the action.

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Remedial Action Decision Document Outline

PART 1: THE DECLARATION

The Declaration functions as the abstract and formal authorizing signature page for the DD.

1. PROJECT NAME AND LOCATION.
2. STATEMENT OF BASIS AND PURPOSE.
   Certify the factual and legal basis for the Selected Remedy.

3. ASSESSMENT OF PROJECT MRS.
   Certify that the MRS poses a threat to public health, welfare, or the environment.

4. DESCRIPTION OF SELECTED REMEDY.
   a. Describe the major components of the Selected Remedy in a bullet fashion.

   b. Describe the scope and role of this MRS.

   c. Describe how this remedial action addresses principal threats and other contamination at the MRS (i.e., what is being treated, what is being contained, and what is the rationale for each).

5. STATUTORY DETERMINATIONS.
   a. Describe how the Selected Remedy satisfies the statutory requirements of CERCLA §121 and discuss the applicability of the 5-year review requirements.

6. DATA CERTIFICATION CHECKLIST.
   The Declaration should certify that the following information is included in the DD (or provide a brief explanation for why this information is not included):

   a. Munitions and Explosives of Concern (MEC) and munitions constituents (MC) and their respective concentrations.

   b. Baseline risk represented by the MEC/MCs.

   c. Cleanup levels established for MEC/MCs and the basis for these levels.

   d. How MEC and MC will be addressed.

   e. Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and DD.

   f. Potential land and groundwater use that will be available at the MRS as a result of the Selected Remedy.

g. Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.

h. Key factor(s) that led to selecting the remedy (i.e., describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision).

7. AUTHORIZING SIGNATURE.

The following general paragraph and signature block. (*Note: Signature block may not appear alone on a page – it must be on the same page with the preceding paragraph*):

"This Decision Document presents the selected response action at [place]. The U.S. Army Corps of Engineers is the lead agency under the Defense Environmental Restoration Program (DERP) at the [FUDS property name] Formerly Used Defense Site, and has developed this Decision Document consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision document will be incorporated into the larger Administrative Record file for [FUDS property name], which is available for public view at [address]. This document, presenting a selected remedy with a present worth cost estimate of [$$], is approved by the undersigned, pursuant to Memorandum, DAIM-ZA, September 9, 2003, subject: Policies for Staffing and Approving Decision Documents (DDs), and to Engineer Regulation 200-3-1, Formerly Used Defense Sites (FUDS) Program Policy."

APPROVED:

(insert individual's signature block here) Date_________________________

For present worth cost estimate of $2M or less:
District Commander" Signature Block

For present worth cost estimate of more than $2M and less than or equal to $10M:
HQUSACE signature block for:
Chief, Department of Defense
Support Team
Directorate of Military Programs

For present worth cost estimate of more than $10M:
Signature block for ACSIM or DASA(ESOH) or both

PART 2: THE DECISION SUMMARY

The Decision Summary identifies the Selected Remedy, explains how the remedy fulfills statutory and regulatory requirements, and provides a substantive summary of the Administrative Record file that supports the remedy selection decision.

1. PROJECT NAME, LOCATION, AND BRIEF DESCRIPTION.
   a. Name and location.

   b. FUDS Project Number.

   c. Lead and support agencies (e.g., DoD, State, Tribes).

   d. Source of cleanup monies (e.g., ER-FUDS, ER-Army, ER-BRAC).

   e. Brief MRS description.

2. PROJECT HISTORY AND ENFORCEMENT ACTIVITIES.
   a. History of MRS activities that led to the current problems.

   b. History of federal, state, and local MRS investigations and removal and remedial actions conducted under CERCLA or other authorities.

   c. History of CERCLA enforcement activities at the MRS (e.g., results of PRP searches, issuances of special notices to PRPs).

3. COMMUNITY PARTICIPATION.
   a. Describe how the public participation requirements in CERCLA and the NCP were met in the remedy selection process (e.g., community relations plans, fact sheets, public notices, public meetings, public Restoration Advisory Board).

   b. Describe other community outreach and involvement efforts.

   c. Describe efforts to solicit views on the reasonably anticipated future land uses and potential future land uses.

4. SCOPE AND ROLE OF RESPONSE ACTION.
   a. The planned sequence of actions.

   b. The scope of problems those actions will address.

   c. The authorities under which each action will be/has been implemented (e.g., removal, remedial).

5. <u>PROJECT MRS CHARACTERISTICS</u>: (Include maps, a site plan, or other graphical presentations, as appropriate.)

a. Describe the conceptual site model (CSM) on which the risk assessment and response action are based.

b. Provide an overview of the MRS, including the following:

(1) Size of MRS (e.g., acres).

(2) Geographical and topographical information (e.g., surface waters, flood plains, wetlands).

(3) Surface and subsurface features (e.g., number and volume of tanks, lagoons, structures, and drums on-site).

(4) Areas of archaeological or historical importance.

c. Describe the sampling strategy (e.g., which media were investigated, what sampling approach was used, over what area, when was the sampling performed).

d. Describe known or suspected sources of contamination.

e. Describe types of contamination and the affected media, including the following:

(1) Types and characteristics of MEC/MCs (e.g., toxic, mobile, carcinogenic, non-carcinogenic).

(2) Quantity/volume of MEC/MC that needs to be addressed.

(3) Concentrations of MEC/MCs in each medium.

(4) RCRA hazardous wastes and affected media.

f. Describe location of contamination and known or potential routes of migration, including the following:

(1) Lateral and vertical extent of contamination.

(2) Current and potential future surface and subsurface routes of human or environmental exposure.

(3) Likelihood for migration of MEC/MCs from current location or to other media.

(4) Human and ecological populations that could be affected.

g. For MRSs with groundwater contamination, describe the following:

(1) Aquifer(s) affected or threatened by site contamination, types of geologic materials, approximate depths, whether aquifer is confined or unconfined.

(2) Groundwater flow directions within each aquifer and between aquifers and groundwater discharge locations (e.g., surface waters, wetlands, other aquifers).

(3) Interconnection between surface contamination (e.g., soils, sediments/surface water) and groundwater contamination.

(4) Confirmed or suspected presence and location of non-aqueous phase liquids.

(5) If groundwater models were used to define the fate and transport of MEC/MC, identify the model used and major model assumptions.

h. Note other site-specific factors that may affect response actions at the MRS.

6. CURRENT AND POTENTIAL FUTURE LAND AND WATER USES.

a. Land Uses.

(1) Current on-site land uses.

(2) Current adjacent/surrounding land uses.

(3) Reasonably Anticipated Future Land Uses and Basis for Future Use Assumptions (e.g., zoning maps, nearby development, 20-year development plans, dialogue with local land use planning officials and citizens, reuse assessment).

b. Groundwater and Surface Water Uses.

(1) Current groundwater and surface water uses.

(2) Potential beneficial groundwater and surface water uses (e.g. potential drinking water, irrigation) and basis for future use assumptions (e.g., Comprehensive State Groundwater Protection Plan, promulgated state classification guidelines).

(3) If beneficial use is potential drinking water source, identify the approximate time frame of projected future drinking water use (e.g., groundwater aquifer not currently used as a drinking water source but expected to be utilized in 30 to 50 years).

(4) Location of anticipated use in relation to location and anticipated migration of contamination.

7. <u>SUMMARY OF PROJECT MRS RISKS.</u>

a. Human Health Risks.

(1) Identify the concentrations of MEC/MC in each medium.

(2) Summarize the results of the exposure assessment.

(3) Summarize the results of the toxicity assessment for the MEC/MC.

(4) Summarize the risk characterization for both current and potential future land use scenarios and identify major assumptions and sources of uncertainty.

b. Ecological Risks.

(1) Identify the concentrations of MEC/MC in each medium.

(2) Summarize the results of the exposure assessment.

(3) Summarize the results of the ecological effects assessment.

(4) Summarize the results of the ecological risk characterization and identify major assumptions and sources of uncertainty.

c. Basis for Response Action.

(1) Clearly Present the Basis for Taking the Response Action at the Conclusion of this Section.

8. <u>REMEDIAL ACTION OBJECTIVES.</u>

a. Present a clear statement of the specific RAOs for the MRS (e.g., treatment of contaminated soils above health-based action levels, restoration of groundwater plume to drinking water levels, and containment of DNAPL source areas) and reference a list or table of the individual performance standards.

b. Discuss the basis and rationale for RAOs (e.g., current and reasonably anticipated future land use and potential beneficial groundwater use).

c. Explain how the RAOs address risks identified in the risk assessment (e.g., how will the risks driving the need for action be addressed by the response action?).

9. <u>DESCRIPTION OF ALTERNATIVES:</u> The objective of this section is to provide a brief understanding of the remedial alternatives developed for the MRS.

a. Remedy Components. Provide a bulleted list of the major components of each alternative, including but not limited to:

(1) Treatment technologies and the materials they will be used to address (e.g., principal threats).
(2) Containment components of remedy (e.g., engineering controls, cap, hydraulic barriers) and the materials they will be used to address (e.g., low concentration source materials, treatment residuals).

(3) Land use controls (and entity responsible for implementing and maintaining them).

(4) Operations and maintenance (O&M) activities required to maintain the integrity of the remedy (e.g., cap maintenance).

(5) Monitoring requirements.

b. Common Elements and Distinguishing Features of Each Alternative. Describe common elements and distinguishing features unique to each response option. Examples of these elements include:

(1) Key ARARs (or ARAR waivers) associated with each alternative (e.g., action- and/or location-specific groundwater treatment units, manifesting of hazardous waste, and regulating solid waste landfills).

(2) Long-term reliability of remedy (potential for remedy failure/replacement costs).

(3) Quantity of untreated MEC/MC to be disposed off-site or managed on-site in a containment system and degree of residual contamination remaining in such waste.

(4) Estimated time required for design and construction (i.e., implementation time frame).

(5) Estimated time to reach cleanup levels (i.e., time of operation, period of performance).

(6) Estimated capital, annual O&M, and total present worth costs, discount rate, and the number of years over which the remedy cost estimate is projected.

(7) Describe uses of presumptive remedies and/or innovative technologies.

c. Expected Outcomes of Each Alternative.

(1) Available land uses upon achieving performance standards. Note time frame to achieve performance standards (e.g., commercial or light industrial use available in 3 years when cleanup levels are achieved).

(2) Available groundwater uses upon achieving performance standards. Note time frame to achieve performance standards (e.g., restricted use for industrial purposes in technical impracticability [TI] waiver zone, drinking water use in non-TI zone upon achieving cleanup levels in 50 to 70 years).

(3) Other impacts or benefits associated with each alternative.

10. <u>COMPARATIVE ANALYSIS OF ALTERNATIVES.</u> Compare the relative performance of each alternative against the others with respect to the nine evaluation criteria (summarize in a table if appropriate).

11. <u>PRINICIPAL MEC/MC ISSUES</u>. Identify the MEC/MC issues at the MRS and discuss how the alternatives will address them.

Note: The *Statutory Determinations* section of the DD should explain whether or not the Selected Remedy satisfies the statutory preference for remedies employing treatment that reduces toxicity, mobility, or volume as a principal element. By indicating whether the principal threats will be addressed by the alternatives, this section of the *Decision Summary* should provide the basis for that statutory determination.

12. SELECTED REMEDY.

a. Summary of the Rationale for the Selected Remedy.

(1) Provide a concise discussion of the key factors for remedy selection.

b. Detailed Description of the Selected Remedy.

(1) Expand on the Description of the Selected Remedy from that which was provided in the Description of Alternatives section and provide a brief overview of the RAOs and performance standards.

c. Cost Estimate for the Selected Remedy.

(1) Present a detailed, activity-based breakdown of the estimated costs associated with implementing and maintaining the remedy (include estimated capital, annual O&M, and total present worth costs discount rate and the number of years over which the remedy cost estimate is projected).

d. Estimated Outcomes of Selected Remedy.

(1) Available land use(s) upon achieving cleanup levels. Note time frame to achieve available use (e.g., commercial or light industrial use available in 3 years when cleanup levels are achieved).

(2) Available groundwater use(s) upon achieving cleanup levels. Note time frame to achieve available use (e.g., restricted use for industrial purposes in TI waiver zone, drinking water use in non-TI zone upon achieving cleanup levels in 50 to 70 years).

(3) Final cleanup levels for each medium (i.e., contaminant-specific cleanup levels), basis for cleanup levels, and risk at cleanup levels (if appropriate).

(4) Anticipated socioeconomic and community revitalization impacts (e.g., increased property values, reduced water supply costs, jobs created, increased tax revenues due to redevelopment, environmental justice concerns addressed, enhanced human uses of ecological resources).

(5) Anticipated environmental and ecological benefits (e.g., restoration of sensitive ecosystems, protection of endangered species, protection of wildlife populations, wetlands restoration).

13. STATUTORY DETERMINATIONS.

a. Explain how the remedy satisfies the requirements of §121 of CERCLA to:

(1) Protect human health and the environment.

(2) Comply with ARARs, or justify a waiver.

(3) Be cost-effective.

(4) Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable (i.e., explain why the Selected Remedy represents the best option).

(5) Satisfy the preference for treatment as a principal element, or justify the selection of an alternative remedy.

b. Explain 5-year review requirements for the Selected Remedy.

14. <u>DOCUMENTATION OF SIGNIFICANT CHANGES FROM PREFERRED ALTERNATIVE OF PROPOSED PLAN.</u> If there are significant changes in the Selected Remedy from the Preferred Alternative:

a. Discuss the Preferred Alternative originally presented in the Proposed Plan.

b. Describe the significant changes in the Selected Remedy.

c. Explain the rationale for the changes and how they could have been reasonably anticipated based on information presented in the Proposed Plan or the Administrative Record file.

<u>PART 3: THE RESPONSIVENESS SUMMARY</u>

The Responsiveness Summary serves the dual purposes of: (1) presenting stakeholder concerns about the MRS and preferences regarding the remedial alternatives; and (2) explaining how those concerns were addressed and the preferences were factored into the remedy selection process. This discussion should cross-reference sections of the Decision Summary that demonstrate how issues raised by the community have been addressed.

1. <u>STAKEHOLDER ISSUES AND LEAD AGENCY RESPONSES</u>: Summarize and respond concisely to issues raised by stakeholders.

2. <u>TECHNICAL AND LEGAL ISSUES</u>: Expand on technical and legal issues, if necessary

Attachment D

Price Spreadsheet

Firm Fixed Price Lump Sum Prices offered and accepted are the sole basis of this contract. Unit Prices included herein have no bearing on the task order price and are proposed only to provide a basis for determining a fair and reasonable price if the Government in its sole discretion chooses to modify the performance requirements of this task order. This is a performance based task order and the inclusion of unit prices in the proposal shall in no way be construed as the Government procuring a specified number of units of any given service. The contract is for the provision of services that ultimately meet the performance requirements of each task.}

Camp Croft				
Task, Title, Type	Qty	Unit	Price	Total
1, Technical Project Planning, FFP/UP	1.0	LS		
1a, Additional meeting, FUP	1.0	Ea		
2, RI/FS Work Plan, FFP	1.0	LS		
2a, Optional, Explosive Siting Plan, FFP	1.0	LS		
2b. Optional, Dive Plan, FFP	1.0	LS		
3, GIS, FFP/UP	1.0	LS		
3a, Additional GIS per month, FUP	1.0	EA		
4, RI/FS Field Activities, FFP/FUP				
4a, Gas Chamber, FFP	1.0	LS		
4b, Grenade Court, FFP	1.0	LS		
4c, Range Complex Land, FFP	1.0	LS		
4d, Range Complex (Lake Craig & Lake Johnson), FFP	1.0	LS		
4e, Optional, Area of Potential Interest 3, FFP	1.0	LS		
4f, Optional, Area of Potential Interest 5, FFP	1.0	LS		
4g, Optional, Area of Potential Interest 8, FFP	1.0	LS		
4h, Optional, Area of Potential Interest 9E, FFP	1.0	LS		
4i, Optional, Area of Potential Interest 9G, FFP	1.0	LS		
4j, Optional, Area of Potential Interest 10A, FFP	1.0	LS		
4k, Optional, Area of Potential Interest 10B, FFP	1.0	LS		
4l, Optional, Area of Potential Interest 11B, FFP	1.0	LS		
4m, Optional, Area of Potential Interest 11C, FFP	1.0	LS		
4n, Optional, Area of Potential Interest, FFP	1.0	LS		

Camp Croft				
Task, Title, Type	Qty	Unit	Price	Total
4n, Evacuations, CPFF	1.0	LS		
Civil Survey, per acre, FUP	1.0	Ea		
Light Vegetation Removal, per acre, FUP	1.0	Ea		
Medium Vegetation Removal, per acre, FUP	1.0	Ea		
Heavy Vegetation Removal, per acre, FUP	1.0	Ea		
Density Transects per acre - Light Brush, FUP	1.0	Ea		
Density Transects per acre - Medium Brush, FUP	1.0	Ea		
Density Transects per acre - Heavy Brush, FUP	1.0	Ea		
DGM Transect geophysics per acre, FUP	1.0	Ea		
Analog Transect geophysics per acre, FUP	1.0	Ea		
DGM Grids geophysics per acre, FUP	1.0	Ea		
Analog Grids geophysics per acre, FUP	1.0	Ea		
Underwater DGM Transects per acre, FUP	1.0	Ea		
Underwater Mag & Dig Transects per acre, FUP	1.0	Ea		
Sonar per acre, FUP	1.0	Ea		
Mob/Demob Underwater Geo Team, FUP	1.0	Ea		
Mob/Demob Sonar Team, FUP	1.0	Ea		
Mob/Demob Underwater MEC Investigation Team, FUP	1.0	Ea		
Mob/Demob Underwater Mag & Dig Team, FUP	1.0	Ea		
Underwater Investigation –On shore support per day, FUP	1.0	Ea		
Underwater Investigation-On shore support per week, FUP	1.0	Ea		
Underwater Investigation-Off Shore support per day, FUP	1.0	Ea		
Underwater Investigation-Off shore support per week, FUP	1.0	Ea		
Mob/Demob Density Transect Team, FUP	1.0	Ea		
Mob/Demob, DGM Team, FUP	1.0	Ea		
Mob/Demob, MEC Investigation Team, FUP	1.0	Ea		
LiDar per acre, FUP	1.0	Ea		
Orthophoto per acre, FUP	1.0	Ea		
Airborne Magnetic per acre, FUP	1.0	Ea		

Camp Croft				
Task, Title, Type	Qty	Unit	Price	Total
Airborne EM per acre, FUP	1.0	Ea		
Airborne Multispectral per acre, FUP	1.0	Ea		
Mob/Demob LiDar, FUP	1.0	Ea		
Mob/Demob Orthophoto, FUP	1.0	Ea		
Mob/Demob Airborne magnetic, FUP	1.0	Ea		
Mob/Demob Airborne EM, FUP	1.0	Ea		
Mob/Demob Airborne Multispectral, FUP	1.0	Ea		
Each Demolition Shot, FUP	1.0	Ea		
Each Underwater Demolition Shot, FUP	1.0	Ea		
Intrusive Investigation – Land, per day, FUP	1.0	Ea		
Intrusive Investigation - Land, per week, FUP	1.0	Ea		
Intrusive Investigation-Water, per day, FUP	1.0	Ea		
Intrusive Investigation-Water, per week, FUP	1.0	Ea		
Program/Project Management, per week, in office, FUP	1.0	Ea		
Program/Project Management, per week, in field, FUP	1.0	Ea		
Site Management (SUXOS, UXOQC, UXOSO), per week, FUP	1.0	Ea		
Contractor can add relevant fixed unit pricing for review and acceptance by the Government.				
5, Remedial Investigation Report Initial, FFP	1.0	LS		
6, Feasibility Study Report Initial MRS, FFP	1.0	LS		
7, Proposed Plan Initial MRS, FFP	1.0	LS		
8, Decision Document Initial MRS, FFP	1.0	LS		
9, Community Relations Support, FFP	1.0	LS		
10, Public Involvement Plan, FFP	1.0	LS		
11, Administrative Record, FFP	1.0	LS		
12, Environmental Sampling & Analysis, FFP/FUP				
12a, Gas Chamber, FFP	1.0	***LS***		
12b, Grenade Court, FFP	1.0	***LS***		
12c, Range Complex Land, FFP	1.0	***LS***		

Camp Croft				
Task, Title, Type	Qty	Unit	Price	Total
12d, Optional, Range Complex (Lake Craig and Lake Johnson), ***FFP***	1.0	***LS***		
12e, Optional, Area of Potential Interest 3, FFP	1.0	***LS***		
12f, Optional, Area of Potential Interest 5, FFP	1.0	***LS***		
12g, Optional, Area of Potential Interest 8, FFP	1.0	***LS***		
12h, Optional, Area of Potential Interest 9E, FFP	1.0	***LS***		
12i, Optional, Area of Potential Interest 9G, FFP	1.0	***LS***		
12j, Optional, Area of Potential Interest 10A, FFP	1.0	***LS***		
12k, Optional, Area of Potential Interest 10B, FFP	1.0	***LS***		
12l, Optional, Area of Potential Interest 11B, FFP	1.0	***LS***		
12m, Optional, Area of Potential Interest 11C, FFP	1.0	***LS***		
12n, Optional, Area of Potential Interest, FFP	1.0	***LS***		
Sampling and analysis, Soil, ten plus QC/QA, MS/MSD, FUP	1.0	Ea		
Sampling and analysis, Water, ten plus QC/QA, MS/MSD, FUP	1.0	Ea		
Sampling and analysis, Sediment, ten plus QC/QA, MS/MSD, FUP	1.0	Ea		
Sampling and analysis, Groundwater sample, FUP	1.0	Ea		
Sampling and analysis, Groundwater, plus QC/QA, MS/MSD, FUP	1.0	Ea		
Sampling and analysis, Groundwater sample using Push Probe, FUP	1.0	Ea		
Incremental Sampling Unit(DU) (100'x100'), FUP	1.0	Ea		
Pre & Post Detonation per set, FUP	1.0	Ea		
Installation of monitoring well, base price per well, FUP	1.0	Ea		
Installation of monitoring well, price per additional foot, FUP	1.0	Ea		
Subsurface Sampling, per 2' - 4' boring, FUP	1.0	Ea		
Contractor can add relevant fixed unit pricing for review and acceptance by the Government.	1.0	Ea		
			Total	

- Note: Use RSMeans, most recent version, for applicable unit pricing using applicable location factors.

Attachment E: Objective Based Standards

Objective	PWS Standard	Potential Tools	Notes
Find Target Areas (areas likely to contain MEC)	Demonstrate that all MEC contaminated areas have been traversed at the completion of fieldwork and that there is at least 90% chance of detecting these areas. (MEC contamination will be defined in accordance with the approved conceptual site model. The CSM for a suspected ground target area might define the character of a confirmed MEC contaminated area as one with elevated anomaly density plus evidence of concentrated munitions use. The CSM for a suspected disposal area might define the character of a confirmed MEC contaminated area as one with geophysical evidence of a burial pit.)	VSP - "Transect Spacing Needed to Locate a UXO Target Area" and "Post- Survey Probability of Traversal". "Locate Hot Spots" (an MC tool) can be used in developed areas to select grid locations. UXO Estimator may be used to estimate the density of UXO with a 90% confidence in areas where VSP is not applicable.	Not only needs to be run prior to field work to develop transect spacing, but also after work is completed to confirm that actual transects meet these requirements.
Bound MEC contaminated areas	Demonstrate that the boundaries of all identified MEC contaminated areas have been delineated to an accuracy of at least +/- half the transect spacing, maximum 250 feet.	Placement of transects and grids.	May need to be refined at TPP meeting.
Provide confidence that the density of MEC outside the bounded contamination areas is sufficiently low.	Demonstrate with at least 90% confidence that all land outside the MEC contaminated areas have less than or equal to (.1 when public use is significant, .5 when public use is moderate and 1 when public use is low) UXO per acre.	UXO Estimator VSP –"Achieve a High Confidence that Few Anomalies are UXO" or "Item Sampling" (Both can be accessed via the Expert Mentor)	Specific density of allowable MEC may be renegotiated at the TPP meeting. Information from the ASR may exclude an area from having to meet this requirement and should be discussed at the TPP meeting.

			It should be noted that percentages can be deceptive for sites with extreme numbers of anomalies
Provide confidence that the nature of MEC inside the contaminated areas has been defined	Demonstrate that a 90% confidence in the nature (type, density and potential depth) of MEC and MEC related debris, for each relatively homogeneous MEC contaminated area, has been achieved.	Acceptance Sampling and/or other statistically valid methods	MEC and MEC related debris should be treated separately. The nature of the MEC related debris should be used to make qualitative judgments where no MEC is found but other site characteristics warrant a more thorough investigation.

Acceptance Sampling:

- Acceptance sampling may be used to tell you how many digs are necessary in each target area in order to estimate type, density and depth with an acceptable percentage of error.
- Example: If you dig x anomalies out the total number of MEC-like anomalies then you will be 90% confident that $\leq$ 1% of anomalies are outliers. In other words you can be confident that the sample you took is representative of the entire area*.
- *Acceptance sampling is only applicable in relatively homogeneous areas.

Assumptions:

- A known target area is more likely to contain MEC than other areas in the MRS.
- An area with an elevated density of MEC related debris is more likely to contain MEC than an area with a low density of MEC related debris.

General Notes:

- All inputs into VSP and UXO Estimator need to be stated and rational must be provided for why these inputs were selected.
- An identified target area may or may not fit the definition of a homogeneous area because it is likely that densities will be higher in the center and decrease as you move closer to the boundary. In this case, the target area should be divided into density contours and statistical analysis should be performed in individual regions in order to satisfy the homogeneity assumption.
- The current guidance for target size is a diameter equal to 1.5 times the maximum fragmentation distance (MFD) for the most conservative ordnance known to be present in the MRS

APPENDIX B
SITE MAPS

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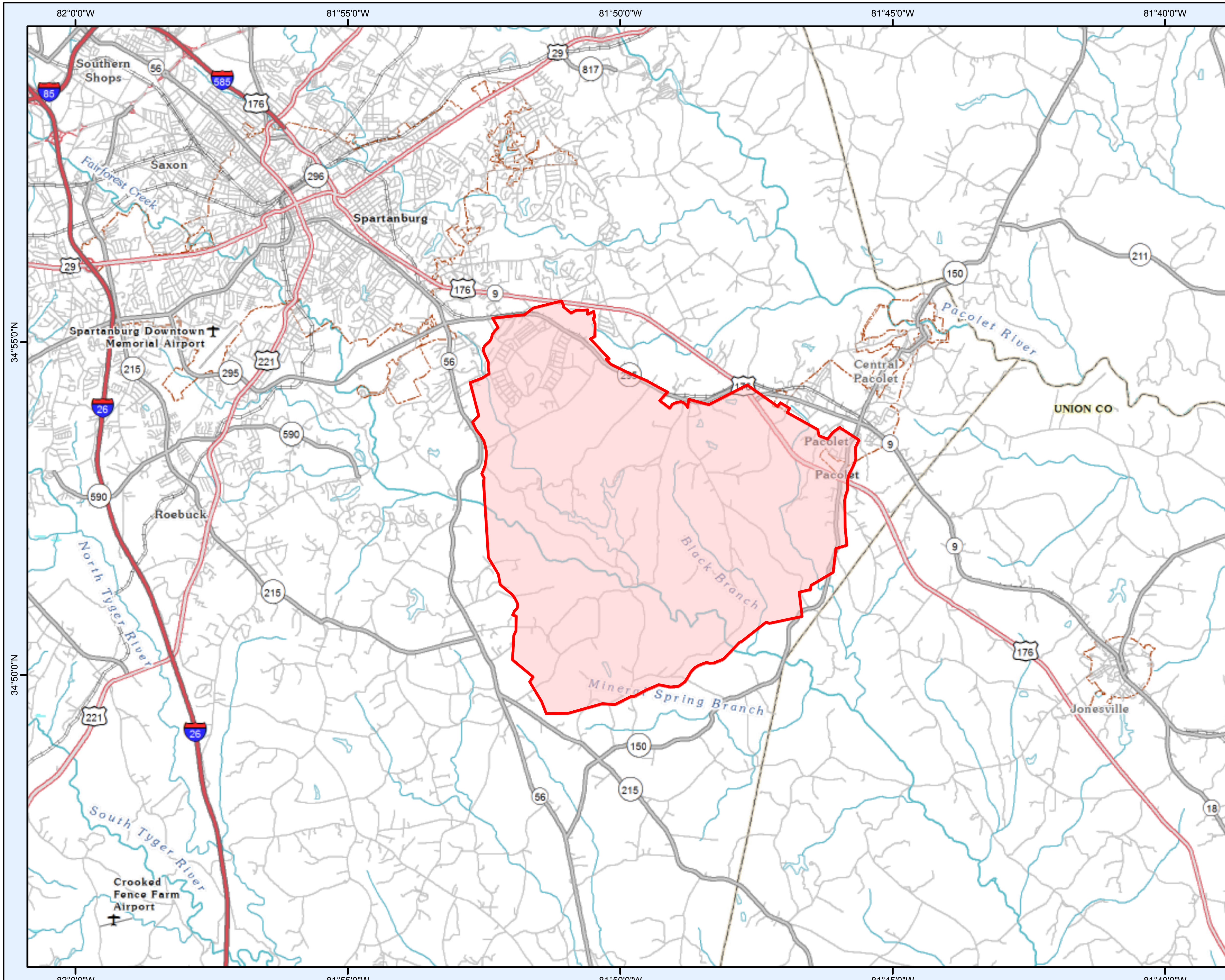

Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
Site Location

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	1

KEY

Approximate Former Camp Croft Boundary

N W E S

0 1 2 Miles

Overview

Source(s)

USAESCH, USGS

Projection

Web Mercator, WGS 1984

Note(s)

Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1" = 2 miles	ATD

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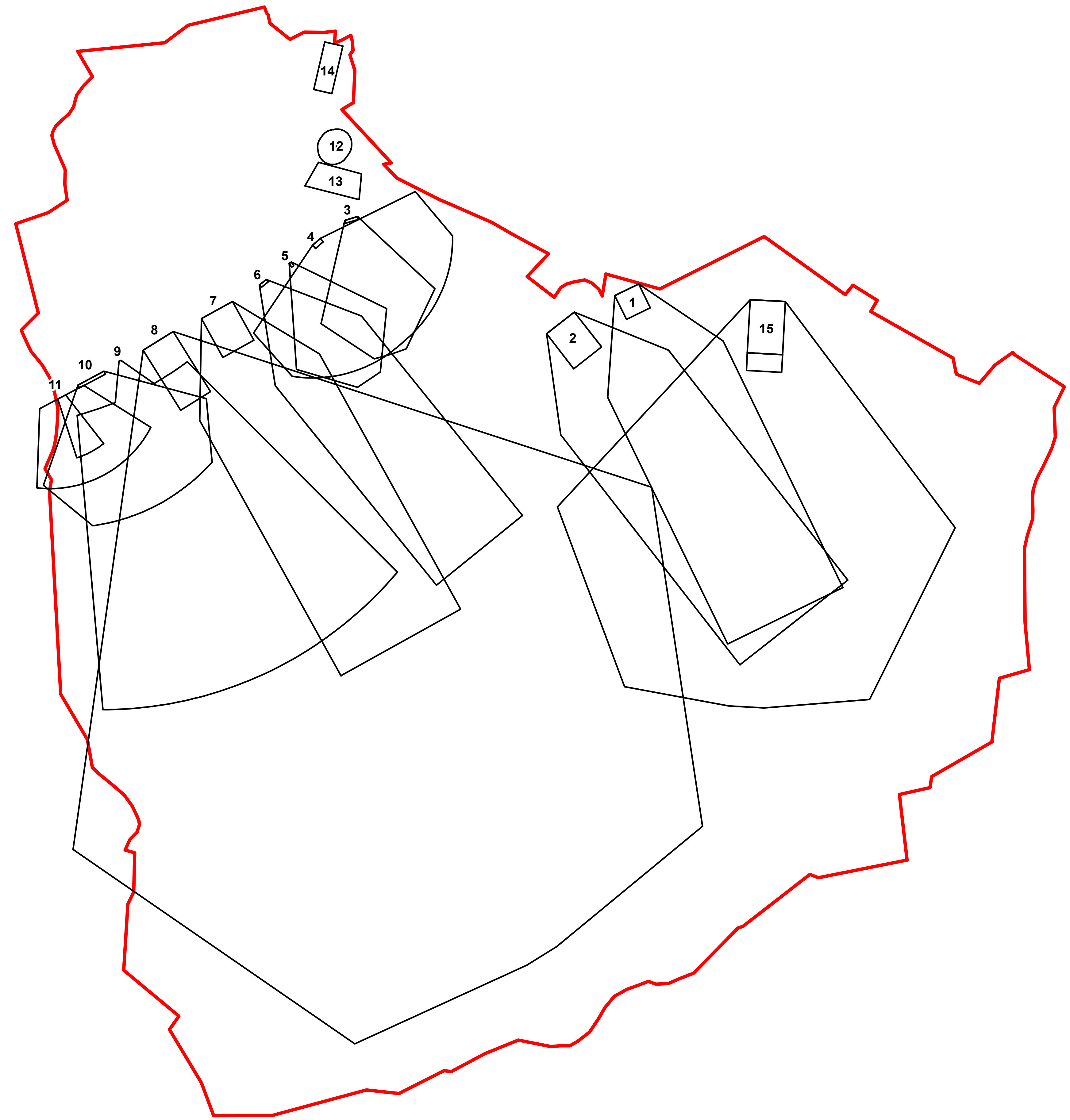
Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
Historic Range Locations

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	2



KEY

Historical Range
Approximate Former Camp Croft Boundary

Range Type:

1. KD 300 Rifle Range (200 - 300 yards)
2. KD 500 Rifle Range (200 - 300 yards)
3. Landscape Target Range (600 ft, 9 sets)
4. AA Miniature Range (1,080 ft)
5. Pistol Range (600 ft, 120 Targets)
6. 1,000 inch Machine Gun Range
7. Rifle Range (Field Targets)
8. Machine Gun Range (Field Targets)
9. 60mm & 81mm Mortar Range
10. 1,000 inch AT Range
11. Moving Target AT Range
12. Grenade Court
13. Bayonet Court
14. Gas Training Area
15. Combat Range

N
W E
S

0 2,000 4,000 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Notes
Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1"=4,000'	ATD

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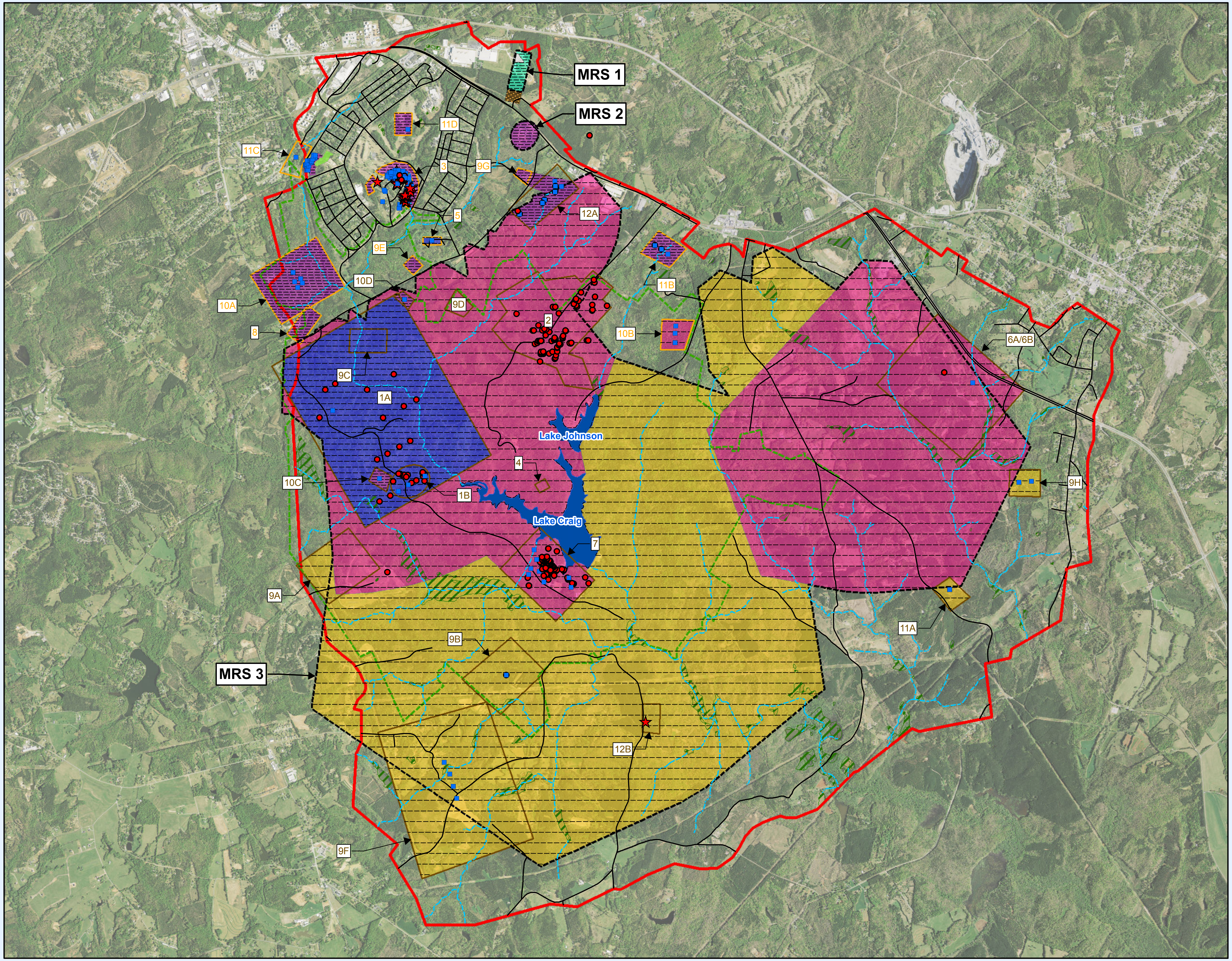

Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
Conceptual Site Model

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	3

KEY

- MD
- MEC
- UXO
- Transects
- Streams
- Streets
- MRS
- Areas of Potential Interest
- Former OOU
- Approximate Park Boundary
- Approximate Former Camp Croft Boundary
- Wetland
- Lake
- Trash Pile - No Investigation
- DGM (100%)
- AIR (16.24m Transect Spacing)
- AIR (36m Transect Spacing)
- AIR (135m Transect Spacing)
- Mag & Dig (36m Transect Spacing)
- Mag & Dig (73m Transect Spacing)
- Mag & Dig (135m Transect Spacing)

N
W E
S

0 2,000 4,000 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Notes
Transect Spacing indicates the computed spacing between transect centers for one meter-wide transect pathways, as calculated by VSP. Engineering scale may only be accurate on a map size of 11 x 17.

Checked By	Engineering Scale	Drawn By
JES	1"=4,000'	ATD

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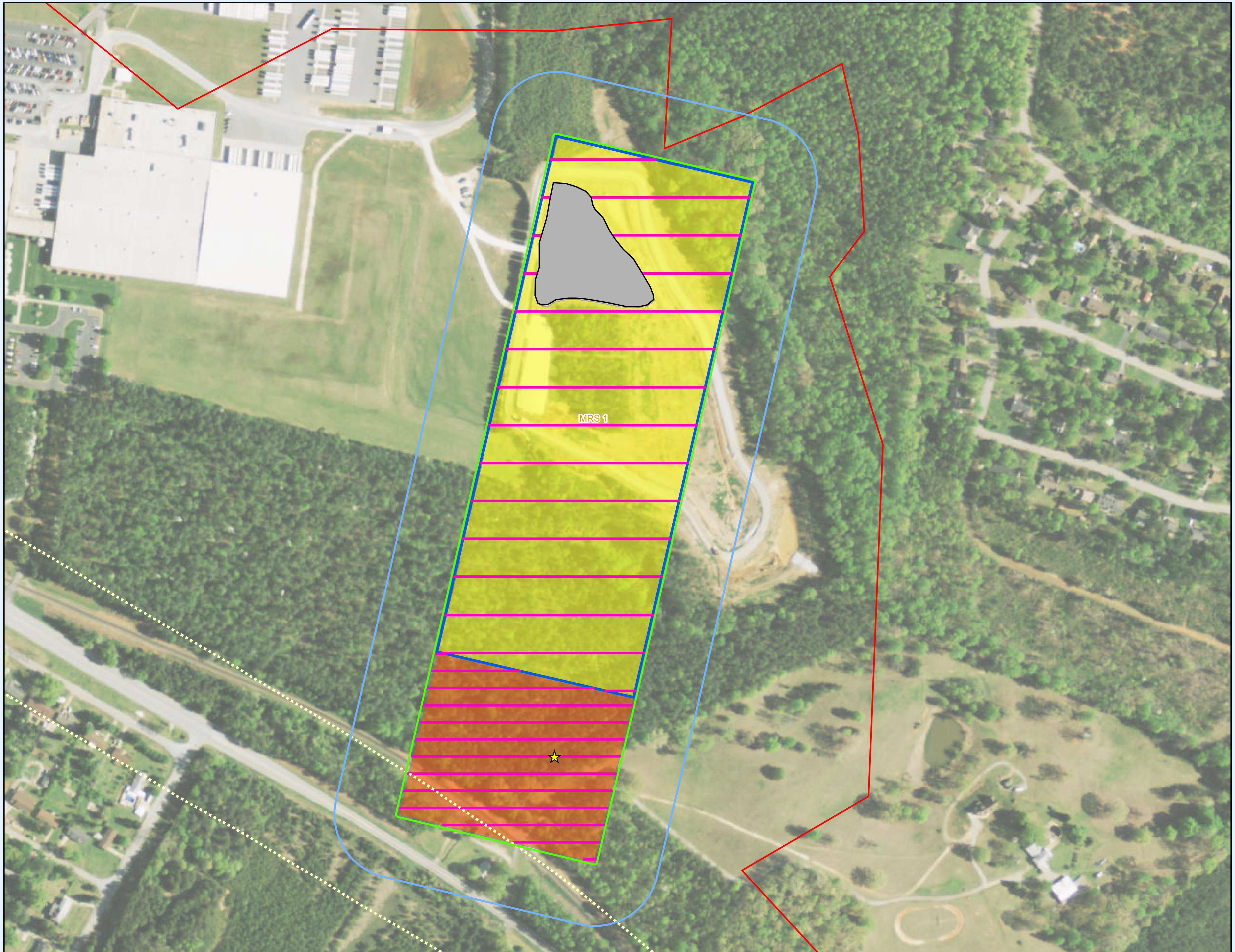

Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
MRS 1

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	4

KEY

- Transcets
- Suspected Location of Gas Chamber
- K40D (8 ft) 40mm M651 CS Grenade
- SMD (200 ft) 40mm M651 CS Grenade
- Trash Pile - No Investigation
- PWS-defined MRS 1 Boundary
- Approximate Former Camp Croft Boundary
- AIR (16.24m Transect Spacing)
- AIR (36m Transect Spacing)
- Buffer* (200 ft)

* Buffer is based upon the greater of the HFD or MSD. No intrusive operations will be conducted in the buffer zone.

N W E S

0 150 300 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)
Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1" = 300'	ATD

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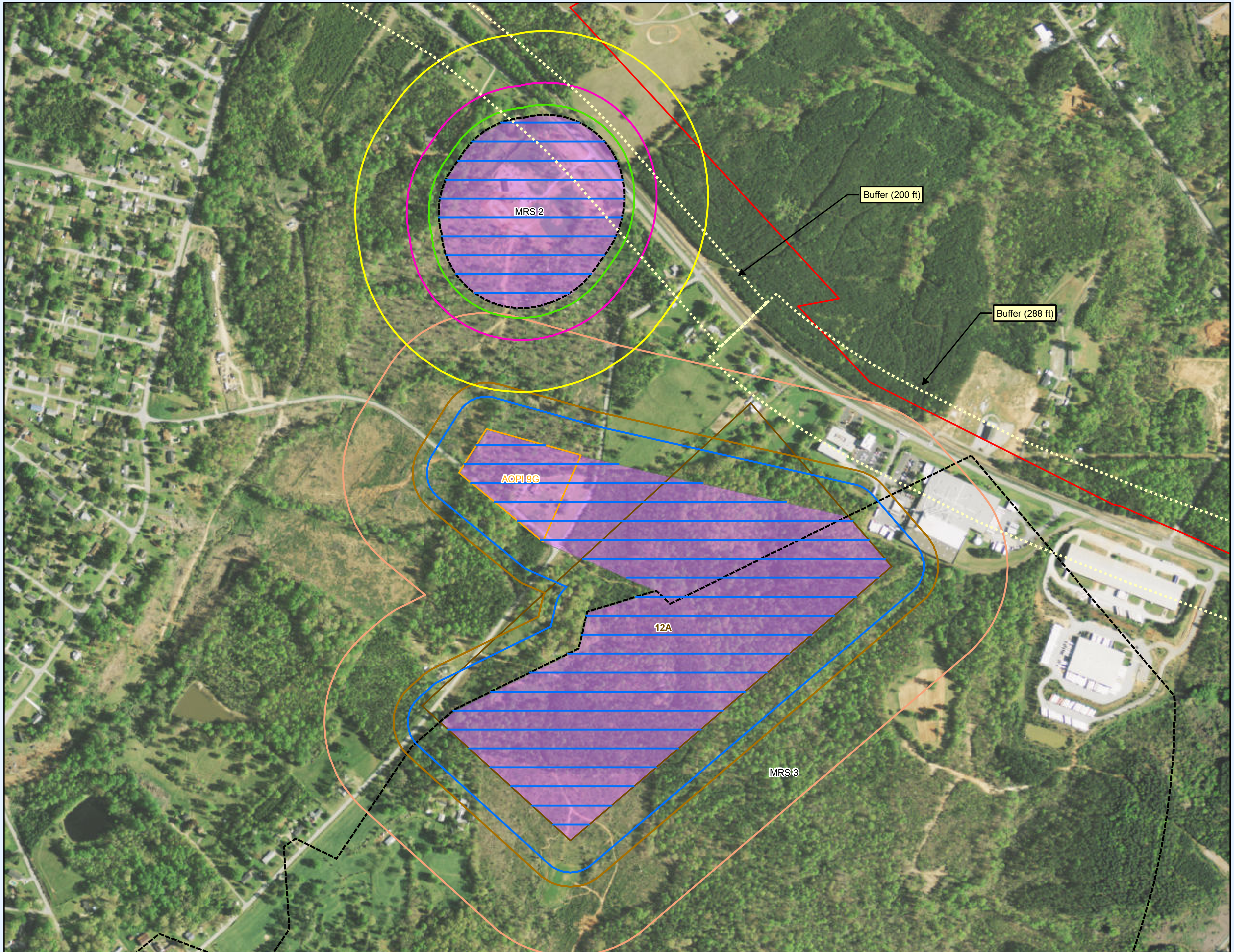

Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
MRS 2, Area of Potential Interest 9G & 12A

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	5

KEY

- Buffer*
- Transects
- MRS
- Areas of Potential Interest
- Former OOU
- Approximate Former Camp Croft Boundary
- Mag & Dig (36m Transect Spacing)

MRS 2:

- 62 ft HFD (Unintentional Detonation) MKII Grenade
- 521 ft MFD (Intentional Detonation) MKII Grenade
- 200 ft MSD (Intentional Detonation, Mitigated with Sandbags) MKII Grenade

AOPI 9G:

- 288 ft HFD (Unintentional Detonation) M26A2 Grenade
- 200 ft MSD (Intentional Detonation) M46 Grenade
- 721 ft MFD (Intentional Detonation) M46 Grenade

* Buffer is based upon the greater of the HFD or MSD. No intrusive operations will be conducted in the buffer zone.

N W E S

0 300 600 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)
Engineering scale may only be accurate on a map size of 11 x 17.

Checked By	Engineering Scale	Drawn By
JES	1' = 600'	ATD

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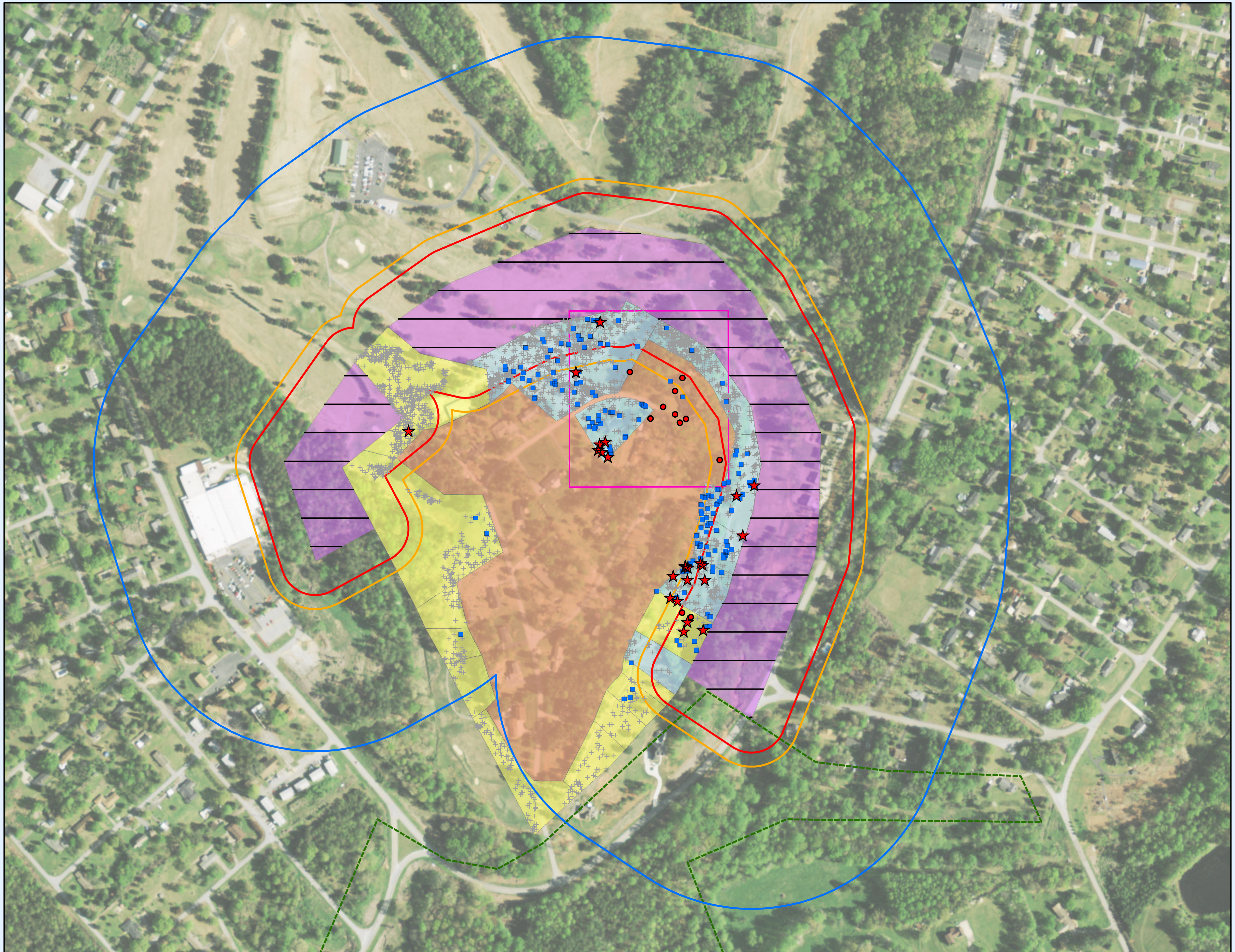

Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
Area of Potential Interest 3

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	6

KEY

- CD
- MD
- MEC
- UXO
- Transects
- 142 ft HFD (Unintentional Detonation) 2.36" M6A3 Rocket
- 790 ft MFD (Intentional Detonation) 2.36" M6A3 Rocket
- 200 ft MSD (Intentional Detonation, Mitigated with Sandbags) 2.36" M6A3 Rocket
- Approximate Park Boundary
- PWS-defined Former OOU 3 Boundary
- Mag & Dig (36m Transect Spacing)
- HFA Completed Removal Action
- ZAPATA Pending Removal Action (DGM complete)
- ZAPATA Completed Removal Action

N W E S

0 200 400 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)
Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1" = 400'	ATD

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Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
Areas of Potential Interest 5 & 9E

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	7

KEY

- Proposed Site Office Trailer Location
- Transects

AoPI 5

- 113 ft HFD (Unintentional Detonation) M9A1 Rifle Grenade
- 709 ft MFD (Intentional Detonation) M9A1 Rifle Grenade
- 200 ft MSD (Intentional Detonation, Mitigated with Sandbags) M9A1 Rifle Grenade
- Approximate Park Boundary
- MRS
- Areas of Potential Interest
- Mag & Dig (36m Transect Spacing)
- Mag & Dig (73m Transect Spacing)
- Mag & Dig (135m Transect Spacing)

AoPI 9E used for Small Arms only.

N W E S

0 150 300 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)
Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1' = 300'	ATD

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Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
Areas of Potential Interest 8 &10A

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	8

KEY

- Transects
- Buffer* (221 ft)
- MRS
- Areas of Potential Interest
- Approximate Former Camp Croft Boundary
- Mag & Dig (36m Transect Spacing)
- Mag & Dig (73m Transect Spacing)
- Mag & Dig (135m Transect Spacing)

AoPI 10A

- 221 ft HFD (Unintentional Detonation) M15 AT Mine
- 1,818 ft MFD (Intentional Detonation) M3 AP Mine
- 200 ft MSD (Intentional Detonation, Mitigated with Sandbags) M3 AP Mine

AoPI 8 used for Small Arms only.

* Buffer is based upon the greater of the HFD or MSD. No intrusive operations will be conducted in the buffer zone.

N W E S

0 300 600 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)
Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1" = 600'	ATD

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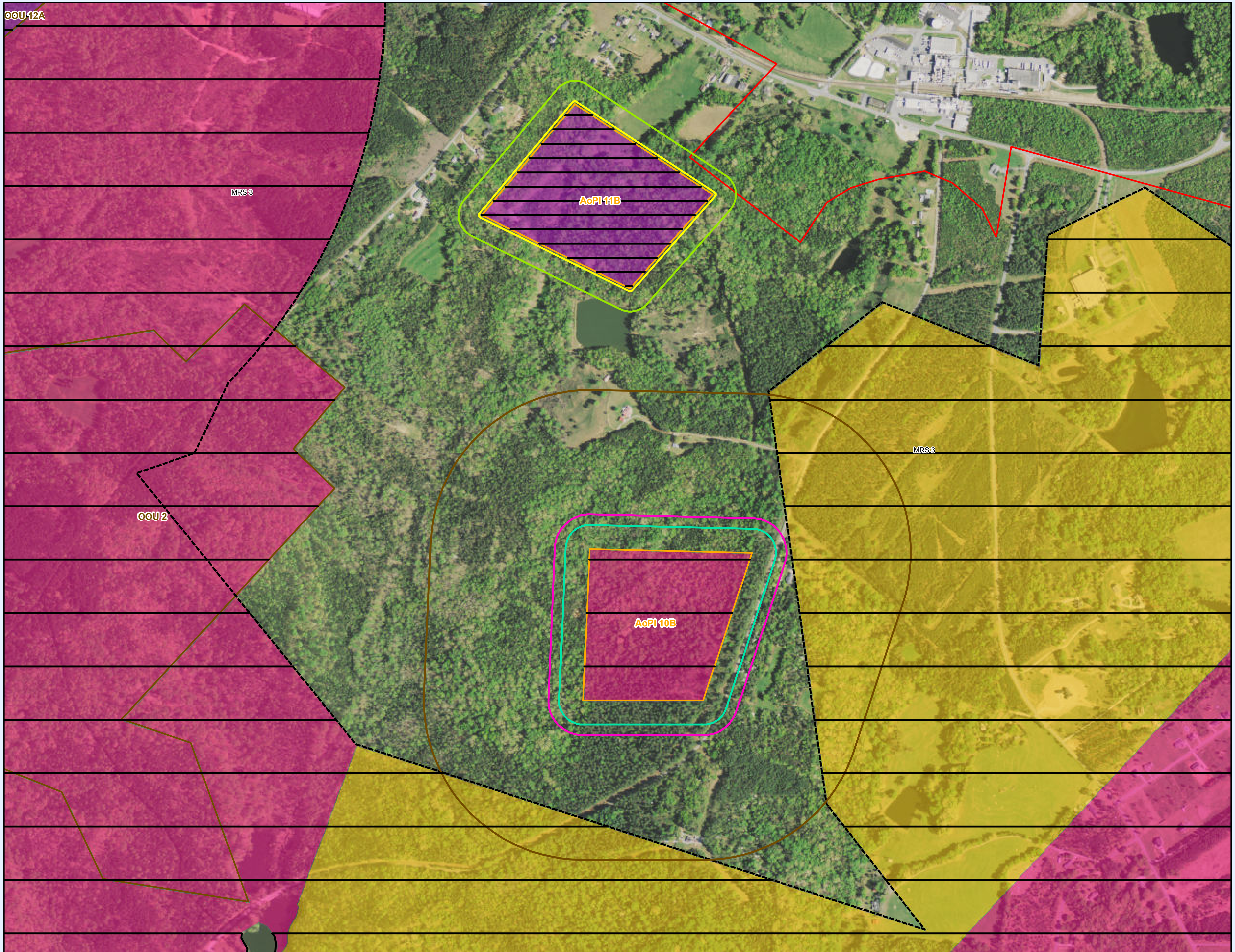

Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
Areas of Potential Interest 10B & 11B

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	9

KEY

- Transects
- **AoPI 11B**
- 23 ft K40D (Unintentional Detonation) M83 60mm Illuminating
- 192 ft MSD (Intentional Detonation, Mitigated with Sandbags) M83 60mm Illuminating
- **AoPI 10B**
- 288 ft HFD (Unintentional Detonation) M26A2 Grenade
- 1,322 ft MFD (Intentional Detonation) 60mm M49A2
- 200 ft MSD (Intentional Detonation, Mitigated with Sandbags) 60mm M49A2
- MRS
- Former OOU
- Areas of Potential Interest
- Approximate Former Camp Croft Boundary
- AIR (135m Transect Spacing)
- Mag & Dig (36m Transect Spacing)
- Mag & Dig (135m Transect Spacing)

N
W E
S

0 400 800 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)
Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1" = 800'	ATD

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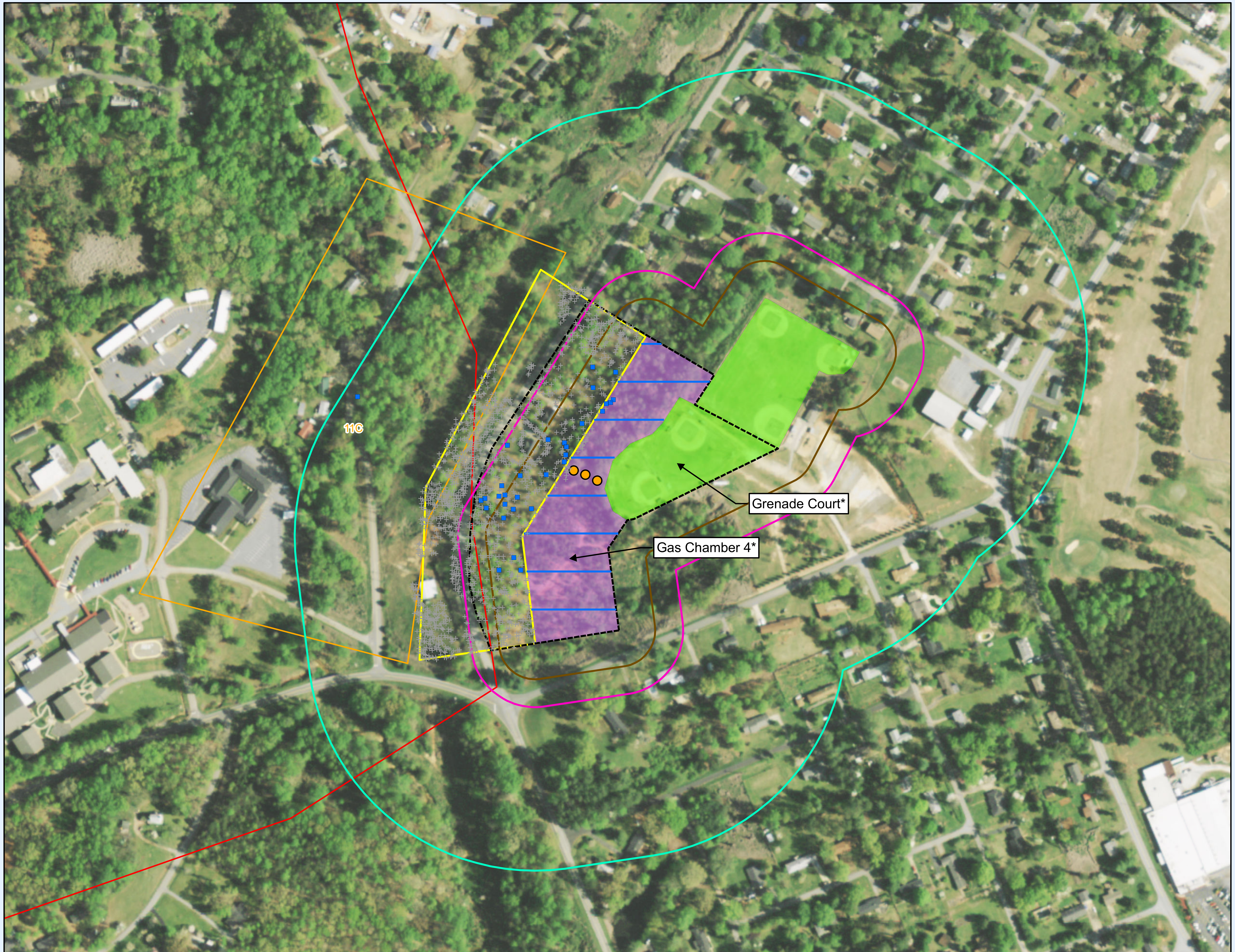

Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
Area of Potential Interest 11C

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	10

KEY

- CD
- MD
- Transects
- Foxholes (Observed During Site Visit)
- 113 ft HFD (Unintentional Detonation) M9A1 Rifle Grenade
- 709 ft MFD (Intentional Detonation) M9A1 Rifle Grenade
- 200 ft MSD (Intentional Detonation, Mitigated with Sandbags)
- ZAPATA-revised OOU 11C Boundary
- Removal Action OOU 11C Boundary
- Areas of Potential Interest
- Approximate Former Camp Croft Boundary
- <all other values>

N W E S

0 150 300 Feet

Source(s)

USAESCH, USGS

Projection

UTM Zone 17 North, NAD83

Note(s)

Distance calculations based on the MKII Grenade

Boundaries and Items are defined in the GIS-based Historical Photographic Analysis dated October 2005

The PWS-defined boundary may be improperly located. Based on findings during ZAPATA's previous removal actions in OOU11C, the area of potential interest may lie to the east of both the PWS-defined boundary and the removal action boundary. However, the USAESCH has requested the PWS-defined boundary be included in future investigations along with those proposed activities shown.

Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1" = 300'	ATD

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Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
Area of Potential Interest 11D

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	11

KEY

- Transects
- 29 ft K40D (Unintentional Detonation) 81mm Practice M879
- 241 ft MSD (Intentional Detonation, Mitigated with Sandbags) 81mm Practice M879
- Areas of Potential Interest
- Mag & Dig (36m Transect Spacing)*

* Mag & Dig will be conducted in wooded areas and DGM will be conducted on the golf course.

N
W E
S

0 150 300 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)
Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1" = 300'	ATD

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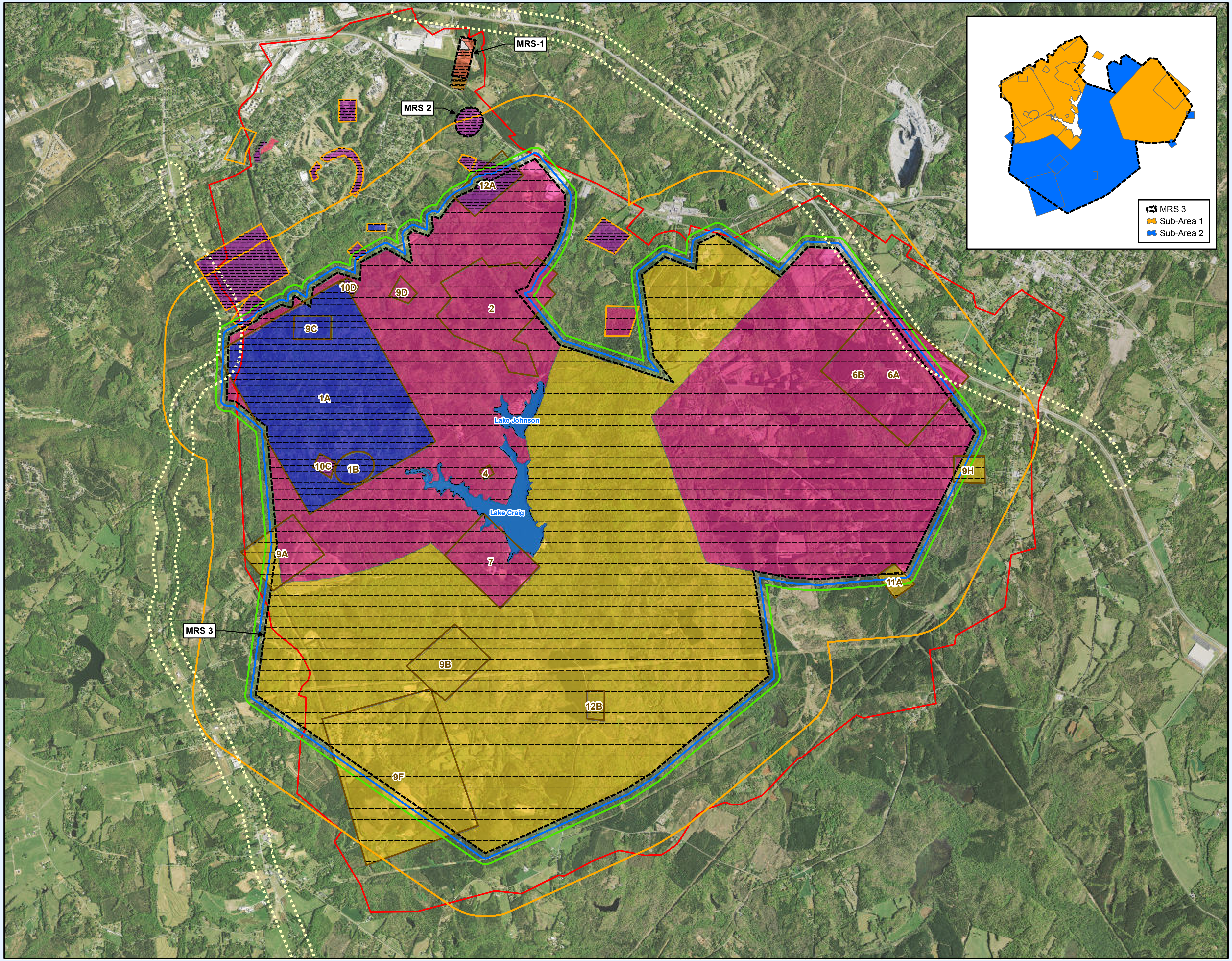

Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
MRS 3

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	12

KEY

- Transects
- Buffer* (450 ft)
- 450 ft HFD (Unintentional Detonation) 155mm M107, Comp. B filled
- 2,630 ft MFD (Intentional Detonation) 155mm M107, Comp. B filled
- 220 ft MSD (Intentional Detonation, Mitigated with Sandbags), 155mm M107 Comp. B filled
- Former OOU
- MRS
- Areas of Potential Interest
- Approximate Former Camp Croft Boundary
- Lake
- Trash Pile - No Investigation
- DGM (100%)
- AIR (16.24m Transect Spacing)
- AIR (36m Transect Spacing)
- AIR (135m Transect Spacing)
- Mag & Dig (36m Transect Spacing)
- Mag & Dig (73m Transect Spacing)
- Mag & Dig (135m Transect Spacing)

* Buffer is based upon the greater of the HFD or MSD. No intrusive operations will be conducted in the buffer zone.

N W E S

0 2,000 4,000 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)
Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1" = 4,000'	ATD

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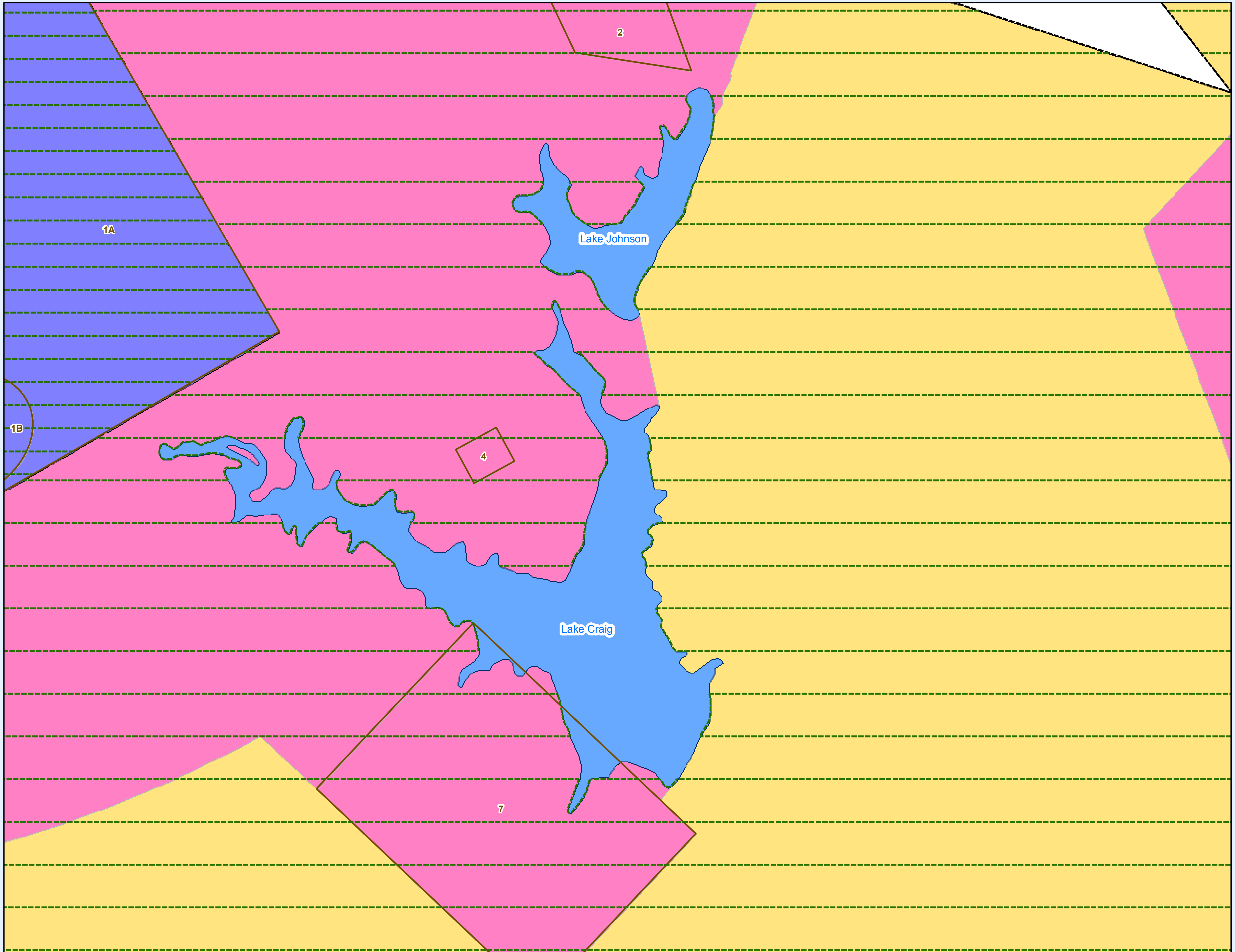

Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
Lake Johnson and Lake Craig

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	13

KEY

- Transects
- MRS
- Former OOU
- Areas of Potential Interest
- Lake
- AIR (135m Transect Spacing)
- Mag & Dig (73m Transect Spacing)
- Mag & Dig (135m Transect Spacing)

N W E S

0 500 1,000 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)
Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1" = 1,000'	ATD

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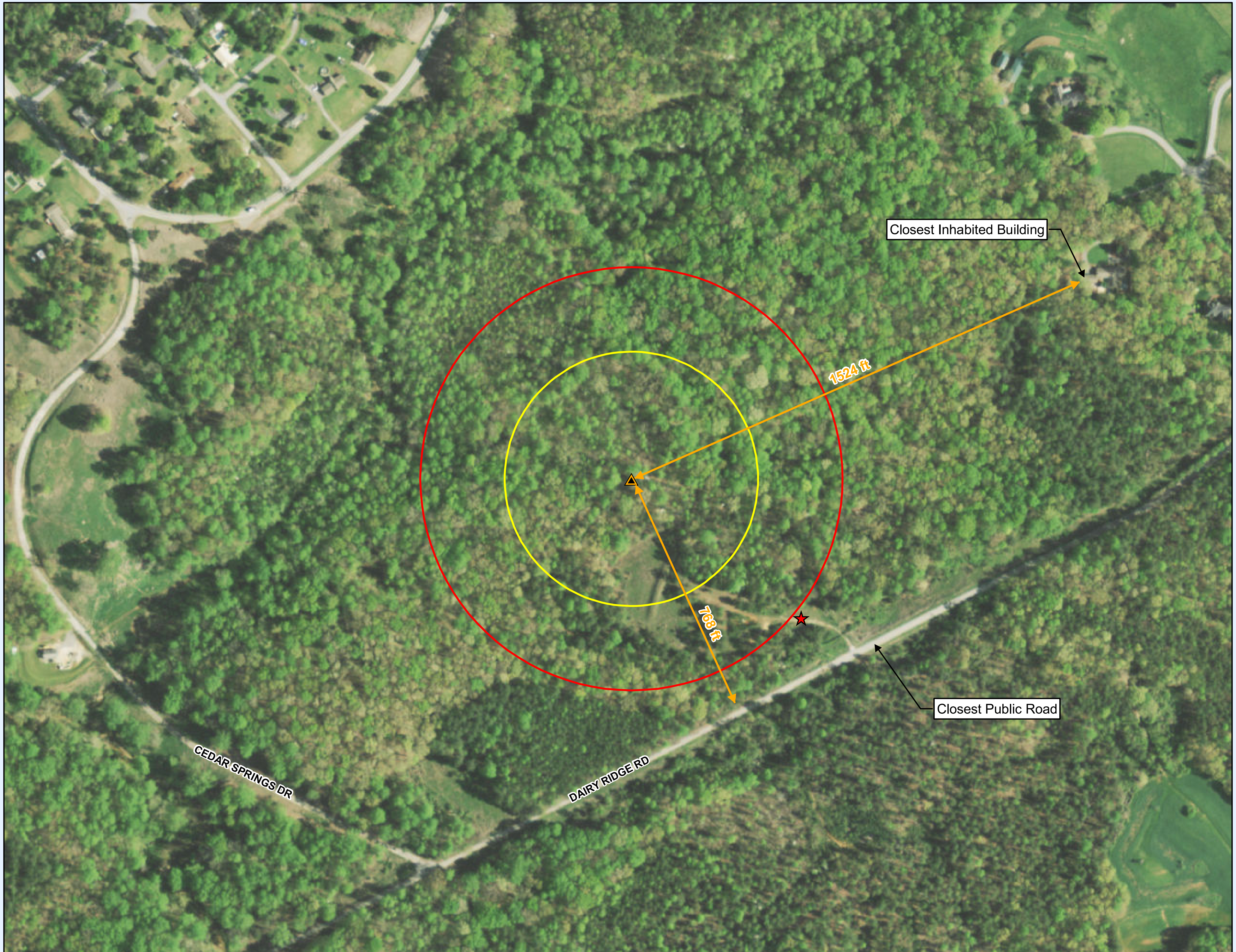

Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
QD ATF Portable Magazine

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	14

KEY

- Portable Explosives Storage Bunker
- Proposed Site Office Trailer Location
- Inhabited Building Distance (658 ft)
- Public Traffic Route Distance (395 ft)

N W E S

0 150 300 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)
Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1" = 300'	ATD

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APPENDIX C
POINTS-OF-CONTACT

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POINTS OF CONTACT AND KEY PROJECT PERSONNEL

AGENCY	NAME	TELEPHONE NUMBER
Emergency Contacts		
Fire Department	No Contact Name	911
Military Police	No Contact Name	911
Ambulance Service	No Contact Name	911
Non-Emergency Contacts		
Spartanburg County Sheriff's Department	Mr. John Dyas	(864) 596-2616
ATF	CJ Hyman	(864) 282-2937
Environmental		
Federal Agency	US Environmental Protection Agency (Region IV)	(800) 887-6063
South Carolina (State)	South Carolina Department of Health and Environmental Control	(800) 898-3432
Facilites		
Creek Golf Course	Taylor Hough	(864) 583-7084
Croft State Natural Area Superintendent	Mr. Gerry Perry	(864) 585-1283
Medical Services		
Spartanburg Regional Hospital	Primary Care	(864) 579-2016
ZAPATA Physician	Dr. Donald Whorton	(510) 748-6900
US Army Corps of Engineers		
Project Manager	Mr. Spencer O'Neal	(256) 895-1574
Technical Manager	Teresa Carpenter	(256) 895-1659
Project Geophysicist	Ms. Debbie Edwards	(256) 895-1626
Contracting Officer	Ms. Lydia Tadesse	(256) 895-1169
OE Safety Specialist*		
Zapata Incorporated		
Program Manager	Mr. Michael Winningham	(704) 358-8240
Project Manager	Mr. Jason Shiflet	(704) 358-8240
Corporate Safety Officer	Dr. George Dwiggins	(704) 358-8240
Senior UXO Supervisor	Mr. Jeff Schwalm	(704) 358-8240
UXO Safety Officer	Mr. Terry Farmer	(704) 358-8240

* When fieldwork begins, the assigned OE Safety Specialists information will be added.

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APPENDIX D
ACCIDENT PREVENTION PLAN

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FINAL

ACCIDENT PREVENTION PLAN (APP)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)

FORMER CAMP CROFT

Contract No. W912DY-10-D-0028
Delivery Order No. 0005

September 9, 2011

Prepared for:

US Army Engineering and Support Center,
Huntsville

and

US Army Corps of Engineers, Charleston District

by:

Zapata Incorporated.
6302 Fairview Road, Suite 600
Charlotte, North Carolina 28210
Phone (704) 358-8240

*This document is a draft document and is pre-decisional, therefore,
it is not subject to the Freedom of Information Act (FOIA).*

ACCIDENT PREVENTION PLAN

This Accident Prevention Plan for the RI/FS Fieldwork at the former Camp Croft has been prepared by Zapata Incorporated for the U.S. Army Engineering and Support Center, Huntsville.

The signatures below attest that this Accident Prevention Plan has been prepared and reviewed by qualified personnel, and that it has been approved for implementation during work on the project described above.

THE AMERICAN BOARD OF INDUSTRIAL HYGIENE
INCORPORATED
CERTIFICATION NUMBER
2345 CP
EXPIRES 6-1-2016
PENNSYLVANIA · 1960
GEORGE A. DWIGGINS, CIH

Approved by/date: ________________ 2 Sep. 2011
George A. Dwiggins, Ph.D.
Certified Industrial Hygienist
Certified Safety Professional
704-358-8240

Approved by/date: ________________
Michael L. Winningham
Vice President of Munitions Response Services
704-358-8240

Plan Concurrence by/date: for ________________
Mr. Tim Hendrix
UXO Safety Officer
704-358-8240

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2.1 EXCERPT FROM THE CORPORATE POLICY ON WORKPLACE HEALTH AND SAFETY......7
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ATTACHMENTS

Attachment 1	Site Safety and Health Plan
Attachment 2	Sample Forms
Attachment 3	Activity Hazard Analyses for Phases of Work
Attachment 4	Heat Stress: Environmental Assessment and Management of Exposure
Attachment 5	Cold Stress: Environmental Assessment and Management of Exposure
Attachment 6	List of Chemical Products with Associated Material Safety Data Sheets
Attachment 7	Images of Dangerous Animals and Plants at the Project Site

1.0 INTRODUCTION

This document and the accompanying site safety and health plan (SSHP, Attachment 1) describe the safety program that will be implemented by Zapata Incorporated (ZAPATA) during work under contract number W912DY-10-D-0028 (Task order 0005). Zapata Incorporated (ZAPATA) will perform a Remedial Investigation / Feasibility Study (RI/FS) at the Former Camp Croft in Spartanburg County, South Carolina.

The project involves detection and investigation of anomalies, with associated brush clearance and collection of soil samples. No excavations are planned. Work will consist of the following activities, each of which is discussed in detail in Attachments 1 and 3:

- Mobilization and site preparation,
- Brush clearing,
- Anomaly investigation and collection of soil samples, and
- Demobilization.

All activities involving work in areas potentially containing unexploded ordnance hazards shall be conducted in full compliance with safety standards of the U.S. Army Corps of Engineers, the Department of the Army, and the Department of Defense, and with state and local safety requirements regarding personnel, equipment, and procedures.

2.0 COMMITMENT TO SAFETY

2.1 EXCERPT FROM THE CORPORATE POLICY ON WORKPLACE HEALTH AND SAFETY

ZAPATA is committed to safety, and to a corporate culture in which all employees are knowledgeable of potential workplace hazards and empowered to participate actively in accident prevention and risk reduction. When asked the question: "Who is responsible for safety?" the correct response is "I am!" Safety is the responsibility of employees at all levels. Managers are expected to promote safety awareness through training programs for their employees, and employees are encouraged to report any concerns about workplace health and safety to management.

The ZAPATA Safety Department is charged with the recognition, evaluation, and management of potential threats to health and safety in the work environment. The Safety Department also is responsible for regulatory compliance in the area of workplace health and safety and for serving in the role of liaison with client safety officials.

The Safety Department reports to an Executive Vice President, a corporate officer outside the chain of command for project management. In matters related to workplace health and safety, designated site safety officers report directly to the Safety Department – not to project or site managers. The Safety Department and/or the site safety officer may require changes in site work procedures to reduce risks to employees. The safety officer may halt site work if necessary.

The project manager will designate a site safety officer responsible for implementing safety procedures. The safety officer will hold safety meetings at a prescribed frequency (at least daily at field projects) to encourage safe work.

Project managers, site managers, and site safety officers are expected to inspect the work environment regularly, review potential project hazards, identify unsafe conditions, and make routine reports to the corporate Safety Department. In addition, they are responsible for investigating accidents and injuries that occur on their sites and preparing reports on these events for review by the ZAPATA manager of health and safety.

All employees are expected to maintain awareness of the potential hazards present at their work site and to follow requirements of safety plans designed to manage those risks. They are required to report unsafe conditions; work-related accidents, injuries, and illnesses; and "near-miss" incidents that could have caused injury to people or damage to property. Corrective action will be taken promptly by the manager of health and safety, a project manager, a site safety officer, or a senior ZAPATA manager, as appropriate. ZAPATA will take no adverse action against any employee who complains in good faith about an unsafe condition in the workplace.

Violation of a safety rule shall be grounds for termination. A project manager or other senior manager may issue a written warning after an employee's first violation, if termination is deemed inappropriate under the circumstances. The written warning shall be included in the employee's personnel record for three years. If the employee commits a second violation that results in a written warning within a three-year period, then he or she shall be terminated.

Subcontractors will work under the same rules that apply to ZAPATA employees, unless some other arrangement is deemed at least equally effective in promoting a safe and healthful work environment. A project manager or site safety officer shall order an employee of a subcontractor to leave the project site and forbid his or her return if that employee shows disregard for site safety rules. A subcontractor firm that fails to enforce site safety rules shall not be permitted to perform field work on a ZAPATA project.

Visitors to project sites shall receive appropriate safety briefings. The site manager or safety officer shall verify that visitors possess any required training or medical certifications, and that they use appropriate personal protective equipment.

2.2 THE ZAPATA SAFETY EXPERIENCE

During the four calendar years 2006 through 2010, ZAPATA employees worked a total of 1,139,000 hours – much of which was accumulated on field projects – with only nine OSHA-recordable incidents. Only two resulted in lost work days. The average rate for OSHA-recordable events during that five-year period was 1.6, which is well below the industry average. ZAPATA employees have experienced two OSHA-recordable events in 2011. The EMR value assigned in 2010 for Zapata Incorporated is 0.74. The EMR value assigned in the previous year was 0.73.

On September 30, 2010, Zapata Incorporated was admitted into the Carolina Star Program, through which the North Carolina Department of Labor recognizes companies with effective safety programs and good safety records in the state. The North Carolina Commissioner of Labor, Cherie Berry, presented the award in a formal ceremony in Charlotte on November 8, 2010. Zapata Incorporated also was presented the Lighthouse Beam Safety Award by BB&T Insurance Services on June 4, 2010.

3.0 PROJECT PARTICIPANTS AND LINES OF AUTHORITY

A detailed organization chart for project management is found in Figure 2-1 in the accompanying work plan document.

3.1 ZAPATA PERSONNEL

The following ZAPATA employees will have critical roles in the safe execution of this project:

Project Manager: Jason Shiflet, P.G.
Site Manager (Senior UXO Supervisor, or SUXOS): Jeff Schwalm
Manager of Health and Safety: George A. Dwiggins, Ph.D., CIH, CSP
Site Safety Officer (UXO Safety Officer, or UXOSO): Tim Hendrix

In matters related to workplace health and safety, the UXOSO will report directly to the manager of health and safety, who reports to corporate management at the most senior level. Routine contact between the UXOSO and the manager of health and safety is anticipated during the course of the project.

3.2 SUBCONTRACTORS AND SUPPLIERS

The following subcontractors and major suppliers that will place employees on the job site have been identified:

- There will not be subcontractor employees on the site

During work in any exclusion zone, these employees of subcontractors will be escorted by a UXO-trained technician at all times, to permit avoidance of ordnance hazards.

The UXOSO will require that employees of any subcontractors adhere to all applicable site safety requirements. This will involve consideration of the nature, location, and duration of their work tasks. At a minimum, employees of subcontractors will receive a daily briefing on anticipated risks and safety rules designed to mitigate those risks. The UXOSO will consult with the manager of health and safety if questions arise. Subcontractors performing work at the site will attend a safety meeting as required by and held by the UXOSO each day prior to the start of work. The UXOSO will monitor subcontractor operations to ensure compliance with site safety requirements.

4.0 TRAINING

All ZAPATA employees, subcontractors' employees and site visitors must be trained in accordance with this document. In every case, appropriate training will include briefings by the UXOSO on site hazards and work rules. In addition, the UXOSO will require evidence of prior completion of mandatory courses in some situations. The UXOSO will maintain a file of training certificates or other documentation verifying that these requirements have been met.

4.1 MANDATORY TRAINING FOR THOSE EXPOSED TO SIGNIFICANT SITE HAZARDS

The UXOSO will verify that the following training courses have been completed by the personnel indicated:

Explosive ordnance disposal (EOD) training. Evidence of EOD certification is required for site workers and visitors potentially exposed to ordnance hazards.

Forty-hour course on health and safety in hazardous waste operations. Evidence of training as a site worker in accordance to 29 CFR 1926.65 is required for site workers and visitors potentially exposed to chemical, radiological, or ordnance hazards. Evidence of a recent annual refresher course also is required.

Eight-hour course on supervision of hazardous waste operations. Evidence of training as a supervisor in accordance with 29 CFR 1926.65 is required for ZAPATA supervisory and management personnel.

Heavy equipment operation. Evidence of training in the safe operation of heavy equipment will be required for operators of bulldozers, forklifts, backhoes, and similar machines.

First Aid / CPR. Evidence of current certification in first aid / CPR will be required for a sufficient number of ZAPATA employees to permit scheduling of at least two with this training on the project site at all times. Procedures to manage bloodborne pathogens should be a component of this training.

Respirator training. The need for training in the use of respirators is **not** anticipated. However, if the manager of health and safety deems that it is necessary, the UXOSO will require that anyone who uses a respirator provide evidence of appropriate training.

OSHA-approved Ten-hour course on construction safety. The UXOSO will keep on the site a certificate confirming that he received training in construction safety within the previous three years, in accordance with Paragraph 01.A.17 of EM 385-1-1.

In addition, the UXOSO will make inquiries to determine whether new employees have previous experience on a hazardous waste or ordnance site. He will arrange for close supervision of inexperienced workers by an experienced supervisor for at least the first three days of their work on the site.

4.2 SITE-SPECIFIC TRAINING

A detailed presentation on site risks and the workplace health-and-safety program will be conducted by the UXOSO before work commences on the site, and at other times when new site workers arrive. Topics will include the following:

- Requirements and responsibilities for maintaining safe and healthful work environment,
- General safety and health policy and procedures,
- Employee and supervisor responsibilities for reporting all accidents,
- Emergency-response plans and procedures for obtaining medical treatment,
- Procedures for reporting and correcting unsafe conditions or practices,
- Specific job hazards and the means to mitigate the risks,
- Names of and contact information for those responsible for safety program administration,
- Site hazards, hazard recognition, and symptoms of excessive exposure to site hazards,
- Proper use of required personal protective equipment,
- Safe use of engineering controls and equipment on the project site.

In addition, the UXOSO will provided detailed safety training in the following areas to workers exposed to the hazard described:

- **Chemical hazard communication**. If chemicals are brought onto the job site, employees potentially exposed to their hazards will receive appropriate safety training. This will include the details of the chemical hazard communication program described in the accompanying site safety and health plan.
- **Fire prevention and response**. The UXOSO will conduct training sessions on measures to prevent fires and procedures for suppressing fires. Employees will receive training in the use of fire extinguishers to fight incipient fires.
- **Control of hazardous energy (lock out / tag out)**. If site work involves the potential for injury from the release of stored energy, then employees will be trained in appropriate lock-out / tag-out procedures described in the accompanying site safety and health plan.

The UXOSO will confer with the manager of health and safety to determine an appropriate schedule for retraining employees in site-specific safety topics. Annual or more frequent refresher sessions will be required.

Daily safety briefings will be conducted by the UXOSO for site personnel prior to the start of each day’s activities. Such sessions will be used to discuss anticipated risks and safe practices to mitigate hazards.

The UXOSO also will conduct appropriate safety briefings for visitors and vendor representatives who will be on the site for short periods. The topics covered will be determined by the nature of the potential hazards to which they will be exposed.

5.0 SAFETY AND HEALTH INSPECTIONS

Informal daily inspections will be conducted by the UXOSO to verify that site operations and personnel are complying with this accident prevention plan and the accompanying site safety and health plan. The results of these inspections will be recorded in the safety log and reported to the SUXOS.

The UXOSO will direct that any safety violation be corrected immediately, and he will halt work if a condition places employees at unacceptable risk. He will confer with the manager of health and safety if unsafe conditions can not be corrected promptly, or if violations occur repeatedly.

The UXOSO will investigate every accident, injury, or near-miss event, and prepare a formal report of the incident for review by the manager of health and safety.

The ZAPATA corporate manager of health and safety will visit the project site when work commences, or soon thereafter, (1) to observe site conditions, (2) to meet with the UXOSO and client safety representatives, (3) to conduct training sessions, (4) to review planned safety procedures, and (5) to implement additional safety procedures, if necessary.

6.0 EXPECTATIONS, INCENTIVE PROGRAMS, AND COMPLIANCE

The ZAPATA safety philosophy is stated in detail in Section 2.1, "Excerpt from the Corporate Policy on Workplace Health and Safety." Project personnel at all levels are strictly accountable for their actions. The site safety officer – the UXOSO, in this case – has complete freedom to enforce safety rules. He may refer a matter to the corporate manager of health and safety, or even to the company president, if this is necessary to correct a safety violation.

The UXOSO will encourage safe work and focus workers' attention on safety by implementing the ZAPATA safety incentive program, "SafetyDraw." This program provides employees an opportunity to win a weekly cash prize if the work group has no accidents or injuries during the week. SafetyDraw will be played at a group meeting at the end of the accident-free work week, or at the beginning of the week immediately following the accident-free work week.

For the purposes of SafetyDraw, an accident free work week will be one in which **none** of the following incidents occurs:

- An OSHA-recordable injury or illness;
- A work-related injury or illness requiring off-site medical diagnosis or treatment;
- An accident resulting in property damage exceeding $100.00;
- An unsafe act or omission resulting in an OSHA citation or a complaint or reprimand from the client; or
- A serious "near miss" or violation of site rules that could have harmed employees or damaged property.

Employees of sub-contractors will be included in SafetyDraw at project sites. An employee of a sub-contractor will be eligible if (1) he or she was present on the site every day of the accident-free week and (2) he or she is present at the meeting at which SafetyDraw is played for that accident-free week.

At the weekly meeting when SafetyDraw is played, each participant will draw a card. Then a card will be drawn randomly from a card set identical to the one from which employees' cards were drawn. If the randomly drawn card matches one drawn earlier by an employee, then that employee wins the cash prize. The probability that some employee will win a given game of SafetyDraw will be between 0.25 and 0.75. (i.e., the ratio of cards to employees will be between 1.33 and 4.)

If no one wins the cash prize for a given accident-free week, then that amount is carried forward to the next week, and added to the weekly cash prize for one accident-free week.

If the work group experiences an accident, injury or other incident listed above, then the prize amount is re-set to zero and SafetyDraw is not played for the week in which the accident occurred. A UXOSO will inform employees of this, and discuss the accident and opportunities to prevent future occurrences.

7.0 ACCIDENT REPORTING

In the event that a reportable accident occurs at the job site, the UXOSO will provide an immediate verbal notification to the ZAPATA manager of health and safety and to the US Army Engineering Support Center at Huntsville (USAESCH). Accidents will be investigated in depth to identify causes and control measures. USAESCH Form 3394 (Attachment 2) will be completed by the UXOSO and forwarded within two working days to the ZAPATA manager of health and safety and to the USAESCH project manager.

Reports to USAESCH will be completed for accidents that result in one or more of the following outcomes**:**

- Fatal injury,
- Injury of employees,
- Lost work days, or
- Property damage exceeding $2,000.

If required, an OSHA Form 300 will be complete by the manager of health and safety, in consultation with the UXOSO.

In the event of a significant near-miss event or other incident for which USAESCH reporting is not required, the UXOSO will investigate the incident and report the results of the investigation using an appropriate ZAPATA form. This form will be sent to the manager of health and safety and to the ZAPATA project manager for review.

Daily records of first-aid treatments will be maintained by the UXOSO on prescribed forms.

Exposure data (man-hours worked) will be provided to the project manager by the SUXOS at regular intervals, and the project manager will prepare the monthly reports for the USAESCH project manager.

8.0 EMERGENCY AND NON-EMERGENCY MEDICAL TREATMENTS

At least two site workers qualified in first aid and CPR will be present on the site at all times. It is anticipated that workers with this training will assist others who have minor injuries on the site.

If injuries are more serious, then the UXOSO will assess the situation and determine a course of action consistent with the written emergency procedures, which are found in the accompanying site safety and health plan. The UXOSO will determine whether the injured person should be transported using a site vehicle, or if an ambulance will be required to transport the injured person to a medical treatment facility.

Emergency medical services will be contacted by calling 911. The designated caller should remain on the line with the 911 operator, unless the caller is needed to assist the injured person.

9.0 PERSONAL PROTECTIVE EQUIPMENT

Basic "level D" personal protective equipment for site work will consist of a basic work outfit offering some protection against abrasion and sunlight, heavy work gloves, sturdy work boots, and safety glasses with side shields or comparable side protection. The following additions to this basic ensemble will be required under the circumstances indicated:

- A hard hat will be required when employees are exposed to the danger of head impacts with hard objects, including tree branches..
- Steel-toe work boots, or boots offering comparable protection to the toes will be required when employees are exposed to the danger of crushing injuries to the foot.
- Earplugs or ear muffs will be required when employees work around loud machinery. The UXOSO will require the use of hearing protection by employees using chainsaws, by employees who approach a noisy drilling operation, and by employees engaged in similarly noisy work.
- Chaps or similar protection of the legs, if this is deemed necessary by the UXOSO for protection against contact with machinery, underbrush, or snakes, or brush-clearing tools.
- Personnel conducting environmental sampling for munitions constituents (MC) will wear disposable nitrile gloves that will be changed every fifteen (15) minutes during collection activities. The UXOSO will require other measures to avoid skin contact with contaminants or to limit inhalation exposures, if necessary.

The UXOSO will assess the adequacy of personal protective equipment during the course of the project, and consult with the manager of health and safety if modifications appear desirable. He will notify the manager of health and safety immediately if unexpected site conditions (such as soil contaminated with chemicals) are encountered to discuss needed changes in protective equipment, work practices, or both.

Site workers will be responsible cleaning their protective equipment and maintaining its effectiveness. ZAPATA will provide cleansing wipes, wash sprays and cloths, or equivalent cleaning supplies for this purpose as necessary. Site personnel will be responsible for daily inspections of their protective equipment. They will be instructed to inform the UXOSO if protective equipment is in need of replacement.

10.0 REQUIRED PLANS, PROGRAMS, AND PROCEDURES

The various safety plans listed below will be implemented during work on the project. These are found in stated section or sections of the accompanying site health and safety plan, unless a different document is cited.

- **Layout plan** showing the location of the Former Camp Croft site and the locations of work areas, access roads, and support zones. SSHP Section 1.0.
- **Emergency response and contingency procedure**. SSHP Section 12.0.
- **Fire prevention and response procedure**. SSHP Section 9.2.
- **Spill control procedure**. SSHP Section 9.12.
- **Hazard Communication Program** requiring collection of material data sheets on all chemicals brought onto the site and training of employees in the hazards associated with storage and use of these chemicals. SSHP Section 9.11.
- **Hazardous Energy Control Plan**. SSHP Section 9.6.
- **Contingency plan for severe weather**. SSHP Sections 9.8 and 12.0.
- **Explosives Management Plan** is found in Section 5.0 of the site **Work Plan document**.
- **Site Sanitation Plan**. SSHP Section 9.9.
- **Drug-free workplace program** administered by the Human Resources Department, in collaboration with the project UXOSO and the SUXOS. ZAPATA is committed to the elimination of drug and alcohol abuse in the workplace and among potential applicants for employment. The written policy, which is **available upon request**, provides for pre-employment, random, and for-cause testing.

Other written site programs will be added if necessary in an ongoing process of program evaluation. The UXOSO and the manager of health and safety will confer frequently to assess the need for additions to the site safety and health plan. **The following plans, programs, or procedures will <u>not</u> be required for work anticipated under this plan:**

- Respiratory protection plan.
- Health hazard control program (beyond measures listed above).
- Lead or asbestos abatement plans.
- Abrasive blasting safety plan.
- Confined-space entry plan.
- Critical lift procedures.
- Demolition plan.
- Diving plan.
- Emergency rescue plan for tunneling.
- Underground construction fire prevention and protection plan.
- Compressed air plan.
- Formwork and shoring erection and removal plan.
- Jacking or slab plans.
- Blasting plan.
- Fall protection plan.
- Steel erection plan.
- Night operations lighting plan.

11.0 APPROACH TO MANAGEMENT OF SITE-SPECIFIC HAZARDS

This accident prevention plan, with attachments, states the contractor's understanding of the hazards inherent in the project and provides detailed procedures for minimizing the potential for injury, illness, and environmental degradation during the course of the contractor's field work. Applicable sections of EM 385-1-1 have been addressed in detail. In particular, an activity hazard analyses for each phase of work is found in Attachment 3.

ATTACHMENT 1
SITE SAFETY AND HEALTH PLAN

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ATTACHMENT 1
SITE SAFETY AND HEALTH PLAN

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1.0 SITE DESCRIPTION

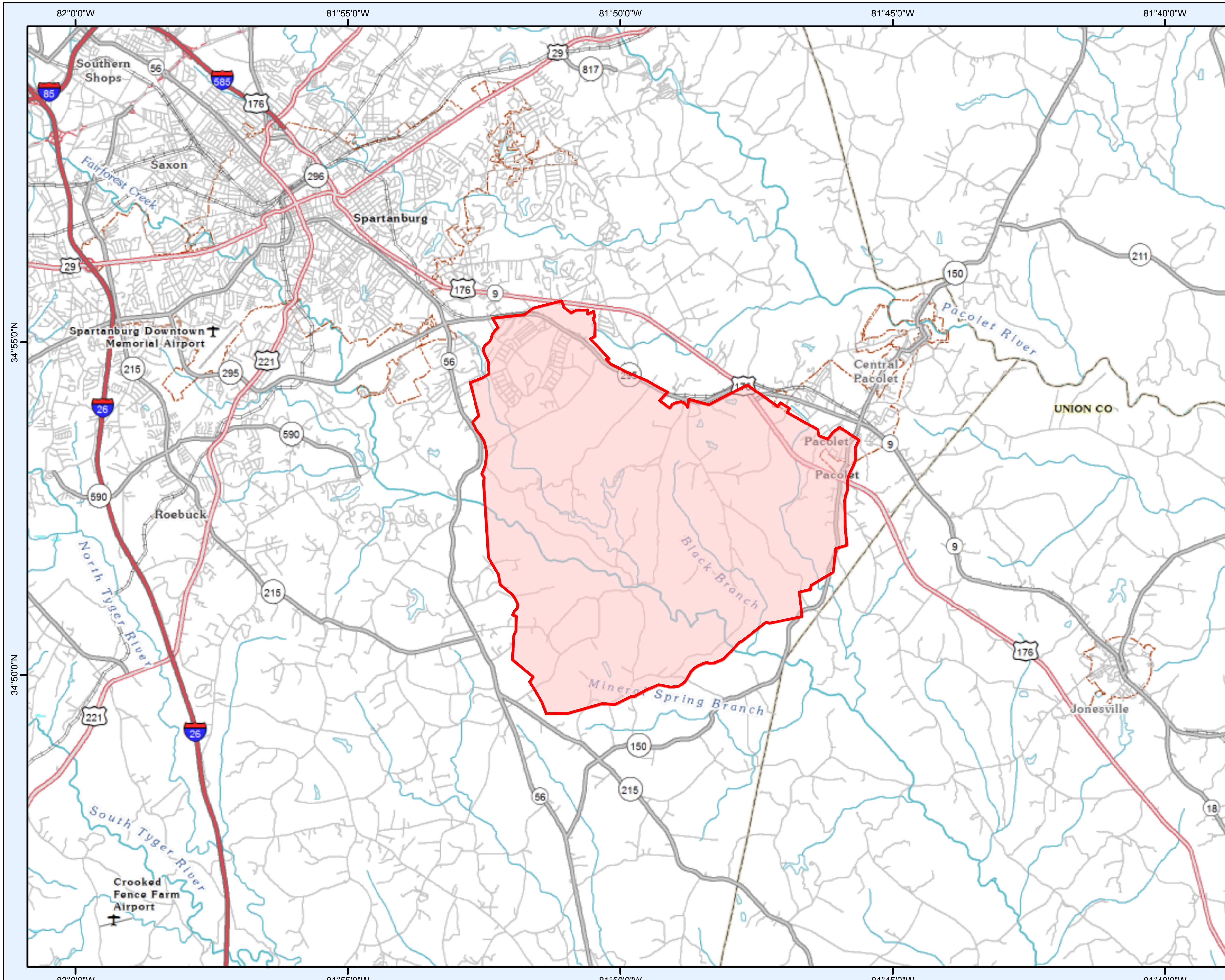
The project site includes many study areas throughout the property formerly occupied by Camp Croft (approximately 11,990 acres). This area is located in the Piedmont region of South Carolina, less than 10 miles southeast of downtown Spartanburg.

The varied terrain in the study areas includes rolling hills, streams, and woodlands. Many designated study areas are in residential neighborhoods and agricultural fields. There are two man-made lakes within Croft State Natural Area, which is on land formerly occupied by Camp Croft.

The Camp Croft Infantry Replacement Training Center was officially activated in 1941. Weapons used at its numerous training ranges included M-1 rifles, Browning automatic rifles, anti-tank rockets, and infantry mortars. Other training activities included obstacle and fit-to-fight courses, gas chambers, gas obstacle course, and amphibious warfare training.

Available information indicates that the principal potential hazard to workers on the former Camp Croft is unexploded ordnance. There is no evidence of chemical munitions, dangerously contaminated soil, or similar hazards, but project personnel will be alert to signs of such hazards and take precautions stated in this document.

A map showing the general area in which investigations are planned is found Figure D-1.



Work Plans for the Remedial Investigation/Feasibility Study
Former Camp Croft, Spartanburg, SC
Site Location

Project Number	Date	Exhibit
00017	SEPTEMBER 2011	1

KEY

Approximate Former Camp Croft Boundary

N W E S

0 1 2 Miles

Overview

Source(s)
USAESCH, USGS

Projection
Web Mercator, WGS 1984

Note(s)
Engineering scale may only be accurate on a map size of 11 x 17

Checked By	Engineering Scale	Drawn By
JES	1" = 2 miles	ATD

US Army Corps of Engineers®

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2.0 HAZARD ANALYSIS AND RISK ASSESSMENT

The principal anticipated hazard to site workers is unexploded ordnance. This hazard will be managed through procedures stated in detail in the work plan document. There is no evidence that chemical or radiological hazards are present on the site. However, if evidence of these is discovered, the site safety officer will notify the project manager and the corporate manager of health and safety as soon as possible. Appropriate addenda to this plan will be prepared.

In the unlikely event that a chemical weapon (or chemical weapons material) is encountered during operations, work will halt immediately, and personnel will withdraw upwind from the area. The USAESCH safety specialist will be notified. Site personnel will stand by and wait for instructions from the USAESCH contracting officer.

Biological hazards anticipated for this project site include bees, wasps, hornets, spiders, ticks, ants, mosquitoes, poisonous snakes, leeches, and blood-borne pathogens. Biological hazards are discussed in detail in Section 9.13 of this document.

The potential for exposure to munitions constituents could exist during collection of soil and water samples, and possibly during other times. Management of this hazard is discussed in Section 9.14 of this document.

Other more routine hazards include the following:

1. Material-lifting hazards, such as back strain, pulled muscles and tendons, pinched or crushed fingers and toes, and lacerations from sharp surfaces on objects lifted;
2. Hazards associated with the operation of hand and power tools (e.g., chain saws), including lacerations and flying objects;
3. Slip, trip, and fall hazards associated with ground cover, exposed tree/brush stumps, uneven terrain, rocks, and vegetation growth;
4. Inclement weather events, such as heavy rain, and lightning;
5. Sharp objects, including nails, broken glass, and exposed tree/brush stumps;
6. Noise from heavy equipment or brush-cutting machinery.
7. Conditions that could cause heat-related illness.

The following distinct phases of project work or distinct potentially hazardous operations have been identified:

- Mobilization and site preparation,
- Brush clearing,
- Anomaly investigation and collection of soil samples, and
- Demobilization

An activity hazard analysis for each of these phases is found in Attachment 3.

If site conditions or activities occur that are not discussed in this document or in the accident prevention plan, then the UXOSO will notify the corporate manager of health and safety immediately, and new procedures will be developed.

3.0 STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

This information is found in Section 3.1 of the Accident Prevention Plan.

4.0 TRAINING

This information is found in Section 4.0 of the Accident Prevention Plan. Training certificates will be maintained in a file on the site by the UXOSO.

5.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

This information is found in Section 9.0 of the Accident Prevention Plan.

6.0 MEDICAL SURVEILLANCE

Workers exposed significantly site hazards, including all employees of ZAPATA, will participate in a program of medical surveillance of the type specified in 29 CFR 1926.65, the OSHA standard on "Workplace Health and Safety in Hazardous Waste Operations and Emergency Response." Such workers must present a physician's statement that they are medically qualified for (1) work in hazardous waste operations and (2) the use of respirators. The UXOSO will evaluate all physicians' letters and refer any questions to the corporate manager of health and safety. Annual medical certification is required; a physician's statement must be no older than one year.

The UXOSO will take note of any restrictions stated on a physician's statement, and make arrangements to avoid any prohibited activity or condition. In addition, the UXOSO will monitor all employees to detect early signs of exhaustion, heat stress, or other conditions that might suggest a lack of fitness for a particular task.

Medical treatment received incident to a workplace injury or illness will be managed in accordance with the OSHA standard referenced above. The UXOSO will notify the corporate manager of health and safety immediately if such an event occurs.

7.0 EXPOSURE MONITORING AND AIR SAMPLING

No routine exposure monitoring or air sampling is anticipated. The UXOSO and the corporate manager of health and safety will confer often to assess the need for such testing, and they will implement a monitoring or sampling program if this is warranted by site activities or conditions.

The UXOSO will monitor employees' noise exposure with a calibrated sound level meter whenever noisy operations are in progress, and require the use of hearing protection whenever the sound level measured in a work area is 85 dBA or greater.

8.0 HEAT AND COLD STRESS

The UXOSO will remain alert to site conditions that could cause heat-related illness or cold stress. The UXOSO will implement procedures found in Attachments 4 and 5, if necessary. These procedures require assessment of the potential for heat-related illness when the air temperature exceeds 70°F, and of the potential for cold stress when the air temperature is below 30°F, under calm conditions. The threshold for assessment of the potential for cold stress is higher under windy conditions.

A WBGT instrument will be present on the site and used for environmental monitoring (except during cool weather).

9.0 SAFETY PROCEDURES, CONTROLS, AND PRACTICES

This section describes safety procedures, controls, and practices that all site personnel must follow to mitigate risks from hazards. The following rules are generally applicable:

The Buddy System. Employees shall not work alone. This "buddy system" requires that every employee work near someone else who could offer assistance or summon help in the event of an accident or illness. At all times, an employee on a field site must be observable by at least one other person or sufficiently close to at least one other person to communicate by voice.

Reporting Unsafe Conditions. Site personnel will immediately report to the UXOSO any unsafe acts or conditions, including – but not limited to – violations of this document or the accident prevention plan.

Reporting Injuries and Illnesses. All injuries or illnesses – including apparently minor ones like insect bites – will be reported to the UXOSO promptly.

Reporting of Pre-existing Medical Conditions. Site personnel will inform the UXOSO of any known medical conditions that may cause illness in the workplace, aggravate a possible work-related illness, or increase the likelihood of accidents. This includes hypersensitive allergic reactions to stinging and biting insects or to contact with poisonous plants; diabetes; high blood pressure; skin or eye sensitivity to sunlight and UV radiation; chronic illness; and acute illnesses, such as a cold, the flu, or stomach/ intestinal disorders. Persons with known hypersensitive allergic reactions to stinging/ biting insects or to toxic plants will carry appropriate emergency medical antidotes on their person at all times when on site.

Prohibition on Horseplay. Site personnel shall not engage in horseplay, running, or other irresponsible behavior harm people, property, or the environment.

Avoidance of Skin Contact with Poisonous Plants. Personnel in vegetated or wooded areas shall wear long-sleeve shirts with the sleeves rolled down to reduce contact with poisonous plants.

Eating, Drinking, and Smoking Restrictions. Eating, drinking and smoking shall be permitted only in areas designated by the UXOSO and at designated break times, after employees have washed their hands. Eating, drinking, and smoking shall be forbidden in any exclusion zone or nearby decontamination area.

Prohibition on Ignition Sources. Ignition of flammable materials in any work area is prohibited, unless approved in writing by the UXOSO. Matches, lighters, or other sources of sparks shall not be allowed in any exclusion zone or nearby decontamination area.

Limit on Personnel Exposed to Potential Risks. The number of personnel in any work area will be the minimum number necessary to perform work tasks in a safe and efficient manner.

Reporting on the Location of Site Personnel. Site personnel will check in with the UXOSO prior to leaving the site and upon returning to the site.

Escorts for Site Visitors. Site visitors are to be escorted by the UXOSO, or an appropriate designee, at all times.

Qualifications for Specific Tasks. Site personnel shall perform only those tasks, which they are qualified by training and, when applicable, appropriate certifications. Such certifications shall include those required by this document and the accident prevention plan.

Limitation on Admission to Work Areas. No one may enter a site work area without the approval of the UXOSO, who shall consider the qualifications of each entrant and the risks present in the areas into which entry is desired.

Housekeeping. All work areas will be maintained in a clean, neat, and orderly fashion, free of loose debris and scrap. Any materials and equipment not being used will be stored or discarded properly. All work areas will be supplied with a trash receptacle that includes a lid. The contents of all trash receptacles will either be removed from the site daily or emptied daily into a larger trash storage container that will be tightly closed each night prior to departure of personnel from the sites.

9.1 MATERIAL HANDLING AND LIFTING PROCEDURES

Site personnel will exercise care in lifting and handling heavy or bulky items. No site worker will attempt to lift any item in excess of **40** pounds without assistance or use of a mechanical device. Materials being lifted either mechanically or manually will not be moved, or suspended, over personnel unless precautions have been made to protect the personnel from falling objects. Whenever heavy or bulky material is to be moved manually, the size, shape, and weight of the object and the distance and path of movement must be considered to prevent joint and back injuries. The following hierarchy will be followed in selecting a means for material handling:

1. Movement of the material by mechanical device (i.e., lift truck, crane, etc.);
2. Movement by manual means using mechanical aid (i.e., dolly or cart); and
3. Movement manually in a planned manner with an adequate number of personnel.

The UXOSO will train employees in proper lifting techniques and require that they lift objects properly. The following procedures shall be followed:

1. A firm grip on the object is essential. Therefore the hands and object will be free of oil, grease, or water, any of which might prevent a firm grip.
2. The hands, and especially the fingers, will be kept away from any points where pinching or crushing could occur, especially when setting the object down.

3. The item will be inspected for metal slivers, jagged edges, burrs, rough or slippery surfaces and pinch points, and gloves will be used, if necessary, to protect the hands.
4. The feet will be placed far enough apart for good balance and stability.
5. Personnel will ensure that solid footing is available prior to lifting the object.
6. When lifting, personnel will remain as close to the load as possible, bend their legs at the knees, keep their back as straight as possible, and lift the object with the legs, as they are straightening from their bending position.
7. Never carry a load that cannot be seen over or around.
8. When placing an object down, the stance and position are identical to that for lifting, with the back kept straight and the legs bent at the knees, while the object is lowered.
9. When two or more people are required to handle an object, care should be taken to ensure the load is lifted and distributed uniformly between the individuals carrying the load. Each person, if possible, will face the direction in which the object is being carried.

9.2 FIRE PREVENTION AND RESPONSE

Potential causes of fires in the work area are (1) Smoking, (2) Lightning, (3) Parking hot vehicles on dry brush, and (4) Electrical short-circuits. The following rules will be followed to reduce the likelihood of a dangerous fire:

Sources of ignition shall be prohibited within 50 feet of any operation or storage location that could present a fire or explosion hazard. Such areas shall be marked conspicuously with signs stating "NO SMOKING, MATCHES, OR OPEN FLAME," if the UXOSO deems such signs necessary.

Smoking is permitted only in designated areas.

Vehicles may not be parked in areas where high vegetation is present. (Catalytic converters can be hot enough to ignite vegetation.)

Employees will watch for lightning strikes that could ignite vegetation. (Other safety procedures require avoidance of storms that could produce lightning.)

Employees will use care when making electrical connections, because a short-circuit could cause a fire.

Appropriately selected fire extinguishers will be available in all vehicles and trailers.

Shovels will be available in all vehicles.

All flammable materials will be stored in a flammable storage cabinet when not in use. The cabinet will be kept in a well ventilated area. Stored quantities of flammable materials will be minimized.

9.3 ELECTRICAL SAFETY

The use of electrical tools and apparatus safety will be conducted in accordance with EM 385-1-1, Section 11. These requirements (as applicable) include, but are not limited to:

All electrical equipment will be of a type listed by Underwriters Laboratories (UL) or Factory Mutual Engineering Corp. to the maximum extent possible for the specific application.

Flexible cord passing through work areas will be covered or elevated to protect it from damage by foot traffic, vehicles, sharp corners, or pinching.
Patched, oil-soaked, worn, or frayed electric cords or cables will not be used.

Extension cords or cables will not be fastened with staples, hung from nails, or suspended by wire.

Portable and semi-portable electrical tools and equipment will be grounded by a multi-conductor cord having an identified grounding conductor and a multi-contact polarized plug-in receptacle.

Semi-portable equipment, floodlights, and work lights will be grounded, and the protective ground will be maintained during moving unless supply circuits are de-energized.

Tools protected by an approved system of double insulation, or its equivalent, need not be grounded.

UL listed ground fault circuit interrupters (GFCIs), calibrated to trip within the threshold values of 5 ma + 1 ma, are required on all circuits used for portable electric tools.

Flexible cord sets will be UL-listed, contain the number of conductors required for the service plus an equipment ground wire, and will be classified as hard usage or extra-hard usage (identified by "outdoor" or "WA" printed on the jacket).

9.4 EXCAVATION AND TRENCHING SAFETY

No excavation exceeding four feet in depth is anticipated. The UXOSO will require that the sides of excavations be sloped, rather than steep. No employee may enter an excavation deeper than four feet.

The UXOSO will report any desired deviation from this to the corporate manager of health and safety before any trench or deep excavation is begun, and appropriate precautions will be developed for safe continuation of work.

9.5 MACHINE GUARDING

In order to protect site personnel from unguarded moving machinery and equipment surfaces, the requirements found in Subpart O of 29 CFR 1910, Section 16B of USAESCH EM 385-1-1 and the general provisions listed below will be followed:

All reciprocating, rotating, or moving parts of machinery or equipment will be guarded in accordance with manufacturer's specifications, if they create a hazard through contact with personnel.

No guard, safety appliance, or device will be removed from machinery or equipment or made ineffective except when making immediate repairs, lubrication, or adjustments, and then only after the power has been shut off.

All guards or safety appliances removed for repair, lubrication, or adjustments will be replaced immediately upon completion of said activity and before the power is restored.

9.6 HAZARDOUS ENERGY CONTROL

All site personnel involved in the use of lock-out / tag-out for the control of hazardous energy will receive on-site training. All training will comply with Section 12 of EM 385-1-1. In the event that tagout procedures are used on site, authorized personnel will be trained in the following limitations of tags:

Tags are essentially warning devices affixed to energy-isolating devices and do not provide the physical restraint on those devices that is provided by a lock;

When a tag is attached to an energy-isolating means, it is not to be removed without authorization of the authorized person responsible for it, and it is never to be bypassed, ignored or otherwise defeated;

Tags must be legible and understandable by all authorized and affected personnel whose work operations are, or may be, in the area; and

Tags must be securely attached to energy-isolating devices so that they cannot be inadvertently or accidentally detached during use.

9.7 ILLUMINATION

Potentially hazardous operations will be performed only during the time period from 30 minutes after sunrise to 30 minutes before sunset.

9.8 LIGHTNING AND SEVERE STORMS

The safety officer will remain aware of weather forecasts and plan for inclement weather during project work. If inclement weather appears imminent, the safety officer will direct site workers to halt work and to take refuge in vehicles or nearby buildings. **A lightning detector will be present on the** site and will be monitored by the UXOSO when threatening weather is noted or when storms are forecast. If the UXOSO deems that lightning is a potential threat, he will order employees to take shelter in an enclosed building with plumbing and electrical wiring, or in a vehicle.

9.9 SANITATION AND DRINKING WATER

An adequate supply of potable (drinkable) water will be provided on site at all times and will be supplied in accordance with the following provisions:

Containers will be clearly marked, capable of being tightly closed, equipped with a tap, maintained in a sanitary manner, and cleaned at least weekly.

Where single-service cups are provided, separate sanitary containers will be provided for the storage of the unused cups and for the disposal of the used cups.

Water or other supplied beverages will not be dipped from the container by any means, and use of a common cup will not be allowed. Use of non-potable water is not anticipated; however, if containers of such water are used, they will be conspicuously labeled "Caution: water unfit for drinking, washing, or cooking.

Toilet and washing facilities will be available at the project site.

9.10 POWER AND HAND TOOL OPERATION

To control the hazards associated with power tool operation, the requirements outlined in EM 385-1-1, Chapter 13; and the safe work practices listed below will be observed when using power tools:

Operation of power tools will be conducted by personnel trained in the use of the tool, its operation, and safety precautions.

Power tools will be inspected prior to use, and defective equipment will be removed from service until repaired.

Power tools with guards for moving parts will have such guards in place prior to and during use, and loose fitting clothing or long hair will be secured away from moving parts.

Hands, feet, etc., will be kept away from all moving parts.

Maintenance and/or adjustments to equipment will not be conducted while it is in operation or connected to a power source, and maintenance on gasoline-powered tools will be conducted only after the spark plug has been removed and secured.

Use of improper or defective hand tools can contribute significantly to the occurrence of accidents on site. Therefore, the requirements outlined in EM 385-1-1, Chapter 13 and the safe work practices listed below will be observed when using hand tools:

Hand tools will be inspected for defects prior to each use.

Defective hand tools will be removed from service and repaired or properly discarded.

Tools will be selected and used in the manner for which they were designed.

Be sure of footing and grip before using any tool.

Do not use tools that have split handles, mushroom heads, worn jaws, or other defects.

Leather work gloves will be worn to increase gripping ability and to protect the hand if a cut, laceration, or puncture hazard exists during the use of the tool.

Safety glasses or a face shield will be used if use of tools presents an eye/face hazard.

Do not use makeshift tools or other improper tools.

When working on elevated surfaces, tools will be secured to ensure they cannot fall on someone below.

9.11 Chemical Hazard Communication

The UXOSO will control the entry of chemical products into the work environment, and limit the number of such products to the minimum necessary for project execution. He will obtain a copy of a material safety data sheet for all such chemical products (unless an exception applies) and maintain these on the site. In addition, the UXOSO will review the hazards inherent in the storage and anticipated use of the chemicals, and provide training to workers exposed to these hazards. Such training will be provided upon initial assignment to the site and before use of the product. Supplemental training will be scheduled and presented whenever a new hazardous substance is introduced into the work area or whenever an employee changes job locations where different products are encountered.

The UXOSO will maintain on the site the following documents and records, and inform site workers of their place of storage: (1) The OSHA standard on chemical hazard communication (29 CFR 1910.1200) and (2) A list of chemical products on the site, with associated material safety data sheets (Attachment 6).

Subcontractors will comply with the requirements presented above and will supply the UXOSO with copies of material safety data sheets for any chemical products that they bring onto the site.

9.12 Spill Control

A portable spill-response kit containing oil/solvent absorbent pillows/pads, PPE and disposal supplies will be maintained in a readily accessible location where fuels, oils, solvents and other environmentally harmful materials are stored on site. The UXOSO will train workers in the proper use of such equipment.

9.13 Biological Hazards

Biological hazards include leeches, insects, ticks, spiders, and scorpions. Poisonous snakes, domestic dogs, and hazardous plants also may be encountered on the project site. Employee awareness and the safe work practices listed below will minimize hazards. The UXOSO will make inquiries about likely biological hazards at the work site, and tailor training material accordingly.

Mosquitoes, flies, and fleas are likely site pests. The UXOSO will maintain a supply of insect repellant on the site and encourage its frequent use when the potential for insect bites exists. The following practices should be followed to avoid risks from poisonous plants:

- Avoid contact with any poisonous or unidentified plants. If poisonous plants are identified, warn others and notify the UXOSO.
- Wash hands, face or other exposed areas at the beginning of each break period and at the end of each work day.
- Avoid contact with contaminated tools, equipment and clothing; and wash these regularly.
- Consider the use of barrier creams, detoxification/wash solutions and orally administered desensitization products.

All snakes should be considered venomous, and all should be avoided. Employees should be extremely cautious when they remove brush, lift rocks and debris, or enter wooded or grassy areas. Heavy gloves, high-top boots, chaps and other protective equipment should be used when needed to prevent contact with snakes.

The following precautions should be followed to avoid the risks of tick bites:

- Standard field gear (work boots, socks, and work uniform) provides good protection against tick bites, particularly if the openings are taped.
- Avoid direct skin contact with ticks by wearing long sleeves, long pants, socks, etc. Consider taping openings in clothing, if this can be done safely.
- When in the field, check yourself often for ticks, particularly on your lower legs and areas covered with hair.
- Spray outer clothing, particularly your pant legs and socks – but not your skin – with an insect repellent that is effective against ticks.
- To the extent feasible, avoid contact with bushes, tall grass, or brush.
- If you find a tick, remove it by pulling on it gently with tweezers. (Do not use matches, a lit cigarette, nail polish or any other type of chemical to "coax" the tick out.)
- Be sure to remove all parts of the tick's body, and disinfect the area with alcohol or a similar antiseptic after removal.
- For several days to several weeks after removal of the tick, look for the signs of the onset of Lyme disease, such as a rash that looks like a bulls-eye or an expanding red circle surrounding a light area, frequently seen with a small welt in the center.
- Also look for the signs of the onset of Rocky Mountain spotted fever, such as inflammation in the form of a rash comprising many red spots under the skin. Inflammation may occur three to 10 days after the tick bite.
- Report symptoms such as flu-like chills, fever, headache, dizziness, fatigue, stiff neck, and bone pain to the UXOSO promptly. These could be the result of tick-borne disease.

Contact with stinging insects like bees, hornets and wasps should be avoided to the extent feasible. The UXOSO will modify work rules as necessary to minimize contact, and implement the following procedures:

- If a worker knows that he is hypersensitive to bee, wasp or hornet stings, he must inform the UXOSO of this condition prior to participation in site activities.
- All site personnel will be watchful for the presence of stinging insects and their nests, and will advise the UXOSO if a nest or swarm is present in or near a work area.
- Any nests located will be treated with insecticide from a distance or marked for avoidance.
- Any employee who receives a sting will notify the UXOSO immediately, so that he can observe the affected employee for signs of allergic reaction.
- Site personnel with a known hypersensitivity to stinging insects will keep required emergency medication on or near their person at all times.

Spiders (including the black widow and brown recluse) and scorpions should be avoided through the same practices discussed above for avoidance of reptiles, ticks, and insects. Site personnel will report any suspected spider bite or scorpion sting to the UXOSO immediately. Also, they will report the location of any scorpions or possibly venomous spiders observed during the work.

Project personnel will avoid contact with domestic or feral dogs – or any potentially dangerous large animals. They should do nothing to encourage dogs or other large animals to approach the work area, and practice strict avoidance if any should come near. Any bite or close contact with such animals should be reported to the UXOSO immediately

9.14 CONTACT WITH CONTAMINATED SOIL OR WATER

Significant exposure to chemical contaminants in soil and water is unlikely. Limited potential for exposure to munitions constituents will exist when employees collect samples of soil or water, or otherwise come into contact with soil or water. The UXOSO will inform site workers of the risks discussed below, and implement the precautions described.

Inhalation of chemical vapors and contaminated dust could occur during excavation operations. Chemical vapors could be present above freshly exposed earth long after excavation tasks are complete. Personnel will attempt to remain upwind of excavation operations, fresh excavations, and piles of freshly exposed earth.

The UXOSO will implement procedures to minimize skin contact with potentially contaminated soil and water. Personnel collecting environmental samples will wear disposable nitrile gloves that will be changed every fifteen (15) minutes during collection activities.

Ingestion of contaminants could occur through hand-to-mouth contact that is easily avoided. The UXOSO will require proper hygienic practices to prevent ingestion of contaminants that might be present on the hands, clothing, or PPE.

The UXOSO will halt work immediately and confer with the ZAPATA manager of health and safety if evidence of grossly contaminated soil or water is noted. Such evidence could include unusual odors, unusually discolored soil or water, or the unexpected presence of chemical containers.

10.0 SITE CONTROL

10.1 WORK ZONE ACCESS CONTROL AND SECURITY

The UXOSO and other site mangers will control access to work areas, and enforce upon site visitors the restrictions found elsewhere in this document.

10.2 WORK ZONES

The exclusion zone around a potentially hazardous operation will be determined in each case by the UXOSO. The exclusion zone will be dictated by the distance necessary to avoid work hazards. If heavy equipment is used, then the "reach" of the bucket, plus a few extra feet, will determine the radius of the exclusion zone.

The support zone will include the office trailer, access roads, and adjacent areas so designated by the UXOSO. The UXOSO will implement procedures to prevent the transport of gross contamination from the exclusion zone into the support zone on boots, clothing, tools and heavy equipment. The need for rigorous decontamination procedures is not anticipated.

If necessary, the UXOSO will designate contamination-reduction zones where employees will remove gross contamination before entry into the support zone, or before movement of tools and equipment into the support zone.

10.3 SITE COMMUNICATIONS

Effective on-site and off-site communication will be established prior to initiation of site activities. On-site communication will be used to coordinate site operations, to maintain site control, to convey safety information, and to alert site personnel to emergency situations. Off-site communication will be available to ensure effective coordination with off-site management personnel, the US Army Corps of Engineers, and emergency response services.

All site personnel will be familiar with the different methods of both on-site and off-site communication. The methods that will be used for on- and off-site communication will include:

1. On-site communications will consist of cell phones or other supplied communication systems. Air horns, bullhorns, sirens, or hand signals can also be used, as needed, for communications.
2. Off-site communications will be accomplished by cell phones or other supplied communication systems. The UXOSO will verify that 911 service is available, and make appropriate alternative arrangements if it is not available.

11.0 PERSONNEL AND EQUIPMENT DECONTAMINATION

Rigorous decontamination procedures will not be necessary, because contact with chemical contaminants in soil and water is not anticipated. The UXOSO will enforce basic precautions to prevent unnecessary skin contact with soil and water. In addition, the UXOSO will require washing of hands upon completion of field work to prevent ingestion of contaminants through the hand-to-mouth exposure route.

12.0 SITE EMERGENCIES

The UXOSO will notify the corporate manager of health and safety, and the ZAPATA ENGINEERING project manager as soon as possible after any site emergency occurs.

12.1 EMERGENCY EQUIPMENT AND FIRST AID REQUIREMENTS

The emergency equipment listed in Table 12-1 will be on site, stored in the location indicated and available for use during the operation specified. Emergency equipment assigned to an area or team will be maintained in proper working order by the team, as directed by the team leader. The UXOSO will conduct an inspection of all emergency equipment at least weekly to ensure completeness and proper working order.

TABLE 12-1 EMERGENCY EQUIPMENT REQUIREMENTS

Emergency Equipment	No. Per Location	Area Where Item(s) Will Be Stored	Operation Requiring Specified Equipment
CPR Mask	1 ea.	Support Zone	All operations
Portable Eye Wash Kit	2 ea.	Each vehicle	All operations
15-Minute Eye Wash	1 ea.	Support Zone	All operations
Biohazard Kit	1 ea.	Support Zone	All operations
First Aid Kit	1 ea.	Each vehicle	All operations
Fire Extinguisher	1 ea.	Each vehicle, and Support Zone	All operations
Cellular Phone and air horn	1 ea.	SUXOS/UXOSO and Support Zone	All operations

The size and number of first aid kits will be sufficient to accommodate the maximum number of people (including government personnel and visitors) on site at any given time.

Portable bottles of eyewash will be readily available in each vehicle. Portable eyewash bottles will be available for immediate use while the injured person is transported to the area where the 15-minute eye flushing station will be available. After flushing, the eyes will be bandaged lightly, and the person will be transported to the appropriate medical facility for further evaluation and treatment, if needed.

Personnel administering first aid and/or CPR will comply with the following:

- Personnel will wear disposable latex gloves if there is any visible body fluid;
- The CPR Pocket Mask will be used when performing CPR and disposed of after;
- Personnel will immediately change clothing that becomes contaminated with body fluids as a result of performing first aid, or as soon as feasible; and
- Personnel will wash their hands immediately after performing first aid procedures.

12.2 Response to Severe Site Emergencies

The UXOSO will identify possible site emergencies that would require quick action. These will include the following scenarios:

- A severely injured or ill employee must be transported to a medical facility.
- Emergency medical services must be summoned to the site.

The UXOSO will make appropriate plans to deal with foreseeable emergencies and communicate this information to all site workers. These plans will include the following:

- Evacuation routes and assemble points,
- Means of alerting all site workers of various types of emergencies,
- Names and telephone numbers of providers of emergency services at the site,
- Names and locations of facilities at which emergency medical treatment could be provided.

A partial list of emergency telephone numbers is found in Table 12-2. The UXOSO will add names and numbers as appropriate. The map showing the route to the nearest hospital is found in Figure D-2.

Table 12-2 Emergency Telephone Numbers

Emergency Contact or Service Provider	Telephone
Spartanburg Regional Hospital	(864) 579-2016
Fire Department	911
Police Department	911
Mr. John Dyas Spartanburg County Sheriff's Department	(864) 596-2616
Jason Shiflet Project Manager, Zapata Incorporated	704-358-8240
George A. Dwiggins, Ph.D., CIH, CSP Manager of Health and Safety, Zapata Incorporated	704-358-8240
Spencer O'Neal Project Manager, USAESCH	256-895-1419
Shawn Boone Project Manager, USACE Charleston District	907-753-2689
CHEMTREC (Hazardous Chemical Information Hotline)	(800) 424-9300
Poison Control Center	(800) 222-1222

FIGURE D-2 HOSPITAL ROUTE

1. Starting in **CAMP CROFT, SC** on **PINEHURST RD** go toward **CEDARWOOD AVE**
2. Turn **LEFT** on **REDWOOD AVE**
3. Turn **RIGHT** on **E CROFT CIR**
4. Continue on **E CROFT CIRCLE DR**
5. Turn **LEFT** on **SOUTHPORT RD(SC-295)**
6. Bear **RIGHT** on **UNION ST**
7. Turn **RIGHT** on **FOREST AVE**
8. Turn **LEFT** on **S PINE ST(US-176)**
9. Turn **RIGHT** on **CRYSTAL DR**
10. Turn **RIGHT** on **CRYSTAL CT**
11. Turn **RIGHT** on **WOODBURN RD**
12. Turn **LEFT** on **EASTWOOD CIR**
13. Arrive at **SPARTANBURG REGIONAL MEDICAL CENTER, 101 EASTWOOD CIR, SPARTANBURG**

13.0 LOGS, REPORTS, AND RECORD KEEPING

13.1 SAFETY, TRAINING, AND VISITOR

The UXOSO will maintain a safety log to record all significant information related to workplace health and safety each day. The safety log should include: (1) a record of safety briefings; details of any accidents, injuries, illnesses, or near misses; details related to the conduct and outcome of internal and external audits; the reason for and duration of safety-related "stop work" orders; and any other issues pertaining to site or personnel safety or health.

The UXOSO will document all safety-related training sessions in a training log or on appropriate forms collected in a file or notebook and maintained on the site. This log will include the initial site-specific training conducted prior to the start of site activities, the safety briefings, hazard-specific training, etc.

The UXOSO will maintain a visitor log, which will be used to record the entry and exit of all visitors. No visitors will be allowed to enter the project site without providing the information required.

13.2 INJURY/ILLNESS/ACCIDENT REPORTS

Accident reporting is discussed in Section 7.0 of the APP.

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ATTACHMENT 2
SAMPLE FORMS

(FOR USE ON THE PROJECT SITE)

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SITE SAFETY OFFICER (SS0)
WET BULB GLOBE THERMOMETER (WBGT)
LOG

DATE	**TIME**	**DRY BULB TEMP**	**WBGT TEMP**	**RECOMMENDED WORK/REST REGIMEN (PER HOUR)** WORK REST
				/
				/
				/
				/
				/
				/
				/
				/
				/
				/

Permissible WBGT Heat Exposure Threshold Limit Values
Values are given in ºF

Work/Rest Regimen (each hour)	Work Load		
	LIGHT	MODERATE	HEAVY
Continuous Work	**85.1**	**81.5**	**78.8**
75% Work - 25% Rest	**86.9**	**83.3**	**81.5**
50% Work – 50% Rest	**88.7**	**85.1**	**83.3**
25% Work – 75% Rest	**90.5**	**87.8**	**86.0**

(For Safety Staff only)	REPORT NO.	EROC CODE	UNITED STATES ARMY CORPS OF ENGINEERS ACCIDENT INVESTIGATION REPORT (For Use of this Form See Help Menu and USACE Suppl to AR 385-40)	REQUIREMENT CONTROL SYMBOL: CEEC-S-8(R2)

1. ACCIDENT CLASSIFICATION

PERSONNEL CLASSIFICATION	INJURY/ILLNESS/FATAL	PROPERTY DAMAGE	MOTOR VEHICLE INVOLVED	DIVING
GOVERNMENT ☐ CIVILIAN ☐ MILITARY	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ CONTRACTOR	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ PUBLIC	☐ FATAL ☐ OTHER		☐	

2. PERSONAL DATA

a. Name (Last, First, MI)	b. AGE	c. SEX ☐ MALE ☐ FEMALE	d. SOCIAL SECURITY NUMBER	e. GRADE

f. JOB SERIES/TITLE	g. DUTY STATUS AT TIME OF ACCIDENT	h. EMPLOYMENT STATUS AT TIME OF ACCIDENT
	☐ ON DUTY ☐ TDY ☐ OFF DUTY	☐ ARMY ACTIVE ☐ ARMY RESERVE ☐ VOLUNTEER ☐ PERMANENT ☐ FOREIGN NATIONAL ☐ SEASONAL ☐ TEMPORARY ☐ STUDENT ☐ OTHER (Specify) ________

3. GENERAL INFORMATION

a. DATE OF ACCIDENT (month/day/year)	b. TIME OF ACCIDENT (Military time) hrs	c. EXACT LOCATION OF ACCIDENT	d. CONTRACTOR'S NAME (1) PRIME:
e. CONTRACT NUMBER ________ ☐ CIVIL WORKS ☐ MILITARY ☐ OTHER (Specify) ________	f. TYPE OF CONTRACT ☐ CONSTRUCTION ☐ SERVICE ☐ A/E ☐ DREDGE ☐ OTHER (Specify) ________	g. HAZARDOUS/TOXIC WASTE ACTIVITY ☐ SUPERFUND ☐ DERP ☐ IRP ☐ OTHER (Specify) ________	(2) SUBCONTRACTOR:

4. CONSTRUCTION ACTIVITIES ONLY (Fill in line and corresponding code number in box from list - see help menu)

a. CONSTRUCTION ACTIVITY	(CODE) #	b. TYPE OF CONSTRUCTION EQUIPMENT	(CODE) #

5. INJURY/ILLNESS INFORMATION (include name on line and corresponding code number in box for items e, f & g - see help menu)

a. SEVERITY OF ILLNESS/INJURY	(CODE) #	b. ESTIMATED DAYS LOST	c. ESTIMATED DAYS HOSPITALIZED	d. ESTIMATED DAYS RESTRICTED DUTY

e. BODY PART AFFECTED	(CODE)	g. TYPE AND SOURCE OF INJURY/ILLNESS	(CODE)
PRIMARY ________	#		
SECONDARY ________	(CODE) #	TYPE ________	#
f. NATURE OF ILLNESS/INJURY ________	(CODE) #	SOURCE ________	(CODE) #

6. PUBLIC FATALITY (Fill in line and correspondence code number in box - see help menu)

a. ACTIVITY AT TIME OF ACCIDENT	(CODE) #	b. PERSONAL FLOATATION DEVICE USED? ☐ YES ☐ NO ☐ N/A

7. MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE	b. TYPE OF COLLISION	c. SEAT BELTS	USED	NOT USED	NOT AVAILABLE
☐ PICKUP/VAN ☐ AUTOMOBILE	☐ SIDE SWIPE ☐ HEAD ON ☐ REAR END	(1) FRONT SEAT			
☐ TRUCK ☐ OTHER (Specify) ________	☐ BROADSIDE ☐ ROLL OVER ☐ BACKING ☐ OTHER (Specify) ________	(2) REAR SEAT			

8. PROPERTY/MATERIAL INVOLVED

a. NAME OF ITEM	b. OWNERSHIP	c. $ AMOUNT OF DAMAGE
(1)		
(2)		
(3)		

9. VESSEL/FLOATING PLANT ACCIDENT (Fill in line and correspondence code number in box from list - see help menu)

a. TYPE OF VESSEL/FLOATING PLANT	(CODE) #	b. TYPE OF COLLISION/MISHAP	(CODE) #

10. ACCIDENT DESCRIPTION (Use additional paper, if necessary)

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11. CAUSAL FACTOR(S) *(Read Instruction Before Completing)*

a. (Explain YES answers in item 13)	YES	NO	a. *(CONTINUED)*	YES	NO
DESIGN: Was design of facility, workplace or equipment a factor?	☐	☐	CHEMICAL AND PHYSICAL AGENT FACTORS: Did exposure to chemical agents, such as dust, fumes, mists, vapors or physical agents, such as, noise, radiation, etc., contribute to accident?	☐	☐
INSPECTION/MAINTENANCE: Were inspection & maintenance procedures a factor?	☐	☐	OFFICE FACTORS: Did office setting such as, lifting office furniture, carrying, stooping, etc., contribute to the accident?	☐	☐
PERSON'S PHYSICAL CONDITION: In your opinion, was the physical condition of the person a factor?	☐	☐	SUPPORT FACTORS: Were inappropriate tools/resources provided to properly perform the activity/task?	☐	☐
OPERATING PROCEDURES: Were operating procedures a factor?	☐	☐	PERSONAL PROTECTIVE EQUIPMENT: Did the improper selection, use or maintenance of personal protective equipment contribute to the accident?	☐	☐
JOB PRACTICES: Were any job safety/health practices not followed when the accident occurred?	☐	☐	DRUGS/ALCOHOL: In your opinion, was drugs or alcohol a factor to the accident	☐	☐
HUMAN FACTORS: Did any human factors such as, size or strength of person, etc., contribute to accident?	☐	☐	b. WAS A WRITTEN JOB/ACTIVITY HAZARD ANALYSIS COMPLETED FOR TASK BEING PERFORMED AT TIME OF ACCIDENT?		
ENVIRONMENTAL FACTORS: Did heat, cold, dust, sun, glare, etc., contribute to the accident?	☐	☐	☐ YES *(If yes, attach a copy.)* ☐ NO		

12. TRAINING

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?	b. TYPE OF TRAINING.	c. DATE OF MOST RECENT FORMAL TRAINING.
☐ YES ☐ NO	☐ CLASSROOM ☐ ON JOB	(Month) (Day) (Year)

13. FULLY EXPLAIN WHAT ALLOWED OR CAUSED THE ACCIDENT; INCLUDE DIRECT AND INDIRECT CAUSES *(See instruction for definition of direct and indirect causes.) (Use additional paper, if necessary)*

a. DIRECT CAUSE

b. INDIRECT CAUSE(S)

14. ACTION(S) TAKEN, ANTICIPATED OR RECOMMENDED TO ELIMINATE CAUSE(S).

DESCRIBE FULLY:

15. DATES FOR ACTIONS IDENTIFIED IN BLOCK 14.

a. BEGINNING (Month/Day/Year)		b. ANTICIPATED COMPLETION (Month/Day/Year)	
c. SIGNATURE AND TITLE OF SUPERVISOR COMPLETING REPORT CORPS ____________ CONTRACTOR ____________	d. DATE *(Mo/Da/Yr)*	e. ORGANIZATION IDENTIFIER *(Div, Br, Sect)*	f. OFFICE SYMBOL

16. MANAGEMENT REVIEW *(1st)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

17. MANAGEMENT REVIEW *(2nd - Chief Operations, Construction, Engineering, etc.)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

18. SAFETY AND OCCUPATIONAL HEALTH OFFICE REVIEW

a. ☐ CONCUR b. ☐ NON CONCUR c. ADDITIONAL ACTIONS/COMMENTS

SIGNATURE	TITLE	DATE

19. COMMAND APPROVAL

COMMENTS

COMMANDER SIGNATURE	DATE

Page 2 of 4 pages

*U.S. GOVERNMENT PRINTING OFFICE: 1993-0-791-757

SITE VISITORS LOG

CONTRACT NO: W912DY-10-D-0028
PROJECT NO:
LOCATION: Former Camp Croft, SC

DATE	NAME	TITLE	COMPANY	SAFETY BRIEF: Y/N	US CITIZEN Y/N	TIME		REMARKS
						IN	OUT	

ZAPATA INCORPORATED VEHICLE CHECK SHEET

SITE:			**CONTRACT: W912DY-10-D-0028**	
TEAM#:			**TEAM LEADER:**	
DATE	**UNDER HOOD***	**WALK AROUND**	**SAFETY EQUIP***	**REMARKS**

Indicate the condition of each check by stating SAT or UNSAT whichever is appropriate.

**Under the hood checks will include:*
Fluid Levels
Belts
Hoses
Checks for leaks

** Safety equipment checks will include:*
Windshield wipers
Fire Extinguishers
First Aid Kits
Vehicle horn and Lights
Tires

Zapata Incorporated

Safety Inspection Log

Date: __________ Time: __________ Contract Number: W912DY-10-D-0028

Task Order: **0005** Location: Former Camp Croft

Weather Conditions: ______________________________

Type of Inspection: Daily:_____ Weekly _____ Special: _____ Reinspection ______

Location inspected: ______________________________

Activity inspected: ______________________________

II. Inspection Requirement	Satisfactory	Unsatisfactory	N/A
Surface Sweep			
Subsurface Sweep			
Excavation Technique			
Personal Protection Equipment			
Work Practices			
Site Control			
First Aid Equipment			
Fire Fighting Equipment			
Explosive Transportation			
Explosive Storage			
Disposal Operations			
Overall Inspection Results			

III. Comments:

- ❖ Worked stopped due to safety violations: Yes ____________ No _______________
- ❖ Personnel Involved: ______________________________
- ❖ Corrective Measures: ______________________________
- ❖ Reinspection required : Yes ____________ No _______________

IV. Signatures: I acknowlege that I have been briefed on the results of this inspection and will take corrective actions (If required)

Site Safety Officer

Sr. UXO Supervisor/Project Manager

Zapata Incorporated		**Safety Meeting Attendance Log**	
Date:	Time:	Contract Number: W912DY-10-D-0028	
Task Order Number: 0005		*Location:*	
Weather Conditions:			
I. Safety Meeting Topic(s):			
II. Attendees:			
Name	Signature	Company	Tick(s)
III. Verification: I certify that the personnel listed on this roster received the briefing described above. Site personnel not present for this meeting will be briefed prior to the beginning of their duties.			
Site Safety Officer:		Date:	

VEHICLE ACCIDENT REPORT

Vehicle

Driver ________________________ Accident Date _______________ Driver's License/State _______________

Address ____

City ____________________ State ___________ Zip _____________ Phone ____________________________

Vehicle # ______________________ Year _______ Make ___________ Model _________ Plate # ____________

State ____________ Vehicle Owner: ( ) GSA ( ) Leased/Rent ( ) Private Vehicle

Vehicle Damage ____ Est. Repair Cost $_________________

Other Vehicles

Driver ________________________ Driver's License __________________________ State _______________

Address ____

City _______________________________ State __________________ Zip __________________

Phone ______________________________ SSN ___________________

Owner's Name (Check if same as driver { }) ____

Address ____________________________ City ________________________ State ______ Zip ____________

Insurance Company ____________________________________ Policy # ______________________________

Vehicle: Year ___________ Make _____________ Model _____________ Plate # _____________ State ______

Vehicle Damage ____

Passenger(s) ( ) Yes ( ) No (List on back) Injuries ( ) Yes ( ) No (List names and address on back)

Accident Description

Date ________________ Time _____________

Location ____

Description ____

____

____

____

____

Witness ___________________________ Address ____

Phone # ___________________________

Police Officer's Name ____ Dept. __________________________

Employee __________________________________ __________________________ ____________
(Print Name) (Signature) (Date)

SUXOS __________________________________ __________________________ ____________
(Print Name) (Signature) (Date)

General Liability, Property Damage, and Loss Report

PROJECT LOCATION ____________________ TASK ORDER #____________ DATE ____________

HOW DID THE DAMAGE OR LOSS OCCUR: ____

____

DESCRIPTION OF DAMAGE OR LOSS: ____

____

IDENTIFICATION OF DAMAGED OR LOST PROPERTY: ________________________________

____

LOCATION OF DAMAGED OR LOST PROPERTY (BEFORE LOSS): __________________________

____

DATE AND TIME OF DAMAGED OR LOST PROPERTY: ________________________________

OWNER OF DAMAGED OR LOST PROPERTY:

NAME ______________________________ PHONE # ____________________________

ADDRESS ____________________________ CITY/STATE __________________________

EMPLOYER NAME & ADDRESS ____

INJURED PARTIES (ALSO COMPLETE A SUPERVISOR EMPLOYEE INJURY REPORT)

1. NAME ______________________________ PHONE # ______________________
   ADDRESS ______________________________ CITY/STATE ____________________
   EMPLOYER NAME & ADDRESS ____
2. NAME ______________________________ PHONE # ______________________
   ADDRESS ______________________________ CITY/STATE ____________________
   EMPLOYER NAME & ADDRESS ____

WITNESSES:

1. NAME ______________________________ PHONE # ______________________
   ADDRESS ______________________________ CITY/STATE ____________________
   EMPLOYER NAME & ADDRESS ____
2. NAME ______________________________ PHONE # ______________________
   ADDRESS ______________________________ CITY/STATE ____________________
   EMPLOYER NAME & ADDRESS ____

WERE PICTURES TAKEN? ( ) YES ( ) NO

WERE POLICE NOTIFIED? ( ) YES ( ) NO DEPT. ______________________________

EMPLOYEE ____________________ ____________________ ____________
(PRINT NAME) (SIGNATURE) (DATE)

SUXOS ____________________ ____________________ ____________
(PRINT NAME) (SIGNATURE) (DATE)

SUPERVISOR'S EMPLOYEE INJURY REPORT

This is an official document to be initiated by the employee's supervisor. Please answer all questions completely. This report must be forwarded to the Safety Manager's office within 24 hours of the injury.

Injured Name ________________________________ Sex___ SSN _________________________ DOB___________

Home Address _______________________________ City __________________State _________Zip __________

Phone ______________________ Job Title ____

SUPERVISOR

Date of Incident _____________ Time __________ Time Reported _________ To Whom? ___________________

Project ___________________________ Project Address ____

Exact Location of Incident __________________________ Did employee leave work? ______ When? ___________

Has employee returned to work ( ) Yes ( ) No When? _________________________

Doctor/Hospital name _____________________________ Address ____

Witness name(s) ____ Statement attached? ( ) Yes ( ) No

Nature of injury ____ Exact body part ________________________

Medical attention: ( ) None ( ) First Aid on-site ( ) Doctor's office ( ) Hospital

Job assignment at time of incident ____

Describe incident ____

____

What corrective action has been taken to prevent recurrence? ____

____

Supervisor _____________________________ _____________________________________ _____________

(Print) (Signature) (Date)

Senior UXO Supervisor

Comments on incident and corrective action

____

____

____

SUXOS _________________________ ___________________________________ _____________________

(Print) (Signature) (Date)

Safety Manager

Concur with action taken? ( ) Yes ( ) No Remarks ____

____

____

OSHA Classification:

( ) Incident Only ( ) First Aid ( ) No lost workdays ( ) Lost Workdays ( ) Fatal

Days away from work _________________ Days restricted work ___________________ Total days charged _____

Coding: A. Injury type or illness ______ B. Injured body part ______ C. Activity at time of accident ___________

D. Injury cause code ______ E. Safety rule violated code ______ F. Accident prevention code _________

Name ___________________________ _______________________________________ ________________

(Print) (Signature) (Date)

MUST BE COMPLETED WITHIN 72 HOURS

ACCIDENT/INJURY INVESTIGATION

Date _______________ Project ______________________________ Date of Accident/Injury _________________

Employee Name ____

Supervisor Name ____

Project Number/Location ____

Description (Provide facts, describe how incident occurred, provide diagram or photos)

Analysis 1 (What unsafe acts or conditions contributed to the incident?)

Analysis 2 (What systematic or management deficiencies contributed to the incident)

Corrective Action(s) (List corrective actions, responsible person, scheduled completion date)

Witnesses (Attach statements or indicate why not available)

Investigated by ____________________________ ______________________________ ________________

(Print Name) (Signature) (Date)

SUXOS __________________________________ ______________________________ ________________

(Print Name) (Signature) (Date)

ATTACHMENT 3
ACTIVITY HAZARD ANALYSES FOR PHASES OF WORK

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ACTIVITY HAZARDS ANALYSIS

Overall Risk Assessment Code (RAC) (Use highest code): M

Date: 9 September 2011

Project: W912DY-10-D-0028 / 0005

Activity: Mobilization and Site Preparation

Activity Location: Former Camp Croft, South Carolina

Prepared By: George A. Dwiggins, Ph.D., CIH, CSP

Risk Assessment Code Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Add Identified Hazards

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Establish field office. Unload and store instruments, equipment and supplies. Transport necessary instruments, equipment and supplies to work sites. Vehicle operation.	Slips, trips, and falls; lacerations from sharp objects; pinched or crushed fingers, feet, and toes; eye injury from flying projectiles or impacts with tree limbs, head injury from impacts; sunburn.	Basic PPE will consist of a hardhat (around mechanical equipment), safety glasses with side shields or comparable side protection, steel-toe work boots or boots offering comparable protection of the toes, leather work gloves; and a basic work outfit offering some protection against abrasion and sunlight. The UXOSO will require good housekeeping practices.	M
X		Musculo-skeletal injury from heavy lifting or strenuous exertions.	The UXOSO will require proper lifting techniques and enforce a 40 pound limit on any unassisted lift. The UXOSO will remind employees frequently that magnetometer use can cause repetitive trauma, and require frequent breaks.	M
X		Heat stress / Cold stress.	The UXOSO will monitor conditions and implement controls in ZAPATA Procedures HS-M-12 and HS-M-13, as appropriate. (The UXOSO will keep a copy of HS-M-12 and HS-M-13 on the site.)	M
X		Biological hazards (including poisonous plants and animals)	The UXOSO will require avoidance of wild animals and – to the extent feasible – avoidance of poisonous plants, insects, spiders, etc.. He will maintain a supply of insect repellant and encourage its use.	M
X		Munitions hazards	The UXOSO will permit only authorized project personnel to enter the work area. No disturbance of ordnance items is anticipated during this activity.	M

ACTIVITY HAZARDS ANALYSIS

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Establish field office. Unload and store instruments, equipment and supplies. Transport necessary instruments, equipment and supplies to work sites. Vehicle operation.	Inclement weather	The UXOSO will remain aware of weather forecasts and plan for inclement weather during project work. If inclement weather appears imminent, the safety officer will direct site workers to halt work and to take refuge in vehicles or nearby buildings.	M
X		Noise	The UXOSO will require the use of earplugs whenever employees work around noisy operations.	M
X		Vehicle accidents	The UXOSO will confirm that only drivers qualified under the ZAPATA fleet safety program are permitted to drive vehicles. The UXOSO will enforce appropriate vehicle safety rules, including a reasonable speed limit, if one is not imposed by site authorities.	M
X		Unauthorized site visitors	The UXOSO will enforce an exclusion zone sufficient to prevent entry of unauthorized personnel into a potentially dangerous area.	M

Add Items

	EQUIPMENT	TRAINING	INSPECTION
X	Various vehicles Shovels and other implements Powered hand tools	All site workers will be briefed on the requirements of the site safety plan, including emergency plans. At least two site workers present at all times must have current first aid and CPR certifications. The UXOSO will conduct a daily safety briefing. The UXOSO will confirm that workers who drive vehicles for ZAPATA business are on the list of qualified drivers.	Daily check for adequacy of site communication. Daily inspection of fire extinguishers and first aid kits. Daily activity inspections by UXOSO. Daily vehicle inspections, in accordance with the ZAPATA fleet-safety program. Inspect all hand tools prior to use and repair or replace damaged tools.

Involved Personnel:

SUXOS, UXOSO, and additional ZAPATA employees.

Acceptance Authority (digital signature): ____________________

ACTIVITY HAZARDS ANALYSIS

Overall Risk Assessment Code (RAC) (Use highest code): M

Date: 9 September 2011

Project: W912DY-10-D-0028 / 0005

Activity: Brush Clearing

Activity Location: Former Camp Croft, South Carolina

Prepared By: George A. Dwiggins, Ph.D., CIH, CSP

Risk Assessment Code Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Add Identified Hazards

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Clear brush by means of hand tools and/or mechanical equipment.	Slips, trips, and falls; lacerations from sharp objects; pinched or crushed fingers, feet, and toes; eye injury from flying projectiles or impacts with tree limbs, head injury from impacts; sunburn.	Basic PPE will consist of a hardhat (around mechanical equipment), safety glasses with side shields or comparable side protection, steel-toe work boots or boots offering comparable protection of the toes, leather work gloves; and a basic work outfit offering some protection against abrasion and sunlight. The UXOSO may require chaps in addition. The UXOSO will require good housekeeping practices.	M
X		Musculo-skeletal injury from heavy lifting or strenuous exertions.	The UXOSO will require proper lifting techniques and enforce a 40 pound limit on any unassisted lift. The UXOSO will remind employees frequently that magnetometer use can cause repetitive trauma, and require frequent breaks.	M
X		Heat stress / Cold stress.	The UXOSO will monitor conditions and implement controls in ZAPATA Procedures HS-M-12 and HS-M-13, as appropriate. (The UXOSO will keep a copy of HS-M-12 and HS-M-13 on the site.)	M
X		Biological hazards (including poisonous plants and animals)	The UXOSO will require avoidance of wild animals and – to the extent feasible – avoidance of poisonous plants, insects, spiders, etc.. He will maintain a supply of insect repellant and encourage its use.	M
X		Munitions hazards	The UXOSO will permit only authorized project personnel to enter the work area. No disturbance of ordnance items is anticipated during this activity.	M

ACTIVITY HAZARDS ANALYSIS

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Clear brush by means of hand tools and/or mechanical equipment.	Inclement weather	The UXOSO will remain aware of weather forecasts and plan for inclement weather during project work. If inclement weather appears imminent, the safety officer will direct site workers to halt work and to take refuge in vehicles or nearby buildings.	M
X		Noise	The UXOSO will require the use of earplugs whenever employees work around noisy operations.	M
X		Vehicle accidents	The UXOSO will confirm that only drivers qualified under the ZAPATA fleet safety program are permitted to drive vehicles. The UXOSO will enforce appropriate vehicle safety rules, including a reasonable speed limit, if one is not imposed by site authorities.	M
X		Unauthorized site visitors	The UXOSO will enforce an exclusion zone sufficient to prevent entry of unauthorized personnel into a potentially dangerous area.	M
X		Flying debris produced by mechanical brush-clearing equipment.	The UXOSO will enforce exclusion zones around brush-clearing equipment during its operation; so that no employee enters a location into which rocks, pieces of wood, or other debris could be thrown.	M

Add Items

	EQUIPMENT	TRAINING	INSPECTION
X	Various vehicles Shovels and other implements Hand tools and/or mechanical equipment for brush clearing	All site workers will be briefed on the requirements of the site safety plan, including emergency plans. At least two site workers present at all times must have current first aid and CPR certifications. The UXOSO will conduct a daily safety briefing. The UXOSO will confirm that workers who drive vehicles for ZAPATA business are on the list of qualified drivers. The UXOSO will confirm that operators of brush-clearing equipment are qualified to perform assigned tasks safely.	Daily check for adequacy of site communication. Daily inspection of fire extinguishers and first aid kits. Daily activity inspections by UXOSO. Daily vehicle inspections, in accordance with the ZAPATA fleet-safety program. Inspect all hand tools prior to use and repair or replace damaged tools. Daily inspection of brush-clearing equipment.

Involved Personnel:

SUXOS, UXOSO, and additional ZAPATA employees.

Acceptance Authority (digital signature): ____________________

NWW Form 385-1 (Revised) April 2008

ACTIVITY HAZARDS ANALYSIS

Overall Risk Assessment Code (RAC) (Use highest code): M

Date: 9 September 2011

Project: W912DY-10-D-0028 / 0005

Activity: Anomaly Investigation and Collection of Soil Samples

Activity Location: Former Camp Croft, South Carolina

Prepared By: George A. Dwiggins, Ph.D., CIH, CSP

Risk Assessment Code Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Add Identified Hazards

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Establishment of grids. Identification of anomalies. Collection of environmental samples.	Slips, trips, and falls; lacerations from sharp objects; pinched or crushed fingers, feet, and toes; eye injury from flying projectiles or impacts with tree limbs, head injury from impacts; sunburn.	Basic PPE will consist of a hardhat (around mechanical equipment), safety glasses with side shields or comparable side protection, work boots, leather work gloves; and a basic work outfit offering some protection against abrasion and sunlight. The UXOSO will require good housekeeping practices.	M
X		Musculo-skeletal injury from heavy lifting or strenuous exertions.	The UXOSO will require proper lifting techniques and enforce a 40 pound limit on any unassisted lift. The UXOSO will remind employees frequently that magnetometer use can cause repetitive trauma, and require frequent breaks.	M
X		Heat stress / Cold stress.	The UXOSO will monitor conditions and implement controls in ZAPATA Procedures HS-M-12 and HS-M-13, as appropriate. (The UXOSO will keep a copy of HS-M-12 and HS-M-13 on the site.)	M
X		Biological hazards (including poisonous plants and animals)	The UXOSO will require avoidance of wild animals and – to the extent feasible – avoidance of poisonous plants, insects, spiders, etc.. He will maintain a supply of insect repellant and encourage its use.	M
X		Electrical shock	The UXOSO will ensure that overhead utility lines are not present in the work area, and that diligent efforts have been made to locate and mark underground utility lines and pipes.	M

ACTIVITY HAZARDS ANALYSIS

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Establishment of grids. Identification of anomalies. Collection of environmental samples.	Inclement weather	The UXOSO will remain aware of weather forecasts and plan for inclement weather during project work. If inclement weather appears imminent, the safety officer will direct site workers to halt work and to take refuge in vehicles or nearby buildings.	M
X		Noise	The UXOSO will require the use of earplugs whenever employees work around noisy operations.	M
X		Vehicle accidents	The UXOSO will confirm that only drivers qualified under the ZAPATA fleet safety program are permitted to drive vehicles. The UXOSO will enforce appropriate vehicle safety rules, including a reasonable speed limit, if one is not imposed by site authorities.	M
X		Unauthorized site visitors	The UXOSO will enforce an exclusion zone sufficient to prevent entry of unauthorized personnel into a potentially dangerous area.	M
X		Munitions hazards	The UXOSO will permit only properly trained UXO technicians to enter the work area. He will require adherence to stringent procedures to avoid unplanned detonation of ordnance. The UXOSO will enforce an exclusion zone sufficient to prevent entry of unauthorized personnel into a potentially dangerous area. The UXOSO will limit the number of personnel within the exclusion zone to the minimum necessary to accomplish the work.	M
X		Excavations	The UXOSO will forbid entry into excavations deeper than four feet, and implement necessary rules to prevent collapse of trench sides. Excavations will be back-filled as soon as possible, before the end of the shift. (No work requiring excavation is anticipated.)	M
X		Chemical munitions, or other unanticipated site hazards	The UXOSO will order the immediate withdrawal or all site personnel upon the discovery of chemical munitions or other unanticipated site hazards. The UXOSO will contact the ZAPATA manager of health and safety as soon as possible if unanticipated site hazards are encountered.	M
X		Skin contact with contaminated soil, water, and sediment. Ingestion of contaminants.	Sampling personnel will wear disposable nitrile gloves that will be changed every fifteen (15) minutes during collection activities. The SSHO will require proper hygienic practices to prevent ingestion of contaminants that might be present on the hands, clothing, or PPE.	

ACTIVITY HAZARDS ANALYSIS

Add Items

	EQUIPMENT	TRAINING	INSPECTION
X	Activity Hazard Analysis for Anomaly Investigation. Page 3 of 3. Magnetometers Various vehicles Shovels and other implements	All site workers will be briefed on the requirements of the site safety plan, including emergency plans. At least two site workers present at all times must have current first aid and CPR certifications. The UXOSO will conduct a daily safety briefing. The UXOSO will confirm that workers who drive vehicles for ZAPATA business are on the list of qualified drivers.	Daily check for adequacy of site communication. Daily inspection of fire extinguishers and first aid kits. Daily activity inspections by UXOSO. Daily vehicle inspections, in accordance with the ZAPATA fleet-safety program. Inspect all hand tools prior to use and repair or replace damaged tools. Daily magnetometer inspections and calibration prior to use.

Involved Personnel:

SUXOS, UXOSO, and additional ZAPATA employees.

Acceptance Authority (digital signature): ______________________

ACTIVITY HAZARDS ANALYSIS

Overall Risk Assessment Code (RAC) (Use highest code): M

Date: 9 September 2011

Project: W912DY-10-D-0028 / 0005

Activity: Demobilization

Activity Location: Former Camp Croft, South Carolina

Prepared By: George A. Dwiggins, Ph.D., CIH, CSP

Risk Assessment Code Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Add Identified Hazards

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Removal and transport of equipment, supplies and instruments from the site	Slips, trips, and falls; lacerations from sharp objects; pinched or crushed fingers, feet, and toes; eye injury from flying projectiles or impacts with tree limbs, head injury from impacts; sunburn.	Basic PPE will consist of a hardhat (around mechanical equipment), safety glasses with side shields or comparable side protection, steel-toe work boots or boots offering comparable protection of the toes, leather work gloves; and a basic work outfit offering some protection against abrasion and sunlight. The UXOSO will require good housekeeping practices.	M
X		Musculo-skeletal injury from heavy lifting or strenuous exertions.	The UXOSO will require proper lifting techniques and enforce a 40 pound limit on any unassisted lift.	M
X		Heat stress / Cold stress.	The UXOSO will monitor conditions and implement controls in ZAPATA Procedures HS-M-12 and HS-M-13, as appropriate. (The UXOSO will keep a copy of HS-M-12 and HS-M-13 on the site.)	M
X		Biological hazards (including poisonous plants and animals)	The UXOSO will require avoidance of wild animals and – to the extent feasible – avoidance of poisonous plants, insects, spiders, etc.. He will maintain a supply of insect repellant and encourage its use.	M
X		Inclement weather	The UXOSO will remain aware of weather forecasts and plan for inclement weather during project work. If inclement weather appears imminent, the safety officer will direct site workers to halt work and to take refuge in vehicles or nearby buildings.	M
X		Noise	The UXOSO will require the use of earplugs whenever employees work around noisy operations.	M

ACTIVITY HAZARDS ANALYSIS

	JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
X	Removal and transport of equipment, supplies and instruments from the site	Vehicle accidents	The UXOSO will confirm that only drivers qualified under the ZAPATA fleet safety program are permitted to drive vehicles. The UXOSO will enforce appropriate vehicle safety rules, including a reasonable speed limit, if one is not imposed by site authorities.	M
X		Unauthorized site visitors	The UXOSO will enforce an exclusion zone sufficient to prevent entry of unauthorized personnel into a potentially dangerous area.	M

Add Items

	EQUIPMENT	TRAINING	INSPECTION
X	Various vehicles	All site workers will be briefed on the requirements of the site safety plan, including emergency plans. At least two site workers present at all times must have current first aid and CPR certifications. The UXOSO will conduct a daily safety briefing. The UXOSO will confirm that workers who drive vehicles for ZAPATA business are on the list of qualified drivers.	Daily check for adequacy of site communication. Daily inspection of fire extinguishers and first aid kits. Daily activity inspections by UXOSO. Daily vehicle inspections, in accordance with the ZAPATA fleet-safety program. Inspect all hand tools prior to use and repair or replace damaged tools.

Involved Personnel:

SUXOS, UXOSO, and additional ZAPATA employees.

Acceptance Authority (digital signature): ______________________

ATTACHMENT 4
HEAT STRESS: ENVIRONMENTAL ASSESSMENT AND MANAGEMENT OF EXPOSURE

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WORKPLACE HEALTH AND SAFETY PROGRAM

PROCEDURE HS-M-12

HEAT STRESS: ENVIRONMENTAL ASSESSMENT AND MANAGEMENT OF EXPOSURE

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Appendix: Background Material on Heat-related Illnesses

1.0 INTRODUCTION

Work in hot, humid environments can cause heat to accumulate in the body faster than it can be dissipated. This accumulation of heat can produce serious illnesses, which range from mild to fatal. The heat-related illnesses, which are described in the appendix, include heat rash, heat cramps, heat exhaustion, and heat stroke. The first three conditions normally do not have extremely serious consequences – unless an exhausted employee falls and suffers injury. Heat stroke, however, can cause death or permanent injury to the brain. For this reason, heat stroke should be treated as a medical emergency, and all heat-related illnesses should be prevented through application of the precautions discussed in this procedure. If situations are encountered that are not addressed in this document, the project manager or site safety officer should contact the corporate Safety Department to discuss appropriate protective measures.

2.0 ASSESSMENT OF THE POTENTIAL FOR HEAT-RELATED ILLNESS

A person's body becomes warmer when heat is added faster than it is dissipated. Many factors affect the rate of heat addition and the rate of heat loss. Increased heat accumulation occurs when a person works more strenuously or exposes himself to a source of radiant heat (e.g., the sun or an industrial boiler). Loss of heat from the body is hindered by high humidity, low air movement, and high temperature of air and surrounding objects. Heavy clothing or additional protective equipment, which might be required on a project site, also can reduce the loss of heat and thus increase heat accumulation.

2.1 ENVIRONMENTAL DETERMINANTS

The environmental determinants of the potential for heat stress are the temperature and humidity of the air, the amount of air movement, and radiant heat from the sun or nearby hot objects. These parameters can be measured easily and combined to calculate the "wet bulb globe temperature index" (WBGT), a useful single-number indicator of the environmental contribution to heat stress exposure. (See HS-T-4.) **When workers are exposed to direct sunlight**, that index is defined in the following way:

$$WBGT = 0.7 \times T_{nwb} + 0.2 \times T_g + 0.1 \times T_{db}$$

Where: WBGT is the Wet Bulb Globe Temperature Index,
T_g is the globe temperature (influenced by air temperature and radiant heat flux),
T_{db} is the dry bulb temperature (influenced by air temperature), and
T_{nwb} is the natural wet bulb temperature (influenced by air temperature, air humidity, and air movement).

When workers are not exposed to direct sunlight, the index is calculated in the following way:

$$WBGT = 0.7 \times T_{nwb} + 0.3 \times T_g$$

A higher value of WBGT indicates a greater potential for heat stress. Both higher air temperature and higher radiant heat increase the value of the WBGT index. Higher air movement and lower air humidity decrease the WBGT value by enhancing evaporative cooling – and lowering the T_{nwb} measurement. (Of course, higher air movement would not lower T_{nwb} if the relative humidity were 100%.)

An alternative to the WBGT index is "adjusted temperature," which is easier to estimate, but much less informative. It is obtained through the following simple calculation:

Adjusted Temperature = [actual air temperature + (13 x {sunshine fraction})].

The actual air temperature is measured by means of a standard mercury thermometer with the bulb shielded from direct sunlight. "Sunshine fraction" is obtained through an estimate of the percent of the time that the sun is not covered by clouds thick enough to produce a shadow (100% sunshine = no cloud cover and sharp distinct shadows, and 0% sunshine = no shadows).

Note that "sunshine fraction" = (percent sunlight) / 100. Relative humidity and wind speed are not included in this much cruder determination of the potential for heat related illness.

2.2 THE CONTRIBUTION OF METABOLIC HEAT

Work generates body heat, which must be dissipated into the environment. More strenuous work generates more heat. At a given WBGT value (*e.g.*, 85 °F), it could be safe to perform continuous light work for hours – but very dangerous to perform heavy work without frequent breaks and other precautions. Any assessment of the potential for heat-related illness requires consideration of the work load. The following classification system may be used:

Work Load	**Examples**
Light	Sitting with moderate arm and leg movements. Standing with light work requiring mostly arm movement. Standing with light work at a machine with some walking about.
Moderate	Scrubbing in a standing position. Walking about with moderate lifting or pushing. Walking on level ground at 6 km/hr while carrying a 3 kg load.
Heavy	Shoveling dry sand. Intermittent heavy lifting with pushing or pulling (*e.g.*, pick and shovel work).
Very Heavy	Shoveling wet sand.

Many jobs involve several task elements, some of which are more or less strenuous than others. It is appropriate in such cases to estimate an average work load over a 15 - 60 minute period. For example, the "moderate" category might be appropriate for a job that required walking and light carrying, with occasional digging with a shovel and moving of heavy objects.

2.3 THE CONTRIBUTIONS OF OTHER FACTORS

Work load and environmental factors are not the only determinants of the potential for heat-related illness. Heavy or impermeable protective clothing can increase the risk greatly, even if the work is not strenuous and the temperature is not high. Also, workers who are not acclimatized to hot work environments are much more likely to experience the harmful effects of heat stress. Many other health and "lifestyle" variables are important as well. These are discussed in the sections that follow, and in the appendix.

3.0 THRESHOLDS OF CONCERN

The risk of heat-related illness among healthy workers who are acclimatized to hot work is low if the WBGT value does not exceed the ACGIH “screening criteria” shown below:

ACGIH Screening Criteria for Heat Stress Exposure (WBGT Values in Degrees Fahrenheit)				
Hourly Work Requirement	**Physical Demand of the Work Task**			
	Light	**Moderate**	**Heavy**	**Very Heavy**
100% Work*	85.1 °F	81.5 °F	78.8 °F	-
75% Work 25% Rest	86.9 °F	83.3 °F	81.5 °F	-
50% Work 50% Rest	88.7 °F	85.1 °F	83.3 °F	81.5 °F
25% Work 75% Rest	90.5 °F	87.8 °F	86.0 °F	85.1 °F
* The schedule includes normal lunch and rest breaks.				

Under these criteria, workers could perform moderately strenuous work, with only the usual rest and lunch breaks, if the WBGT value were 81.5 °F or lower. At a WBGT value of 85 °F, light work could be performed without added breaks, but moderate work could be performed for only thirty minutes out of each hour.

These values should be reduced by several °F if workers are not acclimatized to hot work. Even greater reduction is necessary if workers must wear clothing other than a summer work uniform or its equivalent. The corporate Safety Department should be consulted for guidance in these situations, and the project safety plan should be modified accordingly.

If the adjusted temperature is below about 72.5 °F, then the risk of heat-related illness may be considered low if employees are wearing normal work clothing and working at a low or moderate level or exertion.

4.0 PREVENTION OF HEAT-RELATED ILLNESS

The project manager or site safety and health officer (SSHO) should first determine whether the appropriate threshold of concern is, or likely will be, exceeded. This should be done through consultation with the corporate Safety Department and/or by making actual measurements during project work. The assessment must consider the acclimatization status of workers and the permeability of their work clothing. If the air temperature exceeds – or likely will exceed – 70 ºF, then the potential for heat-related illness should be assessed.

If the selected threshold of concern is exceeded, then the SSHO will implement the program described below. Some elements of the program – those involving training and observation – should be implemented in borderline situations as well, because some individuals could be unusually susceptible to heat-related illness.

4.1 GENERALLY APPLICABLE PRECAUTIONS

The SSHO will implement a program to prevent heat-related illness among employees. The program will include the following elements:

- Education of employees on the dangers of heat-related illnesses, the risk factors that make these illnesses more likely, and the means of preventing them (including the frequent consumption of water, good nutrition, physical fitness, and avoidance of alcohol and drugs).

- Observation throughout the shift of other factors that could affect the potential for heat-related illnesses, including intense solar radiation, high humidity, still air, unusually strenuous work tasks, etc.

- Observation of employees throughout the shift to detect signs of heat-related illness (see appendix) and to identify individuals who might be unacclimatized or otherwise unfit for work in a stressful environment. Older or obese workers, and those with certain medical conditions, could be at increased risk.

The SSHO will give special consideration to unacclimatized workers who are newly assigned to the project (and to those who are returning from an extended absence). Such workers should be allowed to acclimatize over a period of several days, during which time their exposure to stressful conditions should be increased gradually. They should be observed carefully during the acclimatization period; so that any early symptoms of heat stress can be detected. The corporate Safety Department should be consulted for assistance, if necessary.

In addition, the SSHO will make recommendations on the scheduling of tasks to reduce employees' exposure to stressful environments. For example, he or she might propose one or more of the following modifications to the schedule:

- Work in shaded zones should be scheduled for periods when solar radiation is more intense.

- Heavy and moderate work (and perhaps all work) should be cancelled during the hottest part of the day, and performed earlier or later.

- Work in direct sunlight should be performed only when humidity is low and air movement is noticeable (producing a lower natural wet bulb temperature reading).

- Personnel should be rotated to alternate job functions to reduce time spent by any one worker or team at a stressful task.

- Additional, and perhaps longer, breaks from strenuous tasks should be taken.

4.2 WORK/REST REGIMENS

If, after the SSHO's best efforts to make feasible schedule modifications, measurements indicate that the appropriate threshold of concern is exceeded, he or she will implement a work/rest cycle. The protocol selected will depend upon which index of environmental conditions was selected for use during work on the project. Either Section 4.2.1 or Section 4.2.2 will apply.

4.2.1 Protocol for Use of ACGIH Screening Criteria

If the ACGIH screening criteria are exceeded, the SSHO will implement a work/rest cycle with **at least a 15 minute rest period following a work interval no longer than 45 minutes**. The guidelines below should be followed, if this is feasible:

Work/Rest Cycles Conforming to ACGIH Screening Criteria

(WBGT Values in Degrees Fahrenheit)

Hourly Work/Rest Cycle	Physical Demand of the Work Task: Light	Moderate	Heavy	Very Heavy
100% Work*	≤ 85.1 °F	≤ 81.5 °F	≤ 78.8 °F	-
75% Work 25% Rest	85.1 - 86.9 °F	81.5 - 83.3 °F	78.8 - 81.5 °F	-
50% Work 50% Rest	86.9 - 88.7 °F	83.3 - 85.1 °F	81.5 - 83.3 °F	≤ 81.5 °F
25% Work 75% Rest	88.7 - 90.5 °F	85.1 - 87.8 °F	83.3 - 86.0 °F	81.5 - 85.1 °F

* The schedule includes normal lunch and rest breaks.

When the air temperature exceeds 70 °F, the SSHO will begin measuring and recording the WBGT index at least once each hour. He or she then will specify an hourly work/rest cycle consistent with the data in the table above (to the extent feasible) for acclimatized workers wearing normal, permeable work clothing. (A more protective regimen will be specified for unacclimatized workers. The corporate Safety Department will specify alternate regimens for workers wearing very heavy or impermeable protective clothing.)

The SSHO will make feasible adjustments for more or less demanding tasks, as the ACGIH criteria indicate. Additional adjustments will be necessary if heavy protective clothing is worn by workers. (See the applicable site health and safety plan.)

4.2.2 Protocol for Use of Adjusted Temperature

If the adjusted temperature exceeds 72.5 ºF, then the SSHO will require that employees take a at lease a 15-minute break following each work period of maximum duration shown in the table below.

Adjusted Air Temperature *	Break Frequency for Employees Wearing Normal Work Clothing
≥ 90 ºF	After not more than 45 minutes of work
87.5 - 90 ºF	After not more than 60 minutes of work
82.5 - 87.5 ºF	After not more than 90 minutes of work
77.5 - 82.5 ºF	After not more than 120 minutes of work
72.5 - 77.5 ºF	After not more than 150 minutes of work

* Adjusted temperature = [actual air temperature + (13 x {sunshine fraction})]. Measure actual air temperature with a standard mercury thermometer with the bulb shielded from direct sunlight. Estimate sunshine by judging what percent of the time the sun is not covered by clouds that are thick enough to produce a shadow (100% sunshine = no cloud cover and a sharp distinct shadow, and 0% sunshine = no shadows). Note that "sunshine fraction" = Percent sunlight / 100.

The SSHO will require physiological monitoring as described in Section 4.3 during each rest break, and take appropriate action as required by that section.

The SSHO will be very cautious in the use of adjusted temperature to protect employees, especially when humidity is high and air movement is low. Longer breaks and shorter work periods should be required in such situations. Extreme caution is warranted if work tasks are more than moderately strenuous, if heavy clothing is worn, or if the adjusted temperature greatly exceeds 90 ºF. The Safety Department should be consulted in such situations.

4.3 PHYSIOLOGICAL MONITORING

Physiological monitoring to detect the symptoms of heat stress is required under the following circumstances:

(1) A feasible work/rest cycle is not sufficiently protective to conform to the ACGIH recommendations in Section 4.2.1,

(2) The adjusted-temperature protocol described in Section 4.2.2 is used and the adjusted temperature in the workplace exceeds 72.5 ^{o}F, or

(3) Impermeable protective clothing is worn by workers in hot environments.

The SSHO will use one of the methods found in NIOSH Publication 85-115 to conduct the physiological monitoring. (See references.) One of the following measurements shall be used:

(1) Heart Rate. Count the radial (wrist) pulse during a 30-second period as early as possible in the rest period.

(a) If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.

(b) If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third and keep the rest period the same.

(2) Oral Temperature. Use a clinical thermometer (3 minutes under the tongue), or a similar device to measure the oral temperature, at the end of each work period (before drinking).

(a) If oral temperature exceeds 99.6° F (37.6° C), shorten the next work cycle by one-third without changing the rest period.

(b) If oral temperature still exceeds 99.6° F (37.6° C) at the beginning of the next rest period, shorten the following work cycle by one-third.

Tympanic membrane (ear) temperature may be considered equivalent to oral temperature.

Personal monitoring devices that continuously measure heart rate and/or body temperature may be used with the approval of the Safety Department. The SSHO should become familiar with the operation of the devices and instruct employees on their proper use.

4.4 MAINTENANCE OF RECORDS

The SSHO will maintain a written (or electronic) record of measurements and observations required by this procedure. This information may be recorded as entries in the project safety log or as entries on a data sheet created for this purpose.

5.0 REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents (American Conference of Governmental Industrial Hygienists, 2005).

NIOSH Publication 85-115, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (National Institute for Occupational Safety and Health, 1985).

Extreme Heat: A Prevention Guide to Promote Your Personal Health and Safety (Office of Public Affairs, Centers for Disease Control and Prevention, 1996).

Attachment 1

BACKGROUND MATERIAL ON HEAT-RELATED ILLNESSES

Heat Stroke
Heat stroke occurs when the body becomes unable to control its temperature. The body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. Body temperature may rise to 106 °F or higher within 10-15 minutes. **Heat stroke can cause death or permanent disability if emergency treatment is not given.**

Warning signs of heat stroke vary but may include:
- an extremely high body temperature (oral temperature above 103 °F)
- red, hot, and dry skin (no sweating)
- rapid, strong pulse
- throbbing headache
- dizziness
- nausea
- confusion
- unconsciousness

If you see any of these signs, you may be dealing with a life threatening emergency. Have someone call for immediate medical assistance while you begin cooling the victim:
- Get the victim to a shady area.
- Cool the victim rapidly using whatever methods you can. For example, immerse the victim in a tub of cool water; place in a cool shower; spray with cool water from a garden hose; sponge with cool water; or if the humidity is low, wrap the victim in a cool, wet sheet and fan him or her vigorously.
- Monitor body temperature and continue cooling efforts until the body temperature drops to 101-102 °F.
- If emergency medical personnel are delayed, call the hospital emergency room for further instructions.
- Do not give the victim alcohol to drink.
- Get medical assistance as soon as possible.

Sometimes a victim's muscles will begin to twitch uncontrollably as a result of heat stroke. If this happens, keep the victim from injuring himself, but do not place any object in the mouth and do not give fluids. If there is vomiting, make sure the airway remains open by turning the victim on his or her side.

Heat Exhaustion
Heat exhaustion is the body's response to an excessive loss of the water and salt contained in sweat. Those most at risk are elderly people, people with high blood pressure, and people working or exercising in a hot environment.

Warning signs of heat exhaustion include:
- heavy sweating
- paleness
- muscle cramps
- tiredness

- weakness
- dizziness
- headache
- nausea or vomiting
- fainting

The skin may be cool and moist. The victim's pulse rate will be fast and weak, and breathing will be fast and shallow. If heat exhaustion is untreated it may progress to heat stroke. Seek medical attention immediately if symptoms are severe or the victim has heart problems or high blood pressure. Otherwise, help the victim to cool off, and seek medical attention if symptoms worsen or last longer than one hour.

Cooling measures that may be effective include:

- cool, non-alcoholic beverages, as directed by your physician
- rest
- cool shower, bath, or sponge bath
- an air-conditioned environment
- lightweight clothing

Heat Cramps

Heat cramps usually affect people who sweat a lot during strenuous activity. This sweating depletes the body's salt and moisture. The low salt level in the muscles causes painful cramps. Heat cramps may also be a symptom of heat exhaustion.

Heat cramps are muscle pains or spasms – usually in the abdomen, arms, or legs – that may occur in association with strenuous activity. If you have heart problems or are on a low sodium diet, get medical attention for heat cramps.

If medical attention is not necessary, take these steps:

- Stop all activity, and sit quietly in a cool place.
- Drink clear juice or a sports beverage.
- Do not return to strenuous activity for a few hours after the cramps subside because further exertion may lead to heat exhaustion or heat stroke.
- Seek medical attention for heat cramps if they do not subside in one hour.

Heat Rash

Heat rash is a skin irritation caused by excessive sweating during hot, humid weather. It can occur at any age but is most common in young children.

Heat rash looks like a red cluster of pimples or small blisters. It is more likely to occur on the neck and upper chest, in the groin, under the breasts, and in elbow creases.

The best treatment for heat rash is to provide a cooler, less humid environment. Keep the affected area dry. Dusting powder may be used to increase comfort, but avoid using ointments or creams. They keep the skin warm and moist and may make the condition worse. Treating heat rash is simple and it usually does not require medical assistance. Other heat-related problems can be much more severe.

Sunburn
Sunburn should be avoided because it is damaging to the skin. Although the discomfort is usually minor and healing often occurs in about a week, a more severe sunburn may require medical attention.

Symptoms of sunburn are well known. The skin becomes red, painful, and abnormally warm after sun exposure.

Consult a doctor if these symptoms are present:
- fever
- fluid-filled blisters
- severe pain

Also, remember these tips when treating sunburn:
- Avoid repeated sun exposure.
- Apply cold compresses or immerse the sunburned area in cool water.
- Apply moisturizing lotion to affected areas. Do not use salve, butter, or ointment.
- Do not break blisters.

ATTACHMENT 5
COLD STRESS: ENVIRONMENTAL ASSESSMENT AND MANAGEMENT OF EXPOSURE

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Zapata Incorporated

WORKPLACE HEALTH AND SAFETY PROGRAMS

Procedure HS-M-13

COLD STRESS: ENVIRONMENTAL ASSESSMENT

AND MANAGEMENT OF EXPOSURE

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1.0 INTRODUCTION

Exposure to freezing or cold temperatures can cause serious injuries. Among these is frostbite, the freezing of fluid in body tissue. Trench foot is another injury that can be produced by cold (but not necessarily freezing) temperatures when the feet are damp. Hypothermia, the severe drop in the core temperature of the body, is the most serious cold-related injury. It can occur after prolonged exposure to cold air, or after much briefer period of immersion in cold water. These workplace hazards are discussed in detail in the appendix.

This document describes procedures for assessing the potential for cold-related injury in the workplace and for implementing work rules to protect employees. It is designed to prevent exposure to conditions that could lead to either the freezing of exposed skin (frostbite) or a dangerous decrease in body temperature (hypothermia).

If situations are encountered that are not addressed in this document, the project manager or the site safety officer should contact Corporate Safety to discuss appropriate protective measures. Project managers and safety officers should consult Corporate Safety before any major modifications to this procedure are implemented.

2.0 ASSESSMENT OF THE POTENTIAL FOR COLD STRESS

The potential for cold stress is determined primarily by two variables: The temperature of the air and the speed of the wind. At a given temperature, calm air is less dangerous. The “cooling power” of moving air on exposed flesh can be expressed as an equivalent chill temperature (ECT), which combines temperature and air speed. The following table shows values of ECT for various temperature and speed combinations.

EQUIVALENT CHILL TEMPERATURE (°F)

AT VARIOUS AIR TEMPERATURES AND WIND SPEEDS*

Estimated Wind Speed (mph)	**Actual Temperature Reading (°F)**											
	50	**40**	**30**	**20**	**10**	**Zero**	**-10**	**-20**	**-30**	**-40**	**-50**	**-60**
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	- 5	-15	-26	-36	-47	-57	-68
10	40	28	16	- 9	-24	- 24	-33	-46	-58	-70	-83	-95
15	36	22	9	- 5	-18	- 32	-45	-58	-72	-85	-99	
20	32	18	4	-10	-25	- 39	-53	-67	-82	-96		
25		**Zone A**		-15	-29	- 44	-59	-74	-88			
30		**Little Danger** (in < 1hour,		-18	-33	**Zone**	-63	-79		**Zone C**		
35		if skin is dry)		-20	-35	**B****	-67	-82		**Great Danger** (Flesh may freeze within 30 seconds.)		
40	26	10	- 6	-21	-37	- 53	-69	-85				

* Zone B: Increasing Danger (Danger from freezing of exposed flesh within one minute.

The conditions represented by Zones B and C are extremely dangerous to exposed skin. Continuous exposure of exposed skin should not be permitted if the equivalent chill temperature is -25 °F or less. Work under conditions represented by Zone A is much less dangerous to exposed skin. However, workers can suffer frostbite injury in the less severe environment if they develop a false sense of security and fail to take precautions.

The potential for hypothermia also is dependent upon air temperature and air speed. At low ECT values, precautions against this hazard are necessary, even if workers are dressed in well insulating clothing. The danger of hypothermia is especially severe if immersion in water is possible during the work.

3.0 PREVENTION OF COLD-RELATED ILLNESS

The project or site safety and health officer (SSHO) will make an assessment of the potential for cold stress before field work begins. Work rules related to the prevention of cold-related injury will be required if conditions of the type represented in Zones A, B, or C in the table on page 2 are anticipated. Under such conditions, the SSHO will measure temperature and wind speed when work commences each day and at routine intervals (at least every four hours) thereafter, unless he or she believes that some other means of hazard assessment is adequate. The safety department must approve any alternative means of hazard assessment.

When work is conducted under conditions represented in Zones A, B, or C, the SSHO will implement work rules described below to manage the potential hazard.

3.1 GENERALLY APPLICABLE PRECAUTIONS

The SSHO will implement the following work rules, as appropriate, when conditions of the type represented in Zones A, B, or C in the table on page 2 occur in the work environment:

- Employees will receive training on the dangers and symptoms of cold-related injury and the work rules adopted to prevent it.
- Site workers will be warned that older individuals and people with circulatory problems might be at increased risk for clod-related injury, and that added precautions might be necessary to protect them.
- Each employee will be under protective observation by someone else during work.
- (I.e., use of the “buddy system” will be required, as it is on all ZapataEngineering projects.)
- Employees who experience pain in the extremities or evident shivering will be removed from exposure to the cold work environment.
- Work must be halted if frostbite can not be prevented. Continuous skin exposure will not be permitted when the ECT is –25 °F or less (Zones B and C on page 2.
- Tasks should be scheduled to avoid long periods during which workers must sit or stand still.
- Work expectations for new employees should be adjusted downward for the first few days, to permit acclimatization to the cold conditions.
- Dehydration, which decreases blood flow to the extremities, should be avoided. Employees will be encouraged to replenish water lost to perspiration and respiration. The SSHO will provide soups and warm sweet drinks as appropriate.
- The SSHO will develop procedures that reduce the likelihood of immersion in water or soaking of the clothing by other means during project work. Such precautions should apply to any work with liquids like gasoline, alcohols, solvents, or cleaning fluids.
- The SSHO will plan for any likely scenarios that would lead to wet clothing (through immersion in water, soaking by mist, etc.), and provide for quick changing into dry clothing and treatment for hypothermia.
- Emergency plans will give special attention to the prevention of cold-related injury (hypothermia and freezing of damaged tissues)

3.2 SELECTION OF PROTECTIVE CLOTHING

The rules implemented by the SSHO will require that employees wear adequately insulating dry clothing if conditions of the type represented in Zones A, B, or C in the table on page 2 are anticipated. Workers should wear cold-protective clothing appropriate for the environmental conditions and the level of physical activity. The following considerations should guide the selection and use of protective clothing:

- Layered clothing should be used to preserve body heat. An easily removable outer windbreak garment should be worn in windy conditions.
- Inner garments and underwear should be made of fabrics that dry quickly and wick moisture away from the body.
- Outer garments should be made with provisions for easily ventilation to prevent the wetting of inner layers by sweat.
- An employee should not enter or remain in a cold work environment if his or her clothing is wet as a consequence of sweating. If clothing is wet, then the employee should change into dry clothing before returning to the cold environment.
- Gloves and/or mittens should be used as necessary to protect the hands, and employees should be warned not to touch very cold objects and surfaces with bare skin.
- Workers should routinely change socks and removable felt insoles to reduce moisture around the feet.
- Eye protection suitable to the type of hazard should be used. Special precautions against ultraviolet light and glare might be necessary in snow-covered terrain.
- Hardhat liners should be used if necessary. If work must be done on slippery surfaces, then shoe attachments that enhance traction should be used.

3.3 WORK/WARMING REGIMENS

If continuous work must be performed at an ECT below 19.4 °F, then the SSHO or project manager will provide a heated shelter (tent, cabin, or similar space) for warming after exposure to the cold environment. Employees should be encouraged to use the shelter at frequent intervals, and upon (1) onset of heavy shivering, (2) occurrence of minor frostbite, or (3) onset of feelings of excessive fatigue, drowsiness, irritability, or euphoria.

The SSHO will monitor environmental conditions and implement a mandatory work/warming regimen that is at least as protective as the one recommended in the following table for those conditions.

WORK/WARMING SCHEDULE FOR A 4-HOUR SHIFT

Air Temp. (°F)	Air Speed (mph)				
	Calm	**5**	**10**	**15**	**20**
- 15 to - 19	Normal Breaks (1)	Normal Breaks (1)	75 min. max. work period with 2 breaks	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks
- 20 to - 24	Normal Breaks (1)	75 min. max. work period with 2 breaks	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks	30min. max. work period with 5 breaks
- 25 to - 29	75 min. max. work period with 2 breaks	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks	30 min. max. work period with 5 breaks	
- 30 to - 34	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks	30 min. max. work period with 5 breaks		
- 35 to - 39	40 min. max. work period with 4 breaks	30 min. max. work period with 5 breaks	**Non-emergency work should cease.**		
- 40 to - 44	30 min. max. work period with 5 breaks				
- 45 and below					

4.0 REFERENCE MATERIAL ON MEDICAL CONDITIONS

Frostbite
What Happens to the Body: (1) Freezing in the deep layers of skin and tissue; (2) Pale, waxy-white skin color; (3) Skin becomes hard and numb; (4) Fingers, hands, toes, feet, ears, and nose normally are affected fires.

What Should Be Done: (land temperatures)
• Move the person to a warm dry area. Don't leave the person alone.
• Remove any wet or tight clothing that may cut off blood flow to the affected area.
• DO NOT rub the affected area, because rubbing causes damage to the skin and tissue.
• Gently place the affected area in a warm (105°F) water bath and monitor the water temperature to slowly warm the tissue. Don't pour warm water directly on the affected area because it will warm the tissue too fast causing tissue damage. Warming takes about 25-40 minutes.
• After the affected area has been warmed, it may become puffy and blister. The affected area may have a burning feeling or numbness. When normal feeling, movement, and skin color have returned, the affected area should be dried and wrapped to keep it warm. NOTE: If there is a chance the affected
area may get cold again, do not warm the skin. If the skin is warmed and then becomes cold again, it will cause severe tissue damage.
• Seek medical attention as soon as possible.

HYPOTHERMIA - (Medical Emergency)
What Happens to the Body:
NORMAL BODY TEMPERATURE (98.6° F/37°C) DROPS TO OR BELOW 95°F (350 C); FATIGUE OR DROWSINESS; UNCONTROLLED SHIVERING; COOL BLUISH SKIN; SLURRED SPEECH; CLUMSY MOVEMENTS; IRRITABLE, IRRATIONAL OR CONFUSED BEHAVIOR.

What Should Be Done: (land temperatures)
• Call for emergency help (i.e., Ambulance or Call 911).
• Move the person to a warm, dry area. Don't leave the person alone. Remove any wet clothing and replace with warm, dry clothing or wrap the person in blankets.
• Have the person drink warm, sweet drinks (sugar water or sports-type drinks) if they are alert. Avoid drinks with caffeine (coffee, tea, or hot chocolate) or alcohol.
• Have the person move their arms and legs to create muscle heat. If they are unable to do this, place warm bottles or hot packs in the arm pits, groin, neck, and head areas. DO NOT rub the person's body or place them in warm water bath. This may stop their heart.
What Should Be Done: (water temperatures)
• Call for emergency help (Ambulance or Call 911). Body heat is lost up to 25 times faster in water.
• DO NOT remove any clothing. Button, buckle, zip, and tighten any collars, cuffs, shoes, and hoods because the layer of trapped water closest to the body provides a layer of insulation that slows the loss of heat. Keep the head out of the water and put on a hat or hood.

• Get out of the water as quickly as possible or climb on anything floating. DO NOT attempt to swim unless a floating object or another person can be reached because swimming or other physical activity uses the body's heat and reduces survival time by about 50 percent.
• If getting out of the water is not possible, wait quietly and conserve body heat by folding arms across the chest, keeping thighs together, bending knees, and crossing ankles. If another person is in the water, huddle together with chests held closely.

How to Protect Workers:
• Recognize the environmental and workplace conditions that lead to potential cold-induced illnesses and injuries.
• Learn the signs and symptoms of cold-induced illnesses/injuries and what to do to help the worker.
• Train the workforce about cold-induced illnesses and injuries.
• Select proper clothing for cold, wet, and windy conditions. Layer clothing to adjust to changing environmental temperatures. Wear a hat and gloves, in addition to underwear that will keep water away from the skin (polypropylene).
• Take frequent short breaks in warm dry shelters to allow the body to warm up.
• Perform work during the warmest part of the day.
• Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
• Use the buddy system (work in pairs).
• Drink warm, sweet beverages (sugar water, sports-type drinks). Avoid drinks with caffeine (coffee, tea, or hot chocolate) or alcohol.
• Eat warm, high-calorie foods like hot pasta dishes.
Workers Are at Increased Risk When...
• They have predisposing health conditions such as cardiovascular disease, diabetes, and hypertension.
• They take certain medication (check with your doctor, nurse, or pharmacy and ask if any medicines you are taking affect you while working in cold environments).
• They are in poor physical condition, have a poor diet, or are older.

ATTACHMENT 6
LIST OF CHEMICAL PRODUCTS WITH ASSOCIATED MATERIAL SAFETY DATA SHEETS

(FOR USE ON THE PROJECT SITE)

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ATTACHMENT 7
IMAGES OF DANGEROUS ANIMALS AND PLANTS AT THE PROJECT SITE

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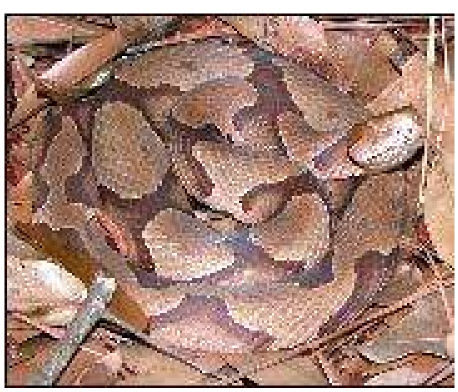
Feral Dog

Coyote

Water Moccasin or Cottonmouth



Copperhead

Coral Snake

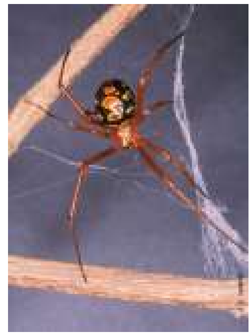
Eastern Diamondback Rattlesnake

Pygmy Rattlesnake

Timber Rattlesnake

Snapping Turtle

Ticks of various species

Widow Spiders of various species


Recluse Spiders




Various Bees, Wasps, Ants (including Fire Ants), Mosquitoes, and (non-venomous) Scorpions

Poison Ivy

Eastern Poison Oak

Poison Sumac

APPENDIX E
UFP-QAPP

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Final Quality Assurance Project Plan (QAPP)

REMEDIAL INVESTIGATION - FEASIBILITY STUDY (RI/FS)

FORMER CAMP CROFT FUDS
FUDS Number: I04SC001603

Contract: W912DY-10-D-0028
Task Order: 0005

Prepared for:

US Army Engineering and Support Center, Huntsville

and

US Army Corps of Engineers, Charleston District

by:

ZAPATA
TRUST • INTEGRITY • QUALITY

September 9, 2011

Intergovernmental Data Quality Task Force

Workbook for Uniform Federal Policy for Quality Assurance Project Plans

Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs

Part 2A: UFP-QAPP Workbook

> This workbook supplements Part 1 of the UFP-QAPP, the UFP-QAPP Manual. Proper completion of these worksheets requires knowledge of the QAPP elements explained in the Manual.

Final
Version 1
March 2005

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WORKBOOK FOR UNIFORM FEDERAL POLICY FOR QUALITY ASSURANCE PROJECT PLANS

INTRODUCTION

This *Workbook for Uniform Federal Policy for Quality Assurance Project Plans* is Part 2A of the *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP). It provides examples of worksheets to assist with the preparation of QAPPs in accordance with Part 1 of the UFP-QAPP (the UFP-QAPP Manual) and Section 6 (Part B) of *Quality Systems for Environmental Data and Technology Programs - Requirements with guidance for use*, ANSI/ASQ E4 (February 2004). This Workbook may be used by the lead organization and its contractors to assist with the preparation of QAPPs for environmental data gathering activities.

Each worksheet addresses specific requirements of the UFP-QAPP. Both the UFP-QAPP Manual and the Workbook are intended to be comprehensive and are not intended to be program-specific. Since the content and level of detail in a specific QAPP will vary by program, by the work being performed, and by the intended use of the data, specific worksheets may not be applicable to all projects.

The ultimate success of an environmental program or project depends on the quality of the environmental data collected and used in decision-making, and this may depend significantly on the adequacy of the QAPP and its effective implementation. It is recommended that the individual worksheets included in this Workbook be taken to the project scoping and planning sessions. The use of the worksheets will aid in identifying the critical project information that will ensure that the right type, quality, and quantity of data are collected to meet all of the project's quality objectives. Though the format of each worksheet is not mandatory, the information required on the worksheets must still be presented in the QAPP, as appropriate to the project. In addition, QAPP preparers are encouraged to develop additional tables, as appropriate to the project. Sufficient written discussion in text format should accompany all tables. Certain sections, by their nature, will require more written discussion than others. In particular, Section 3.1.1 should provide an in-depth explanation of the sampling design rationale, and Section 5.2 should describe the procedures and criteria that will be used for data review.

QAPP Worksheet #1
Title and Approval Page

Site Name/Project Name: Camp Croft FUDS/RI/FS
Site Location: Spartanburg, South Carolina

Document Title: Remedial Investigation, Munitions Constituents, Sampling and Analysis Plan

Lead Organization: USACE, South Atlantic Division, Charleston District (CESAC)

Preparer's Name and Organizational Affiliation: Zapata Incorporated (ZAPATA)

Preparer's Address, Telephone Number, and E-mail Address: 6302 Fairview Road, Suite 600, Charlotte, North Carolina 28210, (704) 358-8240, zapata@zapatainc.com

Preparation Date (Day/Month/Year): 15 July 2011

Investigative Organization's Project Manager/Date: ______________________________
Signature
Printed Name/Organization: Jason Shiflet/Zapata Incorporated

Investigative Organization's Project QA Officer/Date: ____________________________
Signature
Printed Name/Organization: Suzy Cantor-McKinney/Zapata Incorporated

Lead Organization's Project Manager/Date: ____________________________________
Signature
Printed Name/Organization: Shawn Boone/CESAC

Approval Signatures/Date: ____
Signature
Printed Name/Title: Spencer O'Neal/USAESCH Project Manager

Approval Authority: United State Army Corps of Engineers

Other Approval Signatures/Date: ____
Signature
Printed Name/Title: Teresa Carpenter/USAESCH Technical Manager

Document Control Numbering System:

QAPP Worksheet #2
QAPP Identifying Information

Site Name/Project Name: Camp Croft FUDS/RI/FS
Site Location: Spartanburg, South Carolina
Site Number/Code: I04SC001603
Operable Unit: MRS 1, 2 and 3; AoPIs 5, 8, 9E, 9G, 10A, 10B, 11B, 11C, and 11D
Contractor Name: Zapata Incorporated (ZAPATA)
Contractor Number:

Contract Title: Munitions Response Contract for Worldwide Sites
Work Assignment Number:

Title: RI/FS MC UFP-QAPP
Revision Number: 0
Revision Date: 15 July 2011

1. Identify regulatory program: Defense Environmental Restoration Program in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Sections 104 and 121; Executive Order 12580; and the National Oil and Hazardous Substances Pollution contingency Plan (NCP).

2. Identify approval entity: US Army Engineering and Support Center, Huntsville

3. The QAPP is (select one): ☐Generic ☒Project Specific

4. List dates of scoping sessions that were held:

5. List dates and titles of QAPP documents written for previous site work, if applicable:

Title	Approval Date
None	

6. List organizational partners (stakeholders) and connection with lead organization:
   US Army Corps of Engineers, South Atlantic Division, Charleston District (CESAC), Lead Organization
   US Army Engineering and Support Center, Huntsville (USAESCH), Center of Expertise
   South Carolina Department of Health and Environmental Control (SC DHEC), State Regulatory Agency
   Zapata Incorporated (ZAPATA), USAESCH Prime Contractor
   Accutest, Laboratory Services Subcontractor (Primary)
   TestAmerica, Laboratory Services Subcontractor (Secondary/QA)
   Black & Veatch, Risk Assessment and Data Validation Subcontractor
7. List data users:
   US Army Corps of Engineers, South Atlantic Division, Charleston District (CESAC), Lead Organization
   US Army Engineering and Support Center, Huntsville (USAESCH), Center of Expertise
   South Carolina Department of Health and Environmental Control (SC DHEC), State Regulatory Agency
   Zapata Incorporated (ZAPATA), USAESCH Prime Contractor
   Black & Veatch, Risk Assessment Subcontractor
8. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusions below:
   All QAPP elements are applicable to this project with the exception of worksheets 16 and 22. Worksheet 16 is omitted because project schedule is provided in Appendix M of the Work Plan. Worksheet 22 is omitted because field equipment associated with MC sampling is not anticipated for this site.

QAPP Worksheet #2
QAPP Identifying Information
(Continued)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to Related Documents
Project Management and Objectives		
2.1 Title and Approval Page	- Title and Approval Page	
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	- Table of Contents - QAPP Identifying Information	
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	- Distribution List - Project Personnel Sign-Off Sheet	
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table	
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	- Project Planning Session Documentation (including Data Needs tables) - Project Scoping Session Participants Sheet - Problem Definition, Site History, and Background - Site Maps (historical and present)	
2.6 Project Quality Objectives and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	- Site-Specific PQOs - Measurement Performance Criteria Table	

QAPP Worksheet #2
QAPP Identifying Information
(Continued)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to Related Documents
2.7 Secondary Data Evaluation	- Sources of Secondary Data and Information - Secondary Data Criteria and Limitations Table	
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	- Summary of Project Tasks - Reference Limits and Evaluation Table - Project Schedule/Timeline Table	
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.3 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.4 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	- Sampling Design and Rationale - Sample Location Map - Sampling Locations and Methods/SOP Requirements Table - Analytical Methods/SOP Requirements Table - Field Quality Control Sample Summary Table - Sampling SOPs - Project Sampling SOP References Table - Field Equipment Calibration, Maintenance, Testing, and Inspection Table	
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures	- Analytical SOPs - Analytical SOP References Table - Analytical Instrument Calibration Table - Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	

QAPP Worksheet #2
QAPP Identifying Information
(Continued)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to Required Documents
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	- Sample Collection Documentation Handling, Tracking, and Custody SOPs - Sample Container Identification - Sample Handling Flow Diagram - Example Chain-of-Custody Form and Seal	
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples	- QC Samples Table - Screening/Confirmatory Analysis Decision Tree	
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	- Project Documents and Records Table - Analytical Services Table - Data Management SOPs	
Assessment/Oversight		
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses	- Assessments and Response Actions - Planned Project Assessments Table - Audit Checklists - Assessment Findings and Corrective Action Responses Table	
4.2 QA Management Reports	- QA Management Reports Table	
4.3 Final Project Report		

QAPP Worksheet #2
QAPP Identifying Information
(Continued)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to Related Documents
Data Review		
5.1 Overview		
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities	- Verification (Step I) Process Table - Validation (Steps IIa and IIb) Process Table - Validation (Steps IIa and IIb) Summary Table - Usability Assessment	
5.3 Streamlining Data Review 5.3.1 Data Review Steps To Be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining		

QAPP Worksheet #3

Distribution List

QAPP Recipients	Title	Organization	Telephone Number	Fax Number	E-mail Address	Document Control Number
Shawn Boone (Six copies)	Project Manager	CESAC	(843) 329-8158		shawn.a.boone@usace.army.mil	
Spencer O'Neal (Four copies)	Project Manager	USAESCH	(256) 895-1574	(256) 895-1378	spencer.d.oneal@usace.army.mil	
Jason Shiflet	Project Manager	ZAPATA	(704) 378-4918	(704) 358-8342	jshiflet@zapatainc.com	
Jim Eldridge	Risk Assessor Data Validator	Black & Veatch	(206) 852-4168		eldridgejc@bv.com	
Susan Bell	Project Manager	Accutest Laboratories Southeast, Inc.	(813) 741-3338	(813) 741-9137	sueb@accutest.com	

QAPP Worksheet #4

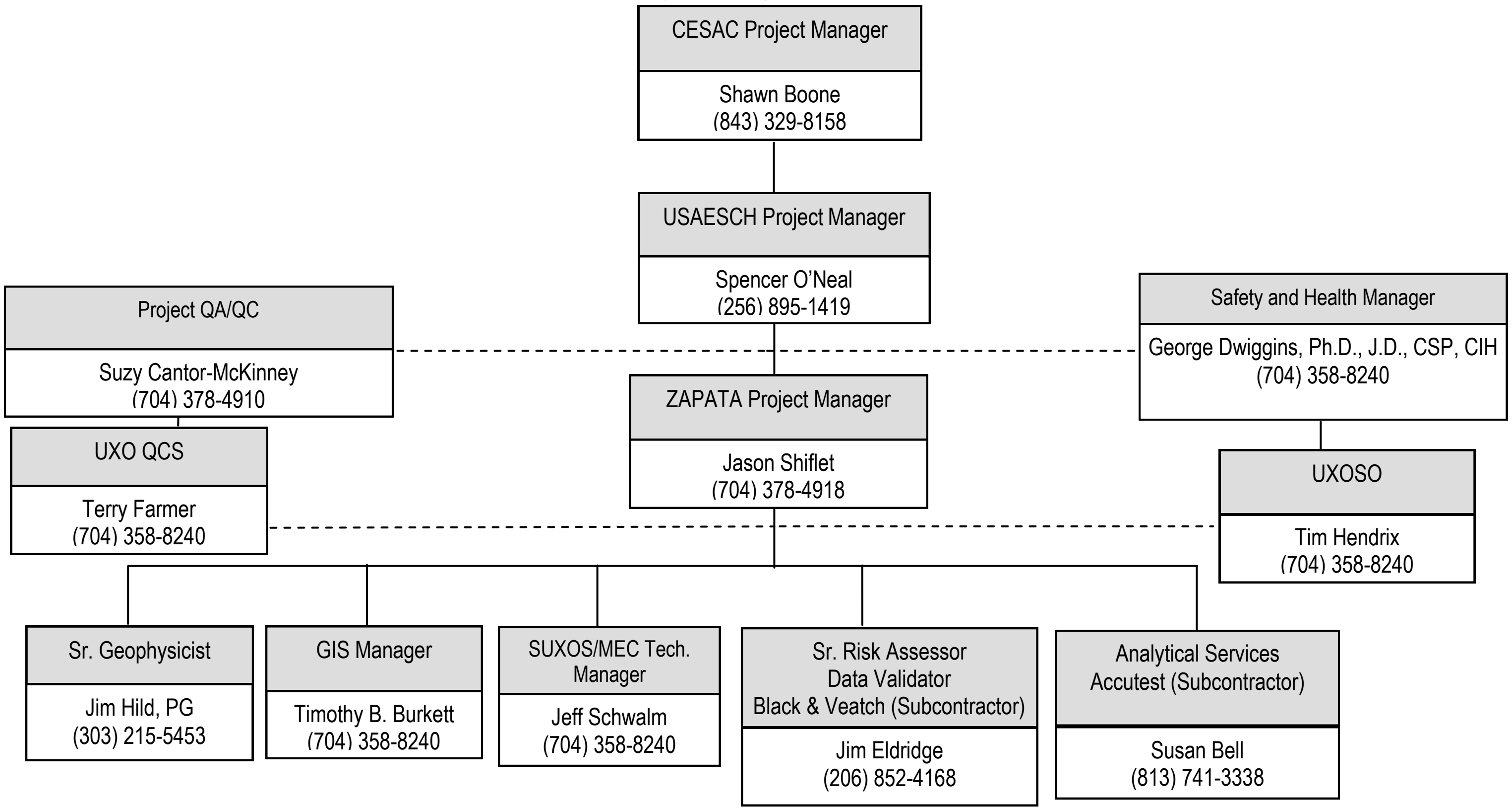
Project Personnel Sign-Off Sheet

Organization: Zapata Incorporated Team

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Michael Winningham	Program Manager	(704) 378-4935		
Jason Shiflet	Project Manager	(704) 378-4918		
Jeff Schwalm	Senior UXO Supervisor	(704) 358-8240		
Terry Farmer	UXO Quality Control Officer	(704) 358-8240		
Tim Hendrix	UXO Safety Officer	(704) 358-8240		
Suzy Cantor-McKinney	Quality Manager	(704) 378-4914		
James Hild, P.G.	Project Geophysicist	(303) 215-5453		
Timothy Burkett	GIS Manager	(704) 378-4932		
Jim Eldridge	Risk Assessor/Data Validator	(206) 852-4168		
Sue Bell	Project Manager	(813) 741-3338		

QAPP Worksheet #5

Project Organizational Chart



QAPP Worksheet #6

Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Overall Project Implementation	CESAC Project Manager	Shawn Boone	(843) 329-8158	Responsible for all direct communications with the regulatory agencies and other stakeholders.
Approval of Amendments to the SAP	USAESCH Project Manager	Spencer O'Neal	(256) 895-1419	Primary point of contact for the USAESCH. Amendments to the SAP will be submitted for approval prior to implementation.
Modification of the SAP	ZAPATA Project Manager	Jason Shiflet	(704) 378-4918	Suggested modifications to the SAP will be evaluated by ZAPATA's Project Manager. If required, the SAP will be modified and submitted for approval.
Delays in Site Activities	ZAPATA SUXOS	Jeff Schwalm	(704) 358-8240	Delays in site activities will be reported to ZAPATA's Project Manager. ZAPATA's Project Manager will notify the USAESCH and CESAC Project Managers.
Deviations from SAP	ZAPATA Quality Officer	Suzy Cantor-McKinney	(704) 378-4910	Deviations from the SAP will be documented in writing. ZAPATA's Quality Officer will notify ZAPATA's Project Manager, who will in turn notify the USAESCH Project Manager.
Stop Work/Corrective Actions	All Site Personnel	Various	Various	For safety or quality related reasons, all site personnel have the authority to temporarily stop work until an issue can be resolved. ZAPATA personnel will notify the ZAPATA Project Manager, who will then notify the USAESCH Project Manager. ZAPATA PM will document, in writing, the work stoppage.
Data Collection and Data Quality Challenges	ZAPATA Quality Officer	Suzy Cantor-McKinney	(704) 378-4910	ZAPATA's Quality Officer will document the data collection and/or data quality challenges in writing and notify ZAPATA's Project Manager.
Analytical Data Results	Accutest Project Manager	Susan Bell	(813) 741-3338	Analytical data will be provided to Black & Veatch as ADR Stage 2a electronic data deliverables (SEDD 2a) for data validation. The analytical data also will be provided to Black & Veatch as EPA Level IV data packages, either in *.pdf or hard copy format.
Analytical Data Validation	Black & Veatch Data Validator	Jim Eldridge	(206) 852-4168	Analytical data will be validated using ADR automated data review software, with reference to the *.pdf/hard copy reports as needed. Validated results will be provided to ZAPATA's Project Manager.
Release of Analytical Data	CESAC Project Manager USAESCH Project Manager	Shawn Boone Spencer O'Neal	(843) 329-8158 (256) 895-1574	Analytical data will be submitted in the RI report. Following USAESCH approval, the data will be provided to the public by releasing the RI report.

QAPP Worksheet #7

Resumes of key project personnel are included in Appendix H of the Work Plan.

Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Shawn Boone	Project Manager	CESAC	Ensure project requirements are met. Provide direction to ZAPATA. Communicate directly with regulatory agencies and stakeholders.	Not Applicable.
Janice Jamar	Contracting Officer	USAESCH	Provide contractual guidance for ZAPATA.	Not Applicable
Spencer O'Neal	Project Manager	USAESCH	Performs project management for USAESCH. Ensure project requirements are met. Oversee project schedule and budget. Provide guidance to ZAPATA. Communicate directly with CESAC.	Not Applicable
Teresa Carpenter	Technical Manager	USAESCH	Provide technical oversight for project requirements. Provides technical guidance to ZAPATA. Monitoring ZAPATA's performance. Evaluate and approve project deliverables.	Not Applicable
Jason Shiflet	Project Manager	ZAPATA	Perform project management for ZAPATA. Ensure project requirements are met. Oversee project budget and schedule. Provide direction to ZAPATA subcontractors. Communicate directly with the USAESCH.	MS, Geology (1999) BS, Geology (1995) Professional Geologist: SC, FL, NC, VA ▪ 12 years project management experience managing projects for USACE and other DoD and commercial clients ▪ Expertise in MEC characterization on RI/FS, and EE/CAs on FUDS and active installations ▪ Experience with Performance-based contracts schedule monitoring, and cost control, and GFE and CAP management

Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Suzy Cantor-McKinney	Quality Manager	ZAPATA	Ensure all project deliverables meet project quality objectives as defined herein.	MS, Land/Water Resource Mgmt (1983) BS, Biology (1982) ▪ 26 years MEC and HTRW experience; 13 years directly with USACE ensures adherence to contract requirements and quality of contract deliverables ▪ 15+ years of technical and project management experience in all phases of MMRP for USACE clients. ▪ Participated in 50+ RAB meetings. Developed MEC awareness/safety education materials ▪ VP, National Association of Ordnance and Explosive Waste Contractors ▪ USACE Construction Quality Management for Contractors
James Hild, P.G.	Project Geophysicist	ZAPATA	Oversee all geophysical site activities, including data collection, QC and reporting.	MS, Geology (1976) BS, Geology (1974) Professional Geologist, FL, KY, OR ▪ 30 years experience conducting geophysical investigations and data analysis for USACE and other DoD agencies ▪ 16 years experience on MMR actions with USACE ▪ Designs/implements geophysical investigations and GPOs; prepares geophysical investigation plans; develops DQOs; validates collection procedures; and supervises data analysis ▪ Expertise in Geosoft® Oasis Montaj, UXO Detect, Access, C++, and data interpretation/analysis ▪ Responsible for QC of geophysical products ▪ Thorough understanding and project experience in compliance with DIDs

Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Jeff Schwalm	Senior UXO Supervisor	ZAPATA	Oversee all munitions related activities. Oversee fieldwork activities.	US Navy Explosive Ordnance School, (1976) Specialized training in radiological protection and construction safety ▪ 36 years of UXO/EOD and MMR action experience ▪ Exceeds required qualifications set forth in DDESBTP-18 for UXOQCS ▪ Executes all aspects of munitions response actions and range clearance activities ▪ Expertise in methods of remediation and full knowledge of Army regulations for MEC/UXO/CWM operations ensuring effective project management and execution ▪ Fully conversant with ZAPATA's Quality and Safety Program as well as EM 385-1-1 and ER 385-1-95
Terry Farmer	UXO QC Specialist	ZAPATA	Oversee quality aspects of fieldwork activities. Communicate directly with ZAPATA Corporate QC Manager and Project Manager.	US Navy Explosive Ordnance School, (1972) ▪ More than 25 years experience, including MMR projects for USACE ▪ Extensive experience in all aspects of UXO detection, disposal, and remediation including construction support ▪ Experience implementing quality control and safety programs
Tim Hendrix	UXO Safety Officer	ZAPATA	Oversee safety aspects of fieldwork activities. Conduct daily safety briefings. Complete daily safety reports. Communicate directly with ZAPATA Corporate Safety Officer and Project Manager.	US Navy Explosive Ordnance School, (1975) ▪ More than 20 years experience, including MMR projects for USACE ▪ Extensive experience in all aspects of UXO detection, disposal, and remediation including construction support ▪ Experience implementing quality control and safety programs

Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Sue Bell	Project Manager	Accutest (subcontractor)	Oversee chemical analytical services. Coordinate laboratory analyses and schedule. Oversee reporting of chemical analytical results. Provide chemical analytical results to data validation subcontractor. Communicate directly with data validator and ZAPATA Project Manager.	Not Applicable.
Jim Eldridge	Risk Assessor Data Validator	Black & Veatch (subcontractor)	Oversee risk assessment tasks in support of ZAPATA. Evaluate the analytical sampling results to determine the potential health and ecological implications of any compounds detected. Communicate directly with ZAPATA Project Manager. Perform data validation services for all analytical data. Generate the Quality Control Summary Report. Communicate directly with analytical laboratory and ZAPATA Project Manager.	BS, Biology (1974) Post Graduate Studies in Environmental Science (1977-1979) ▪ 25 years of CERCLA experience, including RI/FS, EE/CA, OTA, and enforcement support for EPA Regions 4, 7, 8, 9, and 10. ▪ Expert in all aspects of ecological risk assessments; and expert knowledge of Endangered Species Act ▪ Member, Society of Environmental Toxicology and Chemistry; American Association for the Advancement of Science ▪ US Bureau of Land Management - NEPA Analyses and Natural Resources Management ▪ Five years experience supporting ZAPATA's MEC and ERS projects

QAPP Worksheet #8

Special Personnel Training Requirements Table

Project Function	Specialized Training – Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
Project Safety	Adult CPR	American Red Cross	Various	A minimum of two on-site Field Personnel	Various	ZAPATA Human Resources files at corporate office. Copies maintained in the field during site activities.
Project Safety	Adult First Aid	American Red Cross	Various	A minimum of two on-site Field Personnel	Various	See above
Project Safety	Certified Industrial Hygienist Certified Safety Professional	ABIH BCSP	1982 2008	George Dwiggins, Ph.D., CIH, CSP	Corporate Safety Officer	See above
Project Safety	Explosives and Ordnance Disposal	US Navy EOD	1976 1972 1975	Jeff Schwalm Terry Farmer Tim Hendrix	SUXOS UXO QC UXO SO	See above
Hazard Awareness	OSHA HAZWOPER 40-Hr., 24-Hr., and/or 8-Hr.	Various	Various	All Field Personnel, as appropriate	Various	See above
Hazard Awareness	OSHA HAZWOPER Supervisor Training	Various	Various	PM, SUXOS, UXO SO/QC	PM, SUXOS, UXO SO/QC	See above

QAPP Worksheet #9

Project Scoping Session Participants Sheet

Project Name: Camp Croft FUDS/RI/FS **Projected Date(s) of Sampling:** Sept 2011 - March 2012 **Project Manager:** Jason Shiflet	**Site Name:** Camp Croft FUDS/RI/FS **Site Location:** Spartanburg, South Carolina

Date of Session: 16 March 2011
Scoping Session Purpose: To review RI/FS objectives/CSM, proposed approach, and define DQOs.

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Shawn Boone	Project Manager	CESAC	(843) 329-8158	shawn.a.boone@ usace.army.mil	Project Manager
Spencer O'Neal	Project Manager	USAESCH	(256) 895-1574	spencer.d.oneal@ usace.army.mil	Project Manager
Teresa Carpenter	Technical Manager	USAESCH	(256) 895-1659	teresa.m.carpenter@ usace.army.mil	Technical Manager
Deb Edwards	Geophysicist	USAESCH	(256) 895-1626	debra.l.edwards@usace.army. mil	Geophysicist
Susan Byrd	Compliance Officer	SC DHEC	(803) 896-4188	byrdsk@dhec.sc.gov	State Regulator
John Moon	Park Officer	Croft State Natural Area	(864) 585-1283	jmoon@scprt.com	Local Stakeholder
Jason Shiflet	Project Manager	ZAPATA	(704) 378-4910	jshiflet@zapatainc.com	Project Manager
Suzy Cantor-McKinney	Quality Manager	ZAPATA	(704) 3778-4910	scmckinney@zapatainc.com	Quality Manager

Comments/Decisions: TPP Memorandum, Appendix I to the Work Plan

Action Items:

Consensus Decisions:

QAPP Worksheet #10

Problem Definition

The problem to be addressed by the project: The PWS requests a RI/FS at the Former Camp Croft (hereafter referred to as Camp Croft) and specifically identifies three Munitions Response Sites (MRSs) and 11 optional sites of varying sizes located within the FUDS boundary but outside of the three MRSs. The three MRSs include the Gas Chambers (MRS 1), the Grenade Court (MRS 2), and the Land Range Complex (MRS 3). Of the 11 optional sites, 10 are defined in the PWS as "Areas of Potential Interest" (AoPI), and one appears to be associated with MRS 3, that being the Lake Craig and Lake Johnson Range Complex. The MRSs and AoPIs were established based on historical range locations at Camp Croft (see Exhibit 2, Appendix B). The AoPIs correspond to areas previously referred to as Ordnance Operable Units (OOUs); those areas include AoPIs 3, 5, 8, 9E, 9G, 10A, 10B, 11B, 11C, and 11D. Eighteen previously defined OOUs exist within or partially within MRS 3; those include OOUs 1A, 1B, 2, 4, 6A, 6B, 7, 9A, 9B, 9C, 9D, 9F, 9H, 10C, 10D, 11A, 12A, and 12B (see Exhibit 3, Appendix B). The RI/FS process is intended to achieve close-out of these individual areas only. Data from this RI will be used in future remedial investigations of remaining areas of the FUDS outside of these MRSs and AoPIs. The conceptual site model (CSM) and more detail are provided in Section 1.12 and Table 1 of the Work Plans.
The environmental questions being asked: The objective of this task is to determine the presence of, and the nature and extent of the MCs that are detected above the threshold concentrations established by the project TPP team through the DQO process, and to perform an ecological and human health risk assessment in accordance with EPA risk assessment and USACE guidance. To address this objective, ZAPATA will conduct discrete soil sampling for explosives and selected metals (antimony, copper, lead, and zinc) present at the designated MRSs and AoPIs in accordance with USACE guidance. ZAPATA will collect 10 discrete surface soil samples (0 – 2 in. bgs) at each of MRSs and AOPIs. Based on our historical research, MC sampling is not recommended at MRS 1. ZAPATA will also collect 10 discrete background surface soil samples from locations across the site and submit those samples for metals analysis, only. The discrete surface soil sampling at each of the MRSs and AoPIs and background samples will be collected concurrently.
Observations from any site reconnaissance reports: (Summary of Section 1.10 of the Work Plan) ZAPATA examined the information documenting previous investigations and removal actions available on the Camp Croft website, along with our own investigation results. Through that process, it has become apparent that MC has not been assessed during previous activities at Camp Croft.
A synopsis of secondary data or information from site reports: Not applicable.
The possible classes of contaminants and the affected matrices: Selected metals (antimony, copper, lead, and zinc) and explosives may be present in soil.
The rationale for inclusion of chemical and nonchemical analyses: Based on the potential MEC items listed in the initial summary of MEC Risk (Section 1.9 of the Work Plan), explosives constituents, including Pentaerythritol tetranitrate (PETN) and Nitroglycerine, selected metals (antimony, copper, lead, and zinc), and/or white phosphorus (WP) may be present at locations within the project site. Explosives constituents and WP typically degrade when exposed to the environment for considerable lengths of time. We do not anticipate these constituents will be measured at concentrations that exceed selected screening levels. However, we intend to collect discrete samples at locations where high concentrations of explosives constituents (and selected metals) may likely exist; i.e., target areas, if those areas are encountered. We do not intend to collect samples for WP analysis and will only collect samples for analysis for WP if findings indicate the high likelihood that WP exists (e.g., if we encounter a cache of 81mm, Smoke, WP, M57). ZAPATA will use EPA Methods 6020A (for metals) and 8330A (for explosives) to evaluate the media described above.
Information concerning various environmental indicators:
Project decision conditions ("If..., then..." statements): Numerous statistical methods may be appropriate for processing the data collected at Camp Croft. The method selected depends on such things as number of

samples, distribution of the data, and percent of samples with values reported as less than method detection limit or reporting limit. To simplify this process, the EPA offers a statistical package known as the Pro UCL Calculator. ZAPATA obtained the Pro UCL Calculator v4.00.04, from the Technical Support Center for Monitoring and Site Characterization Section of the EPA website (http://www.epa.gov/esd/tsc/TSC_form.htm). Following the calculation of summary statistics and upper confidence limit of the background data during the preliminary data analysis, ZAPATA will perform a comparative analysis of results from the site and background data. ZAPATA referred to two USEPA documents – Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (USEPA, 2002) and Data Quality Assessment: Statistical Methods for Practitioners, QA/GS-9 (USEPA, 2006) – for statistical guidance. For purposes of this work, background refers to concentrations not impacted from potential site-specific releases. An outlier test will be used to identify potential data outliers; those samples will be removed from further statistical analysis to prevent distortion of the statistical results. Chemical analytical results will be processed using Pro UCL v4.00.04. Data will be tabulated into a single column and partitioned, if necessary. Laboratory qualifier codes J and U will be used in the adjacent column to signify an estimated value or value below detection, respectively. For analytical results reported below the reporting limit, a value of one half of the method detection limit will be substituted into the table for calculation.

A statistical hypothesis is a statement that may be supported or rejected by examining relevant data. A null hypothesis (H_0) is any testable presumption set up to be rejected. An alternative hypothesis (H_A) is the logical opposite of the null hypothesis. When analyzing data, stakeholders must establish the level of precision required of the data. Because of uncertainties that result from sampling variation, decisions made using hypothesis tests will be subject to errors. There are two ways to err when analyzing data:

- Type I Error – Based on the observed data, the test may reject the null hypothesis when in fact the null hypothesis is true (false positive). The probability of making a Type I error is designated alpha (α).
- Type II Error – Based on the observed data, the test may fail to reject the null hypothesis when the null hypothesis is in fact false (false negative). The probability of making a Type II error is designated beta (β).

The acceptable level of decision error associated with hypothesis testing is defined by two key parameters; confidence level and power. These parameters are closely related to the two error probabilities α and β.

- Confidence level $100(1-\alpha)\%$ - As the confidence level is lowered, the likelihood of committing a Type I error increases.
- Power $100(1-\beta)\%$ - As the power is lowered, the likelihood of committing a Type II error increases.

EPA (USEPA, 2002) recommends minimum performance measures for Background Test Form 2 of confidence level greater than or equal to 90% ($\alpha = 0.10$) and power greater than or equal to 80% ($\beta = 0.20$). ZAPATA will determine the appropriate test for statistical analysis to allow for an evaluation of the difference in means between the site and background samples following the preliminary data analysis. The specific hypotheses to be used in the test are as follows (USEPA, 2002):

- The null hypothesis (H_0) is that the mean contaminant concentration in samples (μ_s) from the site is not different from the mean concentration in samples (μ_b) from background areas. (H_0: $\mu_s - \mu_b = 0$)
- The alternative hypothesis (H_A) is that the mean contaminant concentration in samples (μ_s) from the site is different from the mean concentration in samples (μ_b) from background areas. (H_A: $\mu_s - \mu_b > 0$)

If the null hypothesis is rejected, it can be concluded with statistical significance that the mean of the site contaminant concentration is different from the mean of the background contaminant concentration (i.e., the site and background mean are not similar). If the null hypothesis is not rejected, it can be assumed that the mean contaminant concentration from the site is not different from the mean contaminant concentration of background. When testing the data, the lower the confidence limit, the more likely this test is to find that the site's mean contaminant concentrations are not different from the background mean contaminant concentrations. Choosing the rejection range for the hypothesis involves balancing both kinds of error (Type I and II). In general, EPA (USEPA, 2002) recommends a minimum confidence limit of 80% and a maximum confidence limit of 95%. These hypothesis will be tested at the 95% confidence level ($\alpha = 0.05$).

If chemical analytical results are detected above EPA RSLs dated November 2010, then those results will be further evaluated in the human health risk assessment (HHRA) as chemicals of potential concern (COPCs). Once any contamination is delineated to the RSL table, EPA Region IV Ecological Screening Values (Eco-SSLs) will be used for ecological risk assessment purposes. The risk assessment process is provided in Section 3.4.12 of the Work Plans.

If chemical analytical results are detected above threshold criteria, then further sampling may be required to delineate the nature and extent of the contaminant.

QAPP Worksheet #11

Project Quality Objectives /Systematic Planning Process Statements

Who will use the data? Data will be used by ZAPATA, the USAESCH and USACE, and SC DHEC.
What will the data be used for? ZAPATA will use the data to determine the nature and extent of selected metals and explosives and to conduct human health and ecological risk assessments at the MRSs and AoPIs. The USACE will use the data to determine potential site-specific follow on activities. The SC DHEC will use the data to assess potential human and ecological impacts of the former military activity.
What type of data are needed? (target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques) Representative sampling locations will be selected following the geophysical survey (and analog) activities. Samples will be collected using standard protocols for sample collection, handling, and shipping. The laboratory will produce Level IV data packages for all analytical samples. Level IV is an EPA term and refers to a data package that contains sufficient information to allow a detailed validation of the data (i.e., reconstruction of the reported results). It includes all raw data applicable to the samples analyzed, including chromatograms and quantitation reports for tuning (for GC/MS analyses), calibration standards, and quality control (QC) samples (method/preparation blanks, matrix and/or blank spikes, laboratory duplicate analyses, and laboratory control samples). Mass spectra are also included, if applicable. Various forms which summarize the results of QC samples, calibration data, and reported sample results are also included. An EPA Contract Laboratory Program (CLP) or CLP-type data package for Superfund / CERCLA projects provides the most complete documentation and is sometimes referred to as a Level IV package, but any data package that includes all of the information that a CLP package does would be considered a Level IV data package, even if not provided on CLP forms. Parameters and analytical methods are identified in Worksheets #15 and #19.
How "good" do the data need to be in order to support the environmental decision? To generate analytical data that will meet the project objectives, it is necessary to define the types of decisions that will be made, identify the intended use of the data, and design a data collection program. Analytical data quality objectives (DQOs) are statements that define the type of data, the manner in which data may be combined, and the acceptable uncertainty in the data, which establish requirements for data quality and quantity based on the intended use of the data. The DQO process is used to assist in determining the appropriate quantifier, detection limits, reporting limits (quantitation limit), analytical methods, and sampling procedures. Data must meet the requirements for Level IV Laboratory Data Deliverables to allow for data validation. Analytical data meeting those criteria will be validated. Only those data approved during the validation process will be reported and evaluated. Project action levels are listed in Worksheet #15.
How much data are needed? (number of samples for each analytical group, matrix, and concentration) The sampling protocol was decided during TPP meetings and is based on allowable quantities set forth in ZAPATA's Performance Work Statement from the USAESCH. The quantities planned for this investigation are provided in detail herein. A minimum of 10 discrete surface soil samples at each MRS and AoPI will be collected. Duplicate/blank samples will be sampled at 10%. If initial soil samples exceed screening criteria, the lateral and horizontal extent of MC contamination will be determined by additional follow-up sampling of areas beyond the identified contaminated area through consultation with the PDT. MC samples will be collected in areas with high anomaly densities. Tentatively, those high density areas are defined as those areas where the anomaly density count is > the 97th percentile of all anomaly densities.
Where, when, and how should the data be collected/generated? The locations of the MRSs and AoPIs are identified on Exhibits in Appendix B in the work plan. Environmental samples will be collected from locations within those MRSs and AoPIs and from across the site (at locations to be determined) between September 2011 and March 2012.
Who will collect and generate the data? ZAPATA personnel will collect all analytical samples. Samples will be shipped to Accutest for analysis. Quality Assurance split samples will be shipped to TestAmerica for analysis. Analytical results will be provided in electronic format as ADR-compatible SEDD 2a files and as EPA Level IV reports (*.pdf or hard copy) to Black & Veatch for data validation. Validated data will be provided to ZAPATA and Black & Veatch for evaluation. Data will be generated at each step along that process. ZAPATA will manage the project database.

How will the data be reported? Data will be summarized in text form in the RI/FS report. Electronic versions of the complete data set will be provided as ADR-processed (reviewed) electronic data on CD in the report or by request. Hard copies of the complete data set will be provided to the USAESCH.
How will the data be archived? Data will be permanently archived by the USAESCH. Approved deliverables will be stored in the public repository by CESAC; text and electronic data will be provided in those reports.

QAPP Worksheet #12

Measurement Performance Criteria Table

Matrix	Soil
Analytical Group	Explosives
Concentration Level[1]	Range from 200 ppb to 200,000 ppb

Sampling Procedure	Analytical Method/SOP	Quantitative Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
SOP FO-003[2]	EPA Methods 8330A/OP019 and GC016	Precision*	• If sample or duplicate <DL, ≤5x difference • If sample or duplicate <RL, ≤3x difference • If both sample and duplicate >RL, ≤4x difference	Field Duplicate (Co-located)	S & A
		Accuracy/Bias	No detectable target analytes less than 1/2 RL	Field Blank	S
		Accuracy in quality system matrix	Laboratory in-house %R limits in effect when ADR project library is finalized, or %R limits provided in the DoD QSM Version 4.1, whichever is more stringent for each target analyte.	Lab Control Sample	A
		Precision	Laboratory in-house limits for %R and %RPD in effect at the time the ADR project library is finalized, or limits provided in the DoD QSM Version 4.1, whichever are more stringent for each target analyte.	Matrix Spike / Matrix Spike Duplicate	A
		Accuracy/Bias	No detectable target analytes less than 1/2 RL	Equipment Blank	S

- As given in Table 4-1 of EM 200-1-6, *Chemical Quality Assurance for HTRW Projects* dated 10 October 1997.
- [1]Concentration range for 8330A soils would be down to 200 ppb with a high range of 200,000 ppb before the laboratory starts saturating the sample with the extraction solvent.
- [2]ZAPATA SOP, refer to Appendix E, Attachment 2.

Measurement Performance Criteria Table

Matrix	Soil
Analytical Group	ICP Metals
Concentration Level	Range from 0.5 ppm to 1,000 ppm

Sampling Procedure	**Analytical Method/SOP**	**Quantitative Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)**
SOP FO-003[1]	EPA Method 6020A (Cu, Zn, Pb, Sb)/ EMA226-04 and EMP072-12	Precision*	• If sample or duplicate <DL, ≤5x difference • If sample or duplicate <RL, ≤3x difference • If both sample and duplicate >RL, ≤2x difference	Field Duplicate (Co-located)	S & A
		Accuracy/Bias	No detectable target analytes less than 1/2 RL	Field Blank	S
		Accuracy in quality system matrix	Relative Percent Difference (RPD) <20%	Lab Control Sample	A
		Precision	Percent Recovery (%R): 80% to 120%	Matrix Spike / Matrix Spike Duplicate	A
		Accuracy/Bias	No detectable target analytes less than 1/2 RL	Equipment Blank	S

- As given in Table 4-1 of EM 200-1-6, *Chemical Quality Assurance for HTRW Projects* dated 10 October 1997.
- [1] ZAPATA SOP, refer to Appendix E, Attachment 2.

QAPP Worksheet #13

Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/ Collection Dates)	How Data Will Be Used	Limitations on Data Use
Archives Search Report	ASR: Former Camp Croft (1993)	USACE Rock Island District	Creation of CSM	Data to be useed as reference only.
Archives Search Report Supplement	ASR Supplement: Former Camp Croft (2004)	USACE Rock Island District	Creation of CSM	Data to be useed as reference only.

QAPP Worksheet #14

Summary of Project Tasks

Sampling Tasks: Potential project activities, with respect to environmental sampling, include the following; 1) Soil samples will be collected as discrete samples from locations across the site, at locations to be determined. Soil samples will be collected from the ground surface to an approximate depth of two inches bgs. Those samples will be analyzed for selected metals and explosives variously using EPA Methods 6020A and 8330A. 2) Pre-Blow-in-Place (BIP) samples will be collected as discrete samples from locations where MEC is designated for BIP. Post-BIP samples will be collected using the 7-wheel composite method from locations designated for BIP (refer to SOP FO-003 for methodology). Those samples will be analyzed using EPA Methods 6020A and 8330A. 3) Background soil samples will be collected from locations across the site. Those locations will be outside of the MRS and AoPI boundaries. Those samples will be analyzed for selected metals using EPA Method 6020A. Investigative derived waste (IDW) will be consolidated in a central location and located just off Dairy Ridge Road in a way that allows easy vehicular access. Drums will be stored on pallets; no more than three drums per pallet. Each drum will be marked with 1) Shawn Boone, 2) shawn.m.boone@usace.army.mil, and 3) contents using a paint pen (e.g., Sharpie Mean Streak®) and vinyl waste label indicating the container is on hold pending analysis. The drums will be numbered sequentially; the sequence will be recorded in the field book along with the drum contents and date.
Analysis Tasks: The analytical laboratories Accutest (primary) and TestAmerica (QA) will prepare, process, and analyze the soil samples. The analytical laboratories will analyze the samples as noted in worksheet #12. The results of the analytical data will be sent to the data validators. Refer to Worksheets #15, #18, #19, #28 and #30.
Quality Control Tasks: Quality Assurance and Quality Control Samples Quality Assurance (QA split) and Quality Control (QC duplicate) samples are analyzed for the purpose of assessing the quality of the sampling effort and of the analytical data. These samples include QA split samples, QC duplicates of field samples, QC equipment rinsate blanks, trip blanks, and ambient samples. Split or duplicate samples are collected as a single sample, homogenized (with the exception of soil VOC samples), divided into two or more equal parts, and placed in separate containers. The number of duplicate samples is generally 10% of the field samples. If directed to do so by the USAESCH, ZAPATA will collect QA samples in the field prior and ship them to TestAmerica for analysis. Quality Control Duplicate Samples The sampling team will collect Quality Control (QC) samples for analysis by the primary laboratory. QC duplicate samples will be generated from field duplicates collected from the standard samples. The identity of QC samples will not be provided to the analysts or laboratory personnel. ZAPATA will keep a log identifying each Quality Control sample to its duplicate soil sample. This procedure ensures that the laboratory will not know which Quality Control sample matches the field sample. A table will be provided in the report that designates the QC sample to the duplicate field sample. The purpose of the QC samples is to provide site-specific, field-originated checks of the quality of the data generated by the laboratory. Quality Assurance Split Samples Quality Assurance (QA) samples will be sent by overnight delivery to TestAmerica (QA) laboratory to evaluate the performance of the primary laboratory. These samples will be generated from field splits.

QC Equipment Rinsate Blanks
Rinsate blanks (or equipment blanks) are samples consisting of analyte-free water collected from a final rinse of sampling equipment after the decontamination procedure have been performed. The purpose of rinsate blanks is to measure the effectiveness of the decontamination process and materials storage/handling protocols. By analyzing rinsate blanks, the potential for cross-contamination of samples by the drilling or sampling equipment may be evaluated.

Temperature Blanks
Temperature blanks are containers of organic-free reagent water that are kept with the field sample containers from the time they leave the laboratory until they are returned to the laboratory. The purpose of temperature blanks is to evaluate the temperature of the cooler during transit and upon arrival at the laboratory.

Secondary Data: Data from previous documents will be reviewed and evaluated for the use in this project. See Worksheet #13.

Data Management Tasks: All soil sample results will be provided by the analytical laboratory (Accutest) and the contracted data validator in hard copy and electronic format. All analytical data collected during the field work portion of this project will be summarized and included in the final report. See Worksheet #34.

Documentation and Records: Worksheet #29 contains a list of the project documents and records that will be generated from the data gathered. The GPS coordinates of all sample locations will be recorded in the field logbook. Chains-of-Custody will be used to track the sample from the site to the laboratory. Shipping airbills related to sample shipments will be retained.

Sample collection, storage, packing, and shipment will be properly documented to ensure chemical data integrity. The log will be a permanently bound field notebook. Field documentation will be entered using indelible ink. Corrections will be made by drawing a single line through the error, then initialing and dating the line. Each page will be dated, initialed, and sequentially numbered.

QC Reports will be prepared daily, dated, signed by the Site Manager, and sent to USACE upon completion of the fieldwork. These reports will include weather information at the time of sampling, sample identification, field instrument measurements, and calibrations. The cover of each notebook will bear the following: 1) project name; 2) project number; and 3) opening and closing dates for data contained in the book. The inside cover will include the address and telephone number of the ZAPATA office.

At the beginning of each daily entry, the date, start time, weather, and planned activities will be recorded. The names of visitors and the purpose of their visits will be noted. Any deviations from the Work Plan will be recorded along with the reason for the deviation. The remainder of this section discusses the procedures for field documentation.

Sampling Activities
Sampling personnel will record in the field logbook the preparation activities that may be pertinent to the sampling event at each sampling location. For soil sampling, documentation may include information on the lithology, presence of surface staining, water logging or ponding, proximity to roads or waste piles, apparent up-gradient physiographic or hydrogeologic features of significance, the depth from which the samples were collected, and the equipment and materials that were used.

Sample Containers
ZAPATA will use sample containers furnished by Accutest and TestAmerica, and verify that the laboratory has and uses pre-cleaned containers. The source and lot numbers of sample containers used in the sampling event will be recorded in the Site Manager's field logbook for each sample collected. The lot number may be used to trace the bottle ware preparation and certification of cleanliness. When bottle ware is shipped directly from the supplier to the field, a formal chain-of-custody is not normally initiated. In this instance, the packing slip serves as the initiation of chain-of-custody.

Sample Location, Sample Medium, and Analytes
The specific location of each sample will be recorded with each sample identification number in the field logbook and on the chain-of-custody form. Other location references may be the distance and bearing from a prominent landmark. The sampled matrix and designated analytes will be recorded in the field logbook and on the chain-of-custody.

Assessment/Audit Tasks: The laboratory QA Officer will implement performance and/ or system audits to insure that data of known and defensible quality are produced during the project. System audits are qualitative evaluations of components of the laboratory quality control measures systems. They determine if the measurement systems are being used appropriately. The audits may be carried out before all systems are operational, during the laboratory program, or after the completion of the program. Such audits typically involve

a comparison of the activities specified in the QA/QC Plan with activities actually scheduled or performed. The data management audit addresses only data collection and management activities. The performance audit is a quantitative evaluation of the measurement systems of a program. It requires testing the measurement systems with samples of known composition or behavior to evaluate precision and accuracy. The performance audit is carried out by or under the auspices of the QA Officer without knowledge of the analyst. Based on this evaluation, the laboratory QA Officer will implement corrective actions as necessary to ensure that reliable data are achieved.
Data Review Tasks: Accutest Laboratories Southeast employs multiple levels of data review to assure that reported data has satisfied all quality control criteria and the client specifications and requirements have been met. The analyst conducts the primary review of all data. Analyst checks focuses on a review of qualitative determinations and checks of precision and accuracy data to verify that existing laboratory criteria have been achieved. Secondary data reviews are performed at the peer level by analysts who have met the qualification criteria for the method in use. It includes a check of all manual calculations; an accuracy check of manually transcribed data from bench sheets to the LIMS, a check of all method and instrument QC criteria, baseline manipulations (if applicable) and a comparison of the data package to client specified requirements. Secondary reviewers have the authority to reject data and initiate re-analysis, corrective action, or reprocessing of data. The report generation group reviews all data and supporting information delivered by the laboratory for completeness and compliance with client specifications. Missing deliverables are identified and obtained from the laboratory. The group also reviews the completed package to verify that the delivered product complies with all client specifications. Non-analytical defects are corrected before the package is sent to the client. The QA Staff reviews approximately 10% of the data produced. The QA review focuses on all elements of the deliverable including the client's specifications and requirements, analytical quality control, sample custody documentation and sample identification. QA reviews at this step in the production process are geared towards systematic process defects, which require procedural changes to effect a corrective action. Black & Veatch will establish an electronic project library in ADR automated data review software. This project library will reflect the data review acceptance criteria established in the UFP-QAPP. For any project library requirements that are not specified in this document, Black & Veatch will use either the contract laboratory's in-house data review acceptance criteria or those specified in the DoD Quality Systems Manual Version 4.1, whichever is more stringent. Black & Veatch will process ADR Stage 2a SEDD files through ADR against the criteria established in the project library. Professional judgment will be used by Black & Veatch to evaluate the ADR data review qualifiers and to modify them as needed. Black & Veatch will also compare a representative portion of the data in the ADR SEDD files to that in the corresponding hard copy or *.pdf reports to confirm that there is consistency betwee the two forms of reporting. Black & Veatch will summarize the data review scope, process, and findings in a Quality Control Summary Report (QCSR). Included in this QCSR will be a review of Daily Quality Control Reports (DQCRs), as well as a section summarizing any recommendations for future investigations ("lessons learned"). ZAPATA will review a random subset of valided data (between 5 - 10%) as an additional quality control check before incorporating the data into a final database for further evaluation.

QAPP Worksheet #15

Reference Limits and Evaluation Table*

Matrix: Soil
Analytical Group: Explosives (EPA Methods 8330A)
Concentration Level¹: Range from 200 ppb to 200,000 ppb

Analyte	CAS Number	Project Action Limit† (mg/kg)	Project Quantitation Limit (mg/kg)	Analytical Method (mg/kg)		Achievable Laboratory Limits (mg/kg)		
				Detection Limits‡	Quantitation Limits§	Detection Limits	Limits of Detection	Reporting Limits
2,4,6-Trinitrotoluene	118-96-7	0.013	0.013	Not Provided	0.25	0.080	0.1	0.2
2,4-Dinitrotoluene	121-14-2	0.00029	0.00029	Not Provided	0.25	0.097	0.1	0.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	0.00023	0.00023	Not Provided	1.0	0.080	0.1	0.2
4-Amino-2,6-dinitrotoluene	19406-51-0	0.056	0.056	Not Provided	Not Provided	0.080	0.1	0.2
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	2.3	2.3	Not Provided	2.2	0.080	0.1	0.2
2-Amino-4,6-dinitrotoluene	35572-78-2	0.056	0.056	Not Provided	Not Provided	0.080	0.1	0.2
Methyl-2,4,6-trinitrophenylnitramine (Tertyl)	479-45-8	1.4	1.4	Not Provided	0.65	0.080	0.1	0.2
2,6-Dinitrotoluene	606-20-2	0.05	0.05	Not Provided	0.26	0.087	0.1	0.2
2-Nitrotoluene	88-72-2	0.00029	0.00029	Not Provided	0.25	0.080	0.1	0.2
Nitrobenzene	98-95-3	0.000079	0.000079	Not Provided	0.26	0.093	0.1	0.2
3-Nitrotoluene	99-08-1	0.0034	0.0034	Not Provided	0.25	0.080	0.1	0.2
1,3,5-Trinitrobenzene	99-35-4	3.9	3.9	Not Provided	0.25	0.080	0.1	0.2
1,3-Dinitrobenzene	99-65-0	0.0033	0.0033	Not Provided	0.25	0.080	0.1	0.2
4-Nitrotoluene	99-99-0	0.0039	0.0039	Not Provided	0.25	0.1	0.15	0.2
Nitroglycerin	55-63-0	0.0016	0.0016	Not Provided	Not Provided	0.5	0.2	2
Pentaerythritol tetranitrate (PETN)	78-11-5	0.025	0.025	Not Provided	Not Provided	0.5	0.2	2

Note: In numerous cases (shaded cells), the lowest technically achievable laboratory detection limits exceed the project action limits. In those cases, the analytical data usability may be subject to additional scrutiny.

* Worksheet #15 of the UFP-QAPP template requests project-specific input on Project Action Limits (PALs), Project Quantitation Limits (PQLs), Analytical Method Detection Limits (MDLs), Analytical Method Quantitation Limits (MQLs), Laboratory Detection Limits (LDLs), and Laboratory Reporting Limits (LRLs). Additional information has been requested; specifically Measurement Quality Objectives (MQOs), Limits of Detection (LOD), and Limits of Quantitation (LOQ), as defined in Appendix B of the DoD QSM Version 4.1 dated 22 April 2009. LOD data have been added. Accutest RLs are set at the LOQs; LOQs are equal to or greater than the lowest calibration standard. Worksheets 12 and 37 indicate the acceptance ranges for accuracy or bias (percent recoveries) and precision (%RPD between MS/MSD or laboratory duplicates).

¹Concentration range for 8330A soils would be down to 200 ppb with a high range of 200,000 ppb before the laboratory starts saturating the sample with the extraction solvent.

† Based on the Risk-based SSL for Protection of Groundwater from the EPA Regional Screening Level (RSL) Summary Table dated June 2011

‡ In some cases, no value is provided in the published methods

§ Estimated quantitation limits (EPA Method 8330A, January 1998)

Reference Limits and Evaluation Table*

Matrix: Soil
Analytical Group: Metals (EPA Methods 6020A)
Concentration Level: Range from 0.5 ppm to 1,000 ppm

Analyte	CAS Number	Project Action Limit† (mg/kg)	Project Quantitation Limit (mg/kg)	Analytical Method (ppm‡) Detection Limits	Analytical Method (ppm‡) Quantitation Limits§	Achievable Laboratory Limits (mg/kg) Detection Limits	Achievable Laboratory Limits (mg/kg) Limits of Detection	Achievable Laboratory Limits (mg/kg) Reporting Limits
Copper	7440-50-8	51	5.1	0.0036**	Not Provided	0.040	0.6	1
Lead	7439-92-1	14	1.4	0.028***	Not Provided	0.008	0.150	0.250
Zinc	7440-66-6	680	68	0.0012***	Not Provided	0.466	1.2	2
Antimony	7440-36-0	0.66	0.66	0.021***	Not Provided	0.073	0.250	0.250

* Worksheet #15 of the UFP-QAPP template requests project-specific input on Project Action Limits (PALs), Project Quantitation Limits (PQLs), Analytical Method Detection Limits (MDLs), Analytical Method Quantitation Limits (MQLs), Laboratory Detection Limits (LDLs), and Laboratory Reporting Limits (LRLs). Additional information has been requested; specifically Measurement Quality Objectives (MQOs), Limits of Detection (LOD), and Limits of Quantitation (LOQ), as defined in Appendix B of the DoD QSM Version 4.1 dated 22 April 2009. LOD data have been added. Accutest RLs are set at the LOQs; LOQs are equal to or greater than the lowest calibration standard. Worksheets 12 and 37 indicate the acceptance ranges for accuracy or bias (percent recoveries) and precision (%RPD between MS/MSD or laboratory duplicates).
† Based on the Risk-based SSL (or MCL-based SSL for lead) for Protection of Groundwater from the EPA Regional Screening Level (RSL) Summary Table dated June 2011
‡ ppm, parts per million is equivalent to mg/kg; published analytical MDLs are in mg/L or µg/L
§ In some cases, no value is provided in the published method
** Estimated instrumental detection limits (EPA Method 6010B, December 1996); EPA Method 6020A does not provide estimates

QAPP Worksheet #16

☑ Worksheet Not Applicable (State Reason)

The project schedule is provided in Appendix M of the Work Plan.

Project Schedule Timeline Table

Activities	Organization	Dates (MM/DD/YY) Anticipated Date(s) of Initiation	Dates (MM/DD/YY) Anticipated Date of Completion	Deliverable	Deliverable Due Date

QAPP Worksheet #17

Sampling Design and Rationale

Describe and provide a rationale for choosing the sampling approach (e.g., grid system, biased statistical approach): The overall sampling approach is largely based on USAESCH sampling guidance and the TPP process. Refer to Worksheet #14 for a detailed description of the sampling approach.
Describe the sampling design and rationale in terms of what matrices will be sampled, what analytical groups will be analyzed and at what concentration levels, the sampling locations (including QC, critical, and background samples), the number of samples to be taken, and the sampling frequency (including seasonal considerations) [May refer to map or Worksheet #18 for details]: Refer to Worksheet #18 and Figure B-2 for details. Sampling Locations Soil samples will be collected as discrete samples from locations across the site at locations to be determined. Soil samples will be collected from the ground surface to an approximate depth of two inches bgs. Those samples will be analyzed for selected metals and explosives variously using EPA Methods 6020A and 8330A. Pre-BIP samples will be collected as discrete samples from locations where MEC is designated for BIP. Post-BIP samples will be collected using the 7-wheel composite method from locations designated for BIP (see SOP FO-003 for methodology). Those samples will be analyzed using EPA Methods 6020A and 8330A. Background soil samples will be collected from locations across the site. Those locations will be outside of the MRS and AoPI boundaries. Those samples will be analyzed for selected metals using EPA Method 6020A.

QAPP Worksheet #18

Minimum Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ID Number	Matrix	Depth (inches)	Analytical Group	Concentration Level[1]	Number of Samples (identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
To be determined (Discrete samples)	Soil	0 to 2	Explosives	Range from 200 ppb to 200,000 ppb	192 total samples 120 discrete samples 12 duplicate (QC) 12 duplicate (MS) 12 duplicate (MSD) 12 duplicate (QA) 24 rinsate blank	SOP FO-003	The locations are not based on MRS boundaries but, are based on site observations and will be determined in the field.
To be determined (Discrete samples)	Soil	0 to 2	Metals	Range from 0.5 ppm to 1,000 ppm	192 total samples 120 discrete samples 12 duplicate (QC) 12 duplicate (MS) 12 duplicate (MSD) 12 duplicate (QA) 24 rinsate blank	SOP FO-003	The locations are not based on MRS boundaries but, are based on site observations and will be determined in the field.
Pre- and Post-BIP locations (Discrete samples for pre-BIP and 7pt.-wheel method for post-BIP)	Soil	0 to 2	Explosives	Range from 200 ppb to 200,000 ppb	52 total samples 26 discrete samples 26 rinsate blank	SOP FO-003	The locations are based on site observations and evidence of MEC.
Pre- and Post-BIP locations (Discrete samples for pre-BIP and 7pt.-wheel method for post-BIP)	Soil	0 to 2	Metals	Range from 0.5 ppm to 1,000 ppm	52 total samples 26 discrete samples 26 rinsate blank	SOP FO-003	The locations are based on site observations and evidence of MEC.
Background (Discrete samples)	Soil	0 to 2	Metals	Range from 0.5 ppm to 1,000 ppm	16 total samples 10 discrete samples 1 duplicate (QC) 1 duplicate (MS) 1 duplicate (MSD) 1 duplicate (QA) 2 rinsate blank	SOP FO-003	Background locations will be beyond MRS boundaries and in areas representative of site conditions. These locations will be determined in the field based on site observations.

[1] Concentration range for 8330A soils would be down to 200 ppb with a high range of 200,000 ppb before the laboratory starts saturating the sample with the extraction solvent.

QAPP Worksheet #19

Analytical SOP Requirements Table

Matrix	Analytical Group	Concentration Level[1]	Analytical and Preparation Method/SOP Reference	Sample Volume	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/ analysis)
Soil	Explosives	Range from 200 ppb to 200,000 ppb	OP019, GC016 EPA 8330A	4 oz.	(1) 4 oz. CMW jar	None	14 days
Soil	Metals	Range from 0.5 ppm to 1,000 ppm	EMP072-12, EMA226-04 EPA 6020A	4 oz.	(1) 4 oz. CMW jar	None	180 days metals

[1] Concentration range for 8330A soils would be down to 200 ppb with a high range of 200,000 ppb before the laboratory starts saturating the sample with the extraction solvent.

QAPP Worksheet #20

Field Quality Control Sample Summary Table

Matrix	Analytical Group	Concentration Level[1]	Analytical and Preparation SOP Reference	No. of Sampling Locations	No. of Field Duplicate Pairs	Inorganic No. of MS/MSD	No. of Field Blanks	No. of Equip. Blanks	No. of PT Samples	Total No. of Samples to Lab
Soil	Explosives	Range from 200 ppb to 200,000 ppb	OP019, GC016 EPA 8330A	120	24	24		24		192
Soil	Metals	Range from 0.5 ppm to 1,000 ppm	MET100, MET104, MET105 EPA 6020A	130	26	26		26		208

[1] Concentration range for 8330A soils would be down to 200 ppb with a high range of 200,000 ppb before the laboratory starts saturating the sample with the extraction solvent.

QAPP Worksheet #21

Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Check if yes)	Comments
FO-002	Field Logbook	ZAPATA	NA	☐	
FO -003	Soil Sampling	ZAPATA	NA	☐	
FO-008	Sample Labeling	ZAPATA	NA	☒	Sample IDs specified in Worksheet #27
FO-009	Chain of Custody	ZAPATA	NA	☐	
FO-010	Sample Packing and Shipping	ZAPATA	NA	☐	
FO-011	Equipment Decontamination	ZAPATA	NA	☐	
DID WERS-009.01	Munitions Constituents Chemical Data Qualifier	USAESCH	NA	☐	DID WERS-009.01

QAPP Worksheet #22

☑ Worksheet Not Applicable (State Reason)

Field equipment associated with MC sampling is not anticipated for this site.

Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference

QAPP Worksheet #23

Analytical SOP References Table

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
MET100	Metals by ICP, 2009	Definitive	Metals	TJA Trace	Accutest Laboratories Southeast, Inc., Orlando, Florida	☐
MET104	Digestion of Soils for ICP Analysis, 2009	Definitive	Metals	SCP Science	Accutest Laboratories Southeast, Inc., Orlando, Florida	☐
MET105	CVAA Analysis of Hg in Soil, 2009	Definitive	Metals	Leeman HydraAA/ Environmental Express digestion block	Accutest Laboratories Southeast, Inc., Orlando, Florida	☐
EMA226-04	Metals by ICP/MS 3/8/2011	Definitive	Metals	Agilent 7700X	Accutest Laboratories Mid Atlantic Dayton, NJ	
EMP073-12	Digestion of soils for ICP and ICP/MS Analysis 9/1/09	Definitive	Metals	Digestion block	Accutest Laboratories Mid Atlantic Dayton, NJ	
OP019	Standard Operating Procedure For The Extraction of Nitroaromatics and Nitramines (Explosives) From Soil Samples for HPLC Analysis	Definitive	Explosives	Ultrasonic Extractor	Accutest Laboratories Southeast, Inc., Orlando, Florida	☐
GC016	Analysis of Nitroaromatics, Nitramines, and Nitrate Esters by HPLC Method SW-846 8330A	Definitive	Explosives	Agilent 1100	Accutest Laboratories Southeast, Inc., Orlando, Florida	☐

QAPP Worksheet #24

Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
Agilent 1100	SW-846 8330A	As needed	%RSD < 20%, or Correlation coefficient R > 0.995	Instrument maintenance, standard inspection, recalibration	Laboratory Analyst	GC016
Agilent 7700X ICP-MS	SW-846 6020A	As needed	Correlation coefficient R > 0.998	Instrument maintenance, standard inspection, recalibration	Laboratory Analyst	EMA226-04

QAPP Worksheet #25

Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
High Performance Liquid Chromatography (HPLC)	Replace disposables, check LC pump tubing, inspect mobile phase degasser, autosampler and temperature control column compartment	Accutest Laboratories Southeast, Inc.	Check LC pump tubing, inspect eluant degasser, autosampler and temperature control column compartment, replace disposables	See Worksheet 23 SOP GC016	See Worksheet 23 SOP GC016	Inspect system; correct problem; re-run calibration and affected samples	Laboratory Analyst	SOP GC106
Agilent 7700X ICP/MS	Torch, nebulizer, spray chamber, autosampler, pump tubing maintenance	SW-846 6020A	Check connections, flush lines, clean nebulizer	Frequency determined by instrument remaining in calibration and free of interference	Passing calibration	Reconnect sample pathways, recalibrate, reanalyze affected samples	Laboratory Analyst	EMA226-04

QAPP Worksheet #26

Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Environmental Technician or UXO Technician/ZAPATA
Sample Packaging (Personnel/Organization): Environmental Technician or UXO Technician/ZAPATA
Coordination of Shipment (Personnel/Organization): Environmental Technician or UXO Technician/ZAPATA
Type of Shipment/Carrier: FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Receiving/Accutest Labs
Sample Custody and Storage (Personnel/Organization): Sample Receiving/Accutest Labs
Sample Preparation (Personnel/Organization): Sample Receiving/Accutest Labs
Sample Determinative Analysis (Personnel/Organization): Analytical Analyst/Accutest
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 60 Days
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 90 days or until they expire
Biological Sample Storage (No. of days from sample collection): NA
SAMPLE DISPOSAL
Personnel/Organization: Sample Control/Accutest
Number of Days from Analysis: 60 Days

QAPP Worksheet #27

Sample Custody Requirements

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): Refer to SOP FO-010

Sampling Procedure:
ZAPATA will perform discrete sampling during sampling activities. ZAPATA will use a stainless-steel hand trowel to collect discrete surface samples. Sampling will be conducted in accordance with USACE and SCDHEC guidelines.

Discrete Surface Soil Sampling
Soil samples will be collected with a stainless-steel hand trowel. Soil samples will be transferred to a stainless-steel bowl for homogenization. Soil samples will be collected in clean new jars provided by Accutest (see Worksheet #19 for Appendix E). Each filled sample container will be placed in a labeled Ziploc bag and stored in a cooler with ice until prepared for shipment. Sample documentation, packaging, and shipping will be in accordance with methods described in subsequent sections. Trip blanks will be provided by the laboratory and will be returned with the samples, in the sample coolers, to the laboratory. QC duplicate samples and QA split samples (if required) will be collected concurrent with the soil samples outlined above for analysis of explosives and selected metals.

Field Equipment and Supplies:
Execution of the scope of work requires the use of exploration and sampling equipment, as well as field screening equipment. The proper decontamination and maintenance are essential to data quality. This section presents the measures employed to assure that equipment conditions do not impact data quality.

Decontamination

Decontamination of the pertinent sampling equipment will be performed between each sampling event. Decontamination will be performed in an area of the site considered to be free from contamination. Sampling and monitoring equipment will be decontaminated prior to sampling, using the following procedure:

1) Rinse with tap water,
2) Soak and wash with laboratory soap solution (Liquinox),
3) rinse thoroughly with tap water,
4) rinse thoroughly with analyte-free water,
5) rinse with pesticide grade isopropyl alcohol,
6) rinse with analyte-free water, and
7) air dry, time permitting, and wrap in aluminum foil if the equipment is to be transported.

Sampling personnel will avoid contacting sampling equipment with the surrounding soils or unprotected hands. The laboratory will supply sample containers. For safety reasons and to minimize contamination, preservatives will be added to the sample bottles prior to delivery to the site. Sample personnel will don new, laboratory-quality disposable gloves prior to each sample event.

Sample Packing:
Samples are packed for shipping in waterproof ice chests and coolers. Unless prohibited by size, sample containers are individually sealed in Ziploc or other plastic bags, prior to packing in the cooler. Bubble wrap or Styrofoam packing is used to prevent breakage during shipment. Frozen gel packs are placed with the

samples in the cooler to maintain the samples at a temperature of approximately 4°C during temporary on-site storage and shipping. Accutest will provide temperature containers, and one will be placed in the cooler at the time of packing. If one is not provided, a spare bottle, filled with tap water will be placed inside the cooler and marked "temperature blank." The temperature blank is used to document that the samples are at their required temperature when they arrive at the laboratory for analysis.

The chain-of-custody form is signed and relinquished by the principal sampler or responsible party (see below). The form is sealed in a waterproof plastic bag and is placed inside the cooler, typically by taping the bag to the inside lid of the cooler.

Following packing, the cooler lid is sealed with strapping or duct tape. Two custody seals are signed and dated and are affixed on/around two corners of the cooler, across the seal of the lid, and are covered with clear tape. The tape will be placed on either end of the custody seal, thereby requiring the seal be broken during any attempt to open the cooler. The cooler is also labeled with "This End Up" and "Fragile" warning markers.

Sample Shipping:
The sample coolers will be shipped, typically on the day samples are collected, by overnight express carrier to the laboratory. A copy of the bill of lading will be retained by ZAPATA and will become part of the sample custody documentation. Prior to sample shipment, the laboratory will be notified by telephone to ensure personnel will be available to receive the coolers. Samples will be shipped for delivery during Accutest's normal operating hours. If samples must be shipped for delivery at other times, ZAPATA will arrange with Accutest to have personnel available to receive off-hours delivery.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): Refer to SOP SAM101, SAM108

Sample Identification Procedures:

A unique identification number will be assigned to each sample. The sample identification number will contain an alphanumeric sequence, which references the sample by matrix, site, and relative position in the sampling sequence. Information pertaining to a particular sample is referenced by its identification number, which is recorded on the sample bottle, in the field logbook, and on the chain-of-custody form.

Soil Samples
Soil samples collected for laboratory analysis using a hand trowel, will be designated first with the 'site identifier,' then a 'ZSB' prefix (referring to ZAPATA soil boring), followed by a numerical boring/location identification number and soil sampling interval as follows:

x-y-[prefix]- z

where:

x: 'CC' - Corresponding for Camp Croft RI/FS
y: MRS #, AoPI #, or BKG (background)
prefix: ZSB
z: ascending number for each soil sample.

For example, the discrete soil sample taken from soil boring #3 of MRS 2 will be identified as CC-MRS2-ZSB-03.

QC duplicate samples will be identified by replacing the 'ZSB' prefix with 'QCS-DUP' (QC Soil Duplicate Sample), preceded by the site identification acronym (without reference to the MRS or background location) and followed by an ascending number for each duplicate sample collected. Thus, the first duplicate sample will be identified as CC-QCS-DUP-01. ZAPATA will keep a log identifying each QC duplicate sample to its duplicate field sample. This procedure ensures that the laboratory will not know which QC sample matches the field samples. A table will be provided in the report that designates the QC duplicate sample to the duplicate field sample.

In a manner similar to that described above, QC Rinsate Blanks for soil samples will be identified by replacing the 'ZSB' prefix with 'QCS-RIN' (QC Soil Rinsate Sample). These will be followed by an ascending number for each rinsate blank submitted to the laboratory.

Chain-of-custody Procedures: Refer to SOP FO-009

The primary objective of sample custody is to provide accurate, verifiable, and traceable records of sample possession and handling from preparation and shipment of bottle ware through laboratory receipt, sample analyses, and data validation. A sample is considered in custody if it is:

- in actual possession of the sampler or transferee,
- in view of the sampler or transferee after establishment of physical possession,
- sealed for sample integrity by the sampler, and/or
- in a secured area, with access restricted to authorized personnel.

Container Preparation/Management

Accutest will furnish sampling containers. Containers will be provided with the Environmental Sampling Supply (ESS) batch number and the lot number for any preservatives provided to permit traceability. All standard custody procedures are maintained for pre-cleaned sample containers. If the containers must be stored between receipt by ZAPATA and sample collection, they will be stored at the ZAPATA field office or in a designated secure area near the site.

Chain-of-Custody Documentation, Traceability, and Sample Integrity (Field)

After sample collection, all sample containers will be labeled with an identification number that uniquely identifies the sample. The sample identification number will be logged in the field logbook and on the Chain-of-Custody Record with the following information:

- sampling location (including state and city),
- sampling personnel,
- date and time of collection,
- field sample location and depth (if appropriate),
- observations of ambient (weather) conditions,
- type of sampling (composite or grab),
- method of sampling,
- sampling matrix or source,
- intended analyses and type of container,
- preservation method, and
- observations of physical characteristics of the sample.

Chain-of-custody is maintained for samples transported from the field to the laboratory by common carrier. Completed custody forms must accompany each sealed cooler and are placed in a plastic bag, which is taped to the inside lid of the cooler. The sampling team in the field seals coolers with a custody seal to ensure that tampering would be immediately evident. A sample identification number is recorded with waterproof ink on the container label. A copy of each packing slip associated with a shipment of samples is maintained in the project files.

QAPP Worksheet #28

QC Samples Table

Matrix	Soil (Discrete Samples)
Analytical Group	Explosives
Concentration Level[1]	Range from 200 ppb to 200,000 ppb
Sampling SOP	SOP FO-003
Analytical Method/ SOP Reference	8330A
Sampler's Name	Field Personnel
Field Sampling Organization	ZAPATA
Analytical Organization	Accutest
No. of Sample Locations	32

QC Sample:	**Frequency/Number**	**SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Field Duplicate	One per matrix per analytical method for each batch of at most 10 samples.	≥30% RPD	None	Laboratory Analyst	Precision	RPD Less than or equal to 30%
Field Blank	One per matrix per analytical method for each batch of at most 20 samples.	>½ RL	If outside of control, reanalyze. Qualify data as needed.	Laboratory Analyst	Accuracy/Bias	No detectable target analytes less than ½ RL

QC Samples Table

Matrix	Soil (Discrete Samples)
Analytical Group	Explosives
Concentration Level[1]	Range from 200 ppb to 200,000 ppb
Sampling SOP	SOP FO-003
Analytical Method/ SOP Reference	8330A
Sampler's Name	Field Personnel
Field Sampling Organization	ZAPATA
Analytical Organization	Accutest
No. of Sample Locations	32

QC Sample:	Frequency/Number	SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Laboratory Control Sample	One per matrix per analytical method for each batch of at most 20 samples.	Laboratory in-house %R limits in effect when ADR project library is finalized, or %R limits provided in the DoD QSM Version 4.1, whichever is more stringent for each target analyte.	If outside of control, reanalyze. Qualify data as needed.	Laboratory Analyst	Accuracy in quality system matrix	% Recovery = (Calculated Value/True Value)*100%, updated annually
Matrix Spike/ Matrix Spike Duplicate (inorganics)	One per matrix per analytical method for each batch of at most 20 samples.	Laboratory in-house %R limits in effect when ADR project library is finalized, or %R limits provided in the DoD QSM Version 4.1, whichever is more stringent for each target analyte.	If outside of control, reanalyze. Qualify data as needed.	Laboratory Analyst	Precision	% Recovery = (Calculated Value-Sample Value/True Value)*100% RPD (%) = [(XA-XB)/XM]*100 Where: XA and XB are the concentrations in the MS and MSD, and XM is the average value of the concentrations in MS and MSD, (XA+XB)/2

QC Samples Table

Matrix	Soil (Discrete Samples)
Analytical Group	Explosives
Concentration Level[1]	Range from 200 ppb to 200,000 ppb
Sampling SOP	SOP FO-003
Analytical Method/ SOP Reference	8330A
Sampler's Name	Field Personnel
Field Sampling Organization	ZAPATA
Analytical Organization	Accutest
No. of Sample Locations	32

QC Sample:	Frequency/Number	SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Equipment Blank	One per matrix per analytical method for each batch of at most 20 samples.	>½ RL	If outside of control, reanalyze. Qualify data as needed.	Laboratory Analyst	Accuracy/Bias	No detectable target analytes less than ½ RL

[1] Concentration range for 8330A soils would be down to 200 ppb with a high range of 200,000 ppb before the laboratory starts saturating the sample with the extraction solvent.

QC Samples Table

Matrix	Soil (Discrete Samples)
Analytical Group	Metals
Concentration Level	Range from 0.5 ppm to 1,000 ppm
Sampling SOP	SOP FO-003
Analytical Method/ SOP Reference	6020A
Sampler's Name	Field Personnel
Field Sampling Organization	ZAPATA
Analytical Organization	Accutest
No. of Sample Locations	32

QC Sample:	Frequency/Number	SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field Duplicate	One per matrix per analytical method for each batch of at most 10 samples.	30% RPD	None	Laboratory Analyst	Precision	RPD Less than or equal to 30%
Field Blank	One per matrix per analytical method for each batch of at most 20 samples.	>½ RL	If outside of control, reanalyze. Qualify data as needed.	Laboratory Analyst	Accuracy/Bias	No detectable target analytes less than ½ RL
Laboratory Control Sample	One per matrix per analytical method for each batch of at most 20 samples.	+/- 20%	If outside of control, reanalyze. Qualify data as needed.	Laboratory Analyst	Accuracy in quality system matrix	+/- 20%
Matrix Spike/ Matrix Spike Duplicate (inorganics)	One per matrix per analytical method for each batch of at most 20 samples.	75-125% Recovery, 20% RPD	If outside of control, Qualify data as needed.	Laboratory Analyst	Precision	75-125% Recovery, 20% RPD

QC Samples Table

Matrix	Soil (Discrete Samples)
Analytical Group	Metals
Concentration Level	Range from 0.5 ppm to 1,000 ppm
Sampling SOP	SOP FO-003
Analytical Method/ SOP Reference	6020A
Sampler's Name	Field Personnel
Field Sampling Organization	ZAPATA
Analytical Organization	Accutest
No. of Sample Locations	32

QC Sample:	Frequency/Number	SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Equipment Blank	One per matrix per analytical method for each batch of at most 20 samples.	>½ RL	If outside of control, reanalyze. Qualify data as needed.	Laboratory Analyst	Accuracy/Bias	No detectable target analytes less than ½ RL

QAPP Worksheet #29

Project Documents and Records Table

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
Field Logbook Sampling Logs Daily Quality Summary Report Chain-of-Custody Records Shipping Records	N/A	Laboratory Analytical Reports Laboratory Quality Control Report Laboratory Chain-of-Custody Records ADR SEDD	Data Validation Report	GIS database, updated as appropriate

QAPP Worksheet #30

Analytical Services Table

Matrix	Analytical Group	Concentration Level[1]	Sample Location/ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization (Name and Address, Contact Person and Telephone Number)	Quality Assurance Laboratory/Organization (Name and Address, Contact Person and Telephone Number
Soil	Explosives	Range from 200 ppb to 200,000 ppb	TBD	8330A	30 days	Accutest Laboratories Southeast, Inc. (Ms. Sue Bell) 4405 Vineland Rd., Suite C-15 Orlando, FL 32811	TestAmerica, Inc., (Ms. Debra Henderer) 4955 Yarrow Street Arvada, CO 80002
Soil	Metals	Range from 0.5 ppm to 1,000 ppm	TBD	6020A	30 days	Accutest Laboratories Southeast, Inc. (Ms. Sue Bell) 4405 Vineland Rd., Suite C-15 Orlando, FL 32811	TestAmerica, Inc., (Ms. Debra Henderer) 4955 Yarrow Street Arvada, CO 80002

[1] Concentration range for 8330A soils would be down to 200 ppb with a high range of 200,000 ppb before the laboratory starts saturating the sample with the extraction solvent.

QAPP Worksheet #31

Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Field Sampling Audit	One; conducted at the start of field operations	Internal	ZAPATA	Terry Farmer UXO QC (ZAPATA)	Field Personnel	Terry Farmer UXO QC (ZAPATA)	Suzy Cantor-McKinney Quality Manager (ZAPATA)
Laboratory Audit*		External			Sue Bell Project Manager (Accutest)		
Field Document Audit	Weekly during field operations	Internal	ZAPATA	Jeff Schwalm SUXOS (ZAPATA)	Field Personnel	Jeff Schwalm SUXOS (ZAPATA)	Suzy Cantor-McKinney Quality Manager (ZAPATA)
Field Safety Audit	Weekly	Internal	ZAPATA	Tim Hendrix UXO SO (ZAPATA)	Field Personnel	Tim Hendrix UXO SO (ZAPATA)	George Dwiggins, Ph.D., CIH, CSP Corporate Safety Officer (ZAPATA)
Analytical Data Review Audit	Daily during field operations	External	Black & Veatch	Jim Eldridge Data Validator (Black & Veatch)	Sue Bell Project Manager (Accutest)	Jason Shiflet Project Manager (ZAPATA)	Suzy Cantor-McKinney Quality Manager (ZAPATA)

* Certificate of Accreditation (Certificate # L2229) dated December 2009 satisfies this requirement.

QAPP Worksheet #32

Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Org.)	Timeframe for Response
Field Sampling Audit	Audit Form	Jason Shiflet Project Manager (ZAPATA)	Immediate	Email and telephone call (record-of-communication)	Teresa Carpenter, Technical Manager (USAESCH) Jason Shiflet, Project Manager (ZAPATA) Field Personnel (ZAPATA)	Immediate
Field Document Audit	Audit Form	Jason Shiflet Project Manager (ZAPATA)	Immediate	Email and telephone call (record-of-communication)	Teresa Carpenter, Technical Manager (USAESCH) Jason Shiflet, Project Manager (ZAPATA) Field Personnel (ZAPATA)	Immediate
Field Safety Audit	Audit Form	Jason Shiflet Project Manager (ZAPATA)	Immediate	Email and telephone call (record-of-communication)	Teresa Carpenter, Technical Manager (USAESCH) Jason Shiflet, Project Manager (ZAPATA) George Dwiggins, Ph.D., CIH, CSP, Corporate Safety Manager (ZAPATA) Field Personnel (ZAPATA)	Immediate
Analytical Data Review Audit	Audit Report	Jason Shiflet Project Manager (ZAPATA)	Within 7 days of audit	Memo to project files	Teresa Carpenter, Technical Manager (USAESCH) Jason Shiflet, Project Manager (ZAPATA) Sue Bell, Project Manager (Accutest) Jim Eldridge, Data Validator (Black & Veatch)	Within 7 days of audit

QAPP Worksheet #33

QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Field Sampling Audit Report	One, at the start of sampling operations	September 2011	Suzy Cantor-McKinney, Quality Manager (ZAPATA)	Spencer O'Neal, Project Manager (USAESCH) Jason Shiflet, Project Manager (ZAPATA)
Laboratory Audit Report	One, prior to sampling operations	Fall 2011	Jim Eldridge, Data Validator (Black & Veatch)	Spencer O'Neal, Project Manager (USAESCH) Jason Shiflet, Project Manager (ZAPATA)
Field Document Audit Report	One, at the start of sampling operations	September 2011	Suzy Cantor-McKinney, Quality Manager (ZAPATA)	Spencer O'Neal, Project Manager (USAESCH) Jason Shiflet, Project Manager (ZAPATA)
Field Safety Audit Report	TBD, as necessary	TBD, as necessary	George Dwiggins, Ph.D., CIH, CSP, Corporate Safety Manager (ZAPATA)	Spencer O'Neal, Project Manager (USAESCH) Jason Shiflet, Project Manager (ZAPATA)
Analytical Data Review Audit Report	One, before the start of data validation	Spring 2012	Jim Eldridge, Data Validator (Black & Veatch)	Spencer O'Neal, Project Manager (USAESCH) Jason Shiflet, Project Manager (ZAPATA)
Final RI/FS Report	One, before submittal of final report	Fall 2012	Suzy Cantor-McKinney, Quality Manager (ZAPATA)	Spencer O'Neal, Project Manager (USAESCH) Jason Shiflet, Project Manager (ZAPATA)

QAPP Worksheet #34

Verification (Step I) Process Table

Verification Input	Description	Internal/ External	Responsible for Verification (Organization)
Field Logbooks	Field logbooks will be reviewed for completeness and placed into the project files. Copies of the field logbook may be included in the final report, as needed.	Internal	Jason Shiflet (ZAPATA)
Chain-of-Custody and shipping airbills	Chain-of-Custody forms will be reviewed internally upon completion and verified against the packed sample coolers. A carbon copy of the chain-of-custody form will be retained on site for the during of the sampling operations. The original chain-of-custody form (minus one carbon copy) will be placed inside a Zip loc bag and taped to the inside of the sample cooler.	Internal	Field Personnel (ZAPATA)
Audits Reports	Original audit reports will be placed in the project files along with any corrective action documentation and implementation.	Internal	Jason Shiflet (ZAPATA)
Laboratory Analytical Data	All analytical data packages will be verified by the laboratory performing the work for completeness prior to submittal.	External	Sue Bell (Accutest)
Laboratory Analytical Data	All analytical data packages will be verified according to the data validation procedures specified in Worksheet #36.	External	Jim Eldridge (Black & Veatch)

QAPP Worksheet #35

Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
IIa	Data Deliverables and QAPP	Ensure the data from Step I was provided.	Suzy Cantor-McKinney, Quality Manager (ZAPATA)
IIa	Analytes	Ensure all analytes specified in Worksheet #15 were analyzed and reported by the laboratory.	See above.
IIa	Chain-of-Custody	Evaluate the traceability of the data from time of sample collection through reporting of the data results.	See above.
IIa	Holding Times	Ensure samples were evaluated within the allowable holding times.	See above.
IIa	Data Qualifiers	Evaluate the laboratory data qualifiers and ensure definitions are appropriate and applied as specified in methods, procedures and contracts.	See above.
IIa	Raw Data	Review 10% of the raw data to confirm laboratory calculations.	See above.
IIb	Sampling Plan	Confirm that the number and type of soil samples specified in Worksheet #20 were collected and analyzed.	See above.
IIb	Sampling Procedure	Confirm sampling SOPs were followed.	See above.
IIb	Field QC Samples	Confirm that the number and type of quality control samples specified in Worksheet #20 were collected and analyzed. Compare the results of collocated field duplicates with criteria established in the QAPP.	See above.
IIb	Project Quantitation Limits	Determine whether the sample results met the project quantitation limits and qualify the data, as necessary.	See above.

QAPP Worksheet #36

Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level[1]	Validation Criteria	Data Validator (Organization)
IIa	Soil	Explosives	Range from 200 ppb to 200,000 ppb	EPA 8330A and QAPP Worksheets 12, 15 and 23	Jim Eldridge (Black & Veatch)
IIb	Soil	Metals	Range from 0.5 ppm to 1,000 ppm	EPA 6020A/ and QAPP Worksheets 12, 15 and 23	Jim Eldridge (Black & Veatch)

[1] Concentration range for 8330A soils would be down to 200 ppb with a high range of 200,000 ppb before the laboratory starts saturating the sample with the extraction solvent.

QAPP Worksheet #37

Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

The following section describes the qualitative DQIs in terms of precision, accuracy, representativeness, completeness, and comparability for both field and laboratory programs.

Precision
Precision is the degree of mutual agreement among individual measurements of a given parameter under the same conditions. The objective for precision is to meet the limits set by the methods and/or in-house limits. Relative percent difference (RPD) is used to express precision between two replicate values for laboratory QC samples (e.g., MS/MSDs, LCS/LCSDs, or laboratory duplicates).

The RPD is calculated as:

$$RPD = \frac{|V1 - V2|}{(V1 + V2) \div 2} \times 100$$

where:

Vl, V2 = Values obtained by analyzing the duplicate samples.

Precision will be evaluated for field duplicates and field splits by the procedures given in USACE document EM 200-1-6 *Chemical Quality Assurance for HTRW Projects* 10 October 1997, summarized as follows.

- When either the sample or duplicate / split result is less than the detection limit (DL), precision is considered acceptable (no disagreement) if the split / duplicate result is within 5x of the sample result.
- When either the sample or duplicate / split result is less than the reporting limit (RL), precision is considered acceptable (no disagreement) if the split / duplicate result is within 3x of the sample result.
- For aqueous samples, when both the sample and duplicate / split results are greater than the RL, precision is considered acceptable (no disagreement) if the duplicate / split is within 2x of the sample result.
- For soil / solid samples, when both the sample and duplicate / split results are greater than the RL, precision is considered acceptable (no disagreement) if the duplicate / split is within 4x (explosives) or 2x (metals) of the sample result.

Accuracy

Accuracy is the degree of agreement of a measurement or the average of several measurements with an accepted reference or "true" value; it is a measure of bias in the system. Percent recovery (%Rec) is used to express accuracy.

The %Rec is calculated as:

$$\%\mathrm{Rec} = \frac{|\mathrm{SPV} - \mathrm{SAV}|}{\mathrm{SA}} \times 100$$

where:

SAV = The background value obtained by analyzing the sample
SA = Concentration of the spike added to the sample
SPV = Value obtained by analyzing the sample with the spike added

Representativeness

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Careful choice and use of appropriate methods in the field will ensure that samples are representative. This is relatively easy with water or air samples, given that the components of these media are usually homogeneously dispersed. In contrast, soil contaminants are unlikely to be evenly distributed; hence, it is important for the sampler and analyst to exercise good judgment when collecting and analyzing a sample.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that one is expecting to obtain under normal conditions. The data set must contain all analytical results and data specified for the project to be considered complete. In addition, all data are compared to project requirements to ensure that specifications have been met. Any deviations are addressed in the report narrative.

Little data exist on the completeness achieved by individual methods. Screening data will be expected to have lower completeness levels. However, because they often are on-site measurement techniques, providing results in real-time or after minimal delay, measurements can be repeated easily. Thus, a high degree of completeness can be achieved with these analytical levels.

The percent completeness for each set of samples is calculated as follows:

$$\mathrm{Completeness} = \frac{\text{valid data obtained}}{\text{total data obtained}} \times 100$$

Project completeness will primarily be based on the analytical samples collected for the target analytes and less on any field observations, screening, or toxicity characteristics (waste characterization samples). ZAPATA expects a completeness level of at least 90%. The validation process may reject the remaining data.

Comparability Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Sampling data should be comparable with data generated using similar methods, samples, and sample conditions. This goal is achieved by using standard techniques to collect and analyze representative samples and reporting analytical results in appropriate units. The objective for comparability is to strive toward the comparability of sample parameters on similar matrices as they relate to precision and accuracy determinations. Strict adherence to QA/QC procedures promotes the comparability of one set of reference data to another or comparability of data among all facilities.
Describe the evaluative procedures used to assess overall measurement error associated with the project: See above.
Identify the personnel responsible for performing the usability assessment: Suzy Cantor-McKinney
Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies: The Project Quality Objectives (PQOs) identified in Worksheet #11 will be evaluated to determine if the PQOs were met. Based on the outcome of this evaluation, the overall quality of the data will be determined. Data requiring reconciliation will be noted. The overall quality and useability of the data will be documented in the Final RI/FS Report along with any limitations associated with the assessment, if necessary.

APPENDIX E
ATTACHMENT 1

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LABORATORY ACCREDITATION BUREAU

Certificate Number L2229

Certificate of Accreditation

Accredited to DoD ELAP and ISO/IEC 17025:2005

Accutest Laboratories Southeast, Inc.

4405 Vineland Rd., Ste C-15
Orlando, FL 32811

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation Granted through: December 15, 2012

R. Douglas Leonard, Jr., Managing Director
Laboratory Accreditation Bureau
Presented the 15th of December, 2009

*See the laboratory's Scope of Accreditation for details of the DoD ELAP requirements
Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

Suzy Cantor-McKinney <scmckinney@zapatainc.com>

Fw: Susitna UFP-QAPP

Sue Bell <SueB@accutest.com> **Wed, Feb 10, 2010 at 8:05 AM**
To: Suzy Cantor-McKinney <scmckinney@zapatainc.com>

Accutest Orlando performs 8330A, 8330B, 6010, 7470 all in house and has DOD certification. Please see attached- thanks

Sue Bell
Project Manager
Accutest Laboratories
Tampa Office, voice: 813.741.3338 / fax : 813.741.9137
sueb@accutest.com

-----Original Message-----
From: Suzy Cantor-McKinney [mailto:scmckinney@zapatainc.com]
Sent: Tuesday, February 09, 2010 1:35 PM
To: Sue Bell
Subject: Fw: Susitna UFP-QAPP

[Quoted text hidden]

accutest laboratories southeast dod certifcate of accreditation.pdf
172K

APPENDIX E
ATTACHMENT 2

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FIELD LOGBOOK DOCUMENTATION: SOP FO-002

1.0 OBJECTIVE / BACKGROUND

Accurate and legible field notes are often included as project deliverables, used for Quality Control, used as supporting documentation for work modifications, and may be required to verify hours worked for payment.

Field records are the basis for later written reports and are discoverable in legal actions. Therefore, entries should be objective, factual and free of personal feelings or terminology that might be deemed inappropriate. Completed field logbooks are "record" documents for QC purposes and must be maintained as part of the official project files.

Field notes are the only record that is left after the field team departs the site. If field notes are not clear and complete, the field activities are of little value. It is therefore critical that field notes contain a complete record of all the observations and measurements made during the field work.

The field logbook should include, where necessary, sketches and narrations to clarify the notes. If stand-alone forms are used for specific items discussed in this procedure (calibration, monitoring, safety, etc.), they should be referenced in the field logbook by date, time and subject. Electronic data should be referenced in the field logbook.

2.0 RESPONSIBLE PARTIES

- Site Manager
- Engineering/Environmental Technician
- SUXOS
- Any field person designated to maintain a field book.

3.0 ACRONYMS AND DEFINITIONS

- SAP – Sampling and Analysis Plan
- SOW – Scope of Work
- SUXOS – Senior UXO Supervisor
- QAPP – Quality Assurance Project (or Program) Plan
- QC – Quality Control

4.0 FIELD BOOK DOCUMENTATION

4.1.1 Physical Characteristics

The field logbook itself should be small and easy to carry and preferably a bright color for ease of identification. It should be bound so the pages will not fall out and the pages should be numbered. It should have a hard cover for durability and for ease of note taking. The field logbook should be weatherproof so that notes can be taken in inclement weather and so that notations will remain legible when wet.

4.1.2 Field Logbook Requirements

Each project should have a dedicated field logbook. Additional dedicated field logbooks may be needed if separate field teams are working on the same project and/or the same site, and/or as field logbooks are filled. Field logbooks may be designated for specific elements of a project (e.g., task, drilling logs, environmental data, safety, QC, etc.). The name of the Project Manager, the name of the Site Manager, the project name and location, and the project number should be entered on the inside of the front cover of the logbook.

The entries should be legible and contain accurate and inclusive documentation of the note taker's project activities. Each page of the field logbook should be dated and initialed. At the end of all entries for each day or at the end of a particular event, the note taker should draw a diagonal line and initial indicating the conclusion of the entry and sign and date the page. Begin a new page for each day's activities.

Recording of field notes takes one or more of three general forms; tabulations, sketches and descriptions.

For tabulations, numerical measurements or data are recorded in columns according to a prescribed plan, often set forth in the project Sampling and Analysis Plan (SAP) or Quality Assurance Project Plan (QAPP). Allow space for computations, if appropriate.

Sketches add much to clarify the true meaning of field notes and should be used liberally, where appropriate. They may be drawn to an approximate scale and important details may be exaggerated for clarity. Small rulers and triangles are useful aids in making sketches. Measurements should be noted directly on the sketch or keyed to relevant tabular data. Legibility is key to the usefulness of a sketch. The sketch must be drawn clearly and large enough to be understandable.

Tabulations and or sketches should be supplemented with descriptions, or descriptions may be stand-alone elements of the field book. The description may be brief if the intent is to clarify a measurement, or it may be a lengthy narrative if it is to be used in the future to reconstruct a field scenario.

All aspects of sample collection and handling as well as visual observations shall be documented in the field logbook. Review the SOW, the SAP and the QAPP, as they may require collection of specific information items in addition to those noted below. Information that should be recorded in the field logbook includes:

Mobilization

- Date and time of fieldwork (start time and end time)
- Personnel on site (subcontractors, visitors and ZAPATA personnel)
- Weather conditions (temperature, precipitation, sun/cloud cover, humidity, etc.)
- Daily safety briefing time and subject
- Additional training/briefings
- Task list for fieldwork
- Vehicle and equipment identification including model numbers and sizes, where applicable
- Reference field forms, if used.

Field Equipment

- Sample collection equipment
- Field analytical equipment
- Equipment used to make physical measurements in the field
- Calibration data for field sampling, field analytical and field physical measurement equipment, as appropriate
- Property numbers of equipment, as available.

Sampling Activities

- Sampling station/location identification
- Maps or sketches of sampling locations
- Time of sample collection
- Description of the sample and the sample collection procedure
- Diagram(s) of the process
- Identification of the sampler(s).

Health and Safety

- Health and safety exposure monitoring
- Explanation of any safety violations and how conditions detrimental to safety were resolved
- Accidents/incidents, including response actions and notifications.

- See attached "Criteria for Recording Safety-Related Information In Field Logbooks"
- See attached "Drill Rig Safety Checklist."

Referencing Forms and Electronic Files

- Electronic data should be tracked within field logbooks; include electronic file name and description and/or instrument type and serial number, as applicable
- Electronic data may include:
  - Digital photographs; note subject matter in field logbook and include time and date of photographs
  - GPS data; include time and date stamp plus control point name and location
  - Forms in electronic media (e.g., PDA); include form name and description
  - Geophysical data
- The individual responsible for a form also is responsible for its reference in the field logbook.

Quality Control

- Comprehensive summary of daily activities
- Documentation of any client direction
- Explanation of deviations from procedures (SOW, SAP, QAPP), including who directed the deviations, how they were implemented
- QC findings and resolutions
- Identification of any non-conformances, including who was notified and how the non-conformances were corrected
- Description of any delays (weather, unauthorized personnel on site, equipment failures, etc). Indicate the names/number of individuals affected and timeframe impacted.
- Erasures are not permitted in field logbooks. Numbers or entries recorded incorrectly should be lined out and the corrected values or information inserted. If entire pages are to be replaced, they should be crossed out neatly and referenced to the substituted pages. All such corrections should be initialed and dated.

5.0 DIAGRAM

Not Applicable

6.0 IMPORTANT NOTES

None

7.0 ASSOCIATED DOCUMENTS

- Drill Rig Safety Checklist.pdf
- Safety-Related Logbook Recording Criteria.pdf

8.0 INFORMATION CONTACTS

Vice President, Program Compliance
Vice President, Environmental Services
Vice President, Munitions Response Services
Senior Vice President, Engineering & Construction

SOIL SAMPLING: SOP FO-003

1.0 OBJECTIVE / BACKGROUND

The objective of soil sampling is to collect a sample that is representative of conditions of interest as they exist at a site. This is done by selecting the appropriate sampling device and/or method, taking measures to avoid introduction of contaminants as a result of poor sampling techniques, and by reducing the potential of cross contamination between samples.

Specific soil sampling requirements are dependent upon investigation objectives. Investigation objectives often include determining the presence, nature and extent of specific compounds relative to the appropriate regulatory standards. Sampling strategies are usually described in detail in a project Work Plan and sub-plans (i.e., Sampling and Analysis Plan and Quality Assurance Project Plan). The intent of this standard operating procedure (SOP) is to provide standardized guidance for soil sample collection for chemical analysis. As such, this procedure is not intended to eliminate the need for professional judgment during unforeseen circumstances. However, deviations from this procedure while executing planned activities must be approved in writing by both the Project Manager and Corporate Quality Officer.

2.0 RESPONSIBLE PARTIES

- Project Manager
- Site Manager
- Engineering/Environmental Technician
- SUXOS
- Field personnel assigned to sampling tasks

3.0 ACRONYMS AND DEFINITIONS

- SU – Sampling Unit
- FID – Flame-ionization Detector
- FO – Field Operations
- ft – Foot/Feet
- ID – Identification
- PID – Photo-ionization Detector
- PPE – Personal Protective Equipment
- SOP – Standard Operating Procedure
- SUXOS – Senior Unexploded Ordnance Supervisor
- QC – Quality Control
- VOCs – Volatile Organic Compounds

4.0 SOIL SAMPLING

Soil sampling must be completed using proper equipment and advanced planning. In some cases, field screening of the soil may be required to facilitate selection of the appropriate sampling interval.

4.1 EQUIPMENT

Equipment requirements are dependent upon the specific sampling objectives, required depth intervals and the existing site conditions, if known. Equipment can categorized as either manual or powered. Manual equipment is commonly used for shallow depths and includes such items as hand augers, soil probes, spoon, spatulas and bowls. These items should be composed of stainless-steel. Powered equipment is more appropriate for deeper sample collection and is usually accomplished using such things as drill rigs/rods, excavators, or similar heavy-equipment. These items are often constructed of materials other than stainless-steel and care should be taken to limit direct contact between these items and the soil sample. In many cases, both powered and manual forms of equipment are employed together.

All sampling equipment utilized for soil boring advancement and sample collection that may potentially come into contact with soil samples must be thoroughly decontaminated before and between sampling events as described in ZAPATA SOP FO-011, Equipment Decontamination.

4.2 PRE-SAMPLING ACTIVITIES

Sampling personnel will record in the field logbook the preparation activities that may be pertinent to the sampling event at each sampling location. For soil sampling, documentation may include information on the presence of surface staining, water logging or ponding, proximity to roads or waste piles, apparent up-gradient physiographic or hydrogeologic features of significance, the depth from which the samples were collected, and the equipment and materials that were used to construct the boring.

4.3 FIELD SCREENING VOLATILE ORGANIC VAPORS

Sample collection depths for sites contaminated with organics can also be determined by evaluating the organic vapors in the headspace above the soil in a jar from aliquots collected as a boring is advanced. For field screening purposes, the soil is placed into a glass jar after removal of the sampler from the ground. Immediately after placing the soil into the jar, the top of the jar is sealed with aluminum foil. The sealed container is labeled with an identification number and timestamp for subsequent headspace analysis. The sample is kept warm and allowed to equilibrate for more than five minutes once the temperature has reached between 68 and 90 degrees Fahrenheit. Once the sample is equilibrated, the headspace above the soil in the jar is analyzed with a photo-ionization detector (PID) or a flame-ionization detector (FID), with or without a carbon filter. The results are recorded in the field logbook and a sample is collected from the interval represented by the highest organic vapor result.

4.4 SOIL SAMPLING COLLECTION METHODS

Soil samples can be collected using various methods; the method selected should be based partially on site conditions/access, sample data and quality requirements, desired depth interval, and cost.

4.4.1 Manual Sample Collection

Soil borings are generally advanced with a stainless-steel hand auger (or similar device). For analyses other than volatile organic compounds (VOCs), soil samples should be removed from the sampling device using a stainless-steel trowel or spoon and transferred to a stainless-steel bowl for homogenization. Surface soil samples may be collected using a stainless-steel hand trowel. Soil samples should be collected in clean new jars often provided by the subcontract laboratory. Soil samples selected for VOCs analysis should be collected first directly from the hand auger or drill rod using a plastic syringe or encore provided by the laboratory. Each sample jar should be identified by completing the sample label noting the sample identification (ID), date and time of collection, method of analysis and sampler's initials. Each filled sample container should be placed in a labeled Ziploc™ bag and stored in a cooler with ice until prepared for shipment.

4.4.2 Mechanical Sample Collection

Various mechanical methods are used to assist in sample collection; these commonly include soil boring advancement using a split-spoon sampler or core barrel, direct-push technology, and direct rotary using an auger. For details related to these methods, refer to documents listed in the Associated Documents section. Generally, these methods assist with sample collection from depths greater than those practical with manual collection methods. A sampling device is advanced to the desire depth and a soil sample is retrieved. For direct rotary using an auger, soil cuttings are brought the surface and bulk soil samples should be collected using a hand trowel. Soil samples should be removed from the sampling device using a stainless-steel trowel or spoon and transferred to a stainless-steel bowl for homogenization. Soil samples should be collected in clean new jars often provided by the subcontract laboratory. Each sample jar should be identified by completing the sample label noting the sample ID, date and time of collection, method of analysis and sampler's initials. Each filled sample container should be placed in a labeled Ziploc bag and stored in a cooler with ice until prepared for shipment.

4.4.3 Excavation/Test Pit Sample Collection

Trenching is used in situations where visual assessment of surface and near-surface contamination and geologic characteristics is required. Excavation/test pit sampling is typically conducted in conjunction with a removal or remedial action. A backhoe is usually used to excavate shallow trenches to a desired depth. Front-end loaders or bulldozers may be used when it is not possible to use a backhoe. Soils removed from the trench/pit shall be carefully placed on plastic sheeting or other appropriate materials in the order of removal from the trench or excavation.

Soil sampling locations within each trench or pit shall be chosen on the basis of visual inspection and any field screening results. Samples shall be collected from either the sidewalls or the bottom of the trenches/excavations. Soil sampling should be conducted outside the trench/excavation, and personnel generally should not enter a trench or pit if there is any other means (e.g., backhoe buckets, hand augers, shovels, or equivalent) to perform the work. If entry is unavoidable, then a competent person shall first determine acceptable entry conditions including sloping, shoring, and air monitoring requirements, personal protective equipment (PPE), and inspections.

Equipment used for trench/pit sampling may include hand augers, core samplers (slide hammer), liners inserted manually into the soil, or hand trowels. In addition, samples may be obtained directly from the trench or from the backhoe bucket. Soil samples should be transferred to a stainless-steel bowl for homogenization. Soil samples should be collected in clean new jars often provided by the subcontract laboratory. Each sample jar should be identified by completing the sample label noting the sample ID, date and time of collection, method of analysis and sampler's initials. Each filled sample container should be placed in a labeled Ziploc™ bag and stored in a cooler with ice until prepared for shipment. Sample locations and descriptions shall be described and recorded on the field logbook.

4.5 Sample Types

In general, two basic types of sample collection techniques are recognized; those are grab and composite, both of which can be used for soil samples for chemical analysis. A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease. Composites are nondiscrete samples composed of more than one specific aliquot collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits. A third sample type, referred to as a bulk sample, can also provide useful information. Bulk samples represent a sample collected from borehole cuttings or other type of disturbed soil, where specific and representative depth intervals cannot be determined. These samples are useful for describing soils but, are generally not appropriate for chemical analysis unless otherwise specified.

4.6 Sample Strategies

The number of samples that should be collected and analyzed depends on the objective of the investigation. There are three basic sampling strategies: random, systematic, and judgmental sampling. Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of a site. Systematic sampling involves collection of samples based on a grid or a pattern which has been previously established. When judgmental sampling is performed, samples are collected only from the portion(s) of the site most likely to be contaminated. ZAPATA frequently uses two sampling approaches that are variants of these sampling strategies for surface soil sampling; multi-incremental (MI) sampling and wagon wheel sampling. Multi-incremental samples are collected in a systematic or random manner over an entire sampling unit by compositing enough evenly distributed aliquots to amass about 1.5 kilograms of soil. Wagon wheel samples are collected by compositing seven aliquots of soil from locations specified using the characteristic design pattern.

4.6.1 Incremental Sample

Incremental samples are usually associated with explosives (and sometimes metals) analysis and are collected from an area commonly referred to as a sampling unit. Sampling units (SUs) are arbitrarily defined areas-of-interest at the project site. Often times they are 100 ft by 100 ft to 300 ft by 300 ft areas but, are not bound by those specifications. SUs are established during the project development based on project objectives, site history and risk of exposure. Once a SU is established, primary soil samples are collected by advancing a specially-designed sampling probe into the ground at evenly-spaced locations over the entire SU. The number of subsample locations (and aliquots) within a SU is determined by the size of the SU; labs require about 1.5 kilograms of soil to perform the analysis. Thirty to 50 soil subsample aliquots are common. Soil samples will be ejected from the incremental sampling probe directly into the labeled sample bag. Sample bags will be sealed and placed in coolers with ice immediately after collection. For quality control (QC) purposes, the incremental samples can be collected in triplicate at a SU. In some instances, the laboratory can take a portion of the incremental sample for metals analysis. A note should be included on the chain-of-custody directing the laboratory to pull the metals soil split prior to grinding the sample for 8330B analysis.

4.6.2 Wagon Wheel Sample

The wagon wheel (or 7-point wheel) can be collected from pre-determined or random locations. Using this methodology, a sample is collected from a center location, then six other samples are collected from about four feet away from the central location in a circle (see Diagram 2). Soil samples are collected as described in the Manual Sample Collection section, herein.

5.0 DIAGRAM

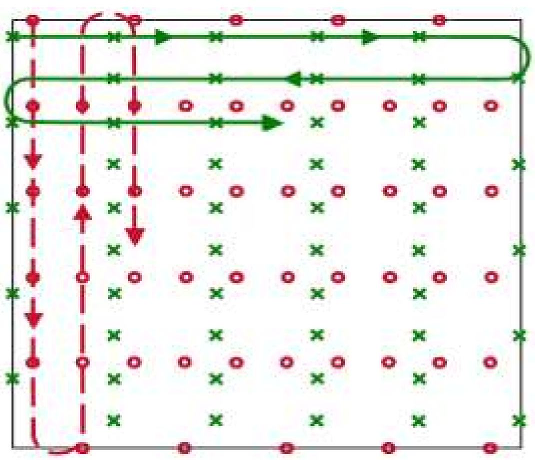

Diagram 1: Example Incremental Sampling Unit (SU)

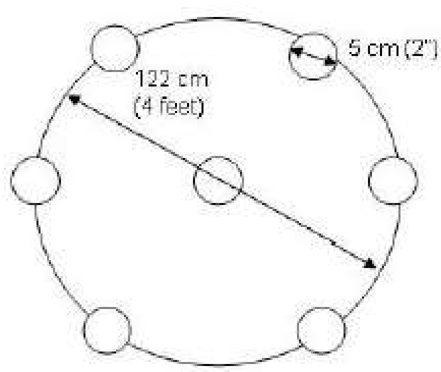

Diagram 2: Example Wagon Wheel (7-Point Wheel)

6.0 IMPORTANT NOTES

- Soil samples are very rarely collected below the water table, as analytical results are generally more accurate if a dry soil sample is submitted to the laboratory.
- Samples may effervesce from contact with the acid preservative. If this occurs, then preservation by acidification is not acceptable and alternate preservation strategies should be considered.
- Holding times for some analyses are quite short (e.g., 48 hours). Consult the Sampling and Analysis Plan for sample holding time information.
- Preservatives can be toxic, flammable and/or corrosive. Proper PPE should be used during sample collection.
- Sample bottle ware and sampling tools should be stored and transported in a clean and vapor-free environment.

7.0 ASSOCIATED DOCUMENTS

- Project Work Plan
- Project Sampling and Analysis Plan
- Quality Assurance Project Plan
- Surface soil sample log sheet
- Subsurface soil sample log sheet
- Environmental Protection Agency (EPA). 2000. Standard Operating Procedure #2012, Soil Sampling. Environmental Response Team. Washington. 18 February.

8.0 INFORMATION CONTACTS

- Vice President, Program Compliance

- Vice President, Environmental Services
- Vice President, Munitions Response Services
- Senior Vice President, Engineering & Construction
- Corporate Safety Officer

Chain of Custody: SOP FO-009

1.0 OBJECTIVE / BACKGROUND

A chain-of-custody (COC) must be maintained for every sample collected on-site. It is very important for the chain-of-custody to be accurate so the samples can be correctly processed by the Laboratory.

2.0 RESPONSIBLE PARTIES

- Any ZAPATA employee collecting samples.

3.0 ACRONYMS AND DEFINITIONS

- COC: Chain-of-custody

4.0 COMPLETION OF CHAIN OF CUSTODY

1. Correctly and clearly fill out all information on the COC provided by the contracted laboratory processing the COC. All analysis parameters, as listed in the project work plans, should be clearly listed for each sample.
2. Fill out following areas in the correct space provided if not already filled out by lab
    a. Clients name and whom the lab should report to (i.e., ZAPATA Project manager).
    b. Reporting address, telephone number, project manager's email address, site name and site location.
    c. Check the box for the labs turn around time for the sample results to be reported back to ZAPATA.
    d. Sample identification number.
    e. Date and time (military) when sample was collected.
    f. Sample matrix (i.e. soil, water or sludge).
    g. Sample container information
        i. Type of sample container (example VOA vial)
        ii. The number of sample containers sent for each sample
        iii. Size of the sample container
    h. Type of preservatives present in jars provided by the laboratory or added in the field (i.e., HCL, etc.)
    i. Analyses required, include both the method name and number. It is very important to include the method number because there may be multiple ways to run a sample using the method name. Thus, you must provide the sample number to match the method used in the work plan.
    j. Sampler must sign and print first and last name in provided area.
    k. Just before COC is placed inside the appropriate cooler, you must sign, date and record the time the COC is relinquished to ensure you have transferred responsibility of the samples to the courier and laboratory.
3. Have a second person check the accuracy of the chain-of-custody before it is sealed in the cooler.

4. Analysis questions should be settled with the ZAPATA Project Manager and the laboratory.

5.0 DIAGRAM

Not Applicable

6.0 IMPORTANT NOTES

- **NONE**

7.0 ASSOCIATED DOCUMENTS

- Work Plans will identify analysis parameters for the specific project.

8.0 INFORMATION CONTACT

The ZAPATA Project Manager

Sample Packing and Shipping: SOP FO-010

1.0 OBJECTIVE / BACKGROUND

Sample packing and shipping is critical to ensure the integrity of the samples. By following this SOP, the sample will arrive to the lab in a timely manner unbroken and at the correct temperature.

2.0 RESPONSIBLE PARTIES

- All ZAPATA field employees

3.0 ACRONYMS AND DEFINITIONS

- COC – Chain of Custody
- DOT- Department of Transportation

4.0 SAMPLE PACKING AND SHIPPING

4.1 SAMPLE PACKING

1. Use the appropriate size cooler that conforms to DOT drop test specifications.
2. Line the bottom, sides and top of the cooler with packing material. Place packing material between each glass container. Wrap all the packing material and containers inside a large thick mil trash bag. A large trash bag fits into a cooler and acts as a final barrier preventing liquids from leaking from the cooler.
3. Foam packing and bubble-wrap work very well for packaging material. They provide shock protection and the trapped air provides thermal insulation, which keeps your samples cold. Avoid using packing material that absorbs water. Materials such as paper, cardboard and peanuts become soggy and decompose in water thereby losing any cushioning effects.
4. Seal each container in a bubble-wrap or Ziploc bag to prevent labels from peeling off containers. Also, seal the chain-of-custody (COC) documents in a Ziploc bag and tape to the inside of the cooler lid.
5. Natural ice in sealed bags is the best choice for keeping containers cold. Blue ice packs do not maintain low enough temperatures in large coolers and are not to be used.
6. Use the appropriate size cooler to pack your samples, leaving enough room for an appropriate amount of ice during shipment. For a 48-quart cooler, place a minimum of four-five one-gallon Ziploc bags of ice in and around the samples. Another method commonly used is to double line the cooler with heavy duty contractor bags and pour three to four 10-pound bags of ice directly on the samples making sure ice is able to get inbetween and all around the samples. After the cooler is packed with ice, tightly close the bags lining the cooler.
7. Apply completed custody seals to each corner of the cooler, across the opening. Tape the cooler well using clear packaging tape. Go completely around the cooler in at least two different areas. Then, tape the seam where the lid closes. All labels and

seals attached to the cooler should also be taped so that they do not come off during shipment.

8. Call the lab to let them know the cooler's arrival date. Give them the tracking number of the package from the shipping courier's paperwork.

4.2 SAMPLE SHIPPING

9. Completely fill out all empty fields in the shipping label. ZAPATA's preferred shipping vender is Fed Ex.
    a. Completely fill out all required spaces in Section 1: Sender's Information of Fed Ex airbill, using the ZAPATA's Charlotte office as the sender's address.
    b. Completely fill out all required spaces for recipient's information (i.e. laboratory) in Section 3 on Fed Ex air bill.
    c. In the Section labeled 4a Express, put an "X" in the box for FedEx Priority Overnight delivery. This is very important because samples are time sensitive.
    d. In Section 5: Packing, put an "X" in the box next to "Other".
    e. In section labeled Special Handling and Delivery Signature Options, put an "X" next to the box "NO" under the area labeled "Does this shipment contain dangerous good?"
    f. If you are shipping on a Friday call the lab to make sure they are accepting deliveries on that Saturday. If they are accepting Saturday deliveries, mark an "X" in the box next to "Saturday Delivery." If you do not mark this box, the package will not be delivered until Monday and the sample may exceed the temperature requirement. If the lab is not accepting Saturday deliveries do not ship samples until the following Monday. Plan ahead to ensure sample holding times are met.
    g. In Section 7: Payment Bill, ask the Project Manger if the Recipient or a third party is to be billed. If so enter the Fed Ex account number in the appropriate place.
    h. Have a second person review your shipping label for the correct address, contact telephone number, and delivery priority. If unsure about sample holding times, double-check the delivery priority with the ZAPATA Project Manager and or the lab's Project Manager. Most shipments will be priority overnight, morning (10:00am) delivery.

5.0 DIAGRAM

Not Applicable

6.0 IMPORTANT NOTES

None

7.0 ASSOCIATED DOCUMENTS

None

8.0 INFORMATION CONTACT

ZAPATA's Project Manager

Equipment Decontamination: SOP FO-011

1.0 OBJECTIVE / BACKGROUND

Proper decontamination is essential to eliminate cross contamination of equipment. Decontamination should occur before each and every use of sampling equipment.

2.0 RESPONSIBLE PARTIES

- Any ZAPATA employee working with sampling equipment.

3.0 ACRONYMS AND DEFINITIONS

- None

4.0 ZAPATA'S EQUIPMENT DECONTAMINATION STANDARDS

4.1 SPECIFICAITON FOR STANDARD CLEANING MATERIALS

1. Soap shall be a standard brand of phosphate-free laboratory detergent such as Liquinox® or Alconox. Use of other detergent must be justified in the approved sampling analysis plan and documented in the field logbooks.
2. Solvent shall be pesticide-grade isopropanol. Use of a solvent other than pesticide-grade isopropanol for equipment cleaning purposes must be justified in the Sampling Analysis Plan.
3. Tap water may be used from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water
4. Analyte free water (deionized water) is tap water that has been treated by passing through a standard deionizing resin column. At a minimum, the finished water should contain no detectable heavy metals or other inorganic compounds (i.e., at or above analytical detection limits) as defined by a standard inductively coupled Argon Plasma Spectrophotometer (ICP) (or equivalent) scan. Analyte free water obtained by other methods is acceptable, as long as it meets the above analytical criteria. A portable system to produce organic/analyte free water under field conditions is available.
5. Other solvents may be substituted for a particular purpose if required. For example, removal of concentrated waste materials may require the use of either pesticide-grade hexane or petroleum ether. After the waste material is removed, the equipment must be subjected to the standard cleaning procedure. Because these solvents are not miscible with water, the equipment must be completely dry prior to use.

4.2 DECONTAMINATION OF DOWN WELL PUMPS

1. Have three decontamination containers (tubs) ready.
   a) First decontamination tub should be distilled or tap water mixed completely with phosphate-free laboratory detergent such as Liquinox®.

b) Second decontamination tub should only have clean deionized water for rinsing.
c) Third decontamination tub should only have deionized water for final rinsing.

2. After removing tubing from pump insert pump into the first decontamination tub and run pump for several minutes to allow enough soapy water to run though the pump. The outside of the pump housing should also be cleaned using a brush.
3. The next step of decontamination is to insert pump in to the second Decontamination tub cleaning techniques using the deionized water should be repeated as described above.
4. Spray / rinse equipment with pesticide grade isopropyl alcohol.
5. The final process is to insert the pump into the third decontamination tub for the final rinse of deionized water to ensure the pump is completely cleaned. Cleaning techniques using the deionized water should be repeated as described above.

4.3 DECONTAMINATION OF SOIL SAMPLING EQUIPMENT (HAND AUGERS, BOWLS, ETC.)

1. Have three decontamination tubs ready.
2. Put all sampling equipment into the first decontamination tub (i.e., distilled water mixed Liquinox®). Scrub thoroughly with brush to insure that all soil residue is completely removed from equipment.
3. Place sampling equipment into the second decontamination tub (deionized water) and wash as described above to ensure all soap is completely rinsed off equipment.
4. Spray / rinse equipment with pesticide grade isopropyl alcohol.
5. Place sampling equipment into the third decontamination tub (deionized water) and rinse equipment thoroughly to ensure equipment is clean.
6. Allow time for equipment to air dry.
7. Wrap all sampling equipment in clean aluminum foil to keep out any cross-contaminates.

4.4 DECONTAMINATION OF DRILLING EQUIPMENT (DOWNHOLE RODS, SAMPLING DEVICES, ECT).

1. Decontamination of augurs, downhole rods and sampling devices (i.e. split spoons)
   a. Upon the subcontracted drillers arrival on site, they sub should be instructed to construct a decontamination pit lined with plastic sidewalls should be high enough to prevent any overspray.
   b. Drillers will clean all equipment inside the decontamination pit prior to drilling and between each borehole.
   c. Drillers must also decontaminate all equipment prior to leaving the site.
   d. When the decontamination pit is full or all decontamination has been completed the drillers will pump the water into 55 gallon drums for disposal.
   e. After all decontamination is complete the plastic used will be wrapped up and placed into a separate 55 gallon drum for disposal.
2. Decontamination of direct-push equipment (i.e., Geoprobe)
   a. All equipment (rods, macro-cores, and shoes) should be decontaminated before arrival on-site and between each new boring.

b. Drillers should have two buckets, one mixed with Liquinox® water and a second with rinse water.
c. Larger downhole tools may require deconning using a decontamination pit, as described above.
d. Each piece of equipment that touches site media (i.e., soil or water) will be washed and rinsed before being used at the next sample location.
e. At the end of each day, water used for decontamination should be placed into separate 55-gallon drums for proper disposal.

5.0 DIAGRAM

Applicable

6.0 IMPORTANT NOTES

None

7.0 INFORMATION CONTACT

ZAPATA Project Manager

APPENDIX E
ATTACHMENT 3

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Library Data Review Criteria: Reporting and Detection Limits

Library Group ID : Susitna Gunnery Range All Methods

Sample Matrix : AQ

Analytical Method	Client Analyte ID	Analyte Name	Reporting Limit Criteria	Reporting Limit Type	Units
6020A	7440-36-0	ANTIMONY	4	MRL	ug/L
	7440-50-8	COPPER	10	MRL	ug/L
	7439-92-1	Lead	1	MRL	ug/L
	7440-66-6	ZINC	10	MRL	ug/L
7470A	7439-97-6	MERCURY	1	MRL	ug/L
8330A	99-35-4	1,3,5-TRINITROBENZENE	0.2	MRL	ug/L
	99-65-0	1,3-DINITROBENZENE	0.2	MRL	ug/L
	118-96-7	2,4,6-TRINITROTOLUENE	0.2	MRL	ug/L
	121-14-2	2,4-DINITROTOLUENE	0.2	MRL	ug/L
	606-20-2	2,6-DINITROTOLUENE	0.2	MRL	ug/L
	35572-78-2	2-AMINO-4,6-DINITROTOLUENE	0.2	MRL	ug/L
	19406-51-0	4-AMINO-2,6-DINITROTOLUENE	0.2	MRL	ug/L
	2691-41-0	HMX	0.2	MRL	ug/L
	99-08-1	m-Nitrotoluene	0.2	MRL	ug/L
	98-95-3	NITROBENZENE	0.2	MRL	ug/L
	55-63-0	NITROGLYCERINE	2	MRL	ug/L
	88-72-2	o-Nitrotoluene	0.2	MRL	ug/L
	78-11-5	PETN	2	MRL	ug/L
	99-99-0	p-Nitrotoluene	0.2	MRL	ug/L
	121-82-4	RDX	0.2	MRL	ug/L
	479-45-8	Tetryl	0.2	MRL	ug/L

Library Data Review Criteria: Reporting and Detection Limits

Library Group ID : Susitna Gunnery Range — All Methods

Sample Matrix : SO

Analytical Method	Client Analyte ID	Analyte Name	Reporting Limit Criteria	Reporting Limit Type	Units
6020A	7440-36-0	ANTIMONY	0.4	MRL	mg/kg
	7440-50-8	COPPER	1	MRL	mg/kg
	7439-92-1	LEAD	0.1	MRL	mg/kg
	7440-66-6	ZINC	1	MRL	mg/kg
7471A	7439-97-6	Mercury	0.083	MRL	mg/kg
8330A	99-35-4	1,3,5-TRINITROBENZENE	200	MRL	ug/Kg
	99-65-0	1,3-DINITROBENZENE	200	MRL	ug/Kg
	118-96-7	2,4,6-TRINITROTOLUENE	200	MRL	ug/Kg
	121-14-2	2,4-DINITROTOLUENE	200	MRL	ug/Kg
	606-20-2	2,6-DINITROTOLUENE	200	MRL	ug/Kg
	35572-78-2	2-AMINO-4,6-DINITROTOLUENE	200	MRL	ug/Kg
	19406-51-0	4-AMINO-2,6-DINITROTOLUENE	200	MRL	ug/Kg
	2691-41-0	HMX	200	MRL	ug/Kg
	99-08-1	m-Nitrotoluene	200	MRL	ug/Kg
	98-95-3	NITROBENZENE	200	MRL	ug/Kg
	55-63-0	NITROGLYCERINE	2000	MRL	ug/Kg
	88-72-2	o-Nitrotoluene	200	MRL	ug/Kg
	78-11-5	PETN	2000	MRL	ug/Kg
	99-99-0	p-Nitrotoluene	200	MRL	ug/Kg
	121-82-4	RDX	200	MRL	ug/Kg
	479-45-8	Tetryl	200	MRL	ug/Kg
8330B	99-35-4	1,3,5-TRINITROBENZENE	100	MRL	ug/Kg
	99-65-0	1,3-DINITROBENZENE	100	MRL	ug/Kg
	118-96-7	2,4,6-TRINITROTOLUENE	100	MRL	ug/Kg
	121-14-2	2,4-DINITROTOLUENE	100	MRL	ug/Kg
	606-20-2	2,6-DINITROTOLUENE	100	MRL	ug/Kg
	35572-78-2	2-AMINO-4,6-DINITROTOLUENE	100	MRL	ug/Kg
	19406-51-0	4-AMINO-2,6-DINITROTOLUENE	100	MRL	ug/Kg
	2691-41-0	HMX	100	MRL	ug/Kg
	99-08-1	m-Nitrotoluene	100	MRL	ug/Kg
	98-95-3	NITROBENZENE	100	MRL	ug/Kg
	55-63-0	NITROGLYCERINE	1000	MRL	ug/Kg
	88-72-2	o-Nitrotoluene	100	MRL	ug/Kg
	78-11-5	PETN	1000	MRL	ug/Kg
	99-99-0	p-Nitrotoluene	100	MRL	ug/Kg
	121-82-4	RDX	100	MRL	ug/Kg
	479-45-8	Tetryl	100	MRL	ug/Kg

DRAFT
PERFORMANCE-BASED QUALITY ASSURANCE SURVEILLANCE PLAN (QASP) FOR
Munitions and Explosives of Concern (MEC) RI/FS
Camp Croft

1. INTRODUCTION

This Performance-Based Quality Assurance Surveillance Plan (QASP) has been developed pursuant to the requirements of the Performance Work Statement (PWS) for Contract W912DY-10-D-0028, Task Order No. 0005. This plan sets forth procedures and guidelines that the USACE will use in evaluating the technical and safety performance of the Contractor. A copy of the Performance Metrics is furnished in the PWS so that the Contractor will be aware of the methods that the Government will employ in evaluating their performance on this contract.

2. PURPOSE OF THE QASP

The QASP is intended to accomplish the following:

a. Define the roles and responsibilities of participating Government officials;
b. Define the types of work to be performed with required end results;
c. Document the evaluation methods that will be employed by the Government in assessing the Contractor's performance;
d. Provide the Surveillance Activity Checklists and Corrective Action Request (CAR) forms that will be used by the Government in documenting and evaluating the Contractor's performance; and
e. Describe the process of performance documentation.
f. Outline quality assurance procedures to be employed by the Government during performance of this task order to confirm that the site characterization is conducted utilizing proper procedures and in accordance with the approved work and safety plans.

3. ROLES AND RESPONSIBILITIES OF PARTICIPATING GOVERNMENT OFFICIALS

The USACE Project Manager: Spencer O'Neal

- Responsible for overall project direction, including technical, contracting and customer-related issues.
- Reviews vouchers and make recommendations to the Contracting Officer for payment action based on completion of designated milestones.
- Reports problems or discrepancies to the Contracting Officer as soon as possible.
- Oversees the implementation of the QASP.
- Reviews contractor submittals.
- Schedules and provides labor codes and funding for all surveillance activities with the appropriate USACE Supervisor (OE Safety Group, Geotechnical Branch, etc.)
- Initiates periodic contractor evaluations in the Contractor Performance Assessment Reporting System (CPARS).

The USACE Technical Manager: Teresa Carpenter

- Participates in preparation of SOW/PWS to ensure that Technical requirements are adequately addressed.
- Participates in proposal review.
- Coordinates reviews of contractor submittals for compliance with contract requirements.
- Coordinates reviews of contractor submittals for compliance with DOD, DA and USACE explosives and CWM safety requirements.
- Coordinates Periodic Inspections of contractor compliance with DOD, DA, and USACE explosives and CWM safety requirements and explosives/CWM related procedures described in the work plan.
- Conducts or Supports other surveillance activities as required by the project team.
- Supports all on-site QA activities.

- Develops the final Quality Assurance Report.

The USACE Contract Specialist TBD

- Monitors contract performance.
- Maintains central repository for all QA tasks required for payment.
- Issues all acceptance/rejection statements.

The USACE Safety Specialist TBD

- Participates in preparation of SOW/PWS to ensure that Safety requirements are adequately addressed.
- Conducts reviews of contractor submittals for compliance with DOD, DA and USACE explosives safety requirements.
- Performs periodic inspections of contractor compliance with DOD, DA, and USACE explosives safety requirements and explosives-related procedures described in the work plan.
- Makes unscheduled, periodic site visits as part of the Government surveillance.
- Conducts or Supports other surveillance activities as required by the project team.
- Supports all on-site QA activities.

The USACE Geophysicist Debbie Edwards

- Participates in preparation of SOW/PWS to ensure that Geophysical Investigation requirements are adequately addressed.
- Participates in proposal review to evaluate geophysical tasks.
- Reviews contractor submittals (documents and data) for compliance with contract requirements.
- Coordinates with USACE team members to perform periodic inspections of contractor's compliance with approved plans and performance requirements.
- Reviews Contractor's QC documentation to ensure accuracy and final Government acceptance.
- Conducts surveillance activities as described in Attachment A and others as required by the project team.
- Verification of anomaly selection criteria and /or existing site condition assumptions.

The USACE Chemist Michael D'Auben

- Participates in preparation of SOW/PWS to ensure that MC requirements are adequately addressed.
- Participates in proposal review to evaluate Environmental Sampling and Chemical Analysis tasks.
- Reviews the work plan for compliance with standard protocols for Environmental Sampling and Chemical Analysis.
- Conducts reviews of Environmental Sampling and Chemical Analysis Data.
- Conducts random site inspections of contractor compliance with environmental sampling requirements of the work plan. This includes ensuring that the contractor is utilizing appropriate sampling techniques, collecting the quantity of primary and QA/QC samples as stated in the work plan and completing the COC correctly with the approved analytical methodology.
- Reviews QCP reporting requirements and accepts reported QC measures.

The USACE GIS team member TBD

- Participates in preparation of SOW/PWS to ensure that GIS requirements are adequately addressed.
- Reviews contractor's Geospatial Information and Electronic submittals.
- Reviews QCP reporting requirements and accepts reported QC measures

The USACE MM-CX TBD

- Reviews Explosives Siting Plan (ESP).

- Provides DRU approval for the ESP.
- Submits ESP to US Army Technical Center for Explosives Safety (USATCES) for review, Department of the Army approval, and submission to the DoD Explosives Safety Board (DDESB) for their review and approval.
- Coordinates resolution of USATCES and DDESB comments on ESP.

The USACE Risk Assessor team member Monique Nixon

- Participates in preparation of SOW/PWS to ensure that risk assessment requirements are adequately addressed.
- Participates in proposal review to evaluate risk assessment-related tasks.
- Participates in TPP meetings, as appropriate.
- Evaluates screening levels for environmental media
- Reviews the work plan to ensure that planned effort will support the level of risk assessment intended.
- Conducts reviews of human health and ecological risk assessments.
- Reviews QCP reporting requirements and accepts reported QC measures/standards.
- Reviews reports containing risk assessments, to include decision-making regarding results of risk assessments

4. METHODOLOGIES TO BE USED TO MONITOR THE CONTRACTOR'S PERFORMANCE

Even though the Government, through its COR, will be monitoring the contractor's performance on a continuing basis, the volume of tasks performed by the contractor makes technical inspections of every task and step impractical. Accordingly, USACE will use the Surveillance Activity Table (Attachment A) as the basis for monitoring the contractor's performance under this contract. The contractor's performance will be evaluated by the Contracting Officer using the Performance Metrics for CPARS provided as in this PWS.

Quality Assurance Surveillance Activities

In general, the work will be evaluated in terms of how well the requirements of the task order are satisfied, the extent to which the work performed follows the approach found in the contractor's technical proposal, clarity of documentation, and timeliness of scheduled task accomplishment. At the discretion of the COR or the Contracting Officer or Specialist, other government officials approved by the Contracting Officer or Specialist may be asked to evaluate a particular deliverable or set of deliverables. Quality Assurance included but is not limited to the following:

Quality Assurance for Geophysics

The Quality Assurance Surveillance Activities for Geophysics are based on the following:

1) Data packages, including all associated QC documentation, are submitted to the Government in lots and IAW DID MR-005-05.01. The Contractor shall propose the lot size and criteria for designation (i.e. woods vs. open, GPS vs RTS vs line and fiducial, array vs man-portable, etc.) for Government concurrence.
2) QC documentation must be generated IAW a documented QCP and the Performance Requirements Tables, as specified in the PWS. All such documentation will be reviewed as part of this QASP.
3) In the event a requirement is not met and the contractor submits the data to the Government, the contractor shall provide rationales for accepting them. All such rationales will be reviewed as part of this QASP. If the rationales are either insufficient or technically unfeasible, or are attempts to justify non-conformances that should be corrected to meet project needs, the submittal(s) will be rejected. Non-conformances identified as part of this QASP will result in the entire lot being returned to the Contractor and require all necessary correction(s) be performed to meet requirements. The Government will issue a CAR to the contractor to document this action.

Quality Assurance for Geospatial Data

The Quality Assurance Surveillance Activities for Geospatial Data are based on the following:

1) Data packages, including all associated QC documentation, are submitted to the Government in lots and IAW DID MR-005-07.01.

Quality Assurance for Chemistry

The Quality Assurance Surveillance Activities for Chemistry are based on the following:

1) Data packages, including all associated QC documentation, are submitted to the Government in lots and IAW DID MR-005-10.01.

Quality Assurance for On-Site Safety/Operations QA

The Quality Assurance Surveillance Activities for On-Site Safety/Operations QA are based on the following:

1) Occupational and explosive safety guidance
2) On-Site Safety Inspections
3) Review of QC documents retained on site during field activities
4) On-Site operations inspections.

5. QUALITY ASSURANCE REPORTING FORMS

The forms used to document surveillance activities include Daily Quality Assurance Report (Attachment B), HNC Form 948, Form 7, Memorandum for Record, and Quality Assurance Forms (Attachment D). Nonconformances will be documented on a Corrective Action Request (CAR), see Attachment C. Non-conformances are documented at the discretion of the person conducting the surveillance activity, but should be fair and reasonable. Each CAR will be annotated as a Critical nonconformance, Major nonconformance, or Minor nonconformance. CARs will be provided to the Contracting Officer for distribution to the contractor. The contractor will be required to correct explosives safety issues immediately. All other CARs will provide a reasonable suspense date for the contractor to review and take appropriate action, usually 15 calendar days. The contractor is required to provide written responses to all CARs.

Completed forms will be consolidated and provided to the Contracting Officer at the end of each month for that month's surveillance activities. These forms, when completed, will document the contractor's compliance with contract requirements and completion of milestone activities. The Contracting Officer will evaluate contractor performance using the definitions contained in the CPARS and the metrics identified in this PWS.

Attachment A
Surveillance Activity Table

Attachment B
Daily QA Report

Attachment C
Corrective Action Request

Attachment D
Quality Assurance Forms

D-1 Digital Geophysical Mapping Quality Assurance Form (Data Submittal)

D-2 Digital Geophysical Mapping Quality Assurance Form

D-3 Digital Geospatial Data/Electronic Submittal Quality Assurance Form

D-4 Geospatial Quality Assurance Form (Data Submittal)

D-5 On-Site Safety/Operations Qa

D-6 Chemistry Quality Assurance Form (Data Submittal)

(Additional QA Forms may be developed)

Draft Attachment A
SURVEILLANCE ACTIVITIES TABLE

(1) Definable Feature of Work	(2) Reference	(3) Performance Indicators	(4) Surveillance Method	(5) Performance Documentation & QA Surveillance Record File	(6) Performance Assessment Record (PAR) Category	(7) Responsible QA Team Member
Document Reviews						
Work Plan Reports/Other Documents	T.O. (see PWS)	Document submitted and accepted in compliance with contract schedule. Resubmissions required based on amount and nature of government comments regarding Formatting, completeness, Technical Accuracy, Regulatory compliance, Conciseness, Decisions supported by data.	100% review of submitted documents.	CEHNC Form 7, Contracting Officer Transmittal Memo; kept in official contract file.	Quality of Product or Service	PDT
Project Execution						
Work Plan Execution	T.O. (see PWS)	Work done in compliance with approved plans and data submittals accepted by government IAW performance documentation	Periodic Inspection	Corrective Action Requests (CAR), Geophysical QA Forms, GIS QA Forms, Chemisty QA Forms, QAR, HNC 948, Memorandum for Record, Trip Reports; Kept in official project file	Quality Of Product or Service	PDT
Schedule						
Project Management: Schedule Control/Reporting	T.O. / WP	Number of instances of contractor impacts on schedule attributable to the contractor and impacts not identified.	100% of project status reports including weekly and monthly as applicable.	PM checklist; kept in PM file	Schedule	Government PM
Cost (Not Applicable for Firm Fixed Price)						
Project Management: Cost Control/Reporting	T.O. / WP	Number of instances of contractor impacts on cost attributable to the contractor and unauthorized cost overruns.	100% of project status reports including weekly and monthly as applicable.	PM checklist; kept in PM file	Cost Control	Government PM
Business Relations						
Meeting preparation and professional conduct	T.O.	Number of customer complaints regarding: 1. Personnel prepared and knowledgeable in areas of expertise. 2. Professional and ethical conduct.	Customer Feedback	Email, letters, customer survey forms; kept in PM file	Business Relations	Government PM
Management of Key Personnel						
Project Management: Personnel	T.O.	Number of instances regarding contractor Personnel and their qualifications for filling key positions/functions.	Periodic Inspection	Trip report, QARs, CARs HNC 948; kept in official project file	Management of Key Personnel and Resources	PDT
Safety						
Execution of Explosives Management Plan & Explosives Siting Plan	DOD 6055.9-STD, EP 385-1-95, DA Pam 385-64, WP	Number and type of violations and/or accidents regarding compliance with explosives safety & OSHA requirements.	Periodic Inspection	QARs, CARs, HNC 948, Trip Reports; Kept in Project Safety Specialist file	Safety	Government Safety Specialist

Draft Attachment B

USACE ORDNANCE AND EXPLOSIVE PROJECT
DAILY QUALITY ASSURANCE REPORT

CONTRACT WITH DELIVERY ORDER: W912DY-10-D-0028, Task Order # 0005, ZAPATA

SITE:

DATE: **TELEPHONE NUMBER:**
FAX NUMBER:

WEATHER:

USACE PROJECT TEAM MEMBER & TITLE: i.e., Joe Smith OE Safety Specialist, Jill Jones, USACE Project geophysicist, etc.

GRIDS COMPLETED BY CONTRACTOR:

SURVEILLANCE ACTIVITY or ACTIVITIES:

GRIDS THAT PASSED GOVERNMENT QA:

CORRECTIVE ACTION REQUESTS (CAR) and/or Form 948 ISSUED:

CONTRACTOR KEY PERSONNEL ON-SITE:

GENERAL OBSERVATIONS:

LESSONS LEARNED:

DISTRIBUTION:
1-CEHNC-OE-CWM-DC (Project Manager)
1-CEHNC-OE-S (FILE)
1-CEHNC-ED (Project Engineer)
1-CEHNC-CT (Contract Specialist)

Attachment C

CORRECTIVE ACTION REQUEST | **NO.** *(1,2,3, etc.for the T.O.)*

USACE Representative:
Date Issued:
Issued to:
Response Due: (*Based on type of nonconformance*)
Contract# and T.O. W912DY-10-D-0028; T.O. 0005
Project Name/Location: Camp Croft RI/FS; Spartanburg, South Carolina

Nonconformance Type (circle one): Critical Major Minor

Description of Condition Found:

Contractor Representative Signature (Noting that CAR Received):

(The Contractor will provide the following information to the Contracting Officer and USACE PM by the "Response Due" date above. Please contact the USACE Representative listed above if you have any questions)

Actual Cause: (Contractor will investigate and determine cause of condition reported above. Actual cause should be stated as specifically as possible)

Action Taken to Correct Condition: (Corrective Action should address root cause, not the symptom)

Action Taken to Prevent Recurrence:

Action Taken to Monitor Effectiveness of Corrective Action: (Generate data as proof. State the monitoring method put in place and who is responsible for reviewing data.)

Contractor Representative Signature/Title/Date Signed: (Form must be signed before returning)

(USACE Project Team Use Only)
Review of Corrective Action:
1) Has condition improved? ___ Yes ___ No
2) Additional corrective action required? ___ Yes ___ No
Comments:
Completed form provided to Contracting Officer: (Date)

Draft DIGITAL GEOPHYSICAL MAPPING QUALITY ASSURANCE FORM *(DATA SUBMITTAL)*

U.S. Army Engineering & Support Center, Huntsville
Camp Croft RI/FS, Spartanburg, SC, Zapata Incorporated
Lot ID:

Recommend Payment: Yes ☐ No ☐
QA Reviewer: ____________
Date: ____________

	Pass	*Fail*	*See Comments*	*Field Observation*	*N/A*
1) Submittal Ontime	☐	☐	☐	☐	☐
2) Submittal Complete (raw/processed data files (mapping & QC), maps, field data sheets, updated Access DB (includes QC results, target selection tables, etc.)	☐	☐	☐	☐	☐
3) Performance Requirements Results (all results documented & failures have RCAs: Static Repeatability, Along line measurement spacing, Speed, Coverage, Dynamic Detection & Positioning Repeatability, Geodetic Equipment Functionality/internal consistency/accuracy)	☐	☐	☐	☐	☐
4) Periodic Recalculation of Performance Requirements (include details in comments section)					
(a) Static Repeatability	☐	☐	☐	☐	☐
(b) Along Line Measurement Spacing	☐	☐	☐	☐	☐
(c) Speed	☐	☐	☐	☐	☐
(d) Coverage	☐	☐	☐	☐	☐
(e) Dynamic Detection Repeatability	☐	☐	☐	☐	☐
(f) Dynamic Positioning Repeatability	☐	☐	☐	☐	☐
(g) Geodetic Functionality	☐	☐	☐	☐	☐
(h) Geodetic Internal Consistency	☐	☐	☐	☐	☐
5) Review of Maps/Gridded data (Assess Potential Field) (visual check: background levelling, striping, latency, noise, in particular view seed items for dynamic detection repeatability)	☐	☐	☐	☐	☐
6) Target Selection (following selection criteria for anomaly & dig lists, each single anomaly has one unique ID, cultural features noted/not selected to dig, no gridding artifacts, reporting of anomaly characteristics accurate)	☐	☐	☐	☐	☐
7) Root Cause Analyses/Non-conformances Reported & Accepted	☐	☐	☐	☐	☐
8) Any additional field observations/QA (add notes below)	☐	☐	☐	☐	☐

Quality Assurance Comments:

Draft DIGITAL GEOPHYSICAL MAPPING QUALITY ASSURANCE FORM *(Anomaly Resolution)*

U.S. Army Engineering & Support Center, Huntsville
Camp Croft RI/FS, Spartanburg, SC, Zapata Incorporated
Lot ID:

Recommend Payment: Yes ☐ No ☐
QA Reviewer: ____________________
Date: ____________________

	Pass	*Fail*	*See Comments*	*Field Observation*	*N/A*
1) Submittal Ontime/Complete (updated Access Tables)	☐	☐	☐	☐	☐
2) Reacquisition Results (offset within allowable distance, reacquisition amplitude >= 80% original, No contacts with original values >x, etc.)	☐	☐	☐	☐	☐
3) Acceptance Sampling (no unresolved anomalies in sample) (post-dig amplitude < criteria or fully documented rationale)	☐	☐	☐	☐	☐
4) Root Cause Analyses/Non-conformances Reported & Accepted	☐	☐	☐	☐	☐
5) Any additional field observations/QA (add notes below)	☐	☐	☐	☐	☐

Quality Assurance Comments:

Draft DIGITAL GEOSPATIAL DATA/ELECTRONIC SUBMITTAL QUALITY ASSURANCE FORM

U.S. Army Engineering & Support Center, Huntsville
Camp Croft RI/FS, Spartanbrg, SC, Zapata Incorporated
Submittal Phase: (Circle One)
Recon SI RI/FS NTCRA NCRA OTHER ESS ESP

Recommend Payment: Yes ☐ No ☐
QA Reviewer: ____________
Date: ____________

	Pass	*Fail*	*See Comments*	*Field Observation*	*N/A*
1) Submittal Ontime/Complete Submittal	☐	☐	☐	☐	☐
2) All required data submittals (feature classes and tables) provided (SDSFIE Data Checker used for features, attributes, and domains)	☐	☐	☐	☐	☐
3) All data submitted geospatially correct and projected within correct coordinate system as per Project Requirements	☐	☐	☐	☐	☐
4) Root Cause Analyses/Non-conformances Reported & Accepted (Insurance that all data sets, digital pictures, and supporting document files are supplied to completely support all finding and conclusions of the Final Report.)	☐	☐	☐	☐	☐
5) Any additional field observations/QA (add notes below)	☐	☐	☐	☐	☐

Quality Assurance Comments:

Draft GEOSPATIAL QUALITY ASSURANCE FORM *(DATA SUBMITTAL)*

U.S. Army Engineering & Support Center, Huntsville
Camp Croft RI/FS, Spartanbrg, SC, Zapata Incorporated
Submittal Phase: (Circle One)
Recon SI RI/FS NTCRA NCRA OTHER ESS ESP

Recommend Payment: Yes ☐ No ☐
QA Reviewer: ____________
Date: ____________

	Pass	*Fail*	*See Comments*	*Field Observation*	*N/A*
1) Submittal Ontime	☐	☐	☐	☐	☐
2) Submittal Complete (Are all corresponding sections of the written report, conveyed within the electronic submittal CD/DVD? Ie. field data sheets, digital pictures, chemical data and analysis, GIS Feature Classes, other Report Appendices)	☐	☐	☐	☐	☐
3) Performance Requirements Results (Do all of the supplied GIS files have correct spatial reference? Is Meta Data provided for all data sets created by the Contractor? Do the supplied electronic files, match the Final written report in content and revision? Can the Final Written Report be produced in whole from the electronic submittal?)	☐	☐	☐	☐	☐
4) Geospatial Data (shape file or personal geodatabase) for GIS, MicroStation for CADD, must conform to the SDSFIE for GIS or A/E CADD Standard for CADD.					
(a) Data Format					
i. ASCII text comma delimited file (table with column headings and point data only)	☐	☐	☐	☐	☐
ii. ESRI shape file	☐	☐	☐	☐	☐
iii. ESRI Coverage	☐	☐	☐	☐	☐
iv. ESRI personal geodatabase	☐	☐	☐	☐	☐
v. ESRI SDE geodatabase	☐	☐	☐	☐	☐
vi. MicroStation/AutoCAD	☐	☐	☐	☐	☐
vii. Other (Specify Type): ____________	☐	☐	☐	☐	☐
(b) Horizontal Datum:					
i. WGS 84	☐	☐	☐	☐	☐
ii. NAD 83 (Preferred)	☐	☐	☐	☐	☐
iii. NAD 27	☐	☐	☐	☐	☐
iv. Other (Specify Type): ____________	☐	☐	☐	☐	☐
(c) Veritcal Datum:					
i. NAVD 88 (Preferred)	☐	☐	☐	☐	☐
ii. NAVD 29	☐	☐	☐	☐	☐
iii. Other (Specify Type): ____________	☐	☐	☐	☐	☐
(d) Coordinate System/Zone:					
i. State of project Location: ______	☐	☐	☐	☐	☐
ii. State Plane Zone (ie. East, West, North, South, Number)	☐	☐	☐	☐	☐
iii. UTM Zone No. _____ Circle One: South North	☐	☐	☐	☐	☐
(e) Project:					
i. Geographic	☐	☐	☐	☐	☐
ii. Transverse Mercatur	☐	☐	☐	☐	☐
iii. Lambert Conformal Conic	☐	☐	☐	☐	☐
iv. Albers	☐	☐	☐	☐	☐
v. Other (Specify Type): ____________	☐	☐	☐	☐	☐
(f) Horizontal Measure:					
i. Feet	☐	☐	☐	☐	☐
ii. Meters	☐	☐	☐	☐	☐
iii. Latitude/Longitude	☐	☐	☐	☐	☐
iv. Other (Specify Type): ____________	☐	☐	☐	☐	☐

(g) Vertical Measure:

i. Feet

ii. Meters

iii. Other (Specify Type): ___________________________

5) Actual Submittal Date, Contractor, Project Name, and Location, and Phase of Project, shown on CD or DVD of electronic submittal

Quality Assurance Comments:

GENERIC QA CHECK LIST
FOR
ON-SITE SAFETY SUPPORT
Rev. **3**

Project Name/Contract No:

Audit Date (Start):________________ Audit Date (End):_______________

To include in part or whole, but not limited to the following checkpoints.

CHECKPOINTS:

1. Documentation Requirements	YES	NO	N/A	COMMENTS
a. Notice to Proceed from KO	☐	☐	☐	
b. Approval Letter for Work Plan/SSHP	☐	☐	☐	
c. Approval Letter for UXO Personnel Identified by Name & Position	☐	☐	☐	
d. Approval Letter, FAA (If Required)	☐	☐	☐	
e. Certificate of Grounding, Lightning Protection (if Required)	☐	☐	☐	
f. Explosive Permits/License (If Required)	☐	☐	☐	
g. GFE Transfer Documentation (If Required)	☐	☐	☐	
h. Approval Letter, Public/Personnel Withdraw Distance 1 Frag in 600 sq. ft.	☐	☐	☐	
i. Dig Permits for Utilities (If Required).	☐	☐	☐	
2. Site-Specific Safety & Health Plan (SSHP)	**YES**	**NO**	**N/A**	**COMMENTS**
a. Emergency Notification List Posted & Available	☐	☐	☐	
b. Emergency Routes/Maps Available & Issued to Each Team	☐	☐	☐	
c. Work Task Identified in Hazard Analysis. Approved SSHP	☐	☐	☐	
d. MSDS(s) On-Site. Approved SSHP	☐	☐	☐	
e. Visitors/Safety Briefing Log Current and Updated	☐	☐	☐	
f. All Personnel On-Site in the Proper PPE.	☐	☐	☐	
g. Minimum of Two Personnel On-Site First Aid/CPR Trained, EM 385-1-1, Section 3, Page 19. Paragraph 03.A.02	☐	☐	☐	
h. 16-Unit First Aid Kits or Kits Approved by a Licensed Physician in the Ratio of one for every 25 persons or less. EM 385-1-1, Section 3, Page 19. Paragraph 03.A.03	☐	☐	☐	
3. Technical Management Reference DID OE-005-02.01	**YES**	**NO**	**N/A**	**COMMENTS**
a. Procedures Established for the Discovery of RCWM	☐	☐	☐	
b. Procedures Developed for Discovery of MEC Which Cannot Be Destroyed in Place	☐	☐	☐	
c. Project Grid Size, Layout, Lane Width(5' or Less) Established	☐	☐	☐	
d. Established Procedures for Chanded Site Conditions	☐	☐	☐	
e. Organizational chart Current and Indicates Assignment, Duties, Responsibilities to Include Geophysical Teams	☐	☐	☐	
f. Procedured for Reporting and Disposition of MPPEH	☐	☐	☐	
g. Procedures Established for Disposal of MEC in Populated/Sensitive Areas	☐	☐	☐	
h. Procedures Established for Managing, reporting, Venting and Disposing of MD and RRD	☐	☐	☐	
i. Additional Task and Procedures being Followed (e.g. PAO, Community Relations, Weekly & Monthly Project Status reports)	☐	☐	☐	
j. Procedured Established for Recording, reporting and implementing Lessons Learned	☐	☐	☐	
k. Limitations Posed and Ability of Detection System(s) Chosen.	☐	☐	☐	
l. Proper use of Geophysical Detections Systems used	☐	☐	☐	
4. Facilities. Reference EM 385-1-1	**YES**	**NO**	**N/A**	**COMMENTS**
a. Adequate Work Space & Facilities (Restrooms etc.)	☐	☐	☐	
b. Good Housekeeping (No Fire Hazards, Tripping Hazards etc.)	☐	☐	☐	
c. Approved and Suitable Containers for Flammable Toxic or Explosive Materials	☐	☐	☐	

GENERIC QA CHECK LIST
FOR
ON-SITE SAFETY SUPPORT
Rev. 3

	YES	NO	N/A	COMMENTS
d. Approved/Adequate Explosive Storage Facilities	☐	☐	☐	
e. Fire/Emergency Exits Clear & Unbarred	☐	☐	☐	
f. Personnel Limits Maintained	☐	☐	☐	
g. Site Security Adequate	☐	☐	☐	
h. Toilets. EM 385-1-1, Section 2, page 14, Paragraph 02.B Toilets.	☐	☐	☐	
i. Washing Facilities. EM 385-1-1, Section 2, Page 16. Paragraph 02.C Washing Facilities	☐	☐	☐	
5. Equipment. Reference Approved WP/Manufacture Operators Manual	**YES**	**NO**	**N/A**	**COMMENTS**
a. Tools Appropriate and Serviceable	☐	☐	☐	
b. Proper Personnel Protective Equipment (PPE) Present, Serviceable & Utilized	☐	☐	☐	
c. Equipment Calibrated (Last cal Date____________ Next cal Date____________)	☐	☐	☐	
d. Survey Equipment Inspected & Serviceable	☐	☐	☐	
e. Heavy Equipment Inspected & Serviceable IAW EM 385-1-1, Section 16	☐	☐	☐	
1. Are Equipped with at Least One Dry Chemical or CO2 Fire Extinguisher - Minimum rating of 5-BC - IAW EM 385-1-1, Section 16.	☐	☐	☐	
f. Two Separate Means of Communications, Radio(s)/Cell Phone, Land Line(s).	☐	☐	☐	
g. Geophysical Equipment On-Hand & Serviceable	☐	☐	☐	
6. Explosive Storage Requirements. Reference EP 1110-1-18	**YES**	**NO**	**N/A**	**COMMENTS**
a. Proper Storage Containers Type 2 Magazines conforming to standards set forth in Section 55.206 of ATFP 5400.7, ATF Explosives Law and Regulations	☐	☐	☐	
b. Placards. Each magazine will display the placards required by DOT regulations in accordance with DOD 6055.9-STD and DA Pam 385-64 for Hazard division of OE stored in the magazine.	☐	☐	☐	
c. Explosive Compatibility Groups. Segregated into the appropriate hazard divisions criteria listed in Chapter 3, DOD 6055.9-STD.	☐	☐	☐	
d. Physical Security. Contractor shall conduct and document physical security survey, the survey is to determined if fencing or guards are required.	☐	☐	☐	
e. Locks. Shall meet the standards listed in Section 55.208 (a) (4), ATFP 5400.7.	☐	☐	☐	
f. A key control system will be documented in the Work Plan, EP 1110-1-18	☐	☐	☐	
g. Lightning Protection. Magazine constructed of metal that has 3/16 inch steel or longer in accordance with National Fire Protection Association (NFPA) 780.	☐	☐	☐	
h. Lightning Protection. Magazine grounded in accordance with NFPA.	☐	☐	☐	
i. Lightning Protection. Magazine is located at least 6.5 feet from the nearest fence.	☐	☐	☐	
j. Lightning Protection. BRAC, IRP and Active Installation will meet the provisions of DOD 6055.9-STD. Army installations will also meet the provisions of DA Pamphlet 385-64.	☐	☐	☐	
k. Fire Protection. Extinguishers of appropriate size (minimum 10 BC) and type will be located in all explosives storage facilities.	☐	☐	☐	
l. Explosive Limits Maintained, 100 lbs. NEW or less	☐	☐	☐	
m. Waiver. MACOM approval for storage of commercial of explosives on-site (if required).	☐	☐	☐	
7. Explosive Management Plan. Reference Approved WP/49 CFR	**YES**	**NO**	**N/A**	**COMMENTS**
a. Signature Authority On-Hand	☐	☐	☐	
b. Periodic Inventories Conducted On-Schedule	☐	☐	☐	
c. Accountability Records Maintained	☐	☐	☐	
d. Lost/Stolen Reporting Procedures In Place	☐	☐	☐	
e. Final Disposition Procedures Documented	☐	☐	☐	
f. Key Control/Security	☐	☐	☐	
8. Transportation of OE. Reference EP 1110-1-18, Chapter 15/49 CFR	**YES**	**NO**	**N/A**	**COMMENTS**

a. Hazardous Waste Manifest (EPA Form 8700-22) (if required)	☐	☐	☐	
b. Hazard Classification of OE IAW TB 700-2	☐	☐	☐	
c. Training of Transporting OE IAW 49 CFR, Part 172 & State Applicable State Requirements	☐	☐	☐	
d. Documented Organizational Responsibilities for Transportation of OE	☐	☐	☐	
e. Approved Transportation Plan	☐	☐	☐	
f. Pre-operational Checks of Vehicles Being Conducted	☐	☐	☐	
g. All Operators Licensed For Vehicle	☐	☐	☐	
h. Fire Fighting & First Aid Equipment On Board	☐	☐	☐	
i. Cargo Properly Segregated/Blocked And Braced and in Proper Container	☐	☐	☐	
j. Proper DOT Placards/Fire Fighting Symbols Used	☐	☐	☐	
9. UXO Operational Plan. Reference Approved WP & EP 1110-1-18	**YES**	**NO**	**N/A**	**COMMENTS**
a. Contractor Following Methodology Defined in WP	☐	☐	☐	
1. SUXO Conducted Physical Check Prior to Sweep Operations	☐	☐	☐	
2. Daily Safety Meeting Conducted by SUXO/SSHO	☐	☐	☐	
b. Geophysical Detection Magnetometer Used	☐	☐	☐	
1. Pre-Operational Checks Performed Prior to Sweep Operations	☐	☐	☐	
2. Operational Condition Annotated in Log Book	☐	☐	☐	
3. UXO Teams	☐	☐	☐	
4. Quality Control	☐	☐	☐	
5. Quality Assurance	☐	☐	☐	
c. Operational Teams Operating IAW WP	☐	☐	☐	
1. UXO Supervisor Conducted Physical Check Prior to Sweep Operation	☐	☐	☐	
2. Pre-Sweep Operational/Safety Brief Conducted	☐	☐	☐	
3. Individual Sweep Lanes/Transects Marked IAW WP	☐	☐	☐	
4. Contacts Marked & Investigated Properly	☐	☐	☐	
5. Results of Sweep Operation Recorded	☐	☐	☐	
6. All OE, Inert Items & Scrap Examined by at Least Two UXO Personnel	☐	☐	☐	
(a.) AEDA (Range Residue) IAW SOW and Properly Addressed in WP	☐	☐	☐	
7. All UXO's Clearly Marked	☐	☐	☐	
d. QC Operations IAW WP	☐	☐	☐	
e. Non-OE Scrap Being Collected (as Required)	☐	☐	☐	
f. OE Scrap Inspected/Vented/Segregated	☐	☐	☐	
g. Geophysical Test Grids Appropriate and IAW SOW	☐	☐	☐	
10. Disposal Operations Planned On-Site IAW the Approved WP and 60A-1-1-31/1-1-22	**YES**	**NO**	**N/A**	**COMMENTS**
a. Disposal Method IAW WP	☐	☐	☐	
	☐	☐	☐	

b. Adequate Security For Disposal Operation	☐	☐	☐	
c. Disposal Notification List Available	☐	☐	☐	
d. All Necessary Notifications Made	☐	☐	☐	
e. Movement of OE Items, Or is OE Consolidation Feasible	☐	☐	☐	
f. Protective Measures/Tamping Being Used/Appropriate for OE Being Destroyed	☐	☐	☐	
g. Limits of the Exclusion Zone Established and Are All Personnel Aware of Limits	☐	☐	☐	
h. Disposal Procedures	☐	☐	☐	
1. Misfire Procedures Properly Performed (Electric)	☐	☐	☐	
2. Misfire Procedures Properly Performed (Non-Electric)	☐	☐	☐	
11. Quality Control Plan. Reference SOW/DID(s)	**YES**	**NO**	**N/A**	**COMMENTS**
a. QC Operational/Checks Being Conducted IAW WP	☐	☐	☐	
b. QC Grid/Transect Established IAW WP	☐	☐	☐	
c. Results of QC Checks Being Recorded	☐	☐	☐	
d. Pass/Fail Criteria Clearly defined IAW SOW/DID OE-005-05.01	☐	☐	☐	
12. Vegetation Removal Reference WP/SSHP & OSHA Req.	**YES**	**NO**	**N/A**	**COMMENTS**
a. Vegetation Removal & Localized, if Required	☐	☐	☐	
b. Equipment Operated To Prevent Impact With Possible Surface UXO	☐	☐	☐	
c. Cutting Does Not Present Impalement Hazard	☐	☐	☐	
d. UXO Personnel Monitoring Cutting Operation	☐	☐	☐	
e. UXO Discovered Marked/Handled Appropriately	☐	☐	☐	
f. Equipment Being Operated Safely & IAW Equipment Operators Manual/WP	☐	☐	☐	

Draft CHEMISTRY QUALITY ASSURANCE FORM (DATA SUBMITTAL)

U.S. Army Engineering & Support Center, Huntsville
Camp Croft RI/FS, Spartanburg, SC, Zapata Incorporated
Lot ID:

Recommend Payment: Yes ☐ No ☐
QA Reviewer: ____________
Date: ____________

	Pass	*Fail*	*See Comments*	*Field Observation*	*N/A*
1) Submittal Ontime	☐	☐	☐	☐	☐
2) Submittal Complete (Electronic Data Deliverables, Daily Quality Control Reports, ERIS Data Uploaded to Database, Data Validation Report, Chemistry related project communication)	☐	☐	☐	☐	☐
3) Daily Quality Control Reports					
a) Submittal on-time (daily during field work)	☐	☐	☐	☐	☐
b) Sampling effort in agreement with approved Work Plan.	☐	☐	☐	☐	☐
c) Any deviation from approved work plan documented	☐	☐	☐	☐	☐
d) Required attachments included (sample tables, COC, additional environmental sampling related project forms)	☐	☐	☐	☐	☐
4) Electronic Data Deliverables (Project Specific library file, DTD file, SEDD stage 2A or 2B XML file, Post-review file, Annotated error log)					
a) Library and Laboratory data correspond	☐	☐	☐	☐	☐
b) Error Reports in agreement	☐	☐	☐	☐	☐
c) Post validation files in agreement with flagged data	☐	☐	☐	☐	☐
5) ERIS Data (Data Upload accurate and complete)	☐	☐	☐	☐	☐
6) Data Validation Report					
a) Validation Report addresses all data packages	☐	☐	☐	☐	☐
b) Identifies analytical problems	☐	☐	☐	☐	☐
c) Identifies Impact on Data Usability	☐	☐	☐	☐	☐
7) Chemistry Related Project Communication (holding times/temperature exceedances, lost or damaged samples, other chemistry related issues)	☐	☐	☐	☐	☐

Quality Assurance Comments:

APPENDIX F
FORMS

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The following forms are provided to record and collect data while performing the current task:

1. Magnetometer Check Sheet
2. Field Data Sheet
3. Correspondence Log
4. Explosives Consumption Certificate
5. Explosives Accountability Log
6. Daily Log and QC Testing (EM61 MKII QC Field Log)
7. QC Inspection Record
8. Camp Croft Dig Sheet _ DGM Grid Reacquisition
9. Camp Croft Dig Sheet _ Transect Reacquisition
10. Camp Croft Dig Sheet_Mag-Dig

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MAGNETOMETER/METAL DETECTOR CHECK SHEET

SITE: Former Camp Croft Spartanburg, SC	**CONTRACT: W912DY-10-D-0028 TASK ORDER#: 0005**
TEAM#:	**TEAM LEADER:**
INSTRUMENT TYPE: FOERSTER	**SERIAL#:**

DATE	OPERATIONAL CHECK	SAT	UNSAT	REMARKS

☐ QC checked by _____________ Date: __________ **Field Data Sheet** ☐ QA checked by __________ Date: ________

Project Name: ___________________________________ **Project Location:** ___________________________________

Geophysical Contractor: ___________________________ **Design Center POC:** _________________________________

Project Geophysicist: _______________________________ **Site Geophysicist:** _____________________________________

Survey Area ID: ___________ **Date:** ______________ **Field Team:** ____

Survey Type: ☐Grid ☐Meandering Path ☐Transect ☐Other ______________

Coordinate System: ☐UTM ☐State Plane NAD ______ ☐Local ☐Other ______________ **Unit of Measure:** ☐ meters ☐ feet

Sketch of Survey Area: **Approx. Scale:** _____________ **North Arrow:** _________

Terrain:

☐Level ☐Moderate Slope ☐Steep

☐Rolling ☐Ruts ☐Gullies

☐Rocky ☐Swampy ☐Dangerous

Tree Cover: **Tree Height:** ____

☐None ☐Light ☐Medium ☐Thick

Brush:

☐None ☐Light ☐Medium ☐Thick

Weather:

☐Sunny ☐Cloudy ☐Drizzle

☐Rain ☐Thunderstorms ☐Hail

☐Fog ☐Humid ☐Snow

Grid Corner Coordinates:

Name	UTM/State Plane	Local
SW	___________, ___________	___________, ___________
NW	___________, ___________	___________, ___________
NE	___________, ___________	___________, ___________
SE	___________, ___________	___________, ___________

	Start	End	File
Battery Voltage:	_____	_____	
Static Background Value:	_____	_____	_______, _______
Static Response Value:	_____	_____	_______, _______

Instrument Clock Drift: ____________

Raw Data File Name: ______________________________ **Repeat Data File Name:** ______________________________

Geophysical Instrumentation: ____ **Serial Number:** ________________

Base Station: ____ Serial Number: ________________

Navigation Method: ____ **Serial Number:** ________________

Additional Comments: ____

____

CORRESPONDENCE LOG

NUMBER	DATE	FROM	TO	SUBJECT

Explosives Consumption Certificate

EXPLOSIVE CONSUMPTION CERTIFICATE				
Zapata Incorporated			SITE AND GRID/TRANSECT NUMBER	
DATE	ISSUE DOCUMENT SERIAL #			
ITEM #	MANUFACTURE	NOMENCLATURE	LOT NUMBER	QUANTITY CONSUMED
CERTIFYING OFFICIAL				
I CERTIFY THAT I SAW THE ABOVE ITEMS CONSUMED DURING DEMOLITION ON (INDICATE DATE)			DATE	
NAME (TYPE OR PRINT)		SIGNATURE		
EMPLOYER		POSITION		

EXPLOSIVES ACCOUNTABILITY LOG

Date of Acquisition	Name/Brand of Manufacturer	Manufacturer's Marks (Lot #)	Quantity (Each, feet, etc.)	Description	Name of Distributor & License/Permit #	Address of Distributor

(Daily Log and QC Testing)

(EM61 MK2 QC field log)

System:________________________ Date: ___________________
GPS Mode: YES NO Zapata Field Personnel:________________________
Wheel Mode: YES NO

QC1 (Equipment/Electronics)

Equipment Serial Numbers
Recorder: Model:________________________ SN_____________________
Left Console: Model:________________________ SN_____________________
Center Console: Model :________________________ SN_____________________
Right Console: Model :________________________ SN_____________________
Bottom Left Coil: Model :________________________ SN_____________________
Bottom Center Coil: Model :________________________ SN_____________________
Bottom Right Coil: Model :________________________ SN_____________________

GPS Equipment:
GPS Base Station Antenna: Model:________________________ SN_____________________
GPS Base Station Receiver: Model:______________________ SN_____________________
GPS Base Station Transmitter: Model:_____________________ SN_____________________
GPS Rover Unit: Model:________________________ SN_____________________
GPS Rover Antenna: Model:________________________ SN_____________________

Pre-Survey Checklist
Warm-up (15 minutes) ________ Start time:______End Time:_______
Check Batteries ________
Check Gasoline Levels ________
Check Cable Connections ________
Visual Inspection of EM Coils ________
Visual Inspection of GPS Antenna ________

QC2 (Sensor Positions)

Height to Bottom of Sensors:__________
GPS Base Station Setup
Base Location: Northing: _____________________Easting: _______________________
Frequency: ________________MHz

QC3 Personal Test

Operator has removed personal effects that may caused instrument interference: ________________

QC4 Cable Shake Test

File name:_____________________

Line: _________________________

Check Cable Connections: ________

Shake Cables while monitoring for change: _______________________

QC5_AM Static/Standard

(3 minutes static test + 1 minute standard test + 1 minute static test)

File Name: _______________ Battery Voltage: _______________

	Static	**Standard**	**Static**	**Residual** (standard minus static)
Left:	_____________	_____________	_____________	_____________
Center:	_____________	_____________	_____________	_____________
Right:	_____________	_____________	_____________	_____________

QC10_AM Latency Test with Position check and Repeat Line Test

File Name: _______________

Line Length: ______________

Known Target: Northing: ______________________Easting: _______________________

QC5_PM Static/Standard

(3 minutes static test + 1 minute standard test + 1 minute static test)

File Name: _______________ Battery Voltage: _______________

	Static	**Standard**	**Static**	**Residual** (standard minus static)
Left:	_____________	_____________	_____________	_____________
Center:	_____________	_____________	_____________	_____________
Right:	_____________	_____________	_____________	_____________

QC10_PM Latency Test with Position check or Repeat Line Test

File Name: _______________

Line Length: ______________
Known Target: Northing: ______________________Easting: _______________________

Zapata Incorporated QC Inspection Record

Site/Location: Former Camp Croft Date: _____/_____/_____

Grid/ Transect Number: _________________ Inspected By: ___________________________

Start Time:_________ AM PM Stop Time: ___________ AM PM

Personnel:			**QC Results:**			
Position	**Name**	**Hours**	**Item**	**Yes**	**No**	**Quantity**
UXOQCS			**OE Found**			
UXO Tech III			**Anomalies**			
UXO Tech II						
UXO Tech I			**Pass Insp.**			

Remarks: ____

____

____

____

Draw the approximate location of items that were answered Yes in QC Results.

SW Corner of Grid – Or End of Transect

QC Officer Signature:____

Camp Croft Dig Sheet_DGM Grid Reacquisition

Dig Results										Post-Dig Excavation QC Results		
Anomaly Type MEC, MD, CD	Description	# of Contacts	Weight (lbs)	Offset		Depth to Top (in)	Date	Team Leader Initials	Photograph	Excavation Hole Cleared?	QC Initials	Date
				Distance (ft)	Direction							

Camp Croft Dig Sheet_DGM Transect Reacquisition

MRS:

[illegible]	Target Parameters					Reacquisition				Dig Results								
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Offset		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Offset		[illegible]	[illegible]	[illegible]
							[illegible]	[illegible]						[illegible]	[illegible]			

Camp Croft Dig Sheet_Mag-Dig

Grid ID	Target Parameters		Dig Results										Post-Dig Excavation QC Results		
							Offset								
	Coordinate (Easting)	Coordinate (Northing)	Anomaly Type (MEC, MD, [illegible])	Description	[illegible]	Weight (lbs)	Distance (ft)	Direction	Depth to [illegible] (in)	Date	[illegible] Initials	Photograph	Excavation Hole Cleared?	[illegible] Initials	Date

APPENDIX G
FRAGMENTATION DATA REVIEW FORMS

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Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Non-Fragmenting Rounds
Munition:	40 mm M651 CS Grenade
Case Material:	Aluminum 7075
Fragmentation Method:	Non-Fragmenting
Secondary Database Category:	
Munition Case Classification:	Non-Fragmenting

DODIC:	B567
Date Record Created:	5/8/2008
Record Created By:	MC
Last Date Record Updated:	12/16/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	CS Starter Mixture
Explosive Weight (lb):	7.14285714285714E-03
Diameter (in):	1.5900
Cylindrical Case Weight (lb):	
Maximum Fragment Weight (Intentional) (lb):	
Design Fragment Weight (95%) (Unintentional) (lb):	
Critical Fragment Velocity (fps):	

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	0.007
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	3
Public Traffic Route Distance (2.3 psi); K24 Distance:	5
Inhabited Building Distance (1.2 psi), K40 Distance:	8
Intentional MSD (0.0655 psi), K328 Distance:	63

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.007
Kinetic Energy 10^6 (lb-ft²/s²):	
Required Wall & Roof Sandbag Thickness (in)	Non-Fragmenting
Expected Maximum Sandbag Throw Distance (ft):	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	
MFD-V [Maximum Fragment Distance, Vertical] (ft):	

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):		
Mild Steel:		
Hard Steel:		
Aluminum:		
LEXAN:		
Plexi-glass:		
Bullet Resist Glass:		

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.007
Kinetic Energy 106 (lb-ft²/s²):	
Water Containment System:	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Grenades & Mines
Munition:	Mk II Grenade
Case Material:	Cast Iron, Grey, CL35
Fragmentation Method:	Pre-formed Fragmenting
Secondary Database Category:	Hand Grenade
Munition Case Classification:	Robust

DODIC:	G890
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/29/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	0.125
Diameter (in):	2.2600
Cylindrical Case Weight (lb):	0.24047
Maximum Fragment Weight (Intentional) (lb):	0.0129
Design Fragment Weight (95%) (Unintentional) (lb):	0.0043
Critical Fragment Velocity (fps):	578

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	0.125
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	9
Public Traffic Route Distance (2.3 psi); K24 Distance:	12
Inhabited Building Distance (1.2 psi), K40 Distance:	20
Intentional MSD (0.0655 psi), K328 Distance:	164

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.125
Kinetic Energy 10^6 (lb-ft²/s²):	0.0022
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	62
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	521
MFD-V [Maximum Fragment Distance, Vertical] (ft):	397

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	1.15	0.79
Mild Steel:	0.07	0.05
Hard Steel:	0.06	0.04
Aluminum:	0.16	0.10
LEXAN:	1.61	1.23
Plexi-glass:	0.73	0.51
Bullet Resist Glass:	0.55	0.37

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.125
Kinetic Energy 106 (lb-ft²/s²):	0.0022
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	200/200

Item Notes

Fragment sizes, number of fragments and HFD came from test information. These numbers were used to calculate MFD-H using TP 16 Eq 4-34 & iterating using TRAJ to calculate the intial velocity. With this information, standard TP 16 methods were used to calculate MFD-V and thicknesses to prevent perforation.

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Grenades & Mines
DODIC:	
Munition:	M9A1 Rifile Grenade
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Rifle Grenade
Munition Case Classification:	Robust
Date Record Created:	8/23/2010
Record Created By:	SDH
Last Date Record Updated:	
Individual Last Updated Record:	
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Pentolite (50/50)
Explosive Weight (lb):	0.25
Diameter (in):	2.2500
Cylindrical Case Weight (lb):	0.36005
Maximum Fragment Weight (Intentional) (lb):	0.0051
Design Fragment Weight (95%) (Unintentional) (lb):	0.0009
Critical Fragment Velocity (fps):	6313

Overpressure Distances

TNT Equivalent (Pressure):	1.38
TNT Equivalent Weight - Pressure (lbs):	0.345
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	13
Public Traffic Route Distance (2.3 psi); K24 Distance:	17
Inhabited Building Distance (1.2 psi), K40 Distance:	28
Intentional MSD (0.0655 psi), K328 Distance:	230

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.285
Kinetic Energy 10^6 (lb-ft²/s²):	0.1016
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	113
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	709
MFD-V [Maximum Fragment Distance, Vertical] (ft):	570

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	3.26	1.62
Mild Steel:	0.62	0.31
Hard Steel:	0.50	0.26
Aluminum:	1.33	0.70
LEXAN:	4.11	2.70
Plexi-glass:	2.64	1.51
Bullet Resist Glass:	2.06	1.11

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.285
Kinetic Energy 106 (lb-ft²/s²):	0.1016
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	200/200

Item Notes

It is possible that this item contains Pentolite (10/90) which is 90% TNT. Since Pentolite (50/50) has a TNT equivalency greater than 1.0 and was more common during the production era, Pentolite (50/50) has been used for analysis until sources are found which prove otherwise.

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
DODIC:	
Munition:	2.36 in M6A3 Rocket (Warhead & Motor)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Rocket
Munition Case Classification:	Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/31/2011
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	See Item Notes
Explosive Weight (lb):	
Diameter (in):	2.3600
Cylindrical Case Weight (lb):	1.30239
Maximum Fragment Weight (Intentional) (lb):	0.0087
Design Fragment Weight (95%) (Unintentional) (lb):	0.0013
Critical Fragment Velocity (fps):	6170

Overpressure Distances

TNT Equivalent (Pressure):	
TNT Equivalent Weight - Pressure (lbs):	0.798
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	17
Public Traffic Route Distance (2.3 psi); K24 Distance:	22
Inhabited Building Distance (1.2 psi), K40 Distance:	37
Intentional MSD (0.0655 psi), K328 Distance:	304

Required Sandbag Thickness

TNT Equivalent (Impulse):	
TNT Equivalent Weight - Impulse (lbs):	0.678
Kinetic Energy 10^6 (lb-ft²/s²):	0.2187
Required Wall & Roof Sandbag Thickness (in)	20
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	142
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	790
MFD-V [Maximum Fragment Distance, Vertical] (ft):	634

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	3.69	1.66
Mild Steel:	0.70	0.32
Hard Steel:	0.57	0.26
Aluminum:	1.49	0.72
LEXAN:	4.45	2.75
Plexi-glass:	2.94	1.55
Bullet Resist Glass:	2.32	1.14

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	
TNT Equivalent Weight - Impulse (lbs):	0.678
Kinetic Energy 106 (lb-ft²/s²):	0.2187
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	

Item Notes

Whd Explosive: Pentolite (50/50); Rkt Mtr Explosive: Ballistite

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds	DODIC:	
Munition:	2.36 in M6A3 Rocket (Warhead Only)		
Case Material:	Steel, Mild	Date Record Created:	9/21/2004
		Record Created By:	MC
Fragmentation Method:	Naturally Fragmenting	Last Date Record Updated:	3/25/2010
Secondary Database Category:	Rocket	Individual Last Updated Record:	SDH
Munition Case Classification:	Robust	Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Pentolite (50/50)
Explosive Weight (lb):	0.5
Diameter (in):	2.3600
Cylindrical Case Weight (lb):	0.68368
Maximum Fragment Weight (Intentional) (lb):	0.0074
Design Fragment Weight (95%) (Unintentional) (lb):	0.0010
Critical Fragment Velocity (fps):	6170

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	133
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	790
MFD-V [Maximum Fragment Distance, Vertical] (ft):	634

Overpressure Distances

TNT Equivalent (Pressure):	1.38
TNT Equivalent Weight - Pressure (lbs):	0.690
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	16
Public Traffic Route Distance (2.3 psi); K24 Distance:	21
Inhabited Building Distance (1.2 psi), K40 Distance:	35
Intentional MSD (0.0655 psi), K328 Distance:	290

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	3.69	1.66
Mild Steel:	0.70	0.32
Hard Steel:	0.57	0.26
Aluminum:	1.49	0.72
LEXAN:	4.45	2.75
Plexi-glass:	2.94	1.55
Bullet Resist Glass:	2.32	1.14

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.570
Kinetic Energy 10^6 (lb-ft²/s²):	0.1403
Required Wall & Roof Sandbag Thickness (in)	20
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.570
Kinetic Energy 106 (lb-ft²/s²):	0.1403
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Rocket Motors
DODIC:	
Munition:	2.36 in Rocket Motor
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	
Munition Case Classification:	Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/31/2011
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Ballistite
Explosive Weight (lb):	0.135582010582011
Diameter (in):	1.2500
Cylindrical Case Weight (lb):	0.61872
Maximum Fragment Weight (Intentional) (lb):	0.0087
Design Fragment Weight (95%) (Unintentional) (lb):	0.0013
Critical Fragment Velocity (fps):	3491

Overpressure Distances

TNT Equivalent (Pressure):	0.8
TNT Equivalent Weight - Pressure (lbs):	0.108
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	9
Public Traffic Route Distance (2.3 psi); K24 Distance:	11
Inhabited Building Distance (1.2 psi), K40 Distance:	19
Intentional MSD (0.0655 psi), K328 Distance:	156

Required Sandbag Thickness

TNT Equivalent (Impulse):	0.8
TNT Equivalent Weight - Impulse (lbs):	0.108
Kinetic Energy 10^6 (lb-ft²/s²):	0.0530
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	103
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	731
MFD-V [Maximum Fragment Distance, Vertical] (ft):	569

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	2.07	1.01
Mild Steel:	0.40	0.19
Hard Steel:	0.33	0.15
Aluminum:	0.85	0.42
LEXAN:	3.38	2.14
Plexi-glass:	2.05	1.12
Bullet Resist Glass:	1.59	0.81

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	0.8
TNT Equivalent Weight - Impulse (lbs):	0.108
Kinetic Energy 106 (lb-ft²/s²):	0.0530
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	200/200

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
DODIC:	C704
Munition:	4.2 in M329 (With Supplementary Charge)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mortar
Munition Case Classification:	Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	7/6/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	8.3
Diameter (in):	4.2000
Cylindrical Case Weight (lb):	10.26457
Maximum Fragment Weight (Intentional) (lb):	0.0808
Design Fragment Weight (95%) (Unintentional) (lb):	0.0136
Critical Fragment Velocity (fps):	6583

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	8.300
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	36
Public Traffic Route Distance (2.3 psi); K24 Distance:	49
Inhabited Building Distance (1.2 psi), K40 Distance:	81
Intentional MSD (0.0655 psi), K328 Distance:	664

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	8.300
Kinetic Energy 10^6 (lb-ft²/s²):	1.7516
Required Wall & Roof Sandbag Thickness (in)	36
Expected Maximum Sandbag Throw Distance (ft):	220
Minimum Separation Distance (ft):	220

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	313
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1641
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1302

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	10.84	4.79
Mild Steel:	1.93	0.88
Hard Steel:	1.59	0.73
Aluminum:	3.91	1.88
LEXAN:	8.26	5.12
Plexi-glass:	6.68	3.54
Bullet Resist Glass:	5.76	2.85

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	8.300
Kinetic Energy 106 (lb-ft²/s²):	1.7516
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	275

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
Munition:	4.2 in M329 (Without Supplementary Charge)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mortar
Munition Case Classification:	Robust

DODIC:	C704
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/31/2011
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	7.8
Diameter (in):	4.2000
Cylindrical Case Weight (lb):	10.26457
Maximum Fragment Weight (Intentional) (lb):	0.0808
Design Fragment Weight (95%) (Unintentional) (lb):	0.0136
Critical Fragment Velocity (fps):	6583

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	7.800
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	36
Public Traffic Route Distance (2.3 psi); K24 Distance:	48
Inhabited Building Distance (1.2 psi), K40 Distance:	79
Intentional MSD (0.0655 psi), K328 Distance:	650

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	7.800
Kinetic Energy 10^6 (lb-ft²/s²):	1.7516
Required Wall & Roof Sandbag Thickness (in)	24
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	311
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1641
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1302

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	10.84	4.79
Mild Steel:	1.93	0.88
Hard Steel:	1.59	0.73
Aluminum:	3.91	1.88
LEXAN:	8.26	5.11
Plexi-glass:	6.68	3.53
Bullet Resist Glass:	5.76	2.83

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	7.800
Kinetic Energy 106 (lb-ft²/s²):	1.7516
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	275

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
Munition:	4.2 in M3A1
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mortar
Munition Case Classification:	Robust

DODIC:	
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	2/16/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	8.17
Diameter (in):	4.2000
Cylindrical Case Weight (lb):	10.68585
Maximum Fragment Weight (Intentional) (lb):	0.0864
Design Fragment Weight (95%) (Unintentional) (lb):	0.0119
Critical Fragment Velocity (fps):	6538

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	8.170
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	36
Public Traffic Route Distance (2.3 psi); K24 Distance:	48
Inhabited Building Distance (1.2 psi), K40 Distance:	81
Intentional MSD (0.0655 psi), K328 Distance:	661

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	8.170
Kinetic Energy 10^6 (lb-ft²/s²):	1.8466
Required Wall & Roof Sandbag Thickness (in)	
Expected Maximum Sandbag Throw Distance (ft):	
Minimum Separation Distance (ft):	

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	316
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1670
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1326

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	11.03	4.85
Mild Steel:	1.97	0.90
Hard Steel:	1.62	0.74
Aluminum:	3.98	1.90
LEXAN:	8.37	5.15
Plexi-glass:	6.80	3.57
Bullet Resist Glass:	5.87	2.87

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	8.170
Kinetic Energy 106 (lb-ft²/s²):	1.8466
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 1/31/2011

Category:	Surface-Launched HE Rounds
DODIC:	
Munition:	4.2 in M3A1
Date Record Created:	9/21/2004
Case Material:	Steel, Mild
Record Created By:	MC
Fragmentation Method:	Naturally Fragmenting
Last Date Record Updated:	2/16/2010
Secondary Database Category:	Mortar
Individual Last Updated Record:	SDH
Munition Case Classification:	Robust
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	8.17
Diameter (in):	4.2000
Cylindrical Case Weight (lb):	10.68600
Maximum Fragment Weight (Intentional) (lb):	0.0864
Design Fragment Weight (95%) (Unintentional) (lb):	0.0119
Critical Fragment Velocity (fps):	6538

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	316
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1670
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1326

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	8.170
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	36
Public Traffic Route Distance (2.3 psi); K24 Distance:	48
Inhabited Building Distance (1.2 psi), K40 Distance:	81
Intentional MSD (0.0655 psi), K328 Distance:	661

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	11.03	4.85
Mild Steel:	1.97	0.90
Hard Steel:	1.62	0.74
Aluminum:	3.98	1.90
LEXAN:	8.37	5.15
Plexi-glass:	6.80	3.57
Bullet Resist Glass:	5.87	2.87

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	8.170
Kinetic Energy 10^6 (lb-ft²/s²):	1.8466
Required Wall & Roof Sandbag Thickness (in)	24
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	8.170
Kinetic Energy 106 (lb-ft²/s²):	1.8466
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	275

Item Notes

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Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
DODIC:	B502
Munition:	37 mm M54
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	1/11/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Tetryl
Explosive Weight (lb):	0.07
Diameter (in):	1.4567
Cylindrical Case Weight (lb):	0.46886
Maximum Fragment Weight (Intentional) (lb):	0.0184
Design Fragment Weight (95%) (Unintentional) (lb):	0.0580
Critical Fragment Velocity (fps):	3459

Overpressure Distances

TNT Equivalent (Pressure):	1.07
TNT Equivalent Weight - Pressure (lbs):	0.075
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	8
Public Traffic Route Distance (2.3 psi); K24 Distance:	10
Inhabited Building Distance (1.2 psi), K40 Distance:	17
Intentional MSD (0.0655 psi), K328 Distance:	138

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.07
TNT Equivalent Weight - Impulse (lbs):	0.075
Kinetic Energy 10^6 (lb-ft²/s²):	0.1101
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	108
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	911
MFD-V [Maximum Fragment Distance, Vertical] (ft):	705

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	2.84	1.76
Mild Steel:	0.56	0.34
Hard Steel:	0.46	0.28
Aluminum:	1.18	0.75
LEXAN:	4.07	3.05
Plexi-glass:	2.61	1.79
Bullet Resist Glass:	2.08	1.37

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.07
TNT Equivalent Weight - Impulse (lbs):	0.075
Kinetic Energy 106 (lb-ft²/s²):	0.1101
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
DODIC:	
Munition:	37 mm M63 HE
Date Record Created:	1/27/2011
Record Created By:	SDH
Case Material:	Steel, Mild
Last Date Record Updated:	
Fragmentation Method:	Naturally Fragmenting
Individual Last Updated Record:	
Secondary Database Category:	Projectile
Date Record Retired:	
Munition Case Classification:	Robust

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	0.0850248
Diameter (in):	1.4703
Cylindrical Case Weight (lb):	0.92200
Maximum Fragment Weight (Intentional) (lb):	0.0330
Design Fragment Weight (95%) (Unintentional) (lb):	0.0132
Critical Fragment Velocity (fps):	3268

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	118
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1044
MFD-V [Maximum Fragment Distance, Vertical] (ft):	801

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	0.085
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	8
Public Traffic Route Distance (2.3 psi); K24 Distance:	11
Inhabited Building Distance (1.2 psi), K40 Distance:	18
Intentional MSD (0.0655 psi), K328 Distance:	144

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	3.19	1.93
Mild Steel:	0.61	0.36
Hard Steel:	0.50	0.30
Aluminum:	1.26	0.78
LEXAN:	4.44	3.22
Plexi-glass:	2.94	1.92
Bullet Resist Glass:	2.39	1.49

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.085
Kinetic Energy 10^6 (lb-ft²/s²):	0.1640
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.085
Kinetic Energy 106 (lb-ft²/s²):	0.1640
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
Munition:	37 mm Mk II
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Extremely Heavy Case

DODIC:	
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	1/11/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	0.053
Diameter (in):	1.4567
Cylindrical Case Weight (lb):	0.49264
Maximum Fragment Weight (Intentional) (lb):	0.0305
Design Fragment Weight (95%) (Unintentional) (lb):	0.0213
Critical Fragment Velocity (fps):	3307

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	0.053
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	7
Public Traffic Route Distance (2.3 psi); K24 Distance:	9
Inhabited Building Distance (1.2 psi), K40 Distance:	15
Intentional MSD (0.0655 psi), K328 Distance:	123

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.053
Kinetic Energy 10^6 (lb-ft²/s²):	0.1668
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	90
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	982
MFD-V [Maximum Fragment Distance, Vertical] (ft):	756

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	2.96	1.95
Mild Steel:	0.57	0.37
Hard Steel:	0.46	0.30
Aluminum:	1.18	0.79
LEXAN:	4.23	3.25
Plexi-glass:	2.76	1.94
Bullet Resist Glass:	2.23	1.51

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.053
Kinetic Energy 106 (lb-ft²/s²):	0.1668
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Black Powder Rounds	DODIC:	B526
Munition:	37 mm M63 TP		
Case Material:	Steel, Mild	Date Record Created:	9/21/2004
		Record Created By:	MC
Fragmentation Method:	Naturally Fragmenting	Last Date Record Updated:	4/27/2010
Secondary Database Category:	Projectile	Individual Last Updated Record:	SDH
Munition Case Classification:	Robust	Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Black Powder
Explosive Weight (lb):	0.084
Diameter (in):	1.4567
Cylindrical Case Weight (lb):	0.68068
Maximum Fragment Weight (Intentional) (lb):	0.0308
Design Fragment Weight (95%) (Unintentional) (lb):	0.0118
Critical Fragment Velocity (fps):	2286

Overpressure Distances

TNT Equivalent (Pressure):	0.4
TNT Equivalent Weight - Pressure (lbs):	0.034
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	6
Public Traffic Route Distance (2.3 psi); K24 Distance:	8
Inhabited Building Distance (1.2 psi), K40 Distance:	13
Intentional MSD (0.0655 psi), K328 Distance:	106

Required Sandbag Thickness

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.034
Kinetic Energy 10^6 (lb-ft²/s²):	0.0805
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	90
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	877
MFD-V [Maximum Fragment Distance, Vertical] (ft):	657

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	2.20	1.43
Mild Steel:	0.37	0.23
Hard Steel:	0.30	0.19
Aluminum:	0.77	0.50
LEXAN:	3.41	2.57
Plexi-glass:	2.08	1.43
Bullet Resist Glass:	1.65	1.09

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.034
Kinetic Energy 106 (lb-ft²/s²):	0.0805
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	200/200

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Black Powder Rounds
DODIC:	
Munition:	37 mm Mk I, LE
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Extremely Heavy Case
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	4/27/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Black Powder
Explosive Weight (lb):	0.034
Diameter (in):	1.4567
Cylindrical Case Weight (lb):	0.43107
Maximum Fragment Weight (Intentional) (lb):	0.0256
Design Fragment Weight (95%) (Unintentional) (lb):	0.0104
Critical Fragment Velocity (fps):	1789

Overpressure Distances

TNT Equivalent (Pressure):	0.4
TNT Equivalent Weight - Pressure (lbs):	0.014
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	4
Public Traffic Route Distance (2.3 psi); K24 Distance:	6
Inhabited Building Distance (1.2 psi), K40 Distance:	10
Intentional MSD (0.0655 psi), K328 Distance:	78

Required Sandbag Thickness

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.014
Kinetic Energy 10^6 (lb-ft²/s²):	0.0410
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	70
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	824
MFD-V [Maximum Fragment Distance, Vertical] (ft):	599

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	1.99	1.43
Mild Steel:	0.29	0.20
Hard Steel:	0.24	0.17
Aluminum:	0.61	0.43
LEXAN:	3.04	2.44
Plexi-glass:	1.79	1.34
Bullet Resist Glass:	1.42	1.02

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.014
Kinetic Energy 106 (lb-ft²/s²):	0.0410
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	200/200

Item Notes

The 37 mm Mk I, LE was titled the 37 mm Mk I, LE practice in previous versions of the DDESB fragmentation database. The previous nomenclature was incorrect as the practice round is sand-loaded and has an inert fuze. The 37 mm Mk I, LE round was designed for use against personnel and light targets. As of 1944 the round was used for practice firing only which was probably the reason for the name confusion.

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Black Powder Rounds
Munition:	37 mm Mk II, LE
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust

DODIC:	
Date Record Created:	4/28/2010
Record Created By:	SDH
Last Date Record Updated:	
Individual Last Updated Record:	
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Black Powder
Explosive Weight (lb):	0.05
Diameter (in):	1.4567
Cylindrical Case Weight (lb):	0.42823
Maximum Fragment Weight (Intentional) (lb):	0.0181
Design Fragment Weight (95%) (Unintentional) (lb):	0.0066
Critical Fragment Velocity (fps):	2318

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	80
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	815
MFD-V [Maximum Fragment Distance, Vertical] (ft):	613

Overpressure Distances

TNT Equivalent (Pressure):	0.4
TNT Equivalent Weight - Pressure (lbs):	0.020
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	5
Public Traffic Route Distance (2.3 psi); K24 Distance:	7
Inhabited Building Distance (1.2 psi), K40 Distance:	11
Intentional MSD (0.0655 psi), K328 Distance:	89

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	2.01	1.34
Mild Steel:	0.34	0.22
Hard Steel:	0.28	0.18
Aluminum:	0.71	0.47
LEXAN:	3.23	2.47
Plexi-glass:	1.93	1.35
Bullet Resist Glass:	1.52	1.02

Required Sandbag Thickness

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.020
Kinetic Energy 10^6 (lb-ft²/s²):	0.0486
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.020
Kinetic Energy 106 (lb-ft²/s²):	0.0486
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	200/200

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
Munition:	57 mm M306
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust

DODIC:	B586
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	1/11/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	0.55
Diameter (in):	2.2100
Cylindrical Case Weight (lb):	0.98529
Maximum Fragment Weight (Intentional) (lb):	0.0127
Design Fragment Weight (95%) (Unintentional) (lb):	0.0023
Critical Fragment Velocity (fps):	6602

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	0.638
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	15
Public Traffic Route Distance (2.3 psi); K24 Distance:	21
Inhabited Building Distance (1.2 psi), K40 Distance:	34
Intentional MSD (0.0655 psi), K328 Distance:	282

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.627
Kinetic Energy 10^6 (lb-ft²/s²):	0.2768
Required Wall & Roof Sandbag Thickness (in)	20
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	162
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	941
MFD-V [Maximum Fragment Distance, Vertical] (ft):	755

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	5.06	2.53
Mild Steel:	0.93	0.48
Hard Steel:	0.76	0.39
Aluminum:	1.97	1.05
LEXAN:	5.27	3.49
Plexi-glass:	3.68	2.13
Bullet Resist Glass:	2.97	1.62

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.627
Kinetic Energy 106 (lb-ft²/s²):	0.2768
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
DODIC:	B632
Munition:	60 mm M49A2
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mortar
Munition Case Classification:	Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/23/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	0.34
Diameter (in):	2.3622
Cylindrical Case Weight (lb):	1.45420
Maximum Fragment Weight (Intentional) (lb):	0.0570
Design Fragment Weight (95%) (Unintentional) (lb):	0.0159
Critical Fragment Velocity (fps):	3982

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	152
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1322
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1025

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	0.340
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	13
Public Traffic Route Distance (2.3 psi); K24 Distance:	17
Inhabited Building Distance (1.2 psi), K40 Distance:	28
Intentional MSD (0.0655 psi), K328 Distance:	229

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	4.96	2.99
Mild Steel:	0.97	0.58
Hard Steel:	0.79	0.48
Aluminum:	1.97	1.23
LEXAN:	5.75	4.21
Plexi-glass:	4.14	2.74
Bullet Resist Glass:	3.47	2.19

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.340
Kinetic Energy 10^6 (lb-ft²/s²):	0.4519
Required Wall & Roof Sandbag Thickness (in)	20
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.340
Kinetic Energy 106 (lb-ft²/s²):	0.4519
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
DODIC:	B632
Munition:	60 mm M49A3
Case Material:	Iron, Pearlitic Malleable
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mortar
Munition Case Classification:	Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/25/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	0.42
Diameter (in):	2.3622
Cylindrical Case Weight (lb):	1.35179
Maximum Fragment Weight (Intentional) (lb):	0.0354
Design Fragment Weight (95%) (Unintentional) (lb):	0.0081
Critical Fragment Velocity (fps):	4788

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	0.487
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	14
Public Traffic Route Distance (2.3 psi); K24 Distance:	19
Inhabited Building Distance (1.2 psi), K40 Distance:	31
Intentional MSD (0.0655 psi), K328 Distance:	258

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.479
Kinetic Energy 10^6 (lb-ft²/s²):	0.4058
Required Wall & Roof Sandbag Thickness (in)	
Expected Maximum Sandbag Throw Distance (ft):	
Minimum Separation Distance (ft):	

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	162
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1156
MFD-V [Maximum Fragment Distance, Vertical] (ft):	910

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	5.24	2.89
Mild Steel:	1.02	0.57
Hard Steel:	0.84	0.47
Aluminum:	2.12	1.22
LEXAN:	5.92	4.13
Plexi-glass:	4.24	2.63
Bullet Resist Glass:	3.51	2.06

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.479
Kinetic Energy 106 (lb-ft²/s²):	0.4058
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
Munition:	60 mm M49A5
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mortar
Munition Case Classification:	Robust

DODIC:	B632
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	9/4/2009
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	0.79
Diameter (in):	2.3622
Cylindrical Case Weight (lb):	1.76541
Maximum Fragment Weight (Intentional) (lb):	0.0206
Design Fragment Weight (95%) (Unintentional) (lb):	0.0036
Critical Fragment Velocity (fps):	6044

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	0.916
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	17
Public Traffic Route Distance (2.3 psi); K24 Distance:	23
Inhabited Building Distance (1.2 psi), K40 Distance:	39
Intentional MSD (0.0655 psi), K328 Distance:	319

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.901
Kinetic Energy 10^6 (lb-ft²/s²):	0.3763
Required Wall & Roof Sandbag Thickness (in)	20
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	184
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1070
MFD-V [Maximum Fragment Distance, Vertical] (ft):	845

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	5.47	2.68
Mild Steel:	1.02	0.51
Hard Steel:	0.84	0.42
Aluminum:	2.14	1.12
LEXAN:	5.65	3.69
Plexi-glass:	4.03	2.29
Bullet Resist Glass:	3.30	1.76

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.901
Kinetic Energy 106 (lb-ft²/s²):	0.3763
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Non-Fragmenting Rounds
Munition:	60 mm M83 Illuminating
Case Material:	Steel, Mild
Fragmentation Method:	Non-Fragmenting
Secondary Database Category:	
Munition Case Classification:	Non-Fragmenting

DODIC:	B627
Date Record Created:	1/27/2011
Record Created By:	SDH
Last Date Record Updated:	
Individual Last Updated Record:	
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Illuminating Compound
Explosive Weight (lb):	0.5
Diameter (in):	2.3310
Cylindrical Case Weight (lb):	
Maximum Fragment Weight (Intentional) (lb):	
Design Fragment Weight (95%) (Unintentional) (lb):	
Critical Fragment Velocity (fps):	

Overpressure Distances

TNT Equivalent (Pressure):	0.4
TNT Equivalent Weight - Pressure (lbs):	0.200
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	11
Public Traffic Route Distance (2.3 psi); K24 Distance:	14
Inhabited Building Distance (1.2 psi), K40 Distance:	23
Intentional MSD (0.0655 psi), K328 Distance:	192

Required Sandbag Thickness

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.200
Kinetic Energy 10^6 (lb-ft²/s²):	
Required Wall & Roof Sandbag Thickness (in)	Non-Fragmenting
Expected Maximum Sandbag Throw Distance (ft):	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	
MFD-V [Maximum Fragment Distance, Vertical] (ft):	

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):		
Mild Steel:		
Hard Steel:		
Aluminum:		
LEXAN:		
Plexi-glass:		
Bullet Resist Glass:		

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.200
Kinetic Energy 106 (lb-ft²/s²):	
Water Containment System:	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

Item Notes

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Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Chemical, WP, & Incendiary Rounds
DODIC:	B630
Munition:	60 mm M302 (Chemical)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Chemical Round
Munition Case Classification:	Extremely Heavy Case
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	12/22/2009
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Tetryl
Explosive Weight (lb):	0.02375
Diameter (in):	2.3620
Cylindrical Case Weight (lb):	0.83700
Maximum Fragment Weight (Intentional) (lb):	0.0112
Design Fragment Weight (95%) (Unintentional) (lb):	0.0030
Critical Fragment Velocity (fps):	1084

Overpressure Distances

TNT Equivalent (Pressure):	1.07
TNT Equivalent Weight - Pressure (lbs):	0.025
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	5
Public Traffic Route Distance (2.3 psi); K24 Distance:	7
Inhabited Building Distance (1.2 psi), K40 Distance:	12
Intentional MSD (0.0655 psi), K328 Distance:	96

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.07
TNT Equivalent Weight - Impulse (lbs):	0.025
Kinetic Energy 10^6 (lb-ft²/s²):	0.0066
Required Wall & Roof Sandbag Thickness (in)	Not Permitted
Expected Maximum Sandbag Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	46
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	581
MFD-V [Maximum Fragment Distance, Vertical] (ft):	419

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	1.25	0.77
Mild Steel:	0.12	0.07
Hard Steel:	0.10	0.06
Aluminum:	0.26	0.15
LEXAN:	1.91	1.34
Plexi-glass:	0.97	0.60
Bullet Resist Glass:	0.73	0.43

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.07
TNT Equivalent Weight - Impulse (lbs):	0.025
Kinetic Energy 106 (lb-ft²/s²):	0.0066
Water Containment System:	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Non-Fragmenting Rounds
Munition:	60 mm TP M50
Case Material:	Steel, Mild
Fragmentation Method:	Non-Fragmenting
Secondary Database Category:	
Munition Case Classification:	Non-Fragmenting

DODIC:	B634
Date Record Created:	
Record Created By:	MC
Last Date Record Updated:	9/15/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Black Powder
Explosive Weight (lb):	0.055
Diameter (in):	2.3622
Cylindrical Case Weight (lb):	
Maximum Fragment Weight (Intentional) (lb):	
Design Fragment Weight (95%) (Unintentional) (lb):	
Critical Fragment Velocity (fps):	

Overpressure Distances

TNT Equivalent (Pressure):	0.4
TNT Equivalent Weight - Pressure (lbs):	0.022
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	5
Public Traffic Route Distance (2.3 psi); K24 Distance:	7
Inhabited Building Distance (1.2 psi), K40 Distance:	11
Intentional MSD (0.0655 psi), K328 Distance:	92

Required Sandbag Thickness

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.022
Kinetic Energy 10^6 (lb-ft²/s²):	
Required Wall & Roof Sandbag Thickness (in)	Non-Fragmenting
Expected Maximum Sandbag Throw Distance (ft):	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	
MFD-V [Maximum Fragment Distance, Vertical] (ft):	

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):		
Mild Steel:		
Hard Steel:		
Aluminum:		
LEXAN:		
Plexi-glass:		
Bullet Resist Glass:		

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.022
Kinetic Energy 106 (lb-ft²/s²):	
Water Containment System:	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
Munition:	81 mm M43
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mortar
Munition Case Classification:	Robust

DODIC:	C225
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/10/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	1.23
Diameter (in):	3.1890
Cylindrical Case Weight (lb):	4.22038
Maximum Fragment Weight (Intentional) (lb):	0.1096
Design Fragment Weight (95%) (Unintentional) (lb):	0.0377
Critical Fragment Velocity (fps):	3776

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	1.230
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	19
Public Traffic Route Distance (2.3 psi); K24 Distance:	26
Inhabited Building Distance (1.2 psi), K40 Distance:	43
Intentional MSD (0.0655 psi), K328 Distance:	351

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	1.230
Kinetic Energy 10^6 (lb-ft²/s²):	0.7813
Required Wall & Roof Sandbag Thickness (in)	24
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	209
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1579
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1215

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	6.61	3.98
Mild Steel:	1.27	0.77
Hard Steel:	1.04	0.63
Aluminum:	2.59	1.60
LEXAN:	6.62	5.05
Plexi-glass:	4.99	3.49
Bullet Resist Glass:	4.22	2.87

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	1.230
Kinetic Energy 106 (lb-ft²/s²):	0.7813
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	200

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
DODIC:	
Munition:	81 mm M56
Date Record Created:	9/21/2004
Record Created By:	MC
Case Material:	Steel, Mild
Last Date Record Updated:	3/2/2010
Fragmentation Method:	Naturally Fragmenting
Individual Last Updated Record:	SDH
Secondary Database Category:	Mortar
Date Record Retired:	
Munition Case Classification:	Non-Robust

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	4.31
Diameter (in):	3.1890
Cylindrical Case Weight (lb):	3.77074
Maximum Fragment Weight (Intentional) (lb):	0.0263
Design Fragment Weight (95%) (Unintentional) (lb):	0.0034
Critical Fragment Velocity (fps):	7384

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	4.310
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	29
Public Traffic Route Distance (2.3 psi); K24 Distance:	39
Inhabited Building Distance (1.2 psi), K40 Distance:	65
Intentional MSD (0.0655 psi), K328 Distance:	534

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	4.310
Kinetic Energy 10^6 (lb-ft²/s²):	0.7170
Required Wall & Roof Sandbag Thickness (in)	24
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	240
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1196
MFD-V [Maximum Fragment Distance, Vertical] (ft):	960

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	8.02	3.43
Mild Steel:	1.41	0.63
Hard Steel:	1.15	0.51
Aluminum:	2.92	1.37
LEXAN:	6.69	4.06
Plexi-glass:	5.05	2.60
Bullet Resist Glass:	4.20	2.01

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	4.310
Kinetic Energy 106 (lb-ft²/s²):	0.7170
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	200

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Chemical, WP, & Incendiary Rounds
DODIC:	C230
Munition:	81 mm M57 WP
Date Record Created:	1/27/2011
Record Created By:	SDH
Case Material:	Steel, Mild
Last Date Record Updated:	
Fragmentation Method:	Naturally Fragmenting
Individual Last Updated Record:	
Secondary Database Category:	WP Round
Date Record Retired:	
Munition Case Classification:	Extremely Heavy Case

Munition Information and Fragmentation Characteristics

Explosive Type:	Tetryl
Explosive Weight (lb):	0.039358
Diameter (in):	3.1380
Cylindrical Case Weight (lb):	2.89600
Maximum Fragment Weight (Intentional) (lb):	0.0189
Design Fragment Weight (95%) (Unintentional) (lb):	0.0023
Critical Fragment Velocity (fps):	673

Overpressure Distances

TNT Equivalent (Pressure):	1.07
TNT Equivalent Weight - Pressure (lbs):	0.042
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	6
Public Traffic Route Distance (2.3 psi); K24 Distance:	8
Inhabited Building Distance (1.2 psi), K40 Distance:	14
Intentional MSD (0.0655 psi), K328 Distance:	114

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.07
TNT Equivalent Weight - Impulse (lbs):	0.042
Kinetic Energy 10^6 (lb-ft²/s²):	0.0043
Required Wall & Roof Sandbag Thickness (in)	Not Permitted
Expected Maximum Sandbag Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	34
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	644
MFD-V [Maximum Fragment Distance, Vertical] (ft):	495

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	1.32	0.63
Mild Steel:	0.09	0.04
Hard Steel:	0.07	0.03
Aluminum:	0.18	0.08
LEXAN:	1.65	0.98
Plexi-glass:	0.80	0.40
Bullet Resist Glass:	0.60	0.28

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.07
TNT Equivalent Weight - Impulse (lbs):	0.042
Kinetic Energy 106 (lb-ft²/s²):	0.0043
Water Containment System:	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Non-Fragmenting Rounds
Munition:	105 mm M84 HC Smoke
Case Material:	Steel, Mild
Fragmentation Method:	Non-Fragmenting
Secondary Database Category:	
Munition Case Classification:	Non-Fragmenting

DODIC:	C452
Date Record Created:	10/19/2006
Record Created By:	MC
Last Date Record Updated:	10/27/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Black Powder
Explosive Weight (lb):	0.042857
Diameter (in):	4.1339
Cylindrical Case Weight (lb):	
Maximum Fragment Weight (Intentional) (lb):	
Design Fragment Weight (95%) (Unintentional) (lb):	
Critical Fragment Velocity (fps):	

Overpressure Distances

TNT Equivalent (Pressure):	0.4
TNT Equivalent Weight - Pressure (lbs):	0.017
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	5
Public Traffic Route Distance (2.3 psi); K24 Distance:	6
Inhabited Building Distance (1.2 psi), K40 Distance:	10
Intentional MSD (0.0655 psi), K328 Distance:	85

Required Sandbag Thickness

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.017
Kinetic Energy 10^6 (lb-ft²/s²):	
Required Wall & Roof Sandbag Thickness (in)	Non-Fragmenting
Expected Maximum Sandbag Throw Distance (ft):	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	
MFD-V [Maximum Fragment Distance, Vertical] (ft):	

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):		
Mild Steel:		
Hard Steel:		
Aluminum:		
LEXAN:		
Plexi-glass:		
Bullet Resist Glass:		

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	0.4
TNT Equivalent Weight - Impulse (lbs):	0.017
Kinetic Energy 106 (lb-ft²/s²):	
Water Containment System:	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Chemical, WP, & Incendiary Rounds
Munition:	105 mm M360 (Chemical)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Chemical Round
Munition Case Classification:	Extremely Heavy Case

DODIC:	C441
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	12/8/2009
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Tetryl
Explosive Weight (lb):	1.246
Diameter (in):	4.1340
Cylindrical Case Weight (lb):	23.21400
Maximum Fragment Weight (Intentional) (lb):	0.5440
Design Fragment Weight (95%) (Unintentional) (lb):	0.1016
Critical Fragment Velocity (fps):	1917

Overpressure Distances

TNT Equivalent (Pressure):	1.07
TNT Equivalent Weight - Pressure (lbs):	1.333
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	20
Public Traffic Route Distance (2.3 psi); K24 Distance:	26
Inhabited Building Distance (1.2 psi), K40 Distance:	44
Intentional MSD (0.0655 psi), K328 Distance:	361

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.07
TNT Equivalent Weight - Impulse (lbs):	1.333
Kinetic Energy 10^6 (lb-ft²/s²):	0.9996
Required Wall & Roof Sandbag Thickness (in)	Not Permitted
Expected Maximum Sandbag Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	248
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	2025
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1442

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	6.38	3.42
Mild Steel:	1.05	0.54
Hard Steel:	0.86	0.44
Aluminum:	2.04	1.09
LEXAN:	6.67	4.43
Plexi-glass:	5.06	2.94
Bullet Resist Glass:	4.48	2.45

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.07
TNT Equivalent Weight - Impulse (lbs):	1.333
Kinetic Energy 106 (lb-ft²/s²):	0.9996
Water Containment System:	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Chemical, WP, & Incendiary Rounds	DODIC:	C442
Munition:	105 mm M60 (Chemical)		
Case Material:	Steel, Mild	Date Record Created:	9/21/2004
		Record Created By:	MC
Fragmentation Method:	Naturally Fragmenting	Last Date Record Updated:	3/31/2011
Secondary Database Category:	Chemical Round	Individual Last Updated Record:	SDH
Munition Case Classification:	Extremely Heavy Case	Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Tetrytol
Explosive Weight (lb):	0.349
Diameter (in):	4.1340
Cylindrical Case Weight (lb):	17.51400
Maximum Fragment Weight (Intentional) (lb):	0.2805
Design Fragment Weight (95%) (Unintentional) (lb):	0.0452
Critical Fragment Velocity (fps):	1137

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	212
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1433
MFD-V [Maximum Fragment Distance, Vertical] (ft):	986

Overpressure Distances

TNT Equivalent (Pressure):	1.07
TNT Equivalent Weight - Pressure (lbs):	0.373
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	13
Public Traffic Route Distance (2.3 psi); K24 Distance:	17
Inhabited Building Distance (1.2 psi), K40 Distance:	29
Intentional MSD (0.0655 psi), K328 Distance:	236

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	3.96	2.06
Mild Steel:	0.45	0.22
Hard Steel:	0.37	0.18
Aluminum:	0.88	0.45
LEXAN:	4.23	2.71
Plexi-glass:	2.77	1.54
Bullet Resist Glass:	2.36	1.22

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.07
TNT Equivalent Weight - Impulse (lbs):	0.373
Kinetic Energy 10^6 (lb-ft²/s²):	0.1776
Required Wall & Roof Sandbag Thickness (in)	Not Permitted
Expected Maximum Sandbag Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.07
TNT Equivalent Weight - Impulse (lbs):	0.373
Kinetic Energy 106 (lb-ft²/s²):	0.1776
Water Containment System:	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
DODIC:	C445
Munition:	105 mm M1 (Composition B filled)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	2/26/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	5.07
Diameter (in):	4.1339
Cylindrical Case Weight (lb):	18.15827
Maximum Fragment Weight (Intentional) (lb):	0.1701
Design Fragment Weight (95%) (Unintentional) (lb):	0.0414
Critical Fragment Velocity (fps):	5058

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	5.881
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	32
Public Traffic Route Distance (2.3 psi); K24 Distance:	43
Inhabited Building Distance (1.2 psi), K40 Distance:	72
Intentional MSD (0.0655 psi), K328 Distance:	592

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	5.780
Kinetic Energy 10^6 (lb-ft²/s²):	2.1759
Required Wall & Roof Sandbag Thickness (in)	
Expected Maximum Sandbag Throw Distance (ft):	
Minimum Separation Distance (ft):	

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	335
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1886
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1475

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	9.88	4.54
Mild Steel:	1.87	0.89
Hard Steel:	1.54	0.73
Aluminum:	3.73	1.82
LEXAN:	8.38	5.43
Plexi-glass:	6.82	3.83
Bullet Resist Glass:	5.97	3.18

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	5.780
Kinetic Energy 106 (lb-ft²/s²):	2.1759
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	200

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
DODIC:	C445
Munition:	105 mm M1 (TNT filled)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust
Date Record Created:	1/27/2011
Record Created By:	SDH
Last Date Record Updated:	
Individual Last Updated Record:	
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	
Diameter (in):	4.1339
Cylindrical Case Weight (lb):	18.15827
Maximum Fragment Weight (Intentional) (lb):	0.2648
Design Fragment Weight (95%) (Unintentional) (lb):	0.0818
Critical Fragment Velocity (fps):	4345

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	4.600
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	30
Public Traffic Route Distance (2.3 psi); K24 Distance:	40
Inhabited Building Distance (1.2 psi), K40 Distance:	67
Intentional MSD (0.0655 psi), K328 Distance:	545

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	4.600
Kinetic Energy 10^6 (lb-ft²/s²):	2.4216
Required Wall & Roof Sandbag Thickness (in)	36
Expected Maximum Sandbag Throw Distance (ft):	220
Minimum Separation Distance (ft):	220

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	300
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	2111
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1637

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	10.01	5.05
Mild Steel:	1.93	0.98
Hard Steel:	1.58	0.80
Aluminum:	3.80	1.98
LEXAN:	8.71	5.89
Plexi-glass:	7.18	4.27
Bullet Resist Glass:	6.37	3.61

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	4.600
Kinetic Energy 106 (lb-ft²/s²):	2.4216
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	275

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
Munition:	105 mm M456 HEAT
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust

DODIC:	C508
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/31/2011
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	2.14
Diameter (in):	4.1280
Cylindrical Case Weight (lb):	7.07754
Maximum Fragment Weight (Intentional) (lb):	0.0976
Design Fragment Weight (95%) (Unintentional) (lb):	0.0149
Critical Fragment Velocity (fps):	5064

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	2.482
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	24
Public Traffic Route Distance (2.3 psi); K24 Distance:	32
Inhabited Building Distance (1.2 psi), K40 Distance:	54
Intentional MSD (0.0655 psi), K328 Distance:	444

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	2.440
Kinetic Energy 10^6 (lb-ft²/s²):	1.2514
Required Wall & Roof Sandbag Thickness (in)	24
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	262
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1644
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1290

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	8.19	3.82
Mild Steel:	1.56	0.74
Hard Steel:	1.28	0.61
Aluminum:	3.14	1.56
LEXAN:	7.49	4.73
Plexi-glass:	5.87	3.20
Bullet Resist Glass:	5.05	2.57

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	2.440
Kinetic Energy 106 (lb-ft²/s²):	1.2514
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	200

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
Munition:	105 mm M67 HEAT (Composition B filled)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust

DODIC:	C446
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/5/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	3.08
Diameter (in):	4.1339
Cylindrical Case Weight (lb):	18.22025
Maximum Fragment Weight (Intentional) (lb):	0.2851
Design Fragment Weight (95%) (Unintentional) (lb):	0.0746
Critical Fragment Velocity (fps):	4178

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	3.573
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	28
Public Traffic Route Distance (2.3 psi); K24 Distance:	37
Inhabited Building Distance (1.2 psi), K40 Distance:	61
Intentional MSD (0.0655 psi), K328 Distance:	501

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	3.511
Kinetic Energy 10^6 (lb-ft²/s²):	2.4883
Required Wall & Roof Sandbag Thickness (in)	
Expected Maximum Sandbag Throw Distance (ft):	
Minimum Separation Distance (ft):	

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	306
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1931
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1492

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	8.60	4.52
Mild Steel:	1.67	0.88
Hard Steel:	1.37	0.72
Aluminum:	3.30	1.81
LEXAN:	8.00	5.40
Plexi-glass:	6.41	3.81
Bullet Resist Glass:	5.63	3.15

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	3.511
Kinetic Energy 106 (lb-ft²/s²):	2.4883
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
DODIC:	C446
Munition:	105 mm M67 HEAT (Pentolite filled)
Date Record Created:	9/21/2004
Record Created By:	MC
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Last Date Record Updated:	3/5/2010
Secondary Database Category:	Projectile
Individual Last Updated Record:	SDH
Munition Case Classification:	Robust
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Pentolite (50/50)
Explosive Weight (lb):	2.94
Diameter (in):	4.1339
Cylindrical Case Weight (lb):	18.22025
Maximum Fragment Weight (Intentional) (lb):	0.3294
Design Fragment Weight (95%) (Unintentional) (lb):	0.0930
Critical Fragment Velocity (fps):	3579

Overpressure Distances

TNT Equivalent (Pressure):	1.38
TNT Equivalent Weight - Pressure (lbs):	4.057
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	29
Public Traffic Route Distance (2.3 psi); K24 Distance:	38
Inhabited Building Distance (1.2 psi), K40 Distance:	64
Intentional MSD (0.0655 psi), K328 Distance:	523

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	3.352
Kinetic Energy 10^6 (lb-ft^2/s^2):	2.1097
Required Wall & Roof Sandbag Thickness (in)	24
Expected Maximum Sandbag Throw Distance (ft):	
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	289
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1932
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1473

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	7.69	4.19
Mild Steel:	1.49	0.81
Hard Steel:	1.23	0.67
Aluminum:	2.98	1.66
LEXAN:	7.63	5.23
Plexi-glass:	6.03	3.66
Bullet Resist Glass:	5.29	3.04

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	3.352
Kinetic Energy 106 (lb-ft^2/s^2):	2.1097
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	200

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
Munition:	155 mm M107 (Composition B filled)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust

DODIC:	D571
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	2/4/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	15.448
Diameter (in):	6.1024
Cylindrical Case Weight (lb):	73.50184
Maximum Fragment Weight (Intentional) (lb):	0.6641
Design Fragment Weight (95%) (Unintentional) (lb):	0.1372
Critical Fragment Velocity (fps):	3584

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	17.920
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	47
Public Traffic Route Distance (2.3 psi); K24 Distance:	63
Inhabited Building Distance (1.2 psi), K40 Distance:	105
Intentional MSD (0.0655 psi), K328 Distance:	858

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	17.611
Kinetic Energy 10^6 (lb-ft²/s²):	4.2663
Required Wall & Roof Sandbag Thickness (in)	
Expected Maximum Sandbag Throw Distance (ft):	
Minimum Separation Distance (ft):	

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	450
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	2630
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2022

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	14.45	6.68
Mild Steel:	2.74	1.29
Hard Steel:	2.25	1.06
Aluminum:	5.30	2.61
LEXAN:	10.69	6.73
Plexi-glass:	9.43	5.10
Bullet Resist Glass:	8.58	4.39

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	17.611
Kinetic Energy 106 (lb-ft²/s²):	4.2663
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 1/31/2011

Category:	Surface-Launched HE Rounds
DODIC:	D571
Munition:	155 mm M107 (Composition B filled)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	2/4/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	15.448
Diameter (in):	6.1020
Cylindrical Case Weight (lb):	73.50200
Maximum Fragment Weight (Intentional) (lb):	0.6641
Design Fragment Weight (95%) (Unintentional) (lb):	0.1372
Critical Fragment Velocity (fps):	3584

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	17.920
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	47
Public Traffic Route Distance (2.3 psi); K24 Distance:	63
Inhabited Building Distance (1.2 psi), K40 Distance:	105
Intentional MSD (0.0655 psi), K328 Distance:	858

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.16
TNT Equivalent Weight - Impulse (lbs):	17.920
Kinetic Energy 10^6 (lb-ft²/s²):	4.2663
Required Wall & Roof Sandbag Thickness (in)	36
Expected Maximum Sandbag Throw Distance (ft):	220
Minimum Separation Distance (ft):	220

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	450
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	2630
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2022

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	14.45	6.68
Mild Steel:	2.74	1.29
Hard Steel:	2.25	1.06
Aluminum:	5.30	2.61
LEXAN:	10.69	6.73
Plexi-glass:	9.43	5.10
Bullet Resist Glass:	8.58	4.39

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.16
TNT Equivalent Weight - Impulse (lbs):	17.920
Kinetic Energy 106 (lb-ft²/s²):	4.2663
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	275

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
Munition:	155 mm M107 (TNT filled)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust

DODIC:	D571
Date Record Created:	2/4/2010
Record Created By:	SDH
Last Date Record Updated:	
Individual Last Updated Record:	
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	14.6
Diameter (in):	6.1024
Cylindrical Case Weight (lb):	73.50184
Maximum Fragment Weight (Intentional) (lb):	1.0548
Design Fragment Weight (95%) (Unintentional) (lb):	0.2710
Critical Fragment Velocity (fps):	4035

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	14.600
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	44
Public Traffic Route Distance (2.3 psi); K24 Distance:	59
Inhabited Building Distance (1.2 psi), K40 Distance:	98
Intentional MSD (0.0655 psi), K328 Distance:	802

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	14.600
Kinetic Energy 10^6 (lb-ft²/s²):	8.5845
Required Wall & Roof Sandbag Thickness (in)	
Expected Maximum Sandbag Throw Distance (ft):	
Minimum Separation Distance (ft):	

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	389
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	2894
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2208

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	14.62	7.33
Mild Steel:	2.82	1.43
Hard Steel:	2.31	1.17
Aluminum:	5.39	2.85
LEXAN:	11.10	7.30
Plexi-glass:	9.91	5.69
Bullet Resist Glass:	9.14	4.99

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	14.600
Kinetic Energy 106 (lb-ft²/s²):	8.5845
Water Containment System:	Not Permitted
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds
DODIC:	
Munition:	155 mm Mk I & Mk III
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust
Date Record Created:	10/3/2005
Record Created By:	MC
Last Date Record Updated:	1/11/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	15.17
Diameter (in):	6.1024
Cylindrical Case Weight (lb):	65.81942
Maximum Fragment Weight (Intentional) (lb):	1.0804
Design Fragment Weight (95%) (Unintentional) (lb):	0.2840
Critical Fragment Velocity (fps):	3034

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	15.170
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	45
Public Traffic Route Distance (2.3 psi); K24 Distance:	59
Inhabited Building Distance (1.2 psi), K40 Distance:	99
Intentional MSD (0.0655 psi), K328 Distance:	812

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	15.170
Kinetic Energy 10^6 (lb-ft²/s²):	4.9726
Required Wall & Roof Sandbag Thickness (in)	
Expected Maximum Sandbag Throw Distance (ft):	
Minimum Separation Distance (ft):	

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	395
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	2876
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2138

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	14.36	7.08
Mild Steel:	2.75	1.35
Hard Steel:	2.25	1.11
Aluminum:	5.29	2.71
LEXAN:	10.81	7.33
Plexi-glass:	9.56	5.72
Bullet Resist Glass:	8.75	5.03

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	15.170
Kinetic Energy 106 (lb-ft²/s²):	4.9726
Water Containment System:	Not Permitted
Minimum Separation Distance (ft):	

Item Notes

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Surface-Launched HE Rounds	DODIC:	D485
Munition:	155 mm M101		
Case Material:	Steel, Mild	Date Record Created:	12/8/2010
		Record Created By:	MMC
Fragmentation Method:	Naturally Fragmenting	Last Date Record Updated:	
Secondary Database Category:	Projectile	Individual Last Updated Record:	
Munition Case Classification:	Robust	Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	14.6
Diameter (in):	6.1250
Cylindrical Case Weight (lb):	73.50184
Maximum Fragment Weight (Intentional) (lb):	1.0548
Design Fragment Weight (95%) (Unintentional) (lb):	0.2710
Critical Fragment Velocity (fps):	4035

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	14.600
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	44
Public Traffic Route Distance (2.3 psi); K24 Distance:	59
Inhabited Building Distance (1.2 psi), K40 Distance:	98
Intentional MSD (0.0655 psi), K328 Distance:	802

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	14.600
Kinetic Energy 10^6 (lb-ft²/s²):	6.6543
Required Wall & Roof Sandbag Thickness (in)	
Expected Maximum Sandbag Throw Distance (ft):	
Minimum Separation Distance (ft):	

Distribution authorized to the Department of Defense and U.S. DoD contractors only for Administrative-Operational Use (17 October 2002). Other requests shall be referred to the Chairman, Department of Defense Explosives Safety Board, Room 856C, Hoffman Building I, 2461 Eisenhower Avenue, Alexandria, VA 22331-0600.

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	389
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	2894
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2208

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	14.62	7.33
Mild Steel:	2.82	1.43
Hard Steel:	2.31	1.17
Aluminum:	5.39	2.85
LEXAN:	11.10	7.30
Plexi-glass:	9.91	5.69
Bullet Resist Glass:	9.14	4.99

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	14.600
Kinetic Energy 106 (lb-ft²/s²):	6.6543
Water Containment System:	Not Permitted
Minimum Separation Distance (ft):	

Item Notes

This is the same as the TNT filled 155 mm M107 except that the M101 has a wider rotating band. Therefore the model for the TNT filled 155 mm M107 was used for this round.

Fragmentation Data Review Form

Database Revision Date 4/15/2011

Category:	Grenades & Mines
Munition:	M1A1 Anti-Tank Mine
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mine
Munition Case Classification:	Non-Robust

DODIC:	
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/26/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	6
Diameter (in):	8.0000
Cylindrical Case Weight (lb):	1.21721
Maximum Fragment Weight (Intentional) (lb):	0.0148
Design Fragment Weight (95%) (Unintentional) (lb):	0.0022
Critical Fragment Velocity (fps):	9780

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	6.000
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	33
Public Traffic Route Distance (2.3 psi); K24 Distance:	44
Inhabited Building Distance (1.2 psi), K40 Distance:	73
Intentional MSD (0.0655 psi), K328 Distance:	596

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	6.000
Kinetic Energy 10^6 (lb-ft²/s²):	0.7078
Required Wall & Roof Sandbag Thickness (in)	24
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

Distribution authorized to the Department of Defense and U.S. DoD contractors only for Administrative-Operational Use (17 October 2002). Other requests shall be referred to the Chairman, Department of Defense Explosives Safety Board, Room 856C, Hoffman Building I, 2461 Eisenhower Avenue, Alexandria, VA 22331-0600.

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	192
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1058
MFD-V [Maximum Fragment Distance, Vertical] (ft):	859

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	9.66	4.30
Mild Steel:	1.53	0.71
Hard Steel:	1.25	0.58
Aluminum:	3.22	1.57
LEXAN:	6.79	4.25
Plexi-glass:	5.14	2.76
Bullet Resist Glass:	4.22	2.11

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	6.000
Kinetic Energy 106 (lb-ft²/s²):	0.7078
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	275.000

Item Notes

APPENDIX H
RESUMES OF KEY PERSONNEL

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ZAPATA
TRUST • INTEGRITY • QUALITY

September 9, 2011

Janice A Jamar
US Army Engineering and Support Center (CEHNC-CT-E)
4820 University Square
Huntsville, AL 35816

RE: Contract No.: W912DY-10-D-0028
Remedial Investigation/Feasibility Study (RI/FS), Camp Croft, South Carolina

Dear Ms. Jamar:

This letter is to certify that the following individuals from Zapata Incorporated are fully qualified to fill the positions listed below in order to perform Munitions Response operations at the former Camp Croft in Spartanburg, South Carolina. Additionally, these individuals are in full compliance with 18 U.S.C. 842.

Name	**Position**	**Corps #**
Jeff Schwalm	SUXOS	0052
Terry Farmer	QC	0759
Tim Hendrix	Safety	0105

The above mentioned individuals are fully qualified to fill the UXO positions and perform all required Munitions Response activities, per the requirements set forth in DDESB TP-18, dated 20 December 2004.

Sincerely,

Cheryl Trotter

Cheryl Trotter, PHR
Human Resources Manager

cc:
Spencer O'Neal

MICHAEL WINNINGHAM
PROGRAM MANAGER

EDUCATION/QUALIFICATIONS:

BS, Industrial Safety, University of Southern Illinois, 1988
US Naval Explosives Ordnance Disposal School, Indian Head, MD, 1987

TRAINING:

40-Hour OSHA Health and Safety Training, 29 CFR 1910.20, 1988
8 Hour OSHA Refresher Course, 2007

LICENSES/REGISTRATIONS/CERTIFICATIONS:

NAVSACOLEOD, Jan 1987

PRESENT POSITION IN OFFERER'S COMPANY: VP Munitions Response Program

RELEVANT EXPERIENCE :

- ✓ 23 years experience in field actions and project management of MEC projects.
- ✓ Has provided technical leadership for the management of tasks involving remedial actions for more than 50 MEC projects and 10 chemical warfare materiel (CWM) projects.
- ✓ Experience Program/Project Manager on numerous projects consisting of both MEC and CWM hazards
- ✓ Development and Execution of Quality Assurance and Quality Control Plans
- ✓ Environmental Assessments and Investigations
- ✓ Expertise in Ordnance and Explosives, Geophysical Investigations and Environmental Restoration and Remediation methods
- ✓ Full knowledge of Army regulations for MEC/CWM operations ensure the effective management and execution of projects

EMPLOYMENT HISTORY:

Project Manager, Range Clearance Activities, Fort Benning and Fort Hood-USAESCH, CESWF and CESAS. Management of range clearance activities at the site, which have included surface and subsurface clearance, surface inspection, and disposal of recovered MEC items. Responsibilities included liaison between the client, the US Army, and USACE Districts during the clearance/inspection of the project site under the requirements of CERCLA.

Project Manager. MEC Removal Action, Marine Corps Air Station, Cherry Point, NC - US Marine Corps. Management of MEC removals at the site, which have included surface and subsurface clearance, and excavation of burial pits. ZAPATA performed a MEC removal at two target areas (MCOLF Atlantic Site and MCOLF Bogue Site) within the Marine Corps Air Station (MCAS) Cherry Point, North Carolina. Responsibilities included liaison between the client, the US Marine Corps and the applicable state agencies during the preparation of remedial investigation plans and the selection of remediation under the requirements of CERCLA.

Project Manager. Range Reconnaissance Activities, Worldwide Locations - US Army Engineering and Support Center, Huntsville. Management of range reconnaissance activities at various worldwide sites, which includes safely identify, assess, and quantify the amount of MEC and Material Potentially Presenting an Explosive Hazard (MPPEH) within the identified range. The results of the surveys will be used for planning and initial cost estimates of subsequent munitions response actions necessary to support the Department of Defense's range construction and maintenance program.

Project Manager. Range Maintenance Activities, Schofield Barracks, Island of Oahu, HI - US Army Engineering and Support Center, Huntsville, USACE Honolulu District, and the US Army (25th Infantry Division). Management of range maintenance activities at the site, which have included surface clearance, surface inspection, and disposal of recovered OE items. Responsibilities included liaison between the client, the US Army, and USACE Honolulu District during the clearance/inspection of the project site under the requirements of CERCLA.

Project Manager. MEC Removal Action, Former Motlow Range, Tullahoma, TN - US Army Engineering and Support Center, Huntsville and USACE Mobile District. Management of MEC removal, which included surface and subsurface clearance, and excavation of burial pits. Responsibilities included liaison between the client, the USACE-Mobile District and the applicable state agencies during the preparation of remedial investigation plans and the selection of remediation under the requirements of CERCLA.

Project Manager. MEC Removal Action, Camp Wellfleet, Wellfleet, MA - US Army Engineering and Support Center, Huntsville and USACE New England District. Management of MEC removals, which included surface and subsurface clearance, excavation of burial pits, and HTW removal operations. Responsibilities included liaison between the client, the MADEQ, the NPS, and the applicable state agencies during the preparation of remedial investigation plans and the selection of remediation under the requirements of CERCLA.

Project Manager. MEC Removal at OOU6, Former Camp Croft, Spartanburg, SC. US Army Engineering and Support Center, Huntsville and USACE Charleston District. Managed an MEC removal action on a parcel of property which was once part of the former Camp Croft Army Training Facility. This removal action involved the daily management of site operations, tracking costs and funding, and providing advice and support to clients on regulatory compliance issues and technology reviews.

Project Manager. MEC Removal Action, Nansemond Ordnance Depot, Suffolk, VA - US Army Engineering and Support Center, Huntsville and USACE Norfolk District. Management of MEC removals, which have included surface and subsurface clearance, excavation of burial pits, and bulk TNT removal operations. Responsibilities included liaison between the client, the USEPA and the applicable state agencies during the preparation of remedial investigation plans and the selection of remediation under the requirements of CERCLA.

Project Manager/Department Manager. MEC Investigation at Former Spring Valley, Washington DC - US Army Engineering and Support Center, Huntsville and USACE

Baltimore District. Project Manager for an Environmental Evaluation/Cost Analysis project addressing multiple sites potentially contaminated with chemical warfare materiel and ordnance. The project involved the development of detailed plans and safety requirements for the assessment of mustard gases and other related contaminants. Extensive soil sampling and intrusive investigation were included for confirmation of the presence of ordnance and chemical waste materials.

Project Manager/Department Manager. MEC Investigation at Former Buckley Bombing Range, CO - US Army Engineering and Support Center, Huntsville and USACE Omaha District The Former Lowry Bombing and Gunnery Range is located approximately 20 miles to the southeast of Denver, Colorado and consists of approximately 65,000 acres. As the Project Manager was responsible for supporting the clearance actions, to include several field efforts were performed including surveying, geophysical data collection and analysis, life-cycle data management, remote sensing, and various OE construction and anomaly avoidance support functions.

CORPORATE HEALTH AND SAFETY MANAGER
GEORGE A. DWIGGINS, Ph.D., J.D., CIH, CSP

EDUCATION/QUALIFICATIONS

1995 J.D., Law, University of South Carolina, Columbia
1981 Ph.D., Environment Sciences and Engineering, University of North Carolina, Chapel Hill
1974 B.S., Physics, University of North Carolina, Chapel Hill

TRAINING:

40-Hour OSHA Health and Safety Training for Hazardous Waste Operations, 1989, 2005
8-Hour OSHA Refresher, 2006

LICENSES/REGISTRATIONS/CERTIFICATIONS:

1982 Certified Industrial Hygienist (CIH), American Board of Industrial Hygiene
1991 Registered Occupational Hygienist (ROH), Canadian Registration Board of Occupational Hygienists
1995 Member, South Carolina Bar
OSHA hazardous waste training and First Aid and CPR Certifications, current.
2008 Certified Safety Professional (CSP), Board of Certified Safety Professionals

PRESENT POSITION IN OFFERER'S COMPANY: Corporate Health and Safety Manager

RELEVANT EXPERIENCE:

- ✓ More than 25 years of experience in workplace health and safety, environmental health, and OSHA compliance including general industry, Munitions and Explosives of Concern (MEC) sites, hazardous waste remediation sites, and construction sites, including Tonopah Test Range
- ✓ 17 years experience in compliance with 29 CFR 1910.120 standards and EM-385-1-1
- ✓ Certified Industrial Hygienist
- ✓ Registered Occupational Hygienist (Canada)

EMPLOYMENT HISTORY:

<u>Health and Safety Manager – UXO, EOD Support, and Geophysical Surveys, Tonopah Test Range, NV.</u> Managed development and implementation of Site Health and Safety Plans that addressed UXO, radiological and biological hazards associated with data collection and excavation of anomalies.

<u>Health and Safety Manager – Various Task Orders, Munitions Response Contract, US Army Engineering and Support Center, Huntsville</u>. Manages development and implementation of Corporate Health and Safety Policy and Site Health and Safety Plans (SHS)s) for numerous MEC, Recovered Chemical Warfare Materiel (RCWM), Environmental, and Construction-related projects. Reviews and evaluates SHSPs and Accident Prevention Plans (APPs) for compliance with appropriate regulations, guidance, and Corporate policy. Provides final approval for SHSPs and APPs for CONUS and OCONUS sites.

Health and Safety Manager – Various Task Orders, IDIQ Charleston Air Force Base, Charleston, SC. Managed programs for workplace health and safety and SHSPs for multiple Environmental and Construction Projects. Worked with various project teams to implement written safety programs, and to establish and maintain site safety.

Manager of Environmental Health. Managed programs for workplace health and safety. Worked with various large sites to implement written safety programs, and to establish and maintain site safety committees.

Attorney – Various Law Cases related to OSHA and workplace issues. Legal counsel for labor and employment law cases related to OSHA citations, employees' EEOC claims, and other workplace health and safety incidents.

Senior Health and Safety Consultant – Development of Training Programs. Developed safe work training programs for asbestos and lead, managed numerous projects involving workplace exposures to chemical, physical, and biological agents.

Senior Health and Safety Consultant – Various Task Orders related to workplace health and safety at hazardous-waste remediation sites. Oversight of workplace health and safety at hazardous-waste remediation sites. Provided OSHA-mandated training for hazardous-waste workers and supervisors. Managed numerous projects involving assessment of workplace exposures to chemical, physical, and biological agents.

SUZY CANTOR-MCKINNEY
QUALITY ASSURANCE MANAGER

EDUCATION/QUALIFICATIONS:

1983 MS, Land and Water Resource Management, University of North Texas
1982 BS, Biology, Marshall University

TRAINING

OSHA 40-Hour Health and Safety Training Instruction
OSHA 8-Hour Supervisor Course 29 CFR 1910.120 (e) (4)

PRESENT POSITION IN OFFERER'S COMPANY: Vice President Program Compliance

RELATIVE EXPERIENCE:

- ✓ 25 years of technical and project management experience in all phases of MEC and environmental investigations.
- ✓ Program Manager for the $525M Military Munitions Response (MMR) contract, managing multiple, simultaneous field investigations, subcontractor activities, and in-house UXO teams at MMR sites throughout the CONUS and OCONUS.
- ✓ Ensured project execution within prescribed budgets, adherence to project schedules, and in conformance with the rigorous standards mandated by the client.

EMPLOYMENT HISTORY:

Quality Manager - RI/FS at Southwest Proving Grounds, AR, the Former Camp Fannin, TX and at the Former Camp Gruber, OK, Huntsville. Reviews project deliverables, including work plans, geophysical plans, and TPP documents for compliance with the DIDs and Army guidance.

Program Manager. Range Reconnaissance Activities, Worldwide Locations - US Army Engineering and Support Center, Huntsville. Oversight of range reconnaissance activities at various worldwide sites, which included safely identifying, assessing, and quantifying the amount of MEC and Material Potentially Presenting an Explosive Hazard (MPPEH) within the identified range. The results of the surveys were used for planning and initial cost estimates of subsequent munitions response actions necessary to support the Department of Defense's range construction and maintenance program.

Program Manager. Range Clearance Activities, Schofield Barracks, Island of Oahu, HI - US Army Engineering and Support Center, Huntsville, USACE Honolulu District, and the US Army (25th Infantry Division). Oversight of range clearance activities which included surface clearance, surface inspection, and disposal of recovered MEC items on more than 1,000 acres. Project was safely completed without interference of the Army's training schedule despite discovery of unanticipated RCWM.

Program Manager. Unexploded Ordnance, Explosive Ordnance Disposal Support, and Geophysical Surveys – National Security Technologies, LLC, NV. Provided oversight for the successful and safe execution of digital geophysical mapping of 1,800 acres using an autonomous vehicle at an accelerated productivity rate. Collected radiological data, excavated military munitions, and provided UXO safety escort.

Program Manager. Military Munitions Response Program (MMRP) Guidance Document Revision, US Army Engineering and Support Center, Huntsville. Revised the MMRP technical guidance for the US Army Corps of Engineers (USACE) to integrate the procedures for performing MMRP response activities to incorporate the remedial process and update the procedures for the non-time critical removal process. This effort involved the revision of Engineer Pamphlet 1110-1-18, Ordnance and Explosive (OE) Response and covered the procedures for design and execution of MMRP activities. The new document established detailed requirements for responses to military munitions and chemical residues at locations other than operational ranges and clarifies reporting of environmental liabilities.

Program Manager. Ordnance and Explosive/Recovered Chemical Warfare Removal Action, Holloman Air Force Base, NM. US Army Engineering and Support Center, Huntsville. Oversight of development of work plans, schedules, cost tracking, field activities and final report for a project site containing military munitions as well as recovered chemical warfare agents. Ensured safe execution of the geophysical survey, range clearance, recovery, and final disposal of several MEC and 18 ampoules of chemical agent from Chemical Agent Identification Sets (CAIS).

Project Manager. Engineering Evaluation/Cost Analysis (EE/CA). Fort McClellan, AL. US Army Engineering and Support Center, Huntsville and USACE Mobile District. Managed all fieldwork and analyses required for the EE/CA conducted on the proposed eastern bypass through the former Fort McClellan. Effectively managed multiple subcontractors (brush clearing, surveying, and geophysical) in the field performing multiple, simultaneous and concurrent tasks. This necessitated the presentation of acceptable risk reduction alternatives based on regulator concerns. She also responded to a Time Critical Removal Action and constructed institutional controls.

Program Manager, OE Removal at the Motlow State Community College, Tullahoma, TN. US Army Engineering and Support Center, Huntsville and USACE Mobile District. Oversight of a removal action on approximately 704 acres of open and wooded land encompassing fields, agricultural areas, and a community college campus. Removal was conducted by both mag-flag-dig operations and through geophysical mapping and anomaly reacquisition. An accelerated schedule to accommodate college campus schedules to minimize the impact to the public was implemented.

Project Manager. Restoration Advisory Board (RAB). The former Camp Croft, Spartanburg, SC. US Army Engineering and Support Center, Huntsville and USACE Charleston District. Ms. Cantor-McKinney established and continues to coordinate the activities of the RAB, which is comprised of diverse community members. Coordination of activities for this site includes: development and implementation of the community relations plan, preparation and presentation of relevant project-related materials, conduct of public meetings, and serving as a liaison between the RAB, US Army Corps of Engineers, and the community.

JASON SHIFLET, PG
PROJECT MANAGER

EDUCATION

M.S., Geology, University of Georgia, 1999
B.S., Geology, Clemson University, 1995

TRAINING:

Ph.D. Candidate, Infrastructure and Environmental Systems, UNC at Charlotte, 2005 – present
Annual Medical Surveillance, December 14, 2007
8-Hour OSHA Health and Safety Training Refresher, 29 CFR 1910.120 (e) (8), 2009
Stable Isotope Short Course, Battelle, May 2006
NITON Handheld X-Ray Fluorescence (XRF) Spectrum Analyzer 8-Hour Course, 2005
8-Hour Site Supervisor Training, 29 CFR 1910.120 (e) (4), All Pro Occupational Trainers, Inc., October 29, 1998
40-Hour OSHA Health and Safety Training, 29 CFR 1910.20 (e) (3), All Pro Occupational Trainers, Inc., August 27, 1998

LICENSES/REGISTRATION/CERTIFICATIONS:

PG #2385, FL, 2005 – 2011; PG #1805, GA, 2005 – 2011; PG #1756, NC, 2000 – 2011; PG #1744, VA, 2007 - 2011

PRESENT POSITION IN OFFERER'S COMPANY: Project Manager/Technical Manager

RELATIVE EXPERIENCE:

- ✓ 12 years of technical and project management experience in all phases of MEC and environmental investigations.
- ✓ Field Supervision
- ✓ Field Investigation and Data Collection
- ✓ Environmental Site Assessment
- ✓ Remediation Design
- ✓ Contractor Oversight
- ✓ Geological Analysis and Interpretation

EMPLOYMENT HISTORY:

Project Manager - Disposal/Removal Action Amelia Earhart Park, FL, US Army Corps of Engineers, Savannah District. Managed up to 20 field personnel and four subcontractors**.** Used direct-push technology (DPT) and EM survey to confirm the presence of buried drums/contamination, and identifying contaminants in the soil or groundwater, and making remedial recommendations. Managed removal of >1,500 cubic yards of soil and debris, the disposal at Subtitle D and Subtitle C facilities, and site restoration. Successfully managed the discovery of 78 drums (one with unknown material), one small fuel storage tank, and 15 MD items.

Project Geologist – Performance-based Remediation, Former Tripp's Mini-Mart, SC. Provided technical support for multiple remedial technologies, including free product removal by aeration and extraction, insitu air stripping, enhanced aerobic bioremediation, and chemical reduction for successful site cleanup.

Project Manager - Interim Remedial Actions Former Lake City Naval Air Station, Lake City, FL, US Army Corps of Engineers, Savannah District. Responsible for adherence to schedule and budget and preparation of progress reports. Managed fieldwork, including advancing 30 DPT and 18 hand auger soil borings, installing 26 shallow and four vertical extents monitoring wells, sampling soil for analytical analysis, sampling groundwater at 43 wells, sampling surface water and excavation of contaminated soil. Quality was ensured by staffing qualified personnel and senior review of deliverables prior to transmittal.

Project Manager -MEC Site Investigation and EE/CA at the Former Armstrong Air-to-Air Gunnery Range, SD, US Army Engineering and Support Center, Huntsville. Provided oversight of the MEC investigation and DGM for Title VI land transfer to the Bureau of Indian Affairs. Managed two subcontractors, facilitated stakeholder involvement, and prepared cost/schedule progress reports. Project was completed within budget.

JIM HILD, PG
SENIOR GEOPHYSICIST

EDUCATION/QUALIFICATIONS:

BS, Geology, 1974
MS, Geology, 1976

LICENSES/REGISTRATIONS/CERTIFICATIONS:

Professional Geologist - PG #1282, FL, 1992 – 2010; PG #445, KY, 1993 – 2009; PG #G1507, OR, 1994 – 2009

PRESENT POSITION IN OFFERER'S COMPANY: Senior Geophysicist

RELEVANT EXPERIENCE:

- ✓ Project Management and Field Supervision
- ✓ Field Investigation and Data Collection Designs
- ✓ Implements Geophysical Investigations and GPOs
- ✓ Expertise in Geosoft® Oasis Montaj, UXO Detect, Access, C++
- ✓ Trains and supervises data collection personnel; prepares geophysical investigation plans; develops DQOs; validates collection procedures; and supervises data analysis
- ✓ Data interpretation and analysis

EMPLOYMENT HISTORY:

Senior Geophysicist. RI/FS, Former Camp Gruber Military Reservation, OK and RI/FS, Former Southwest Proving Grounds, AR US Army Engineering and Support Center, Huntsville. Mr. Hild has provided oversight on all aspects of geophysics, including the Geophysical Investigation Plan, the Geophysical Prove-out Plan, and digital geophysical mapping. The DGM surveys will assist in characterization of the MRS to support the RI/FS for each respective project.

Senior Geophysicist. Disposal/Removal Action Amelia Earhart Park, FL (US Army Corps of Engineers, Savannah District. Designed and provided oversight for the electromagnetic survey to confirm the presence of buried drums.

Senior Geophysicist. UXO, EOD Support, and Geophysical Surveys, Tonopah Test Range (TTR), NV. A DGM survey was conducted using an EM61-MKII time domain electromagnetic (TDEM) system and the Multi-sensor Towed Array Detection System (MTADS) to detect potential munitions, to identify potential depleted uranium (DU) rings, and to identify potential penetrators. Data collection was accomplished using an autonomous remote controlled vehicle at an average rate of just under 50 acres per 12-hour day with a path tracking error of less than 4 cm.

Senior Geophysicist. UXO Investigation, Arapahoe Park Development Site, Aurora, CO. Conducted an electromagnetic geophysical survey conducted at the Arapahoe Park Development Site in Aurora, Colorado, located on the Former Lowry Bombing and Gunnery Range. The Geonics Limited EM61 MKII Time Domain Electromagnetic detection system was used to map metal objects within the survey area representing potential ordnance items, which were then intrusively investigated to reduce the risk of encountering UXO and improving the safety of the land for future use.

TIMOTHY B. BURKETT, GISP
GIS MANAGER

EDUCATION/QUALIFICATIONS: MS, Geography and Regional Planning, Indiana University of Pennsylvania, 1995
BA, Geography, University of Pittsburgh, 1994

TRAINING: Introduction to ARCINFO, ESRI Learning Center, Charlotte NC
Introduction to Gothic, Laser-Scan, Reston VA

PRESENT POSITION IN OFFERER'S COMPANY: GIS Manager

RELATIVE EXPERIENCE:

- ✓ Database Development and Management
- ✓ Custom IT solutions
- ✓ GIS Feasibility Studies and Implementation Plans
- ✓ Imagery Processing
- ✓ Quality Control of GIS Products
- ✓ Data Set Conversion
- ✓ GIS/GPS Integration
- ✓ Perform on-site consulting and training
- ✓ Internet based Mapping solutions
- ✓ Handheld based Mapping solutions

EMPLOYMENT HISTORY:

Project Manager. NAAF Airfield Mapping, Charleston Air Force Base, Charleston SC.
Mr. Burkett is managing all aspects of this project. The project is updating the 2003 study and delivering updated airfield surface maps to CAFB. He will conduct the field work to include surveying obstructions and potential airfield violations that will need addressed by Air Mobility Command.

Project Manager. Joint Base Charleston General Plan. Charleston Air Force Base, Charleston, SC (#3016). Mr. Burkett was responsible for managing the execution of the project to coordinating invoices. He managed client expectations and served as the principal POC for the project. Mr. Burkett also served as the CAFB representative when working with NWS personnel on joint base data calls. He assembled input from the team and created the deliverables for team review. Mr. Burkett managed a 5 person team and 1 sub-contractor (Atriax). He routinely communicated with the client via telephone and face-to-face meetings and conducted review meetings after each deliverable. Quality measures were defined at project kick-off with the client and were ensured through review meetings. This project was completed on schedule. *Challenges:* Due to the initial stages of Joint Basing, this concept was a moving target. There were many simultaneous efforts that affected what the document could/should contain. The team was forced to keep track of these efforts and be sure to document the findings in the final report. This was the first Joint Base General Plan resulting from BRAC 2005. *Accomplishments:* Mr. Burkett built strong relationships with NWS and CAFB throughout this project. The end result was a general planning document that would serve as the starting point for future development once Joint Base Charleston is established.

Project Manager. Munitions Master Plan. Charleston Air Force Base, Charleston, SC .
Mr. Burkett was responsible for managing the execution of the project to coordinating invoices. He managed client expectations and served as the principal POC for the project. Mr. Burkett also served as the technical lead when dealing with Wing Safety in regards to planning concerns and assembled input from the team and created the deliverables for team review. Mr. Burkett managed a 4 person team and 1 sub-contractor (Atriax). He routinely communicated with the client via telephone and face-to-face meetings and conducted review meetings after each deliverable. Quality measures were defined at project kick-off with the client and were ensured through review meetings. This project was completed on schedule. *Accomplishments:* Conducted very successful multi-day charrette to gather input from numerous stakeholders from local base and command. Worked closely with Wing Safety to ensure all site plans would adhere to munitions storage and safety arc criteria. Final deliverable was designed as an appendix for the 2020 plan; this format will make updates much simpler for the client.

Project Manager. Historical Aerial Photography Research – Naval Weapons Station Charleston, Charleston SC
Mr. Burkett managed all aspects of this project. This project entailed locating and organizing historical aerial photographs of the base and creating GIS datasets for use in environmental site analysis. State libraries were also researched to locate additional site specific photographs. All photographs were then digitized and registered to local state plane coordinates for use in GIS.
GIS Manager. Update to HazMat Tracking Database. Naval Weapons Station Charleston, Charleston SC
Mr. Burkett managed the development and integration of updates to an existing database application to track Hazardous Material Shipments for the installation. After Zapata delivered the original database application, the client desired additional functionality to further enhance the tool. The project also focused on integrating new graphical user interfaces to allow for faster and simpler data entry. This project also required the system to be NMCI compliant. (Navy Marine Computer Initiative)

Project Manager. Munitions Master Plan, Charleston Air Force Base, Charleston SC.
Mr. Burkett serves as Project Manager for this planning effort. The project entails relocating many functions and operations to reduce overall Safety Arcs for the base. This project also investigates modernizing the range and munitions storage structures to current AF standards.

Project Manager. Naval Air Station Key West – HazMat Tracking Database. Naval Weapons Station Charleston, Charleston SC
Mr. Burkett managed the development and integration of a new database application to track Hazardous Material Shipments for the installation. This project created many automated queries and forms for Navy and Florida State reporting purposes. The project also focused on integrating new graphical user interfaces to allow for faster and simpler data entry. This project also required the system to be NMCI compliant. (Navy Marine Computer Initiative)

Project Manager, Joint Base General Plan, Charleston Air Force Base, Charleston SC.
Mr. Burkett served as Project Manager for this planning effort. To date, it is the first joint base general plan as at outcome of the 2005 BRAC report. Due to the work ZE has conducted at both NWSCHS and CAFB, ZE was a logical choice to perform this general plan for CAFB. The team

has investigated both facilities and associated land use and general plans to create a document for Installation Management to use during the base realignment process.

GIS Manager. Naval Weapons Station Charleston – HazMat Tracking Database.
Mr. Burkett managed the development and integration of a new database application to track Hazardous Material Shipments for the installation. This project created many automated queries and forms for SCDEHC reporting purposes. The project also focused on integrating new graphical user interfaces to allow for faster and simpler data entry. This project also required the system to be NMCI compliant. (Navy Marine Computer Initiative)

GIS Manager. DMPTR MEC Removal Project. Fort Hood, TX. Mr. Burkett managed the GIS analysis, cartographic support and boundary survey locations for the project. He supplied various input on the map products to aid in the removal process along with analysis required that was aimed to eliminate the potential risk of human life.

GIS Manager, GeoBase Support, Charleston Air Force Base, Charleston SC. Mr. Burkett manages the off-site personnel providing day-to-day support to the Enterprise GIS system at CAFB. He also provides technical support to the base and personnel. Mr. Burkett has been actively involved in the GIS/GeoBase operations at the base since its inception over 6 years ago.

JEFF SCHWALM
SITE MANAGER/SENIOR UXO SUPERVISOR

EDUCATION/QUALIFICATIONS:
1976 US Naval Explosives Ordnance Disposal School, Indian Head, MD

TRAINING:
Radiological Worker II, 2006
8-Hour OSHA Refresher Training, Annually
40-Hour OSHA Health and Safety Training for Hazardous Waste Operations, 29 CFR 1910.20, 1993 10 hour OSHA Construction Safety and Health, 2007

LICENSES/REGISTRATIONS/CERTIFICATIONS: NAVSACOLEOD, 1976

PRESENT POSITION IN OFFERER'S COMPANY: Munitions Response Senior Project Manager/SUXOS

RELEVANT EXPERIENCE:
- ✓ Over 36 years experience in field actions and project management of UXO, MEC, and OMRS projects at DOE and DOD sites
- ✓ Experienced in radiological waste removal
- ✓ Experience managing Task Orders and ID/IQ contracts
- ✓ Experienced in all phases of OMRS process for evaluating, storing, and disposing of foreign munitions

EMPLOYMENT HISTORY:
UXO Principal Investigator – UXO, EOD Support, and Geophysical Surveys, Tonopah Test Range, NV. Managed personnel to conduct UXO investigations at the Tonopah Test Range. Served as technical primary point-of-contact to NSTec Subcontract Technical Representative. Provided estimates for additional scoped work. Submitted, weekly, monthly and other reports as required.

Project Manager – Ordnance and Explosives Removal at OOU3, Former Camp Croft, Spartanburg, SC. Managed the ordnance and explosives (OE) removal action within a subdivision and adjacent recreational property which was once part of the former Camp Croft Army Training Facility. This removal action involved the daily management of site operations, tracking costs and funding, and providing advice and support to clients on regulatory compliance issues and technology reviews. Project included digital geophysical mapping using CHI^2 advanced anomaly discrimination.

Project Manager – Ordnance and Explosives Removal Action, Former Motlow Range, Tullahoma, TN. Management of OE removal at the site, which have included surface and subsurface clearance, and excavation of burial pits. Responsibilities included liaison between the client, the USCE-Mobile District and the applicable state agencies during the preparation of remedial investigation plans and the selection of remediation under the requirements of CERCLA.

Forward Project Manager – Captured Enemy Ammunition Program, Iraq. Provided contractor oversight, liaison between government contractors and Army units within geographical areas, and resolve technical and administrative issues for the US Army Engineering and Support Center, Huntsville at various locations throughout Iraq in support of the Captured Enemy Ammunition Program.

Project Manager – Navy/DRI Site, CO, Former Lowery Bombing and Gunnery Range (FLBR), CO. Management of a Navy/DRI project to include radiological waste removal and final reports.

FLGBR/managed all aspects of project to include financial, public meetings, coordinating with state and federal regulators.

Senior UXO Supervisor – Tobyhanna State Park, PA. Field manager for a Time Critical Removal Action within a state park with sensitive environmental issues.

Senior UXO Supervisor – Chemical Warfare Removal Action, Black Hills, SD. Field manager for surface and subsurface removal of OE and conventional and chemical munitions debris. Trained a 24-person Native American workforce in support of field operations. Removed, certified and disposed of over 200 tons of munitions debris.

QC Specialist/Site Safety Officer – Fort Sill, OK. Provided safety and quality management for multi-stage field project that resulted in the remediation of over 15,000 ordnance and explosive items from 1300 acres and the proper removal, certification and disposal of over 200 tons of scrap.

UXO Supervisor – Chemical Warfare EE/CA, Camp Sibert, AL. Field manager responsible for team supervision, planning and coordination of all field operations in a Chemical Warfare EE/CA.

Senior Site Supervisor – Chemical Warfare Removal Action, Spring Valley, Washington DC. Field manager responsible for team supervision, planning and coordination of all field operations in a Chemical Warfare Removal Action.

Senior Site Supervisor – Armstrong Air-to-Air Gunnery Range, SD. Field manager responsible for team supervision, planning and coordination of all field operations in a site investigation and waste removal.

Senior Site Supervisor – Bush River Bomb Pile Hazardous Waste Removal, Aberdeen Proving Grounds, MD. Field manager responsible for team supervision, planning and coordination of all field operations in a hazardous waste removal action project at the Bush River Bomb pile.

Senior Site Supervisor – Chemical Warfare EE/CA and Removal Action, Ft. McClellan, AL. Field manager responsible for team supervision, planning and coordination of all field operations in a Chemical Warfare EE/CA and Removal Action.

Senior Site Supervisor – Chemical Warfare Removal Action, Spring Valley, Washington DC. Field manager responsible for team supervision, planning and coordination of all field operations in a Chemical Warfare Removal Action.

Senior Site Supervisor – Former BlackHills Army Depot, SD. Field manager responsible for team supervision, planning and coordination of all field operations in the removed and disposal of all equipment remaining at the Former BlackHills Army Depot.

EOD Noncommissioned Officer – US Air Force, Multiple duty locations, Worldwide. Provided technical and managerial support for ordnance removal and emergency management projects in support of operations and training. Retired as Superintendent EOD FLT, Nellis AFB after eight years of service in this position.

GLEN TERRY FARMER
UXO QUALITY CONTROL SPECIALIST (UXOQCS)

EDUCATION/QUALIFICATIONS:
1999 B.S Buisness Administration,
1972 GraduateBasic EOD School,

TRAINING
HAZWOPER 8-Hour Refresher, Annually
Environmental Safety Supervisor, 2004
OSHA Construction Safety, 2004
HAZWOPER 40-Hour, 2000
CPR/First Aid Trailing 2006

PRESENT POSITION IN OFFEROR'S COMPANY: SUXOS

RELEVANT EXPERIENCE:
- ✓ Over 25 years of experience in Explosive Ordnance Disposal
- ✓ Extensive experience in all aspects of UXO detection, disposal, and remediation including construction support
- ✓ Experience implementing work plans and health and safety plans
- ✓ Experience implementing quality control and safety programs

EMPLOYMENT HISTORY:
UXO Safety Officer-Fort Bliss, TX. Provided UXO safety support, surverying and geotechnical operations.

UXO Safety Officer-Fort Hood, TX; DMPTR Range Clearance Project. Responsible for ensuring site safety during clearance of digital multipurpose training range.

UXO Safety Officer-Indian Town Gap, PA Provide UXO safety escourt during preliminary assesment.

UXO Tech III-Earl, NJ Supervised team during sifiting operations

UXO Tech III – Massachusetts Military Reservation, MA. Supervised brush clearance and provided escort for geophysical survey and land survey teams.

UXO Safety Officer – Ft. Bragg, NC. Responsible for site safety during surface reconnaissance.

UXO Safety Officer –Ft. Riley, KS. Responsible for site safety during surface reconnaissance.

UXO Tech III – Ft. Bragg, NC. Provided escort for Endangered Species personnel on several ranges.

UXO Safety Officer – Ft. Benning, GA. Responsible for site safety during surface reconnaissance.

UXO Tech III – Former Waikane Valley Training Area, HI. Supervised surface reconnaissance.

UXO Tech III – Former Rocket Range MCAS Cherry Point, NC. Provided escort for geophysical survey team.
UXO Safety Officer – Former Camp Croft, Spartanburg, SC. Responsible for site safety during brush clearing, geophysical survey, and intrusive operations.

Senior UXO Supervisor –Former Erie Gunnery Range, OH. Supervised surface reconnaissance.

UXO Safety Officer –Holloman AFB, NM. Responsible for site safety during the recovery of chemical warfare materiel.

UXO Tech III – Former NAS South Weymouth, MA. Conducted UXO avoidance operations at a construction site.

UXO Tech III/Quality Control Supervisor – Former Lowry Gunnery Range, CO. Supervised intrusive operations on 20mm Projectile Range and supervised quality control sampling of grids.

UXO Tech III – NAF Adak, AK. Supervised intrusive operations on Form 37mm Projectile Range.

UXO Tech III – Ft. McClellan, AL. Supervised intrusive operations on former mortar and rocket ranges.

UXO Tech III – Ft. McClellan, AL. Supervised the plotting of anomalies during an EECA.

UXO Tech III – 1 Former Myrtle Beach AFB, SC. Supervised 1 of 2 teams in the sifting of 5,000 cubic yards of soil from a Fire in Bunker (FIB) used to sight in 20mm aircraft cannon.

UXO Tech III, Team Leader/Diving Supervisor – Former Navy Ammunition Supply Point Bremerton, WA. Supervised the underwater recovery of more than 3,000 ordnance items buried in the vicinity of 2 piers. Prepared dive plans, conducted safety briefings, identified ordnance, and supervised the day-to-day operations of a 10-person team.

UXO Tech III – Ft. McClellan, AL. Conducted down-hole monitoring and UXO avoidance in support of construction operations.

UXO Tech II – Former Camp Croft, SC. Investigated anomalies utilizing Engineering Controls (Bud Light), Schonstadt, MK26, and Vallon Metal Detectors.

UXO Tech II – Former Turret Gunnery Range, Brooksville, FL. Operated Trimble GPS to reacquire marks and the EM61 and Schonstadt Metal Detectors to locate contacts.

Department Head, EOD Mobile Unit 6, Charleston, SC. Readiness and Training Officer responsible for evaluation and training of ten EOD Detachments in operational and administrative procedures. Supervised 70 EOD personnel.

Officer in Charge, EOD Mobile Unit 6 Detachment Charleston, SC. Disposed of more than 200,000 pounds (NEW) of retrograde ordnance. Provided support to military and civilian communities, and US. Secret Service. Managed the Naval Weapons Station Demolition Range. Supervised 4 EOD Techs and 5 Civilian Ordnance Techs.

Officer in Charge, EOD Mobile Unit 6 Detachment 8. Deployed to Norway, Sicily, and Persian Gulf in support of Mine Countermeasure Operations. Recovered or destroyed 39 enemy sea mines and numerous surface munitions during Operation Desert Storm. Supervised 8 EOD personnel.

TIM HENDRIX
UXO SAFETY OFFICER (UXOSO)

EDUCATION/QUALIFICATIONS:

Associate Degree in Explosive Ordnance Disposal; Community College of the Air Force, 1987

TRAINING

Basic Explosive Ordnance Disposal Course, Indian Head Md. 25 July 1975
40-Hour OSHA Health & Safety Training, 29 CFR 1910.20, 8-Hour Refresher, Oct. 1993
8-Hour Supervisor Course, Annually
American Red Cross First Aid and CPR Certification

PRESENT POSITION IN OFFERER'S COMPANY: PM/SUXOS

RELATIVE EXPERIENCE:

- ✓ Site Assessments and Corrective Action Plans
- ✓ Work Plans and Final Reports associated with MEC
- ✓ Planning, coordinating, managing, MEC removal projects

EMPLOYMENT HISTORY:

Project Manager. Geophysical Validation Project, Curtis Bay, MD (2101) and Construction Support, Fort Riley, KS. Mr. Hendrix is currently managing a trenching and soil sampling project at the former Curtis Bay Ammunition Depot in Maryland and a Construction Support project at Fort Riley in Kansas. Both projects started on the same day and are progressing ahead on schedule.

Project Manager. Site Investigation. Kansas Army Ammunition Plan, Parsons, KS. Mr. Hendrix was the off-site manager of a project sub-contracted from CDM Federal Programs Corporation. Coordinated, planned and managed the necessary equipment and UXO teams required to investigate 9 trenches and 8 single point anomalies. The project was scheduled for 19 days and the team completed the task in 5 days.

UXO Safety Officer. Site Investigation. Camp Gruber, OK. Mr. Hendrix managed the site safety program for 20 UXO technicians. He ensured that each individual on-site maintained an awareness of potential site hazards and followed requirements of the safety plan. Also, Mr. Hendrix provided daily safety briefings for site personnel. The project finished with zero reportable accidents or injuries.

Project Manager. ISBC/CLF, Fort Bliss, TX. US Army Corp of Engineers, Fort Worth District. Mr. Hendrix was the on-site manager on a MEC removal project on Range 48, Dona Ana, NM and Range 37, McGregor Base Camp, NM. This project involved managing ordnance removal from the construction footprint on two ranges that were 25 miles apart. Three sever person teams cleared 67,236 subsurface anomalies and destroyed over 243 live military ordnance items in the effort to make the range safe for construction.

Senior UXO Supervisor (SUXOS), DMPRC, Fort Stewart, GA. Mr. Hendrix was responsible for 4 UXO teams that cleared the 168 acre surface and subsurface construction footprint. These teams excavated 56,000 anomalies and destroyed over 279 live MEC items. Over 50,000 pounds of Munitions debris and 18,000 pounds of Target debris was safely removed from the area.

Senior UXO Supervisor (SUXOS). Digital Purpose Training Range, Browns Creek, Fort Hood, TX. Mr. Hendrix provided oversight to 3 MEC removal teams that cleared the 86 acre surface and subsurface construction footprint. These teams excavated 84,784 anomalies and destroyed over 100 MEC items. Over 400,000 lbs of Target debris and 63,000 lbs of Munitions debris was safely removed from the area.

Quality Control Officer (UXOQC). Schofield Barracks, Oahu, Hawaii. Mr. Hendrix was responsible for the quality of 3 UXO teams that used heavy equipment to clear high hazard footprint areas. These teams excavated the coffins and drains of selected targets and safely disposed of an additional 200 munitions items left from the previous clearance.

Senior UXO Supervisor (SUXOS). Cherry Point, NC. Mr. Hendrix provided oversight for 1 UXO team that worked in two areas clearing single point anomalies at Bouge Airfield and a 60 acre rocket range in Atlantic, NC. The team excavated 412 anomalies and explosively vented 302 practice bombs and rockets.

Quality Control Officer (UXOQC). Schofield Barracks, Oahu, Hawaii. Mr. Hendrix was responsible for the quality of 3 UXO teams that cleared 194 acres. These teams performed 86,386 subsurface excavations. Also, during this project 20,672 pounds of MD and 52,089 pounds of cultural and target debris was removed from the construction footprint. In all, 730 items were safely destroyed.

Senior UXO Supervisor (SUXOS). Kahuku Training Area, Kahuku, Oahu, Hawaii. Mr. Hendrix provided oversight for 3 UXO teams that performed 29,636 subsurface excavations. Also, during this project 1760 pounds of Munitions Debris and 2814 pounds of Cultural Debris were removed from the construction footprint. In addition, 5494 rounds of small arms ammunition were also removed. In all, 99 UXO items were safely disposed of.

Senior UXO Supervisor (SUXOS). Former Camp Wellfleet, Wellfleet MA. More than a thousand pounds of munitions debris was removed from four areas during phase III of this project. In addition, 3000 lbs of Calcium Hydride Canisters and related debris was removed and processed through a local environmental company.

Senior UXO Supervisor (SUXOS). Infantry Squad Battle Course, Fort Benning, Georgia. A total of 244 surface and 92 sub-surface grids were investigated. The UXO teams performed 13,693 subsurface excavations. Also, during this project 17,413 pounds of OE scrap and 493,896 pounds of NON-OE scrap range residue and targets were removed. The number of live MEC disposed of by venting was 496.

UXO Safety/Quality Control Officer. Former Camp Wellfleet, Wellfleet, MA. Mr. Hendrix was responsible for both safety and quality for all MEC teams on this project. Airborne and ground geophysics were used to locate anomalies within areas on the Cape Cod National Seashore Park. Phase II of this project had 3 UXO teams investigate 231 Single Point Anomalies resulting in 740 pounds of Munitions debris and 1,454 pounds Cultural debris. (ZapataEngineering, 01/04-03/04)

UXO Safety/Quality Control Officer. Former Motlow Community College, Tullahoma, TN. Mr. Hendrix was responsible for both safety and quality for all MEC teams on this project. Hundreds of 37mm projectiles were located and destroyed on the campus and in the surrounding area.

APPENDIX I
TECHNICAL PROJECT PLANNING (TPP) WORK SHEETS

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AGENDA

Project Name: Remedial Investigation/Feasibility Study (RI/FS), Former Camp Croft, Spartanburg, South Carolina

Date of Meeting: 16 March 2011

Time of Meeting: 8:30 am – 4:30 pm

Attendees:

1. Shawn Boone, USACE, Charleston
2. Spencer O'Neal, USAESCH
3. Teresa Carpenter USAESCH
4. Jason Shiflet, ZAPATA
5. Michael Winningham, ZAPATA
6. Suzy Cantor-McKinney, ZAPATA
7. Jeff Schwalm, ZAPATA
8. Susan Byrd, SC DHEC
9. South Carolina Parks and Recreation (tentative)
10. Croft State Natural Area (tentative)

Purpose of Meeting:

The purpose of this meeting is to establish the TPP team and to begin the TPP process for the Remedial Investigation/Feasibility Study at the former Camp Croft FUDS. Zapata Incorporated (ZAPATA) has developed Pre-Work Plans based on a technical proposal submitted to the United States Army Engineering and Support Center, Huntsville (USAESCH) in response to a Performance Work Statement dated 02 December 2010. Proposed meeting goals and discussion topics are provided below.

Meeting Goals:

1. Assemble and introduce the TPP team
2. Clarify the general RI/FS process
3. Obtain consensus on the project objectives
4. Facilitate the evaluation of potential data gaps from existing documents
5. Refine the preliminary CSM
6. Determine data requirements to achieve project objectives
7. Establish RI DQOs
8. Complete the initial TPP process such that Work Plans can be developed

Discussion Topics:

1. Opening Remark and introductions
2. Review agenda goals
3. Brief review of RI/FS process
4. Discuss the preliminary Conceptual Site Model
5. Complete TPP Worksheets (from Interim Guidance Document 01-02)
6. Discuss data collection strategies
7. Closing Remarks

Action Items (note responsible party and proposed due date):

Responsible Party	Target Due Date	Action

Croft TPP
RI/FS
3/16/2011

Name/agency	Email
Suzy McKinney ZAPATA	scmckinney@zapatainc.com
Deb Edwards, USACE	Debra.L.Edwards@usace.army.mil
John Moon Croft SNA	jmoon@scprt.com
Spencer O'Neal USACE	Spencer.D.Oneal@USACE.Army.mil
Teresa Carpenter (USACE)	teresa.m.carpenter@usace.army.mil
Shawn Boone USACE Charleston	shawn.a.boone@usace.army.mil
Susan Byrd SC DHEC	byrdsk@Dhec.sc.gov
Jason Shiflet ZAPATA	jshiflet@zapatainc.com

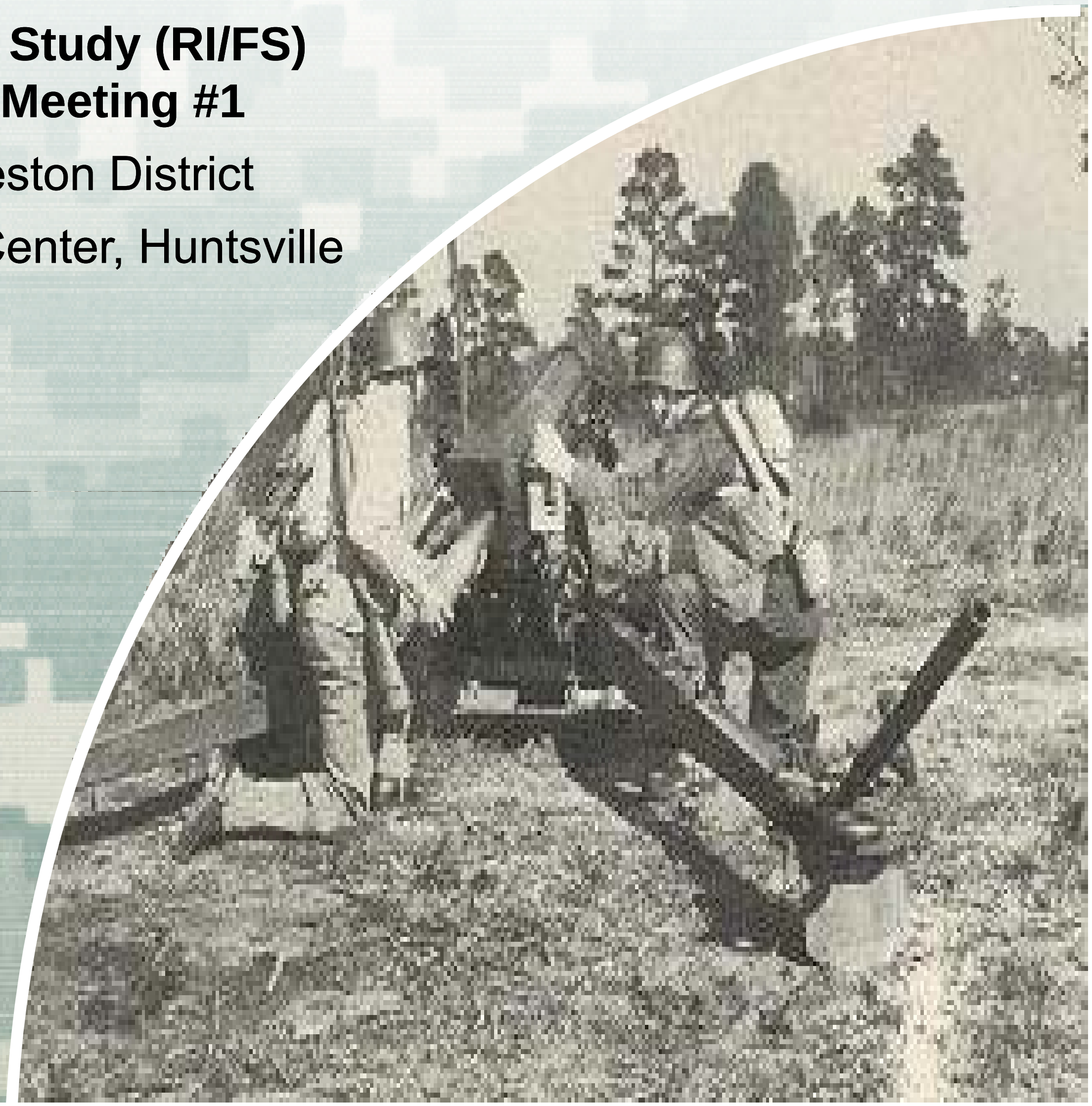
Former Camp Croft
Spartanburg, South Carolina

Remedial Investigation/Feasibility Study (RI/FS)
Technical Project Planning (TPP), Meeting #1

US Army Corps of Engineers, Charleston District

US Army Engineering and Support Center, Huntsville

16 March 2011



US Army Corps of Engineers
BUILDING STRONG®

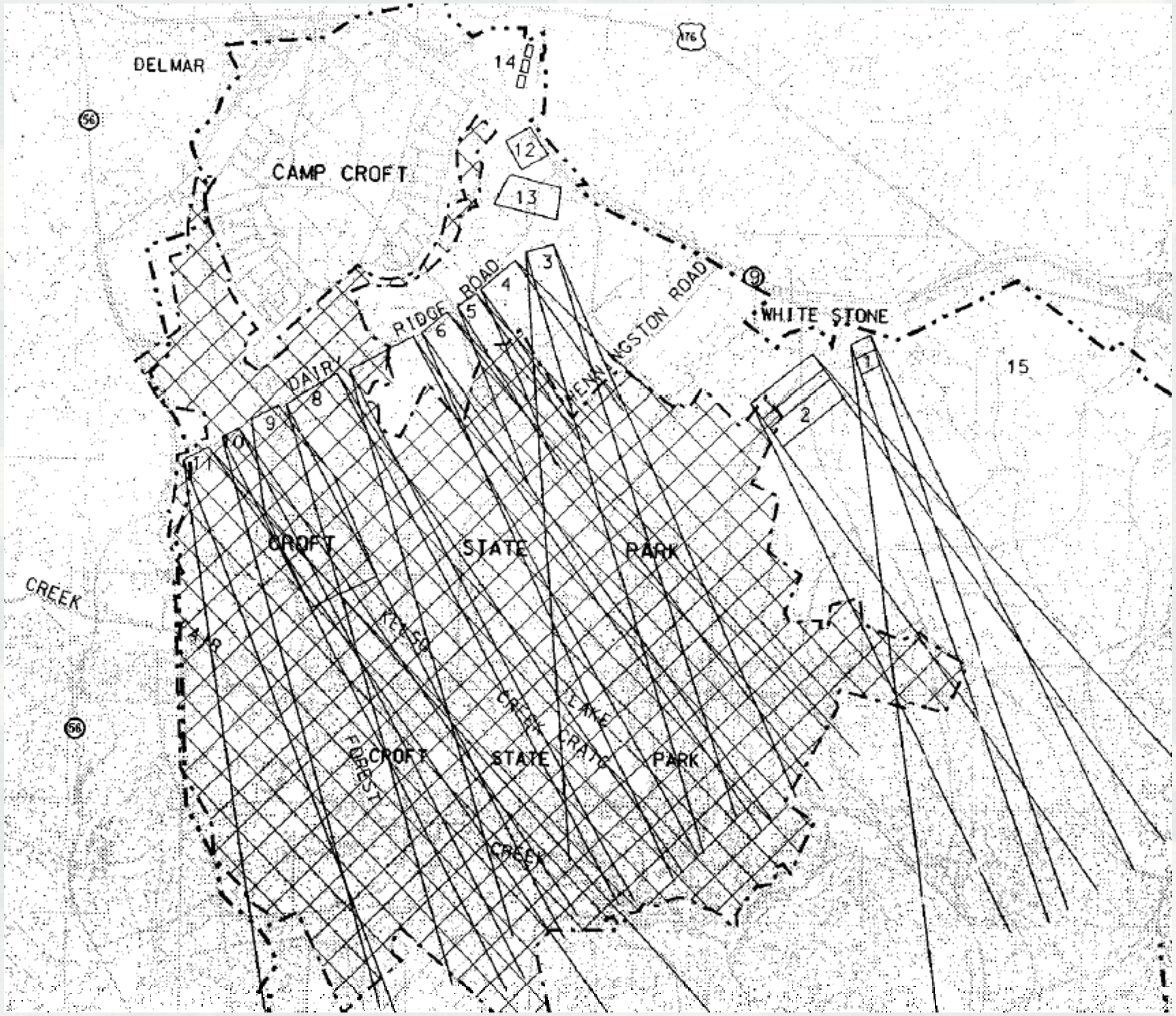
History

The infantry replacement Training Center in Spartanburg, South Carolina was activated on January 10, 1941.   It was a training facility for all phases of combat and encompassed approximately 19,000 acres.

By July 1945, nearly 200,000 men had trained at the facility named “Camp Croft.”

In 1947, the camp was declared excess to the War Assets Administration, and parcels of the land were disposed of by sale or quitclaim to organizations, business interests, and former owners.

History



LEGEND:

1. Rifle – Auto. Rifle – 200-300 yds
2. Rifle – Auto. Rifle – 200-300 yds
3. Landscape Target – 600', 9 sets
4. AA Miniature Range – 1080'
5. Pistol – 600', 120 targets
6. 1000 inch machine gun range
7. Rifle – Auto. Rifle – field targets
8. Machine gun – field targets
9. 60mm and 81mm mortar
10. 1000 inch AT
11. Moving target AT
12. Grenade court
13. Bayonet court
14. Gas Chambers
15. Combat Ranges

Source: Archives Search Report, 1993

The MEC Problem

Military uses that can result in the presence of MEC:

- Ranges and Impact Areas
- Training Areas
- Facilities
- Disposal Areas

Munitions and Explosives of Concern (MEC)

Our focus is minimizing the safety hazards from MEC remaining at this FUDS site.

MEC and UXO:

- MEC consists of munitions and explosives, including fired and/or discarded items, explosive filler, etc.
- UXO is defined as *unexploded ordnance*
- UXO is *a subset of MEC*

Project Object

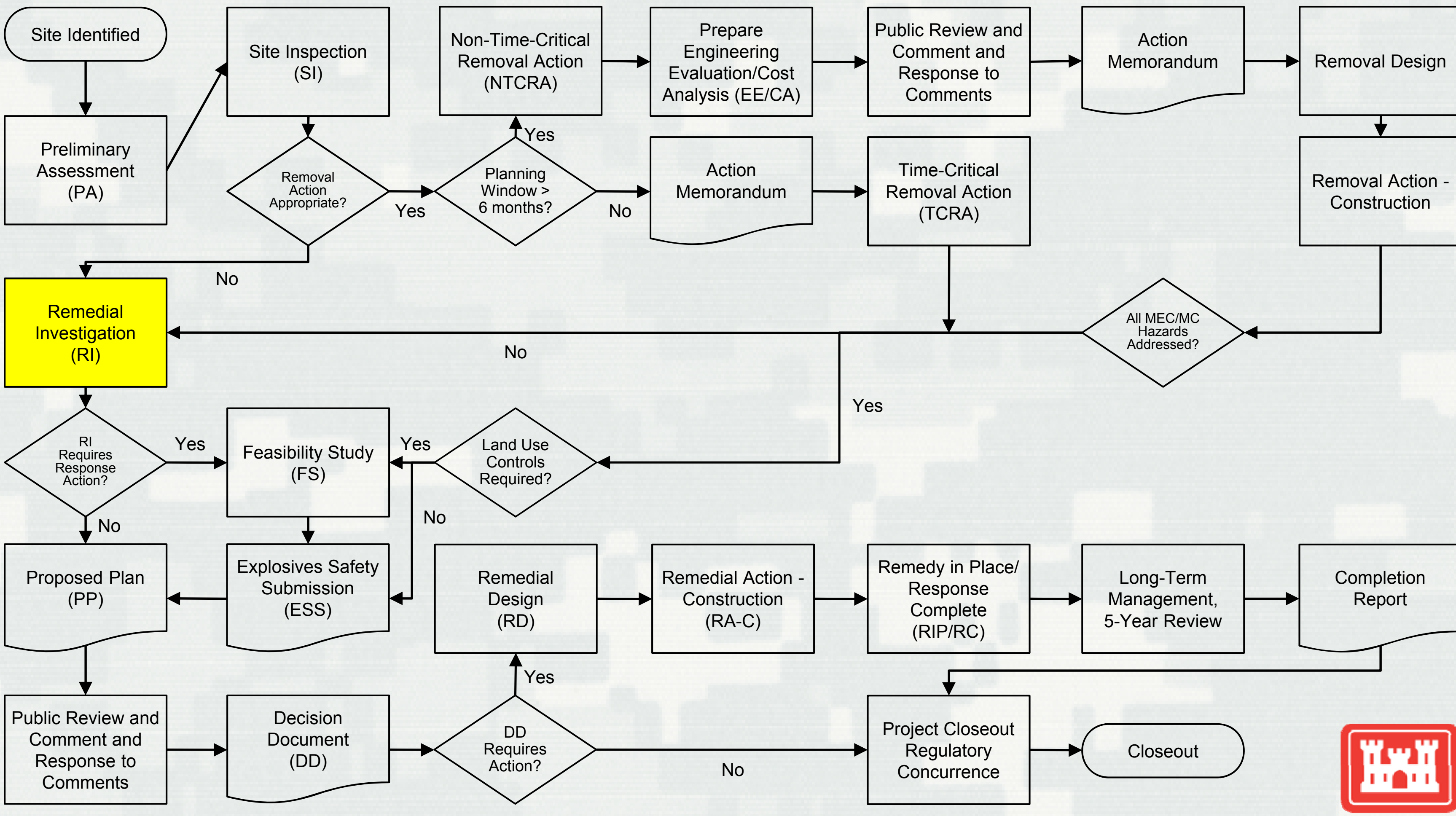
- Achieve acceptance of Decision Document (DD) at
  - Gas Chambers MRS,
  - Grenade Court MRS, and
  - Land Range Complex MRS by 31 January 2013.
- Achieve acceptance of DD in compliance with
  - factors listed in 40 Code of Federal Regulations (CFR) 300.430(d)(2),
  - the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA),
  - Department of Defense (DoD),
  - U.S. Army and
  - USACE regulations and guidance.

Stakeholder Involvement

Stakeholders provide input throughout the project:

- Voice community concerns
- Participate on the Restoration Advisory Board (RAB)/attend RAB meetings
- Review and give input on technical reports

Munitions Response Process Under CERCLA



Yes

No

Inventory

Preliminary Assessment/Findings of Determination, 1991

- Determines FUDS eligibility
- Recommends projects (MEC, HTRW, etc.)

Archives Search Report (ASR), 1993

- Details site history
- Historical photo analysis
- Compiles information on past military activities

Archives Search Supplement, 2004 *(printed)*

- Provided additional information on 15 ranges/sub-ranges

GIS-Based Historical Photographic Analysis, 2005

- Identified and mapped areas of potential concern (ground scars, impact craters, trenches, ranges, etc) based on the analysis of historical aerial photographs.

Investigation

Engineering Evaluation/Cost Analysis (EE/CA)

Two EE/CAs have been completed for the former Camp Croft. Areas of investigation are divided into smaller, manageable areas referred to as ordnance operable units (OOUs).

The EE/CAs identified munitions concerns and presented risk reduction alternatives for each area of concern.

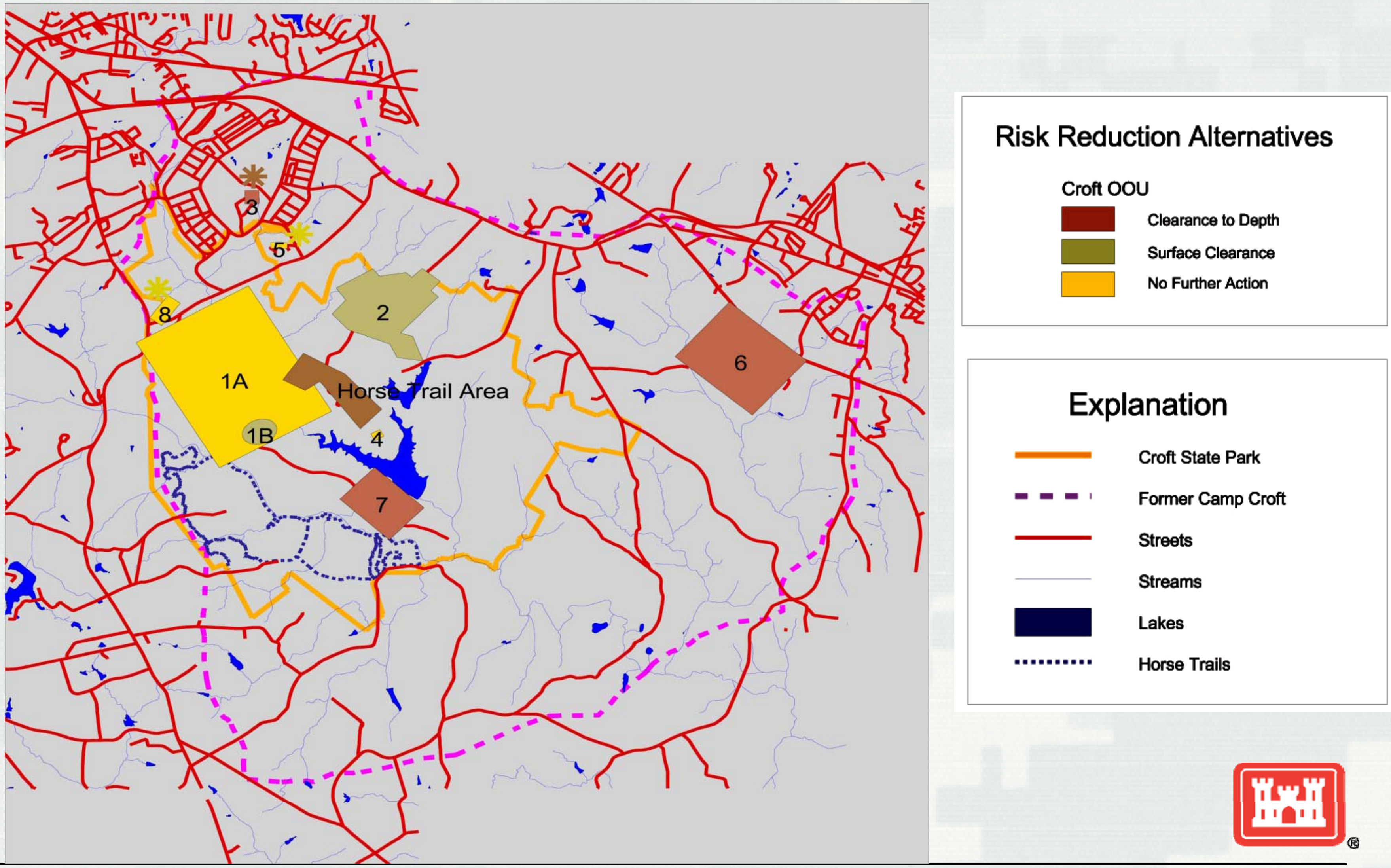
Phase I - January 1996
Action Memorandum dated February 1996
Phase II - January 1998
Action Memorandum dated March 1999

Investigation

The EE/CA process included:

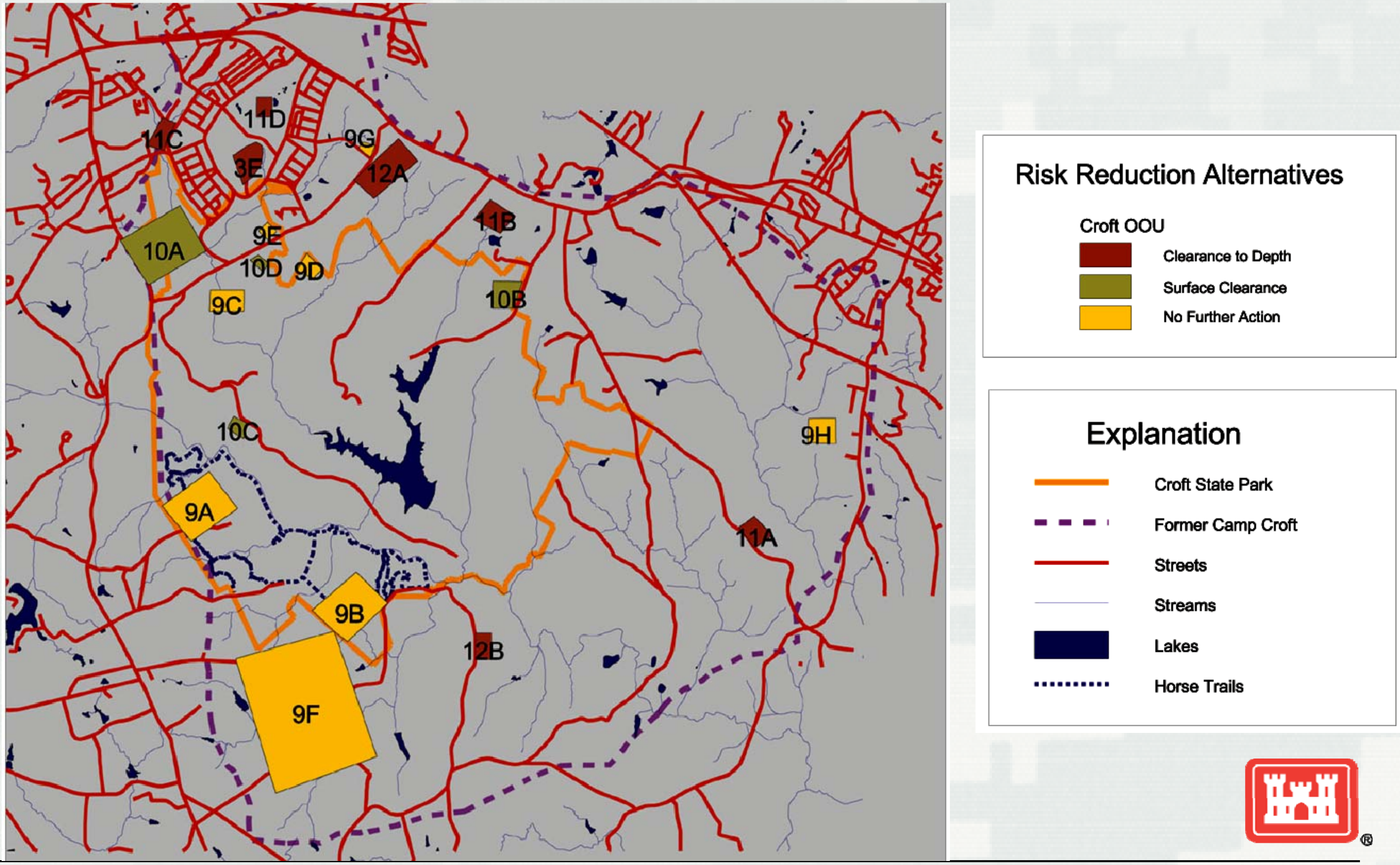
- Review of historical information
- Data collection
- Evaluation of risk based on:
  - Types of munitions (UXO, inert, scrap)
  - Depth of penetration
  - Sensitivity of the munitions
  - Likelihood of human exposure based on land use
- Documentation of Response Alternatives and Associated Costs
- Regulatory and Public Review/Comment Period
- Action Memorandum (authorizing remedial responses) signed by the US Army Corps of Engineers

Phase I EE/CA



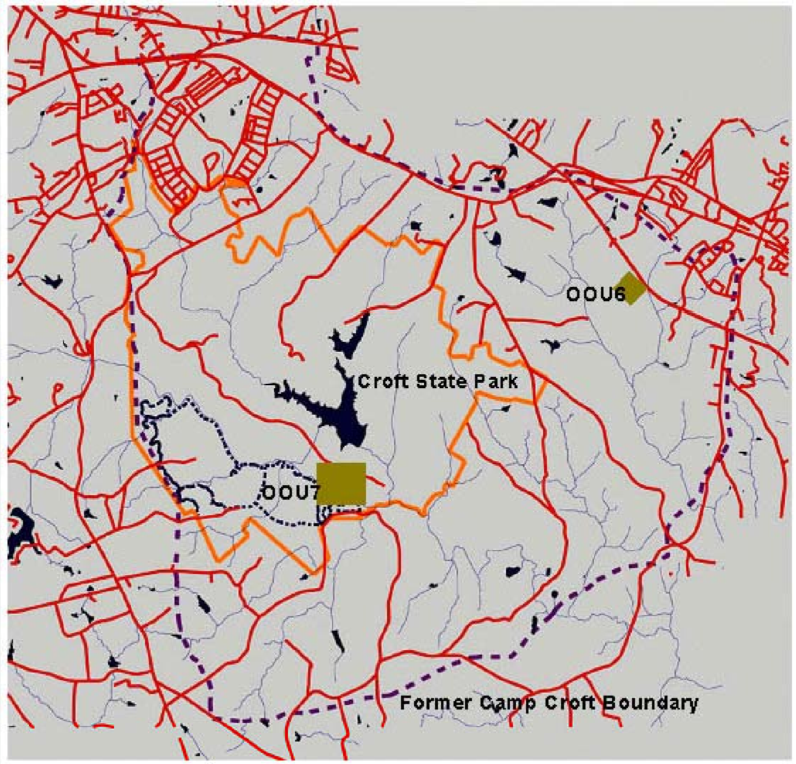
3
5
8
2
1A
1B
Horse Trail Area
4
7
6
Risk Reduction Alternatives
Croft OOU
Clearance to Depth
Surface Clearance
No Further Action
Explanation
Croft State Park
Former Camp Croft
Streets
Streams
Lakes
Horse Trails

Phase II EE/CA



Response Actions to Date

Two Time Critical Removal Actions (TCRAs) were completed in 1994-1995 to clear munitions hazards from the ground surface in areas readily accessible to the public. These areas included:



- 50 acres of Croft State Park, near the fitness trail
- 15 acres of privately-owned property

<u>Surface Clearance</u>

Items found:

36 – 60mm mortar
1 – 155mm projectile w/ burster tube
3 – 2.36" rockets (expended)
1 – 105mm projectile
14,000 pounds scrap

Response Actions to Date

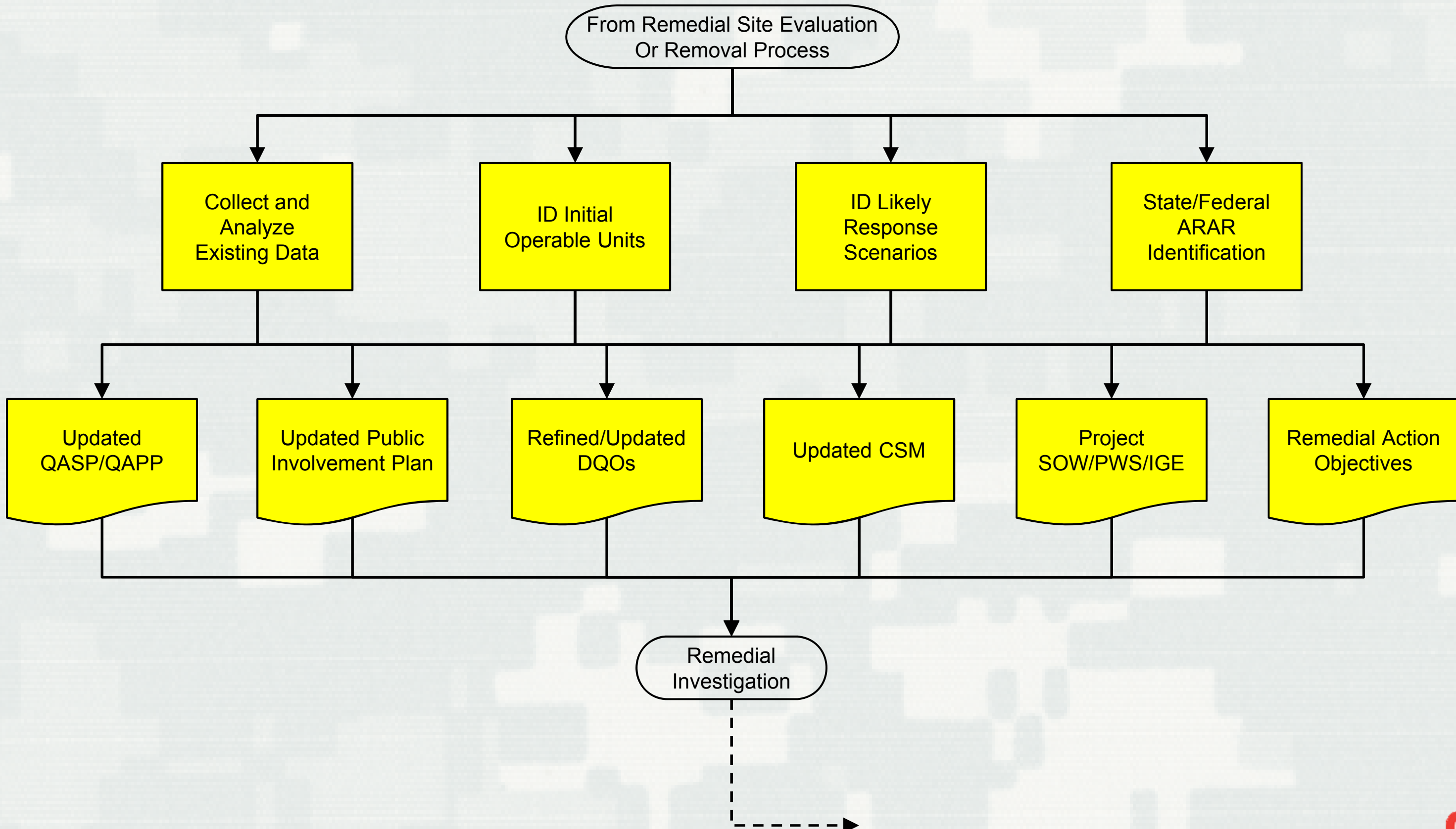
The following non-time critical removal actions have occurred:

OOU6 – Clearance of 4 acres; completed in 2001

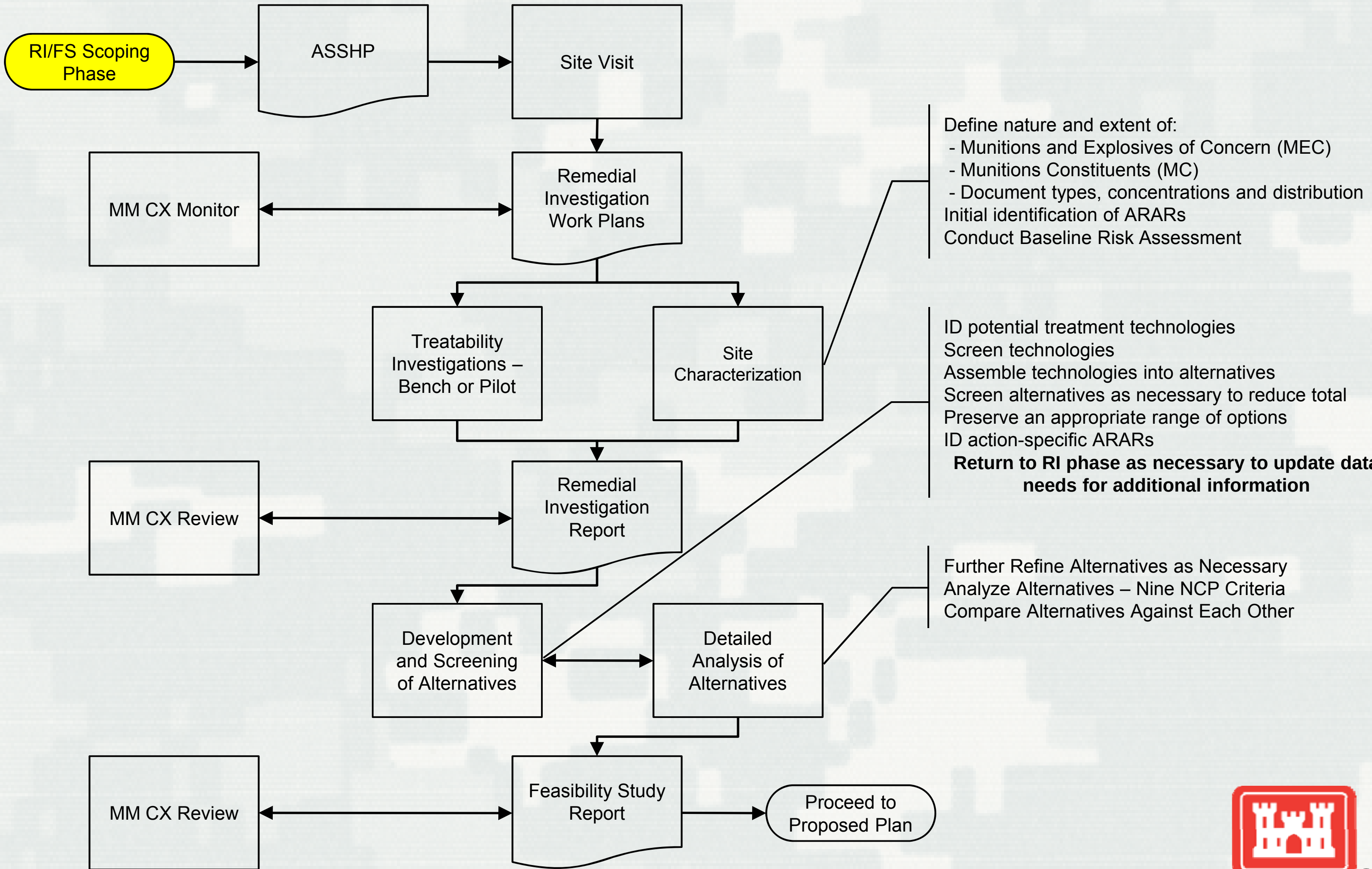
OOU3/OOU3 Expanded – Clearance of ~45 acres; completed in 2011

OOU11C – Clearance of 17 acres; completed in 2010

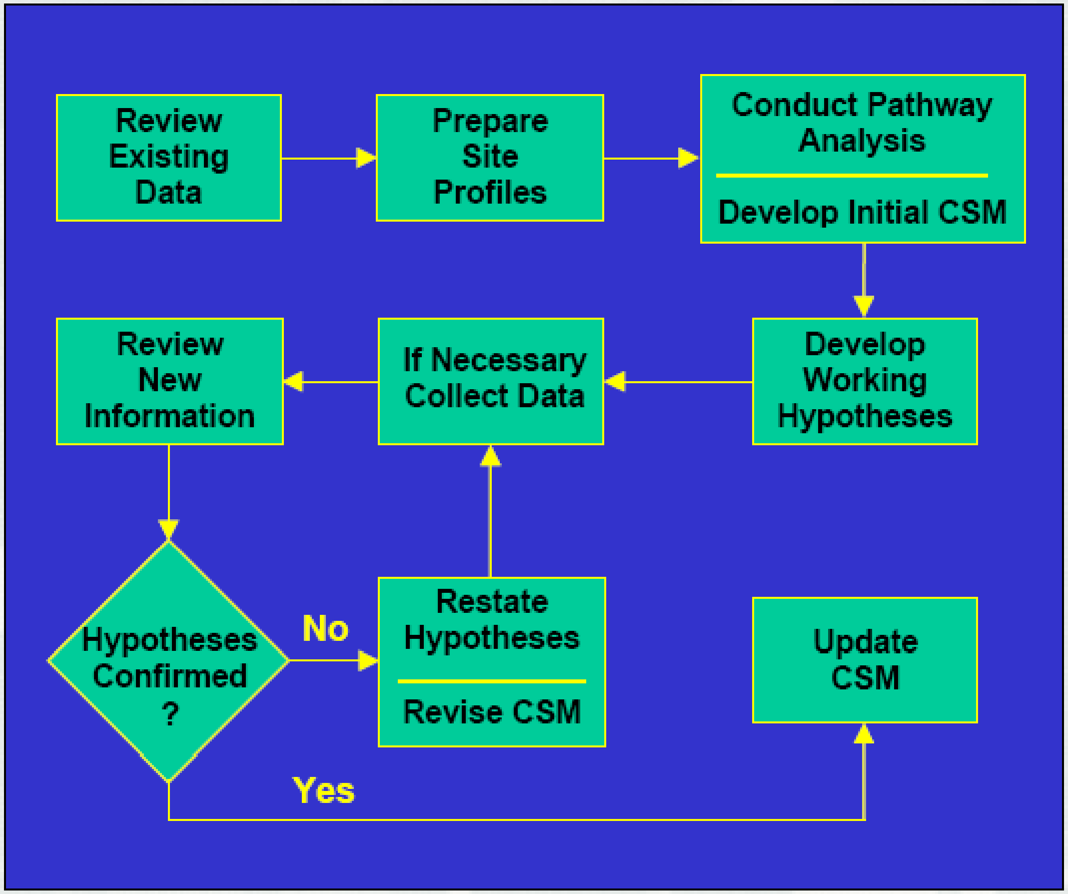
RI/FS Process



RI/FS Process (Con't.)



CSM Development Process



Ref.: EM 1110-1-1200

Conceptual Site Model

- 15 Military Munitions Response (MMR) areas have been identified in the Archive Search Report (ASR; USACE, 1993) and ASR Supplement (USACE, 2004).
- 3 correspond to the three designated MRSs (i.e., the Gas Chamber, Grenade Court, and the Range Complex).
  - Range Complex (MRS 3) is composed of Lake Johnson and Lake Craig and 12 sub-ranges.
  - Sub-ranges include small arms, mortar, rifle grenade, anti-tank rockets, and combat ranges.
  - 10 of the 12 sub-ranges, documented ordnance use was limited to small arms ammunition.
  - Documented use at Ranges 9 and 11 included all types of 60mm and 81mm mortars, rifle grenades and 2.36-inch rockets.
- ZAPATA reviewed investigation and removal action documents and compared findings with ASR and ASR Supplement information.
  - We identified discrepancies between documented ordnance types and actual findings in numerous locations.
  - For example, 60mm and 81mm mortars and 105mm hexachlorethane smoke rounds were recovered at OOU6 (former Range 15).

Proposed RI Fieldwork

- We propose to conduct a combination of:
  - ► Mag-and-dig – analog instrument-assisted intrusive investigations,
  - ► AIR – analog instrument-assisted surface reconnaissance,
  - ► DGM – digital geophysical mapping of transects and grids, and
  - ► MC sampling, both discrete and incremental

Transect Spacing

- based on MKII grenade, rifle grenade or 60mm mortar
- Determined using VSP
- Methodology (Mag-and-dig vs. AIR) based on range usage and previous RI/FS experience

VSP Input and Results

Munition	Range to No More Than 1 Hazardous Fragment/600 ft² Area	1.5 Hazardous Fragment Range (ft)	Survey Design	Survey Area Geometry	Anomaly Distribution	Background Anomaly Density (anom/acre)	False Negative (%)	Decision Rule: % Confidence[1]	Detection Probability[2]	Calculated Transect Spacing (ft)	Recommended Transect Spacing (ft)
60mm	166.3	250	Parallel	Circular	Bivariate Normal	15	5	95	90	416	400
MKII Grenade	62	93	Parallel	Circular	Bivariate Normal	15	5	95	90	112	100
Rifle Grenade	87	130.5	Parallel	Circular	Bivariate Normal	15	5	95	90	173	150

Munition	Range to No More Than 1 Hazardous Fragment/600 ft² Area	1.5 Hazardous Fragment Range (ft)	1.5 Hazardous Fragment range (m)	Average (ft) Excluding TP	Average (m) Excluding TP
37 mm M54	114	171	52.13414634	156.75	47.78963415
37 mm M63 TP	95	142.5	43.44512195	156.75	47.78963415
37 mm Mk I, LE Practice	68	102	31.09756098	102	31.09756098
37 mm MK II (0.053lb)	90	135	41.15853659	149.5	45.57926829
60 mm M49A2	150	225	68.59756098	249.5	76.06707317
60 mm M49A3	166	249	75.91463415	249.5	76.06707317
60 mm M49A5	183	274.5	83.68902439	249.5	76.06707317
60 mm TP M50	79	118.5	36.12804878	118.5	36.12804878
81 mm M362A1	243	364.5	111.1280488	345.6	105.3658537
81 mm M374	234	351	107.0121951	345.6	105.3658537
81 mm M43	230	345	105.1829268	345.6	105.3658537
81 mm M45	224	336	102.4390244	345.6	105.3658537
81 mm M56	221	331.5	101.0670732	345.6	105.3658537
81 mm TP M43A1	89	133.5	40.70121951	133.5	40.70121951
MKII Grenade	62	93	28.35365854	93	28.35365854
Rifle Grenade Robust	87	130.5	39.78658537	130.5	39.78658537

MC Sampling

- Samples should be collected from "biased" locations (i.e., target areas or firing points)
- Incremental samples (IS) collected from sampling units of ~100 ft by 100 ft
- IS analyzed for explosives and select metals (Cu, Pb, Sb, and Zn)
- If white phosphorus is discovered, we will collect discrete samples

Data Quality Objectives

- Data Quality Objectives (DQOs) are statements that;
  - ► define the quality, quantity and type of data required,
  - ► the manner in which data may be collected, and
  - ► the acceptance criteria for those data.

MEC DQOs

- Problem statement: Determine the nature and extent of MEC within each MRS and AoPI.
- Refer to MEC initial DQO table included with read-ahead materials

MC DQOs

- Problem statement: Determine the nature and extent of MC within each MRS and AoPI.
- All plans and requirements for MC will be addressed in the UFP-QAPP
- UFP-QAPP should specify data types, quantities, acceptable decision errors, and how data will be used.

MC DQOs

- Samples will be analyzed for
  - ►Explosives, incl. PETN & NG
    - IS samples via EPA Method 8330B
    - Discrete samples via EPA Method 8330A
  - ►Select metals (Cu, Sb, Pb, and Zn)
    - IS/discrete samples via EPA Method 6010B
  - ►White phosphorous (if evidence exists)
    - Discrete samples via EPA Method 7580

MC DQOs

- QA/QC samples will be collected as follows;
  - ►QC duplicates – 1:10 (minimum per MRS),
  - ►QA splits – 1:10 (minimum per MRS),
  - ►MS/MSD – 1:20 (minimum per MRS)
  - ►Equipment rinsate – 1 per day per matrix
  - ►Temperature blanks – 1 per cooler

MC Action/Quantitation Limits

- Project action limits will be based on the most stringent of either EPA Regional Screening Levels – To Be Determined
- Project Quantitation Limits will be approximately 10% of the Action Limits
- Achievable Laboratory Limits (including detection and reporting limits) vary; most recently determined values will be included with the work plans.

Reference Limits - Explosives

Matrix: Soil

Analytical Group: Explosives (EPA Method 8330B)

Concentration Level: Low

Analyte	CAS Number	Project Action Limit (mg/kg)	Project Quantitation Limit (mg/kg)	Analytical Method (mg/kg)		Achievable Laboratory Limits (mg/kg)		
				Detection Limits	Quantitation Limits	Detection Limits	Limits of Detection	Reporting Limits
2,4,6-Trinitrotoluene	118-96-7			Not Provided	0.25	0.040	0.05	0.1
2,4-Dinitrotoluene	121-14-2			Not Provided	0.25	0.040	0.05	0.1
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4			Not Provided	1.0	0.056	0.075	0.1
4-Amino-2,6-dinitrotoluene	19406-51-0			Not Provided	Not Provided	0.040	0.05	0.1
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine ()	2691-41-0			Not Provided	2.2	0.041	0.05	0.1
2-Amino-4,6-dinitrotoluene	35572-78-2			Not Provided	Not Provided	0.048	0.05	0.1
Methyl-2,4,6-trinitrophenylnitramine (Tertyl)	479-45-8			Not Provided	0.65	0.045	0.05	0.1
2,6-Dinitrotoluene	606-20-2			Not Provided	0.26	0.063	0.075	0.1
2-Nitrotoluene	88-72-2			Not Provided	0.25	0.041	0.05	0.1
Nitrobenzene	98-95-3			Not Provided	0.26	0.040	0.05	0.1
3-Nitrotoluene	99-08-1			Not Provided	0.25	0.040	0.05	0.1
1,3,5-Trinitrobenzene	99-35-4			Not Provided	0.25	0.040	0.05	0.1
1,3-Dinitrobenzene	99-65-0			Not Provided	0.25	0.040	0.05	0.1
4-Nitrotoluene	99-99-0			Not Provided	0.25	0.040	0.05	0.1
Nitroglycerin	55-63-0			Not Provided	Not Provided	0.250	0.5	1
Pentaerythritol tetranitrate (PETN)	78-11-5			Not Provided	Not Provided	0.440	0.5	1

Reference Limits - Metals

Matrix: Soil

Analytical Group: Metals (EPA Methods 6020A/7471A)

Concentration Level: Low

Analyte	CAS Number	Project Action Limit (mg/kg)	Project Quantitation Limit (mg/kg)	Analytical Method (ppm)		Achievable Laboratory Limits (mg/kg)		
				Detection Limits	Quantitation Limits	Detection Limits	Limits of Detection	Reporting Limits
Copper	7440-50-8			0.0036	Not Provided	0.036	1	2
Lead	7439-92-1			0.028	Not Provided	0.008	0.125	0.250
Zinc	7440-66-6			0.0012	Not Provided	0.466	1.5	2
Antimony	7440-36-0			0.021	Not Provided	0.022	0.250	0.250

Data Collection

Hand-held analog all metals detector

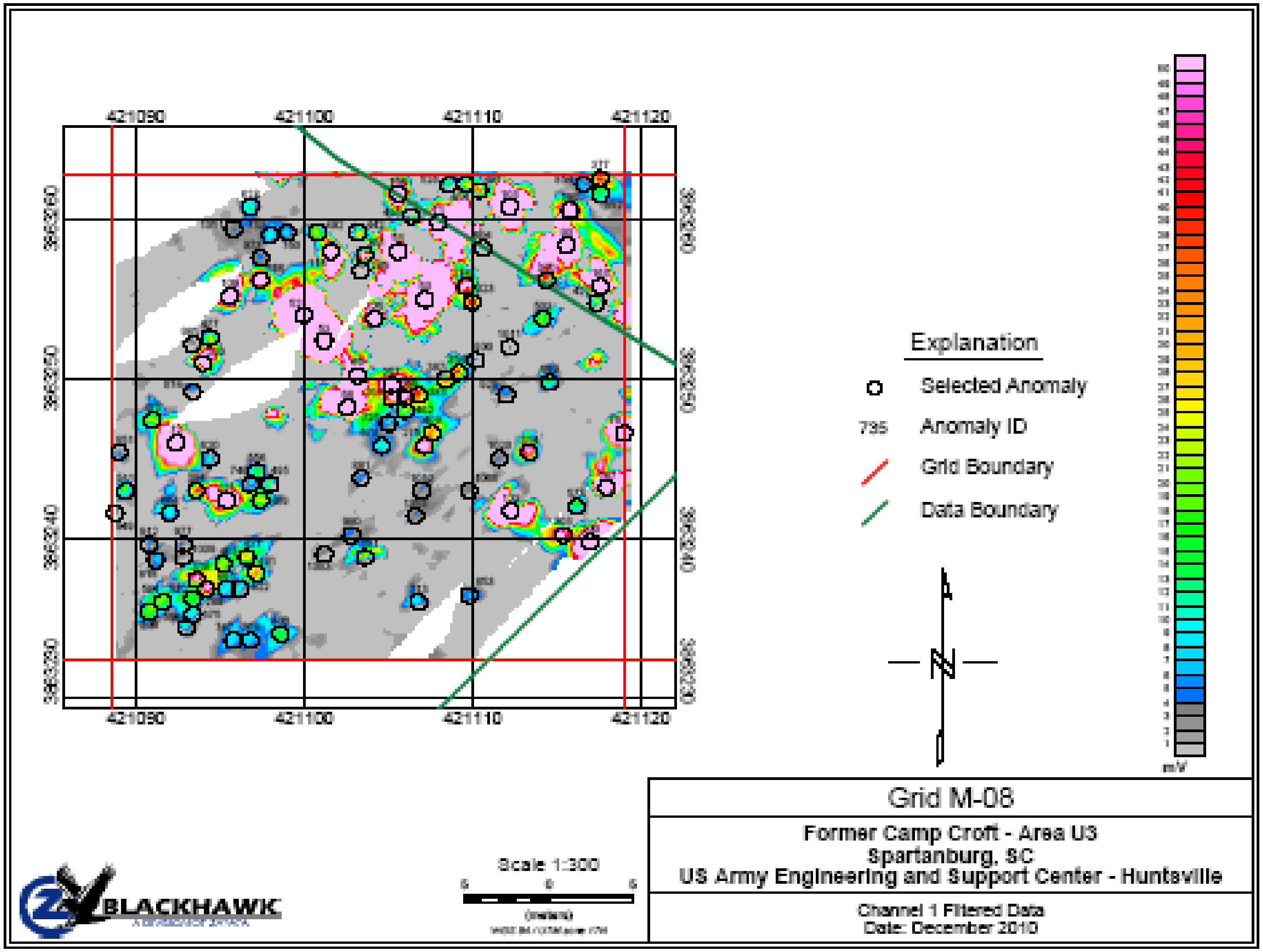
- Produces an audible signal to indicate subsurface metallic items

Data Collection

Digital Geophysical Mapping

- Digital data are recorded and analyzed to identify subsurface items most likely to be MEC

Data Collection

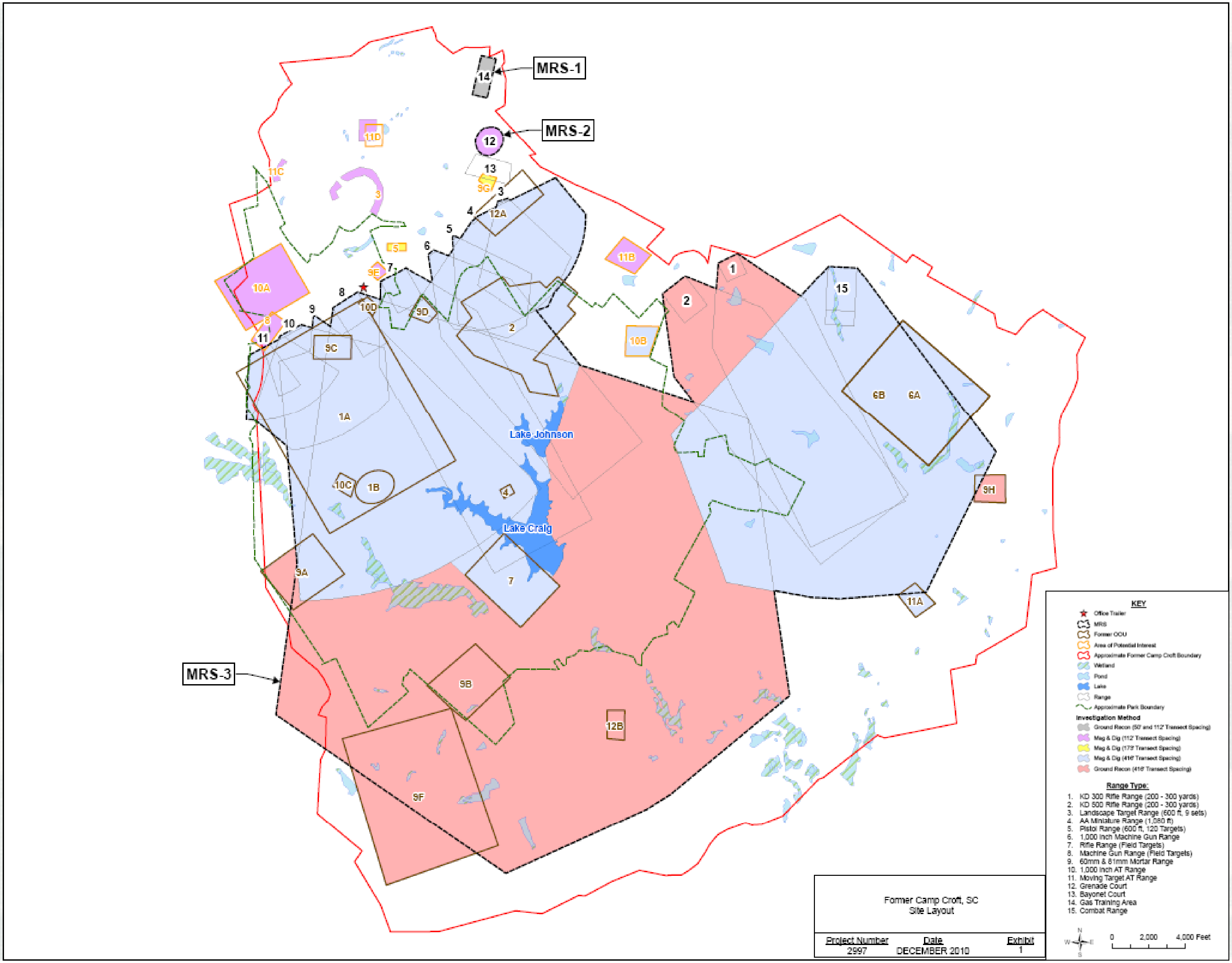


Data Collection

Anomalies selected for investigation/removal

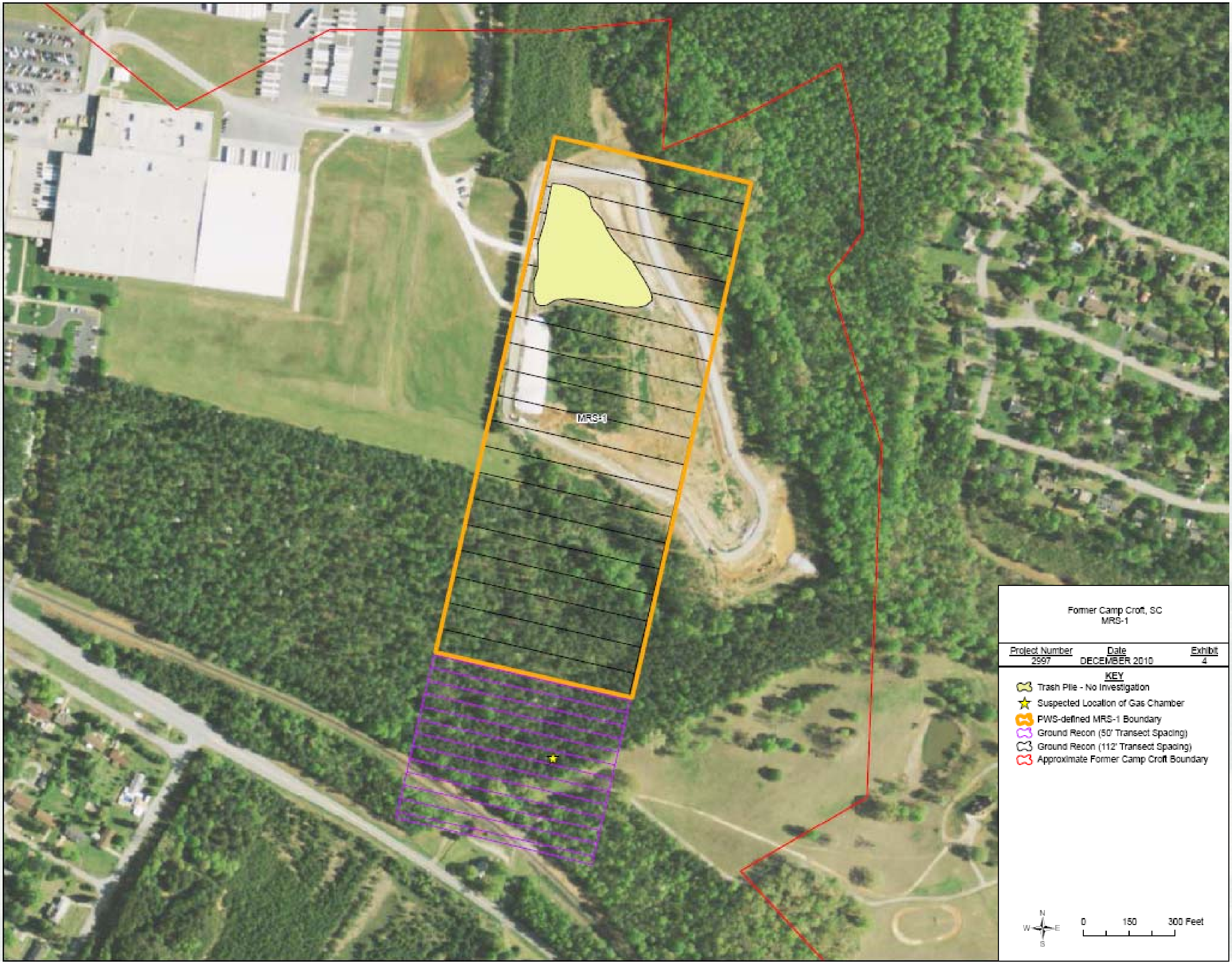
MC Sampling

- Collection of soil samples to determine presence of munitions constituents (explosives, and select metals)


MRS-1
MRS-2
MRS-3
14
12
13
9G
3
4
12A
5
6
11B
11C
11D
5
9E
7
8
10A
9
8
10
11
10D
9D
2
9C
1
2
15
10B
1A
6B
6A
Lake Johnson
10C
1B
4
9H
Lake Craig
9A
7
11A
9B
12B
9F
KEY
Office Trailer
MRS
Former OOU
Area of Potential Interest
Approximate Former Camp Croft Boundary
Wetland
Pond
Lake
Range
Approximate Park Boundary
Investigation Method
Ground Recon (50' and 112' Transect Spacing)
Mag & Dig (112' Transect Spacing)
Mag & Dig (173' Transect Spacing)
Mag & Dig (416' Transect Spacing)
Ground Recon (416' Transect Spacing)
Range Type:
1. KD 300 Rifle Range (200 - 300 yards)
2. KD 500 Rifle Range (200 - 300 yards)
3. Landscape Target Range (600 ft, 9 sets)
4. AA Miniature Range (1,080 ft)
5. Pistol Range (600 ft, 120 Targets)
6. 1,000 Inch Machine Gun Range
7. Rifle Range (Field Targets)
8. Machine Gun Range (Field Targets)
9. 60mm & 81mm Mortar Range
10. 1,000 Inch AT Range
11. Moving Target AT Range
12. Grenade Court
13. Bayonet Court
14. Gas Training Area
15. Combat Range
N
W
E
S
0
2,000
4,000 Feet
Former Camp Croft, SC
Site Layout
Project Number
2997
Date
DECEMBER 2010
Exhibit
1

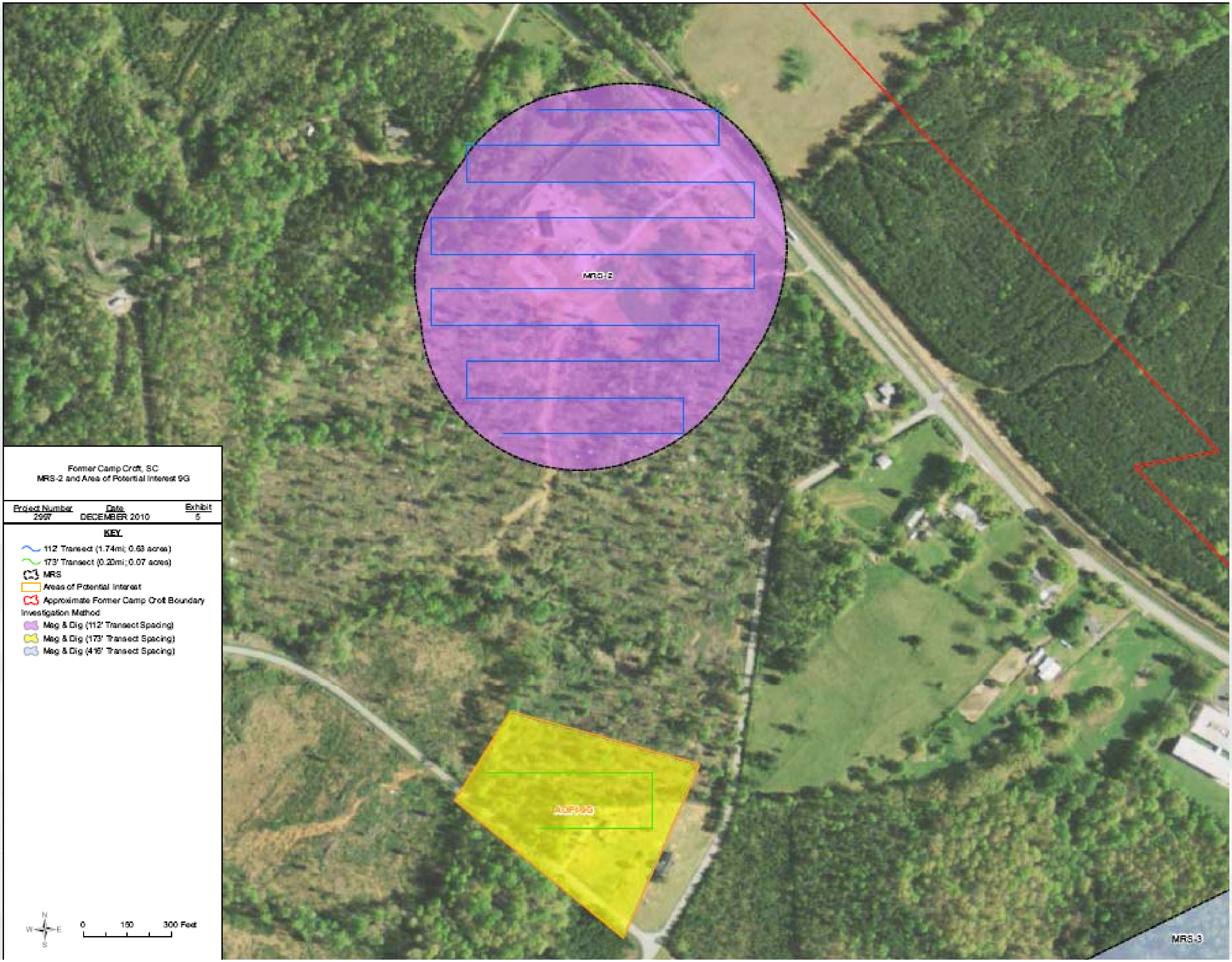
MRS 1

- Gas chamber #1 is located south of the southern boundary of MRS1.
- Perform AIR along transects to identify areas of potential munitions contamination.
  - 112 ft spacing within the PWS-defined MRS boundary (based on grenades)
  - 50 ft spacing to south of PWS-defined MRS boundary
- Develop anomaly density maps and document MD, CD and MEC.
- Use EM61 in 50'x50' grids at locations (TBD) to locate disposal pits and/or consolidated disposal area. Within grids, intrusively investigate 100% discrete anomalies. If a large indistinguishable anomaly is present, i.e. a disposal pit, a test trench will be excavated.
- MC sampling – None.
  - Per the ASR Supplement, it is unlikely that CS is present after 50 years.
  - This is not a compound routinely analyzed by certified laboratories, and is currently not included in the ADR software database.
  - Smoke canisters are not expected to be comprised of metals of concern.


MRS-1
Former Camp Croft, SC
MRS-1
Project Number
2997
Date
DECEMBER 2010
Exhibit
4
KEY
Trash Pile - No Investigation
Suspected Location of Gas Chamber
PWS-defined MRS-1 Boundary
Ground Recon (50' Transect Spacing)
Ground Recon (112' Transect Spacing)
Approximate Former Camp Croft Boundary
N
W
E
S
0
150
300 Feet

MRS 2 and AoPI 9G

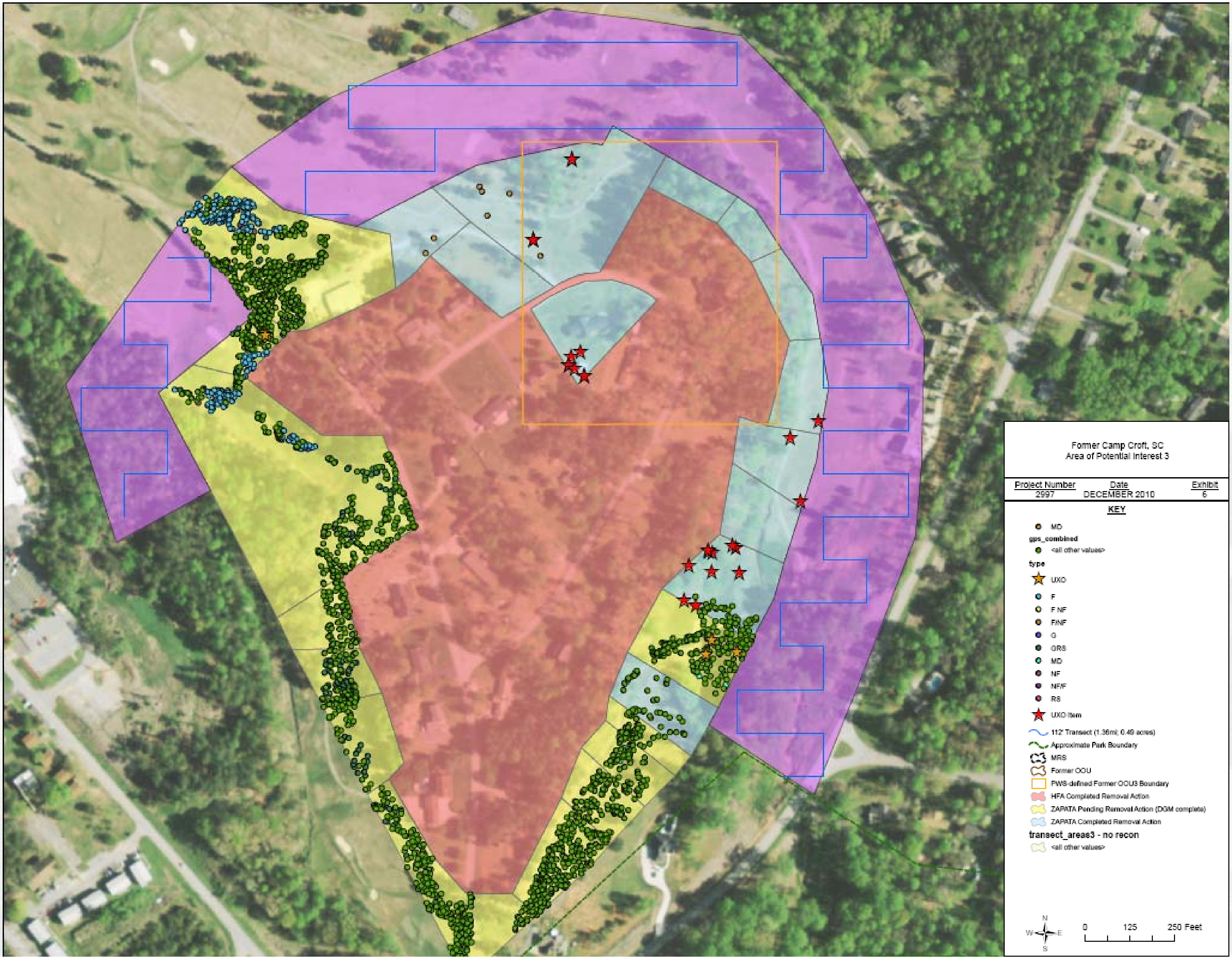
- MRS 2
  - Perform mag-and-dig along transects spaced 112 ft apart to identify areas of potential munitions contamination
  - Develop anomaly density maps and document MD, CD, and MEC
  - Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
  - Within grids, intrusively investigate 100% discrete anomalies
  - MC Sampling – One sampling unit (SU) for explosives and select metals; and possibly discrete sampling for white phosphorous
- AoPI 9G
  - Perform mag-and-dig along transects spaced 173 ft apart to identify areas of potential munitions contamination
  - Develop anomaly density maps and document MD, CD, and MEC
  - Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
  - Within grids, intrusively investigate 100% discrete anomalies
  - MC Sampling – One sampling unit (SU) for explosives and select metals



MRS-2
AOPI-9G
MRS-3
Former Camp Croft, SC
MRS-2 and Area of Potential Interest 9G
Project Number
2997
Date
DECEMBER 2010
Exhibit
5
KEY
112' Transect (1.74mi; 0.63 acres)
173' Transect (0.20mi; 0.07 acres)
MRS
Areas of Potential Interest
Approximate Former Camp Croft Boundary
Investigation Method
Mag & Dig (112' Transect Spacing)
Mag & Dig (173' Transect Spacing)
Mag & Dig (416' Transect Spacing)
N
W
E
S
0
150
300 Feet

AoPI 3

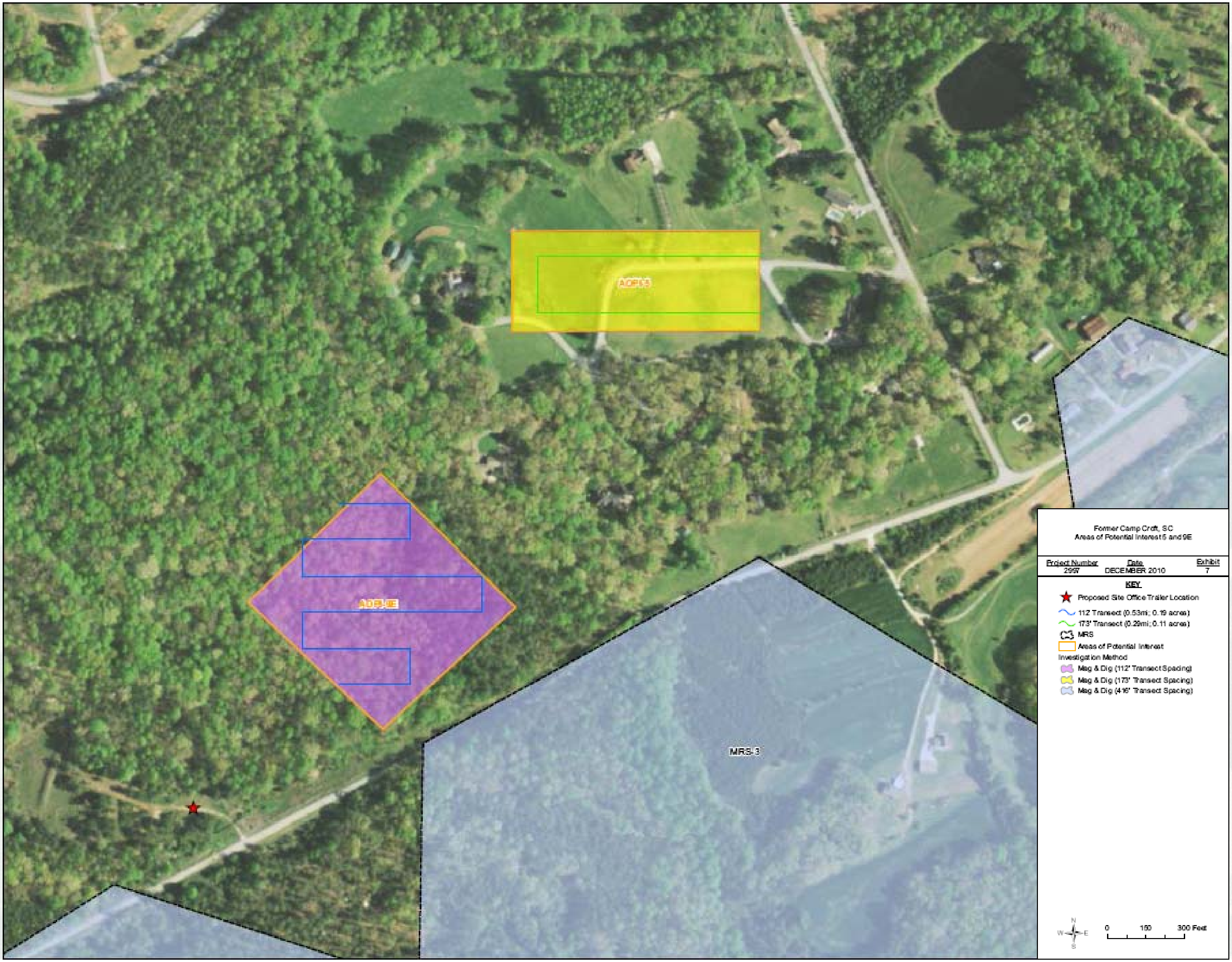
- Areas that have undergone previous MEC removals will be excluded
- Extent of MEC has not been defined
- Perform operations along transects spaced 112 ft apart to identify areas of potential munitions contamination
  - During the kick-off meeting, the method of investigation was not agreed upon; potential ideas include mag-and-dig, DGM with EM61 and/or the Metal Mapper, or some combination of these.
- Develop anomaly density maps and document MD, CD, and MEC
- Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
- Within grids, intrusively investigate 100% discrete anomalies
- MC Sampling – One sampling unit (SU) for explosives and select metals; and possibly discrete sampling for white phosphorous



Former Camp Croft, SC
Area of Potential Interest 3
Project Number
2997
Date
DECEMBER 2010
Exhibit
6
KEY
MD
gps_combined
<all other values>
type
UXO
F
F NF
F/NF
G
GRS
MD
NF
NF/F
RS
UXO Item
112' Transect (1.36mi; 0.49 acres)
Approximate Park Boundary
MRS
Former OOU
PWS-defined Former OOU3 Boundary
HFA Completed Removal Action
ZAPATA Pending Removal Action (DGM complete)
ZAPATA Completed Removal Action
transect_areas3 - no recon
<all other values>
N
W
E
S
0
125
250 Feet

AoPI 5 and 9E

- AoPI 5
  - Perform mag-and-dig along transects spaced 173 ft apart to identify areas of potential munitions contamination
  - Develop anomaly density maps and document MD, CD, and MEC
  - Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
  - Within grids, intrusively investigate 100% discrete anomalies
  - MC Sampling – One sampling unit (SU) for explosives and select metals
- AoPI 9E
  - Perform mag-and-dig along transects spaced 112 ft apart to identify areas of potential munitions contamination
  - Develop anomaly density maps and document MD, CD, and MEC
  - Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
  - Within grids, intrusively investigate 100% discrete anomalies
  - MC Sampling – One sampling unit (SU) for explosives and select metals


AOPI-5
AOPI-9E
MRS-3
Former Camp Croft, SC
Areas of Potential Interest 5 and 9E
Project Number
2997
Date
DECEMBER 2010
Exhibit
7
KEY
Proposed Site Office Trailer Location
112 Transect (0.53mi; 0.19 acres)
173' Transect (0.29mi; 0.11 acres)
MRS
Areas of Potential Interest
Investigation Method
Mag & Dig (112' Transect Spacing)
Mag & Dig (173' Transect Spacing)
Mag & Dig (416' Transect Spacing)
N
W
E
S
0
150
300 Feet

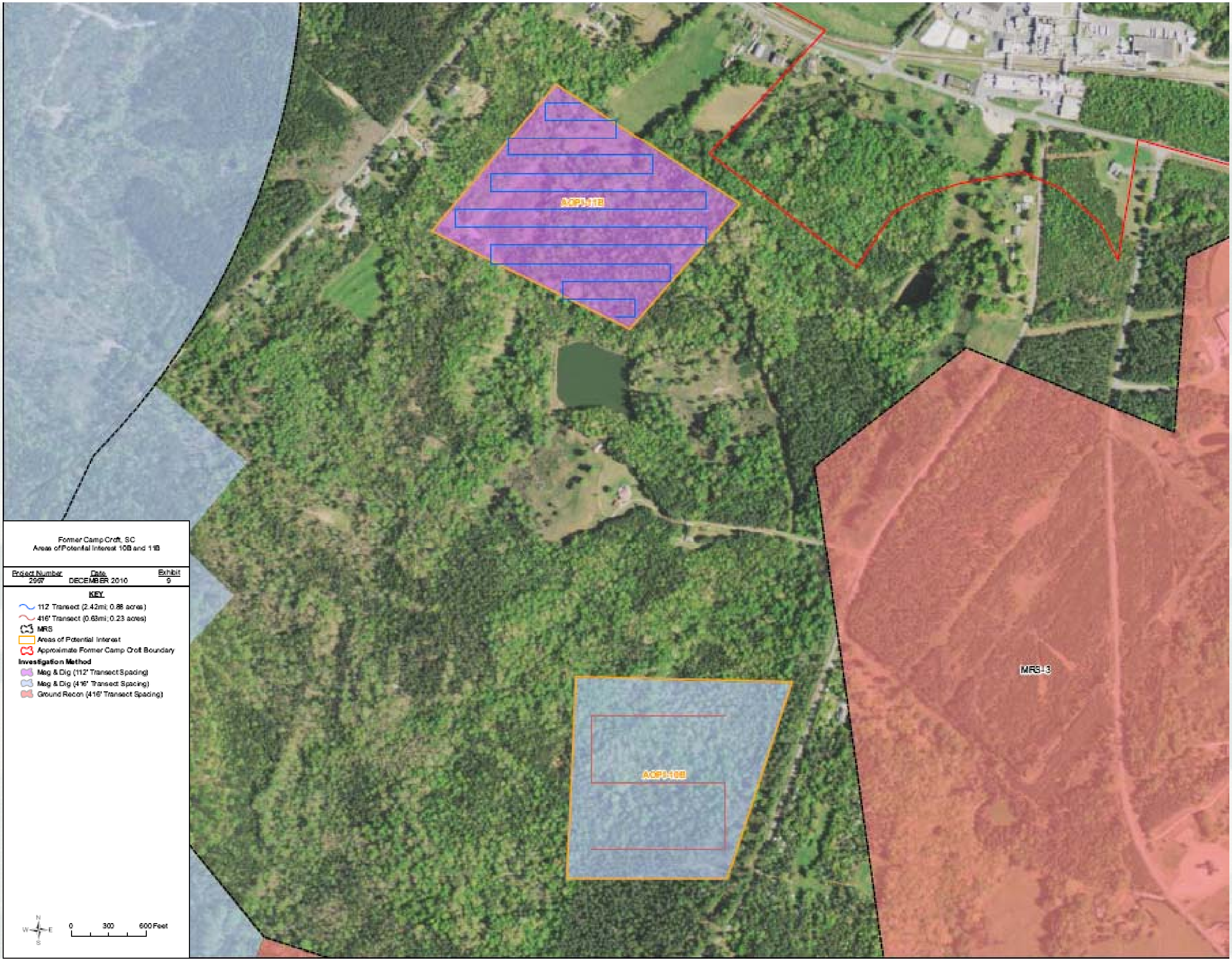
AoPI 8 and 10A

- AoPI 8
  - Perform mag-and-dig along transects spaced 112 ft apart to identify areas of potential munitions contamination
  - Develop anomaly density maps and document MD, CD, and MEC
  - Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
  - Within grids, intrusively investigate 100% discrete anomalies
  - MC Sampling – One sampling unit (SU) for explosives and select metals
- AoPI 10A
  - Perform mag-and-dig along transects spaced 112 ft apart to identify areas of potential munitions contamination
  - Develop anomaly density maps and document MD, CD, and MEC
  - Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
  - Within grids, intrusively investigate 100% discrete anomalies
  - MC Sampling – One sampling unit (SU) for explosives and select metals


AOPI-10A
AOPI-8
MRS-3
Former Camp Croft, SC
Areas of Potential Interest 8 and 10A
Project Number
2997
Date
DECEMBER 2010
Exhibit
8
KEY
112' Transect (2.16mi; 0.79 acres)
112' Transect (12.09mi; 4.40 acres)
MRS
Areas of Potential Interest
Approximate Former Camp Croft Boundary
Investigation Method
Mag & Dig (112' Transect Spacing)
Mag & Dig (416' Transect Spacing)
N
W
E
S
0
250
500 Feet

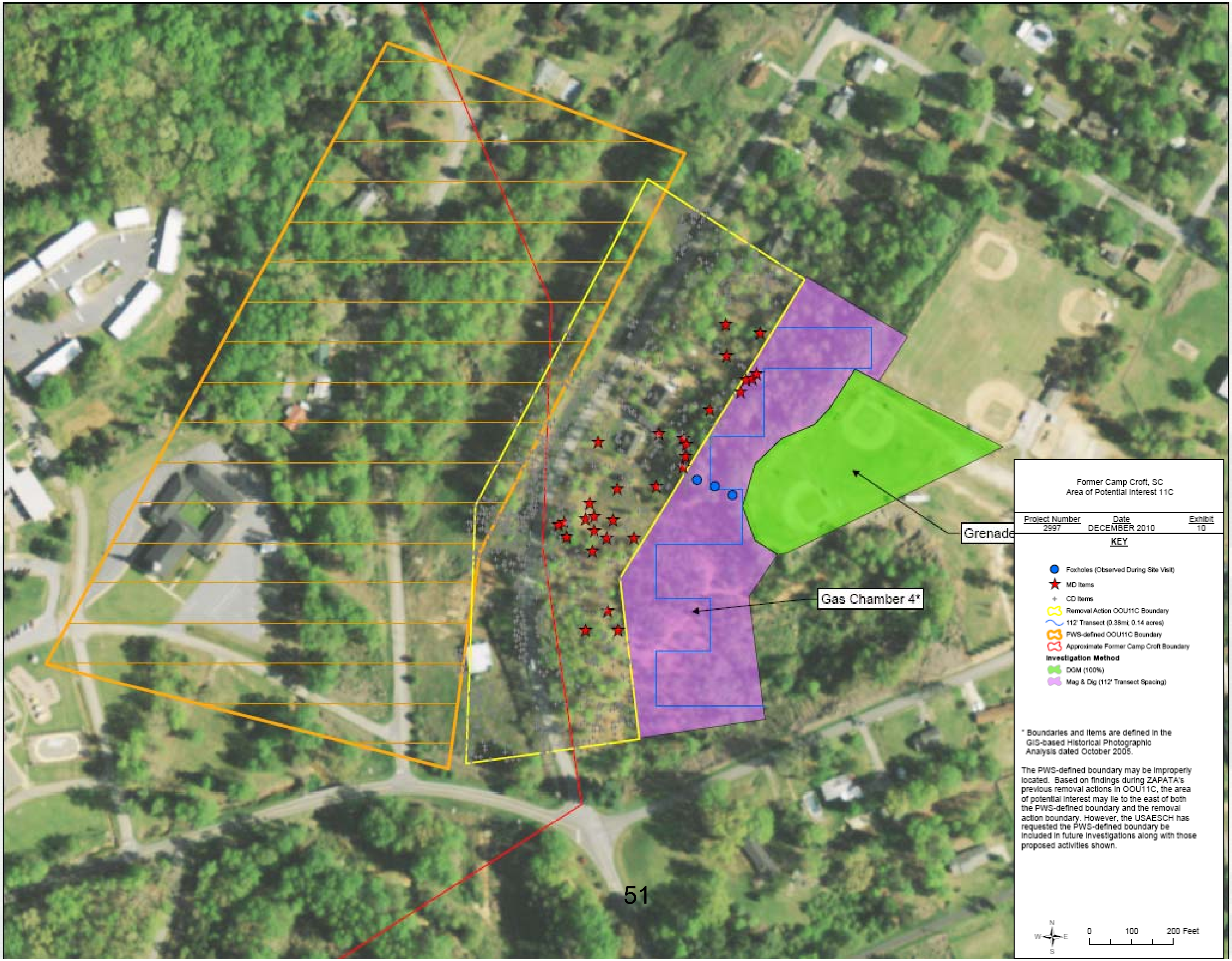
AoPI 10B and 11B

- AoPI 10B
  - Perform mag-and-dig along transects spaced 416 ft apart to identify areas of potential munitions contamination
  - Develop anomaly density maps and document MD, CD, and MEC
  - Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
  - Within grids, intrusively investigate 100% discrete anomalies
  - MC Sampling – One sampling unit (SU) for explosives and select metals
- AoPI 11B
  - Perform mag-and-dig along transects spaced 112 ft apart to identify areas of potential munitions contamination
  - Develop anomaly density maps and document MD, CD, and MEC
  - Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
  - Within grids, intrusively investigate 100% discrete anomalies
  - MC Sampling – One sampling unit (SU) for explosives and select metals


AOPI-11B
AOPI-10B
MRS-3
Former Camp Croft, SC
Areas of Potential Interest 10B and 11B
Project Number
2967
Date
DECEMBER 2010
Exhibit
9
KEY
112' Transect (2.42mi; 0.88 acres)
416' Transect (0.63mi; 0.23 acres)
MRS
Areas of Potential Interest
Approximate Former Camp Croft Boundary
Investigation Method
Mag & Dig (112' Transect Spacing)
Mag & Dig (416' Transect Spacing)
Ground Recon (416' Transect Spacing)
N
W
E
S
0
300
600 Feet

AoPI 11C

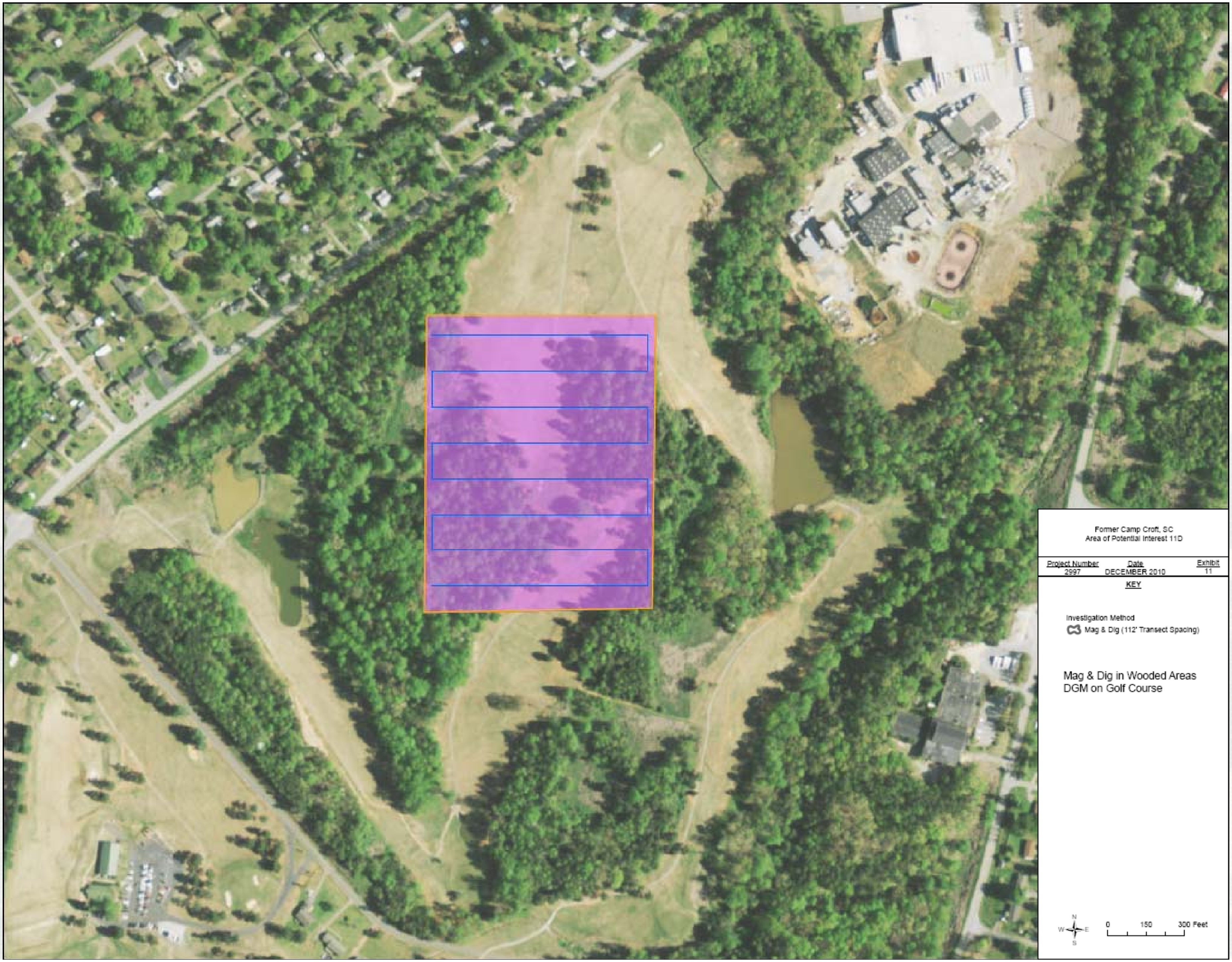
- Areas that have undergone previous MEC removals will be excluded
- Based on findings during ZAPATA's previous removal actions in OOU11C, we recommend conducting investigations to the east of both the PWS-defined boundary and the removal action boundary
- Perform mag-and-dig along transects spaced 112 ft apart to identify areas of potential munitions contamination (PWS-defined area & east of removal action boundary)
- Develop anomaly density maps and document MD, CD, and MEC
- Perform 100% DGM of two ball fields
- Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
- Within grids, intrusively investigate 100% discrete anomalies
- MC Sampling – One sampling unit (SU) for explosives and select metals



Grenade
Gas Chamber 4*
Former Camp Croft, SC
Area of Potential Interest 11C
Project Number 2997
Date DECEMBER 2010
Exhibit 10
KEY
Foxholes (Observed During Site Visit)
MD Items
CD Items
Removal Action OOU11C Boundary
112' Transect (0.38mi; 0.14 acres)
PWS-defined OOU11C Boundary
Approximate Former Camp Croft Boundary
Investigation Method
DGM (100%)
Mag & Dig (112' Transect Spacing)
* Boundaries and Items are defined in the GIS-based Historical Photographic Analysis dated October 2005.
The PWS-defined boundary may be improperly located. Based on findings during ZAPATA's previous removal actions in OOU11C, the area of potential interest may lie to the east of both the PWS-defined boundary and the removal action boundary. However, the USAESCH has requested the PWS-defined boundary be included in future investigations along with those proposed activities shown.
N
W
E
S
0
100
200 Feet

AoPI 11D

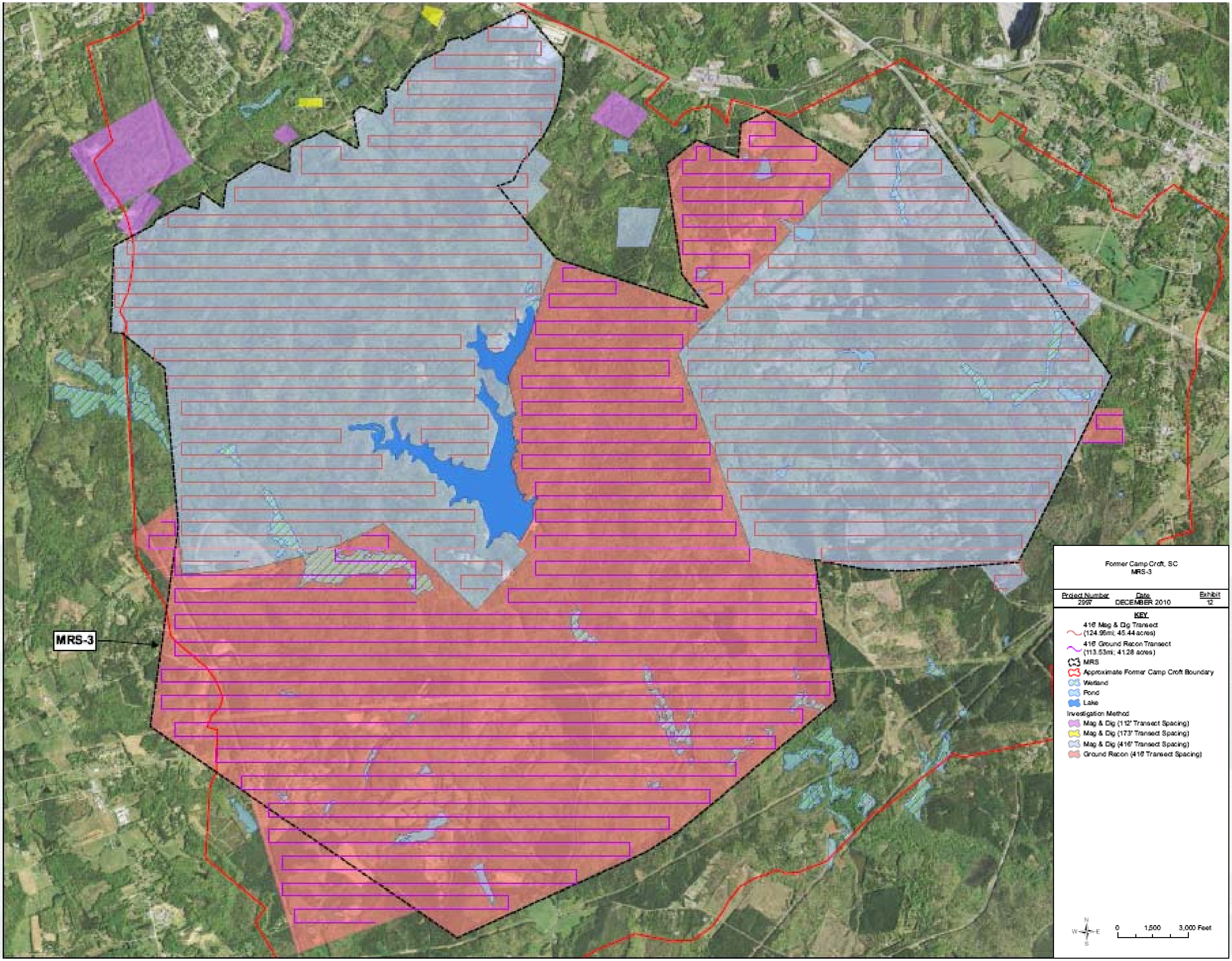
- Perform operations along transects spaced 112 ft apart to identify areas of potential munitions contamination
  - Wooded areas – mag-and-dig along transects
  - Golf course – 100% DGM along transects
  - Overlap these two methods
- Develop anomaly density maps and document MD, CD, and MEC
- Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
- Within grids, intrusively investigate 100% discrete anomalies
- MC Sampling – One sampling unit (SU) for explosives and select metals



Former Camp Croft, SC
Area of Potential Interest 11D
Project Number
2997
Date
DECEMBER 2010
Exhibit
11
KEY
Investigation Method
Mag & Dig (112' Transect Spacing)
Mag & Dig in Wooded Areas
DGM on Golf Course
N
W
E
S
0
150
300 Feet

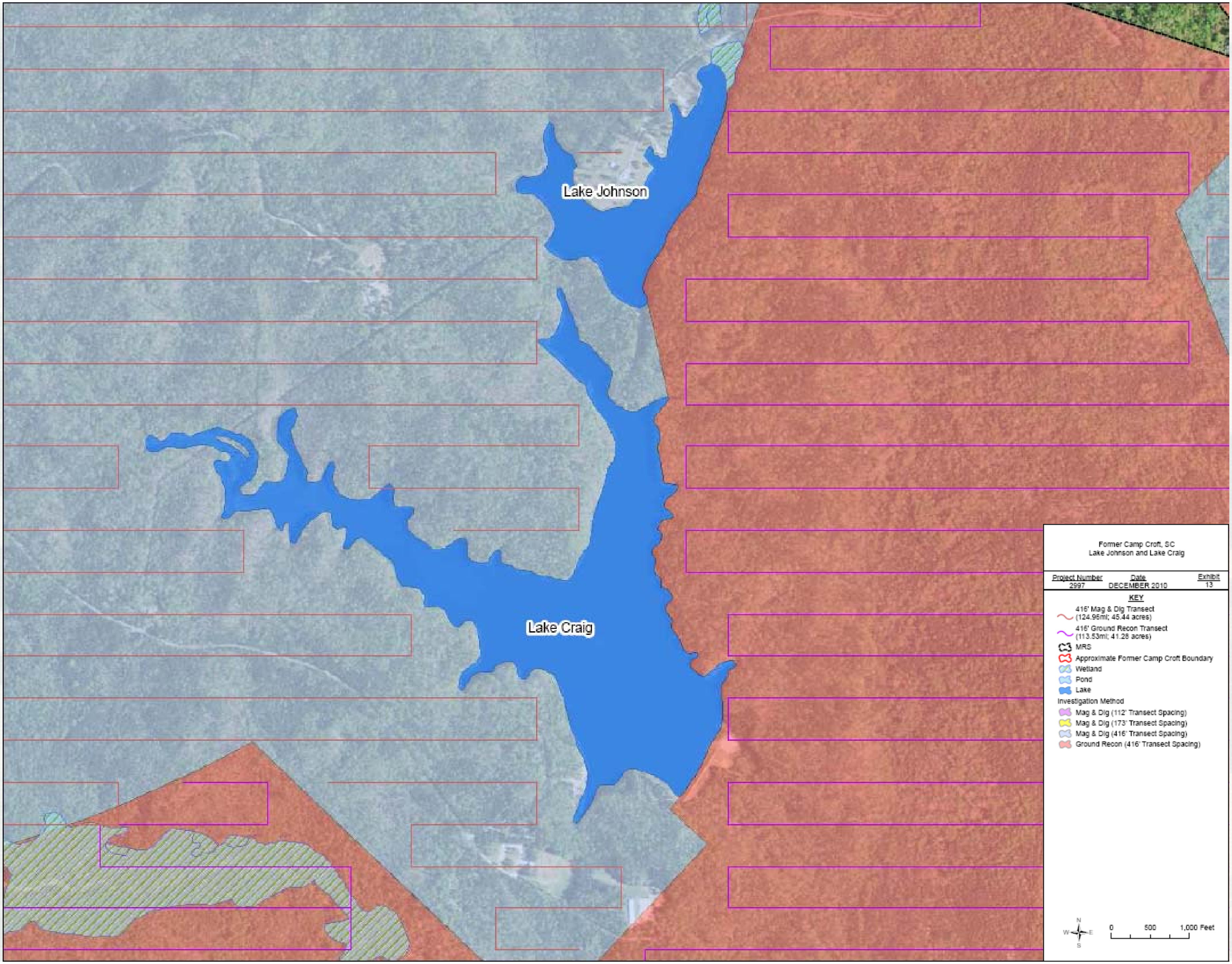
MRS 3

- Sub-divide MRS into two areas
- MC Sampling – 10 sampling units (SU) across both sub-areas for explosives and select metals
- Sub-area 1
  - Perform mag-and-dig along transects spaced 416 ft apart to identify areas of potential munitions contamination
  - Develop anomaly density maps and document MD, CD, and MEC
  - Place grids (50 ft by 50 ft equivalent) in areas of high, medium, and low density
  - Within grids, intrusively investigate 100% discrete anomalies
- Sub-area 2
  - Perform AIR along transects spaced 416 ft apart to identify areas of potential munitions contamination
  - Develop anomaly density maps and document MD, CD, and MEC


MRS-3
Former Camp Croft, SC
MRS-3
Project Number
2997
Date
DECEMBER 2010
Exhibit
12
KEY
416' Mag & Dig Transect (124.96mi; 45.44 acres)
416' Ground Recon Transect (113.53mi; 41.28 acres)
MRS
Approximate Former Camp Croft Boundary
Wetland
Pond
Lake
Investigation Method
Mag & Dig (112' Transect Spacing)
Mag & Dig (173' Transect Spacing)
Mag & Dig (416' Transect Spacing)
Ground Recon (416' Transect Spacing)
N
S
E
W
0
1,500
3,000 Feet

Lakes Craig and Johnson

- Based on site restrictions, no data will be collected in the Lakes
- Transects (both mag-and-dig and AIR) will be conducted up to and along the shoreline of the lakes
- Develop anomaly density maps and document MD, CD, and MEC
- No MC samples will be collected


Lake Johnson
Lake Craig
Former Camp Croft, SC
Lake Johnson and Lake Craig
Project Number
2997
Date
DECEMBER 2010
Exhibit
13
KEY
416' Mag & Dig Transect
(124.96mi; 45.44 acres)
416' Ground Recon Transect
(113.53mi; 41.28 acres)
MRS
Approximate Former Camp Croft Boundary
Wetland
Pond
Lake
Investigation Method
Mag & Dig (112' Transect Spacing)
Mag & Dig (173' Transect Spacing)
Mag & Dig (416' Transect Spacing)
Ground Recon (416' Transect Spacing)
N
W
E
S
0
500
1,000 Feet

Safety

UXO Safety Procedures

The Three R's

Recognize - Military munitions/ordnance becomes a danger only when it is disturbed. When you see an item, STOP.

Retreat - Do not move closer to get a better look! Never attempt to remove anything near it. Do not touch, move, or disturb. MOVE AWAY.

Report - Immediately report any suspected military munitions. Call 911

Technical Project Planning Memorandum – No. 1

Subject: FUDS Military Munitions Response Program Documentation of Technical Project Planning Project Team Meeting for a Remedial Investigation/Feasibility Study (RI/FS)

Site: Former Camp Croft, Spartanburg, SC

Contract: Contract Number W912DY-10-D-0028, Task Order 0005

The Technical Project Planning (TPP) meeting was conducted on 16 March 2011 at the Spartanburg Marriott at Renaissance Park in Spartanburg, South Carolina from 8:30am to 3:30pm. The Project Delivery Team (PDT) is composed of the participants listed below; all were present (sign-in sheet attached). Meeting participants introduced themselves.

1. Shawn Boone	Project Manager, US Army Corps of Engineers (USACE), Charleston District
2. Spencer O'Neal	Project Manager, US Army Engineering and Support Center, Huntsville (USAESCH)
3. Teresa Carpenter	Technical Lead, USAESCH
4. Deb Edwards	Geophysicist, USAESCH
5. Susan Byrd	South Carolina Department of Health and Environmental Control (DHEC)
6. John Moon	South Carolina Department of Parks, Recreation & Tourism (DPRT), Croft State Natural Area
7. Jason Shiflet	Project Manager, Zapata Incorporated (ZAPATA)
8. Suzy McKinney	Quality Control Manager, ZAPATA

Meeting Discussion Summary:

The purpose of the meeting was to establish the PDT team and to begin the TPP process for the RI/FS at the former Camp Croft. Mr. Shiflet opened the meeting with a brief presentation to explain the RI/FS process and where this task is within that process. The project includes Munitions Response Sites (MRS) 1, 2, and 3, Areas of Potential Interest (AoPI) 3, 5, 8, 9E, 9G, 10A, 10B, 11B, 11C, 11D, and Lakes Craig and Johnson. The presentation and general discussions about the Former Camp Croft RI/FS task order led to numerous questions (for clarification) from Mr. Moon. These general discussions continued until just before noon, when Mr. Moon had to leave. After a short break, the PDT continued project specific discussions until the meeting adjourned at 3:30pm. The outcome of these discussions resulted in the refinement of the preliminary conceptual site model, the conceptual site exposure model, and preliminary MEC DQOs, and established the framework for the Draft Work Plans. The bullet points listed below are highlights from the day's discussions.

1) The Croft State Natural Area allows three two-day bow hunts for deer between September and November, each year.

2) The Croft State Natural Area hosts Horse Shows on the third Saturday of each month between February and November, each year.

3) Shawn has had recent discussions with the public regarding the potential existence of various munitions items in and around the Former Camp Croft. For example, Jimmy Tobias noted that "howitzer like munitions" were found in and along the creek (*possibly Fairforest Creek*) during the bridge construction along SC Highway 150. Mr. Tobias also noted that he's seen lots of military munitions east of AoPI 9G and north of AoPI 12A. The PDT agreed that it would be prudent to solicit site-specific information from local, knowledgeable persons.

4) The PDT agreed that Spartanburg County Sheriff's Office munitions responses should be incorporated into the project Geographic Information System (GIS).

5) The PDT agreed that Lieutenant Dyas of the Spartanburg County Sheriff's Office should be invited to the next TPP meeting.

6) Previously cleared areas (i.e., areas where removal actions have been completed) should be incorporated into the project GIS.

7) Soil sample analytical results for munitions constituents (MC), namely explosives and metals (Cu, Pb, Sb, and Zn), will first be compared to the EPA Regional Screening Level (RSL) Summary Table (dated November 2010). These can be found at http://www.epa.gov/region9/superfund/prg/. Once any contamination is delineated to the RSL table, EPA Region IV Ecological Screening Values will be used for ecological risk assessment purposes. These can be found at http://www.epa.gov/region4/waste/ots/epatab4.pdf.

8) If a risk assessment is required, the munitions Center of Expertise (CX) may require that surface and subsurface samples be included in the risk assessment. The USAESCH agreed to discuss the issue with the CX. If both surface and subsurface samples are required for the risk assessment, then those similar depth intervals would likely be required for background samples.

9) The PDT agreed that all soil samples will be discrete. Those samples will be collected from the ground surface to a depth of two inches. If burrowing animals are present, deeper samples may be required.

10) Background soil sampling will not be required unless there are analytical results that exceed the EPA RSLs. If background soil sampling is required, field teams must document the soil type during sampling so that sample results can be compared to similar soil types. DHEC recommended that ZAPATA should consider submitting a Freedom of Information Act (FOIA) request to local agencies requesting available background data sets.

11) The PDT discussed data collection needs on golf course property, particularly in the fairways and greens. It was agreed that the USACE should initiate a meeting with the golf course

owners as soon as possible to discuss investigation options. Potential options include using an EM61 or the MetalMapper system, followed by some amount of intrusive investigation.

12) AoPI 12A is partially within MRS 3. In MRS 3 (and within AoPI 12A), transect spacings should be set at 112 ft based on a MKII grenade.

13) Previous work conducted in AoPI 12B indicated the existence of a rifle grenade. Rather than compressing the transect spacing within AoPI 12B, the PDT requested that ZAPATA place a transect through AoPI 12B.

14) The PDT discussed the possibility of using ZAPATA's existing geophysical prove-out (from earlier site work). The USAESCH agreed to consider the possibility and will follow up with ZAPATA.

15) For mag-and-dig transects, the PDT was unable to define the anomaly density threshold that would be considered excessive and thus would trigger the need to sample only a statistically significant portion of the anomalies along the transect. Examples of 40 and 60 anomalies per 100 ft segment were provided as possible values. The USAESCH agreed to seek clarification and provide input.

16) The PDT discussed collecting MC samples in areas with high anomaly densities. Tentatively, those high density areas are defined as those areas where the anomaly density count is > the 97^{th} percentile of all anomaly densities.

17) The PDT agreed that pre-blow-in-place (BIP) samples would not be used in the risk assessment (if a risk assessment is required).

18) The question was raised whether there should be more coverage near the horse ring and park office, due to higher concentration of visitors/access. The USAESCH agreed to seek clarification and provide input.

19) The PDT discussed tighter transect line spacing in areas where grenades have been found; perhaps a DQO using tighter line spacing in the HFD (from the boundary of the grid where the grenade was found) and increase line spacing from point at which the last grenade fragment was found. The PDT ultimately decided against this approach from an implementability stand point. If evidence of grenades is prevalent, and the PDT feels that more data are required, the PDT may elect to place grid(s) in the area, and/or add transects in between existing transects for better characterization.

20) The PDT discussed AoPI 3 and the need (or lack thereof) for additional data. Extensive activities have been conducted in and around AoPI 3. Based on the amount of data available from those previous activities, the question of whether or not the nature of contamination at AoPI 3 has been defined was posed. Furthermore, since the PDT has defined the lateral extent of MEC in the data quality objectives (DQO) table as the distance equal to the transect spacing determined for the respective area (i.e., 112 ft for AoPI 3) beyond the last MEC discovered, it is possible to place a 112 ft buffer around AoPI 3 and conclude that both the nature and extent of the contamination has been defined. The USAESCH agreed to discuss the matter with the CX and provide comment to the PDT.

21) The PDT agreed that grids placed in mag-and-dig areas will be digitally geophysically mapped (DGM). From those DGM grids, all MEC-like anomalies will be investigated. MEC-like anomalies will be based on results determined during the geophysical proveout; those selections will be discussed with the PDT prior to intrusive investigation. In analog instrument-assisted reconnaissance (AIR) areas, grids will be evaluated by mag-and-dig methods. In those grid, all anomalies will be intrusively investigated since the nature and extent of munitions along AIR transects will be unknown.

22) The PDT agreed that investigations at AoPI 11C should be conducted east of those previously conducted along Cedar Springs Drive. Investigation within the area identified as AoPI 11C in the Performance Work Statement (PWS) is not required.

23) DHEC requested that the Uniform Federal Policy for Quality Assurance Project Plan (UFP-QAPP) include a) rationale for how selected group of metals were determined and b) how and when the need for background samples will be determined.

24) The PDT requested that ZAPATA confirm Accutest and TestAmerica have certifications for South Carolina. ZAPATA has confirmed, in writing, that both labs hold South Carolina certification.

25) The PDT discussed the preferred format of the Work Plans. ZAPATA made some suggestions to improve clarity and readability based on recent experiences with another RI/FS. The PDT agreed to review the proposed format (see attached).

Attachments:

Meeting Agenda
Sign-in Sheet
RI/FS Presentation
Conceptual Site Models
Conceptual Site Exposure Models
Munitions and Explosives of Concern Data Quality Objective Tables
EM 200-1-2 Worksheets
Work Plans outline
Project Figures
Project Schedule

Exhibit 2 – Preliminary Conceptual Site Model

MRS/Area of Potential Interest (AoPI)	Approximate Acres	Suspect Past DoD Activities based on the ASR, ASR Supplement, and GIS-based Historical Photographic Analysis	Potential MEC/MD	Previous Investigation / Clearance Actions	Adjusted RI acreage	Post-DoD / Current Land Use and Potential Receptors	RI Field Sampling * *Transect spacing is based on VSP, using 1.5x HFD from the HE item (90% confidence for that item or larger)
MRS 1 Gas Chambers	23.8	Training using CS smoke pots/grenades. Assume disposal of canisters in pits or tossed away from the gas chamber (gas chamber #1) in the same general area. Training trenches may also be associated with gas chambers. **NOTE:** Three other gas chambers are identified in historical photographic analysis. Gas chamber # 2 and gas chamber #3 are in the vicinity of the 10th and 3rd holes of the golf course, respectively, adjacent to AoPI 3 (previously referred to as OOU3). Gas chamber # 4 is due east of AoPI 11C (previously referred to as OOU 11C) near the ball fields.	CS smoke pots/grenades. No documented finds since site closure.	General location of gas chamber #3 has been geophysically mapped while investigating OOU3. Anomalies will be intrusively investigated in January 2011.	23.8	Private/commercial. Receptors: residents, landowners, employees. Site is publicly accessible other than the commercial property, which has restricted access.	Upon review of the historical photographic analysis, gas chamber #1 is located south of the southern boundary of MRS1. As such, the field investigation will be focused south of the delineated MRS1. Field investigation will be expanded to include general vicinity of gas chambers #2 and 3 as part of the AoPI 3 investigation, and gas chamber #4 as part of the AoPI 11C investigation. Within the PWS-defined MRS boundary, perform a surface reconnaissance along transects spaced 112 ft apart based on grenades to identify areas of potential munitions contamination. Develop anomaly density maps and document MD, CD and MEC. To the south of the PWS-defined boundary, perform a surface reconnaissance along transects spaced 50 ft apart, to determine anomaly density. Use EM61 in 50'x50' grids to locate disposal pits and/or consolidated disposal area. Within grids, intrusively investigate all MEC-like anomalies. If a large indistinguishable anomaly is present, i.e. a disposal pit, a test trench will be excavated to characterize the anomalous area. ***MC sampling*** – None. Per the ASR Supplement, it is unlikely that CS is present after 50 years. In addition, this is not a compound routinely analyzed by certified laboratories, and is currently not included in the ADR software database. There is no need to sample for metals – smoke canisters are not expected to be comprised of metals of concern for risk analysis.
MRS 2 Grenade Court	24.9	Live and practice grenade training.	Live and practice grenades. No documented finds since site closures.	None.	24.9	Private property. Receptors: landowners, residents. Area is publicly accessible.	Mag and dig 100% of anomalies using a MineLab detector along transects spaced at 112' based on a grenade. Develop anomaly density maps and document MD, CD and MEC. The MineLab was selected for use in MRS 2 and MRS 3 based on the magnetic rocks and responsive soils throughout the project site. Place grids (50'x50' equivalent) in areas of high, medium and low-density areas. Grid acreage will be at least 10% of the total transect acreage. DGM grids using EM61. Intrusively investigate MEC-like anomalies. ***MC sampling*** – One discrete soil sample (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu). If evidence of white phosphorus is discovered, discrete soil samples will be collected for chemical analysis.
MRS 3 Operational Range Complex	12,102.4 (not including Lake Johnson and Lake Craig)	Artillery training and combat range using live and practice munitions. Documented and undocumented firing points. 15 ranges, as documented in the Supplemental ASR.	60mm mortars, 81mm mortars, 1,000" AT, rifle grenades. Items found since site closure include: 37mm, 57mm, 60mm, 81mm, 105mm, 2.36" rockets, grenades, rifle	EE/CA (1996 and 1998). MEC surface removals at OOU1B, OOU2, and OOU7 in 1997. MEC removal at	12,102.4	State park, private property. Receptors: recreational users (hikers, bikers, camping, horseback riding), residents,	Due to the nature of the previous clearances, the minimal amount of acreage that was cleared, and the difficulty in accurately relocating the exact grids/acreage that was cleared more than 10 years ago, these areas will be included in the investigation, as described below. These data will allow the PDT to evaluate the effectiveness of the past removal actions, for consideration in the RI and FS documents. MRS 3 will be divided into sub-areas based on past land use. *Sub-area 1* is inclusive of the range complex most likely to have MK II grenades, 37mm, and 60mm mortars or larger munitions, based

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			grenades, 155mm with burster tube. Specifically: _1A_ - 37mm and 57mm inert projectiles. _1B_ – 60mm and 81mm mortar parts. _2_ – 60mm and 81mm mortar parts, 4.2" mortar parts. _6A/6B_ – M43 81mm mortars, M49 60mm mortar, M84 105mm HC smoke round. _7_ – 60mm mortars, 81mm mortars, 2.36" rocket parts. _9F_ – 37mm APT with tracer (expended), grenade ring. _10C_ – MKII practice grenade scrap. _10D_ – Grenade frag, part of a white phosphorus grenade. _11A_ – Grenade top, 60mm mortar (expended). _12A_ – Grenade spoon, M9 HEAT rifle grenades practice rifle grenades, 2.36" rocket motors, frag, and scrap, MKII hand grenades and scrap. _12B_ – M9 rifle grenade.	OOU6A/6B in 2001. Less than 1% of the MRS has undergone MEC clearance, most of which was surface or shallow depth clearance as part of Time Critical Removal Actions.		landowners. Some timber harvesting on private property. Public access; some of the southern areas may be inaccessible due to limited road, dense vegetation.	on documented MEC finds. *Sub-area 2* represents all remaining portions where only sporadic and small quantities of munitions have been found. If MEC/MD is found up to the boundary of the MRS, including formerly identified OOUs, ZAPATA will coordinate with the Project Delivery Team to expand the investigation via instrument-assisted reconnaissance or mag and dig, to increase confidence that the boundary of MEC is defined. ***Sub-area 1*** - Mag and dig 100% anomalies using a MineLab detector at various transect spacings, those being 112 ft for MK II grenades, 242 ft for 37mm projectiles, and 416 ft for 60mm mortars. Develop anomaly density maps and document MD, CD and MEC. Conduct an instrument-assisted recon along transects in wetlands, documenting anomaly counts. There will be no intrusive investigation of anomalies in the wetlands. Place grids (50'x50' equivalent) in areas of high, medium and low density areas. Grid acreage will be at least 10% of the total transect acreage. DGM grids using EM61. Intrusively investigate MEC-like anomalies. ***Sub-area 2*** – Perform a surface reconnaissance along transects spaced 416 ft apart based on a 60mm mortar to identify areas of potential munitions contamination. Develop anomaly density maps and document MD, CD and MEC. ***MC sampling -*** Ten (10) discrete soil samples (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu) based on range fans/firing points, terrestrial targets, and findings from mag-and-dig.

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RANGE COMPLEX (LAKE CRAIG AND LAKE JOHNSON)	Total ~ 185.6 Lake Johnson footprint = 37.5 acres. ZAPATA contacted State Park personnel on 12/3/10 and SC DNR on 12/6/10 concerning lake water levels. Officials indicated that Lake Johnson has been drained but is currently being naturally filled and has approximately 7 acres of water. Lake Craig is 148.1 acres.	Situated within MRS 3.	60mm and 81mm mortars. No documented finds since site closure.	None	185.6	State park. Receptors: recreational users (boating, fishing). Site is publicly accessible.	Two investigation methodologies are proposed for MRS; mag-and-dig and surface reconnaissance, with variable transect spacings. Based on site restrictions, no data collection within the lakes is proposed. Mag-and-dig transects proposed for areas west of the lakes will be performed up to the water boundary, will turn and follow the shoreline until the point at which the transects turn and lead away from the lake. This will allow for data collection to occur along the lake shorelines. A similar method will be employed during surface reconnaissance east of the lakes. As with MRS 3, those data will be used to develop anomaly density maps and document MD, CD and MEC. ***MC sampling –*** No samples will be collected.
AREAS OF POTENTIAL INTEREST – GENERAL COMMENTS		Mixed use.					Field work in AoPI is contingent upon rights-of-entry. If MEC/MD is found up to the boundary of any AoPI, ZAPATA will coordinate with the Project Delivery Team to expand the investigation via instrument-assisted reconnaissance or mag and dig, to increase confidence that the boundary of MEC is defined.

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AREA OF POTENTIAL INTEREST 3	PWS AoPI = 11 acres. Previous defined OOU 3 (Wedgewood) = 46 acres.	Cantonment area.	Grenades. Items found since site closure include: grenades, 2.36" rocket fragmentation.	EE/CA (1996), multiple removal reports. Subsurface clearance to depth in approximately 40 acres in the Wedgewood development that encompasses the majority of AoPI 3. DGM and some clearance in golf course buffer. General location of gas chamber #3 has been geophysically mapped while investigating OOU3. Anomalies will be intrusively investigated in January 2011. Results of this clearance may alter the CSM.	Approx. 3 acres.	Residential and recreational (golf course). Receptors: Residents, golfers, and golf course maintenance personnel. Site is publicly accessible.	Areas that have undergone previous MEC removals will be excluded from the acres investigated under this RI based upon coordinates provided in removal documents. Extent of MEC has not been defined. MEC has been encountered beyond the currently delineated boundary of AoPI 3 as documented during the MEC removal at OOU3. Field investigation will occur beyond this boundary to the west, north and east to the road depicted in the historical photo analysis. While the 112 ft transect spacing is proposed for these extend areas of investigation, it is unclear what method of investigation is most appropriate; potential ideas include mag-and-dig, DGM with EM61 and/or the MetalMapper, or some combination of these. The method should be determined during the TPP process. ZAPATA believes that the location of gas chamber #2, as shown in the historical photographic analysis, has been investigated during previous MEC investigations/removals. In the event that this area was not characterized, the proposed line spacing is adequate to identify gas canisters. ***MC sampling*** - One discrete soil sample (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu).
AREA OF POTENTIAL INTEREST 5	5.5	North of the Range 7 firing point; southwest of grenade court.	Grenades. Items found since site closure include: rifle grenade.	EE/CA (1996)	5.5	Residential. Receptors: landowners, residents. Area is publicly accessible.	Mag and dig 100% transects using a MineLab detector at 173' line spacing, based on a rifle grenade. Develop anomaly density maps and document MD, CD and MEC. Place grids (50'x50' equivalent) in areas of high, medium and low-density areas. Grid acreage will be at least 10% of the total transect acreage. DGM grids using EM61. Intrusively investigate MEC-like anomalies. ***MC sampling*** - One discrete soil sample (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu).

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AREA OF POTENTIAL INTEREST 8	23.9	North of the Range 11 firing point.	Small arms ammunition. No documented finds since site closure.	EE/CA (1996)	23.9	State Park. Receptors: recreational users (hikers, bikers, camping, horseback riding). Site is publicly accessible.	Mag and dig 100% transects using a MineLab detector at 112' spacing. Develop anomaly density maps and document MD, CD and MEC. Place grids (50'x50' equivalent) in areas of high, medium and low-density areas. Grid acreage will be at least 10% of the total transect acreage. DGM grids using EM61. Intrusively investigate MEC-like anomalies. ***MC sampling*** - One discrete soil sample (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu).
AREA OF POTENTIAL INTEREST 9E	7.6	Northwest of the Range 7 firing point.	Small arms ammunition; which have also been found since site closure.	EE/CA (1998)	7.6	State Park. Receptors: recreational users (hikers, bikers, camping, horseback riding). Area is publicly accessible.	Mag and dig 100% transects using a MineLab detector at 112' spacing. Develop anomaly density maps and document MD, CD and MEC. Place grids (50'x50' equivalent) in areas of high, medium and low-density areas. Grid acreage will be at least 10% of the total transect acreage. DGM grids using EM61. Intrusively investigate MEC-like anomalies. ***MC sampling*** - One discrete soil sample (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu).
AREA OF POTENTIAL INTEREST 9G	6.6	North of the Range 3 firing point.	Small arms ammunition; which have also been found since site closure. Anecdotal evidence of grenades has been provided by the public.	EE/CA (1998)	6.6	Private property. Receptors: Residents. Area is publicly accessible.	Based on anecdotal information provided by the public and the Spartanburg County Sheriff's Office, it is recommended that AoPI 9G be expanded to the east, up to the MRS 3 boundary. Mag and dig 100% transects using a MineLab detector at 112' line spacing. Develop anomaly density maps and document MD, CD and MEC. Place grids (50'x50' equivalent) in areas of high, medium and low-density areas. Grid acreage will be at least 10% of the total transect acreage. DGM grids using EM61. Intrusively investigate MEC-like anomalies. ***MC sampling*** - One discrete soil sample (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu).
AREA OF POTENTIAL INTEREST 10A	171.5	North of AoPI 8 and Ranges 10 and 11 firing points.	Grenades and mortars. Items found since site closure include: rifle grenade parts, land mine parts , practice grenade, 2.36" rocket, small arms ammunition.	EE/CA (1998)	171.5	State Park Receptors: recreational users (hikers, bikers, camping, horseback riding). Area is publicly accessible.	Mag and dig 100% transects at 112' line spacing using a MineLab detector. Develop anomaly density maps and document MD, CD and MEC. Place grids (50'x50' equivalent) in areas of high, medium and low-density areas. Grid acreage will be at least 10% of the total transect acreage. DGM grids using EM61. Intrusively investigate MEC-like anomalies. ***MC sampling*** - One discrete soil sample (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu).

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AREA OF POTENTIAL INTEREST 10B	33.6	Southwest of Range 2 firing point.	Undetermined. Items found since site closure include: small arms ammunition, 60mm mortar.	EE/CA (1998)	33.6	State Park Receptors: recreational users (hikers, bikers, camping, horseback riding). Area is publicly accessible.	Mag and dig 100% transects at 416' line spacing using a Mine Lab detector. Develop anomaly density maps and document MD, CD and MEC. Place grids (50'x50' equivalent) in areas of high, medium and low-density areas. Grid acreage will be at least 10% of the total transect acreage. DGM grids using EM61. Intrusively investigate MEC-like anomalies. ***MC sampling*** - One discrete soil sample (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu).
ARE OF POTENTIAL INTEREST 11B	34.7	Northwest of Range 2 firing point.	Undetermined. Items found since site closure include: small arms ammunition, grenade part.	EE/CA (1998)	34.7	Private property. Receptors: residents. Area is publicly accessible.	Mag and dig 100% transects using a MineLab detector at 112' line spacing. Develop anomaly density maps and document MD, CD and MEC. Place grids (50'x50' equivalent) in areas of high, medium and low-density areas. Grid acreage will be at least 10% of the total transect acreage. DGM grids using EM61. Intrusively investigate MEC-like anomalies. ***MC sampling*** - One discrete soil sample (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu).

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AREA OF POTENTIAL INTEREST 11C	23.0	Undetermined.	Undetermined. Items found since site closure include: grenades grenade fuzes, anti-tank mines.	EE/CA (1998) Clearance to depth of 11 acres (2010).	12	Private property. Receptors: residents, landowners. Area is publicly accessible.	Areas that have undergone previous MEC removals will be excluded from the acres investigated under this RI. The PWS-defined boundary may be improperly located. Based on findings during ZAPATA's previous removal actions in OOU11C, the area of potential interest may lie to the east of both the PWS-defined boundary and the removal action boundary. However, the USAESCH has requested the PWS-defined boundary be included in future investigations along with those proposed activities to the east. Investigate additional acres to the east of the AoPI based on the 2010 removal action data and site knowledge. Additional acreage will include the approximate location of gas chamber #4, based on historical photographic analysis. Conduct mag and dig of 100% anomalies at 112' transect spacing using a MineLab detector. Develop anomaly density maps and document MD, CD and MEC. 100% digital geophysical mapping of ball fields east of AoPI 11C to illustrate extent of anomaly density. Based upon findings of mag and dig, and discussions w/PDT, MEC-like items may be intrusively investigated. Place grids (50'x50' equivalent) in areas of high, medium and low density mag and dig areas. ***MC sampling*** - One discrete soil sample (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu).
AREA OF POTENTIAL INTEREST 11D	15.1	Cantonment area.	Undetermined. Items found since site closure include: grenade, mortars (reported to sheriff).	EE/CA (1998)	15.1	Private property / recreational. Receptors: golfers and golf course maintenance personnel. Area is publicly accessible.	Location of AoPI in PWS appears to be offset, based on evaluation of the historic photo analysis. AoPI will be shifted due west. Mag and dig 100% transects using a MineLab at 112' line spacing in area identified in the historic photographic analysis. Develop anomaly density maps and document MD, CD and MEC. Place grids (50'x50' equivalent) in areas of high, medium and low-density areas. Grid acreage will be at least 10% of the total transect acreage. DGM grids using EM61. Intrusively investigate MEC-like anomalies. ***MC sampling*** - One discrete soil sample (from 0 to 2" bgs) for explosives and select metals (Pb, Sb, Zn, Cu).

NOTES: The proposed methodology assures that the following metrics will be met.

- Transect spacing and numbers of anomalies to be investigated results in 90% confidence that all MEC contaminated areas have been identified.
- Boundaries of MEC contaminated areas will be delineated to an accuracy of +/- half of the transect spacing for each MRS/AoPI.
- All land outside of the areas likely to contain MEC have less than or equal to .1 UXO/acre when public use is significant, .5 UXO/acre when public use is moderate, 1 UXO/acre when public use is low by using UXO density as recommended by UXO Estimator.
- Transect spacing and rationale for grid placement will result in 90% confidence that the nature of MEC and MEC debris for each homogenous MEC contaminated area has been achieved.
- Transect spacing, mag and dig along transects, development of anomaly density maps, and intrusive investigation in grids will provide comprehensive data to ensure FS cost estimates are within an accuracy of +50%/-30%.

Table 1 – Munitions and Explosives of Concern Data Quality Objectives – MRS 1

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 112 ft apart in the MRS boundary and 50 ft apart south of the MRS boundary; grids will equate to 50 ft by 50 ft areas within the MRS. • Transect spacing is designed to search for areas where the smoke grenade (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the MRS. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the smoke grenade. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using AIR. • Perform DGM in grids. • Data collection along 0.99 acres/2.71 miles of transects and 0.29 acres/5 grids. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on AIR data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of a representative number of anomalies (to be determined by PDT) for AIR transects. • Intrusive investigation of all MEC-like anomalies for DGM grids. • Test trench of large anomalies.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 2 – Munitions and Explosives of Concern Data Quality Objectives – MRS 2

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 112 ft apart and grids will equate to 50 ft by 50 ft areas within the MRS. • Transect spacing is designed to search for areas where the MK II grenade (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the MRS. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the MK II grenade. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM, AIR and/or mag-and-dig. • Data collection along 0.63 acres/1.74 miles of transects and 0.11 acres/2 grids. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of all MEC-like anomalies for DGM grids.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 3 – Munitions and Explosives of Concern Data Quality Objectives – MRS 3

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be variously spaced apart (i.e., 112 ft, 242 ft, or 416 ft) and grids will equate to 50 ft by 50 ft areas within the MRS. • Transect spacing is designed to search for areas where the MK II grenades, 37mm, or 60mm mortars (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the MRS. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the MK II grenades, 37mm, or 60mm mortars. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM, AIR and/or mag-and-dig. • Data collection along 91.87 acres/252.63 miles of transects and 9.24 acres/161 grids. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM and AIR data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of a representative number of anomalies (to be determined by PDT) for AIR transects. • Intrusive investigation of all anomalies for AIR grids. • Intrusive investigation of all MEC-like anomalies for DGM grids.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 4 – Munitions and Explosives of Concern Data Quality Objectives – AoPI 3

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 112 ft apart and grids will equate to 50 ft by 50 ft areas within the AoPI. • Transect spacing is designed to search for areas where the MK II grenade (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the AoPI. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the MK II grenade. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM and mag-and-dig. • Data collection along 0.69 acres/1.89 miles of transects and 0.11 acres/2 grids. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of all MEC-like anomalies for DGM grids.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.

NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

(The DQOs presented here, for AoPI 3, may change following meetings between the USAESCH and the golf course owners.)

Table 5 – Munitions and Explosives of Concern Data Quality Objectives – AoPI 5

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 173 ft apart and grids will equate to 50 ft by 50 ft areas within the AoPI. • Transect spacing is designed to search for areas where the rifle grenade (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the AoPI. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the rifle grenade. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM and mag-and-dig. • Data collection along 0.11 acres/0.30 miles of transects and 0.06 acres/1 grid. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of all MEC-like anomalies for DGM grids.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 6 – Munitions and Explosives of Concern Data Quality Objectives – AoPI 8

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 112 ft apart and grids will equate to 50 ft by 50 ft areas within the AoPI. • Transect spacing is designed to search for areas where the MK II grenade (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the AoPI. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the MK II grenade. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM and mag-and-dig. • Data collection along 0.79 acres/2.16 miles of transects and 0.11 acres/2 grids. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of all MEC-like anomalies for DGM grids.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 7 – Munitions and Explosives of Concern Data Quality Objectives – AoPI 9E

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 112 ft apart and grids will equate to 50 ft by 50 ft areas within the AoPI. • Transect spacing is designed to search for areas where the MK II grenade (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the AoPI. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the MK II grenade. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM and mag-and-dig. • Data collection along 0.19 acres/0.53 miles of transects and 0.06 acres/1 grid. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of all MEC-like anomalies for DGM grids.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 8 – Munitions and Explosives of Concern Data Quality Objectives – AoPI 9G

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 112 ft apart and grids will equate to 50 ft by 50 ft areas within the AoPI. • Transect spacing is designed to search for areas where the MK II grenade (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the AoPI. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the MK II grenade. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM and mag-and-dig. • Data collection along 0.65 acres/1.78 miles of transects and 0.11 acres/2 grids. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of all MEC-like anomalies for DGM grids.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 9 – Munitions and Explosives of Concern Data Quality Objectives – AoPI 10A

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 112 ft apart and grids will equate to 50 ft by 50 ft areas within the AoPI. • Transect spacing is designed to search for areas where the MK II grenade (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the AoPI. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the MK II grenade. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM and mag-and-dig. • Data collection along 4.40 acres/12.09 miles of transects and 0.46 acres/8 grids. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of all MEC-like anomalies for DGM grids.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 10 – Munitions and Explosives of Concern Data Quality Objectives – AoPI 10B

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 416 ft apart and grids will equate to 50 ft by 50 ft areas within the AoPI. • Transect spacing is designed to search for areas where the 60mm mortar (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the AoPI. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the 60mm mortar. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM and mag-and-dig. • Data collection along 0.23 acres/0.63 miles of transects and 0.06 acres/1 grid. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of all MEC-like anomalies for DGM grids.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 11 – Munitions and Explosives of Concern Data Quality Objectives – AoPI 11B

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 112 ft apart and grids will equate to 50 ft by 50 ft areas within the AoPI. • Transect spacing is designed to search for areas where the MK II grenade (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the AoPI. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the MK II grenade. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM and mag-and-dig. • Data collection along 0.88 acres/2.42 miles of transects and 0.11 acres/2 grids. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of all MEC-like anomalies for DGM grids.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 12 – Munitions and Explosives of Concern Data Quality Objectives – AoPI 11C

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present within each MRS. • Determine the spatial extent of MEC within each MRS. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 112 ft apart and grids will equate to 50 ft by 50 ft areas within the AoPI. • Transect spacing is designed to search for areas where the MK II grenade (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the AoPI. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the MK II grenade. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM and mag-and-dig. • Data collection along 0.14 acres/0.38 miles of transects and 5.03 acres of DGM (4.97 acres on ball field and 0.06 acres on 1 grid). • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of all MEC-like anomalies for DGM areas/grids.

Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 13 – Munitions and Explosives of Concern Data Quality Objectives – AoPI 11D

DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 112 ft apart and grids will equate to 50 ft by 50 ft areas within the AoPI. • Transect spacing is designed to search for areas where the MK II grenade (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the AoPI. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the MK II grenade. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using DGM and mag-and-dig. • Data collection along 0.42 acres/1.17 miles of transects and 0.06 acres/1 grid. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on DGM data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of all MEC-like anomalies for DGM grids.

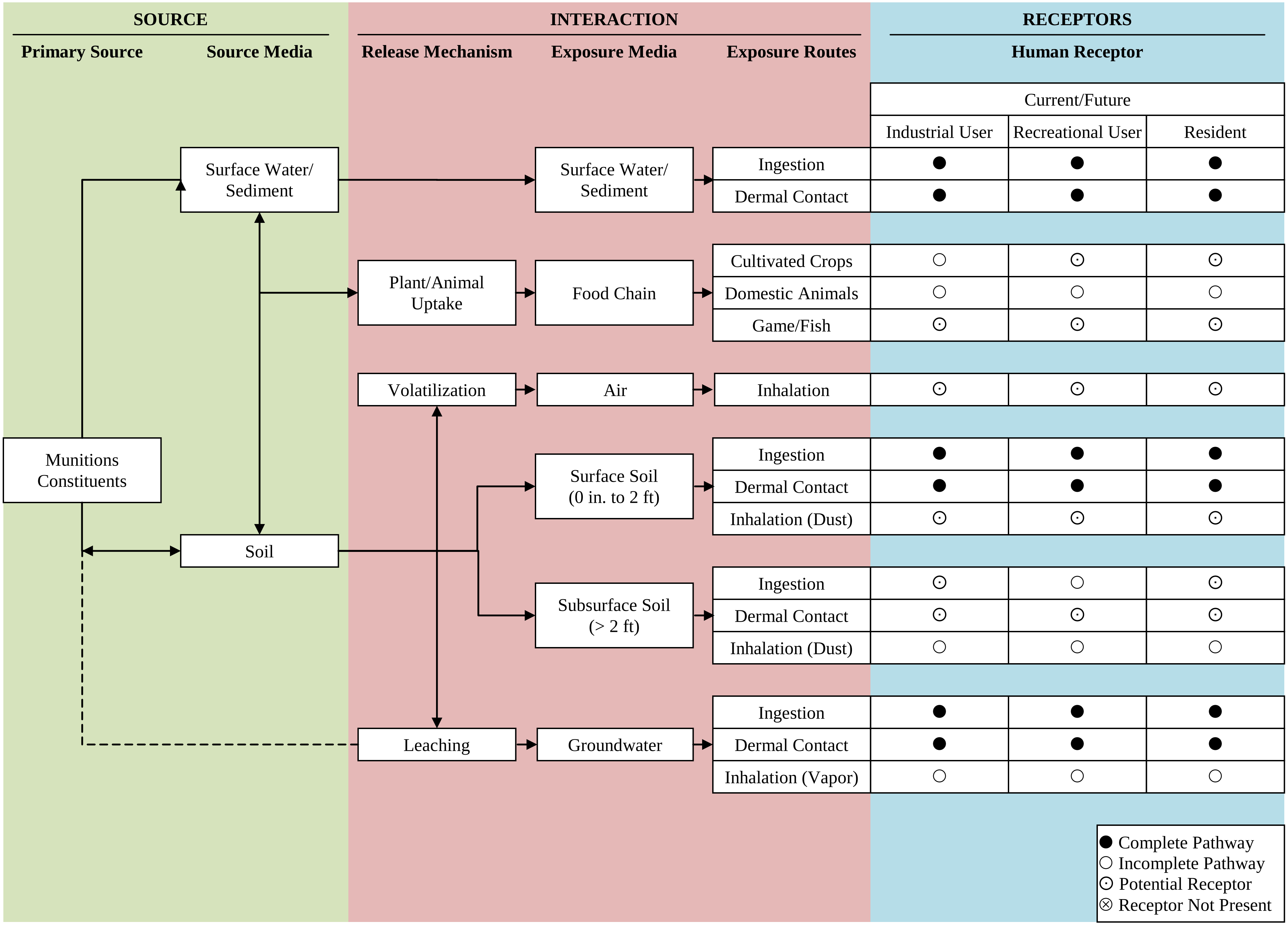
Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Table 14 – Munitions and Explosives of Concern Data Quality Objectives – Lake Craig and Lake Johnson

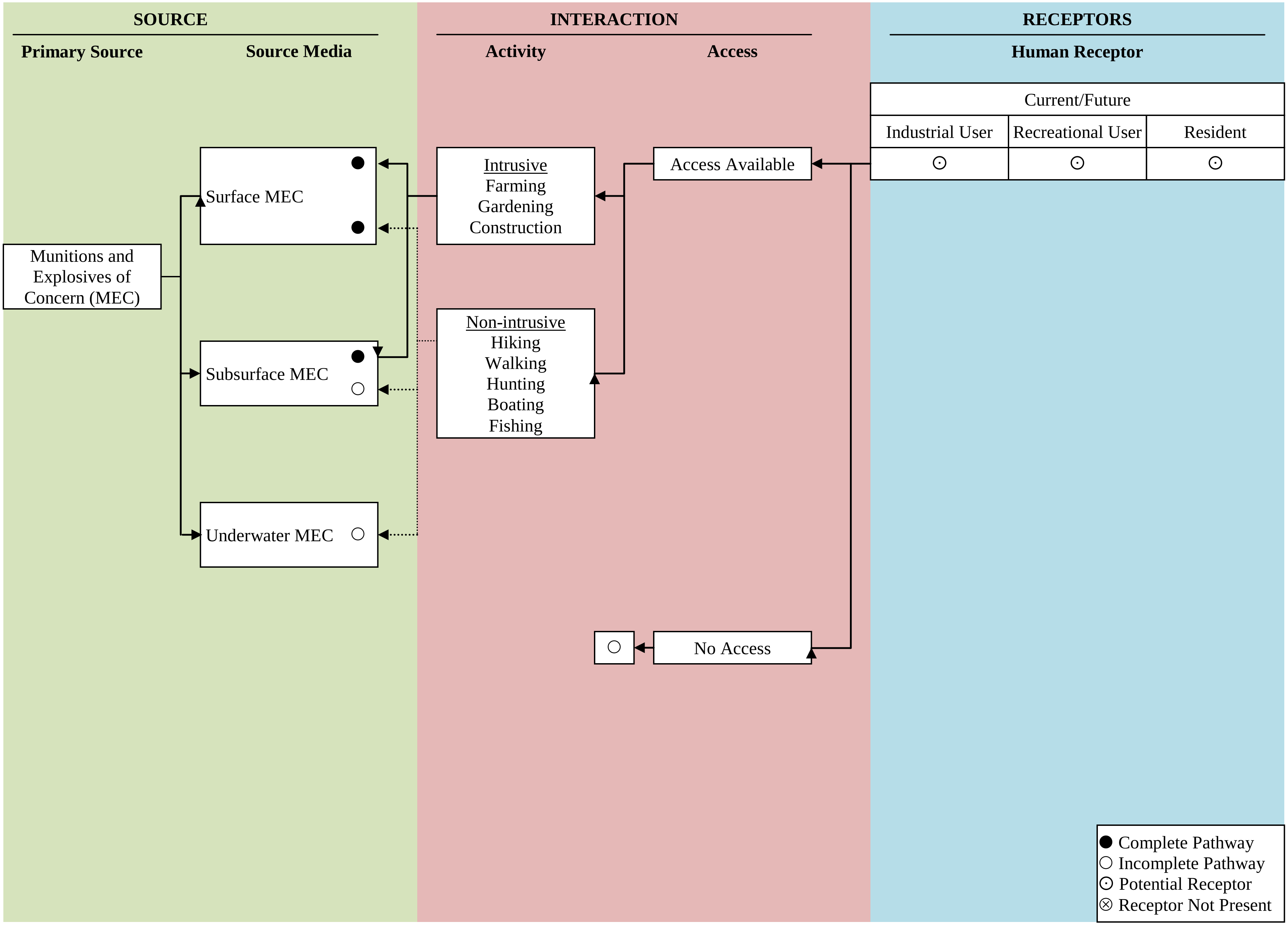
DQO	Problem Statement	Project Goals	Required Information Inputs	Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates the study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the target population and define spatial limits*	*Develop the logic for drawing conclusions from findings*	*Specify probability limits for false rejections and false acceptance decision errors*	*Select the plan that meets the performance criteria*
MRS Characterization	• Determine the nature and extent of MEC along the shoreline.	• Determine the location and type of MEC present. • Determine the spatial extent of MEC. • Determine if MEC exposure pathways for humans are complete. • Determine if MEC pose a human health risk. -------------------------------- Possible Actions: • No DoD Action Indicated • Institutional Controls • MEC Removal • Combination of Actions	• Data collected during previous activities. • Results of visual observations along transects and in grids. • Analog (density) and/or digital (instrument response) geophysical data. • Results of intrusive investigation of identified anomalies. • Survey of site receptors, demographics and land use.	• During field activities, transects will be spaced approximately 416 ft apart and grids will equate to 50 ft by 50 ft areas along the shoreline. • Transect spacing is designed to search for areas where the 60mm mortar (the smallest found item with an explosive hazard) would explode on impact with the ground, detonate and fragment. • Grid locations in areas of high, medium, and low anomaly count areas will be determined based on results of transect investigations. • The anomaly selection threshold in DGM grids is based on the maximum value determined during the geophysical proveout. The initial value is set at 11x the diameter of the MK II grenade (the smallest found item with an explosive hazard across all MRSs/AoPIs). • Intrusively investigate potential MEC items. -------------------------------- Constraints: Rights-of-entry, weather, current land use activities.	• Maximum depth at which each type of MEC was encountered will be used to define the vertical extent for that type of MEC. • The location and spatial extent of MEC will be used to define the lateral extent for each type of MEC encountered; the extent beyond the last MEC discovered will be equal to the transect spacing for the area in question. • If evidence of MEC is found, then discovery location may be within a zone where ordnance landed that did not function as designed. • All MD, frag, and targets will be evaluated as possibly indicative of the location of MEC. -------------------------------- Alternative actions will be formulated in the Feasibility Study based on the location and density of MEC, land use, and other data gathered during the investigation and comparison of those data with criteria established herein.	• Anomaly reacquisition (from DGM data) within 1 meter accuracy. • Transect pathway positional accuracy is +/- 20 %, as an average across the study area. • Depth of detection for DGM data (i.e., the failure criteria) is 7x the diameter of the 60mm mortar. • QC/QA blind seed items will be detected and identified.	• Visually inspect and determine anomaly density within transects using AIR or mag-and-dig. • Data collection along 0.60 acres/1.65 miles of transects and 0.11 acres/2 grids. • Overlap DGM and analog data collection methods along a sample of transects for comparability. • Synthesize anomaly density data into figures for PDT review and anomaly selection. • Select grid placement locations. Grids will be placed in high, medium, and low anomalous areas, based on mag-and-dig and AIR data and discussions with the PDT; biased placement of percentage of grids to define location of potential MEC in areas beyond target zone. • Intrusive investigation of all anomalies for mag-and-dig transects. • Intrusive investigation of a representative number of anomalies (to be determined by PDT) for AIR transects. • Intrusive investigation of all anomalies for AIR grids. • Intrusive investigation of all MEC-like anomalies for DGM grids.

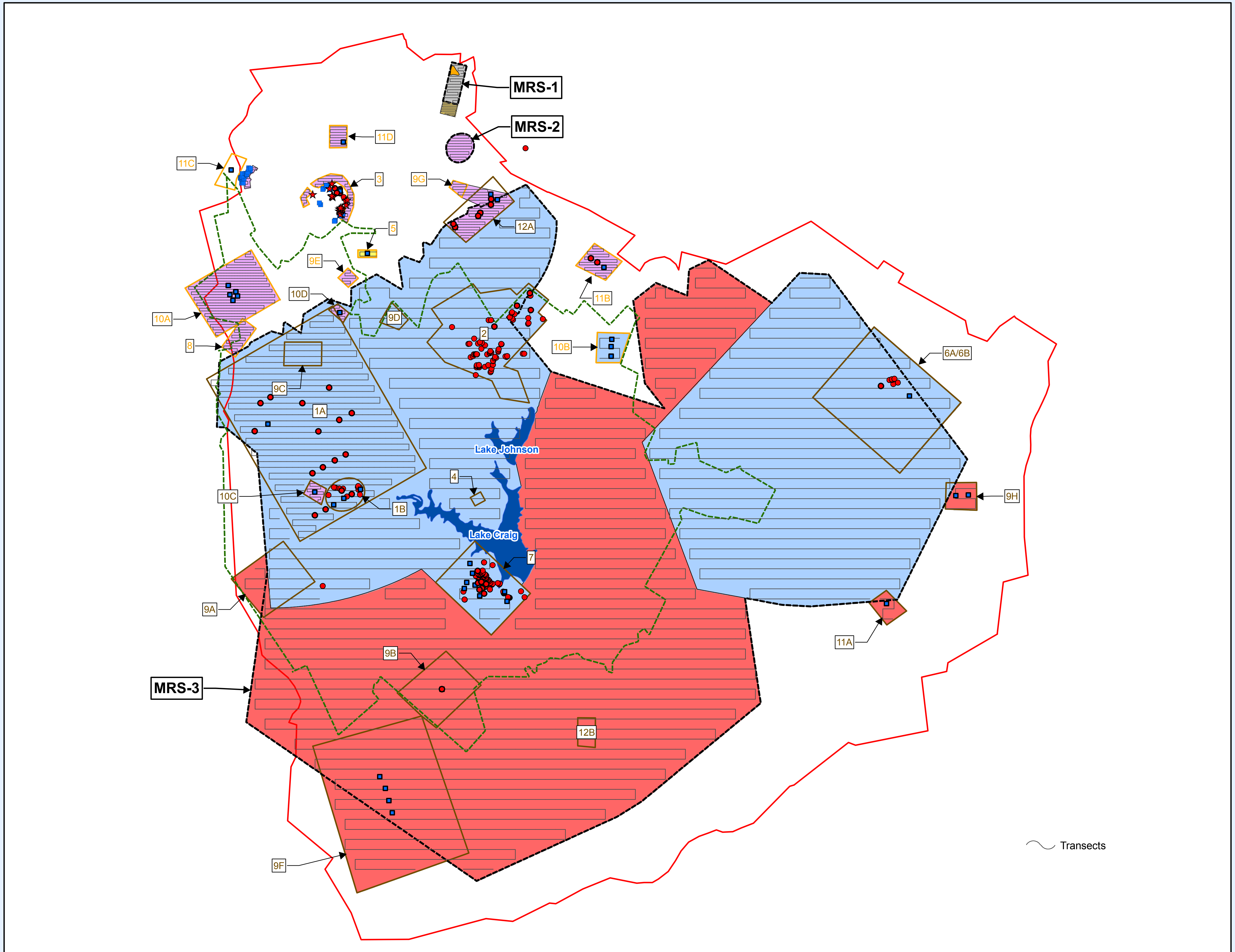
Reference: Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA//G-4, EPA/240/B-06/001, February 2006.
NOTE: MEC performance criteria are included in Section 4.0; MC DQOs are included in the UFP-QAPP (Appendix E).

Munitions Constituents Conceptual Site Exposure Model



Munitions and Explosives of Concern Conceptual Site Exposure Model





Former Camp Croft, SC
Transect Spacing

Project Number	Date	Exhibit
00017	APRIL 2011	1

KEY

- UXO
- MD
- MEC
- Approximate Park Boundary
- Trash Pile - No Investigation
- MRS
- Areas of Potential Interest
- Former OOU
- Approximate Former Camp Croft Boundary
- Lake
- Ground Recon - 50' Transect Spacing
- Ground Recon - 112' Transect Spacing
- Ground Recon - 416' Transect Spacing
- Mag & Dig - 112' Transect Spacing
- Mag & Dig - 173' Transect Spacing
- Mag & Dig - 416' Transect Spacing

N
W E
S

0 2,000 4,000 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Notes

Checked By	Engineering Scale	Drawn By
SCM	1"=4,000'	ATD

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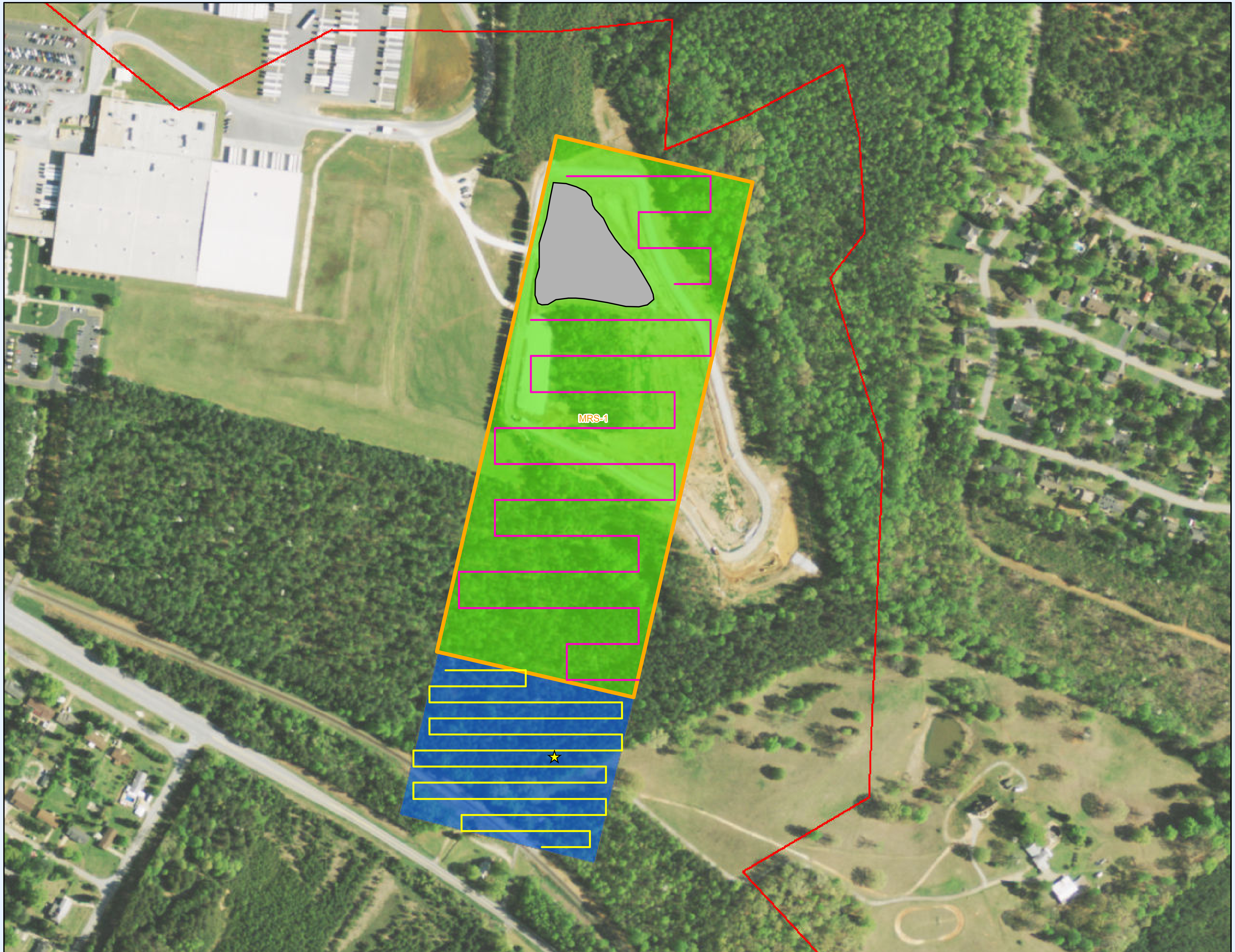

Former Camp Croft, SC
MRS-1

Project Number	Date	Exhibit
00017	DECEMBER 2010	4

KEY

- Trash Pile - No Investigation
- Suspected Location of Gas Chamber
- 112' Ground Recon Transects (1.46 miles)
- 50' Ground Recon Transects (1.20 miles)
- PWS-defined MRS-1 Boundary
- Ground Recon - 50' Transect Spacing
- Ground Recon - 112' Transect Spacing
- Approximate Former Camp Croft Boundary

N W E S

0 150 300 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)

Checked By	Engineering Scale	Drawn By
SCM	AS SHOWN	ATD

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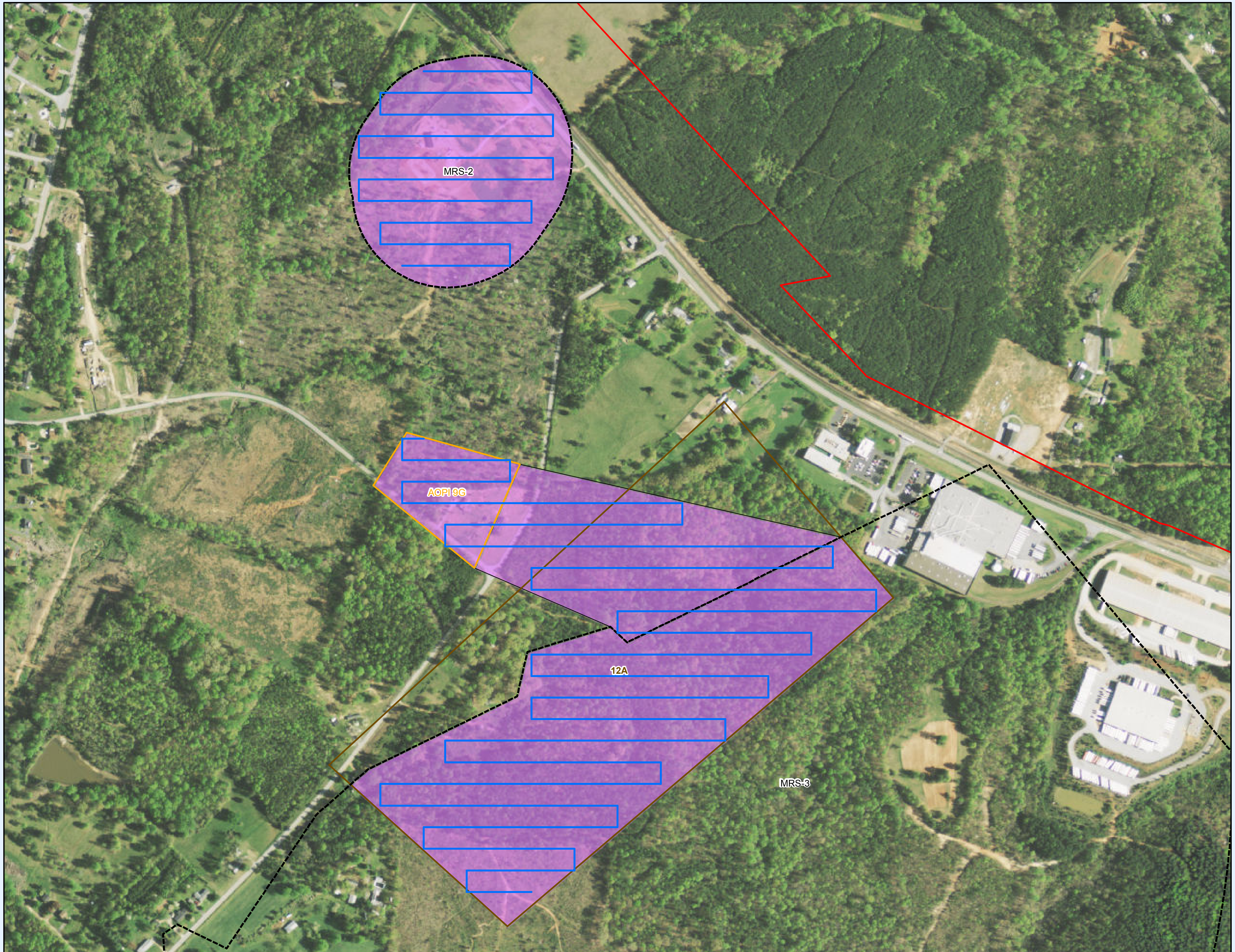

Former Camp Croft, SC
MRS-2, Area of Potential Interest 9G & 12A

Project Number	Date	Exhibit
00017	APRIL 2011	5

KEY

- 112' Ground Recon Transects (6.83 mi)
- Approximate Park Boundary
- MRS
- Areas of Potential Interest
- Former OOU
- Approximate Former Camp Croft Boundary
- Mag & Dig - 112' Transect Spacing

N W E S

0 250 500 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)

Checked By	Engineering Scale	Drawn By
SCM	AS SHOWN	ATD

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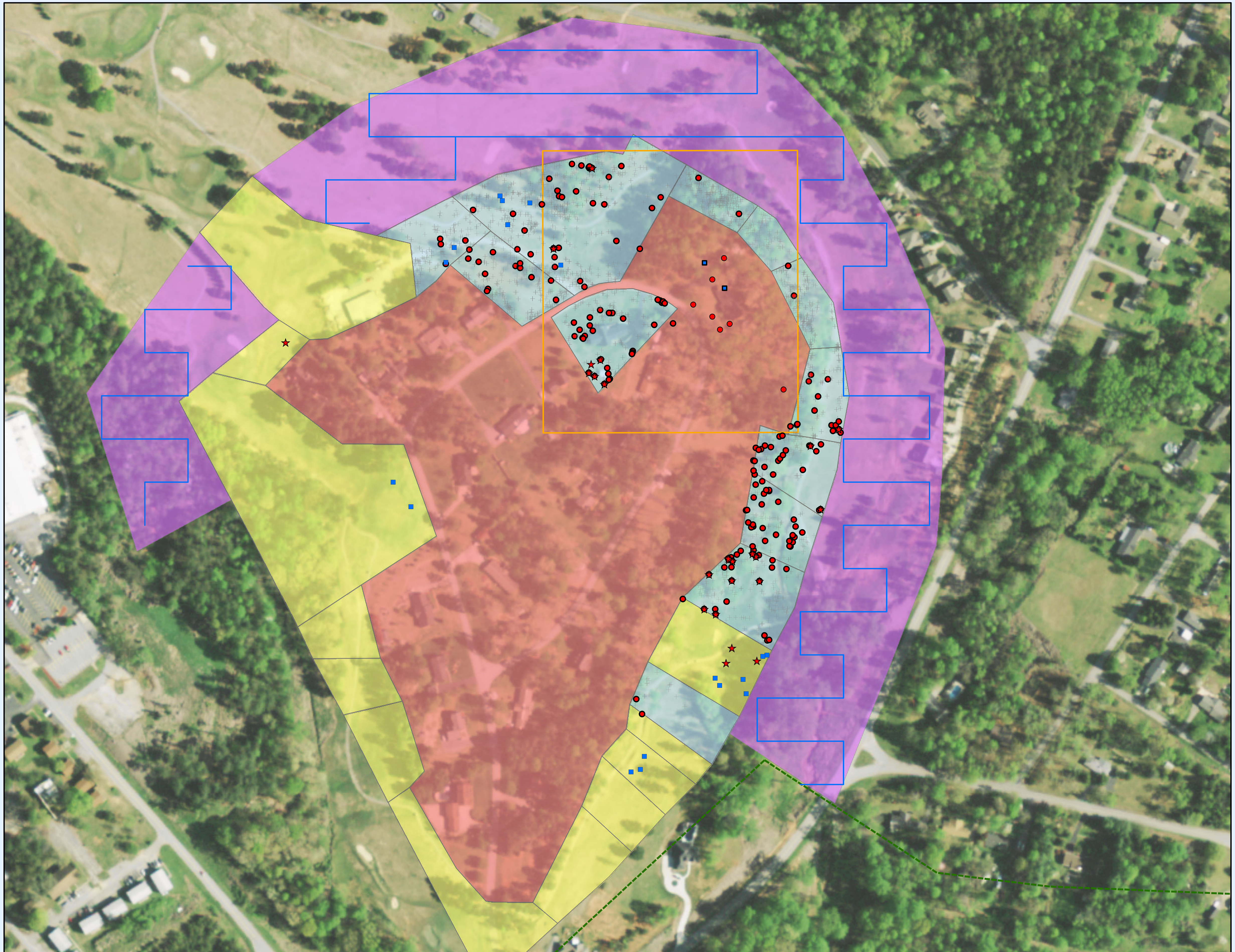

Former Camp Croft, SC
Area of Potential Interest 3

Project Number	Date	Exhibit
00017	APRIL 2011	6

KEY

- UXO
- MD
- MEC
- CD Item
- 112' Ground Recon Transects (1.89 mi)
- Approximate Park Boundary
- MRS
- PWS-defined Former OOU3 Boundary
- HFA Completed Removal Action
- ZAPATA Pending Removal Action (DGM complete)
- ZAPATA Completed Removal Action
- Mag & Dig - 112' Transect Spacing

N W E S

0 125 250 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)

Checked By	Engineering Scale	Drawn By
SCM	AS SHOWN	ATD

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Former Camp Croft, SC
Areas of Potential Interest 5 and 9E

Project Number	Date	Exhibit
00017	APRIL 2011	7

KEY

- Proposed Site Office Trailer Location
- 173 ft Transect (0.29 mi)
- 112 ft Transect (0.47 mi)
- MRS
- Approximate Former Camp Croft Boundary
- Areas of Potential Interest
- Mag & Dig - 112' Transect Spacing
- Mag & Dig - 173' Transect Spacing
- Mag & Dig - 416' Transect Spacing

N W E S

0 150 300 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)

Checked By	Engineering Scale	Drawn By
SCM	AS SHOWN	ATD

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Support Center Huntsville
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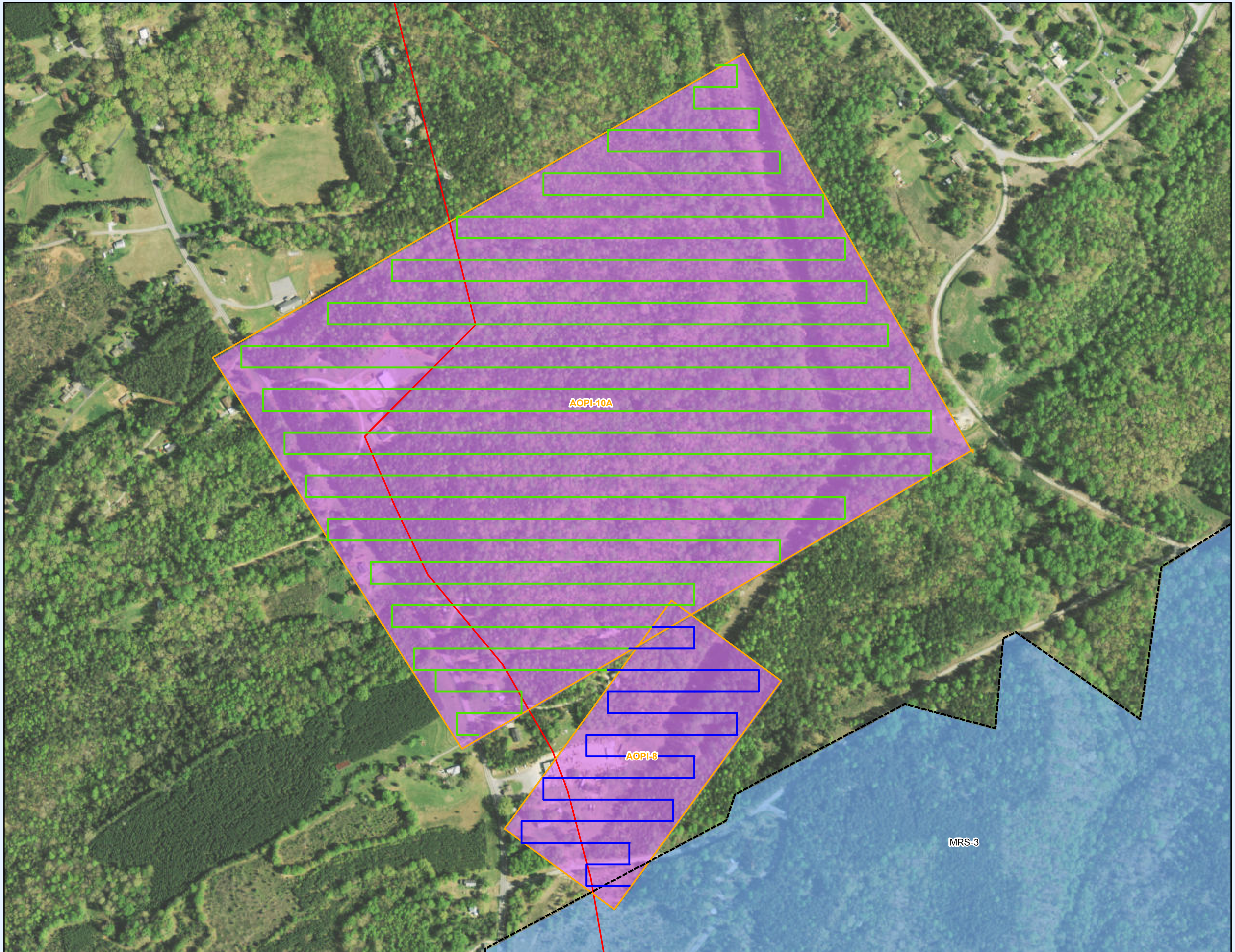

Former Camp Croft, SC
Areas of Potential Interest 8 and 10A

Project Number	Date	Exhibit
00017	APRIL 2011	8

KEY

- 112' Transect (12.13 mi)
- 112' Transect (2.12 mi)
- MRS
- Areas of Potential Interest
- Approximate Former Camp Croft Boundary
- Mag & Dig - 112' Transect Spacing
- Mag & Dig - 416' Transect Spacing

N S W E

0 250 500 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)

Checked By	Engineering Scale	Drawn By
SCM	AS SHOWN	ATD

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Engineering and
Support Center Huntsville
4820 University Square
Huntsville, AL 35816

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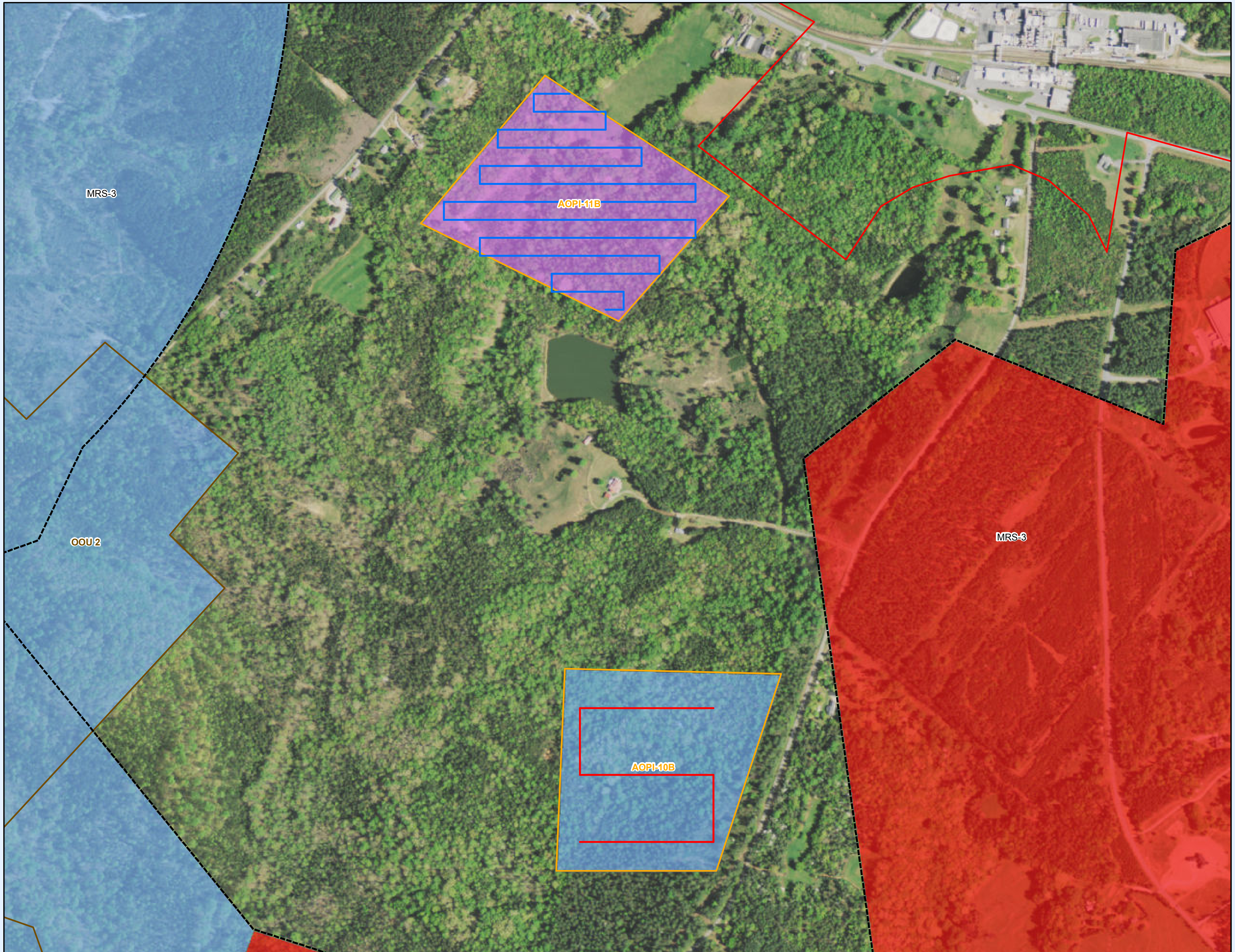

Former Camp Croft, SC
Areas of Potential Interest 10B and 11B

Project Number	Date	Exhibit
00017	APRIL 2011	9

KEY

- 416' Transect (0.63 mi)
- 112' Transect (2.42 mi)
- MRS
- Former OOU
- Areas of Potential Interest
- Approximate Former Camp Croft Boundary
- Ground Recon - 416' Transect Spacing
- Mag & Dig - 112' Transect Spacing
- Mag & Dig - 416' Transect Spacing

N W E S

0 300 600 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)

Checked By	Engineering Scale	Drawn By
SCM	AS SHOWN	ATD

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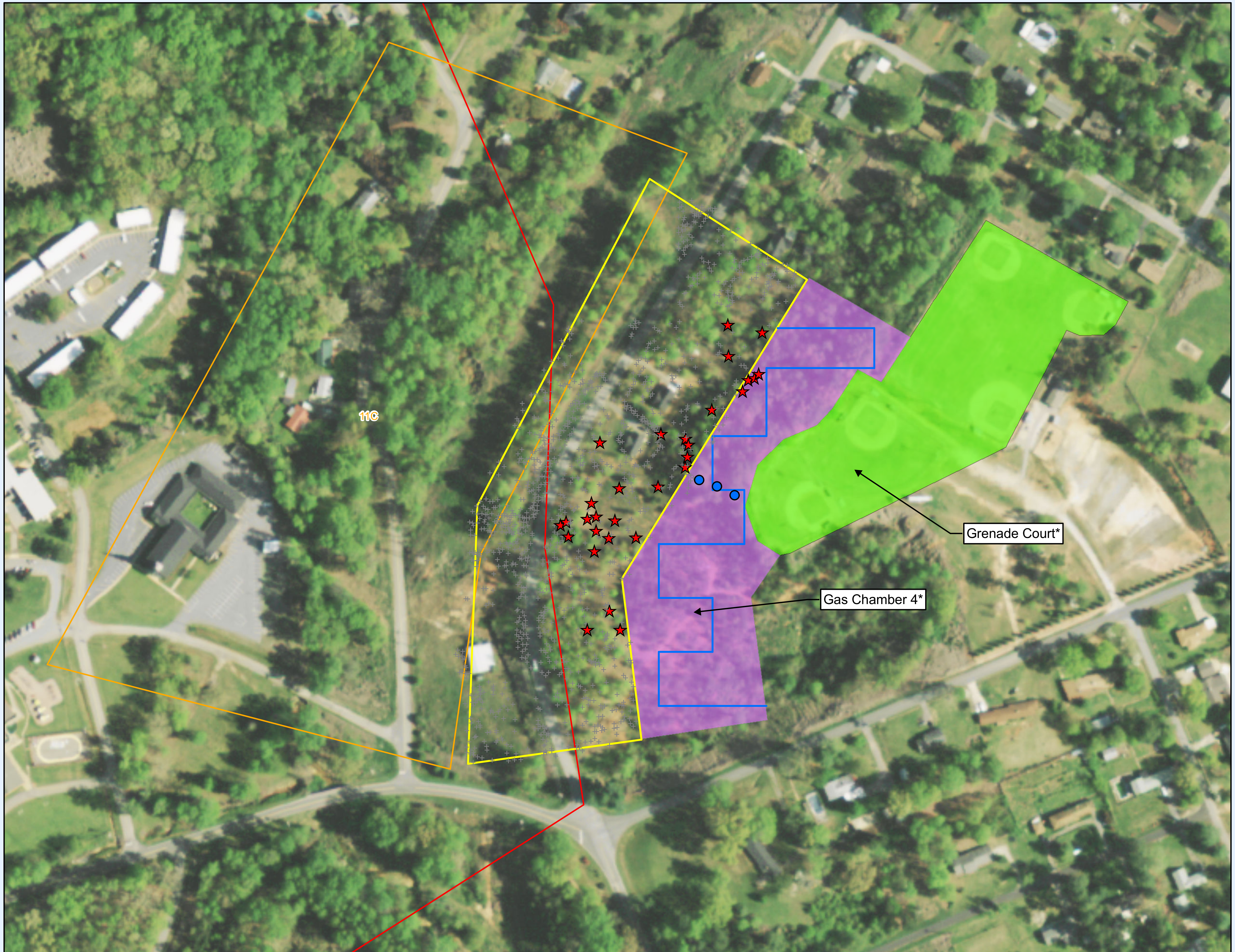

Former Camp Croft, SC
Area of Potential Interest 11C

Project Number	Date	Exhibit
00017	APRIL 2011	10

KEY

- Foxholes (Observed During Site Visit)
- MD Items
- CD Items
- 112' Transect (0.38 mi)
- Removal Action OOU11C Boundary
- Areas of Potential Interest
- Approximate Former Camp Croft Boundary
- DGM (100%)
- Mag & Dig - 112' Transect Spacing

* Boundaries and Items are defined in the GIS-based Historical Photographic Analysis dated October 2005.

The PWS-defined boundary may be improperly located. Based on findings during ZAPATA's previous removal actions in OOU11C, the area of potential interest may lie to the east of both the PWS-defined boundary and the removal action boundary. However, the USAESCH has requested the PWS-defined boundary be included in future investigations along with those proposed activities shown.

N W E S

0 100 200 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)

Checked By	Engineering Scale	Drawn By
SCM	AS SHOWN	ATD

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Former Camp Croft, SC
Area of Potential Interest 11D

Project Number	Date	Exhibit
00017	APRIL 2010	11

KEY

112' Transect (1.17 mi)
Areas of Potential Interest
Mag & Dig / DGM - 112' Transect Spacing*

N
W E
S

0 150 300 Feet

Source(s)
USAESCH, USGS

Projection
UTM Zone 17 North, NAD83

Note(s)

*** Mag & Dig will be conducted in wooded areas and DGM will be conducted on the golf course.**

Checked By	Engineering Scale	Drawn By
SCM	AS SHOWN	ATD

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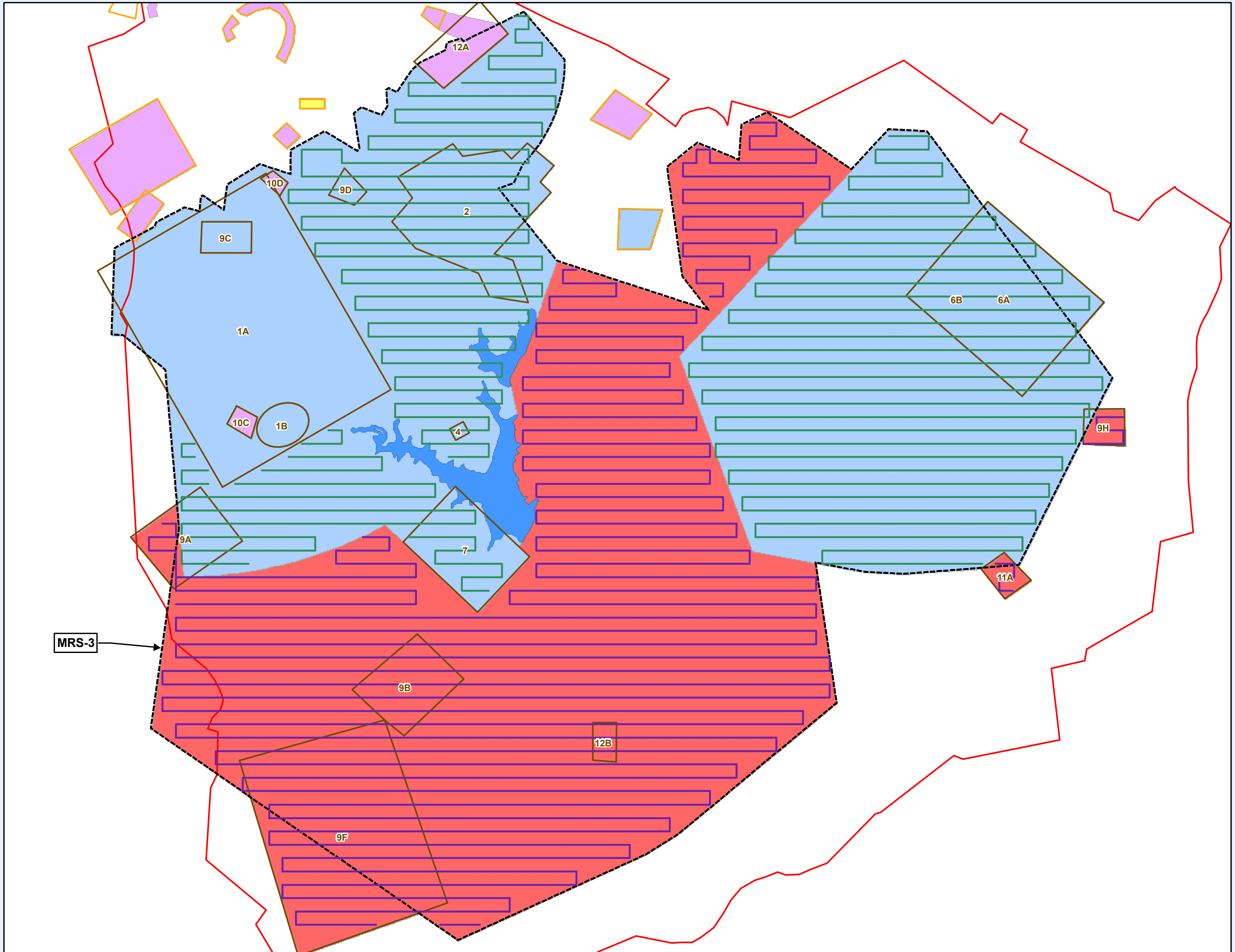

Former Camp Croft, SC
MRS-3

Project Number	Date	Exhibit
00017	APRIL 2011	12

KEY

- 416' Transect - Mag & Dig (99.59 mi)
- 416' Transect - Recon (114.20 mi)
- MRS
- Former OOU
- Areas of Potential Interest
- Approximate Former Camp Croft Boundary
- Lake
- Ground Recon - 50' Transect Spacing
- Ground Recon - 112' Transect Spacing
- Ground Recon - 416' Transect Spacing
- Mag & Dig - 112' Transect Spacing
- Mag & Dig - 173' Transect Spacing
- Mag & Dig - 416' Transect Spacing

N W E S

0 1,500 3,000 Feet

Source(s)
USAESCH, USGS
Projection
UTM Zone 17 North, NAD83
Note(s)

Checked By	Engineering Scale	Drawn By
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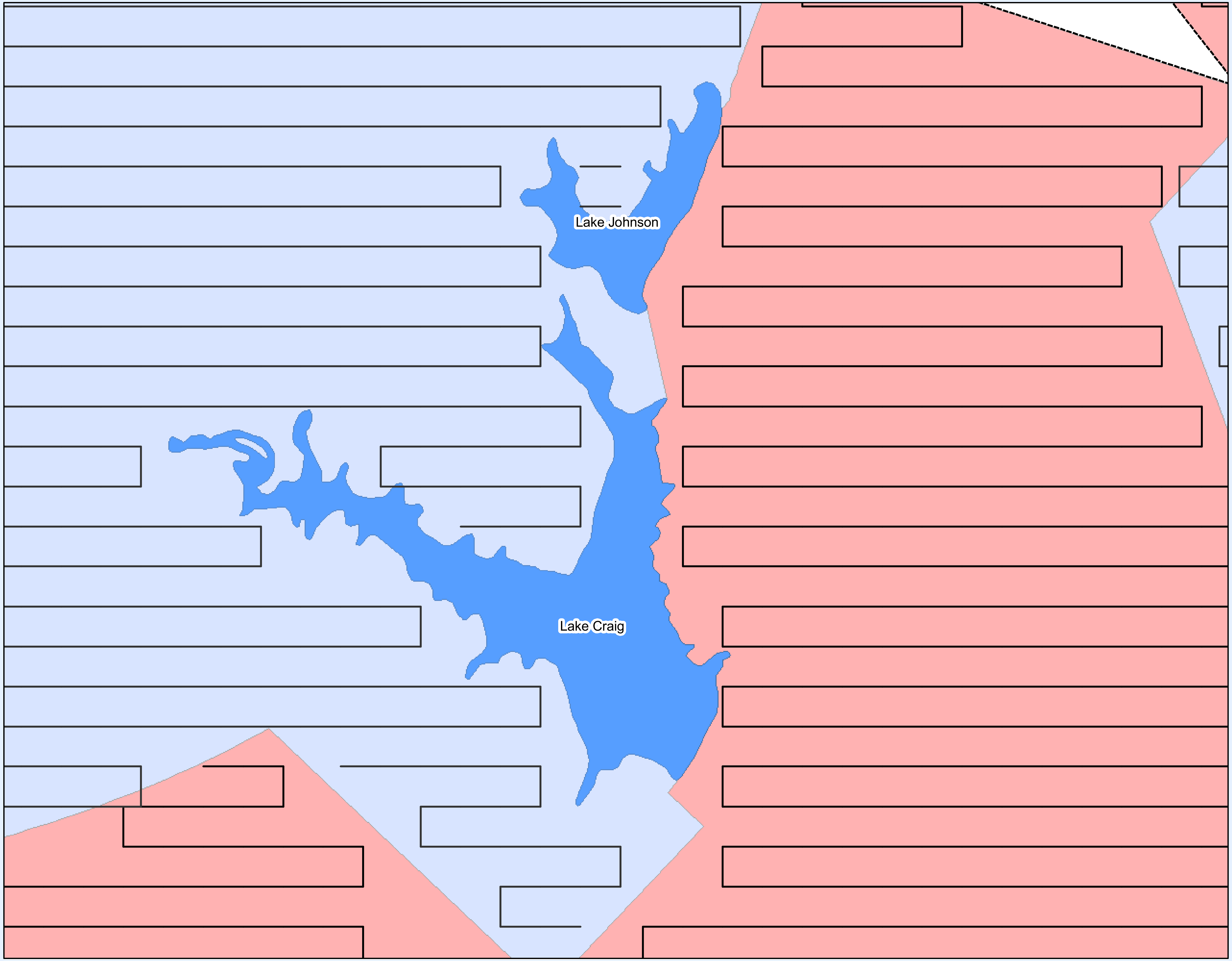

Former Camp Croft, SC
Lake Johnson and Lake Craig

Project Number	Date	Exhibit
00017	APRIL 2011	13

KEY

416' Transect
MRS
Approximate Former Camp Croft Boundary
Lake
Ground Recon - 416' Transect Spacing
Mag & Dig - 416' Transect Spacing

N
W E
S

0 500 1,000 Feet

Source(s)
USAESCH, USGS
Projection
UTM Zone 17 North, NAD83
Note(s)

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Exhibit 14: Visual Sample Plan (VSP) Input and Results

Munition	Range to No More Than 1 Hazardous Fragment/600 ft^2 Area	1.5 Hazardous Fragment Range (ft)	Survey Design	Survey Area Geometry	Anomaly Distribution	Background Anomaly Density (anom/acre)	False Negative (%)	Decision Rule: % Confidence[1]	Detection Probability[2]	Calculated Transect Spacing (ft)
60mm	166.3	250	Parallel	Circular	Bivariate Normal	15	5	95	90	416
37mm	114	171	Parallel	Circular	Bivariate Normal	15	5	95	90	242
MKII Grenade	62	93	Parallel	Circular	Bivariate Normal	15	5	95	90	112
Rifle Grenade	87	130.5	Parallel	Circular	Bivariate Normal	15	5	95	90	173

Munition	Range to No More Than 1 Hazardous Fragment/600 ft^2 Area	1.5 Hazardous Fragment Range (ft)	1.5 Hazardous Fragment range (m)	Average (ft) Excluding TP	Average (m) Excluding TP
37 mm M54	114	171	52.13414634	156.75	47.78963415
37 mm M63 TP	95	142.5	43.44512195	156.75	47.78963415
37 mm Mk I, LE Practice	68	102	31.09756098	102	31.09756098
37 mm MK II (0.053lb)	90	135	41.15853659	149.5	45.57926829
60 mm M49A2	150	225	68.59756098	249.5	76.06707317
60 mm M49A3	166	249	75.91463415	249.5	76.06707317
60 mm M49A5	183	274.5	83.68902439	249.5	76.06707317
60 mm TP M50	79	118.5	36.12804878	118.5	36.12804878
57 mm M306	162	243	74.08536585	243	74.08536585
81 mm M362A1	243	364.5	111.1280488	345.6	105.3658537
81 mm M374	234	351	107.0121951	345.6	105.3658537
81 mm M43	230	345	105.1829268	345.6	105.3658537
81 mm M45	224	336	102.4390244	345.6	105.3658537
81 mm M56	221	331.5	101.0670732	345.6	105.3658537
81 mm TP M43A1	89	133.5	40.70121951	133.5	40.70121951
MKII Grenade	62	93	28.35365854	93	28.35365854
Rifle Grenade Robust	87	130.5	39.78658537	130.5	39.78658537

Notes:
[1]Anomalies above background
[2] 350 anomalies above background

Project Objective Worksheet

Site: Former Camp Croft, Spartanburg, SC

Project: Remedial Investigation/Feasibility Study

Project Objective						
	Executable Stage					Project Objective
No.	Current	Future	Description	Source	Data User(s)	Classification
1	X		The project objective is to determine the nature and extent of potential MEC/MC contamination associated with the former FUDS and to evaluation potential remedial alternatives for areas where contamination exists.	ASR, ASR Supplement, GIS-Based Historical Photograph Analysis, EE/CAs, and Removal Reports	_X_ Risk _X_ Compliance _X_ Remedy _X_ Responsibility	_X_ Basic ___ Optimum ___ Excessive
2	X		Eliminate from further consideration those releases that pose no significant threat to public health or the environment.		_X_ Risk _X_ Compliance _X_ Remedy _X_ Responsibility	_X_ Basic ___ Optimum ___ Excessive
3		X	Expand the existing project beyond the identified MRSs, AoPIs and FUDS boundary, as necessary based on findings.		_X_ Risk _X_ Compliance _X_ Remedy _X_ Responsibility	___ Basic _X_ Optimum ___ Excessive
4		X	Expansion of the existing project to encompass the entire FUDS property and possibly beyond that boundary.		_X_ Risk _X_ Compliance _X_ Remedy _X_ Responsibility	___ Basic ___ Optimum _X_ Excessive
					___ Risk ___ Compliance ___ Remedy ___ Responsibility	___ Basic ___ Optimum ___ Excessive
					___ Risk ___ Compliance ___ Remedy ___ Responsibility	___ Basic ___ Optimum ___ Excessive

Site Information Worksheet

Site: Former Camp Croft, Spartanburg, SC

Project: Remedial Investigation/Feasibility Study

	Site Information Needed	Potential Source(s) of Site Information	User of Site Information	Suggested Means to Obtain Site Information	Deadline for Obtaining Site Information
1	Determine if threatened or endangered species are known to be present at the site.	SC DHEC	Risk Assessors	Formal request in writing.	Prior to Work Plan development.
2	Obtain historical response information from the Spartanburg County Sheriff's Bomb Disposal Unit.	Spartanburg County Sheriff's Department	All data users	Formal request in writing.	Prior to Work Plan development.
3	Consolidate anecdotal information regarding historical site usage and potential munitions findings from the public.	Public	All data users	Work with existing RAB to request this information.	Prior to Work Plan development.
4					
5					
6					

Phase 1 MFR Worksheet

Author(s)/Reviewer(s):
US Army Corps of Engineers, Charleston District (CESAC)
US Army Engineering and Support Center, Huntsville (USAESCH)
Zapata Incorporated (ZAPATA)
South Carolina Department of Health & Environmental Control (SC DHEC)
South Carolina Department of Parks, Recreation & Tourism (SC DPRT)

Revision Date: 06-Apr-11 Review Date: ____________

Location: Spartanburg, SC
Site: Former Camp Croft (FUDS I04SC001603)
Project: Remedial Investigation/Feasibility Study (RI/FS)
(Attach Phase I MFR to PMP)

TPP TEAM (EM 200-1-2, Paragraph 1.1.1)

Decision Makers	Data User Perspectives	Data Implementor Perspectives
Customer: - CESAC	Risk: - CESAC & USAESCH	Sampling: - CESAC, USAESCH, ZAPATA
Project Manager: - Mr. Shawn Boone (CESAC)	Compliance: - CESAC & USAESCH	
Regulator(s): - SC DHEC	Remedy: - CESAC & USAESCH	Analysis: - CESAC, USAESCH, ZAPATA
Stakeholders: - SC DHEC, SC DPRT, Private Landowners, Industry, and the Restoration Advisory Board (RAB)	Responsibility: - CESAC & USAESCH	

CUSTOMER'S GOALS (EM 200-1-2, Paragraph 1.1.2)

Future Land Use(s) at Site	Regulatory Compliance Status and Issues	Interim Site Closeout Goal (if applicable)
Various: - Recreational - Residential - Industrial - Agricultural - Undeveloped	This site falls under the Defense Environmental Restoration Program (DERP) – Formerly Used Defense Sites (FUDS) Program. Work will be conducted in accordance with 29 Code of Federal Regulations (CFR) 1910.120, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response action, the National Contingency Plan (NCP) to the maximum extent practical, and pursuant to ER 200-3-1, dated 10 May 2004. There are no known areas/parcels within the project site that have a designated compliance status or issue (e.g., National Priority Listing, Resource Conservation and Recovery Act permitting, etc.) other than those described.	Interim Goals: - Completion of RI Stage. - Completion of FS Stage. - Acceptance of a Decision Document (DD).

CUSTOMER'S GOALS (continued)

Site Closeout Statement

Site closeout will be achieved when the exposure potential of munitions of concern (MEC) and munitions constituents (MC) has been as safely mitigated as possible to acceptable risk levels according to the Technical Project Planning (TPP) team members in a manner in which the property is conducive to future land use expectations. In order to achieve site closure, the nature and extent of any potential MEC/MC will have to be characterized, the feasibility of potential remedial alternatives evaluated, and the acceptance of selected alternatives employed, as necessary.

The current RI/FS project specifically identifies three Munitions Response Sites (MRSs) and 11 optional sites of varying sizes located within the FUDS boundary but outside of the three MRSs. The three MRSs include the Gas Chambers (MRS 1), the Grenade Court (MRS 2), and the Land Range Complex (MRS 3). Of the 11 optional sites, 10 are defined in the PWS as “Areas of Potential Interest” (AoPI), and one appears to be associated with MRS 3, that being the Lake Craig and Lake Johnson Range Complex. The AoPIs correspond to areas previously referred to as Ordnance Operable Units (OOUs); those areas include AoPIs 3, 5, 8, 9E, 9G, 10A, 10B, 11B, 11C, and 11D. Eighteen previously defined OOUs exist within or partially within MRS 3; OOUs 1A, 1B, 2, 4, 6A, 6B, 7, 9A, 9B, 9C, 9D, 9F, 9H, 10C, 10D, 11A, 12A, and 12B.

Customer's Schedule Requirements

Acceptance of Decision Documents (DD) at the Gas Chambers MRS, Grenade Court MRS, and Land Range Complex MRS should be achieved by 31 January 2013.

Customer's Site Budget

Budget requirements to achieve site closure are unknown at this time. Potential management/cleanup costs will be evaluated during the FS process.

IDENTIFY SITE APPROACH

EXISTING SITE INFORMATION DATA

Attachment(s) to Phase I MFR	Site Information Repository	Preliminary Conceptual Site Model
Numerous documents including the Archive Search Report (ASR), ASR Supplement, and interim response action documents can be found at http://www.campcroft.net. A Preliminary Conceptual Site Model (CSM) has been attached to this worksheet.	Spartanburg County Library 151 South Church Street Spartanburg, SC 29306 (864) 596-3500	A preliminary conceptual site model was develeoped for this RI/FS project.

POTENTIAL POINTS OF COMPLIANCE

Potential points of compliance include the MRS and AoPI boundaries, the Croft State Natural Area boundary, the former FUDS boundary, and former range fan boundaries.

MEDIA OF POTENTIAL CONCERN

The media of potential concern includes surface and subsurface soil.

Project Objectives

The project objective is to determine the nature and extent of potential MEC/MC contamination associated with the former FUDS and to evaluation potential remedial alternatives for areas where contamination exists.

Eliminate from further consideration those releases that pose no significant threat to public health or the environment.

See attached worksheets developed by PDT.

IDENTIFY SITE APPROACH (continued)

REGULATOR AND STAKEHOLDER PERSPECTIVES

Regulators	Community Interests	Others
(To be added by stakeholder.)	(To be added by stakeholder.)	(To be added by stakeholder.)

PROBABLE REMEDIES

Probable remedies include 1) No DoD Action Indicated, 2) Institutional controls, 3) engineering controls, 4) surface removal, 5) subsurface removal, and 6) any combination of the these options (e.g., surface removal and institutional controls). The selection of the appropriate remedy will be MRS and AoPI specific and will be based on findings from the RI/FS process.

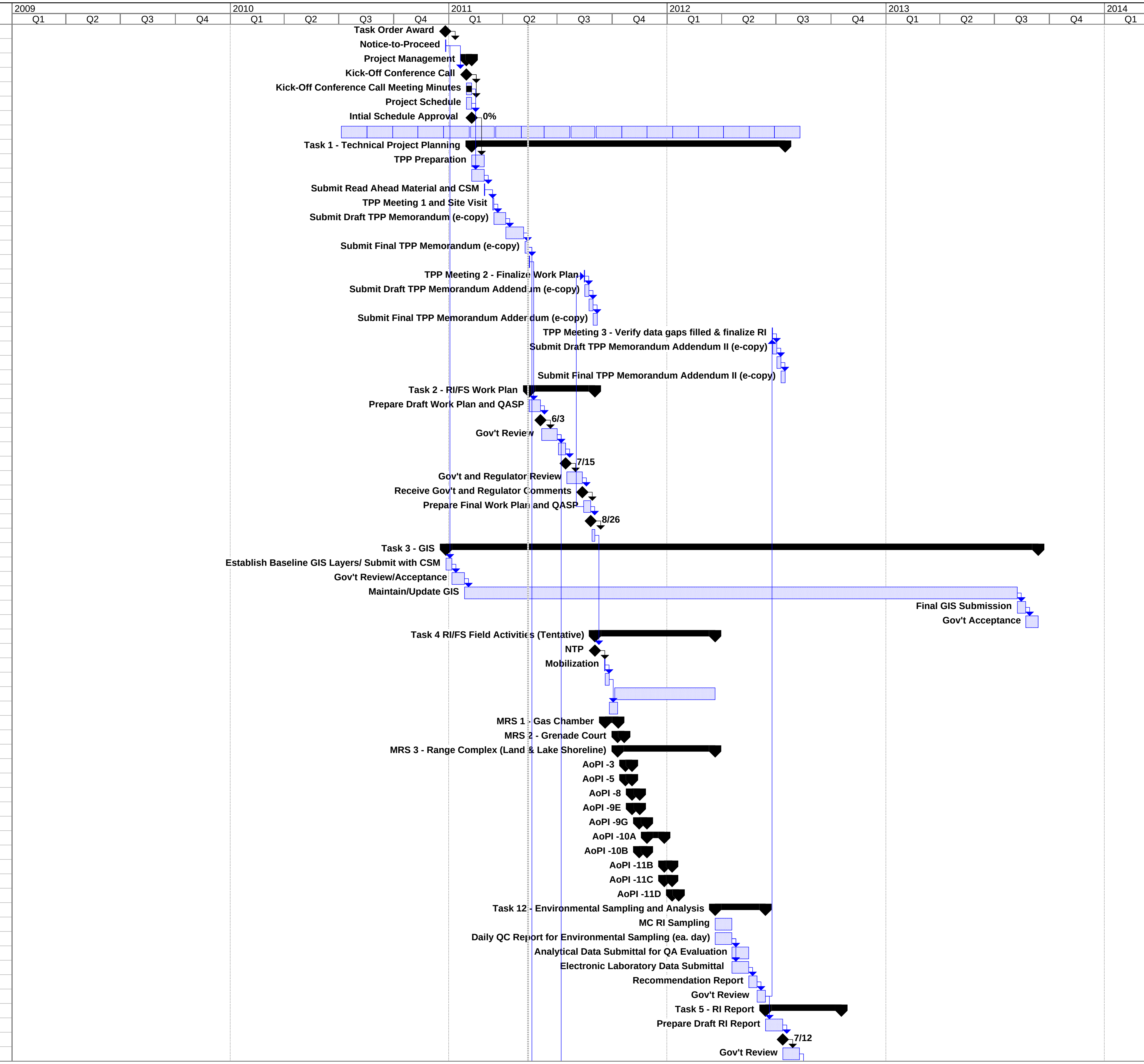
EXECUTABLE STAGES TO SITE CLOSEOUT

Executable stages relevant to the this project are listed below along with a brief description.

1) TPP Process - develop project objectives with project delivery team (PDT),
2) Work Plan - develop the investigation and safety plans into comprehensive document,
3) Fieldwork - conduct various field activities,
4) Remedial Investigation (RI) Report - document the fieldwork findings and risk assessment,
5) Feasibility Study (FS) Report - evaluate the feasibility of remedial options and alternatives,
6) Proposed Plan - allow the public to evaluate the proposed plan as determined following the FS,
7) Decision Document (DD) - document the PDT and public preferences for remedial action, and
8) Public Involvement Plan (PIP) - engage the public throughout the process using the PIP.

IDENTIFY CURRENT PROJECT		
SITE CONSTRAINTS AND DEPENDENCIES Administrative Constraints and Dependencies 1) Funding, 2) Scheduling, 3) Contracting mechanism, and 4) Rights-of-entry (ROE). Technical Constraints and Dependencies 1) Physical characteristics - geology, topography, vegetation, 2) Aerial extent of project site, 3) Availability of public access on park property, 4) Variable and unknown historical munitions usage, 5) Health and safety requirements (CFR, USACE and ZAPATA SOPs), 6) Certified laboratories (for MC analyses), and 7) Landowner site usage (e.g., recreational golfing, agricultural, timber harvest). Legal and Regulatory Milestones and Requirements 1) Consistent with CERCLA and NCP, 2) Public and stakeholder involvement and review, 3) Contracted obligations, and 4) Funding beyond this RI/FS stage.		
CURRENT EXECUTABLE STAGE This stage of the project includes the RI/FS through the DD.		
Basic	Optimum	Excessive
MEC and MC investigation and characterization in MRSs and AoPIs, risk assessment of findings, reporting and documentation of remedial options/alternatives.	Expand the existing project beyond the identified MRSs, AoPIs and FUDS boundary, as necessary based on findings.	Expansion of the existing project to encompass the entire FUDS property and possibly beyond that boundary.

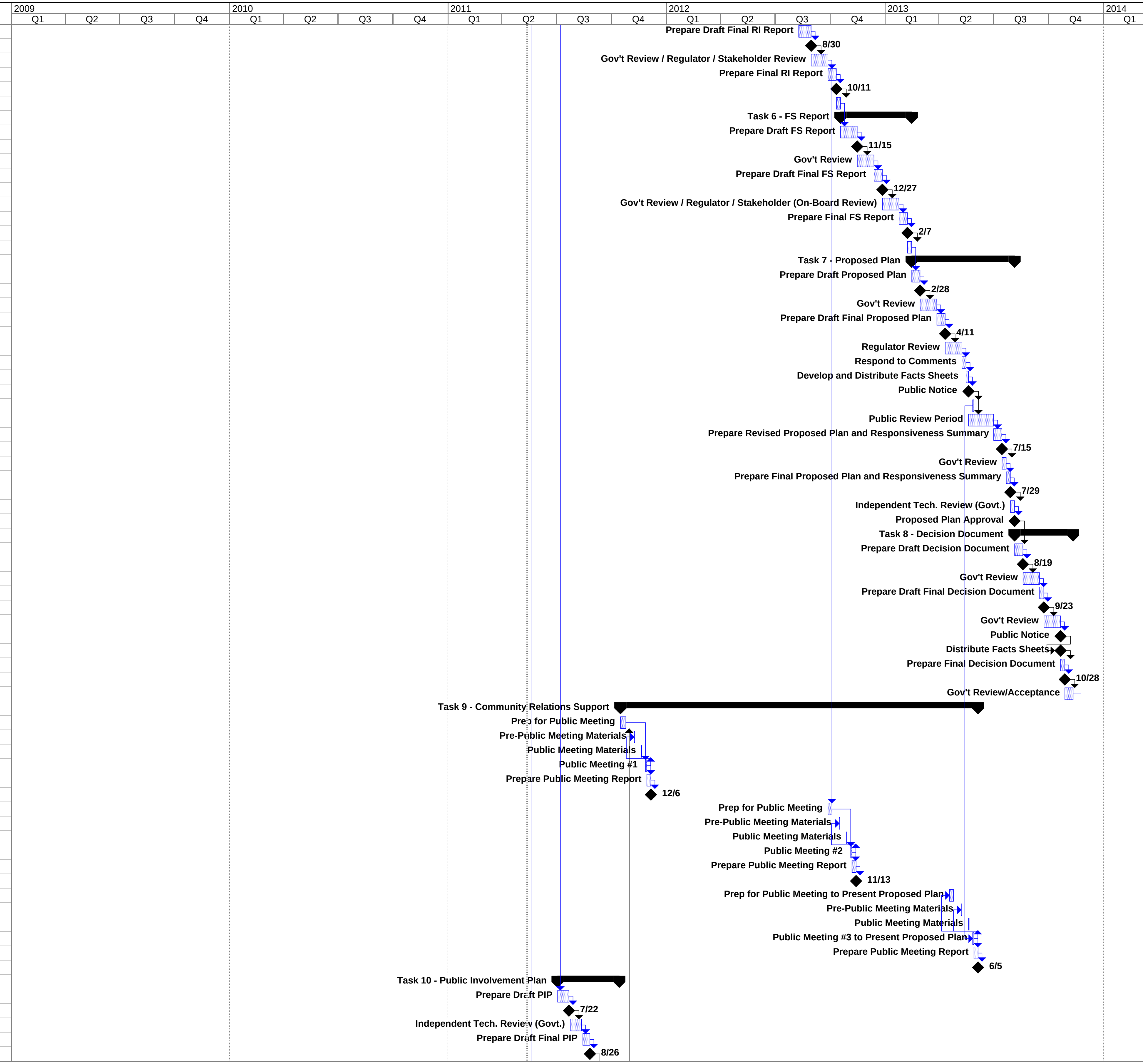
ID	Task Name	Duration	Start	Finish	Predecessors
1	Task Order Award	0 days	Mon 12/27/10	Mon 12/27/10	
2	Notice-to-Proceed	1 day	Mon 12/27/10	Mon 12/27/10	1
3	**Project Management**	**7 days**	**Mon 1/31/11**	**Tue 2/8/11**	
4	Kick-Off Conference Call	0 days	Mon 1/31/11	Mon 1/31/11	2FS+2 days
5	Kick-Off Conference Call Meeting Minutes	7 days	Mon 1/31/11	Tue 2/8/11	4
6	Project Schedule	7 days	Mon 1/31/11	Tue 2/8/11	4
7	Intial Schedule Approval	0 days	Tue 2/8/11	Tue 2/8/11	6
8	**Monthly Report**	**702 days**	**Tue 7/6/10**	**Wed 3/13/13**	
32	**Task 1 - Technical Project Planning**	**374 days**	**Wed 2/9/11**	**Mon 7/16/12**	
33	TPP Preparation	15 days	Wed 2/9/11	Tue 3/1/11	7
34	CSM Revision	15 days	Wed 2/9/11	Tue 3/1/11	5
35	Submit Read Ahead Material and CSM	1 day	Wed 3/2/11	Wed 3/2/11	34
36	TPP Meeting 1 and Site Visit	2 days	Wed 3/16/11	Thu 3/17/11	35FS+9 days
37	Submit Draft TPP Memorandum (e-copy)	14 days	Fri 3/18/11	Wed 4/6/11	36
38	Draft TPP Memorandum - Govt Review	22 days	Thu 4/7/11	Fri 5/6/11	37
39	Submit Final TPP Memorandum (e-copy)	5 days	Mon 5/9/11	Fri 5/13/11	38
40	Receive Gov't. Approval of Final TPP Memorandum	1 day	Mon 5/16/11	Mon 5/16/11	39
41	TPP Meeting 2 - Finalize Work Plan	1 day	Tue 8/16/11	Tue 8/16/11	57SS+1 day
42	Submit Draft TPP Memorandum Addendum (e-copy)	5 days	Wed 8/17/11	Tue 8/23/11	41
43	Draft TPP Memorandum Addendum - Govt Review	5 days	Wed 8/24/11	Tue 8/30/11	42
44	Submit Final TPP Memorandum Addendum (e-copy)	5 days	Wed 8/31/11	Tue 9/6/11	43
45	TPP Meeting 3 - Verify data gaps filled & finalize RI	1 day	Mon 6/25/12	Mon 6/25/12	182FS+7 days
46	Submit Draft TPP Memorandum Addendum II (e-copy)	5 days	Tue 6/26/12	Mon 7/2/12	45
47	Draft TPP Memorandum Addendum II - Govt Review	5 days	Tue 7/3/12	Mon 7/9/12	46
48	Submit Final TPP Memorandum Addendum II (e-copy)	5 days	Tue 7/10/12	Mon 7/16/12	47
49	**Task 2 - RI/FS Work Plan**	**80 days**	**Mon 5/16/11**	**Fri 9/2/11**	
50	Prepare Draft Work Plan and QASP	15 days	Mon 5/16/11	Fri 6/3/11	40FS-1 day
51	Ship Draft Work Plan and QASP (Gov't only)	0 days	Fri 6/3/11	Fri 6/3/11	50
52	Gov't Review	20 days	Mon 6/6/11	Fri 7/1/11	51
53	Prepare Draft-Final Work Plans and QASP	10 days	Mon 7/4/11	Fri 7/15/11	52
54	Ship Draft-Final Work Plans and QASP	0 days	Fri 7/15/11	Fri 7/15/11	53
55	Gov't and Regulator Review	20 days	Mon 7/18/11	Fri 8/12/11	54
56	Receive Gov't and Regulator Comments	0 days	Fri 8/12/11	Fri 8/12/11	55
57	Prepare Final Work Plan and QASP	10 days	Mon 8/15/11	Fri 8/26/11	56
58	Ship Final Work Plans and QASP	0 days	Fri 8/26/11	Fri 8/26/11	57
59	Receive Gov't Approval of Final Work Plans	5 days	Mon 8/29/11	Fri 9/2/11	58
60	**Task 3 - GIS**	**708 days**	**Tue 12/28/10**	**Thu 9/12/13**	
61	Establish Baseline GIS Layers/ Submit with CSM	8 days	Tue 12/28/10	Thu 1/6/11	2
62	Gov't Review/Acceptance	15 days	Fri 1/7/11	Thu 1/27/11	61
63	Maintain/Update GIS	660 days	Fri 1/28/11	Thu 8/8/13	62
64	Final GIS Submission	10 days	Fri 8/9/13	Thu 8/22/13	63
65	Gov't Acceptance	15 days	Fri 8/23/13	Thu 9/12/13	64
66	**Task 4 RI/FS Field Activities (Tentative)**	**143 days**	**Fri 9/2/11**	**Wed 3/21/12**	
67	NTP	0 days	Fri 9/2/11	Fri 9/2/11	59
68	Mobilization	1 day	Mon 9/19/11	Mon 9/19/11	67FS+10 days
69	Site Setup and Site-Specific Training	5 days	Tue 9/20/11	Mon 9/26/11	68
70	Anomaly Density GIS Mapping (Concurrent with Field Activities)	120 days	Thu 10/6/11	Wed 3/21/12	74,95FF
71	Analog and Digital Test Plot Setup, Performance, Report	10 days	Tue 9/27/11	Mon 10/10/11	69
72	**MRS 1 - Gas Chamber**	**16 days**	**Tue 9/20/11**	**Tue 10/11/11**	
80	**MRS 2 - Grenade Court**	**9 days**	**Tue 10/11/11**	**Fri 10/21/11**	
88	**MRS 3 - Range Complex (Land & Lake Shoreline)**	**117 days**	**Tue 10/11/11**	**Wed 3/21/12**	
96	**AoPI -3**	**9 days**	**Mon 10/24/11**	**Thu 11/3/11**	
104	**AoPI -5**	**9 days**	**Mon 10/24/11**	**Thu 11/3/11**	
112	**AoPI -8**	**9 days**	**Fri 11/4/11**	**Wed 11/16/11**	
120	**AoPI -9E**	**9 days**	**Fri 11/4/11**	**Wed 11/16/11**	
128	**AoPI -9G**	**9 days**	**Wed 11/16/11**	**Mon 11/28/11**	
136	**AoPI -10A**	**21 days**	**Tue 11/29/11**	**Tue 12/27/11**	
144	**AoPI -10B**	**9 days**	**Wed 11/16/11**	**Mon 11/28/11**	
152	**AoPI -11B**	**9 days**	**Wed 12/28/11**	**Mon 1/9/12**	
160	**AoPI -11C**	**9 days**	**Wed 12/28/11**	**Mon 1/9/12**	
168	**AoPI -11D**	**9 days**	**Tue 1/10/12**	**Fri 1/20/12**	
176	**Task 12 - Environmental Sampling and Analysis**	**60 days**	**Thu 3/22/12**	**Wed 6/13/12**	
177	MC RI Sampling	20 days	Thu 3/22/12	Wed 4/18/12	95
178	Daily QC Report for Environmental Sampling (ea. day)	20 days	Thu 3/22/12	Wed 4/18/12	95
179	Analytical Data Submittal for QA Evaluation	20 days	Thu 4/19/12	Wed 5/16/12	178
180	Electronic Laboratory Data Submittal	20 days	Thu 4/19/12	Wed 5/16/12	178
181	Recommendation Report	10 days	Thu 5/17/12	Wed 5/30/12	180
182	Gov't Review	10 days	Thu 5/31/12	Wed 6/13/12	181
183	**Task 5 - RI Report**	**91 days**	**Thu 6/14/12**	**Thu 10/18/12**	
184	Prepare Draft RI Report	21 days	Thu 6/14/12	Thu 7/12/12	182
185	Ship Draft RI Report	0 days	Thu 7/12/12	Thu 7/12/12	184
186	Gov't Review	20 days	Fri 7/13/12	Thu 8/9/12	185



RI/FS at Camp Croft, SC
Date: Fri 5/13/11
Zapata Incorporated

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

ID	Task Name	Duration	Start	Finish	Predecessors
187	Prepare Draft Final RI Report	15 days	Fri 8/10/12	Thu 8/30/12	186
188	Ship Draft Final RI Report	0 days	Thu 8/30/12	Thu 8/30/12	187
189	Gov't Review / Regulator / Stakeholder Review	20 days	Fri 8/31/12	Thu 9/27/12	188
190	Prepare Final RI Report	10 days	Fri 9/28/12	Thu 10/11/12	189
191	Ship Final RI Report	0 days	Thu 10/11/12	Thu 10/11/12	190
192	Receive Final RI Report Approval	5 days	Fri 10/12/12	Thu 10/18/12	191
193	**Task 6 - FS Report**	**85 days**	**Fri 10/19/12**	**Thu 2/14/13**	
194	Prepare Draft FS Report	20 days	Fri 10/19/12	Thu 11/15/12	192
195	Ship Draft FS Report	0 days	Thu 11/15/12	Thu 11/15/12	194
196	Gov't Review	20 days	Fri 11/16/12	Thu 12/13/12	195
197	Prepare Draft Final FS Report	10 days	Fri 12/14/12	Thu 12/27/12	196
198	Ship Draft Final FS Report	0 days	Thu 12/27/12	Thu 12/27/12	197
199	Gov't Review / Regulator / Stakeholder (On-Board Review)	20 days	Fri 12/28/12	Thu 1/24/13	198
200	Prepare Final FS Report	10 days	Fri 1/25/13	Thu 2/7/13	199
201	Ship Final FS Report	0 days	Thu 2/7/13	Thu 2/7/13	200
202	Receive Final FS Report Approval	5 days	Fri 2/8/13	Thu 2/14/13	201
203	**Task 7 - Proposed Plan**	**122 days**	**Fri 2/15/13**	**Mon 8/5/13**	
204	Prepare Draft Proposed Plan	10 days	Fri 2/15/13	Thu 2/28/13	202
205	Ship Draft Proposed Plan	0 days	Thu 2/28/13	Thu 2/28/13	204
206	Gov't Review	20 days	Fri 3/1/13	Thu 3/28/13	205
207	Prepare Draft Final Proposed Plan	10 days	Fri 3/29/13	Thu 4/11/13	206
208	Ship Draft Final Proposed Plan	0 days	Thu 4/11/13	Thu 4/11/13	207
209	Regulator Review	20 days	Fri 4/12/13	Thu 5/9/13	208
210	Respond to Comments	5 days	Fri 5/10/13	Thu 5/16/13	209
211	Develop and Distribute Facts Sheets	2 days	Fri 5/17/13	Mon 5/20/13	210
212	Public Notice	0 days	Mon 5/20/13	Mon 5/20/13	211
213	Public Meeting w/ Transcriber (aka Public Meeting #3)	2 days	Tue 5/28/13	Wed 5/29/13	212FS+5 days
214	Public Review Period	30 days	Tue 5/21/13	Mon 7/1/13	212
215	Prepare Revised Proposed Plan and Responsiveness Summary	10 days	Tue 7/2/13	Mon 7/15/13	214
216	Submit Revised Proposed Plan and Responsiveness Summary	0 days	Mon 7/15/13	Mon 7/15/13	215
217	Gov't Review	5 days	Tue 7/16/13	Mon 7/22/13	216
218	Prepare Final Proposed Plan and Responsiveness Summary	5 days	Tue 7/23/13	Mon 7/29/13	217
219	Submit Final Proposed Plan and Responsiveness Summary	0 days	Mon 7/29/13	Mon 7/29/13	218
220	Independent Tech. Review (Govt.)	5 days	Tue 7/30/13	Mon 8/5/13	219
221	Proposed Plan Approval	0 days	Mon 8/5/13	Mon 8/5/13	220
222	**Task 8 - Decision Document**	**70 days**	**Tue 8/6/13**	**Mon 11/11/13**	
223	Prepare Draft Decision Document	10 days	Tue 8/6/13	Mon 8/19/13	221
224	Submit Draft Decision Document	0 days	Mon 8/19/13	Mon 8/19/13	223
225	Gov't Review	20 days	Tue 8/20/13	Mon 9/16/13	224
226	Prepare Draft Final Decision Document	5 days	Tue 9/17/13	Mon 9/23/13	225
227	Submit Draft Final Decision Document	0 days	Mon 9/23/13	Mon 9/23/13	226
228	Gov't Review	20 days	Tue 9/24/13	Mon 10/21/13	227
229	Public Notice	0 days	Mon 10/21/13	Mon 10/21/13	228
230	Distribute Facts Sheets	0 days	Mon 10/21/13	Mon 10/21/13	229
231	Prepare Final Decision Document	5 days	Tue 10/22/13	Mon 10/28/13	230
232	Submit Final Decision Document	0 days	Mon 10/28/13	Mon 10/28/13	231
233	Gov't Review/Acceptance	10 days	Tue 10/29/13	Mon 11/11/13	232
234	**Task 9 - Community Relations Support**	**428 days**	**Mon 10/17/11**	**Wed 6/5/13**	
235	Prep for Public Meeting	7 days	Mon 10/17/11	Tue 10/25/11	263
236	Pre-Public Meeting Materials	1 day	Wed 11/9/11	Wed 11/9/11	238FS-15 days
237	Public Meeting Materials	1 day	Mon 11/21/11	Mon 11/21/11	238FS-7 days
238	Public Meeting #1	2 days	Mon 11/28/11	Tue 11/29/11	235FS+23 days
239	Prepare Public Meeting Report	5 days	Wed 11/30/11	Tue 12/6/11	238
240	Submit Public Meeting Report	0 days	Tue 12/6/11	Tue 12/6/11	239
241	Prep for Public Meeting	5 days	Fri 9/28/12	Thu 10/4/12	189
242	Pre-Public Meeting Materials	1 day	Wed 10/17/12	Wed 10/17/12	244FS-15 days
243	Public Meeting Materials	1 day	Mon 10/29/12	Mon 10/29/12	244FS-7 days
244	Public Meeting #2	2 days	Mon 11/5/12	Tue 11/6/12	241FS+21 days
245	Prepare Public Meeting Report	5 days	Wed 11/7/12	Tue 11/13/12	244
246	Submit Public Meeting Report	0 days	Tue 11/13/12	Tue 11/13/12	245
247	Prep for Public Meeting to Present Proposed Plan	5 days	Fri 4/19/13	Thu 4/25/13	250FS-29 days
248	Pre-Public Meeting Materials	1 day	Thu 5/9/13	Thu 5/9/13	250FS-15 days
249	Public Meeting Materials	1 day	Tue 5/21/13	Tue 5/21/13	250FS-7 days
250	Public Meeting #3 to Present Proposed Plan	2 days	Tue 5/28/13	Wed 5/29/13	213SS
251	Prepare Public Meeting Report	5 days	Thu 5/30/13	Wed 6/5/13	250
252	Submit Public Meeting Report	0 days	Wed 6/5/13	Wed 6/5/13	251
253	**Task 10 - Public Involvement Plan**	**75 days**	**Mon 7/4/11**	**Fri 10/14/11**	
254	Prepare Draft PIP	15 days	Mon 7/4/11	Fri 7/22/11	52
255	Submit Draft PIP	0 days	Fri 7/22/11	Fri 7/22/11	254
256	Independent Tech. Review (Govt.)	15 days	Mon 7/25/11	Fri 8/12/11	255
257	Prepare Draft Final PIP	10 days	Mon 8/15/11	Fri 8/26/11	256
258	Submit Draft Final PIP	0 days	Fri 8/26/11	Fri 8/26/11	257



RI/FS at Camp Croft, SC
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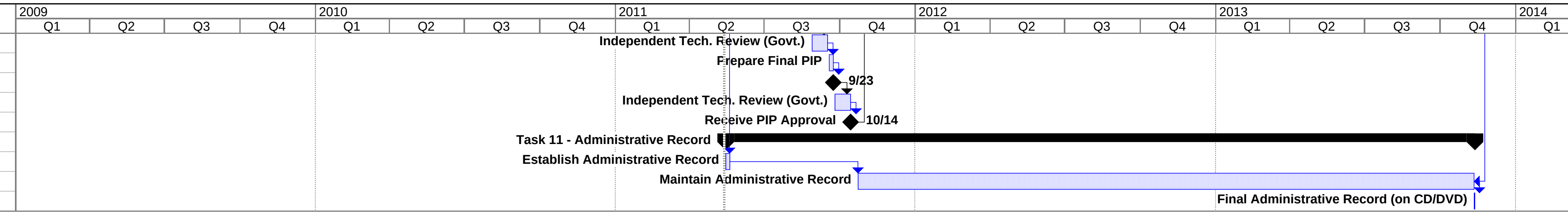
Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

ID	Task Name	Duration	Start	Finish	Predecessors
259	Independent Tech. Review (Govt.)	15 days	Mon 8/29/11	Fri 9/16/11	258
260	Prepare Final PIP	5 days	Mon 9/19/11	Fri 9/23/11	259
261	Submit Final PIP	0 days	Fri 9/23/11	Fri 9/23/11	260
262	Independent Tech. Review (Govt.)	15 days	Mon 9/26/11	Fri 10/14/11	261
263	Receive PIP Approval	0 days	Fri 10/14/11	Fri 10/14/11	262
264	**Task 11 - Administrative Record**	**652 days**	**Mon 5/16/11**	**Tue 11/12/13**	
265	Establish Administrative Record	5 days	Mon 5/16/11	Fri 5/20/11	39
266	Maintain Administrative Record	536 days	Mon 10/24/11	Mon 11/11/13	265,233FF
267	Final Administrative Record (on CD/DVD)	1 day	Tue 11/12/13	Tue 11/12/13	266



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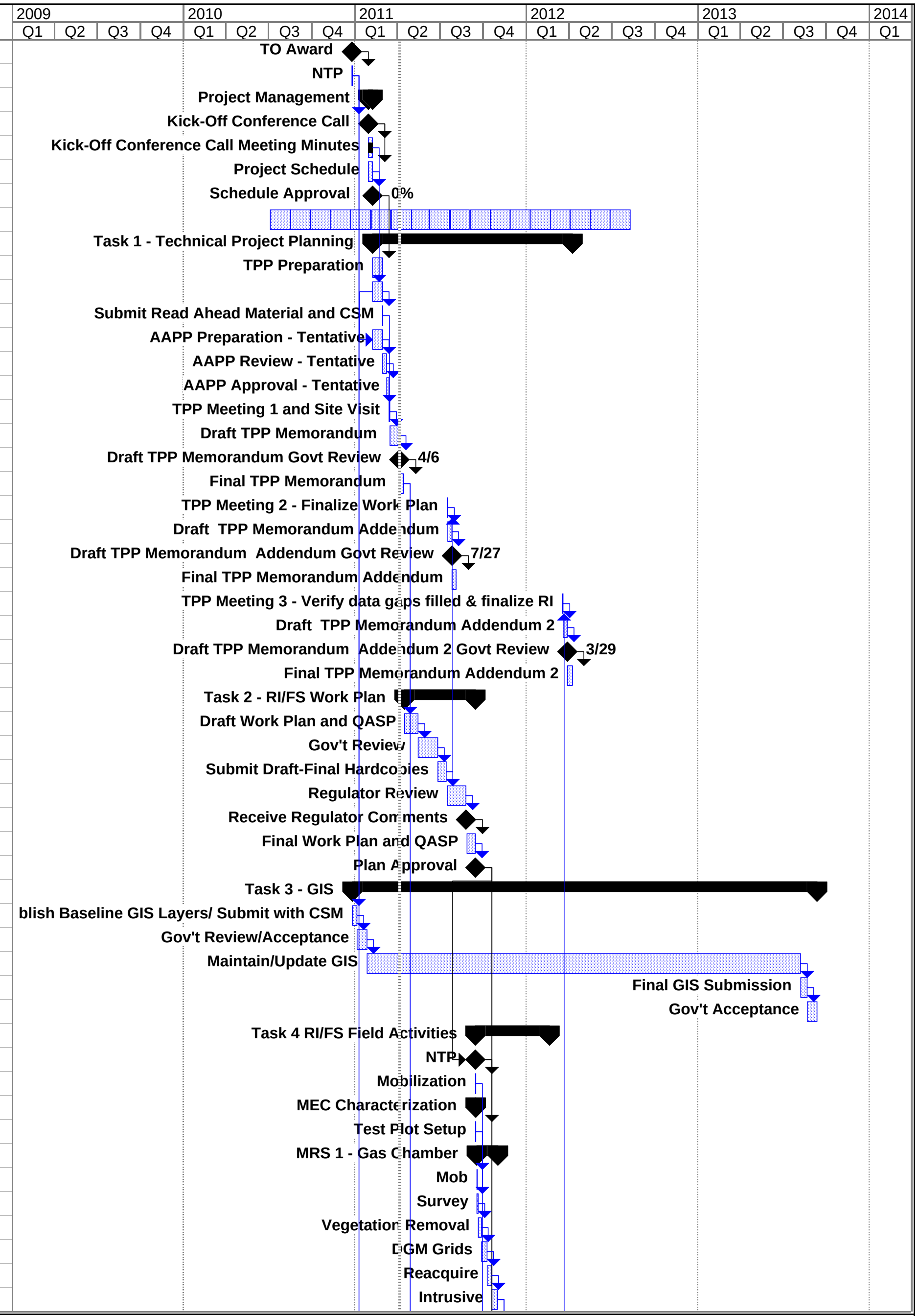
Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

ID	Task Name	Duration	Start	Finish	Predecessors
1	TO Award	0 days	Mon 12/27/10	Mon 12/27/10	
2	NTP	1 day	Mon 12/27/10	Mon 12/27/10	1
3	**Project Management**	**7 days**	**Mon 1/31/11**	**Tue 2/8/11**	
4	Kick-Off Conference Call	0 days	Mon 1/31/11	Mon 1/31/11	2FS+2 days
5	Kick-Off Conference Call Meeting Minutes	7 days	Mon 1/31/11	Tue 2/8/11	4
6	Project Schedule	7 days	Mon 1/31/11	Tue 2/8/11	4
7	Schedule Approval	0 days	Tue 2/8/11	Tue 2/8/11	6
8	**Monthly Report**	**702 days**	**Tue 7/6/10**	**Wed 3/13/13**	
32	**Task 1 - Technical Project Planning**	**304 days**	**Wed 2/9/11**	**Mon 4/9/12**	
33	TPP Preparation	15 days	Wed 2/9/11	Tue 3/1/11	7
34	CSM Revision	15 days	Wed 2/9/11	Tue 3/1/11	5
35	Submit Read Ahead Material and CSM	1 day	Wed 3/2/11	Wed 3/2/11	34
36	AAPP Preparation - Tentative	15 days	Wed 2/9/11	Tue 3/1/11	34SS
37	AAPP Review - Tentative	7 days	Wed 3/2/11	Thu 3/10/11	36
38	AAPP Approval - Tentative	3 days	Fri 3/11/11	Tue 3/15/11	37
39	TPP Meeting 1 and Site Visit	2 days	Wed 3/16/11	Thu 3/17/11	35FS+9 days
40	Draft TPP Memorandum	14 days	Fri 3/18/11	Wed 4/6/11	39
41	Draft TPP Memorandum Govt Review	0 days	Wed 4/6/11	Wed 4/6/11	40
42	Final TPP Memorandum	7 days	Thu 4/7/11	Fri 4/15/11	41
43	TPP Meeting 2 - Finalize Work Plan	1 day	Mon 7/18/11	Mon 7/18/11	54
44	Draft TPP Memorandum Addendum	7 days	Tue 7/19/11	Wed 7/27/11	43
45	Draft TPP Memorandum Addendum Govt Review	0 days	Wed 7/27/11	Wed 7/27/11	44
46	Final TPP Memorandum Addendum	7 days	Thu 7/28/11	Fri 8/5/11	45
47	TPP Meeting 3 - Verify data gaps filled & finalize RI	1 day	Tue 3/20/12	Tue 3/20/12	197FS+7 days
48	Draft TPP Memorandum Addendum 2	7 days	Wed 3/21/12	Thu 3/29/12	47
49	Draft TPP Memorandum Addendum 2 Govt Review	0 days	Thu 3/29/12	Thu 3/29/12	48
50	Final TPP Memorandum Addendum 2	7 days	Fri 3/30/12	Mon 4/9/12	49
51	**Task 2 - RI/FS Work Plan**	**109 days**	**Mon 4/18/11**	**Thu 9/15/11**	
52	Draft Work Plan and QASP	21 days	Mon 4/18/11	Mon 5/16/11	42
53	Gov't Review	30 days	Tue 5/17/11	Mon 6/27/11	52
54	Submit Draft-Final Hardcopies	14 days	Tue 6/28/11	Fri 7/15/11	53
55	Regulator Review	30 days	Mon 7/18/11	Fri 8/26/11	54
56	Receive Regulator Comments	0 days	Fri 8/26/11	Fri 8/26/11	55
57	Final Work Plan and QASP	14 days	Mon 8/29/11	Thu 9/15/11	56
58	Plan Approval	0 days	Thu 9/15/11	Thu 9/15/11	57
59	**Task 3 - GIS**	**708 days**	**Tue 12/28/10**	**Thu 9/12/13**	
60	Establish Baseline GIS Layers/ Submit with CSM	8 days	Tue 12/28/10	Thu 1/6/11	2
61	Gov't Review/Acceptance	15 days	Fri 1/7/11	Thu 1/27/11	60
62	Maintain/Update GIS	660 days	Fri 1/28/11	Thu 8/8/13	61
63	Final GIS Submission	10 days	Fri 8/9/13	Thu 8/22/13	62
64	Gov't Acceptance	15 days	Fri 8/23/13	Thu 9/12/13	63
65	**Task 4 RI/FS Field Activities**	**112 days**	**Thu 9/15/11**	**Mon 2/20/12**	
66	NTP	0 days	Thu 9/15/11	Thu 9/15/11	58
67	Mobilization	1 day	Fri 9/16/11	Fri 9/16/11	66
68	**MEC Characterization**	**1 day**	**Fri 9/16/11**	**Fri 9/16/11**	
69	Test Plot Setup	1 day	Fri 9/16/11	Fri 9/16/11	58
70	**MRS 1 - Gas Chamber**	**33 days**	**Mon 9/19/11**	**Wed 11/2/11**	
71	Mob	1 day	Mon 9/19/11	Mon 9/19/11	69
72	Survey	3 days	Mon 9/19/11	Wed 9/21/11	67
73	Vegetation Removal	5 days	Thu 9/22/11	Wed 9/28/11	72
74	DGM Grids	8 days	Thu 9/29/11	Mon 10/10/11	73
75	Reacquire	8 days	Tue 10/11/11	Thu 10/20/11	74
76	Intrusive	8 days	Fri 10/21/11	Tue 11/1/11	75



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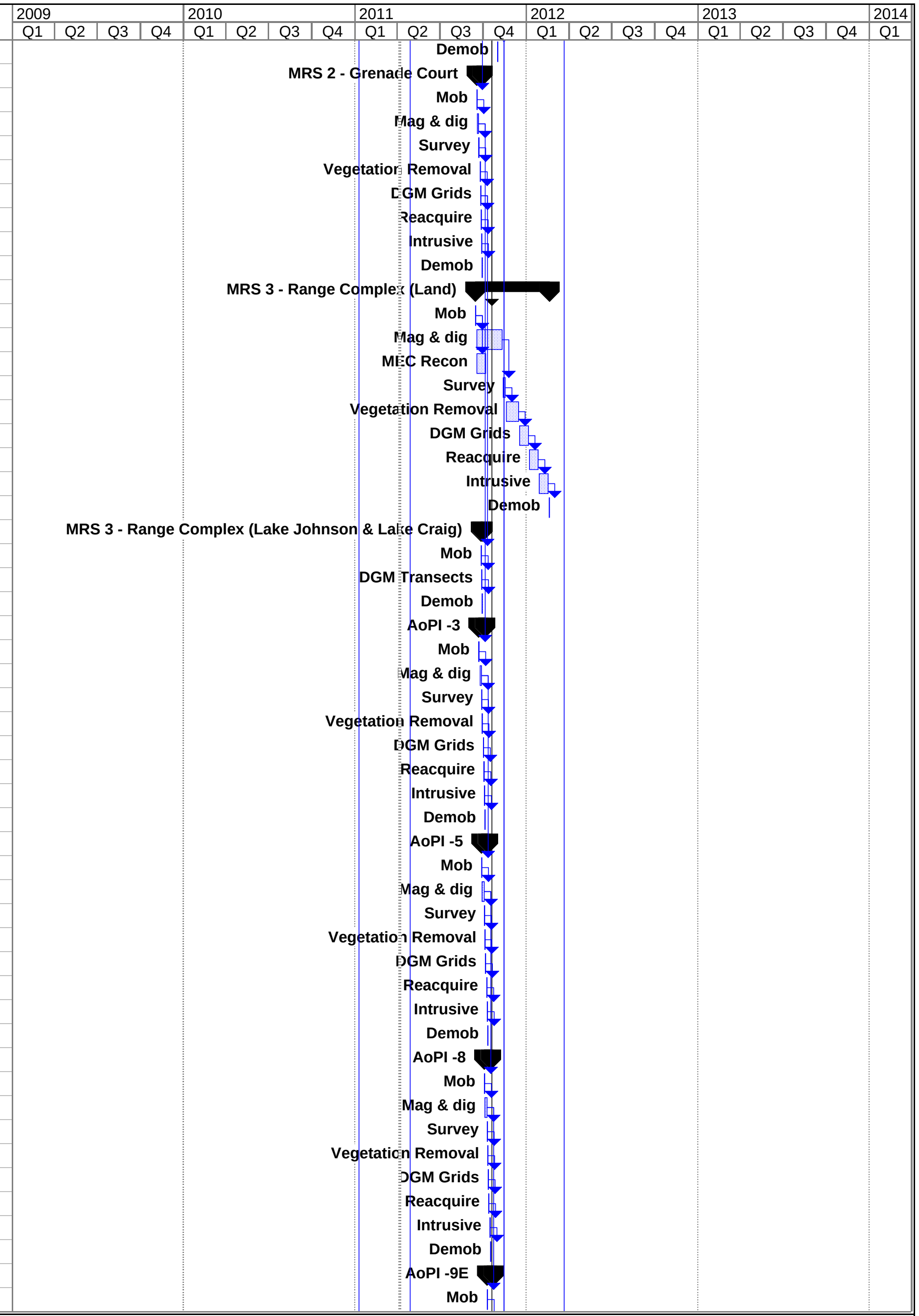
ID	Task Name	Duration	Start	Finish	Predecessors
77	Demob	1 day	Wed 11/2/11	Wed 11/2/11	76
78	**MRS 2 - Grenade Court**	**10 days**	**Mon 9/19/11**	**Fri 9/30/11**	
79	Mob	1 day	Mon 9/19/11	Mon 9/19/11	69
80	Mag & dig	3 days	Tue 9/20/11	Thu 9/22/11	79
81	Survey	1 day	Fri 9/23/11	Fri 9/23/11	80
82	Vegetation Removal	1 day	Mon 9/26/11	Mon 9/26/11	81
83	DGM Grids	1 day	Tue 9/27/11	Tue 9/27/11	82
84	Reacquire	1 day	Wed 9/28/11	Wed 9/28/11	83
85	Intrusive	1 day	Thu 9/29/11	Thu 9/29/11	84
86	Demob	1 day	Fri 9/30/11	Fri 9/30/11	85
87	**MRS 3 - Range Complex (Land)**	**112 days**	**Fri 9/16/11**	**Mon 2/20/12**	
88	Mob	1 day	Fri 9/16/11	Fri 9/16/11	66
89	Mag & dig	40 days	Mon 9/19/11	Fri 11/11/11	88
90	MEC Recon	15 days	Mon 9/19/11	Fri 10/7/11	88
91	Survey	5 days	Mon 11/14/11	Fri 11/18/11	89
92	Vegetation Removal	20 days	Mon 11/21/11	Fri 12/16/11	91
93	DGM Grids	15 days	Mon 12/19/11	Fri 1/6/12	92
94	Reacquire	15 days	Mon 1/9/12	Fri 1/27/12	93
95	Intrusive	15 days	Mon 1/30/12	Fri 2/17/12	94
96	Demob	1 day	Mon 2/20/12	Mon 2/20/12	95
97	**MRS 3 - Range Complex (Lake Johnson & Lake Craig)**	**3 days**	**Wed 9/28/11**	**Fri 9/30/11**	
98	Mob	1 day	Wed 9/28/11	Wed 9/28/11	83
99	DGM Transects	1 day	Thu 9/29/11	Thu 9/29/11	98
100	Demob	1 day	Fri 9/30/11	Fri 9/30/11	99
101	**AoPI -3**	**10 days**	**Fri 9/23/11**	**Thu 10/6/11**	
102	Mob	1 day	Fri 9/23/11	Fri 9/23/11	80
103	Mag & dig	3 days	Mon 9/26/11	Wed 9/28/11	102
104	Survey	1 day	Thu 9/29/11	Thu 9/29/11	103
105	Vegetation Removal	1 day	Fri 9/30/11	Fri 9/30/11	104
106	DGM Grids	1 day	Mon 10/3/11	Mon 10/3/11	105
107	Reacquire	1 day	Tue 10/4/11	Tue 10/4/11	106
108	Intrusive	1 day	Wed 10/5/11	Wed 10/5/11	107
109	Demob	1 day	Thu 10/6/11	Thu 10/6/11	108
110	**AoPI -5**	**10 days**	**Thu 9/29/11**	**Wed 10/12/11**	
111	Mob	1 day	Thu 9/29/11	Thu 9/29/11	103
112	Mag & dig	3 days	Fri 9/30/11	Tue 10/4/11	111
113	Survey	1 day	Wed 10/5/11	Wed 10/5/11	112
114	Vegetation Removal	1 day	Thu 10/6/11	Thu 10/6/11	113
115	DGM Grids	1 day	Fri 10/7/11	Fri 10/7/11	114
116	Reacquire	1 day	Mon 10/10/11	Mon 10/10/11	115
117	Intrusive	1 day	Tue 10/11/11	Tue 10/11/11	116
118	Demob	1 day	Wed 10/12/11	Wed 10/12/11	117
119	**AoPI -8**	**10 days**	**Wed 10/5/11**	**Tue 10/18/11**	
120	Mob	1 day	Wed 10/5/11	Wed 10/5/11	112
121	Mag & dig	3 days	Thu 10/6/11	Mon 10/10/11	120
122	Survey	1 day	Tue 10/11/11	Tue 10/11/11	121
123	Vegetation Removal	1 day	Wed 10/12/11	Wed 10/12/11	122
124	DGM Grids	1 day	Thu 10/13/11	Thu 10/13/11	123
125	Reacquire	1 day	Fri 10/14/11	Fri 10/14/11	124
126	Intrusive	1 day	Mon 10/17/11	Mon 10/17/11	125
127	Demob	1 day	Tue 10/18/11	Tue 10/18/11	126
128	**AoPI -9E**	**10 days**	**Tue 10/11/11**	**Mon 10/24/11**	
129	Mob	1 day	Tue 10/11/11	Tue 10/11/11	121



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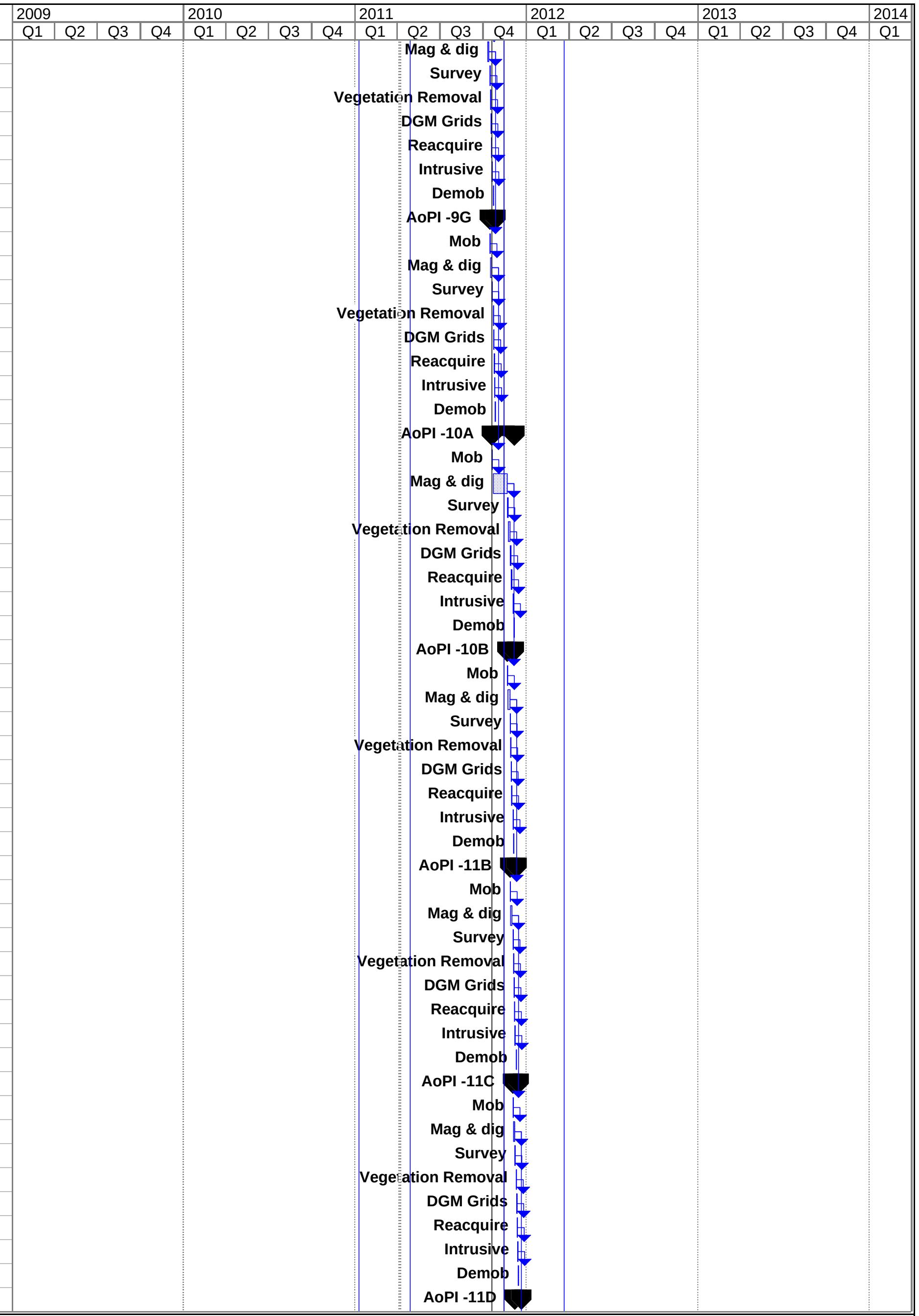
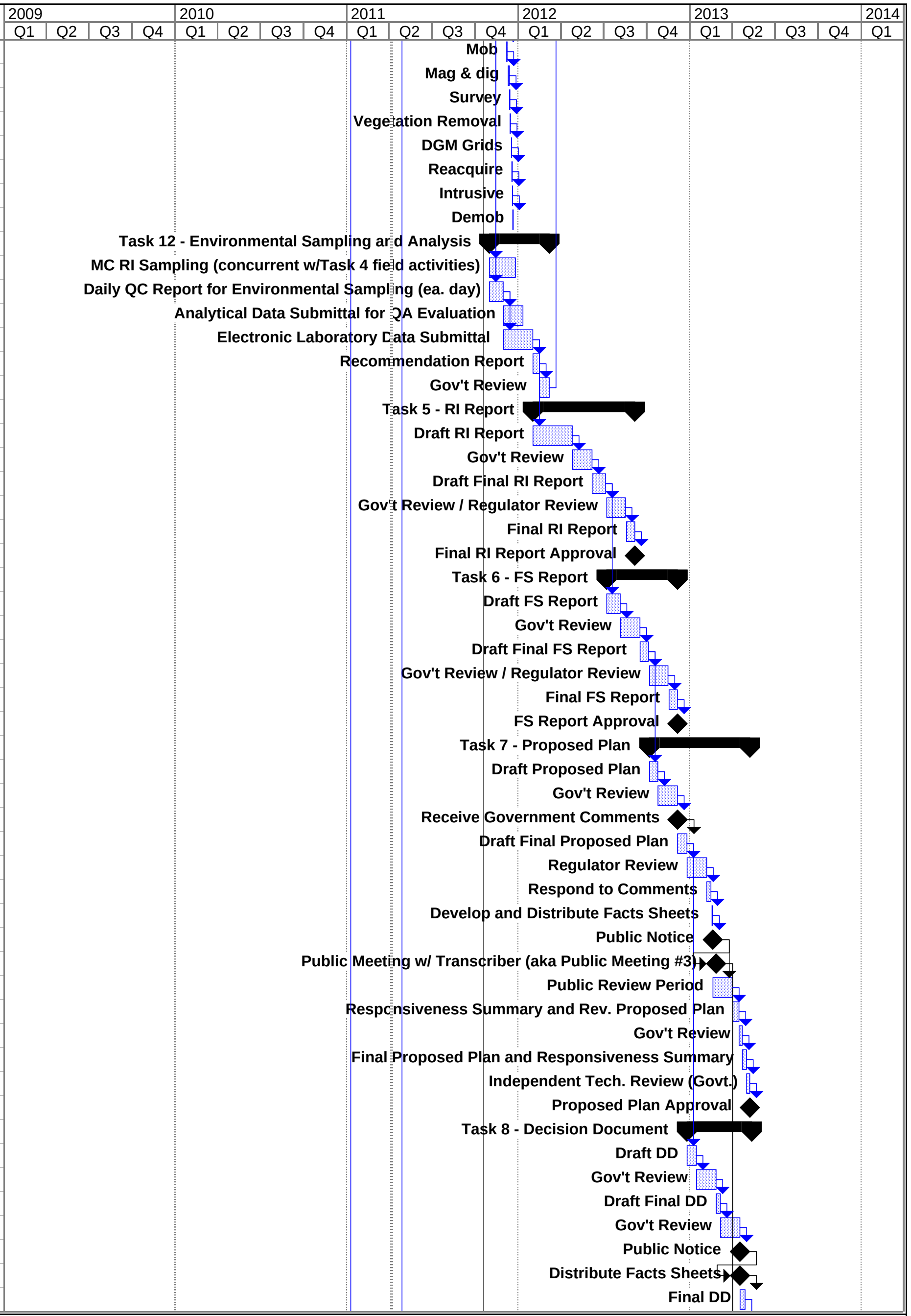
Task		Progress		Summary		External Tasks	
Deadline							
Split		Milestone		Project Summary		External Milestone	

ID	Task Name	Duration	Start	Finish	Predecessors
130	Mag & dig	3 days	Wed 10/12/11	Fri 10/14/11	129
131	Survey	1 day	Mon 10/17/11	Mon 10/17/11	130
132	Vegetation Removal	1 day	Tue 10/18/11	Tue 10/18/11	131
133	DGM Grids	1 day	Wed 10/19/11	Wed 10/19/11	132
134	Reacquire	1 day	Thu 10/20/11	Thu 10/20/11	133
135	Intrusive	1 day	Fri 10/21/11	Fri 10/21/11	134
136	Demob	1 day	Mon 10/24/11	Mon 10/24/11	135
137	**AoPI -9G**	**10 days**	**Mon 10/17/11**	**Fri 10/28/11**	
138	Mob	1 day	Mon 10/17/11	Mon 10/17/11	130
139	Mag & dig	3 days	Tue 10/18/11	Thu 10/20/11	138
140	Survey	1 day	Fri 10/21/11	Fri 10/21/11	139
141	Vegetation Removal	1 day	Mon 10/24/11	Mon 10/24/11	140
142	DGM Grids	1 day	Tue 10/25/11	Tue 10/25/11	141
143	Reacquire	1 day	Wed 10/26/11	Wed 10/26/11	142
144	Intrusive	1 day	Thu 10/27/11	Thu 10/27/11	143
145	Demob	1 day	Fri 10/28/11	Fri 10/28/11	144
146	**AoPI -10A**	**34 days**	**Fri 10/21/11**	**Wed 12/7/11**	
147	Mob	1 day	Fri 10/21/11	Fri 10/21/11	139
148	Mag & dig	22 days	Mon 10/24/11	Tue 11/22/11	147
149	Survey	2 days	Wed 11/23/11	Thu 11/24/11	148
150	Vegetation Removal	2 days	Fri 11/25/11	Mon 11/28/11	149
151	DGM Grids	2 days	Tue 11/29/11	Wed 11/30/11	150
152	Reacquire	2 days	Thu 12/1/11	Fri 12/2/11	151
153	Intrusive	2 days	Mon 12/5/11	Tue 12/6/11	152
154	Demob	1 day	Wed 12/7/11	Wed 12/7/11	153
155	**AoPI -10B**	**10 days**	**Wed 11/23/11**	**Tue 12/6/11**	
156	Mob	1 day	Wed 11/23/11	Wed 11/23/11	148
157	Mag & dig	3 days	Thu 11/24/11	Mon 11/28/11	156
158	Survey	1 day	Tue 11/29/11	Tue 11/29/11	157
159	Vegetation Removal	1 day	Wed 11/30/11	Wed 11/30/11	158
160	DGM Grids	1 day	Thu 12/1/11	Thu 12/1/11	159
161	Reacquire	1 day	Fri 12/2/11	Fri 12/2/11	160
162	Intrusive	1 day	Mon 12/5/11	Mon 12/5/11	161
163	Demob	1 day	Tue 12/6/11	Tue 12/6/11	162
164	**AoPI -11B**	**10 days**	**Tue 11/29/11**	**Mon 12/12/11**	
165	Mob	1 day	Tue 11/29/11	Tue 11/29/11	157
166	Mag & dig	3 days	Wed 11/30/11	Fri 12/2/11	165
167	Survey	1 day	Mon 12/5/11	Mon 12/5/11	166
168	Vegetation Removal	1 day	Tue 12/6/11	Tue 12/6/11	167
169	DGM Grids	1 day	Wed 12/7/11	Wed 12/7/11	168
170	Reacquire	1 day	Thu 12/8/11	Thu 12/8/11	169
171	Intrusive	1 day	Fri 12/9/11	Fri 12/9/11	170
172	Demob	1 day	Mon 12/12/11	Mon 12/12/11	171
173	**AoPI -11C**	**10 days**	**Mon 12/5/11**	**Fri 12/16/11**	
174	Mob	1 day	Mon 12/5/11	Mon 12/5/11	166
175	Mag & dig	3 days	Tue 12/6/11	Thu 12/8/11	174
176	Survey	1 day	Fri 12/9/11	Fri 12/9/11	175
177	Vegetation Removal	1 day	Mon 12/12/11	Mon 12/12/11	176
178	DGM Grids	1 day	Tue 12/13/11	Tue 12/13/11	177
179	Reacquire	1 day	Wed 12/14/11	Wed 12/14/11	178
180	Intrusive	1 day	Thu 12/15/11	Thu 12/15/11	179
181	Demob	1 day	Fri 12/16/11	Fri 12/16/11	180
182	**AoPI -11D**	**10 days**	**Fri 12/9/11**	**Thu 12/22/11**	



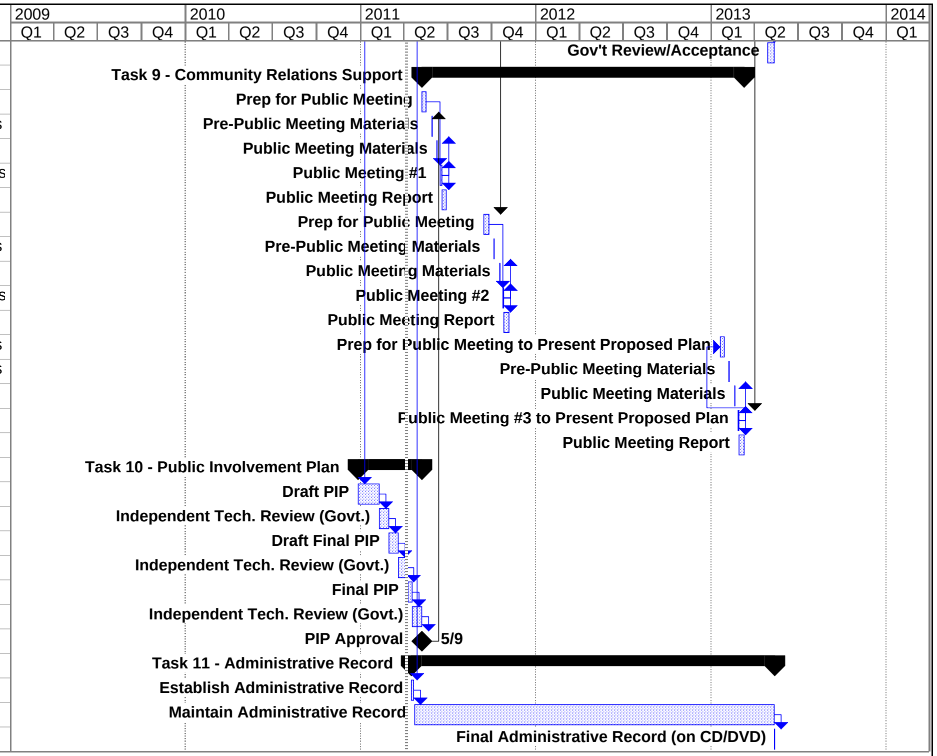
RI/FS at Camp Croft, SC Date: Wed 4/6/11 Zapata Incorporated	Task		Progress		Summary	External Tasks	Deadline
	Split		Milestone		Project Summary	External Milestone	

ID	Task Name	Duration	Start	Finish	Predecessors
183	Mob	1 day	Fri 12/9/11	Fri 12/9/11	175
184	Mag & dig	3 days	Mon 12/12/11	Wed 12/14/11	183
185	Survey	1 day	Thu 12/15/11	Thu 12/15/11	184
186	Vegetation Removal	1 day	Fri 12/16/11	Fri 12/16/11	185
187	DGM Grids	1 day	Mon 12/19/11	Mon 12/19/11	186
188	Reacquire	1 day	Tue 12/20/11	Tue 12/20/11	187
189	Intrusive	1 day	Wed 12/21/11	Wed 12/21/11	188
190	Demob	1 day	Thu 12/22/11	Thu 12/22/11	189
191	**Task 12 - Environmental Sampling and Analysis**	**92 days**	**Wed 11/2/11**	**Thu 3/8/12**	
192	MC RI Sampling (concurrent w/Task 4 field activities)	40 days	Wed 11/2/11	Tue 12/27/11	76
193	Daily QC Report for Environmental Sampling (ea. day)	22 days	Wed 11/2/11	Thu 12/1/11	76
194	Analytical Data Submittal for QA Evaluation	30 days	Fri 12/2/11	Thu 1/12/12	193
195	Electronic Laboratory Data Submittal	45 days	Fri 12/2/11	Thu 2/2/12	193
196	Recommendation Report	10 days	Fri 2/3/12	Thu 2/16/12	195
197	Gov't Review	15 days	Fri 2/17/12	Thu 3/8/12	196
198	**Task 5 - RI Report**	**155 days**	**Fri 2/3/12**	**Thu 9/6/12**	
199	Draft RI Report	60 days	Fri 2/3/12	Thu 4/26/12	195
200	Gov't Review	30 days	Fri 4/27/12	Thu 6/7/12	199
201	Draft Final RI Report	21 days	Fri 6/8/12	Fri 7/6/12	200
202	Gov't Review / Regulator Review	30 days	Mon 7/9/12	Fri 8/17/12	201
203	Final RI Report	14 days	Mon 8/20/12	Thu 9/6/12	202
204	Final RI Report Approval	0 days	Thu 9/6/12	Thu 9/6/12	203
205	**Task 6 - FS Report**	**109 days**	**Mon 7/9/12**	**Thu 12/6/12**	
206	Draft FS Report	21 days	Mon 7/9/12	Mon 8/6/12	201
207	Gov't Review	30 days	Tue 8/7/12	Mon 9/17/12	206
208	Draft Final FS Report	14 days	Tue 9/18/12	Fri 10/5/12	207
209	Gov't Review / Regulator Review	30 days	Mon 10/8/12	Fri 11/16/12	208
210	Final FS Report	14 days	Mon 11/19/12	Thu 12/6/12	209
211	FS Report Approval	0 days	Thu 12/6/12	Thu 12/6/12	210
212	**Task 7 - Proposed Plan**	**154 days**	**Mon 10/8/12**	**Thu 5/9/13**	
213	Draft Proposed Plan	14 days	Mon 10/8/12	Thu 10/25/12	208
214	Gov't Review	30 days	Fri 10/26/12	Thu 12/6/12	213
215	Receive Government Comments	0 days	Thu 12/6/12	Thu 12/6/12	214
216	Draft Final Proposed Plan	14 days	Fri 12/7/12	Wed 12/26/12	215
217	Regulator Review	30 days	Thu 12/27/12	Wed 2/6/13	216
218	Respond to Comments	7 days	Thu 2/7/13	Fri 2/15/13	217
219	Develop and Distribute Facts Sheets	2 days	Mon 2/18/13	Tue 2/19/13	218
220	Public Notice	0 days	Tue 2/19/13	Tue 2/19/13	219
221	Public Meeting w/ Transcriber (aka Public Meeting #3)	0 days	Tue 2/26/13	Tue 2/26/13	220FS+5 days
222	Public Review Period	30 days	Wed 2/20/13	Tue 4/2/13	220
223	Responsiveness Summary and Rev. Proposed Plan	10 days	Wed 4/3/13	Tue 4/16/13	222
224	Gov't Review	5 days	Wed 4/17/13	Tue 4/23/13	223
225	Final Proposed Plan and Responsiveness Summary	7 days	Wed 4/24/13	Thu 5/2/13	224
226	Independent Tech. Review (Govt.)	5 days	Fri 5/3/13	Thu 5/9/13	225
227	Proposed Plan Approval	0 days	Thu 5/9/13	Thu 5/9/13	226
228	**Task 8 - Decision Document**	**98 days**	**Thu 12/27/12**	**Mon 5/13/13**	
229	Draft DD	14 days	Thu 12/27/12	Tue 1/15/13	216
230	Gov't Review	30 days	Wed 1/16/13	Tue 2/26/13	229
231	Draft Final DD	7 days	Wed 2/27/13	Thu 3/7/13	230
232	Gov't Review	30 days	Fri 3/8/13	Thu 4/18/13	231
233	Public Notice	0 days	Thu 4/18/13	Thu 4/18/13	232
234	Distribute Facts Sheets	0 days	Thu 4/18/13	Thu 4/18/13	233
235	Final DD	7 days	Fri 4/19/13	Mon 4/29/13	234



Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

ID	Task Name	Duration	Start	Finish	Predecessors
236	Gov't Review/Acceptance	10 days	Tue 4/30/13	Mon 5/13/13	235
237	**Task 9 - Community Relations Support**	**480 days**	**Tue 5/10/11**	**Mon 3/11/13**	
238	Prep for Public Meeting	7 days	Tue 5/10/11	Wed 5/18/11	260
239	Pre-Public Meeting Materials	1 day	Tue 5/31/11	Tue 5/31/11	241FS-15 days
240	Public Meeting Materials	1 day	Fri 6/10/11	Fri 6/10/11	241FS-7 days
241	Public Meeting #1	2 days	Fri 6/17/11	Mon 6/20/11	238FS+21 days
242	Public Meeting Report	7 days	Tue 6/21/11	Wed 6/29/11	241
243	Prep for Public Meeting	7 days	Fri 9/16/11	Mon 9/26/11	58
244	Pre-Public Meeting Materials	1 day	Fri 10/7/11	Fri 10/7/11	246FS-15 days
245	Public Meeting Materials	1 day	Wed 10/19/11	Wed 10/19/11	246FS-7 days
246	Public Meeting #2	2 days	Wed 10/26/11	Thu 10/27/11	243FS+21 days
247	Public Meeting Report	7 days	Fri 10/28/11	Mon 11/7/11	246
248	Prep for Public Meeting to Present Proposed Plan	7 days	Mon 1/21/13	Tue 1/29/13	251FS-29 days
249	Pre-Public Meeting Materials	1 day	Fri 2/8/13	Fri 2/8/13	251FS-15 days
250	Public Meeting Materials	1 day	Wed 2/20/13	Wed 2/20/13	251FS-7 days
251	Public Meeting #3 to Present Proposed Plan	2 days	Wed 2/27/13	Thu 2/28/13	221
252	Public Meeting Report	7 days	Fri 3/1/13	Mon 3/11/13	251
253	**Task 10 - Public Involvement Plan**	**95 days**	**Tue 12/28/10**	**Mon 5/9/11**	
254	Draft PIP	32 days	Tue 12/28/10	Wed 2/9/11	2
255	Independent Tech. Review (Govt.)	14 days	Thu 2/10/11	Tue 3/1/11	254
256	Draft Final PIP	14 days	Wed 3/2/11	Mon 3/21/11	255
257	Independent Tech. Review (Govt.)	14 days	Tue 3/22/11	Fri 4/8/11	256
258	Final PIP	7 days	Mon 4/11/11	Tue 4/19/11	257
259	Independent Tech. Review (Govt.)	14 days	Wed 4/20/11	Mon 5/9/11	258
260	PIP Approval	0 days	Mon 5/9/11	Mon 5/9/11	259
261	**Task 11 - Administrative Record**	**542 days**	**Mon 4/18/11**	**Tue 5/14/13**	
262	Establish Administrative Record	5 days	Mon 4/18/11	Fri 4/22/11	42
263	Maintain Administrative Record	536 days	Mon 4/25/11	Mon 5/13/13	262
264	Final Administrative Record (on CD/DVD)	1 day	Tue 5/14/13	Tue 5/14/13	263



RI/FS at Camp Croft, SC Date: Wed 4/6/11 Zapata Incorporated	Task		Progress		Summary		External Tasks	Deadline
	Split		Milestone		Project Summary		External Milestone	

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US Army Corps of Engineers

Technical Project Planning Memorandum – No. 2

Subject: FUDS Military Munitions Response Program Documentation of Technical Project Planning Project Team Meeting for a Remedial Investigation/Feasibility Study (RI/FS)

Site: Former Camp Croft, Spartanburg, SC

Contract: Contract Number W912DY-10-D-0028, Task Order 0005

The Technical Project Planning (TPP) meeting was conducted on 24 August 2011 by teleconference from 2:00pm to 2:30pm. The Project Delivery Team (PDT) is composed of the participants listed below; all but John Moon and Deb Edwards participated in the call. Meeting participants introduced themselves.

1. Shawn Boone	Project Manager, US Army Corps of Engineers (USACE), Charleston District
2. Spencer O'Neal	Project Manager, US Army Engineering and Support Center, Huntsville (USAESCH)
3. Teresa Carpenter	Technical Lead, USAESCH
4. Deb Edwards	Geophysicist, USAESCH
5. Susan Byrd	South Carolina Department of Health and Environmental Control (DHEC)
6. John Moon	South Carolina Department of Parks, Recreation & Tourism (DPRT), Croft State Natural Area
7. Jason Shiflet	Project Manager, Zapata Incorporated (ZAPATA)
8. Suzy McKinney	Quality Control Manager, ZAPATA

Meeting Discussion Summary:

The purpose of the meeting was to discuss ZAPATA's responses to USAESCH comments on the Draft-Final Work Plans for the Remedial Investigation/Feasibility Study (RI/FS), Former Camp Croft, Spartanburg, South Carolina dated 15 July 2011, along with several outstanding project-related topics. A summary of the items discussed is provided below.

1) Ms. Byrd discussed several comments that Ms. Cindy Carter of SC DHEC had communicated to her; those items are summarized below.

   - In Paragraph 1.5.6.3 of the Draft-Final Work Plan, please edit the text regarding groundwater to indicate ZAPATA's understanding of potential groundwater contamination at the former Camp Croft. ZAPATA recommends the following edits, "The quantity of water available from ground sources is usually less than that which may be obtained from surface water sources. However, the importance of ground water lies in the fact that it is generally of good quality and available in most parts of the county. ZAPATA found no conclusive existing information regarding groundwater quality within the former Camp Croft boundary during the development of this work plan. As a result, groundwater can satisfy the requirements for most domestic, agricultural, and small industrial uses."

- In Paragraph 1.9 of the Draft-Final Work Plan, please carefully review the statements about chemical warfare materiel. ZAPATA recommends the following edits, "The ASR and ASR Supplement indicate that, in addition to various small arms, a variety of MEC was used at Camp Croft. No evidence of contamination by Chemical Warfare Materiel (CWM) or CWM components has been ~~identified or reported~~ confirmed. Reported encounters with MEC at the site confirm that a variety of munitions were used at Camp Croft and that some MEC does not match documented use at some ranges."
- On 25 August 11, SC DHEC had a follow-up comment; Ms. Byrd asked (via telephone) that ZAPATA be very clear (in the work plan) regarding our plans to investigate potential contamination identified during our fieldwork activities. ZAPATA agreed to add the following statement to the work plan, "Through the course of ZAPATA's investigations, if contamination (munitions or chemical) is discovered in soil, sediment, surface water, or groundwater and that contamination is determined to be attributable to the Department of Defense through activities conducted on the property during ownership, ZAPATA will attempt to determine the source, nature and extent of that contamination to the extent required under CERCLA for remedial investigations."

2) The USAESCH mentioned that the responses to comments (see attached) are acceptable.

3) The USAESCH mentioned that the Draft Public Involvement Plan for the Remedial Investigation/Feasibility Study (RI/FS), Former Camp Croft, Spartanburg, South Carolina dated 10 August 2011 is currently in review.

4) The USACE, Charleston District has begun the process to obtain rights-of-entry (ROEs). ZAPATA and SC DHEC offered to assist in the process should the USACE need support.

5) Mr. Shiflet discussed on-going coordination with Ms. Audrey Nore of USAESCH regarding revisions to the Explosive Siting Plan (ESP). Mr. O'Neal request that ZAPATA continue to support Ms. Nore in that process to facilitate completion of that document; ZAPATA agreed.

6) The PDT decided to include the Draft ESP and Explosive Safety Submission (ESS) in Appendix O of the Final Work Plans, as was done in the Draft-Final Work Plans. ZAPATA will indicate in that appendix that the ESP and ESS are undergoing a separate and parallel review process and will be stand-alone documents. The draft ESP and ESS are included in the Final Work Plans for informational purposes only.

7) The USAESCH requested ZAPATA complete the Final Work Plans as soon as possible, inquiring if 30 August was possible. ZAPATA noted that we would attempt to meet that delivery date.

Upon concurrence with the recommended revisions noted in #1 above, ZAPATA will finalize the work plan for submittal.

Attachments:

Responses to USAESCH comments on the Draft-Final Work Plans for the Remedial Investigation/Feasibility Study (RI/FS), Former Camp Croft, Spartanburg, South Carolina dated 15 July 2011

U. S. ARMY ENGINEERING AND SUPPORT CENTER - HUNTSVILLE

CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT Camp Croft, SC

CN 07-128-11 SD 10AUG11

☐ SITE DEV & GEO
■ ENVIR PROT& UTIL
☐ ARCHITECTURAL
☐ STRUCTURAL

☐ MECHANICAL
☐ MFG TECHNOLOGY
☐ ELECTRICAL
☐ INST & CONTROLS

☐ SAFETY
☐ ADV TECH
☐ ESTIMATING
☐ SPECIFICATIONS

☐ SYSTEMS ENG
☐ VALUE ENG
☐ OTHER

REVIEW RI/FS WP Draft Final
DATE 08AUG11
NAME Teresa Carpenter 256-895-1659

ITEM	DRAWING NO. OR REFERENCE	COMMENT	RESPONSE TO COMMENT
		All comments have been satisfactorily addressed.	Noted.

ACTION CODES
A - ACCEPTED/CONCUR
D - ACTION DEFERRED
W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

U. S. ARMY ENGINEERING AND SUPPORT CENTER - HUNTSVILLE

CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT: Camp Croft RI/FS; CN: 07-128-11 ; S: 10 Aug 11

■ SITE DEV & GEO
☐ ENVIR PROT& UTIL
☐ ARCHITECTURAL
☐ STRUCTURAL
☐ MECHANICAL
☐ MFG TECHNOLOGY
☐ ELECTRICAL
☐ INST & CONTROLS
☐ SAFETY
☐ ADV TECH
☐ ESTIMATING
☐ SPECIFICATIONS
☐ SYSTEMS ENG
☐ VALUE ENG
☐ OTHER

REVIEW: Draft Final Work Plan
DATE: 10 August 11
NAME: Debbie Edwards/ED-CS-G/256-895-1626

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1.	Table 18	Previous comment: "The term GPO is used frequently throughout the document and it is actually referring to an IVS. Please clarify the terminology." The GPO terminology remains in Table 18, however, the acronym GPO is not previously defined.	A. References to GPO have been revised in Table 18 (and throughout the document) to correctly reference IVS.
		All other comments have been addressed.	Noted.

ACTION CODES
A - ACCEPTED/CONCUR
D - ACTION DEFERRED
W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

U. S. ARMY ENGINEERING AND SUPPORT CENTER – HUNTSVILLE — CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS — PROJECT: CN: 07-128-11 — NAME: Former Camp Croft, SC — SD: 10-AUG-11

☐ SITE DEV & GEO ■ ENVIR PROT& UTIL ☐ ARCHITECTURAL ☐ STRUCTURAL ☐ MECHANICAL ☐ MFG TECHNOLOGY ☐ ELECTRICAL ☐ INST & CONTROLS ☐ SAFETY ☐ ADV TECH ☐ ESTIMATING ☐ SPECIFICATIONS ☐ SYSTEMS ENG ☐ VALUE ENG ☐ OTHER

REVIEW: DRAFT-FINAL RI/FS Work Plan
DATE: August 9, 2011
NAME: Michael D'Auben / 256-895-1460

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
		Work Plan	
1		Acceptable response.	Noted.
		QAPP	
2	Appendix E Worksheet #2	Acceptable response.	Noted.
3	Appendix E Worksheet #10	Acceptable response.	Noted.
4	Appendix E Worksheet #12	Acceptable response.	Noted.
5	Appendix E Worksheet #12	Acceptable response.	Noted.
6	**Appendix E Worksheet #12**	**Acceptable response with the understanding that the current laboratory values will be presented in the Final Work Plan.**	Noted.
7	Appendix E Worksheet #14	Acceptable response.	Noted.
8	**Appendix E Worksheet #15**	**It is understood that risk-based screening limits are sometimes lower than common and approved laboratory methods are capable of achieving. When this is the case, however, it must be documented and explained in the QAPP so that questions are not raised after the fact when the laboratory results are presented in the final report.**	Noted.

ACTION CODES
A - ACCEPTED/CONCUR
D - ACTION DEFERRED
W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

U. S. ARMY ENGINEERING AND SUPPORT CENTER – HUNTSVILLE CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS PROJECT: CN: 07-128-11 NAME: Former Camp Croft, SC SD: 10-AUG-11

☐ SITE DEV & GEO ☐ MECHANICAL ☐ SAFETY ☐ SYSTEMS ENG
■ ENVIR PROT& UTIL ☐ MFG TECHNOLOGY ☐ ADV TECH ☐ VALUE ENG
☐ ARCHITECTURAL ☐ ELECTRICAL ☐ ESTIMATING ☐ OTHER
☐ STRUCTURAL ☐ INST & CONTROLS ☐ SPECIFICATIONS

REVIEW: DRAFT-FINAL RI/FS Work Plan
DATE: August 9, 2011
NAME: Michael D'Auben / 256-895-1460

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
9	Appendix E Worksheet #27	Acceptable response.	Noted.
10	Appendix E Worksheet #28	Acceptable response.	Noted.
11	Appendix E Worksheet #30	Acceptable response.	Noted.
12	Appendix E Worksheet #37	Acceptable response.	Noted.

ACTION CODES
A - ACCEPTED/CONCUR
D - ACTION DEFERRED
W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

U. S. ARMY ENGINEER DIVISION HUNTSVILLE

DESIGN REVIEW COMMENTS

PROJECT: Camp Croft South Carolina
Due Date 10 August 2011

CORPS OF ENGINEERS
CN: 07-128-11

☐ SITE DEV & GEO ☐ MECHANICAL ☒ OED SAFETY ☐ SYSTEMS ENG
☐ ENVIR PROT& UTIL ☐ MFG TECHNOLOGY ☐ ADV TECH ☐ VALUE ENG
☐ ARCHITECTURAL ☐ ELECTRICAL ☐ ESTIMATING ☐ OTHER
☐ STRUCTURAL ☐ INST & CONTROLS ☐ SPECIFICATIONS

REVIEW Back check Final Work Plan
DATE 25 July 2011
NAME John Zimmer

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
		I have back check the 24 comments from Mr. Randall King dated 20 June 2011 on the work plan dated 15 July 2011. Comments 1-5, 7, 8, 10 -13, 15-24 have been adequately addressed and incorporated into the document but I have the following 3 comments for comments 6, 9, and 14 remaining:	Noted.
1	Comment 6 Para. 3.4.9.9 Pg 3-19	The action was to submit a table #19 in the document. Table #19 is missing add table to the tables section.	A. Table 19 was added to the Draft-Final Work Plan; it is unclear why the reviewer's copy of that table was missing. ZAPATA will make every effort to include all text, tables, figures, and appendices in Final Work Plans.
2	Comment #9 Para 3.4.9.16 Pg. 3-29	As stated by Mr. King, this is a conventional project so the standard basic actions are required to be in the work plan. The information provided goes into too much detail for this conventional RI/FS. Correct the paragraphs and insert the basic actions required for a Conventional MEC removal.	A. Section 3.4.9.16 has been revised to include the basic actions required at conventional MEC sites.
3	Comment 14 Para 5.10 Pg. 5-5	Please provide the USACE KO letter authorizing you to transfer the explosives to another USAESCH project or the local law enforcement bomb squad and provide that letter as an attachment to the work plan.	A. ZAPATA has requested a letter from the USAESCH KO and will include that letter authorizing such actions in the Final Work Plans. (Note: The letter from the USAESCH may be delayed. In that case, ZAPATA will disburse the letter to recipients of the Final Work Plan under separate cover.)
		End of comments	

ACTION CODES
A - ACCEPTED/CONCUR
D - ACTION DEFERRED
W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

U. S. ARMY ENGINEER DIVISION HUNTSVILLE — CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT: Camp Croft Draft-Final Work Plan (Zapata TO 5) 07-128-11

☐ SITE DEV & GEO
☐ ENVIR PROT& UTIL
☐ ARCHITECTURAL
☐ STRUCTURAL
☐ MECHANICAL
☐ MFG TECHNOLOGY
☐ ELECTRICAL
☐ INST & CONTROLS
■ SAFETY
☐ ADV TECH
☐ ESTIMATING
☐ SPECIFICATIONS
☐ SYSTEMS ENG
☐ VALUE ENG
☐ OTHER

REVIEW: Draft-Final (O'Neal)
DATE: 5 August 2011
NAME: Kellie Williams / SO/ 256-895-1584-

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1.	General	The SO has no record of reviewing the draft document and does not have any comments to back check.	Noted.

ACTION CODES
A - ACCEPTED/CONCUR
D - ACTION DEFERRED
W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

APPENDIX J
GEOPHYSICAL SYSTEM VERIFICATION

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ATTACHMENT

Blind Seed Procedures: SOP FO-013

ABBREVIATIONS AND ACRONYMS

AoPI	Area of Potential Interest
APP	Accident Prevention Plan
APT	Armor-piercing with tracer
ASCII	American Standard Code for Information Interchange
AT	Anti-tank
DGM	Digital Geophysical Mapping
DID	Data Item Description
DQO	Data Quality Objectives
EM	Electromagnetic
ft	feet
*.FTP	File Transfer Protocol
FUDS	Formerly Used Defense Site
GPS	Global Positioning System
GSV	Geophysical System Verification
HE	high explosive
Hz	Hertz
IAW	In Accordance With
in	Inches
m	Meter
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
MK2	Geonics EM61-MK2
mm	millimeter
mV	millivolts
NRL	Naval Research Laboratory
Oasis	Geosoft Oasis Montaj® v. 7.1.1 YW or 7.2
OPUS	Online Positioning User Service
PWS	Performance Work Statement

RI/FS	Remedial Investigation / Feasibility Study
ROE	Right of Entry
RTK-GPS	Real-Time Kinematic Global Positioning System
SNR	Signal to Noise Ratio
SOP	Standard Operating Procedures
Susitna	Susitna Gunnery Range FUDS
TPP	technical project planning
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Engineer Support Center, Huntsville
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
WAAS	Wide Area Augmentation System
WGS84	World Geodetic System 1984
WP	Work Plan
ZAPATA	Zapata Incorporated

1.0 INTRODUCTION

1.0.1 The Geophysical System Verification (GSV) Plan is prepared in response to the Performance Work Statement (PWS) for Remedial Investigation and Feasibility Study (RI/FS) at Former Camp Croft Formally-Used Defense Site (FUDS) (Camp Croft), Spartanburg, South Carolina. The GSV Plan is submitted as the Geophysical Prove-out as described in data item description (DID) WERS-004.01. Zapata Incorporated (ZAPATA) will not begin field operations on the GSV plot(s) until the government has accepted the GSV Plan and Accident Prevention Plan (APP).

1.0.2 ZAPATA will produce both draft final and final versions of a GSV Letter Report; prepared IAW DID WERS-004.01, upon completion of the GSV survey. The approved Final GSV Letter Report will be incorporated into the Final RI/FS Work Plan (WP) per DID WERS-001.01. The GSV Letter Report will include a table with the seed item identification number, as-built coordinates from the southwest corner of the GSV grid, depths below ground surface and orientation of each seed item.

2.0 GEOPHYSICAL SYSTEM VERIFICATION PURPOSE

2.0.1 The purpose of the GSV is to determine the optimum geophysical system configuration and standard procedures for the Munitions Response Sites (MRSs) and Areas of Potential Interest (AoPIs) at Camp Croft. This process will test, document and verify site-specific capabilities of proposed survey platforms, sensors, positioning equipment, data analysis, data management and associated equipment and personnel. The GSV will establish that the system meets typical detection performance capabilities for the specified targets as well as establish site-specific anomaly characteristics for selection criteria with the use of inert MKII grenades, the smallest munitions of concern for the RI/FS.

2.0.2 Some typical detection depths and amplitudes are shown in the Naval Research Laboratory's (NRL) reports "EM61-MK2 Response of Standard Munitions Items" and "EM61-MK2 Response of Three Surrogate Munitions," and ESTCP's "Geophysical System Verification (GSV): A Physics-Based Alternative to Geophysical Prove-outs for Munitions Response." Due to the nature of the Susitna project (transects with a limited number of grids), a daily instrument verification strip (IVS) is not practical; instead, a GSV will be conducted. During the GSV, ZAPATA will use surrogate munitions and inert MKII grenades as seed items. A seed item is defined as any item placed on the ground surface or buried below the ground surface for the purposes of testing geophysical equipment. "Blind" seed items are emplaced by the contractor and/or the Government for quality control (QC)/quality assurance (QA). The location/type of blind seeds is unknown to the site geophysicist and data processors.

2.0.3 Although responses produced in this GSV should be similar to the curves described in the referenced reports, they vary due to the condition of the specific item, and site specific variables. GSV test plots provide a safe area for the geophysical investigation team(s) to develop site-specific field and evaluation procedures necessary to demonstrate compliance with project requirements (from EM 1110-1-4009). The GSV will be carried out in accordance with all procedures stated in the DID WERS-004.01, which includes development of the GSV Plan and acceptance of the GSV results by the U.S. Army Engineering Support Center, Huntsville (USAESCH) prior to beginning the production site survey.

2.0.4 The GSV data quality objectives will translate to performance criteria during data collection at the five MRS'. Specifically:

- The depth of detection for a MKII grenade is 7x the diameter.
- Local DGM anomaly positioning will be within 1 m of the intrusively identified target position
- Specifications defined in DID WERS-004.01 will be met.
- Surface seed items placed on DGM transects will be identified and responses will be in accordance with the NRL Least/Most favorable response curves.
- QC/QA blind seeds within the grids will be detected and identified for investigation.

3.0 SITE SELECTION AND LOCATION

The proposed GSV location is near the proposed office trailer site (see Exhibit 7, Appendix B). The GSV will possess similar conditions in terms of terrain, vegetation, geology, soil, field conditions, and electrical interference as the digital geophysical mapping (DGM) areas.

3.1 PRE-SEEDING (BACKGROUND) GEOPHYSICAL MAPPING

An unexploded ordnance (UXO)-qualified technician will conduct an instrument-assisted surface sweep of the proposed GSV grid(s) to ensure that no MEC items or other metal objects are present on the surface. DGM over the proposed test plot will be conducted using the Geonics EM61-MK2 (MK2) in a cart-mounted configuration, coupled with a global positioning system (GPS) before the burial of test items (pre-seed) to provide background response information. This process will also ensure that seeded items are not placed near natural (magnetic geology) or cultural anomalies. If a large number of geophysical anomalies are detected, they may require removal by the UXO Tech, in which case additional background DGM will be conducted or the test plot may be relocated.

3.2 SIZE AND CONFIGURATION

3.2.1 Two types of geophysical production surveys will be conducted, transects and grids. Both types of surveys and all equipment employed therein will be demonstrated during the GSV.

3.2.2 A list of proposed seed items and the conceptual seed item map is shown in the following section. The production DGM data will be collected in a single pass along transects and within individual grids, selected using the information obtained from the transects. The GSV will be an 8 x 26 m grid in which data will also be collected as two 26 m parallel transects spaced 4 m apart.

3.2.3 During GSV survey, data will be collected using the MK2 in towed-mode with or without GPS depending on site conditions. When in GPS mode, the MK2 will be coupled with the Trimble GeoXH. If there are insufficient acquirable GPS satellites due to a dense canopy, local positioning will be acquired using tape measures from a defined coordinate origin with the EM61 collecting data in time acquisition mode. Both positioning methods will be demonstrated during the GSV.

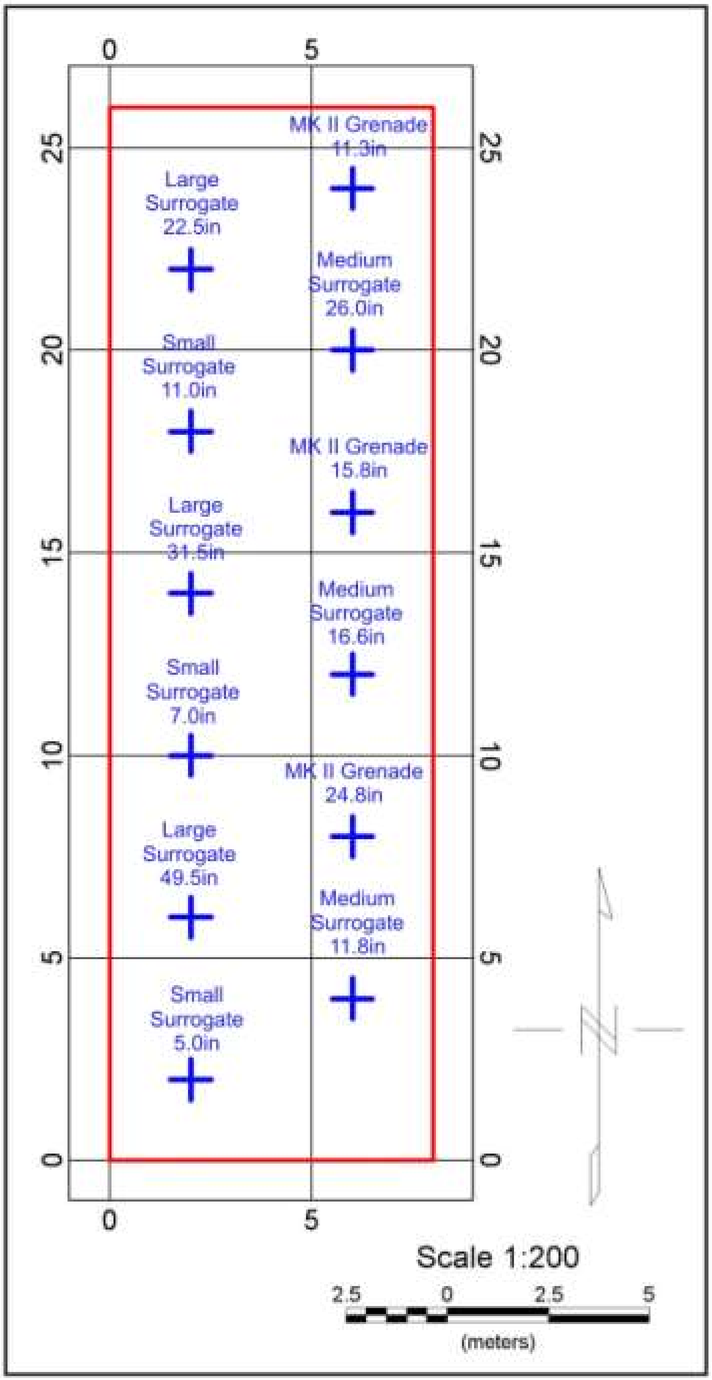
3.3 SURVEY ACCURACY

If line of sight conditions permit, general survey control for the GSV survey will be brought in by ZAPATA using Online Positioning User Service (OPUS) GPS methods, resulting in horizontal accuracy better than five centimeters (cm). Surveying will be performed by the field crew using survey grade RTK-GPS with centimeter level accuracy. All four corners of the GSV and each planted seed item location will be surveyed using RTK-GPS. If conditions do not permit use of RTK-GPS, the southwest grid corner will be surveyed using a Trimble GeoXH. All grid corners and seeds coordinates will be determined using local coordinates though use of tape measures.

4.0 LAYOUT

The planned layout of the known items within the GSV is depicted in Figure 4-1. This layout is subject to change depending upon unforeseen site conditions. Furthermore, the USAESCH may place blind seed items within the GSV.

Figure 4-1 Conceptual Seed Item Map



4.1 PROBABLE MUNITIONS

4.1.1 Probable munitions on the site range from MKII grenades to 155mm projectiles. The MKII grenade will be the only probable munitions employed as a seed item during the investigation. All other seed items will be standardized surrogate items.

4.1.2 The 11x diameter depths of detection for the surrogates are listed, however; site-specific detection depths can vary based on site-specific conditions. The typical anticipated detection depths will be established during the GSV based on site noise and the known response as outlined in NRL/MR/6110-09-983, "*EM61-MK2 Response of Three Surrogates*" dated March 12, 2009. ZAPATA will compare the results of the GSV to the NRL-published values to verify that equipment is operating properly. The results of the GSV will be detailed in the GSV Letter Report.

4.1.3 During grid production surveying, the DQO for MEC targets and burial depths will be detection of the smallest (most probable) target, the MKII grenade, at depth of 7x diameter or greater. Intrusive investigation of anomalies will take place during the DGM and mag-and-dig investigation phases.

TABLE 4-1 PROBABLE MUNITIONS AND SEED SIMULANTS

Probable Munitions
MKII grenades (and variants)
Projectile, 37mm, armor-piercing with tracer (APT)
Projectile, 57mm
Projectile, 60mm, high explosive (HE), M49 (and variants)
Projectile, 81mm, HE, M43 (and variants)
Projectile, 105mm, M84
Projectile, 155mm
Rifle grenade, Anti-tank (AT), M9A1 (and variants)
Rocket, HEAT, 2.36-inch, M6A1 (and variants)
Mortar, 4.2-inch

Seed Munitions (Inert or Simulated)				
Item	**Diameter millimeter (mm)**	**5x Detection Depth (inches)**	**7x Detection Depth (inches)**	**11x Detection Depth (inches)**
MKII grenade	57.4	11.3	15.8	24.9
Small Surrogate	25.4	5	7	11
Medium Surrogate	60.3	11.85	16.6	26
Large Surrogate	114.3	22.5	31.5	49.5

4.2 SEEDED ITEMS

ZAPATA proposes using items and methodology consistent with NRL's report NRL/MR/6110—09-9183 "EM61-MK2 Response of Three Surrogates" dated March 12, 2009. In addition to three MKII grenades, ZAPATA proposes to use three standard surrogate items described in that report. These items are comprised of black, welded steel, Schedule 40 straight pipe nipple, threaded on both ends. Table 4-2 lists the probable munition surrogates and inert ammunition to be seeded in the GSV.

TABLE 4-2 SURROGATES TO BE SEEDED IN THE GSV

Item Number	Description	Outside Diameter Inches (in)	Outside Diameter (mm)	Length (in)	Depth (in)	Orientation	X local (m)	Y local (m)
1	Small Surrogate	1.0	25.4	4	5	Horizontal/Perpendicular to Line of Travel	2	2
2	Large Surrogate	4.5	114.3	12	49.5	Horizontal/Perpendicular to Line of Travel	2	6
3	Small Surogate	1.0	25.4	4	7	Horizontal/Perpendicular to Line of Travel	2	10
4	Large Surrogate	4.5	114.3	12	31.5	Horizontal/Perpendicular to Line of Travel	2	14
5	Small Surrogate	1.0	25.4	4	11	Horizontal/Perpendicular to Line of Travel	2	18
6	Large Surrogate	4.5	114.5	12	22.5	Horizontal/Perpendicular to Line of Travel	2	22
7	Medium Surrogate	2.37	60.2	8	11.85	Horizontal/Perpendicular to Line of Travel	6	4
8	MKII Grenade	2.26	57.4		24.9	Horizontal/Perpendicular to Line of Travel	6	8
9	Medium Surrogate	2.37	60.2	8	16.6	Horizontal/Perpendicular to Line of Travel	6	12
10	MKII Grenade	2.26	57.4		15.8	Horizontal/Perpendicular to Line of Travel	6	16
11	Medium Surrogate	2.375	60.2	8	26.0	Horizontal/Perpendicular to Line of Travel	6	20
12	MKII Grenade	2.26	57.4		11.3	Horizontal/Perpendicular to Line of Travel	6	24

4.2.1 Depths and Orientation

4.2.1.1 A record of the emplacement of each seed item will include a photograph, survey coordinates, depth, orientation, date and time of emplacement, backfill (if applicable), and the name(s) of the team members involved.

4.2.1.2 The seed items will be buried at various depths and the least favorable orientation (horizontal and perpendicular to the direction of data collection) to demonstrate that the project objectives, as stated in the PWS, are technically feasible. Additionally, this will demonstrate that the MK2 is functioning as expected. ZAPATA will bury each item at depths of five, seven and eleven times their diameters. These depths are show in Table 4-2, however these may change due to unanticipated site conditions (it may not be possible to bury the large item at a depth of over 4 ft). Additionally, if during the open hole tests it is determined that a specific seed item is not detected at the proposed depth; the final burial depth will be shallower. The lack of detection and change of burial depth will be documented in the field notes. In addition to the seed items, a survey nail (or nail bundles) similar to those to be used to mark transect waypoints will also be placed within the GSV. The field geophysicist will survey the top center point of the seed item on a cache, or the center of a single item and the adjacent surface elevation after the item is emplaced. Seed items will be painted blue and tagged with a non-biodegradable label identifying the items as inert. The labels will include a contract reference number, a point of contact address, a telephone number, and target identifier.

4.2.2 In-Field Seed Item Depth Testing

ZAPATA will conduct open-hole tests over selected seed items before they are buried, in order to confirm that they are, in fact, detectable. In addition, data will be collected over the seed items placed on the ground surface, to ascertain that the millivolts (mV) responses are in accordance with the NRL documented standards.

4.2.3 Blind Seed Items for Quality Assurance (QA) and Quality Control (QC)

4.2.3.1 QA Blind Seeds

If USACE desires to place QA blind seed(s) within the GSV, provisions will be made by ZAPATA. Although blind QA items may be smaller or buried deeper than those described herein, ZAPATA will not be held to detection capabilities greater than those specified in the PWS and guidance documents. If USACE places blind seed(s) in the GSV, the blind items will be buried after the pre-seed GSV DGM, and before the post-seed GSV DGM.

4.2.3.2 Small Surrogate/QC Blind Seed Lateral Response Characteristics

QC blind seeds will consist of 1” diameter by 4” length pipe nipple (part number 44615K466) analogous to the small surrogate seeds placed in the GSV. In order to better understand the QC blind seed response characteristics associated with lateral sensor/QC blind seed offset, ZAPATA will acquire 10 transects displaced 0.25 m laterally over line one, containing the small surrogate GSV seed items. Though the small surrogates within the GSV are oriented such that their responses will be the least favorable while the QC blind seeds will be oriented horizontal (travel direction of the DGM grid survey is unknown), the empirical results allow ZAPATA and USACE to better determine the likelihood of successfully identifying QC blind seeds. The lateral response curves and their variance will be included in the GSV Letter Report.

4.3 CULTURAL INTERFERENCE

If DGM is to be conducted in areas determined to have significant cultural interference, consideration will be given to duplicating that interference in the test plot. Sources of cultural interference could include proximity to buildings and power lines, and/or the presence of cultural debris (metallic trash items).

5.0 DATA COLLECTION VARIABLES

The test plot data will be collected and analyzed using the same equipment and procedures intended for the production DGM. The production DGM is to be collected both as single pass transects across a large area, with or without the GPS, and as individual grids, again, with or without GPS. Key personnel from the GSV will perform the production survey. ZAPATA may conduct one or several geophysical surveys using the proposed MK2 geophysical instrument. The data collection variables listed below are subject to modification and evaluation during the GSV survey. Not every factor will be evaluated in multiple surveys. Sufficient data will be collected to analyze changes in anomaly responses typical of system variability. These data collection variables will be evaluated during the GSV using the tests and frequency schedule outlined in Appendix K of the WP. Based on discussions during the TPP process, our DQO for this GSV will be to produce data sufficiently accurate to detect and locate items at acceptable depths of detection.

5.1 INSTRUMENTS TO BE USED

We anticipate performing DGM within grids using a cart-mounted geophysical instrument, e.g., the EM61-MK2 time-domain electromagnetic (TDEM) metal detection system. Positioning instrumentation will consist of Trimble GPS units utilizing post-processed kinematic (PPK) procedures for survey accuracy.

5.2 INSTRUMENT ORIENTATION AND DIRECTION OF TRAVEL

Instrument orientation and direction of travel have little effect on electromagnetic (EM) data collected by the MK2. However, different orientations of cylindrical items in relation to the direction of travel produce different responses, with items long axis perpendicular to the direction of travel producing the smallest response. To account for this, ZAPATA will orient items within the GSV perpendicular to the direction of travel.

5.3 MEASUREMENT INTERVAL

MK2 instrument readings will be collected in towed-mode at 10 samples/second (10 Hertz [Hz]) whether using GPS or non-GPS techniques. These intervals are sufficient to meet survey objectives.

5.4 LINE WIDTH

The MK2 coil is one meter square and thus, collects a swath of data 1 m wide. Ideal line spacing within grids will be 0.75 m in order to allow for data overlap. For the proposed transect DGM, a single line of data will be collected.

5.5 NAVIGATION AND MAPPING SYSTEM

5.5.1 During production transect data collection, data will be collected in time mode and coupled with GPS data from the Trimble Geo XH system. In lieu of intermittent or unattainable GPS coverage, positioning will be determined by linearly interpolating between known hub locations.

5.5.2 Initially, the GSV/production grid data corners will be established with a local coordinate system (tape measures). After data collection, a corner will be surveyed using a Trimble GeoXH to establish real world coordinates. Selected anomalies will be re-acquired within the grids using a local coordinate system allowing 1 m accuracy during reacquisition. Local coordinates will then be converted, or, "warped", to real-world coordinates for reporting purposes.

5.5.3 The GPS positional data for the transect hubs will be collected using a Trimble GeoXH or equivalent system with an absolute accuracy of several meters. The GPS data will also be corrected using the wide area augmentation system (WAAS) and then post processed to improve its accuracy. This will result in an absolute positional accuracy equal to or better than the 10m, defined as the DQO. The positional data will be recorded in World Geodetic System 1984 (WGS84) Longitude and Latitude. The data coordinates will be converted to local UTM coordinates Zone 6N for input onto the general site database. The EM and Trimble GeoXH data are recorded simultaneously and stored on the datalogger.

5.6 GSV COLLECTION METHOD

As described in Section 3.1, prior to the collection of the GSV, a pre-seed survey will be conducted over the potential GSV location to determine the presence of any in situ items and the background noise.

5.6.1 Digital Geophysical Mapping

5.6.1.1 DGM will be conducted over the GSV as a grid and as transects. Grid data will be collected so that the lines pass directly over the items of interest. The GSV grid data will consist of 17 lines spaced 0.5 meters apart covering an 8 x 24 m grid. The individual profiles will be grid and targets picked from the grids. DGM will be collected in skirt mode using both GPS and non-GPS positioning methods.

5.6.1.2 The two lines collected directly over the seed items will be pulled out of the grid format data to demonstrate the transect method. The transect targets will be picked using the profile data. Both the grid and transect data will be documented separately.

5.6.2 Analog

Analog instrumentation will be tested by dividing the GSV into ~5 ft wide search lanes, for survey by a geophysical and/or UXO technician using a Minelab. The technician will swing the detector back and forth across the search lane while slowly walking forward, covering the entire search lane in this manner. The operator will detect an audible signal as the instrument passes over a ferrous metal object, prompting the placement of non-metallic pin flag in the ground to mark the location of the anomaly for subsequent comparison with the location of buried seed items. This process is simply an instrument function check, since no digital data are recorded during the analog survey and there is no record of the interpretation performed by the operator. If the instrument fails to detect the appropriate seeds, it will be replaced, and the replacement instrument will be tested for functionality.

5.7 FIELD EDITING OF DATA

5.7.1 Minimal field editing is expected. Generally, the data are directly exported in American Standard Code for Information Interchange (ASCII) format.

5.7.2 Data processing will be performed at ZAPATA's office in Golden, Colorado. Data temporarily stored in the field logger will be downloaded into a laptop computer and transferred via file transfer protocol (*.FTP) site to the Golden office. Information will be recorded on the daily field notes and provided to the data processors with the raw data. This includes, but is not limited to:

- Grid Name and Location;

- Line numbers, survey direction, fiducial locations, and Start and End Points of line data (if needed with non-GPS only); and
- Removal of data dropouts, spikes, and physical feature interference sources (GPS Data only).

6.0 DATA PROCESSING

Once the initial editing steps have been performed, data will be transferred to Golden for processing analysis/interpretation and final map production. All instrument standardization tests will be evaluated ensuring that standards are met. All data will be carefully leveled, contoured, and displayed on a map for interpretation following the steps described in Section 3.4.7.and Tables 18 and 19 of the WP.

6.1 PROCESSING DOCUMENTATION

A processing log of all instrument standardization results and of all processing parameters will be kept. This information will be entered into the DGM DID Tables Access database (Attachment B of DID WERS-004.01).

6.2 ANOMALY SELECTION VARIABLES

6.2.1 Anomalies in the gridded data will be selected from the data using the Geosoft Oasis Montaj® v. 7.1.1 YW or 7.2 (Oasis) UX-Detect package and additional steps described in Section 3.4.9.5 of the WP. Anomalies on transect data will be selected using ZAPATA's proprietary profile target picker (this is due to the non-functionality of the Oasis profile picker).

6.2.2 Anomaly characteristics will be evaluated to determine selection criteria that may be used to reduce the level of digging required. Targets picked from grid and transect data will be assigned a ranking based on one or more additional target properties including, but not limited to:

- Signal Strength
- Size (foot print)
- Time constants (Tau)

6.2.3 This ranking system will be determined during the GSV and described in the GSV letter report. The ranking process may be changed, with USACE approval, if the production data indicates the necessity to do so. Each target will then be scrutinized by the project geophysicists, and evaluated as to validity and position. Targets that are found to be invalid or misplaced will be removed or moved. Anomalies that are not selected by the algorithm, yet are deemed to represent a target, will be picked manually. The rankings of anomalies may be overwritten by the geophysicist if deemed necessary. For the standard surrogates, data must fall within the established curves listed in the (NRL) reports "EM61-MK2 Response of Standard Munitions Items" and "EM61-MK2 Response of Three Surrogate Munitions."

6.3 TARGET EVALUATION

Targets selected from the DGM of the GSV will be compared with their known location. If a detected target location is more then one meter in distance from the known target location, that seed item has not truly been detected. Tables and maps comparing the known targets with detected targets will be generated. Ranges of values for the each of the characteristics listed above will be calculated for targets picked from gridded data. A target selection strategy for the production grid data will then be developed from these ranges. Per EM 1110-1-4009, the geophysical data will be evaluated for detection rate, false alarm rate, and for equipment durability and safety. In addition, detection depths and the magnitude of responses for individual seed items will be compared to results of MK2 responses conducted by the NRL in the previously mentioned reports. If the GSV results are consistent with the NRL results, the NRL detection tables will be used as an additional factor in determining target picking criteria.

7.0 ANOMALY REACQUISITION

The anomaly reacquisition procedures will be demonstrated during the GSV process. The MK2 will be used to reacquire the GSV targets as well as the targets from the production grid data. Field personnel will locate the position of the detected anomaly using tape measures. They will then use the MK2 to locate the anomaly, searching within a meter of the detected location. If the anomaly cannot be reacquired, it will be noted as such and a root-cause-analysis will be performed by conducting sweeps at right angles to the transect line with the MK2. If the reacquired target is more then 1 m from its detected location, that will also be noted, and again, a root-cause-analysis will be conducted for possible explanations (i.e., noise, measurement errors, etc).

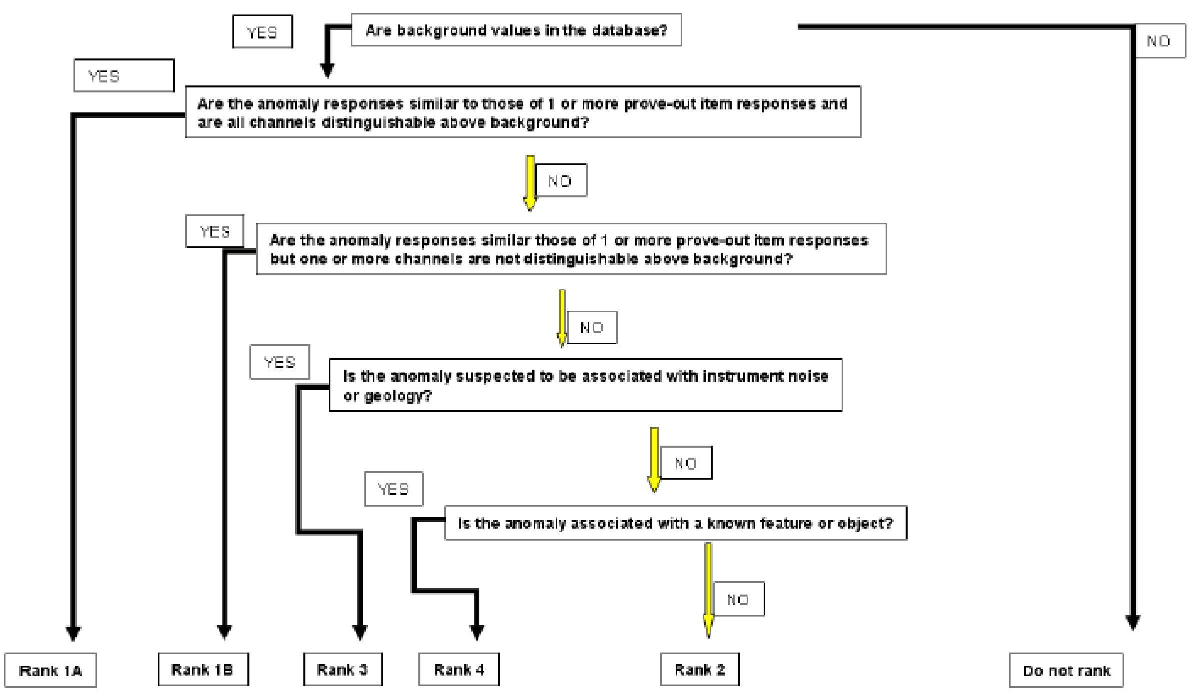
8.0 GEOPHYSICAL SYSTEM VERIFICATION (GSV) LETTER REPORT

8.1 REPORT CONTENTS

8.1.1 After the GSV fieldwork has been completed, a GSV Letter Report will be prepared to include the following as per EM 1110-1-4009:

- As-built drawing of the GSV plot(s);
- Representative pictures of all seed items;
- Geophysical Data Maps;
- Summary of the GSV results;
- Proposed geophysical equipment, techniques and methodologies for the production survey;
- Anomaly Identification, Ranking/Prioritization Criteria, and Dig selection criteria, similar to shown in Figure 8-1;

FIGURE 8-1 REPORTING TABLE WITHIN EM 1110-1-4009



- Instrument specific and process specific criteria for defining the quality of the geophysical data;
- Demonstration of the absolute (10 m) and relative (1.0 m) of the Trimble GeoXH to reacquire transect targets, and
- Any other pertinent data/information used in decision making.

8.1.2 Although the GSV will be used as a metrics benchmark, site-specific conditions and/or decision matrices can vary outside of the GSV plot location. Therefore, particular emphasis will be placed on the level of signal-to-noise (not to be used as pass or fail criterion) that is acceptable for detecting all target objectives to their maximum expected or detectable depth (as defined in DID WERS-004.01), determined from the GSV. Data acquisition procedures and methods will be defined during the GSV and documented in the GSV Letter Report so that effective verification procedures can be incorporated into all work performed in the production survey. Also, different aspects of data collection methods (i.e., variables of speed and/or terrain) that may cause "failure" or that may lead to target items not being detected will be defined during the GSV. Methods will be developed to recognize and/or prevent these types of failures from occurring. Verification procedures will be recorded in the field and documented in the GSV Letter Report.

8.2 CD Included With GSV Letter Report

8.2.1 A CD will be prepared and submitted with the Letter Report containing the following files:

- The GSV Letter Report text (Microsoft Word format);
- Raw and final processed geophysical data will be in column delineated ASCII files in the format X, Y, V1, V2… where X = Easting Coordinate, Y = Northing Coordinate, and V1, V2, V3, etc. are the instrument readings. Coordinate data will be in the UTM Coordinate System.
- Geophysical maps in their native format Oasis *.XYZ and as raster bit-map images such as *.BMP, *.JPEG or *.GIF;
- Seed item location spreadsheet (Microsoft Excel format);
- The Microsoft Access database as specified in DID WERS-004.01 containing all target picks, and QC results; and
- Spreadsheet (Microsoft Excel format) of all control points, survey points and benchmarks established or used during the location survey task.

8.2.2 ZAPATA will not proceed with production geophysical mapping until the USAESCH approves the GSV results and verbal or written Notice to Proceed is received from the Contracting Officer. This may occur prior to the approval of the GSV Letter Report. A table of final GSV seed item locations and descriptions, processed GSV data, and target lists will be delivered to the USAESCH. The approval to precede on the production data will be given based on these items. The Letter Report will be included as an Appendix to the Final RI/FS WP and to future geophysical reports associated with the survey area.

9.0 REFERENCES

Environmental Security Technology Certification Program, 2009, *Geophysical System Verification (GSV): A Physics-Based Alternative to Geophysical Prove-outs for Munitions Response,* H.H. Nelson, et al*., July 2009.*

Naval Research Laboratory, 2008, *EM61-MK2 Response of Standard Munitions Items*, H.H. Nelson, et. al., Chemical Dynamics and Diagnostics Branch, Chemistry Division, NRL/MR/6110--08-9155, United States Navy, October 6, 2008.

Naval Research Laboratory, 2009, *EM61-MK2 Response of Three Munitions Surrogates*, H.H. Nelson, et. al., Chemical Dynamics and Diagnostics Branch, Chemistry Division, NRL/MR/6110--09-9183, United States Navy, March 12, 2008

U.S. Army Corps of Engineers (USACE), 2000, *Ordnance and Explosives Response*, Engineer Manual EM 1110-1-4009, 15 June 2007.

U.S. Army Corps of Engineers (USACE), 2007, *Geophysics*, DID MR-005-05.01, 20 December 2007.

BLIND SEED PROCEDURES: SOP FO-013

1.0 OBJECTIVE / BACKGROUND

A blind seed program verifies that data collection, processing, and reacquisition methodologies meet requirements set forth by the United States Army Corps of Engineers (USACE) and Zapata Incorporated's (ZAPATA) internal set of Standard Operating Procedures (SOP)s. Blind seeds provide an opportunity for the QA personnel to monitor geophysical teams and to perform root-cause analyses to remedy performance deficiencies while teams are mobilized.

2.0 RESPONSIBLE PARTIES

- Senior Geophysicist
- Site Geophysicist
- Project Manager

3.0 ACRONYMS AND DEFINITIONS

- AOC – Area of Concern
- GPS – Global Positioning System
- ID - Identification
- ISO – Industry Standard Objects
- QA – Quality Assurance
- WP – Work Plan

4.0 BLIND SEED PROCEDURES

4.1 SEED APPROVAL AND COMPOSITION

All seed items must be approved by the QA personnel assigned to the project or management not directly involved with data collection, processing, or reacquisition, (unless otherwise stated in the WP). ZAPATA uses an Industry Standard Object (ISO) 1.0 x 4.0 inch pipe nipple (part number 44615K466) as a blind seed.

4.2 SAFETY

Seeds are to be emplaced by a UXO technician only. The potential seed location must be in an area that has been deemed as clear of all native in-situ anomalies within a one-half meter radius (1.64 feet) about the emplacement point. This area must be cleared with an approved metal detector (i.e. White, Schonstedt, EM61, etc...) If the area is not deemed clean, a new location must be chosen and the above step repeated.

4.3 GENERAL PLACEMENT OF THE BLIND SEED

The seeding must be performed in such a way as to be "blind" or unknown to personnel performing data collection, processing, and intrusive investigations. The person emplacing the seeds must be an UXO technician with experience operating Global Positioning System (GPS) equipment. Seeds are to be placed at locations and depths where routine operations will identify them. It should not be the goal of the person seeding to place blind seeds in areas where failure is probable, since the failure to reacquire a blind seed may result in the repeating of data collection, processing, and/or reacquisition over an entire grid or area

Blind seeds are to be placed minimally five feet within the perimeter of an area(s) of concern (AOC). This includes all internal boundaries or obstructions including, but not limited to: mag-and-dig areas, natural or man-made obstacles, brush, etc…

- All blind seeds should not be visible to field personnel.
- ISO seed depth and orientation will be a function of the particular ISO seed item chosen, coupled with the site conditions and project objectives. Therefore, the ISO seed emplacement design will be discussed within the WP.

4.4 COORDINATE ACQUISITION OF A BLIND SEED

When seeding, coordinates of each blind seed must be recorded and coordinate files sent only to the QA Manager for archiving, unless otherwise specified in the WP.

- In areas of reliable GPS data acquisition, coordinates of the blind seeds should be recorded with GPS. Be aware that handheld GPS devices cannot be employed due to their limited accuracy.
- If GPS is not available, the seed location must be determined in local coordinates. When establishing a local coordinate system, it is SOP that the SW grid corner is designated as the 0, 0 point. In order to determine the location of the seed item, a minimum of three separate measurements with tape are required. To accomplish this, the following method should be used:
    - Determine the coordinates by placing two measuring tapes along opposite grid edges; and
    - Use the third tape to measure the distance perpendicular to the other two tapes forming an “H” with the bar of the “H” passing through the seed location and all angles equaling 90-degrees

It is <u>*not acceptable*</u> *to approximate blind seed locations.*

4.5 SEED IDENTIFICATION

The SOPs and WP will provide unique descriptive identification (ID) codes to be used for the blind seed items. This naming convention should not be developed independently by field personnel. If possible, all seeds should be engraved with the ID code or otherwise marked with a permanent or semi-permanent medium. This will allow the blind seed to be tracked throughout the duration of the project. If an inert ordnance item is to be used as a blind seed item, it must be painted blue per industry requirements. For small projects, uniquely marking each blind seed is not necessary.

5.0 DIAGRAM

Not Applicable

6.0 IMPORTANT NOTES

- **Summary of Seeding Procedures:** The following steps summarize the information on the placement and documentation of blind seed items.
    - GPS and Non-GPS

   - Acquire an approved blind seed.
   - Locate an area within the survey area five feet away from the perimeter of the AOC or internal boundaries or obstructions.
   - Perform a pre-seed sweep with an approved metal detector a half a meter (1.64 feet) in radius about the potential emplacement point to ensure there are no native items or responses that may interfere with the relocation of the blind seed.
   - If a survey nail is used, the item should be uniformly positioned in the ground (as close to vertical as possible with the head of the nail located between two to three inches bgs).
   - ISO seed depth and orientation will be function of the particular item chosen coupled with the site conditions and project objectives. Consult the WP for details.
   - If any of the aforementioned steps fail, repeat at a different location until successful.
- GPS
   - In areas of reliable GPS data acquisition, coordinates of the blind seeds should be recorded with GPS. Be aware that handheld GPS devices cannot be employed due to their limited accuracy.
- Non-GPS
   - When establishing a local coordinate system, it is SOP that the SW grid corner is designated as the 0, 0 point.
   - A minimum of three separate measurements with tape are required and the following method should be used.
   - Place two measuring tapes along opposite grid edges.
   - Use the third tape to measure the distance perpendicular to the other two tapes forming an "H" with the bar of the "H" passing through the seed location and all angles equaling 90-degrees.
- GPS and Non-GPS
   - Record the blind seeds unique ID codes and location. At no time is it acceptable to approximate blind seed locations, or to deviate from the established unique ID codes without consent of the QA manager.

7.0 ASSOCIATED DOCUMENTS

Blind Seed Procedures Summary

8.0 INFORMATION CONTACT

Senior Geophysicist

APPENDIX K
INSTRUMENT STANDARDIZATION QUALITY CONTROL REQUIREMENTS

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INSTRUMENT STANDARDIZATION QUALITY CONTROL REQUIREMENTS FOR OE DIGITAL GEOPHYSICAL MAPPING

To facilitate the detection of buried munitions, the US Army Engineering and Support Center, Huntsville (USAESCH) has defined standard equipment tests and data quality requirements for its Ordnance and Explosives – Digital Geophysical Mapping (OE-DGM) contractors. USAESCH has found that it is imperative to perform and review QC tests before carrying out production geophysical work. This ensures that the geophysical system is functioning properly and optimized for the target objectives.

The most common instruments in use today for metallic OE detection are magnetometers, and electromagnetic metal detectors. This document will identify the USAESCH required QC tests and acceptance criteria for these types of instruments.

1.0 QC STEPS/TESTS

The required equipment tests and frequency of testing are summarized in Table K-1.

TABLE K-1 QC TEST FREQUENCY

Test #	Test Description	Specific detector	Power on	Beginning of Day	Beginning & End of Day	1st Day of Project for each operator	1 Line per Grid or 100 ft. per Linear Mile
1	Equipment Warm-up		X				
2	Record Sensor Positions			X			
3	Personnel Test			X			
4	Vibration Test (Cable Shake)			X			
5	Static Background and Static Spike				X		
6	Height Optimization					X	
7	6 Line Test					X	
9	Repeat Lines						X

1.1 EQUIPMENT/ELECTRONICS WARM-UP

Purpose: Minimize sensor drift due to thermal stabilization. Most instruments need a few minutes to warm up before data collection begins. Follow the manufacturer's instructions or, if none are given, observe the data readings until they stabilize.

Acceptance Criteria: Equipment Specific (typically 5-15 minutes).

1.2 RECORD RELATIVE SENSOR POSITIONS

Purpose: Document relative navigation and sensor offsets, detector separation, and detector heights above the ground surface. This will ensure that detector offset corrections and gradient calculations can be done correctly, that the surveys are repeatable and that the GPS base station is properly located.
Acceptance Criteria: +/- One inch (2.54 cm)

1.3 PERSONNEL TEST

Purpose: Ensure survey personnel have removed all potential interference sources from their "bodies". Common interference sources are ballpoint pens in the operator's pocket and steel-toed boots or large metallic belt buckles, which can produce data anomalies similar to OE targets. All personnel who will be coming within close proximity of the sensor during survey operations must approach the sensor and have a second person monitor and record the results.

Acceptance Criteria: EM61 +/- 2mV, Mag +/- 3nT

1.4 VIBRATION TEST (CABLE SHAKE)

Purpose: Identify and replace shorting cables and broken pin-outs on connectors. With the instrument held in a static position and collecting data, shake all cables to test for shorts and broken pin-outs. An assistant is helpful to observe any changes in instrument response. If shorts are found, the cable should be immediately repaired or replaced. After repair, cables need to be rigorously tested before use.

Acceptance Criteria: Data Profile does not exhibit data spike responses.

1.5 STATIC BACKGROUND AND STATIC STANDARD RESPONSE (SPIKE) TEST

Purpose: Quantify instrument background readings, electronic drift, locate potential interference spikes in the time domain, and determine impulse response and repeatability of the instrument to a standard test item. A standard 2" diameter steel trailer ball (Uniball- available from U-haul) is the preferred test item, as it is easily acquired and transported. Improper instrument function, the presence of local sources of ambient noise (such as EM transmissions from high-voltage electric lines), and instability in the earth's magnetic field (as during a magnetic storm) are all potential causes of inconsistent, non-repeatable readings. A minimum of three minutes static background collection after instrument warm-up, followed by a 1-minute standard response test followed by a 1-minute static background data is required. The operator must review the readings to confirm their stability prior to continuing with the geophysical survey.

Acceptance Criteria: Static Background Test: EM61 +/- 2.5 mV Channel 3,

Spike Test: EM61 +/- 20% of average standard item response, after background correction.

1.6 HEIGHT OPTIMIZATION

Purpose: Determine the sensor height that optimizes the target signal-to-noise ratio and maintains adequate sensitivity. This test is most often used for magnetic data, and for the GEM-3 instrument. It could also be used for an EM-61 used in harness or "litter" mode. A line is established with at least one test object along its length. Data is collected with the instrument using a minimum of three different sensor heights, and the height that best meets the objectives is selected.

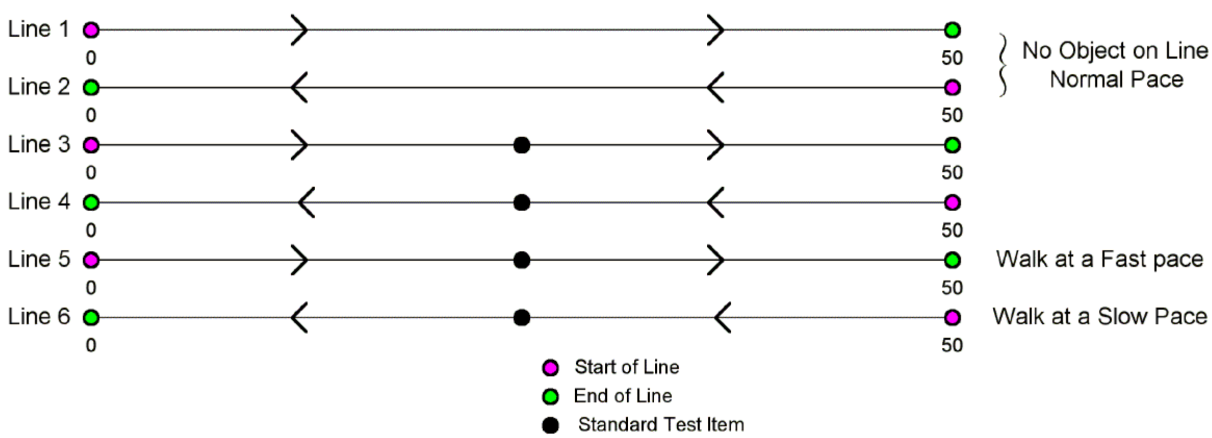
Acceptance Criteria: Maximum signal-to-noise ratio that reliably detects smallest target objective.

1.7 SIX LINE TEST

Purpose: Document latency, heading effects, repeatability of response amplitude, and positional accuracy.

This test should be performed in an area relatively clear of anomalous response. The test line will be well marked to facilitate data collection over the exact same line each time the test is performed. Background response over the test line is established in Lines 1 and 2. A standard test item, such as a steel trailer hitch ball will be used for Lines 3 through 6. Heading effects, repeatability of response amplitude, positional accuracy, and latency are evaluated.
Acceptance Criteria: Repeatability of response amplitude +/-20%, Positional Accuracy +/- 20cm.

FIGURE K-1 SIX LINE TEST



1.8 REPEAT DATA

Purpose: Determine positional and geophysical data repeatability. One line per grid, or 100 feet per mile for transect or meandering path surveys, will be repeated before and after the survey. This repeat line should have the test standard placed at approximately the halfway point in an area lacking anomalous responses.

When viewed in profile and compared to original data, repeat data provides a means of evaluating the ability of the instrument to respond consistently, and evaluates the positional accuracy of the data. Errors in positional repeatability outside acceptable tolerances indicate a problem in the method of navigation or navigational equipment operation. Errors outside acceptable tolerances for the amplitude repeatability response indicate a problem in the detector system or in the ability of the operator to perform an adequate survey.

Acceptance Criteria: Repeatability of response amplitude +/-20%, Positional Accuracy in line +/- 20cm, Positional Accuracy across line +/- 50cm.

APPENDIX L
SCRAP MANAGEMENT

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1.0 MUNITIONS DEBRIS AND CULTURAL DEBRIS

1.1.1 Scrap Collection Procedures

1.1.1.1 As part of the RI/FS, metallic items including munitions debris (MD) may be collected. Inert ordnance items will be inspected to verify there is no explosive filler or explosive residue remaining within the round. An estimate (in pounds) of the scrap collected will be recorded at the end of each workday. The scrap will be consolidated and placed in a secured container.

1.1.2 MD Inspection

1.1.2.1 Detailed accounting of all materials (MEC and MD) encountered. A log entry will be made for all MD and materials recovered, which indicates the general types of materials encountered and pounds of scrap found within different transects. MD and CD may be stored in the same general area but cannot be co-mingled prior to certification by the on-site USACE OE Safety Specialist and SUXOS that the MD materials were inert and demilitarized, if required. The following five-step process for inspecting and classifying MD items and CD will be followed:

1.1.2.2 A UXO Technician I will only tentatively identify a located item as Cultural Debris or MPPEH.

1.1.2.3 A UXO Technician II will:

- Inspect each item as it is recovered and determine the following:
  - Is the item a UXO or a component of a military munition?
  - Does the item contain explosives or other dangerous materials?
  - Does the item require detonation?
  - Does the item require demilitarization (demil) to expose dangerous fillers?
  - Does the item require draining of engine fluids, illuminating dials and other visible liquid HTRW materials?
- Segregate items requiring demil procedures from those ready for certification.
  - Items found to contain explosives hazards or other dangerous fillers will be processed IAW applicable procedures.

1.1.2.4 A UXO Technician III will:

- Inspect recovered item(s) to determine if free of explosives hazards or other dangerous fillers and engine fluids, illuminating dials and other visible liquid HTRW materials.
- Make a determination regarding items suspected of containing explosive hazards or other dangerous fillers prior as to whether they are acceptable to move.
- Supervise detonation of items found to contain explosive hazards or other dangerous fillers, which have been deemed unacceptable to move.
- Supervise the consolidation of recovered scrap metal for containerization and sealing.

1.1.2.5 The UXOQCS will:

- Conduct daily audits of the procedures used by UXO teams and individuals for processing MEC.
- Perform and document, a minimum of 10 percent random sampling (by pieces, volume or area), of all scrap metal collected from the various teams to ensure no items with explosives hazards, engine fluids, illuminating dials and other visible liquid HTRW materials are identified as scrap metal.

1.1.2.6 The UXOSO will:

- Ensure the specific procedures and responsibilities for processing MPPEH for certification as MD (scrap metal) is being followed, performed safely, consistent with applicable regulations, and in accordance with this USACE approved WP.
- Will perform random checks of processed MD to ensure items being identified as scrap are free from any explosive hazards, engine fluids, illuminating dials, and other visible liquid HTRW materials.

1.1.2.7 The SUXOS will:

- Be responsible for ensuring work and Quality Control Plan (QCP) specifies the procedures and responsibilities for processing MD for final disposition as scrap metal.
- Ensure a Requisition and Turn-in Document. DD Form 1348-1A is completed for all scrap metal to be transferred for final disposition
- Perform random checks to satisfy that the MD is free from explosive hazards necessary to complete DD Form 1348-1A.
- Certify all MD is free of explosive hazards, engine fluids, illuminating dials and other visible HTRW materials.
- Be responsible for ensuring that these inspected materials are secured in a closed, labeled, and sealed container and documented as follows:
    - The container will be closed and clearly labeled on the outside with the following information: The first container will be labeled with a unique identification that will start with USACE/FCC/ ZapataIncorported/0001/Seals's unique identification and continue in sequence.
    - The container will be closed in such a manner that a seal must be broken in order to open the container. A seal will bear the same unique identification as the container or the container will be clearly marked with the seal's identification if different from the container.
    - The Contractor will provide a documented description of the container with the following information for each container:
        - Contents
            - Weight of container
            - Former Camp Croft site
            - Zapata Incorporated
            - Names of SUXOS and USACE OE Safety Specialist
            - Unique container identification number
            - Seal identification number

1.1.3 MD Certification and Verification

1.1.3.1 The Contractor will ensure that scrap metal generated from intrusive activities is properly inspected. Only personnel who are UXO qualified per DDESB Technical Paper (TP) 18 will perform these inspections. The SUXOS will certify and the USACE OE Safety Specialist will verify that the scrap metal is free of explosive hazards.

1.1.3.2 DD Form 1348-1A will be used as certification/verification documentation. All DD Form 1348-1A must clearly show the typed or printed names of the SUXOS and the USACE OE Safety Specialist, organization, signature, and Contractor's home office and field office phone number of the person certifying and verifying the scrap metal.

- Local directives and agreements may supplement these procedures. Coordination with local concerns will identify any desired or requested supplementation to these procedures.
- In addition to the data elements required and any locally agreed to directives, the DD Form 1348-1A will clearly indicate the following for scrap metal:
    - Basic material content (Type of metal; e.g. steel or mixed.
    - Estimated weight
    - Unique identification of each of the containers and seals stated as being turned over
    - Location where scrap was obtained
    - Seal identification, if different from the unique identification of the sealed container.

The following certification/verification will be entered on each DD Form 1348-1A for turn over of scrap and will be signed by the SUXOS and USACE OE Safety Specialist.

"This certifies and verifies that the material listed has been 100 percent inspected and to the best of our knowledge and belief, are inert and/or free of explosives or related materials."

1.1.4 Maintaining the Chain of Custody and Final Disposal

1.1.4.1 ZAPATA, in coordination with the Corps of Engineers, will arrange for maintaining the chain of custody and final disposition of the certified and verified materials. The certified and verified material will only be released to an organization that will:

- Upon receiving the unopened labeled containers each with its unique identified and unbroken seal ensuring a continued chained of custody, and after reviewing and concurring with all the provided supporting documentation, sign for having received and agreeing with the provided documentation that the sealed containers contained no explosive hazards when received. This will be signed on **company letterhead** and stating that the contents of these sealed containers will not be sold, traded or otherwise given to another party until the contents have been smelted and are only identifiable by their basic content.

- Send notification and supporting documentation to ZAPATA documenting the contents of the sealed containers have been smelted and are now only identifiable by their basic content.
- This document will be incorporated by ZAPATA into the final report as documentation for supporting the final disposition of munitions debris.
- If the chain of custody is broken, the affected MPPEH must undergo a second 100 percent inspection, a second 100 percent re-inspection, and be documented to verify its explosives safety status (identified as either munitions debris or range related debris).

1.1.4.2 Material that has been documented as safe is no longer considered MPPEH as long as the chain of custody remains intact. A legible copy of inspection, re-inspection, and documentation will accompany the material through final disposition and be maintained for a period of three years thereafter.

1.1.4.3 Material that is still MPPEH after inspection may be released only to a qualified receiver. The following will be accomplished prior to release of the property:

- ZAPATA will ensure that MPPEH that has been documented as hazardous is only transferred or released to those entities that:
    - Have the licenses and permits required to receive, manage, or process the materials.
    - Have technical experts about the known or suspected explosive hazards associated with the MPPEH.
    - Are qualified to receive, manage, and process MPPEH in accordance with DoD Instruction 4140.62.
- Have personnel who are:
    - Experienced in the management and processing of hazardous materials equivalent to the MPPEH.
    - Trained and experienced in the identification and safe handling of used and unused military and/or any potential explosive hazards that may be associated with the specific MPPEH.
    - The receiver will be advised of all of the potential hazards associated with the MPPEH and agree to receive and process the material IAW with DoD Instruction 4141.62.
- All MPPEH shipments over public transportation routes will comply with DoD guidance that implements hazardous material transportation regulations.
- ZAPATA will ensure that chain of custody and accountability records are maintained through final disposition of MPPEH. A legible copy of inspection, re-inspection, and documentation will accompany MPPEH through final disposition and be maintained for a period of three years thereafter.

1.1.5 MD Storage

1.1.5.1 MDAS and metallic debris will have already been inspected and segregated by the UXO teams. This debris (shaped MDAS, MDAS fragments and metallic debris) will be stored in three separate containers. The first container will be used for scrap metal. Items such as banding wire, hinges, nails, empty drums and canisters will be placed in the scrap metal container. The second container will be used for MDAS fragments. MDAS that has been inspected and re-inspected/certified to not require further treatment prior to final disposition, such as indiscernible fragments will be placed in this container type. The third container will be used for shaped MDAS, which requires further treatment by demilitarization prior to final disposition. These lockable containers will be stored inside of a CONEX box located near the field trailer.

1.1.5.2 The following information/records will be maintained and UXO teams will perform true and accurate physical inventories, which will include all empty, partially filled, and filled scrap containers on hand. The UXO teams will perform the following scrap container inventories:

- Upon receipt, every container will be assigned a serial number. The numbers are assigned and will be in sequence starting with the number 001 and a two or three letter site designation.
- At least twice a week with the start of the workweek and the end of the workweek being mandatory.
- When materials are added to each container.
- When the containers are filled and transported offsite.
- During movement of containers onsite to ensure accuracy of records and inventory.
- At the end of the project and/or if items are transferred to another contractor.

1.1.5.3 Upon the initial receipt, during weekly inventory, and/or during transfer of the serialized containers, the following information will be entered in the site's Container Accountability Log:

- Date container arrived on site.
- Name of company providing the container.
- Identification markings (i.e., serial number or other distinctive designation).
- Quantity of containers onsite.
- Description of scrap metal inside each container (e.g., MDAS-shaped, MDAS-fragments, metallic debris-non MDAS).
- Inspection status (inspected, re-inspected, certified, verified) of each container.
- Date and location (name, address, contact information) the container was transported from Former Camp Croft.

1.1.5.4 Two people will be required to open and close MDAS storage containers – whether the containers are empty, partially filled, or full. The SUXOS and the UXOQCS will enter in the container log the date/time the container was opened, the security seal number being opened, the date/time the container was closed for the day, and the new security seal number. At the end of each workday, containers holding inspected, re-inspected, certified/verified MDAS, whether partially full or filled, will be secured, locked, and sealed with tamperproof seals. These containers will be closed in such a manner that a seal must be broken in order to open them. A seal will bear the same unique identification number as the container, or the container will be clearly marked with the seal's identification if different from the container.

1.1.6 MDAS Transport and Offsite Disposal

1.1.6.1 Non ordnance-related scrap metal (e.g. empty containers, hinges, metal debris, wire banding, etc.) that has been consolidated will be shipped, under chain of custody and straight bill of lading, to a local metals recycling company. These materials will not be transported under DD Form 1348-1A and are authorized for direct recycle. Transportation and receipt of these materials do not require the use of "witness destruct" procedures.

1.1.6.2 Sealed containers holding MDAS shapes and fragments will also be shipped under chain of custody, with each shipment being accompanied by a fully-executed DD Form 1348-1A and straight bill of lading. The lockable containers will be secured when not attended by the Senior UXO Supervisor or the UXOQCS. The containers holding MDAS fragments will be shipped to a certified facility for re-inspection and final disposition.

1.1.6.3
Shaped MDAS will be transported to a certified facility for re-inspection and further processing by shredding and final disposition.

APPENDIX M
PROJECT SCHEDULE

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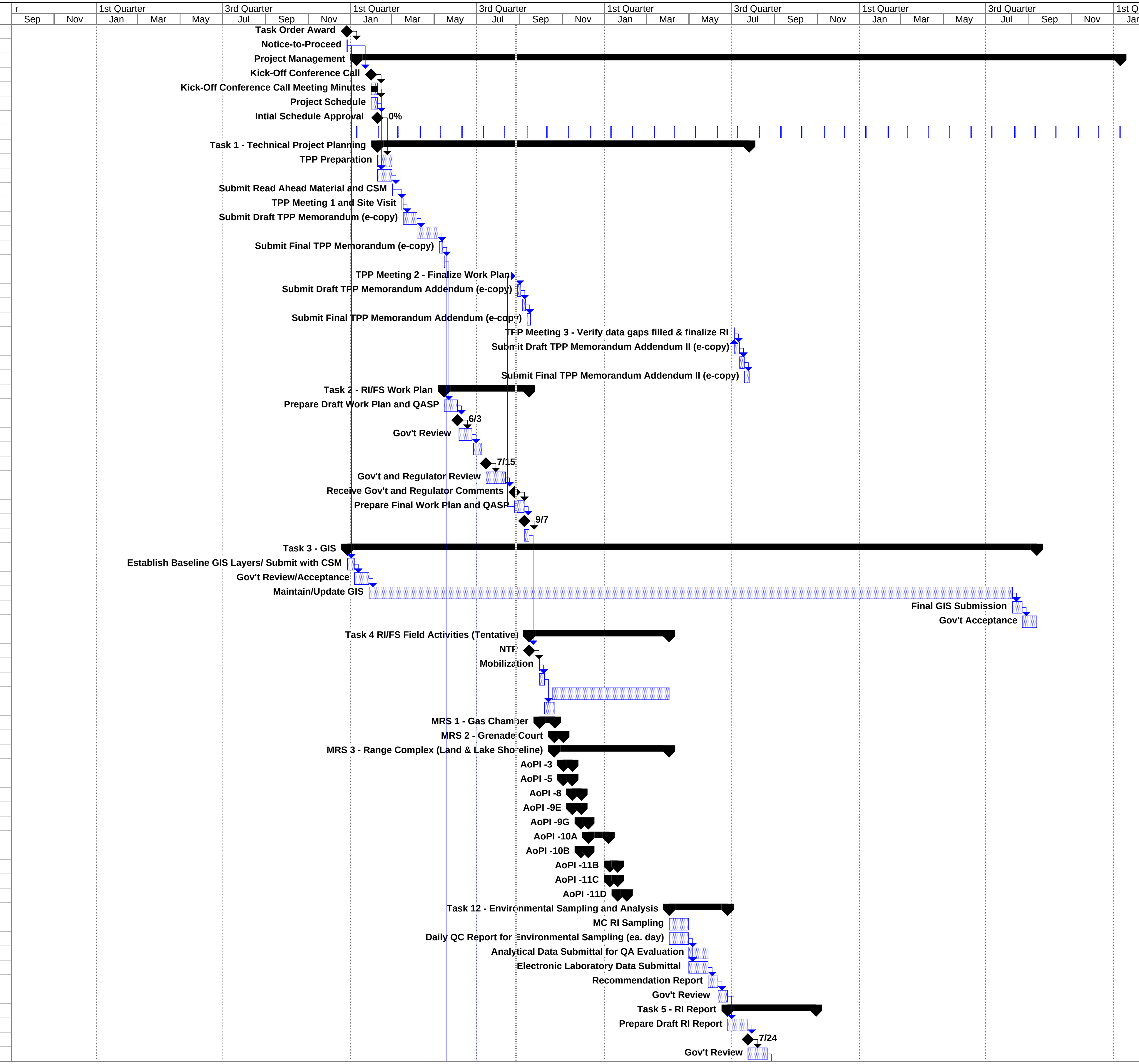
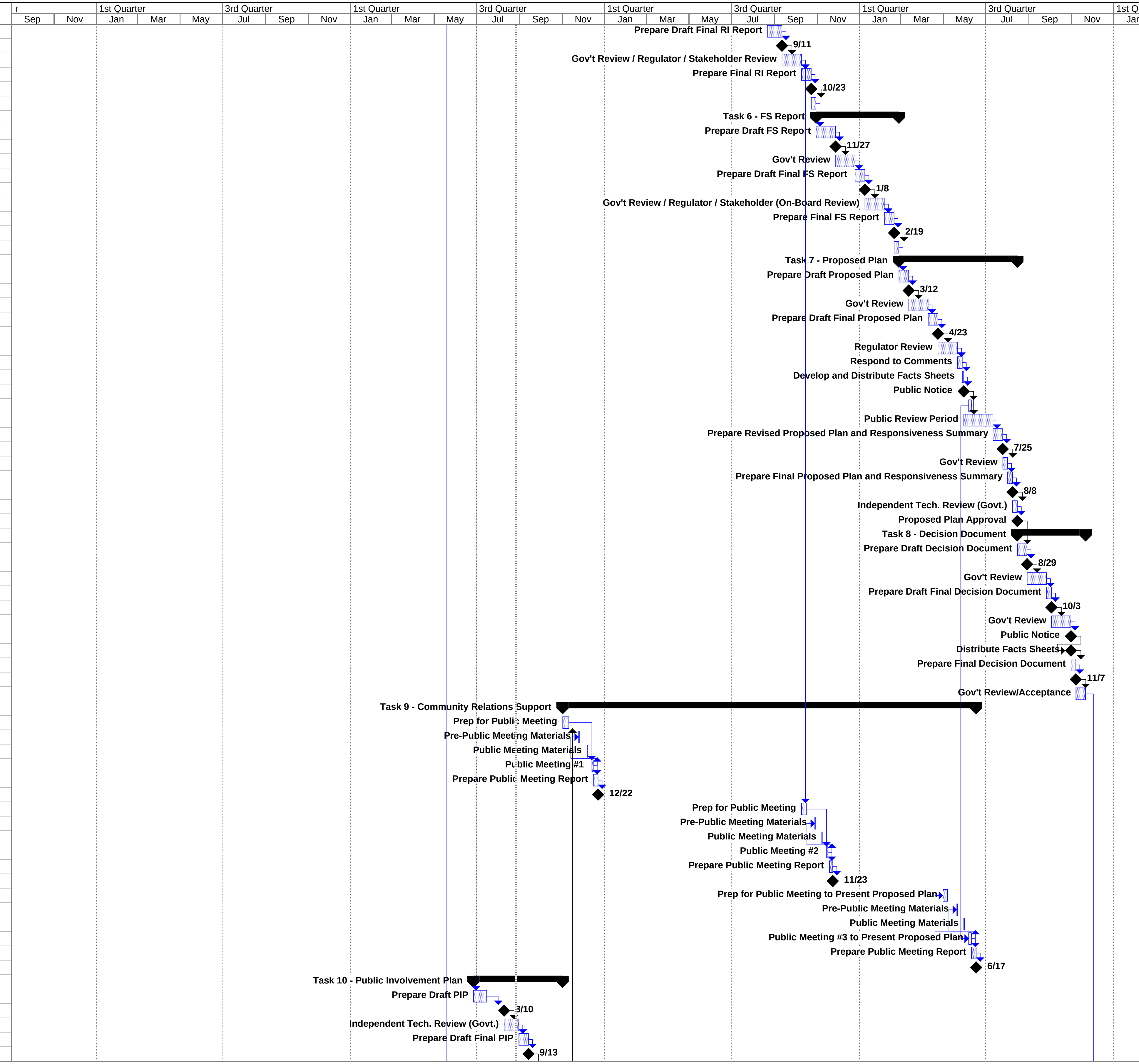
ID	Task Name	Duration	Start	Finish	Predecessors
1	Task Order Award	0 days	Mon 12/27/10	Mon 12/27/10	
2	Notice-to-Proceed	1 day	Mon 12/27/10	Mon 12/27/10	1
3	**Project Management**	**785 days**	**Mon 1/10/11**	**Fri 1/10/14**	
4	Kick-Off Conference Call	0 days	Mon 1/31/11	Mon 1/31/11	2FS+2 days
5	Kick-Off Conference Call Meeting Minutes	7 days	Mon 1/31/11	Tue 2/8/11	4
6	Project Schedule	7 days	Mon 1/31/11	Tue 2/8/11	4
7	Intial Schedule Approval	0 days	Tue 2/8/11	Tue 2/8/11	6
8	**Monthly Report**	**785 days**	**Mon 1/10/11**	**Fri 1/10/14**	
46	**Task 1 - Technical Project Planning**	**382 days**	**Wed 2/9/11**	**Thu 7/26/12**	
47	TPP Preparation	15 days	Wed 2/9/11	Tue 3/1/11	7
48	CSM Revision	15 days	Wed 2/9/11	Tue 3/1/11	5
49	Submit Read Ahead Material and CSM	1 day	Wed 3/2/11	Wed 3/2/11	48
50	TPP Meeting 1 and Site Visit	2 days	Wed 3/16/11	Thu 3/17/11	49FS+9 days
51	Submit Draft TPP Memorandum (e-copy)	14 days	Fri 3/18/11	Wed 4/6/11	50
52	Draft TPP Memorandum - Govt Review	22 days	Thu 4/7/11	Fri 5/6/11	51
53	Submit Final TPP Memorandum (e-copy)	5 days	Mon 5/9/11	Fri 5/13/11	52
54	Receive Gov't. Approval of Final TPP Memorandum	1 day	Mon 5/16/11	Mon 5/16/11	53
55	TPP Meeting 2 - Finalize Work Plan	1 day	Fri 8/26/11	Fri 8/26/11	71SS+1 day
56	Submit Draft TPP Memorandum Addendum (e-copy)	5 days	Mon 8/29/11	Fri 9/2/11	55
57	Draft TPP Memorandum Addendum - Govt Review	5 days	Mon 9/5/11	Fri 9/9/11	56
58	Submit Final TPP Memorandum Addendum (e-copy)	5 days	Mon 9/12/11	Fri 9/16/11	57
59	TPP Meeting 3 - Verify data gaps filled & finalize RI	1 day	Thu 7/5/12	Thu 7/5/12	196FS+7 days
60	Submit Draft TPP Memorandum Addendum II (e-copy)	5 days	Fri 7/6/12	Thu 7/12/12	59
61	Draft TPP Memorandum Addendum II - Govt Review	5 days	Fri 7/13/12	Thu 7/19/12	60
62	Submit Final TPP Memorandum Addendum II (e-copy)	5 days	Fri 7/20/12	Thu 7/26/12	61
63	**Task 2 - RI/FS Work Plan**	**88 days**	**Mon 5/16/11**	**Wed 9/14/11**	
64	Prepare Draft Work Plan and QASP	15 days	Mon 5/16/11	Fri 6/3/11	54FS-1 day
65	Ship Draft Work Plan and QASP (Gov't only)	0 days	Fri 6/3/11	Fri 6/3/11	64
66	Gov't Review	15 days	Mon 6/6/11	Fri 6/24/11	65
67	Prepare Draft-Final Work Plans and QASP	10 days	Mon 6/27/11	Fri 7/8/11	66
68	Ship Draft-Final Work Plans and QASP	0 days	Fri 7/15/11	Fri 7/15/11	
69	Gov't and Regulator Review	20 days	Fri 7/15/11	Thu 8/11/11	68
70	Receive Gov't and Regulator Comments	0 days	Wed 8/24/11	Wed 8/24/11	69FS+9 days
71	Prepare Final Work Plan and QASP	10 days	Thu 8/25/11	Wed 9/7/11	70
72	Ship Final Work Plans and QASP	0 days	Wed 9/7/11	Wed 9/7/11	71
73	Receive Gov't Approval of Final Work Plans	5 days	Thu 9/8/11	Wed 9/14/11	72
74	**Task 3 - GIS**	**708 days**	**Tue 12/28/10**	**Thu 9/12/13**	
75	Establish Baseline GIS Layers/ Submit with CSM	8 days	Tue 12/28/10	Thu 1/6/11	2
76	Gov't Review/Acceptance	15 days	Fri 1/7/11	Thu 1/27/11	75
77	Maintain/Update GIS	660 days	Fri 1/28/11	Thu 8/8/13	76
78	Final GIS Submission	10 days	Fri 8/9/13	Thu 8/22/13	77
79	Gov't Acceptance	15 days	Fri 8/23/13	Thu 9/12/13	78
80	**Task 4 RI/FS Field Activities (Tentative)**	**143 days**	**Wed 9/14/11**	**Mon 4/2/12**	
81	NTP	0 days	Wed 9/14/11	Wed 9/14/11	73
82	Mobilization	1 day	Thu 9/29/11	Thu 9/29/11	81FS+10 days
83	Site Setup and Site-Specific Training	5 days	Fri 9/30/11	Thu 10/6/11	82
84	Anomaly Density GIS Mapping (Concurrent with Field Activities)	120 days	Tue 10/18/11	Mon 4/2/12	88,109FF
85	Analog and Digital Test Plot Setup, Performance, Report	10 days	Fri 10/7/11	Thu 10/20/11	83
86	**MRS 1 - Gas Chamber**	**16 days**	**Fri 9/30/11**	**Fri 10/21/11**	
94	**MRS 2 - Grenade Court**	**9 days**	**Fri 10/21/11**	**Wed 11/2/11**	
102	**MRS 3 - Range Complex (Land & Lake Shoreline)**	**117 days**	**Fri 10/21/11**	**Mon 4/2/12**	
110	**AoPI -3**	**9 days**	**Thu 11/3/11**	**Tue 11/15/11**	
118	**AoPI -5**	**9 days**	**Thu 11/3/11**	**Tue 11/15/11**	
126	**AoPI -8**	**9 days**	**Wed 11/16/11**	**Mon 11/28/11**	
134	**AoPI -9E**	**9 days**	**Wed 11/16/11**	**Mon 11/28/11**	
142	**AoPI -9G**	**9 days**	**Mon 11/28/11**	**Thu 12/8/11**	
150	**AoPI -10A**	**21 days**	**Fri 12/9/11**	**Fri 1/6/12**	
158	**AoPI -10B**	**9 days**	**Mon 11/28/11**	**Thu 12/8/11**	
166	**AoPI -11B**	**9 days**	**Mon 1/9/12**	**Thu 1/19/12**	
174	**AoPI -11C**	**9 days**	**Mon 1/9/12**	**Thu 1/19/12**	
182	**AoPI -11D**	**9 days**	**Fri 1/20/12**	**Wed 2/1/12**	
190	**Task 12 - Environmental Sampling and Analysis**	**60 days**	**Tue 4/3/12**	**Mon 6/25/12**	
191	MC RI Sampling	20 days	Tue 4/3/12	Mon 4/30/12	109
192	Daily QC Report for Environmental Sampling (ea. day)	20 days	Tue 4/3/12	Mon 4/30/12	109
193	Analytical Data Submittal for QA Evaluation	20 days	Tue 5/1/12	Mon 5/28/12	192
194	Electronic Laboratory Data Submittal	20 days	Tue 5/1/12	Mon 5/28/12	192
195	Recommendation Report	10 days	Tue 5/29/12	Mon 6/11/12	194
196	Gov't Review	10 days	Tue 6/12/12	Mon 6/25/12	195
197	**Task 5 - RI Report**	**91 days**	**Tue 6/26/12**	**Tue 10/30/12**	
198	Prepare Draft RI Report	21 days	Tue 6/26/12	Tue 7/24/12	196
199	Ship Draft RI Report	0 days	Tue 7/24/12	Tue 7/24/12	198
200	Gov't Review	20 days	Wed 7/25/12	Tue 8/21/12	199



RI/FS at Camp Croft, SC
Date: Fri 8/26/11
Zapata Incorporated

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

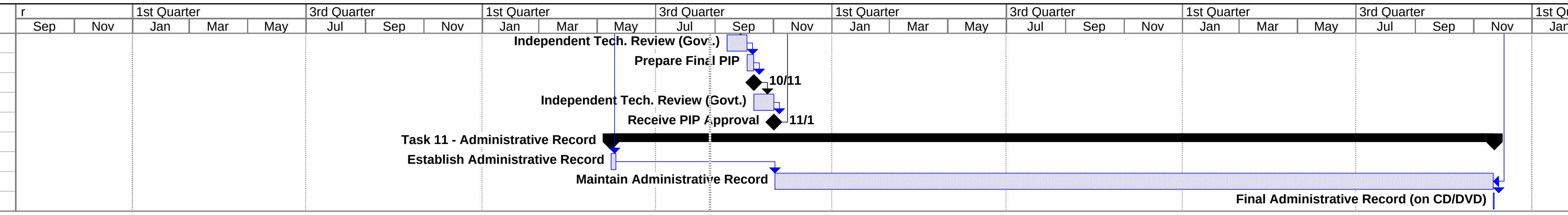
ID	Task Name	Duration	Start	Finish	Predecessors
201	Prepare Draft Final RI Report	15 days	Wed 8/22/12	Tue 9/11/12	200
202	Ship Draft Final RI Report	0 days	Tue 9/11/12	Tue 9/11/12	201
203	Gov't Review / Regulator / Stakeholder Review	20 days	Wed 9/12/12	Tue 10/9/12	202
204	Prepare Final RI Report	10 days	Wed 10/10/12	Tue 10/23/12	203
205	Ship Final RI Report	0 days	Tue 10/23/12	Tue 10/23/12	204
206	Receive Final RI Report Approval	5 days	Wed 10/24/12	Tue 10/30/12	205
207	**Task 6 - FS Report**	**85 days**	**Wed 10/31/12**	**Tue 2/26/13**	
208	Prepare Draft FS Report	20 days	Wed 10/31/12	Tue 11/27/12	206
209	Ship Draft FS Report	0 days	Tue 11/27/12	Tue 11/27/12	208
210	Gov't Review	20 days	Wed 11/28/12	Tue 12/25/12	209
211	Prepare Draft Final FS Report	10 days	Wed 12/26/12	Tue 1/8/13	210
212	Ship Draft Final FS Report	0 days	Tue 1/8/13	Tue 1/8/13	211
213	Gov't Review / Regulator / Stakeholder (On-Board Review)	20 days	Wed 1/9/13	Tue 2/5/13	212
214	Prepare Final FS Report	10 days	Wed 2/6/13	Tue 2/19/13	213
215	Ship Final FS Report	0 days	Tue 2/19/13	Tue 2/19/13	214
216	Receive Final FS Report Approval	5 days	Wed 2/20/13	Tue 2/26/13	215
217	**Task 7 - Proposed Plan**	**122 days**	**Wed 2/27/13**	**Thu 8/15/13**	
218	Prepare Draft Proposed Plan	10 days	Wed 2/27/13	Tue 3/12/13	216
219	Ship Draft Proposed Plan	0 days	Tue 3/12/13	Tue 3/12/13	218
220	Gov't Review	20 days	Wed 3/13/13	Tue 4/9/13	219
221	Prepare Draft Final Proposed Plan	10 days	Wed 4/10/13	Tue 4/23/13	220
222	Ship Draft Final Proposed Plan	0 days	Tue 4/23/13	Tue 4/23/13	221
223	Regulator Review	20 days	Wed 4/24/13	Tue 5/21/13	222
224	Respond to Comments	5 days	Wed 5/22/13	Tue 5/28/13	223
225	Develop and Distribute Facts Sheets	2 days	Wed 5/29/13	Thu 5/30/13	224
226	Public Notice	0 days	Thu 5/30/13	Thu 5/30/13	225
227	Public Meeting w/ Transcriber (aka Public Meeting #3)	2 days	Fri 6/7/13	Mon 6/10/13	226FS+5 days
228	Public Review Period	30 days	Fri 5/31/13	Thu 7/11/13	226
229	Prepare Revised Proposed Plan and Responsiveness Summary	10 days	Fri 7/12/13	Thu 7/25/13	228
230	Submit Revised Proposed Plan and Responsiveness Summary	0 days	Thu 7/25/13	Thu 7/25/13	229
231	Gov't Review	5 days	Fri 7/26/13	Thu 8/1/13	230
232	Prepare Final Proposed Plan and Responsiveness Summary	5 days	Fri 8/2/13	Thu 8/8/13	231
233	Submit Final Proposed Plan and Responsiveness Summary	0 days	Thu 8/8/13	Thu 8/8/13	232
234	Independent Tech. Review (Govt.)	5 days	Fri 8/9/13	Thu 8/15/13	233
235	Proposed Plan Approval	0 days	Thu 8/15/13	Thu 8/15/13	234
236	**Task 8 - Decision Document**	**70 days**	**Fri 8/16/13**	**Thu 11/21/13**	
237	Prepare Draft Decision Document	10 days	Fri 8/16/13	Thu 8/29/13	235
238	Submit Draft Decision Document	0 days	Thu 8/29/13	Thu 8/29/13	237
239	Gov't Review	20 days	Fri 8/30/13	Thu 9/26/13	238
240	Prepare Draft Final Decision Document	5 days	Fri 9/27/13	Thu 10/3/13	239
241	Submit Draft Final Decision Document	0 days	Thu 10/3/13	Thu 10/3/13	240
242	Gov't Review	20 days	Fri 10/4/13	Thu 10/31/13	241
243	Public Notice	0 days	Thu 10/31/13	Thu 10/31/13	242
244	Distribute Facts Sheets	0 days	Thu 10/31/13	Thu 10/31/13	243
245	Prepare Final Decision Document	5 days	Fri 11/1/13	Thu 11/7/13	244
246	Submit Final Decision Document	0 days	Thu 11/7/13	Thu 11/7/13	245
247	Gov't Review/Acceptance	10 days	Fri 11/8/13	Thu 11/21/13	246
248	**Task 9 - Community Relations Support**	**424 days**	**Wed 11/2/11**	**Mon 6/17/13**	
249	Prep for Public Meeting	7 days	Wed 11/2/11	Thu 11/10/11	277
250	Pre-Public Meeting Materials	1 day	Fri 11/25/11	Fri 11/25/11	252FS-15 days
251	Public Meeting Materials	1 day	Wed 12/7/11	Wed 12/7/11	252FS-7 days
252	Public Meeting #1	2 days	Wed 12/14/11	Thu 12/15/11	249FS+23 days
253	Prepare Public Meeting Report	5 days	Fri 12/16/11	Thu 12/22/11	252
254	Submit Public Meeting Report	0 days	Thu 12/22/11	Thu 12/22/11	253
255	Prep for Public Meeting	5 days	Wed 10/10/12	Tue 10/16/12	203
256	Pre-Public Meeting Materials	1 day	Mon 10/29/12	Mon 10/29/12	258FS-15 days
257	Public Meeting Materials	1 day	Thu 11/8/12	Thu 11/8/12	258FS-7 days
258	Public Meeting #2	2 days	Thu 11/15/12	Fri 11/16/12	255FS+21 days
259	Prepare Public Meeting Report	5 days	Mon 11/19/12	Fri 11/23/12	258
260	Submit Public Meeting Report	0 days	Fri 11/23/12	Fri 11/23/12	259
261	Prep for Public Meeting to Present Proposed Plan	5 days	Wed 5/1/13	Tue 5/7/13	264FS-29 days
262	Pre-Public Meeting Materials	1 day	Tue 5/21/13	Tue 5/21/13	264FS-15 days
263	Public Meeting Materials	1 day	Fri 5/31/13	Fri 5/31/13	264FS-7 days
264	Public Meeting #3 to Present Proposed Plan	2 days	Fri 6/7/13	Mon 6/10/13	227SS
265	Prepare Public Meeting Report	5 days	Tue 6/11/13	Mon 6/17/13	264
266	Submit Public Meeting Report	0 days	Mon 6/17/13	Mon 6/17/13	265
267	**Task 10 - Public Involvement Plan**	**92 days**	**Mon 6/27/11**	**Tue 11/1/11**	
268	Prepare Draft PIP	15 days	Mon 6/27/11	Fri 7/15/11	66
269	Submit Draft PIP	0 days	Wed 8/10/11	Wed 8/10/11	268
270	Independent Tech. Review (Govt.)	15 days	Wed 8/10/11	Tue 8/30/11	269
271	Prepare Draft Final PIP	10 days	Wed 8/31/11	Tue 9/13/11	270
272	Submit Draft Final PIP	0 days	Tue 9/13/11	Tue 9/13/11	271



RI/FS at Camp Croft, SC
Date: Fri 8/26/11
Zapata Incorporated

Task	Split	Progress	Milestone	Summary	Project Summary	External Tasks	External Milestone	Deadline

ID	Task Name	Duration	Start	Finish	Predecessors
273	Independent Tech. Review (Govt.)	15 days	Wed 9/14/11	Tue 10/4/11	272
274	Prepare Final PIP	5 days	Wed 10/5/11	Tue 10/11/11	273
275	Submit Final PIP	0 days	Tue 10/11/11	Tue 10/11/11	274
276	Independent Tech. Review (Govt.)	15 days	Wed 10/12/11	Tue 11/1/11	275
277	Receive PIP Approval	0 days	Tue 11/1/11	Tue 11/1/11	276
278	**Task 11 - Administrative Record**	**660 days**	**Mon 5/16/11**	**Fri 11/22/13**	
279	Establish Administrative Record	5 days	Mon 5/16/11	Fri 5/20/11	53
280	Maintain Administrative Record	536 days	Thu 11/3/11	Thu 11/21/13	279,247FF
281	Final Administrative Record (on CD/DVD)	1 day	Fri 11/22/13	Fri 11/22/13	280



RI/FS at Camp Croft, SC
Date: Fri 8/26/11
Zapata Incorporated

Task	Split	Progress	Milestone	Summary	Project Summary	External Tasks	External Milestone	Deadline

APPENDIX N

GUIDANCE DOCUMENT HNC-ED-CS-S-98-7
"USE OF SANDBAGS FOR MITIGATION OF FRAGMENTATION AND BLAST EFFECTS DUE TO INTENTIONAL DETONATION OF MUNITIONS"

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US Army Corps of Engineers
Engineering and Support Center, Huntsville

Use of Sandbags for Mitigation of Fragmentation and Blast Effects Due to Intentional Detonation of Munitions

HNC-ED-CS-S-98-7
AUGUST 1998

DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD
2461 EISENHOWER AVENUE
ALEXANDRIA, VIRGINIA 22331-0600

DDESB-KO

23 February 1999

MEMORANDUM FOR DIRECTOR US ARMY TECHNICAL CENTER FOR EXPLOSIVES SAFETY (ATTENTION: SIOAC-ES)

SUBJECT: Use of Sandbags for Mitigation of Fragmentation and Blast Effects Due to Intentional Detonations of Munitions, Report HNC-ED-CS-S-98-7 (August 1998)

References: (a) SIOAC-ESL memorandum, dated 30 Nov 98, same subject

(b) Joseph M. Serena and Michelle Crull, "Use of Sandbags for Mitigation of Fragmentation and Blast Effects Due to Intentional Detonations of Munitions, Report HNC-ED-CS-S-98-7," (August 1998)

The subject site plan forwarded by reference (a) has been reviewed with respect to explosives safety criteria. The site plan addresses the use of sandbags, IAW reference (b) to mitigate hazards and protect personnel from intentional detonations of munitions up to the 155-mm M107. Based on the information furnished, the proposed use of sandbags for intentional detonations at ordnance and explosives (OE) sites, IAW reference (b) is approved.

A copy of this site plan package and this letter of approval must be available at OE sites where intentional detonations are conducted that use procedures of this siting package.

Point of contact is Dr. Chester E. Canada, DDESB-KT2 (PH: commercial: 703-325-1369, FAX: 703-325-6227, E-MAIL: canadce@hqda.army.mil).

Daniel T. Tompkins

DANIEL T. TOMPKINS
Colonel, USAF
Chairman

cc:
Army Safety Office, ATTN: DACS-SF, Chief of Staff, 200 Army Pentagon, Washington, DC 20310-0200
Commander, U.S. Army Corps of Engineers, ATTN: CESO, 20 Massachusetts Avenue NW, Washington DC 20314-1000
Commander, U.S. Army Engineering and Support Center Huntsville, ATTN: CEHNC-ED-CS and CEHNC-OE-CX-Q, P.O. Box 1600, Huntsville, AL 35807-4301

Use of Sandbags for Mitigation of Fragmentation and Blast Effects Due to Intentional Detonation of Munitions

Prepared by
Joseph M. Serena, III, PE
Michelle Crull, PhD, PE

August 1998

Department of the Army
Huntsville Center, Corps of Engineers
Attn: CEHNC-ED-CS-S
P.O. Box 1600
Huntsville, AL 35807-4301
Telephone: Commercial 256-895-1650

Reviewed by: ______________________ 8/13/98
WALLACE WATANABE — Date
Chief, Structural Branch

Reviewed by: ______________________ 8/[illegible]
PAUL M. LAHOUD, PE — Date
Chief, Civil-Structures Division

EXECUTIVE SUMMARY

The U.S. Army Engineering and Support Center, Huntsville (USAESCH) is currently engaged in projects which require the disposal of uncovered/discarded ordnance and explosives (OE) on public and private lands. The uncovered OE item is often detonated in place if it is too dangerous to move. In some cases, covering and tamping with loose earth is used to contain the blast and fragments. Another method to mitigate the fragmentation and blast effects is to cover the item with sandbags. However, traditionally there has been no method to determine the optimum configuration or the required thickness of such a sandbag enclosure.

The Structural Branch, USAESCH, sponsored a test program in 1997 to evaluate the use of sandbag enclosures for fragment and blast mitigation, for intentional detonations at Ordnance and Explosives (OE) sites. Southwest Research Institute (SwRI), under contract to USAESCH, performed a two phase test program of sandbag enclosures. In phase one, the preliminary explosive test phase, four tests on a 155-mm projectile were performed to refine and optimize the test procedure. This test procedure was used in phase two, the comprehensive explosive test phase. In phase two, a total of fourteen tests with five different munitions were performed to determine the thickness of sandbags required to capture all primary fragments. Measurements were made of the overpressures at various places, sandbag throw distances, depth of fragment penetration, and noise levels. High-speed film cameras, video recorders and digital cameras were used to visually record the events.

Required Wall and Roof Thicknesses for Sandbag Enclosures, with Expected Sandbag Throw Distances and Pressures, for Five Tested Munitions

Munition	Charge Weight, Comp B, lb	Required Wall and Roof Sandbag Thickness, in	Expected Maximum Sandbag Throw Distance, ft	Expected Peak Pressure @ 40 feet, psi	Expected Peak Pressure @ 80 feet, psi	Expected Sound Level @ 100 feet, dB
155-mm M107	15.4	36	220	0.18	0.09	115
4.2-in M329A2	8.17 (TNT)	24	125	0.16	0.06	116
105-mm M1	5.08	24	135	0.18	0.08	120
81-mm M374A2	2.1	20	125	0.14	0.05	119
60-mm M49A3	0.43	12	25	0.08	0.03	118

The results of these tests have been used to develop guidelines for the use of sandbag enclosures. The guidelines include required sandbag thicknesses, configuration and construction of the sandbag enclosures, and withdrawal distances based on the greater of sandbag throw distances or 200 ft. This document provides a summary of the test results and these guidelines.

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1.0 Introduction

The U.S. Army Engineering and Support Center, Huntsville (USAESCH) is currently engaged in projects which require the disposal of uncovered/discarded ordnance and explosives (OE) on public and private lands. The uncovered OE item is often detonated in place if it is too dangerous to move. In some cases, covering and tamping with loose earth is used to contain the blast and fragments. Another method to mitigate the fragmentation and blast effects is to cover the item with sandbags. However, traditionally there has been no method to determine the optimum configuration or the required thickness of such a sandbag enclosure.

The Structural Branch, USAESCH, sponsored a test program in 1997 to evaluate the use of sandbag enclosures for fragment and blast mitigation, for intentional detonations at Ordnance and Explosives (OE) sites. Southwest Research Institute (SwRI), under contract to USAESCH, performed a two phase test program of sandbag enclosures. In phase one, the preliminary explosive test phase, four tests on a 155-mm projectile were performed to refine and optimize the test procedure. This test procedure was used in phase two, the comprehensive explosive test phase. In phase two, a total of fourteen tests with five different munitions were performed to determine the thickness of sandbags required to capture all primary fragments. Measurements were made of the overpressures at various places, sandbag throw distances, depth of fragment penetration, and noise levels. High-speed film cameras, video recorders and digital cameras were used to visually record the events.

The results of these tests have been used to develop guidelines for the use of sandbag enclosures. The guidelines include required sandbag thicknesses, configuration and construction of the sandbag enclosures, and withdrawal distances based on the greater of sandbag throw distances or 200 ft. This document provides a summary of the test results and these guidelines.

2.0 Test Program

2.1 Fragmentation Characteristics of Munitions

Prior to beginning this test program the fragmentation characteristics of a variety of munitions frequently encountered during OE site operations were determined. The fragmentation characteristics were calculated in accordance with procedures outlined in TM5-1300, "Structures to Resist the Effects of Accidental Explosions" [1] and detailed in CEHNC-ED-CS-S-98-1, "Methods for Predicting Primary Fragmentation Characteristics of Cased Explosives" [2]. The fragmentation characteristics were used to predict preliminary thicknesses of sand required to prevent perforation for the five munitions tested.

Optimally, the fragments from the munition will strike the sandbags before the blast wave so that the fragments are penetrating undisturbed sand. To ensure that this will occur it is necessary to reduce the coupling between the explosive charge and the surrounding soil. This coupling is dependent on the separation distance between the charge and the soil. Full coupling implies that the maximum amount of energy, or velocity, is transferred from the explosive into the soil immediately adjacent to the charge. If an explosive charge is placed in a cavity, so that an air gap exists between the charge and the walls of the cavity, coupling between the explosive and soil is reduced. Therefore, a standoff of some distance is required to reduce the coupling effect. Calculations to determine the velocity of sand particles from a buried explosion were performed. The velocity of the sand particles was compared to the velocity of the design fragment through sand. These calculations suggest that at a distance between 6 and 12 inches from the explosion, the fragment velocity exceeds the particle velocity. Therefore, the initial standoff distances for the tests were 6 and 12 inches.

2.2 Preliminary Explosive Test Phase

In the preliminary explosive tests, four tests of statically detonated 155-mm M107 projectiles were performed. These tests provided the data needed to specify the amount and configuration of sandbags that are required to safely detonate a 155-mm projectile in place, verified that the general test procedure was satisfactory, and defined the instrumentation and data acquisition systems for the subsequent comprehensive explosive tests. Figure 1 shows the site layout for the tests of sandbag enclosures. Although, munitions are rarely oriented vertically for demolition in place, the vertical orientation provided the opportunity to evaluate a greater number of combinations of wall thicknesses and standoff distances. Figures 2 and 3 show the sandbag enclosure configurations for vertical and horizontal weapon tests.

The test matrix for the preliminary explosive tests is shown in Table 1. Two tests were run with the 155-mm in the vertical orientation and two in the horizontal orientation. Each test allowed five standoff distances and five sandbag thicknesses to be evaluated.

The sandbags were made of woven polypropylene, as is commonly used by explosives and ordnance disposal (EOD) personnel, and the volume/weight of the sandbags was either 0.5 ft^3/50 lbs for the large bags or 0.25 ft^3/25 lbs for the small bags. The small bags were used for test two. No additional information was provided by using the small bags so these were not used for any other tests. The bags were filled with a "washed river" sand that was judged to be "typical" by a local soil consultant (Fugro-McClelland Southwest, Inc.).

To determine the sandbag throw distribution some of the sandbags in the first two tests were filled with sand colored with dye. The dye did not improve the quality of the test results. Spray paint was used in the subsequent tests to mark each bag with its original position in the sandbag enclosure. A different color was used to indicate the wall or the roof and numbers were used to indicate the layer in which the sandbag was located.

predicts that 24 inches of sand will stop the design fragment from the 155-mm M107 projectile.

Sandbag throw distances were recorded in 10 foot increments from ground zero to the furthest sandbags. The maximum sandbag throw distances were 150 feet, 191 feet, 157 feet, and 150 feet for tests 1 through 4, respectively. All of the furthest thrown sandbags came from the roof. In most cases, the roof sandbags were found relatively intact while the wall sandbags were often disintegrated. The bulk of the sandbags fell within 100 feet with only a few beyond this distance. An examination of the sandbag throw distances show that the standoff, the size of the bag, and the weapon orientation did not affect the throw distance to any significant degree.

Blast overpressures were recorded for all 4 tests (see Table 2). As shown, the sandbag enclosures greatly reduced the magnitude of the pressure. In test 3, a digital sound meter was placed 100 feet from ground zero and the maximum sound level recorded was 114.7 decibels.

Table 2 – Blast Overpressures from Preliminary Explosive Tests

Test No.	Side 1				Side 4			
	P1 @ 40', psi	P2 @ 40', psi	P3 @ 80', psi	P4 @ 80', psi	P5 @ 40', psi	P6 @ 40', psi	P7 @ 80', psi	P8 @ 80', psi
155-1	0.67	0.71	ND	ND	0.37	0.38	ND	ND
155-2	1.31	1.18	ND	ND	0.74	0.97	ND	ND
155-3	0.16	0.16	0.07	0.06	0.16	0.18	0.09	ND
155-4	0.04	0.04	0.03	0.03	0.07	0.08	ND	0.05

ND = no data

2.3 Comprehensive Explosive Tests

An additional fourteen tests were performed: one more using 155-mm M107 projectiles, four using 105-mm M1 projectiles, three using 4.2-in M329A2 projectiles, four using 81-mm M374A2 mortars, and two using 60-mm M49A3 mortars. The test matrix for the comprehensive explosive tests is shown in Table 3. For all tests performed with the munition in the vertical orientation, detonation was achieved using a donor charge of 100 grams (50 grams for test 60-1) of C-4 in the fuze well. For all tests performed with the munition in the horizontal orientation, detonation was achieved using a well perforator. TOA pins were used for all tests to check if a high order detonation was achieved.

For each of the comprehensive explosive tests, woven polypropylene 0.5 ft^3 sandbags were filled with 50 lbs of washed river sand. The sandbags were painted and numbered as described in Section 2.2 to indicate their original position in the sandbag enclosure. Moisture content was not controlled nor monitored during the test program.

4

predicts that 24 inches of sand will stop the design fragment from the 155-mm M107 projectile.

Sandbag throw distances were recorded in 10 foot increments from ground zero to the furthest sandbags. The maximum sandbag throw distances were 150 feet, 191 feet, 157 feet, and 150 feet for tests 1 through 4, respectively. All of the furthest thrown sandbags came from the roof. In most cases, the roof sandbags were found relatively intact while the wall sandbags were often disintegrated. The bulk of the sandbags fell within 100 feet with only a few beyond this distance. An examination of the sandbag throw distances show that the standoff, the size of the bag, and the weapon orientation did not affect the throw distance to any significant degree.

Blast overpressures were recorded for all 4 tests (see Table 2). As shown, the sandbag enclosures greatly reduced the magnitude of the pressure. In test 3, a digital sound meter was placed 100 feet from ground zero and the maximum sound level recorded was 114.7 decibels.

Table 2 – Blast Overpressures from Preliminary Explosive Tests

	Side 1				Side 4			
Test No.	P1 @ 40', psi	P2 @ 40', psi	P3 @ 80', psi	P4 @ 80', psi	P5 @ 40', psi	P6 @ 40', psi	P7 @ 80', psi	P8 @ 80', psi
155-1	0.67	0.71	ND	ND	0.37	0.38	ND	ND
155-2	1.31	1.18	ND	ND	0.74	0.97	ND	ND
155-3	0.16	0.16	0.07	0.06	0.16	0.18	0.09	ND
155-4	0.04	0.04	0.03	0.03	0.07	0.08	ND	0.05

ND = no data

2.3 Comprehensive Explosive Tests

An additional fourteen tests were performed: one more using 155-mm M107 projectiles, four using 105-mm M1 projectiles, three using 4.2-in M329A2 projectiles, four using 81-mm M374A2 mortars, and two using 60-mm M49A3 mortars. The test matrix for the comprehensive explosive tests is shown in Table 3. For all tests performed with the munition in the vertical orientation, detonation was achieved using a donor charge of 100 grams (50 grams for test 60-1) of C-4 in the fuze well. For all tests performed with the munition in the horizontal orientation, detonation was achieved using a well perforator. TOA pins were used for all tests to check if a high order detonation was achieved.

For each of the comprehensive explosive tests, woven polypropylene 0.5 ft^3 sandbags were filled with 50 lbs of washed river sand. The sandbags were painted and numbered as described in Section 2.2 to indicate their original position in the sandbag enclosure. Moisture content was not controlled nor monitored during the test program.

Pressure gages, a sound meter, high speed cameras, digital cameras and video cameras were used for data acquisition during each test. Internal and external witness screens were used to determine how deeply the fragments moved into the sandbag mass and whether any fragments exited the sandbag enclosure.

Table 3 – Test Matrix for Comprehensive Explosive Tests

Test No.	Orientation	Standoff, in.					Wall Thickness, in.				Wall Height, in.	
		S_1	S_2	S_3	S_4	S_R	T_1	T_2	T_3	T_4	H_1	H_2
155-5	Horizontal	7	7	5	6	7	36	36	36	36	13	36
4.2-1	Vertical	5.5	5.5	5.5	5.5	6	20	24	31	36	19	24
4.2-2	Horizontal	6.5	6.5	6	6	7	24	25	24	24	11	24
4.2-3	Horizontal	6	5	5	6	7	24	25	25	24	11	24
105-1	Vertical	5.5	5.5	5.5	5.5	6	20	26	31	35	25	24
105-2	Vertical	0	0	4	6	6	29	25	19	25	26	23
105-3	Horizontal	7	5	5	5	9	24	24	24	24	13	24
105-4	Horizontal	6.5	6	5	6	7	25	25	24	24	11	23
81-1	Vertical	5	5	6	6	6	12	19	23	30	15	18
81-2	Horizontal	7	6	5.5	7	6	18	24	18	24	9	18
81-3	Horizontal	7	6	5	6	7	18	19	18	19	10	18
81-4	Horizontal	6	5.5	5.5	5.5	8	19	20	19	20	11	18
60-1	Vertical	6	6	6	6	6	13	19	23	30	11	12
60-2	Horizontal	6.5	3	5.5	3	6	12	12	12	12	8	13

All detonations were high order and results were obtained. The assorted witness screens were scattered across the site. Where possible, each screen was identified and photographed and the number of fragment holes or the condition of the screen was recorded. Sandbag throw distances were recorded in 10 foot increments from ground zero to the furthest sandbags. Blast overpressures were recorded for all tests at 40 feet and 80 feet from ground zero. A digital sound meter was placed 100 feet from ground zero. A summary of the results is shown in Table 4.

The final test for each munition was a confirmation test. These included tests 155-5, 4.2-3, 105-4, 81-3 and 60-2. The purpose of the confirmation tests was to model as closely as possible the actual use of sandbags in field conditions. In each test the internal witness screens were omitted. Sandbags were staggered both horizontally and vertically. External witness screens were placed over the roof and the two sides facing away from the pressure gages. After each test, the external witness screens were recovered and inspected for fragment penetrations. No such penetrations were identified. Therefore, the sandbag thicknesses defined in Table 4 are those used in the confirmation tests. For two munitions, the penetration data from internal witness panels suggests that somewhat smaller sandbag thicknesses may be sufficient to capture all fragments. As stated above for the 155-mm M107, internal witness screens show no fragment penetrations for sandbag thicknesses of about 24 inches or more. For the

4.2-inch M329A2 mortar, the internal witness screens show no fragment penetrations deeper than about 18 inches. However, the thicknesses of 36 inches for the 155-mm M107 and 24 inches for the 4.2-inch M329A2 are retained for use in the field, since sandbag throw distances are based on these thicknesses. While possibly thicker than necessary from capturing fragments, the increased total mass of the sandbags results in reduced sandbag throw distances.

Detailed descriptions of all tests and results are provided in "Evaluation of Sandbags for Fragment and Blast Mitigation" by Southwest Research Institute [3].

3.0 Guidelines for Use of Sandbags

3.1 Enclosure Geometry

Table 5 summarizes the results of the tests. This table specifies the minimum thickness of sandbag walls and roof that is needed to completely contain the fragments for the five munitions that were tested in this project. It also gives the expected maximum sandbag throw distances, the peak pressures at 40 feet and 80 feet, and the sound level at 100 feet, for the five munitions. For safety and conservatism, the expected sandbag throw distances are approximately 10% larger than the largest distances actually measured in the tests. Thus, the expected sandbag throw distances given in Table 5 are conservative in two ways: first, the largest measured sandbag throw distance from all tests of a particular round is used and second, this value is increased by 10%. Due to the already low values of peak pressures, a similar increase in the expected peak pressures was not deemed necessary or justified.

Table 4 – Summary of Results from Comprehensive Explosive Tests

Munition	Sandbag Thickness (in) to Defeat Fragments	Max. Sandbag Throw Distance (ft)		Max Peak Overpressure (psi) @ 40 ft		Max Peak Overpressure (psi) @ 80 ft		Max Noise Level (dB) at 100 ft
		Side of Round	Nose/Tail of Round	Side of Round	Nose of Round	Side of Round	Nose of Round	
155-mm M107	36	200	130	0.06	0.12	0.04	0.05	114.7
4.2-in M329A2	24	110	70	0.12	0.14	0.04	0.06	115.8
105-mm M1	24	120	50	0.17	0.18	0.07	0.08	119.3
81-mm M374A1	20	110	30	0.14	0.08	0.05	0.03	118.3
60-mm M49A3	12	20	20	0.06	0.08	0.02	0.03	117.3

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Obviously, the five munition types do not cover all of the munitions that may be encountered. To determine the minimum wall and roof thickness for a particular shell other than those found in Table 5, the approach is as follows:

(1) Determine the initial fragment velocity (V_F) in ft/s, the maximum fragment weight (W_F) in pounds, and the kinetic energy ($W_F V_F^2/2$) in lb-ft^2/s^2 for the particular munition.

(2) Identify the munition with the next largest kinetic energy, from Table 6.

(3) Use the sandbag wall and roof thickness from Table 5 for the munition with the next largest kinetic energy shown in Table 6.

Table 6 provides the maximum fragment weight, the initial fragment velocity, and the resulting kinetic energy for the 5 munition types. The maximum fragment weight and the initial fragment velocity values were determined with the Mott and Gurney equations, as presented in TM 5-1300 [1] and detailed in HNC-ED-CS-S-98-1 [2].

Table 5 - Required Wall and Roof Thicknesses for Sandbag Enclosures, with Expected Sandbag Throw Distances and Pressures, for Five Tested Munitions

Munition	Charge Weight, Comp B, lb	Required Wall and Roof Sandbag Thickness, in	Expected Maximum Sandbag Throw Distance, ft	Expected Peak Pressure @ 40 feet, psi	Expected Peak Pressure @ 80 feet, psi	Expected Sound Level @ 100 feet, dB
155-mm M107	15.4	36	220	0.18	0.09	115
4.2-in M329A2	8.17 (TNT)	24	125	0.16	0.06	116
105-mm M1	5.08	24	135	0.18	0.08	120
81-mm M374A2	2.1	20	125	0.14	0.05	119
60-mm M49A3	0.43	12	25	0.05	0.03	118

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Table 6 - Maximum Fragment Weight, Initial Fragment Velocity and Kinetic Energy for Five Tested Munitions

Munition	W_F, Maximum Fragment Weight, lb	V_F, Initial Fragment Velocity, ft/s	Kinetic Energy, 10^6 lb-ft^2/s^2
155-mm M107	0.467	4667	5.085
4.2-in M329A2	0.079	6391	1.613
105-mm M1	0.155	4870	1.868
81-mm M374A2	0.031	6721	0.700
60-mm M49A3	0.033	3605	0.214

As an example, for a shell such as the 3-in Stokes Mortar Round, the maximum fragment weight and initial fragment velocity are 0.0436 lb and 6189 ft/s, respectively. The resulting kinetic energy is 0.835 x 10^6 lb-ft^2/s^2. The next largest fragment kinetic energy in Table 6 is the 4.2-in M329A2 round. Therefore, a sandbag enclosure with a roof and wall thicknesses of 24 inches should be used to contain the fragments and suppress the blast overpressures. The maximum sandbag throw distance is 125 ft. Therefore, the withdrawal distance is 200 ft.

Based on this procedure, a more complete list of typical munitions is given in Table 7. This table includes the required sandbag wall and roof thicknesses and maximum expected sandbag throw distances to be used for each munition. For other munitions not listed in Table 7, the procedure given above can be used. The procedure should not be used to extrapolate sandbag thicknesses or sandbag throw distances for munitions larger than the 155-mm M107.

3.2 Enclosure Construction Method

The enclosure construction method follows the procedure that was used to build the test enclosures, with a few modifications. Figure 4 illustrates a typical enclosure. Figure 5 shows a photograph of a sandbag enclosure for an 81 mm mortar.

The sandbag fabric should be woven polypropylene. Each bag should have a nominal volume of 0.5 ft^3 and an approximate weight when full of 50 lb. The bags should be filled with washed sand, either dry or in saturated surface dry (that is, slightly moist) condition. Wet sand should not be used. Prefilled sandbags should be protected from the rain by storage on pallets, off the ground surface, and by covering them with a plastic tarpaulin or similar cover to prevent them from becoming saturated with water. The gradations and physical composition of the sand are not critical but it should be at least typical of local construction practice for sand used in foundations and backfill. Minor inclusions of clay or soils materials can be permitted. However, no rocks or stones should be placed in the sandbags. Typically, the sand used for the tests had a density of about 100 pounds per cubic foot and a moisture content of 6-7%.

Four walls of identical thickness should surround the munition. The minimum wall thickness should be the thickness determined using the procedure in Section 3.1 above. The sandbag walls should be stacked to maintain a clear standoff distance of 6 inches between the shell and the inside face of each wall. The interior face of each wall should be vertical but the exterior face can be built with a 1:6 slope (2" horizontal to 12" vertical). If a sloped outer face is used, the thickness of the wall, at the nominal "top" of the wall, 6 inches above the top of the munition, must be no less than the specified required thickness

The sandbags should be placed tightly against each other. All vertical joints should be staggered, so there is no clear line of sight from the munition to the exterior. As the wall is built, each new layer of sandbags should run in opposite direction to the layer below, so that the layers are interlocked (see Figure 6).

At a minimum, a double layer of sandbags shall be used. For example, when a 12" thickness is required, the sandbags should be oriented so that two sandbags are necessary to achieve this thickness (see Figure 7).

After the walls are constructed to a height of 6" above the upper surface of the munition, the shaped charge or other initiator should be placed on the shell. Ideally, the use of shaped charges, such as oil well perforators, is recommended. These add very little to the total charge weight for each detonation, given the highly directional nature of the effects of the shaped charge. Also, the use of shaped charges for initiation parallels test procedures. The shaped charge should be located either on top of the munition or on its side. If it is located on the side of the round, the charge should be tilted downward sufficiently to ensure that the shaped charge jet penetrates the round and is directed into the ground, rather than into the opposite sandbag wall. Generally, a small mound of sand next to the round can be used to establish this orientation.

A sheet of 3/4-inch thick Douglas Fir (or equivalent) plywood should be cut to the dimensions of the cavity between the walls, plus 12 inches in each direction. The plywood sheet is then centered on the walls so that it bears on 6" of each wall. The additional sandbags that make up the roof of the enclosure are then placed on top. As with the side walls, the roof sandbags should be stacked with staggered horizontal joints and alternating directions in each layer. The exterior sides of the roof may also be vertical or have a 1:6 slope. The thickness of the sandbag roof, above the plywood panel, must be the same as the required wall thickness.

After the sandbag layers of the roof have been placed to the correct height, the enclosure is complete and the munition may be detonated.

Table 7 - Required Wall and Roof Thicknesses for Sandbag Enclosures, with Expected Sandbag Throw Distances and Pressures, for Tested and Non-Tested Munitions

Munition	Charge Weight (lb)	W_F, Maximum Fragment Weight, lb	V_F, Initial Fragment Velocity, ft/s	Kinetic Energy, 10^6 lb-ft^2/s^2	Required Wall and Roof Sandbag Thickness, in	Expected Maximum Sandbag Throw Distance, ft	With-drawal Distance, ft
155mm M107*	15.48	0.467	4667	5.086	36	220	220
4.7-in Mark I	6.07	0.591	3566	3.761	36	220	220
105mm M1*	5.08	0.155	4870	1.840	24	135	200
4.2-in M329A2*	8.165	0.079	6391	1.607	24	125	200
4-in Stokes	7.92	0.078	6336	1.570	24	125	200
75mm M48	1.47	0.153	3471	0.922	24	125	200
3-in Stokes	2.1	0.044	6189	0.835	24	125	200
2.75-in M229 Rocket	4.8	0.050	5569	0.777	24	125	200
81mm M374*	2.1	0.031	6721	0.696	20	125	200
37mm MK II	0.53	0.030	5758	0.490	20	125	200
60mm M49A3*	0.42	0.024	5114	0.310	12	25	200
FMU 54A/B	0.357	0.006	9031	0.263	12	25	200
40mm MK2 Mod 0	0.187	0.033	3605	0.215	12	25	200
MK II Grenade	0.125	0.014	3425	0.083	12	25	200
25mm M792	0.096	0.005	5736	0.081	12	25	200
M67 Grenade	0.40625	0.001	7006	0.029	12	25	200
20mm M56A4	0.0264	0.0000011	4941	0.004	12	25	200

* = tested munitions

3.3 Withdrawal Zone

A withdrawal zone is necessary for any detonation. This withdrawal zone applies to everyone, both public and operational personnel. The withdrawal zone is the maximum of the sandbag throw distance, the distance to a sound level of 140 db, or 200 ft. For all munitions tested, the sound level at 100 ft was substantially less than 140 db. At 200 ft. the sound level will be even lower. The withdrawal zones are also listed in Table 7.

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4.0 Summary and Conclusions

A test program has been performed to determine the effects of sandbag enclosures for mitigating fragments and blast effects due to an intentional detonation of a munition. A total of eighteen tests on five different munitions were performed. A summary of the test procedures and results are presented in this document.

The results of these tests have been used to develop guidelines for the use of sandbag enclosures to mitigate the fragments and blast effects due to an intentional detonation of a munition. Methods for determining the required sandbag thickness and the resulting sandbag throw distance are detailed in Section 3.0. Figures 4, 5, 6 and 7 show the resulting sandbag enclosures.

5.0 References

1. TM5-1300, "Structures to Resist the Effects of Accidental Explosions", Departments of the Army, the Navy, and the Air Force, November 1990.

2. HNC-ED-CS-S-98-1, "Methods for Predicting Primary Fragmentation Characteristics of Cased Explosives", M. Crull, U.S. Army Engineering and Support Center, Huntsville, January 1998.

3. "Evaluation of Sandbags for Fragment and Blast Mitigation", D. Stevens, Southwest Research Institute, San Antonio, TX, January 1998.

4. "User's Guide for Microcomputer Programs CONWEP and FUNPRO Applications of TM 5-855-1. "Fundamentals of Protective Design For Conventional Weapons"", Revision 2, D. Hyde, US Army Corps of Engineers Waterways Experiment Station, February 1989.

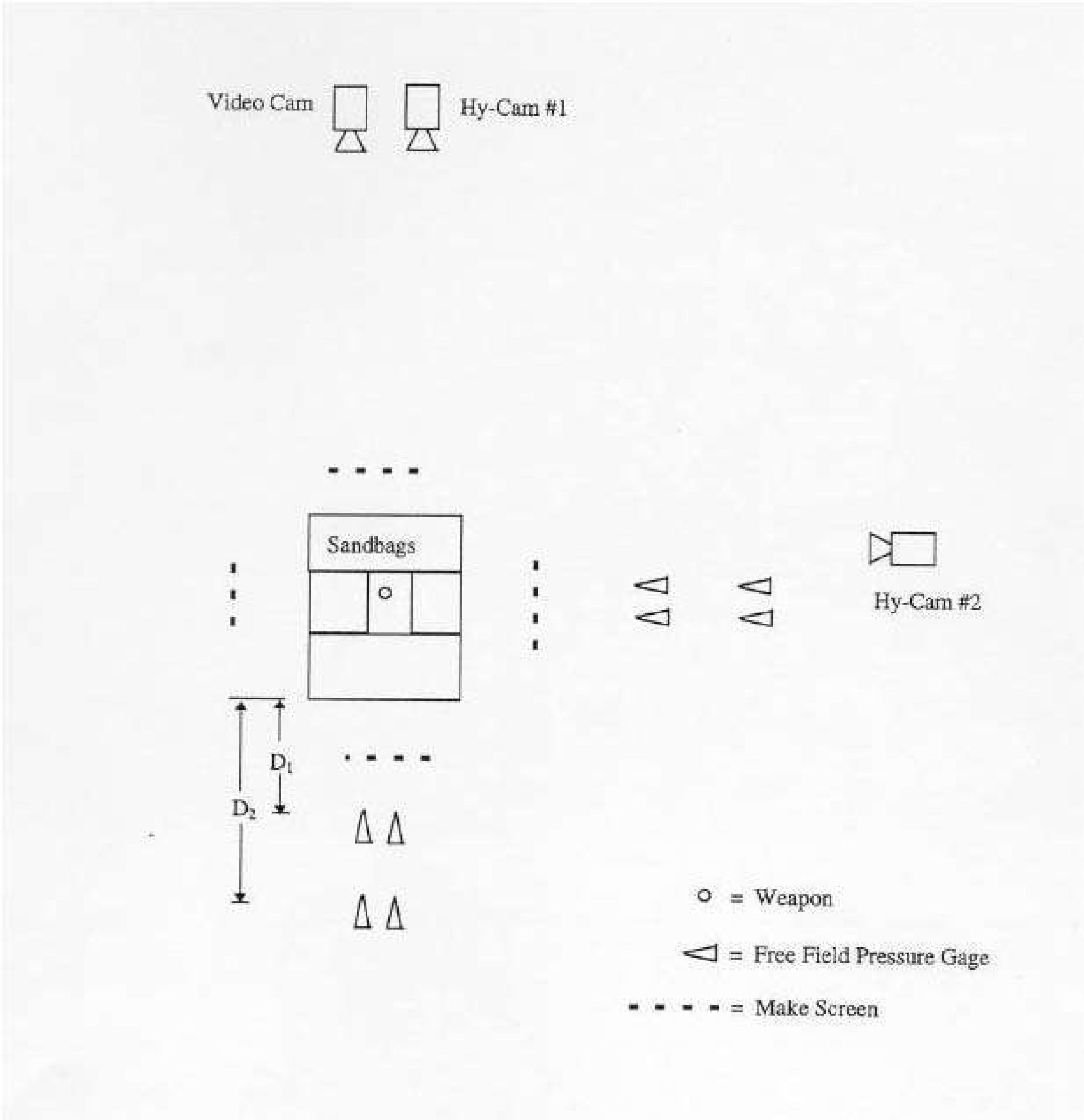

Figure 1 – Site Layout for Tests of Sandbag Enclosures

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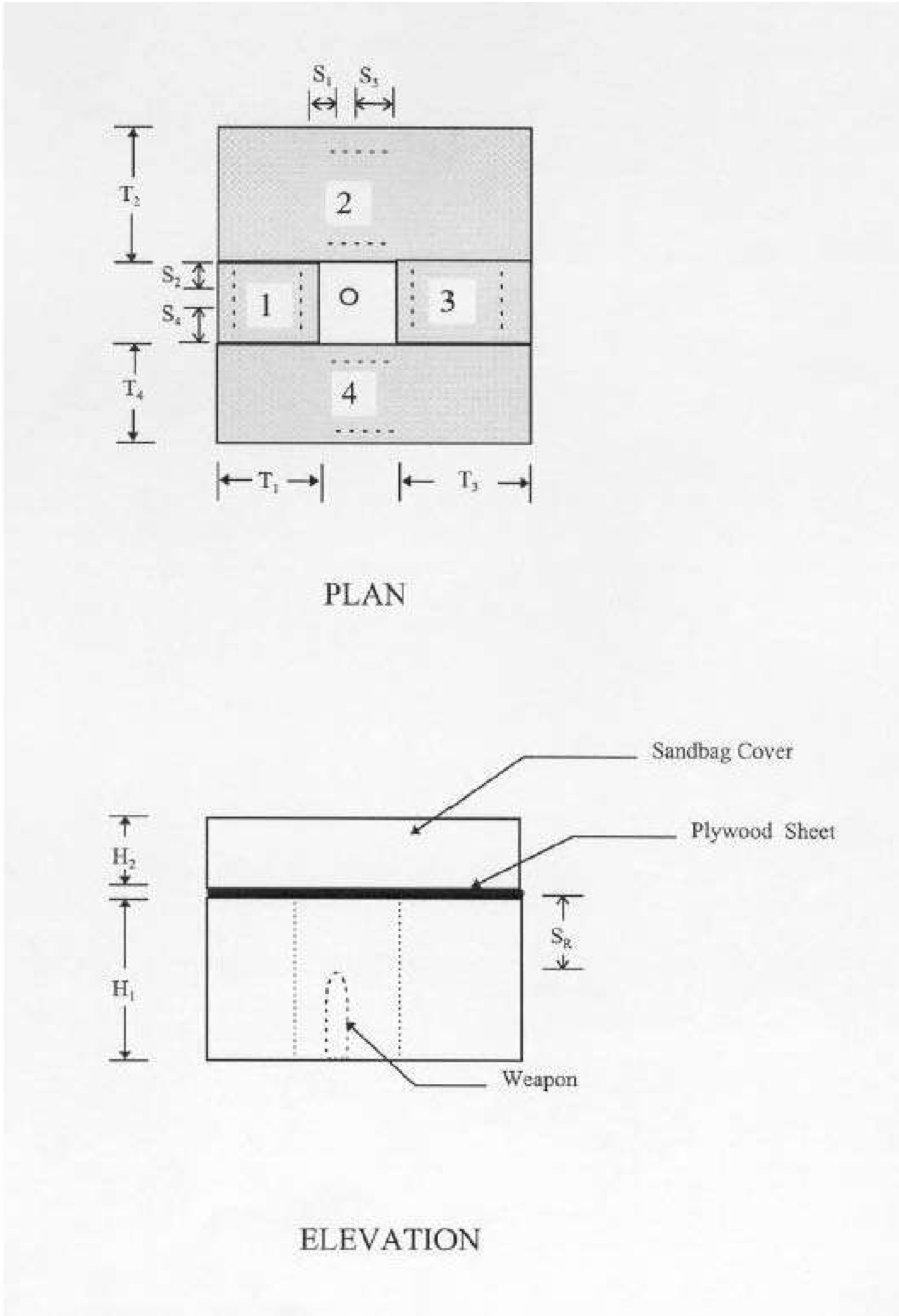

Figure 2 – Sandbag Enclosure Configuration for Vertical Weapon Tests

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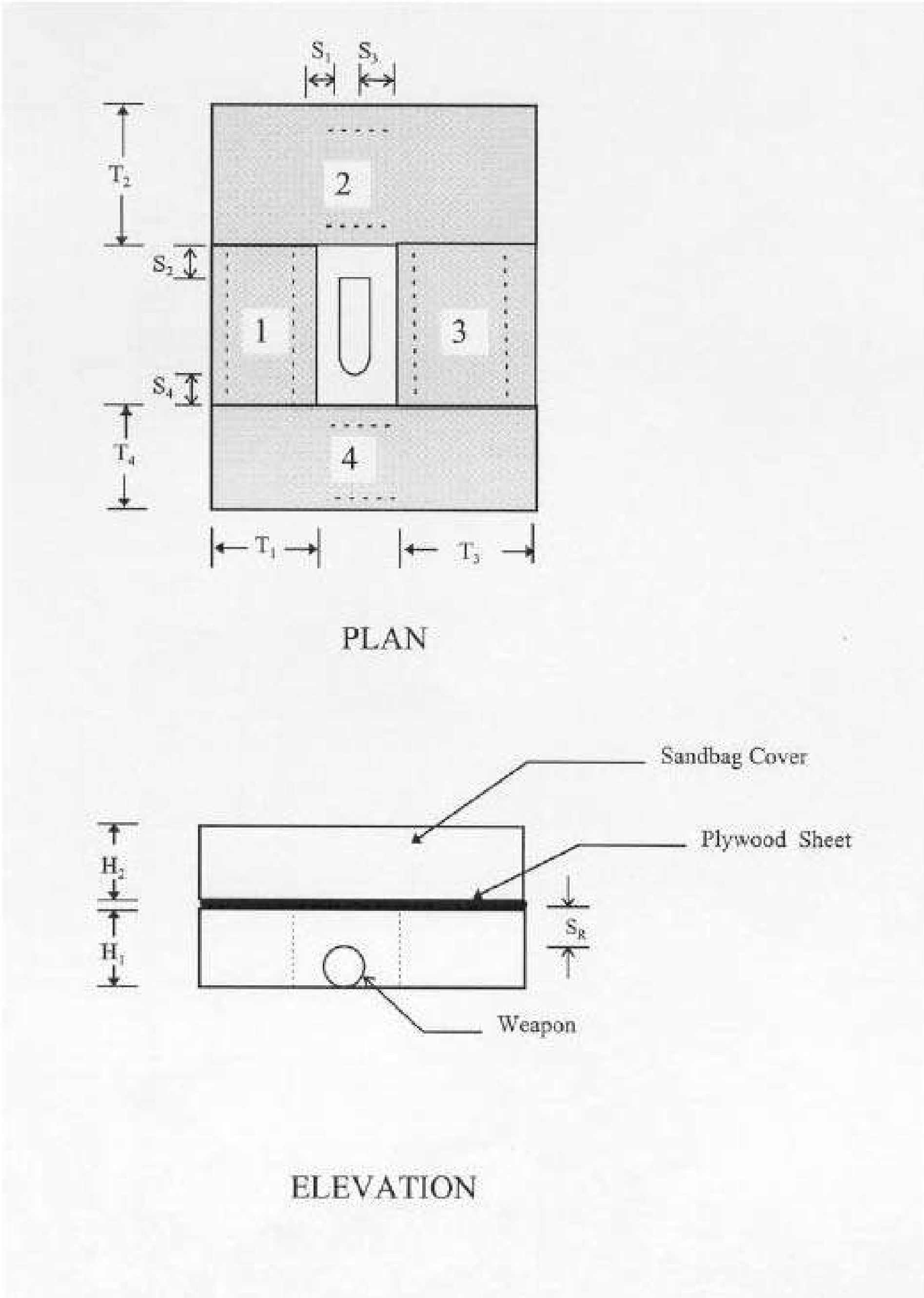

Figure 3 – Sandbag Enclosure Configuration for Horizontal Weapon Tests

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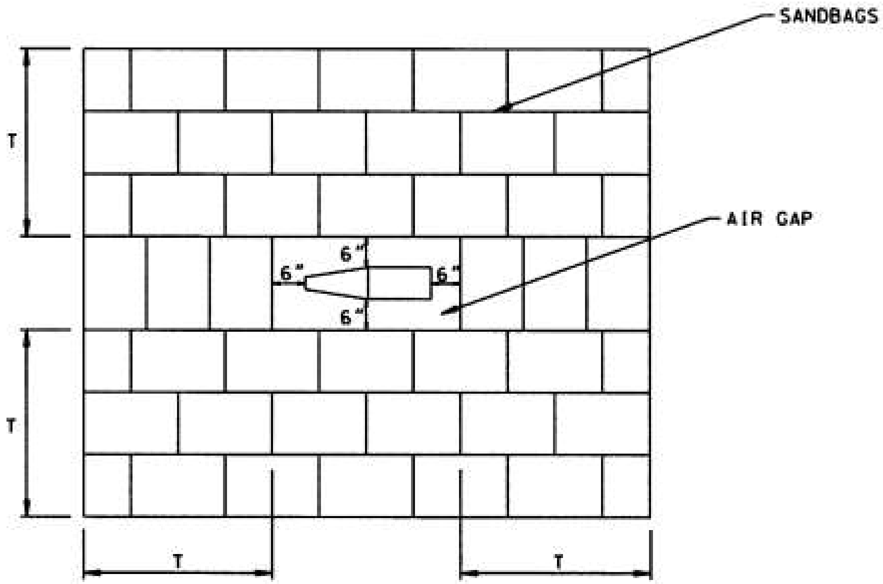
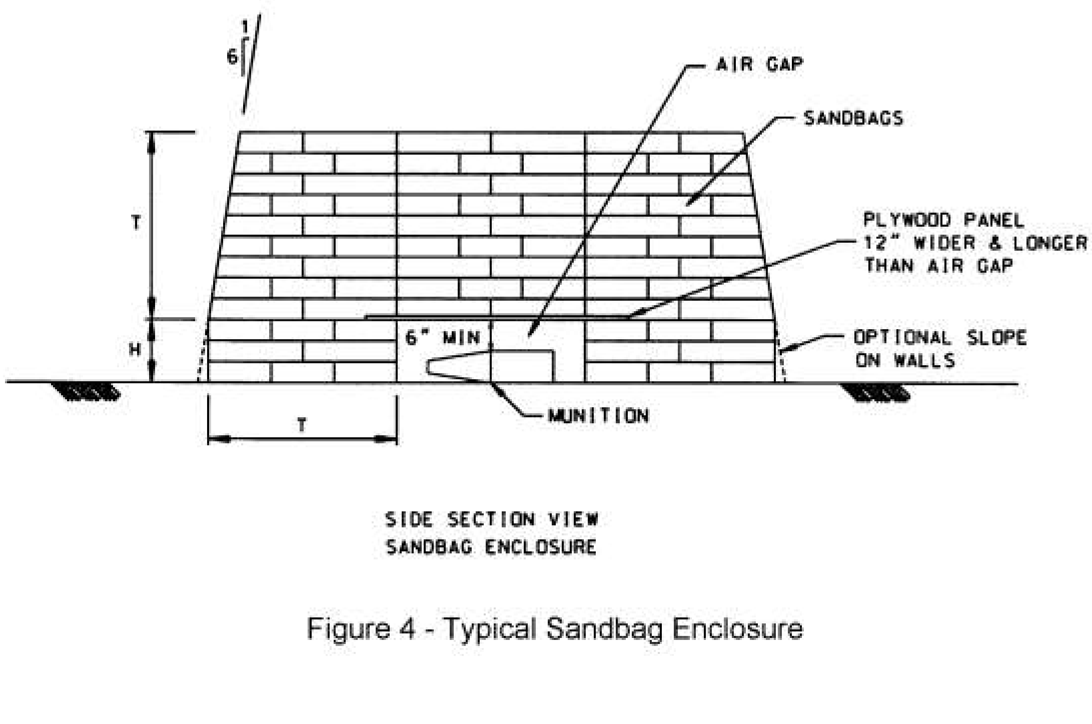


T=THICKNESS OF SANDBAGS REQUIRED FOR SPECIFIC MUNITION

PLAN VIEW AT ELEVATION H
SANDBAG ENCLOSURE



SIDE SECTION VIEW
SANDBAG ENCLOSURE

Figure 4 - Typical Sandbag Enclosure

Figure 5 – Sandbag Enclosure for an 81 mm M374A2 mortar.

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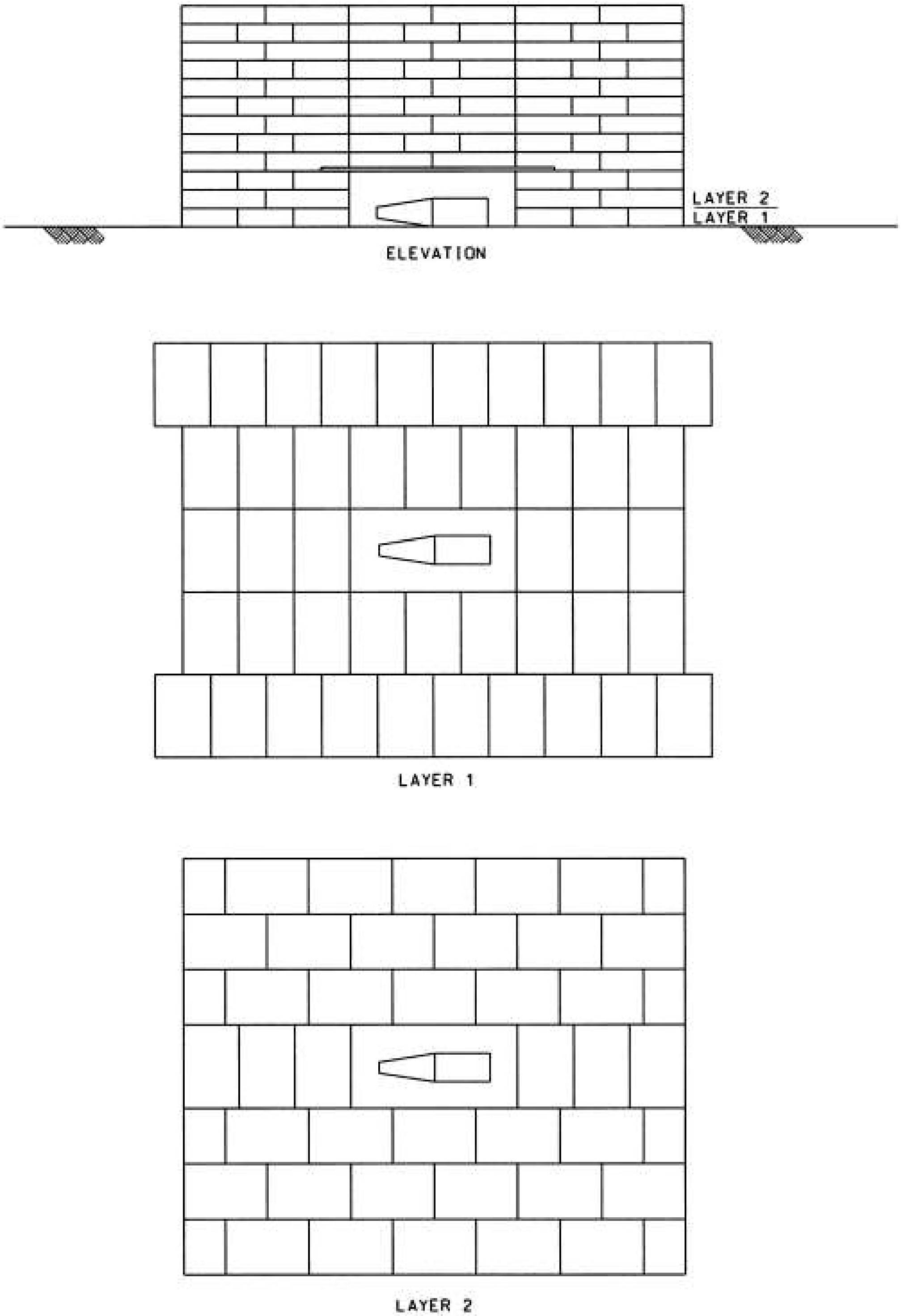

Figure 6 - Interlocking Alternate Layers of Sandbags

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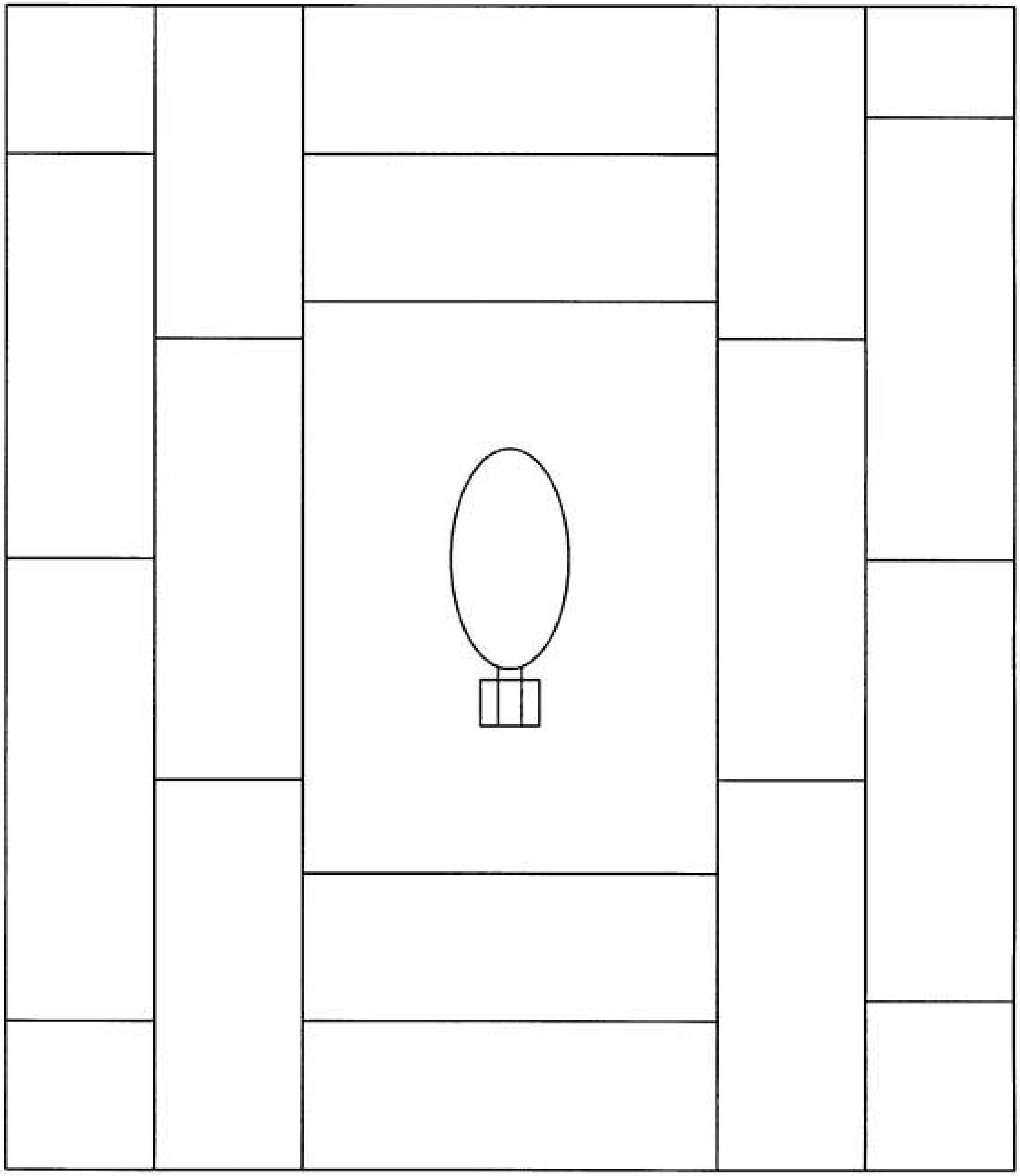

Figure 7 - Configuration for 12" Wall Enclosures

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APPENDIX O
EXPLOSIVE SITING PLAN (ESP)
AND
EXPLOSIVE SAFETY SUBMISSION (ESS)

(Note: The ESP and ESS undergo a separate and parallel review process concurrent with ZAPATA's activities under this task order. Those documents, when completed, will be stand-alone documents and will be attached to ZAPATA's Final Work Plans. The versions of the ESP and ESS provided herein are for informational purposes only. ZAPATA will not be authorized to being fieldwork until the ESP and ESS are finalized and accepted by the government.)

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Explosive Site Plan

REMEDIAL INVESTIGATION

Former Camp Croft

MRS 1 - Gas Chambers
MRS 2 - Grenade Court
MRS 3 - Range Complex (Land)
Area of Potential Interest (AoPI) 3
Area of Potential Interest (AoPI) 5
Area of Potential Interest (AoPI) 6
Area of Potential Interest (AoPI) 9G
Area of Potential Interest (AoPI) 10A
Area of Potential Interest (AoPI) 10B
Area of Potential Interest (AoPI) 11B
Area of Potential Interest (AoPI) 11C
Area of Potential Interest (AoPI) 11D

Spartanburg, SC

26 August 2011

Prepared by

US ARMY CORPS OF ENGINEERS
Engineering and Support Center, Huntsville

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6.0 SCOPE OF REMEDIAL ACTION **4**

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APPENDIX A – MAPS **A1**

APPENDIX B – CALCULATION SHEETS **B1**

1. **Site:**
   a. Name: Former Camp Croft
   b. State: Spartanburg, SC
   c. This remedial investigation (RI) is being performed under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and is part of the overall Remedial Action Process. Subsequent removal responses may be dictated in the future during the remainder of the remedial response process, as determined by action memoranda or other decision documents. Based on the results of this characterization and subsequent decision document, an Explosives Safety Submission (ESS) will be submitted in accordance with DoD 6055.09-M.

2. **Anticipated Dates:**
   a. Start: 15 August 2011

3. **Purpose:**
   a. Munitions Response Site (MRS) remedial investigation and characterization to collect the information needed to design the required munitions response and to prepare, as appropriate, an ESS for the selected response.
   b. Clarifies that qualified UXO personnel will perform all MEC activities at the site.

4. **Site Background and Current Conditions:**
   a. Former Camp Croft Infantry Replacement Center (IRTC), located less than 10 miles southeast of the city of Spartanburg in Spartanburg County, South Carolina, operated during World War II to train soldiers in the use of weapons including cannons, mortars, anti-tank and anti-aircraft rockets, machine guns, hand grenades, and small arms. Following closure of the 19,000-acre facility, the government transferred approximately 7,000 acres to the South Carolina Commission of Forestry for the creation of the current Croft State Park. The remaining property was sold by the War Assets Administration to the public for residential, business, and agricultural use. Although the government had previously taken steps to clear former Camp Croft Army Training Facility of ordnance waste and potentially explosive ordnance items, some ordnance contamination remained.
   b. The Remedial Action will be performed within three munitions response sites (MRSs), 10 Areas of Potential Interest (AoPI), and one site that is within the Formerly Used Defense Site (FUDS), but outside of the MRSs. The 10 AoPIs correspond to areas previously referred to as Ordnance Operable Units (OOUs).

The discussion on each area is outlined below, and the areas are shown on Figure 1-1. The Munitions with the Greatest Fragmentation Distances (MGFDs) are listed in Table 7-1.

1. **MRS 1 – Gas Chambers:** The Gas Chambers MRS was used to train soldiers on the effects of gas munitions. CS smoke pots/grenades are believed to be the primary training item used at this site. Based on historical information, it is not believed that Chemical Agent Identification Sets (CAIS) or Chemical Warfare Materiel (CWM) was used at this MRS. Q-D Arcs for the K40 and K328 distances (non-fragmenting round) are depicted on Figure 4-1.
2. **MRS 2 – Grenade Court**: This Range is the location of a former WWII era grenade court. It is assumed that this range was a live grenade court and utilized Mk II fragmentation grenades and M21 Practice Hand Grenades. Q-D Arcs are depicted on Figure 4-2.
3. **MRS 3 – Range Complex 1** This Range Complex contained WWII era ranges 1-11 and 15. Within this MRS there was a mortar range, anti-tank range, and several small arms ranges. A large portion of the complex is now a state park while the remainder is privately owned. Munitions listed in the 2004 ASR Supplement that were used on this range included small arms, 2.36-inch M6A1/M6A3 Rockets, M9A1 Anti-tank Rifle Grenades, 60mm M49 HE Mortars, 81mm M43/M56 HE Mortars, 60mm/80mm Illumination and Smoke Mortars, and various practice rockets and mortars. AoPI 6 was extracted from this MRS for Q-D purposes due to the larger MEC findings within AoPI 6 during previous investigations. Q-D Arcs are depicted on Figure 4-3.
4. **AoPI 3 –** This Area was investigated during the Engineering Evaluation/Cost Analysis (EE/CA) Investigation, Phases I and II. It comprises an entire subdivision, and was formerly used as a practice grenade range. During a Removal Action conducted in March, 1997, seven MK II fragmentation hand grenades were recovered. 2.36-inch rocket fragments were also found, which may have been overshoot from another firing range. Q-D Arcs are depicted on Figure 4-4.
5. **AoPI 5 –** During the EE/CA investigation in 1996, a rifle grenade was discovered. There is no other supporting information for this AoPI. There is no model number available for the rifle grenade. Q-D Arcs are depicted on Figure 4-5.
6. **AoPI 6 –** This AoPI is a portion of MRS 3. However, within this AoPI, a 155mm burster tube, 105mm HE projectiles and 105mm smoke canisters, 81mm illumination mortars, and 60mm mortars were discovered during previous investigations and removals within the AoPI 6. Q-D Arcs are

depicted on Figure 4-6.

7. **AoPI 9G –** Small arms ammunition has been discovered in this AoPI since Site Closure. Anecdotal evidence of grenades has been provided by the public. There is no information for the model of grenade that was found. Q-D Arcs are depicted on Figure 4-7.
8. **AoPI 10A –** This area lies entirely within Croft State Park. EE/CA Sampling indicated that the entire AoPI 10 contained significant amounts of Munitions Debris (MD) associated with high order detonations. Items included rifle grenade debris, land mine debris, empty 60mm Mortar Illumination Candle, an empty grenade, and a single intact inert 2.36-inch practice round was discovered. No HE 2.36-inch rockets, grenades or 60mm mortars were discovered, and are not expected to be encountered. Q-D Arcs are depicted on Figure 4-8.
9. **AoPI 10B –** EE/CA Sampling indicated that the entire AoPI 10 contained significant amounts of MD associated with high order detonations. It was formerly used as an area for training maneuvers. MD from hand grenades and 60mm Mortars was discovered within this AoPI. Q-D Arcs are depicted on Figure 4-9.
10. **AoPI 11B –** This AoPI is located in an area that was used for training maneuver areas, and is currently an open field used for grazing. MD from hand grenades, a 60mm M83 illumination round and small arms have been found in this AoPI. Q-D Arcs are depicted on Figure 4-10.
11. **AoPI 11C –** This AoPI is located in an area that was used for training maneuver areas, and is currently a privately owned mostly wooded property. Suspected MEC include hand grenades, rifle grenades, rockets, mortars and small arms. M9 Rifle Grenade fragments and MKII Hand Grenades have been found in this MRS. Q-D Arcs are depicted on Figure 4-11.
12. **AoPI 11D –** This AoPI is located in an area that is a suspected former grenade range, and is currently a golf course. The Sherriff's office responded to findings of a MkII practice grenades and 60mm/81mm practice mortars within this AoPI. No other MEC items have been found.   Q-D Arcs for the K40 and K328 distances (non-fragmenting round) are depicted on Figure 4-12.

5. Executing Agencies:

- **a.** US Army Corps of Engineers, Huntsville Center
- **b.** US Army Corps of Engineers, Savannah District
- **c.** Contractor, Zapata Engineering

6. **Scope of Investigative/Characterization Action:**
   - **a.** A surface and subsurface (to depth of detection) investigative action is required to fully characterize the site to determine the extent and boundaries of contamination, and identify possible future remedial actions.
   - **b.** The selected technique for conducting the investigation for contaminants is a surface sweep and intrusive investigation of potential MEC and debris to depth of detection.
   - **c.** The investigative action will identify possible future remedial action areas for this site. Munitions Constituents (MC) soil borings will be performed using anomaly avoidance.
   - **d.** No Mechanized MEC Activities will be performed during this RI/FS.
   - **e.** Table 6-1 identifies the different Areas to be investigated within this project location.

Table 6-1

Area	Type of Investigation	Total acreage of Site	Acreage to be Investigated
MRS 1 - Gas Chambers	Surface and Subsurface Remedial Investigation	23.8	1.28
MRS 2 - Grenade Court	Surface and Subsurface Remedial Investigation	24.9	0.74
MRS 3 - Range Complex (Land) (Including AoPI 6)	Surface and Subsurface Remedial Investigation	12,102.4	85.5
AoPI 3	Surface and Subsurface Remedial Investigation	11	0.80
AoPI 5	Surface and Subsurface Remedial Investigation	5.5	0.17
AoPI 9G	Surface and Subsurface Remedial Investigation	6.6	1.89
AoPI 10A	Surface and Subsurface Remedial Investigation	171.5	4.86
AoPI 10B	Surface and Subsurface Remedial Investigation	33.6	0.29
AoPI 11B	Surface and Subsurface Remedial Investigation	34.7	0.99
AoPI 11C	Surface and Subsurface Remedial Investigation	23.0	5.17
AoPI 11D	Surface and Subsurface Remedial Investigation	15.1	

7. **Safety Criteria:**
   - **a.** The munitions with the greatest fragmentation distance (MGFD) at the site are identified in Table 7-1. The MGFDs were chosen for each MRS/AoPI in relation to all available historical information of MEC found during previous investigations or removals. During the course of this investigation, if a MEC item with a greater fragmentation distance is encountered, the MSD will be adjusted in accordance

with DDESB Technical Paper 16, operations will continue, and an amendment to this ESP submitted expeditiously for approval.

Table 7-1								
Minimum Separation Distances (MSD)								
		MSD (ft)[1]						
		For Unintentional Detonations			For Intentional Detonations			
Area	MEC	Team Separation Distance (K40)	Hazardous Fragment Distance (HFD)	To Sides and Rear using MOFB [2]	Without Engineering Controls	Using Sandbag Mitigation[3]	Using Double Sandbag Mitigation[3]	Using Water Mitigation [3]
MRS 1 - Gas Chambers	40mm M651 CS Grenade	***8***	***8 (K40)***	***N/A***	663 (K328)	N/A	N/A	N/A
MRS 2 - Grenade Court	Mk II Hand Grenade	***20***	***62***	***20***	521	200	12.5	200/200 [B]
MRS 3 - Range Complex 1 (excluding AoPI 6)	81mm M43	43	209	74	1579	200	12.5	200 [A]
	81mm M56	***65***	***240***	***N/A***	1196	200	N/A	200 [A]
AoPI 3	2.36 inch M6A3 Rocket	***37***	***142***	***37***	790	200	12.5	264/200
AoPI 5	M9A1 Rifle Grenade	28	***113***	28	709	200	12.5	200/200 [B]
	M31 Rifle Grenade	***36***	92	***74***	500	200	12.5	264/200
AoPI 6	155 M101	98	389	***N/A***	***2894***	N/A	N/A	N/A
	155 M107 (Comp B)	105	***450***	***N/A***	2630	220	N/A	275
	155 M795	***123***	443	***N/A***	2739	N/A	N/A	N/A
AoPI 9G	M26A2 Grenade	***30***	***288***	***30***	312	200	12.5	200/200 [B]
	M46 Grenade	18	90	18	721	200	12.5	200/200 [B]
AoPI 10A	M26A2 Grenade	30	***288***	30	312	200	12.5	200/200 [B]
	M15 AT Mine	***119***	221	***N/A***	1027	N/A	N/A	N/A
	M3 AP Mine	39	180	74	1818	200	12.5	200
AoPI 10B	M26A2 Grenade	30	***288***	30	312	200	12.5	200/200 [B]
	60mm M49A5	***39***	184	***74***	1070	200	12.5	264/200 [B]
	60mm M49A2	28	152	28	1322	200	12.5	264/200 [B]
AoPI 11B	M26A2 Grenade	***30***	***288***	***30***	312	200	12.5	200/200 [B]
	M46 Grenade	18	90	18	721	200	12.5	200/200 [B]
AoPI 11C	M9A1 Rifle Grenade	***28***	***113***	***28***	709	200	12.5	200/200 [B]
AoPI 11D	81mm Practice M879	***29***	***29 (K40)***	***N/A***	241 (K328)	N/A	N/A	N/A

Notes:

All Values in Bold Italics are the MSDs for unintentional detonations that must be used on-site for the Area.

[1]See Appendix B for calculation sheets documenting MSDs.

[2] MOFB - Miniature Open Front Barricade (in accordance with HNC-ED-CS-S-98-1 Revision 1).

[3] See Appendix B for required sandbag thickness (HNC-ED-CS-S-98-7) and water containment system (HNC-ED-CS-S-00-3).

A = 1100 Gallon Tank; B = 5 gal carboys/inflatable pool

b. See Appendix B for Fragmentation Data Sheets.

c. See Table 7-1 for Minimum Separation Distances. Quantity-Distance (QD) arcs are shown in Appendix A on Figures 4-1 through 4-10.

d. Any occupied buildings or public roadways/waterways in the MSD areas during MEC operations will be evacuated and/or roadways/waterways blocked to prevent non-essential personnel from entering during the conduct of MEC operations.

e. All Material Potentially Presenting an Explosive Hazard (MPPEH) will be processed in accordance with (IAW) DoDI 4140.62 and EM 1110-1-4009. All MPPEH will be assessed and its explosives safety status determined and documented prior to transfer within the DoD or release from DoD control. Prior to release to the public, MPPEH will be documented by authorized and technically qualified personnel as Material Documented as Safe (MDAS) after a 100% inspection and an independent 100% re-inspection to determine that it is safe from an explosives safety perspective.

8. Methods of Disposal:

a. If disposal activities are required, they will be performed by qualified UXO personnel within the MRS. The MSDs for intentional detonations are shown in Table 7-1 and Q-D Arcs are shown on Figures 7-1 through 7-2.

b. Sandbags (HNC-ED-CS-S-98-7 Amendment 1, HNC Safety Advisory dated 12 July 2010, and the DDESB Memorandum "Clarifications Regarding Use of Sandbags for Mitigation of Fragmentation and Blast Effects due to Intentional Detonation of Munitions", Nov. 29 2010) or water mitigation (HNC-ED-CS-S-00-3) may be used to reduce the intentional detonation MSD as shown in Table 7-1. Tamping (single or multiple items) may be used in accordance with DDESB Technical Paper 16 and the Buried Explosion Module. In addition to Single Sandbag Mitigation, Double Sandbag Mitigation is approved for items up to and including 81mm diameter munitions that do not exceed TNT Net Explosive Weight (NEW) of 1.39 lbs IAW HNC-ED-CS-S-98-7 Amendment 1.

c. The MGFD for Camp Croft MRSs and AoPIs are shown in Table 7-1. Items with smaller fragmentation distances may be found. Demolition of these items may be done using the item-specific minimum separation distances and engineering controls in accordance with DDESB TP 16 Fragmentation Database. For items not in the DDESB TP 16 Fragmentation Database, the maximum fragment distance may be calculated IAW the generic equations in DDESB TP 16. (Note: the Generic Equation Calculator (GEQ) is available on the DDESB's secure website at http://www.ddesb.pentagon.mil/.)

d. On-call explosives delivery will be used for any MEC items recovered during operations. Explosives will be provided by a local vendor on an as-needed basis. MEC will be marked and guarded, if necessary, until disposal is accomplished.

e. The Miniature Open Front Barricade (MOFB) or the Open Front Barricade (OFB) may be used as necessary during intrusive operations in accordance with HNC-ED-CS-S-98-9 or HNC-ED-CS-S-99-1, respectively (reports will be available on site) in areas where the terrain allows.

f. All explosive operations will follow the procedures outlined in TM 60A-1-1-31 and EM 385-1-97, Explosives Safety and Health Requirements Manual, demolition operations will be performed daily or items properly guarded until operations can be conducted.

g. Collection points are those areas used to temporarily accumulate MEC determined acceptable to move by the SUXOS and UXOSO pending destruction at the end of the day using consolidated shots. MEC items at collection points must be laid out as shown in “Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives (OE) Sites”. The maximum net explosive weight (NEW) at a collection point will be limited such that the K40 overpressure distance for the total NEW does not exceed the HFD for the area. Consolidating multiple MEC is anticipated for this project.

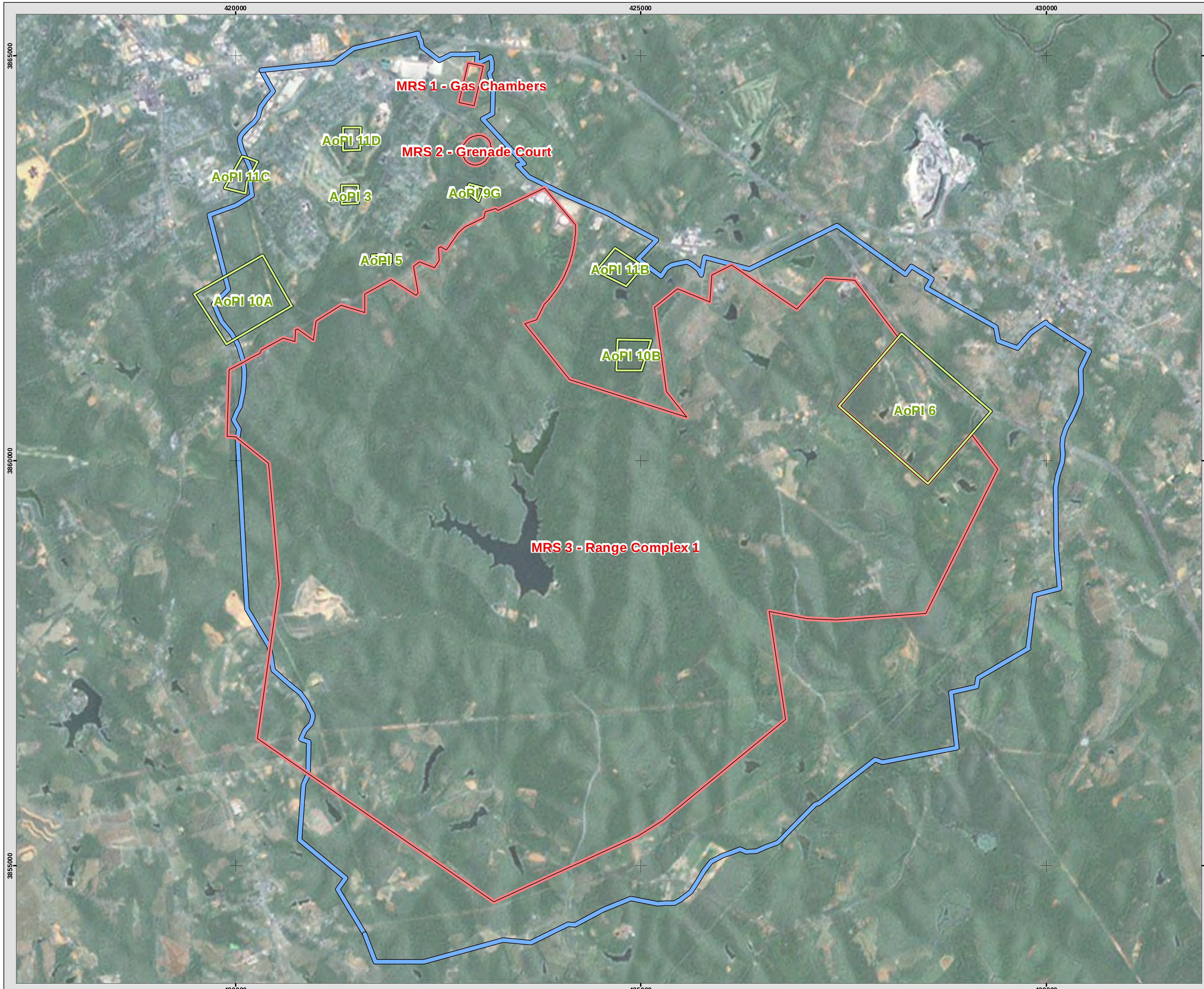
h. If determined acceptable to move by the SUXOS and UXOSO consolidating multiple MEC may be anticipated for this project, US Army Engineering and Support Center, Huntsville (USAESCH) publication “Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives (OE) Sites”, dated March 2000 will be used and a copy of this report will be available on site. The maximum net explosive weight (NEW) for a consolidated shot will be limited such that the K328 overpressure distance for the total NEW (including donor charges) does not exceed the MSD for the intentional detonation.

`

APPENDIX A
MAPS

Figure 1-1

Location Map
Camp Croft, SC



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- Property Boundary
- AoPI Boundaries
- MRS Boundaries

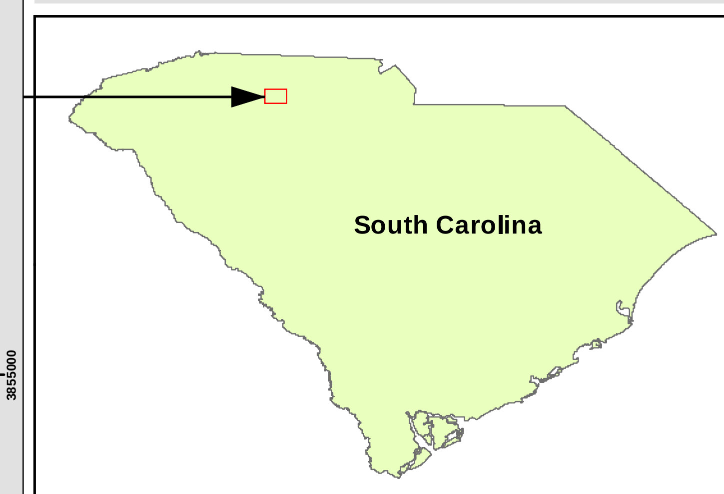

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Figure 4-1
MRS 1 - Gas Chambers
MRS/AoPI Q-D Arcs
Camp Croft, SC

Legend

- MRS/AoPI Boundary
- K40, 8 ft
- K328, 63 ft

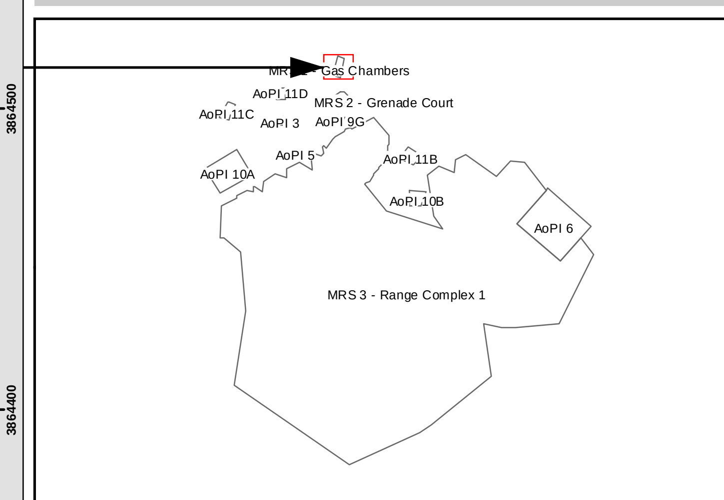

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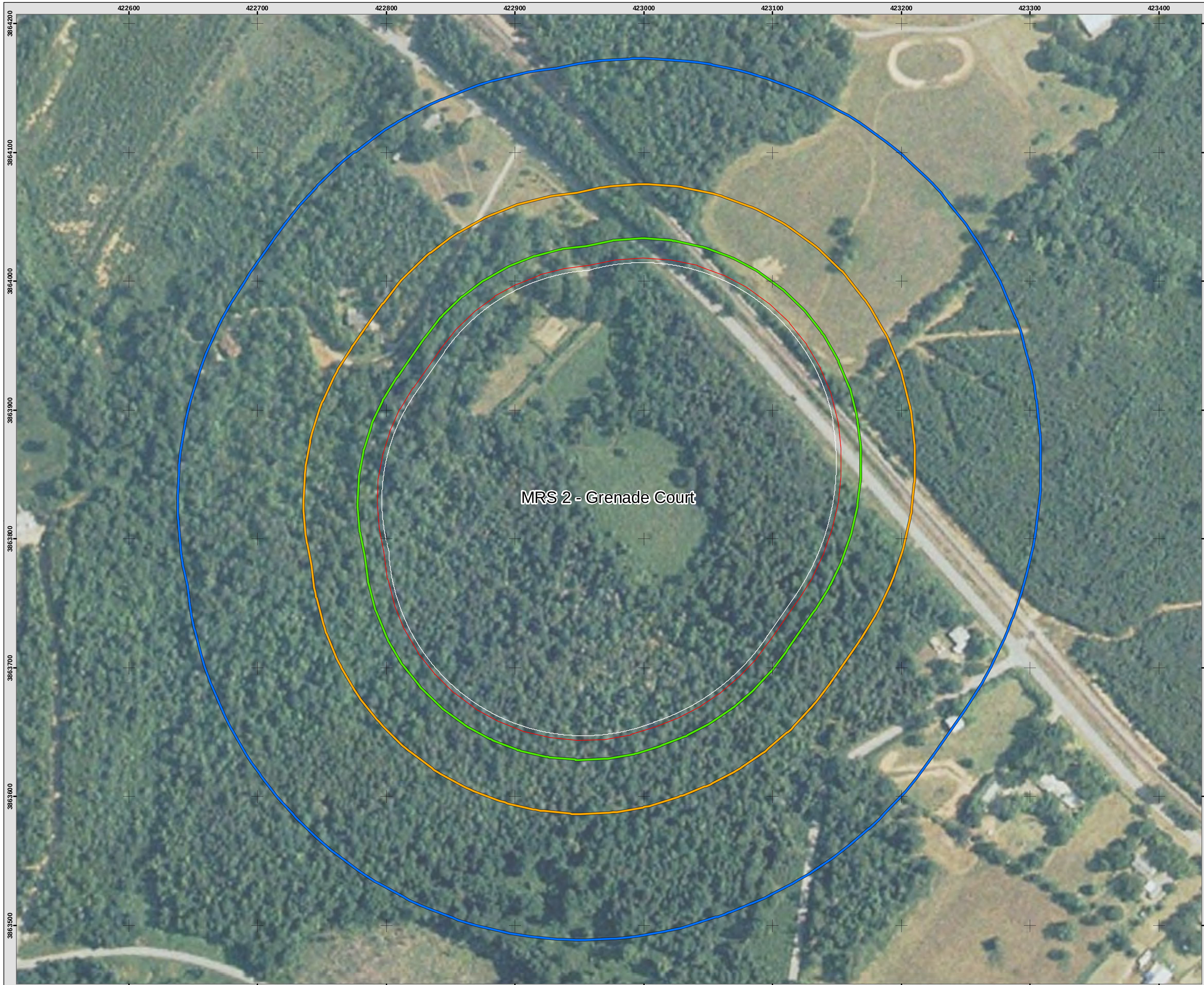
Figure 4-2
MRS 2 - Grenade Court
MRS/AoPI Q-D Arcs
Camp Croft, SC



Legend

- MRS/AoPI Boundary
- Double Sandbag Mitigation, 12.5 ft
- HFD, 62 ft
- Sandbag Mitigation, 200 ft
- MFD-H, 521 ft

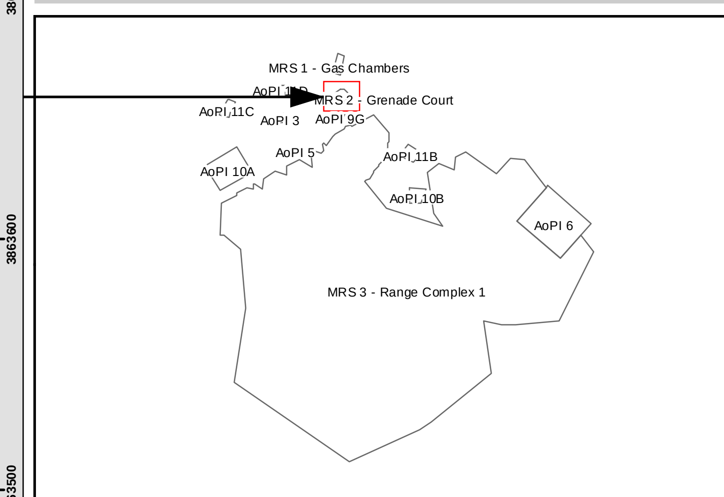


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Figure 4-3
MRS 3 - Range Complex 1
MRS/AoPI Q-D Arcs
Camp Croft, SC

Legend

- MRS/AoPI Boundary
- Double Sandbag Mitigation, 12.5 ft
- Sandbag Mitigation, 200 ft
- HFD, 240 ft
- MFD-H, 1579 ft

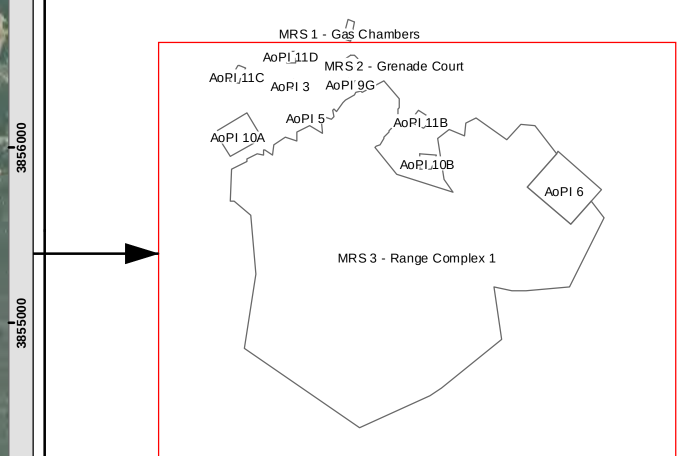

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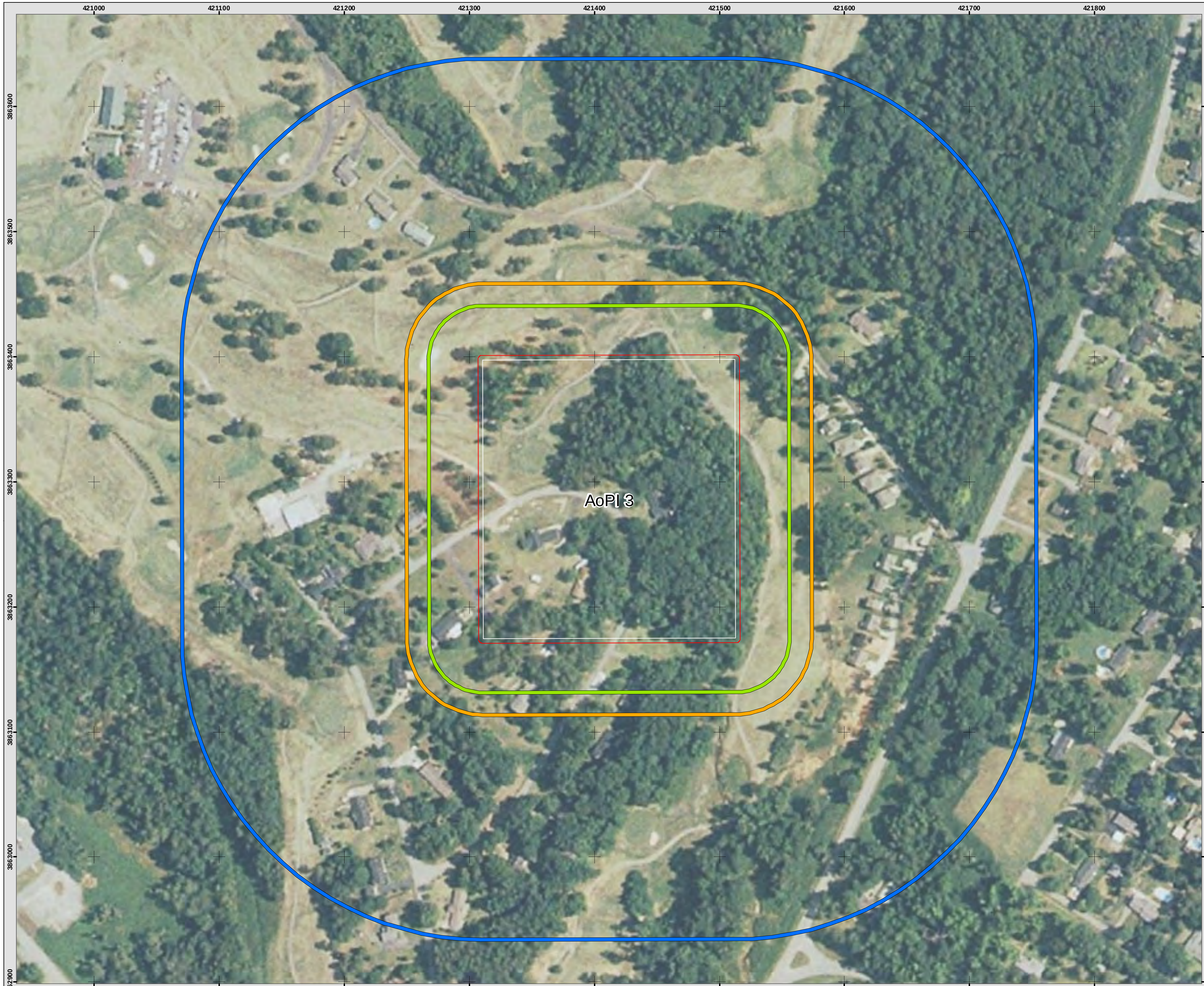
Figure 4-4
AoPI 3
MRS/AoPI Q-D Arcs
Camp Croft, SC



Legend

- MRS/AoPI Boundary
- Double Sandbag Mitigation, 12.5 ft
- HFD, 142 ft
- Sandbag Mitigation, 200 ft
- MFD-H, 790 ft

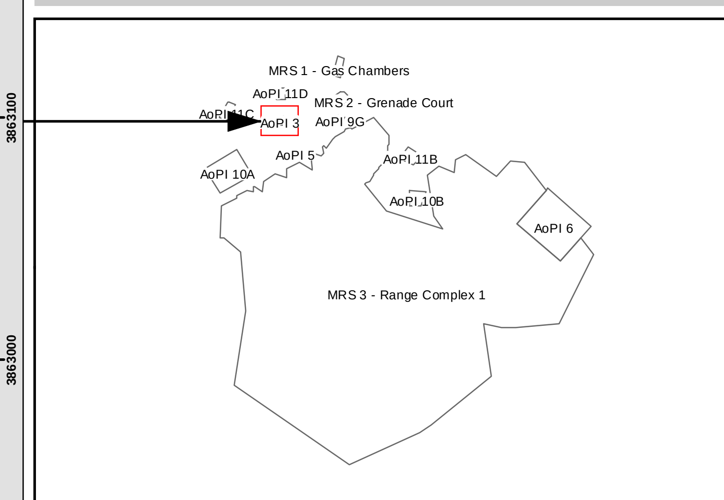


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Figure 4-5
AoPI 5
MRS/AoPI Q-D Arcs
Camp Croft, SC

Legend

- MRS/AoPI Boundary
- Double Sandbag Mitigation, 12.5 ft
- HFD, 113 ft
- Sandbag Mitigation, 200 ft
- MFD, 709 ft

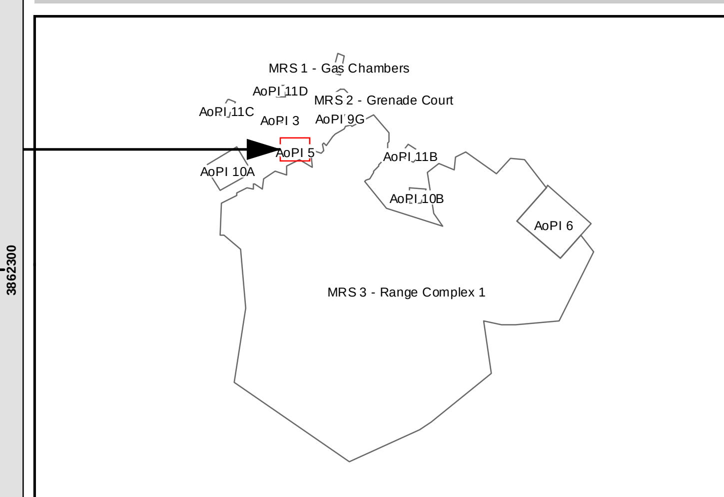

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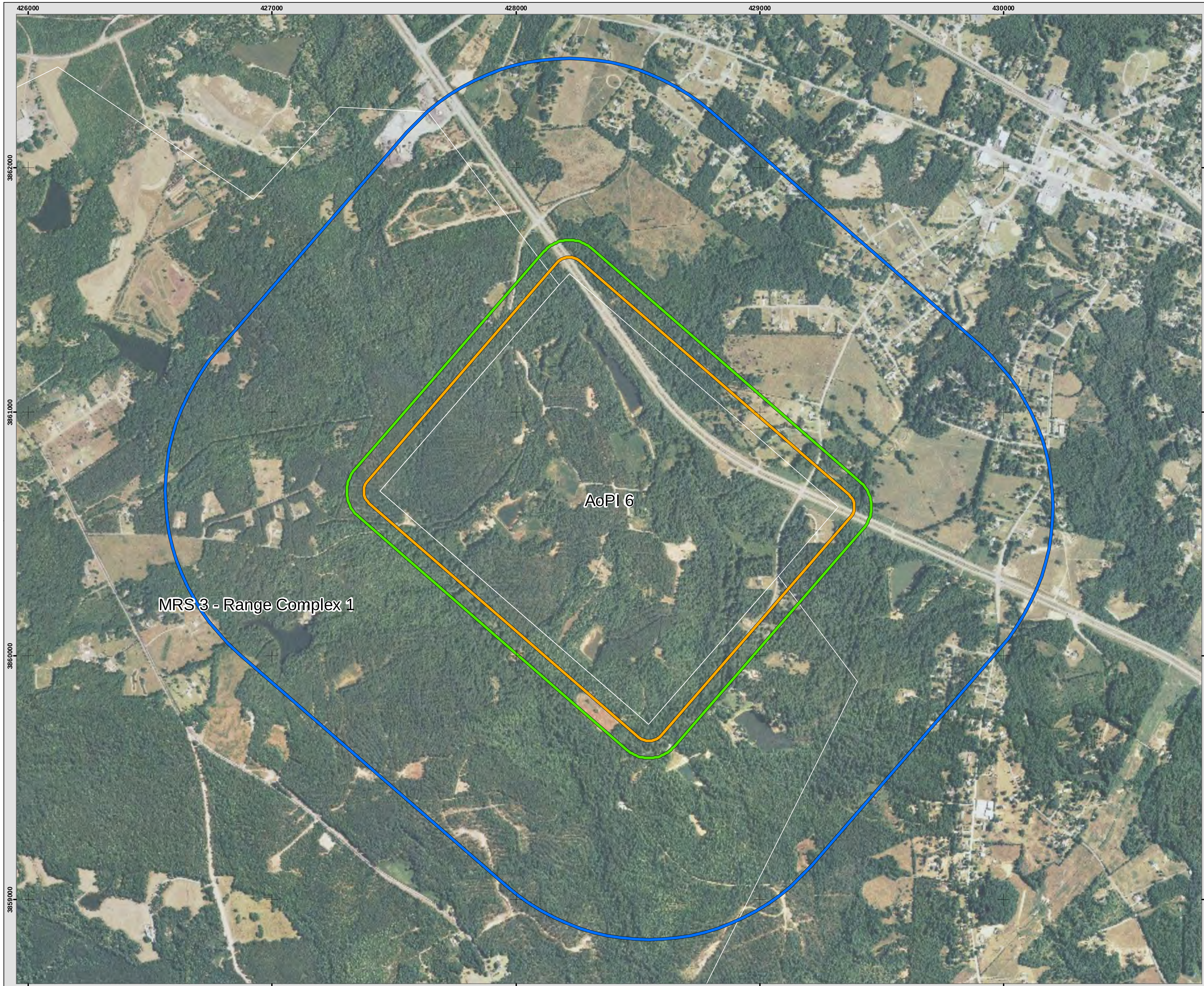
Figure 4-6
AoPI 6
MRS/AoPI Q-D Arcs
Camp Croft, SC



Legend

- MRS/AoPI Boundary
- Sandbag Mitigation, 220 ft
- HFD, 450 ft
- MFD, 2894 ft

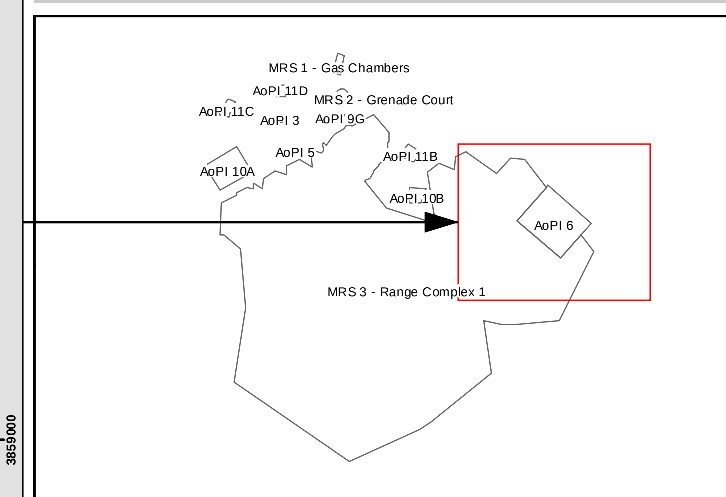


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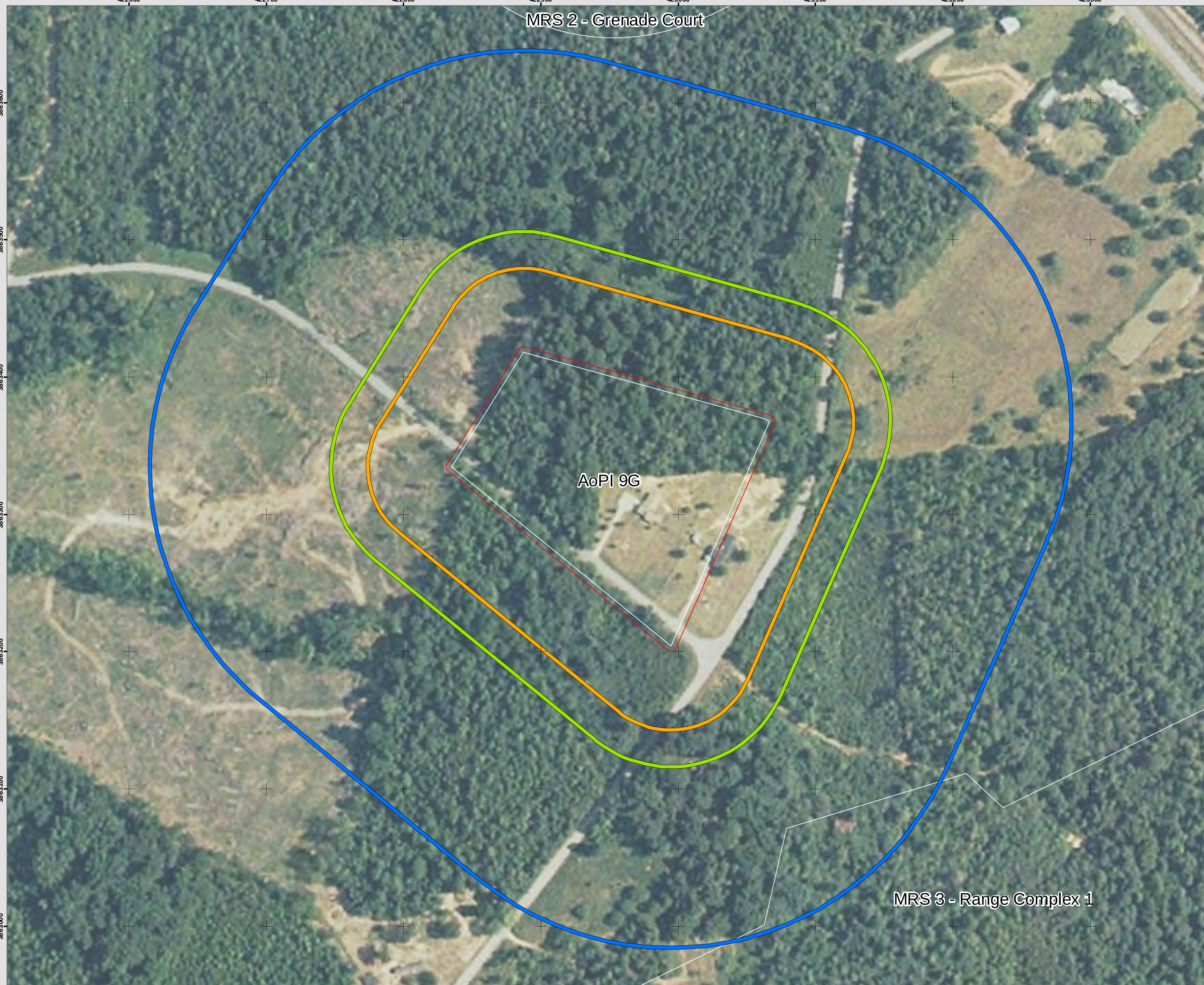
Figure 4-7
AoPI 9G
MRS/AoPI Q-D Arcs
Camp Croft, SC



Legend

- MRS/AoPI Boundary
- Double Sandbag Mitigation, 12.5 ft
- Sandbag Mitigation, 200 ft
- HFD, 288 ft
- MFD-H, 721 ft

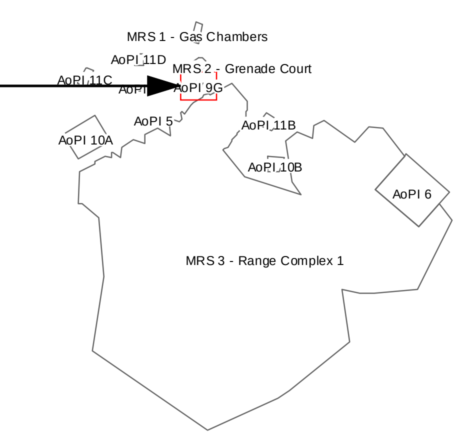


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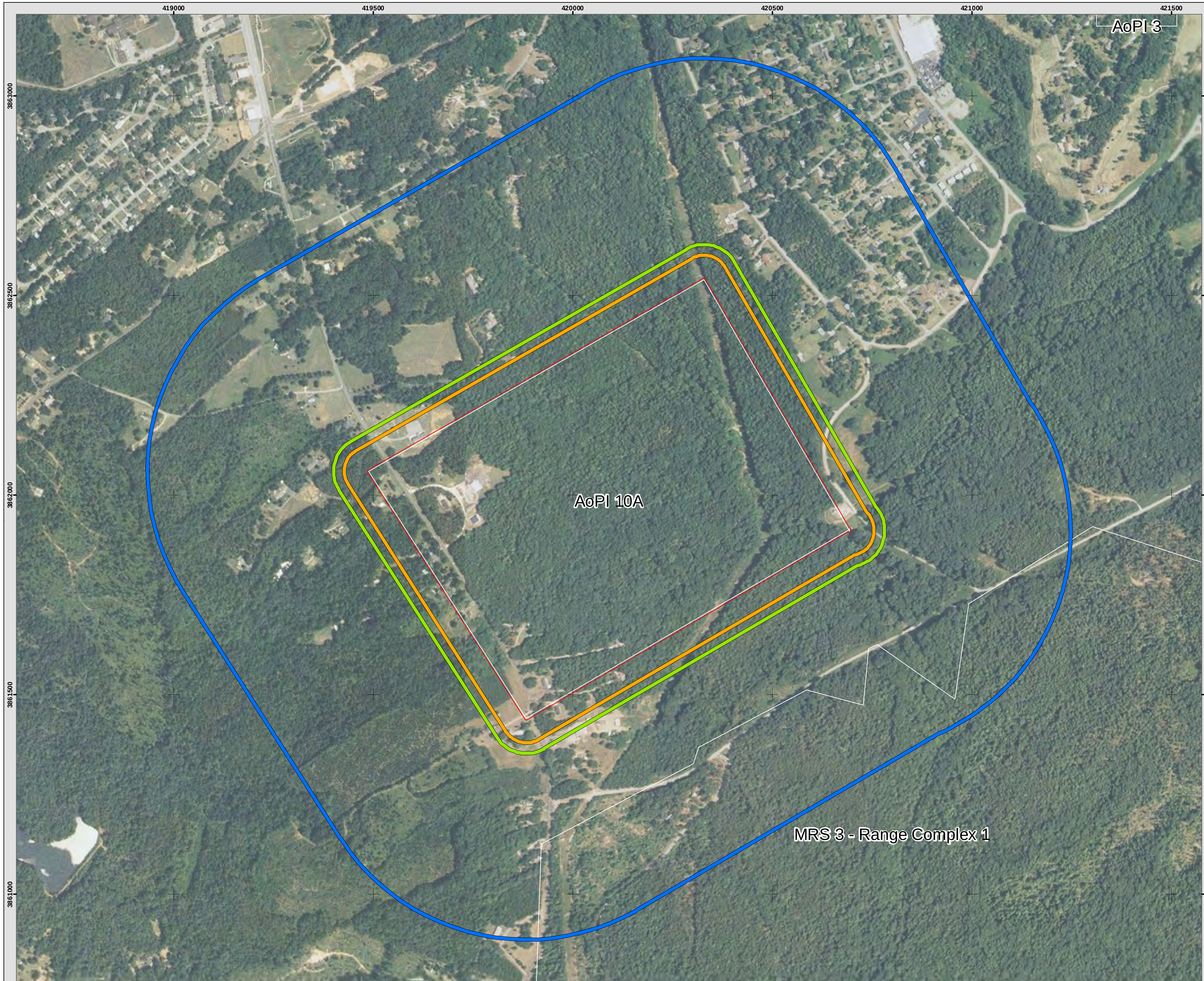
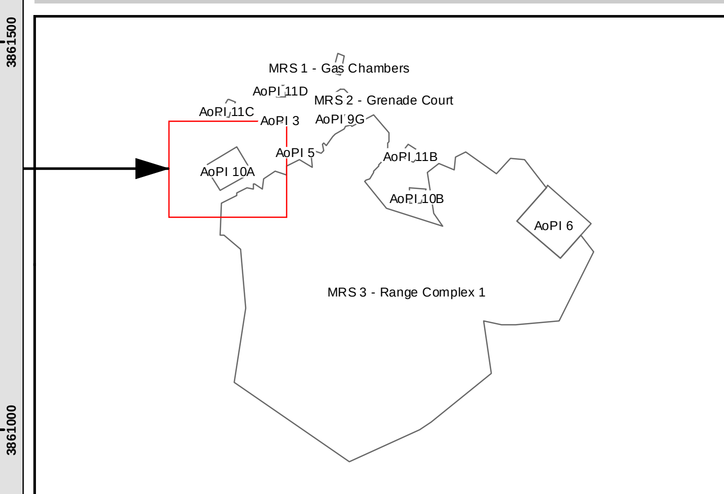
Figure 4-8
AoPI 10A
MRS/AoPI Q-D Arcs
Camp Croft, SC



Legend

- MRS/AoPI Boundary
- Double Sandbag Mitigation, 12.5 ft
- Sandbag Mitigation, 200 ft
- HFD, 288 ft
- MFD-H, 1818 ft



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Coordinate System: WGS84 UTM Zone 17N, meters			PDF: PROJECTS\States\SC\Camp_Croft_SC\ESP_FY11\PDF\Fig4-x_croft_esp.pdf

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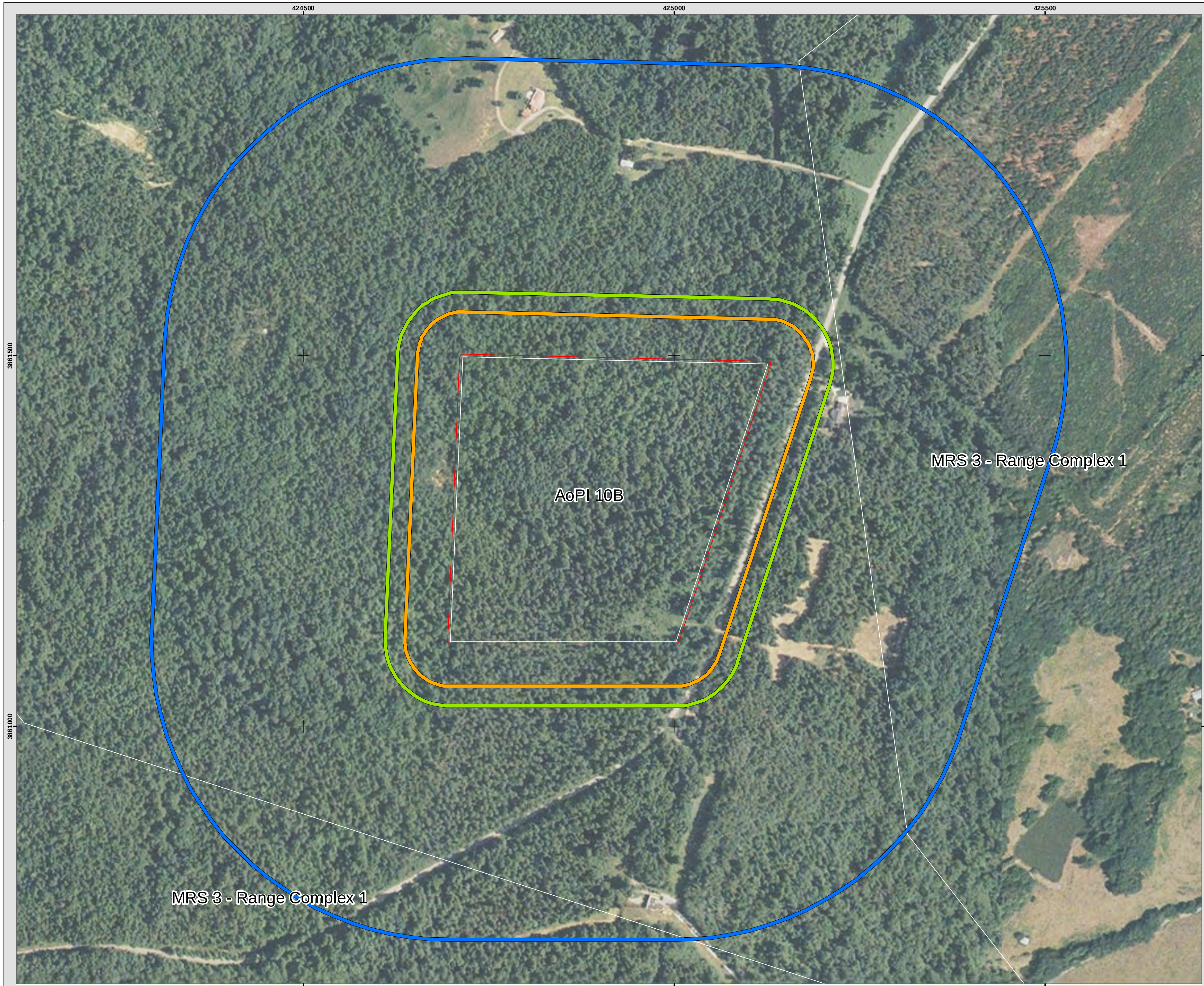
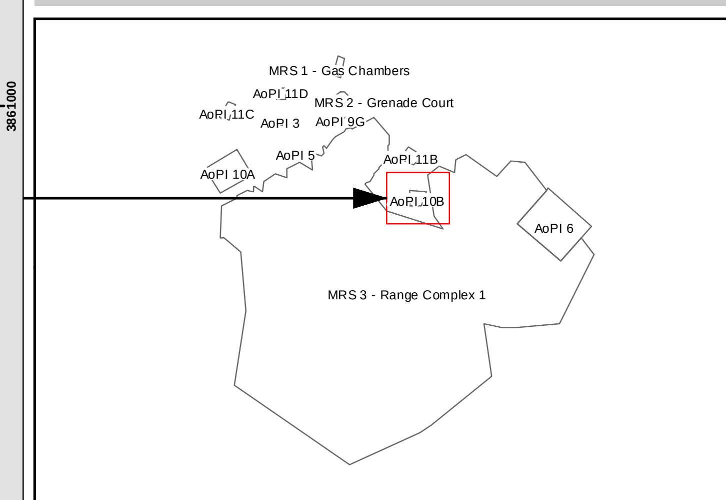
Figure 4-9
AoPI 10B
MRS/AoPI Q-D Arcs
Camp Croft, SC



Legend

- MRS/AoPI Boundary
- Double Sandbag Mitigation, 12.5 ft
- Sandbag Mitigation, 200 ft
- HFD, 288 ft
- MFD-H, 1322 ft



0 500 1,000
Feet

Drawn By: GDW	Date Saved: 8/29/2011 2:38:29 PM		MXD: PROJECTS\States\SC\Camp_Croft_SC\ESP_FY11\MXD\Fig4-x_croft_esp.mxd
Coordinate System: WGS84 UTM Zone 17N, meters			PDF: PROJECTS\States\SC\Camp_Croft_SC\ESP_FY11\PDF\Fig4-x_croft_esp.pdf

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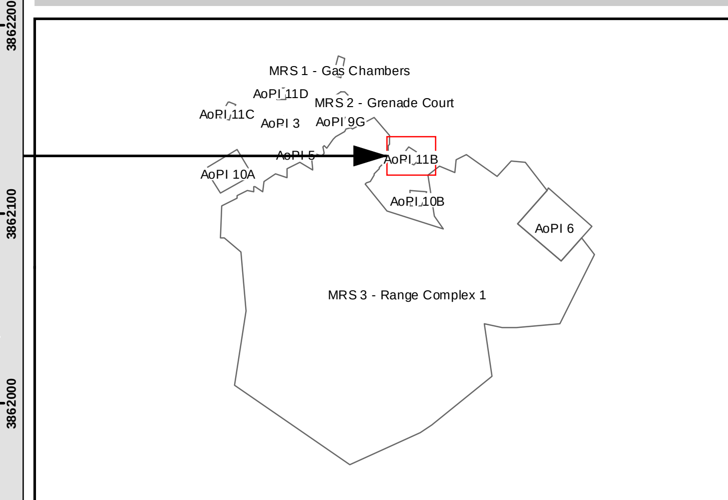
Figure 4-10
AoPI 11B
MRS/AoPI Q-D Arcs
Camp Croft, SC

Legend

- MRS/AoPI Boundary
- Double Sandbag Mitigation, 12.5 ft
- Sandbag Mitigation, 200 ft
- HFD, 288 ft
- MFD, 721 ft



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Coordinate System: WGS84 UTM Zone 17N, meters		PDF: PROJECTS\States\SC\Camp_Croft_SC\ESP_FY11\PDF\Fig4-x_croft_esp.pdf

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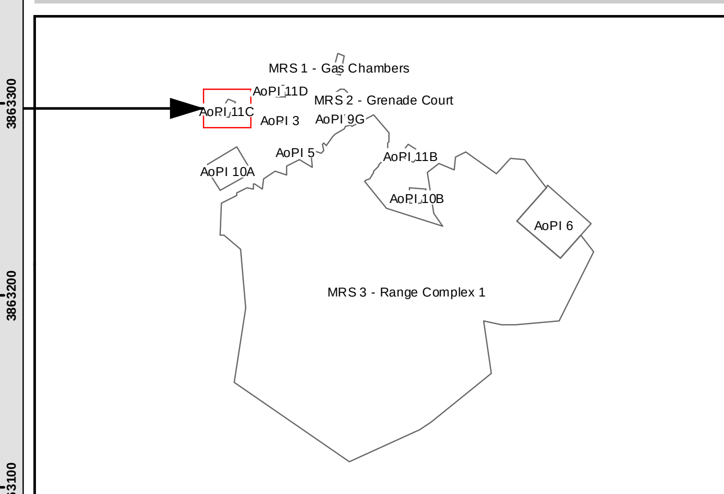
Figure 4-11
AoPI 11C
MRS/AoPI Q-D Arcs
Camp Croft, SC

Legend

- MRS/AoPI Boundary
- Double Sandbag Mitigation, 12.5 ft
- Sandbag Mitigation, 200 ft
- HFD, 113 ft
- MFD-H, 709 ft



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Coordinate System: WGS84 UTM Zone 17N, meters			PDF: PROJECTS\States\SC\Camp_Croft_SC\ESP_FY11\PDF\Fig4-x_croft_esp.pdf

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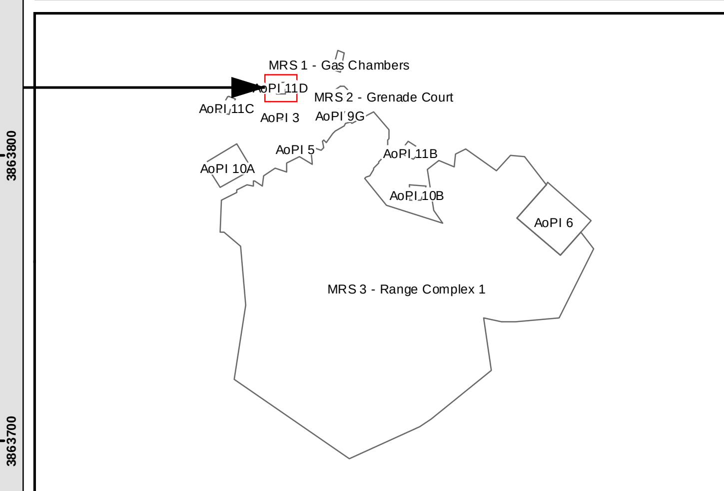
Figure 4-12
AoPI 11D
MRS/AoPI Q-D Arcs
Camp Croft, SC

Legend

- MRS/AoPI Boundary
- K40, 29 ft
- K328, 241 ft



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0 100 200 300 400 500 Feet	Drawn By: GDW	Date Saved: 8/29/2011 2:41:21 PM	MXD: PROJECTS\States\SC\Camp_Croft_SC\ESP_FY11\MXD\Fig4-x_croft_esp.mxd
	Coordinate System: WGS84 UTM Zone 17N, meters		PDF: PROJECTS\States\SC\Camp_Croft_SC\ESP_FY11\PDF\Fig4-x_croft_esp.pdf

APPENDIX B
CALCULATION SHEETS

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Non-Fragmenting Rounds
Munition:	40 mm M651 CS Grenade
Case Material:	Aluminum 7075
Fragmentation Method:	Non-Fragmenting
Secondary Database Category:	
Munition Case Classification:	Non-Fragmenting

DODIC:	B567
Date Record Created:	5/8/2008
Record Created By:	MC
Last Date Record Updated:	12/16/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	CS Starter Mixture
Explosive Weight (lb):	7.14285714285714E-03
Diameter (in):	1.5900
Cylindrical Case Weight (lb):	
Maximum Fragment Weight (Intentional) (lb):	
Design Fragment Weight (95%) (Unintentional) (lb):	
Critical Fragment Velocity (fps):	

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	0.007
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	3
Public Traffic Route Distance (2.3 psi); K24 Distance:	5
Inhabited Building Distance (1.2 psi), K40 Distance:	8
Intentional MSD (0.0655 psi), K328 Distance:	63

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.007
Kinetic Energy 10^6 (lb-ft²/s²):	
Required Wall & Roof Sandbag Thickness (in)	Non-Fragmenting
Expected Maximum Sandbag Throw Distance (ft):	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

Distribution authorized to the Department of Defense and U.S. DoD contractors only for Administrative-Operational Use (17 October 2002). Other requests shall be referred to the Chairman, Department of Defense Explosives Safety Board, Room 856C, Hoffman Building I, 2461 Eisenhower Avenue, Alexandria, VA 22331-0600.

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	
MFD-V [Maximum Fragment Distance, Vertical] (ft):	

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):		
Mild Steel:		
Hard Steel:		
Aluminum:		
LEXAN:		
Plexi-glass:		
Bullet Resist Glass:		

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.007
Kinetic Energy 106 (lb-ft²/s²):	
Water Containment System:	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

Item Notes

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Grenades & Mines
Munition:	Mk II Grenade
Case Material:	Cast Iron, Grey, CL35
Fragmentation Method:	Pre-formed Fragmenting
Secondary Database Category:	Hand Grenade
Munition Case Classification:	Robust

DODIC:	G890
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/29/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	0.125
Diameter (in):	2.2600
Cylindrical Case Weight (lb):	0.24047
Maximum Fragment Weight (Intentional) (lb):	0.0129
Design Fragment Weight (95%) (Unintentional) (lb):	0.0043
Critical Fragment Velocity (fps):	578

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	0.125
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	9
Public Traffic Route Distance (2.3 psi); K24 Distance:	12
Inhabited Building Distance (1.2 psi), K40 Distance:	20
Intentional MSD (0.0655 psi), K328 Distance:	164

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.125
Kinetic Energy 10^6 (lb-ft²/s²):	0.0022
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	62
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	521
MFD-V [Maximum Fragment Distance, Vertical] (ft):	397

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	1.15	0.79
Mild Steel:	0.07	0.05
Hard Steel:	0.06	0.04
Aluminum:	0.16	0.10
LEXAN:	1.61	1.23
Plexi-glass:	0.73	0.51
Bullet Resist Glass:	0.55	0.37

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.125
Kinetic Energy 106 (lb-ft²/s²):	0.0022
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	200/200

Item Notes

Fragment sizes, number of fragments and HFD came from test information. These numbers were used to calculate MFD-H using TP 16 Eq 4-34 & iterating using TRAJ to calculate the intial velocity. With this information, standard TP 16 methods were used to ca

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Surface-Launched HE Rounds
DODIC:	C225
Munition:	81 mm M43
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mortar
Munition Case Classification:	Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/10/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	1.23
Diameter (in):	3.1890
Cylindrical Case Weight (lb):	4.22038
Maximum Fragment Weight (Intentional) (lb):	0.1096
Design Fragment Weight (95%) (Unintentional) (lb):	0.0377
Critical Fragment Velocity (fps):	3776

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	1.230
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	19
Public Traffic Route Distance (2.3 psi); K24 Distance:	26
Inhabited Building Distance (1.2 psi), K40 Distance:	43
Intentional MSD (0.0655 psi), K328 Distance:	351

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	1.230
Kinetic Energy 10^6 (lb-ft²/s²):	0.7813
Required Wall & Roof Sandbag Thickness (in)	24
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	209
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1579
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1215

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	6.61	3.98
Mild Steel:	1.27	0.77
Hard Steel:	1.04	0.63
Aluminum:	2.59	1.60
LEXAN:	6.62	5.05
Plexi-glass:	4.99	3.49
Bullet Resist Glass:	4.22	2.87

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	1.230
Kinetic Energy 106 (lb-ft²/s²):	0.7813
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	200

Item Notes

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Surface-Launched HE Rounds
DODIC:	
Munition:	81 mm M56
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mortar
Munition Case Classification:	Non-Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/2/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	4.31
Diameter (in):	3.1890
Cylindrical Case Weight (lb):	3.77074
Maximum Fragment Weight (Intentional) (lb):	0.0263
Design Fragment Weight (95%) (Unintentional) (lb):	0.0034
Critical Fragment Velocity (fps):	7384

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	4.310
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	29
Public Traffic Route Distance (2.3 psi); K24 Distance:	39
Inhabited Building Distance (1.2 psi), K40 Distance:	65
Intentional MSD (0.0655 psi), K328 Distance:	534

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	4.310
Kinetic Energy 10^6 (lb-ft²/s²):	0.7170
Required Wall & Roof Sandbag Thickness (in)	24
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	240
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1196
MFD-V [Maximum Fragment Distance, Vertical] (ft):	960

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	8.02	3.43
Mild Steel:	1.41	0.63
Hard Steel:	1.15	0.51
Aluminum:	2.92	1.37
LEXAN:	6.69	4.06
Plexi-glass:	5.05	2.60
Bullet Resist Glass:	4.20	2.01

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	4.310
Kinetic Energy 106 (lb-ft²/s²):	0.7170
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	200

Item Notes

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Surface-Launched HE Rounds
DODIC:	
Munition:	2.36 in M6A3 Rocket (Warhead & Motor)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Rocket
Munition Case Classification:	Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/31/2011
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	See Item Notes
Explosive Weight (lb):	0.50/0.135
Diameter (in):	2.3600
Cylindrical Case Weight (lb):	1.30239
Maximum Fragment Weight (Intentional) (lb):	0.0087
Design Fragment Weight (95%) (Unintentional) (lb):	0.0013
Critical Fragment Velocity (fps):	6170

Overpressure Distances

TNT Equivalent (Pressure):	1.38/0.8
TNT Equivalent Weight - Pressure (lbs):	0.798
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	17
Public Traffic Route Distance (2.3 psi); K24 Distance:	22
Inhabited Building Distance (1.2 psi), K40 Distance:	37
Intentional MSD (0.0655 psi), K328 Distance:	304

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14 / 0.8
TNT Equivalent Weight - Impulse (lbs):	0.678
Kinetic Energy 10^6 (lb-ft²/s²):	0.2187
Required Wall & Roof Sandbag Thickness (in)	20
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	142
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	790
MFD-V [Maximum Fragment Distance, Vertical] (ft):	634

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	3.69	1.66
Mild Steel:	0.70	0.32
Hard Steel:	0.57	0.26
Aluminum:	1.49	0.72
LEXAN:	4.45	2.75
Plexi-glass:	2.94	1.55
Bullet Resist Glass:	2.32	1.14

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14 / 0.8
TNT Equivalent Weight - Impulse (lbs):	0.678
Kinetic Energy 106 (lb-ft²/s²):	0.2187
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	264/200

Item Notes

Whd Explosive: Pentolite (50/50); Rkt Mtr Explosive: Ballistite

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Grenades & Mines	DODIC:	
Munition:	M9A1 Rifile Grenade		
Case Material:	Steel, Mild	Date Record Created:	8/23/2010
		Record Created By:	SDH
Fragmentation Method:	Naturally Fragmenting	Last Date Record Updated:	
Secondary Database Category:	Rifle Grenade	Individual Last Updated Record:	
Munition Case Classification:	Robust	Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Pentolite (50/50)
Explosive Weight (lb):	0.25
Diameter (in):	2.2500
Cylindrical Case Weight (lb):	0.36005
Maximum Fragment Weight (Intentional) (lb):	0.0051
Design Fragment Weight (95%) (Unintentional) (lb):	0.0009
Critical Fragment Velocity (fps):	6313

Overpressure Distances

TNT Equivalent (Pressure):	1.38
TNT Equivalent Weight - Pressure (lbs):	0.345
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	13
Public Traffic Route Distance (2.3 psi); K24 Distance:	17
Inhabited Building Distance (1.2 psi), K40 Distance:	28
Intentional MSD (0.0655 psi), K328 Distance:	230

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.285
Kinetic Energy 10^6 (lb-ft²/s²):	0.1016
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	113
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	709
MFD-V [Maximum Fragment Distance, Vertical] (ft):	570

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	3.26	1.62
Mild Steel:	0.62	0.31
Hard Steel:	0.50	0.26
Aluminum:	1.33	0.70
LEXAN:	4.11	2.70
Plexi-glass:	2.64	1.51
Bullet Resist Glass:	2.06	1.11

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.285
Kinetic Energy 106 (lb-ft²/s²):	0.1016
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	200/200

Item Notes

It is possible that this item contains Pentolite (10/90) which is 90% TNT. Since Pentolite (50/50) has a TNT equivalency greater than 1.0 and was more common during the production era, Pentolite (50/50) has been used for analysis until sources are found

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Grenades & Mines
DODIC:	G970
Munition:	M31 Rifle Grenade
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Rifle Grenade
Munition Case Classification:	Non-Robust
Date Record Created:	7/24/2007
Record Created By:	MC
Last Date Record Updated:	3/31/2011
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	0.62
Diameter (in):	2.6160
Cylindrical Case Weight (lb):	0.27137
Maximum Fragment Weight (Intentional) (lb):	0.0013
Design Fragment Weight (95%) (Unintentional) (lb):	0.0002
Critical Fragment Velocity (fps):	9250

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	0.719
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	16
Public Traffic Route Distance (2.3 psi); K24 Distance:	22
Inhabited Building Distance (1.2 psi), K40 Distance:	36
Intentional MSD (0.0655 psi), K328 Distance:	294

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.707
Kinetic Energy 10^6 (lb-ft²/s²):	0.0556
Required Wall & Roof Sandbag Thickness (in)	20
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	92
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	500
MFD-V [Maximum Fragment Distance, Vertical] (ft):	409

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	3.69	1.65
Mild Steel:	0.60	0.28
Hard Steel:	0.50	0.23
Aluminum:	1.35	0.66
LEXAN:	3.81	2.39
Plexi-glass:	2.39	1.28
Bullet Resist Glass:	1.80	0.90

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.707
Kinetic Energy 106 (lb-ft²/s²):	0.0556
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	264/200

Item Notes

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Surface-Launched HE Rounds
Munition:	155 mm M107 (Composition B filled)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust

DODIC:	D571
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	2/4/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	15.448
Diameter (in):	6.1024
Cylindrical Case Weight (lb):	73.50184
Maximum Fragment Weight (Intentional) (lb):	0.6641
Design Fragment Weight (95%) (Unintentional) (lb):	0.1372
Critical Fragment Velocity (fps):	3584

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	17.920
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	47
Public Traffic Route Distance (2.3 psi); K24 Distance:	63
Inhabited Building Distance (1.2 psi), K40 Distance:	105
Intentional MSD (0.0655 psi), K328 Distance:	858

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	17.611
Kinetic Energy 10^6 (lb-ft²/s²):	4.2663
Required Wall & Roof Sandbag Thickness (in)	36
Expected Maximum Sandbag Throw Distance (ft):	220
Minimum Separation Distance (ft):	220

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	450
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	2630
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2022

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	14.45	6.68
Mild Steel:	2.74	1.29
Hard Steel:	2.25	1.06
Aluminum:	5.30	2.61
LEXAN:	10.69	6.73
Plexi-glass:	9.43	5.10
Bullet Resist Glass:	8.58	4.39

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	17.611
Kinetic Energy 106 (lb-ft²/s²):	4.2663
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	275

Item Notes

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Surface-Launched HE Rounds
DODIC:	D485
Munition:	155 mm M101
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust
Date Record Created:	12/8/2010
Record Created By:	MMC
Last Date Record Updated:	
Individual Last Updated Record:	
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	14.6
Diameter (in):	6.1250
Cylindrical Case Weight (lb):	73.50184
Maximum Fragment Weight (Intentional) (lb):	1.0548
Design Fragment Weight (95%) (Unintentional) (lb):	0.2710
Critical Fragment Velocity (fps):	4035

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	14.600
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	44
Public Traffic Route Distance (2.3 psi); K24 Distance:	59
Inhabited Building Distance (1.2 psi), K40 Distance:	98
Intentional MSD (0.0655 psi), K328 Distance:	802

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	14.600
Kinetic Energy 10^6 (lb-ft²/s²):	6.6543
Required Wall & Roof Sandbag Thickness (in)	Not Permitted
Expected Maximum Sandbag Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	389
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	2894
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2208

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	14.62	7.33
Mild Steel:	2.82	1.43
Hard Steel:	2.31	1.17
Aluminum:	5.39	2.85
LEXAN:	11.10	7.30
Plexi-glass:	9.91	5.69
Bullet Resist Glass:	9.14	4.99

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	14.600
Kinetic Energy 106 (lb-ft²/s²):	6.6543
Water Containment System:	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Item Notes

This is the same as the TNT filled 155 mm M107 except that the M101 has a wider rotating band. Therefore the model for the TNT filled 155 mm M107 was used for this round.

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Surface-Launched HE Rounds
Munition:	155 mm M795
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Projectile
Munition Case Classification:	Robust

DODIC:	D529
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	2/4/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	28.814
Diameter (in):	6.0430
Cylindrical Case Weight (lb):	61.96831
Maximum Fragment Weight (Intentional) (lb):	0.6139
Design Fragment Weight (95%) (Unintentional) (lb):	0.1116
Critical Fragment Velocity (fps):	4434

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	28.814
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	55
Public Traffic Route Distance (2.3 psi); K24 Distance:	74
Inhabited Building Distance (1.2 psi), K40 Distance:	123
Intentional MSD (0.0655 psi), K328 Distance:	1006

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	28.814
Kinetic Energy 10^6 (lb-ft²/s²):	6.0347
Required Wall & Roof Sandbag Thickness (in)	Not Permitted
Expected Maximum Sandbag Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	443
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	2739
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2111

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	15.11	7.34
Mild Steel:	2.79	1.42
Hard Steel:	2.29	1.16
Aluminum:	5.44	2.85
LEXAN:	10.90	7.19
Plexi-glass:	9.67	5.57
Bullet Resist Glass:	8.86	4.79

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	28.814
Kinetic Energy 106 (lb-ft²/s²):	6.0347
Water Containment System:	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Item Notes

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Grenades & Mines
Munition:	M26A2 Grenade
Case Material:	Steel, Mild
Fragmentation Method:	Pre-formed Fragmenting
Secondary Database Category:	Hand Grenade
Munition Case Classification:	Non-Robust

DODIC:	
Date Record Created:	9/30/2009
Record Created By:	SDH
Last Date Record Updated:	
Individual Last Updated Record:	
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	0.3625
Diameter (in):	2.3750
Cylindrical Case Weight (lb):	0.30954
Maximum Fragment Weight (Intentional) (lb):	0.0003
Design Fragment Weight (95%) (Unintentional) (lb):	0.0003
Critical Fragment Velocity (fps):	7978

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	0.421
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	13
Public Traffic Route Distance (2.3 psi); K24 Distance:	18
Inhabited Building Distance (1.2 psi), K40 Distance:	30
Intentional MSD (0.0655 psi), K328 Distance:	246

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.413
Kinetic Energy 10^6 (lb-ft²/s²):	0.0099
Required Wall & Roof Sandbag Thickness (in)	12
Expected Maximum Sandbag Throw Distance (ft):	25
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	288
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	312
MFD-V [Maximum Fragment Distance, Vertical] (ft):	256

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	1.42	1.42
Mild Steel:	0.26	0.26
Hard Steel:	0.22	0.22
Aluminum:	0.61	0.61
LEXAN:	2.36	2.36
Plexi-glass:	1.26	1.26
Bullet Resist Glass:	0.90	0.90

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.413
Kinetic Energy 106 (lb-ft²/s²):	0.0099
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	200/200

Item Notes

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Grenades & Mines
DODIC:	K120
Munition:	M3 AP Mine
Case Material:	Cast Iron, Grey, CL35
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mine
Munition Case Classification:	Robust
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/29/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	0.9
Diameter (in):	3.5000
Cylindrical Case Weight (lb):	4.98474
Maximum Fragment Weight (Intentional) (lb):	0.2100
Design Fragment Weight (95%) (Unintentional) (lb):	0.0509
Critical Fragment Velocity (fps):	3845

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	0.900
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	17
Public Traffic Route Distance (2.3 psi); K24 Distance:	23
Inhabited Building Distance (1.2 psi), K40 Distance:	39
Intentional MSD (0.0655 psi), K328 Distance:	317

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.900
Kinetic Energy 10^6 (lb-ft²/s²):	1.5523
Required Wall & Roof Sandbag Thickness (in)	24
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	180
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1818
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1396

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	8.98	5.09
Mild Steel:	1.82	1.04
Hard Steel:	1.49	0.85
Aluminum:	3.59	2.12
LEXAN:	9.04	6.40
Plexi-glass:	7.18	4.54
Bullet Resist Glass:	6.30	3.78

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.900
Kinetic Energy 106 (lb-ft²/s²):	1.5523
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	200.000

Item Notes

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Grenades & Mines
Munition:	M15 AT Mine
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mine
Munition Case Classification:	Non-Robust

DODIC:	K180
Date Record Created:	7/12/2007
Record Created By:	MC
Last Date Record Updated:	1/12/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	22.75
Diameter (in):	12.6500
Cylindrical Case Weight (lb):	2.02193
Maximum Fragment Weight (Intentional) (lb):	0.0119
Design Fragment Weight (95%) (Unintentional) (lb):	0.0014
Critical Fragment Velocity (fps):	12018

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	26.390
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	54
Public Traffic Route Distance (2.3 psi); K24 Distance:	71
Inhabited Building Distance (1.2 psi), K40 Distance:	119
Intentional MSD (0.0655 psi), K328 Distance:	977

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	25.935
Kinetic Energy 10^6 (lb-ft²/s²):	0.8594
Required Wall & Roof Sandbag Thickness (in)	Not Permitted
Expected Maximum Sandbag Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	221
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1027
MFD-V [Maximum Fragment Distance, Vertical] (ft):	839

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	12.27	4.93
Mild Steel:	1.76	0.75
Hard Steel:	1.44	0.61
Aluminum:	3.73	1.68
LEXAN:	7.22	4.27
Plexi-glass:	5.57	2.77
Bullet Resist Glass:	4.57	2.11

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	25.935
Kinetic Energy 106 (lb-ft²/s²):	0.8594
Water Containment System:	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Item Notes

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Surface-Launched HE Rounds
Munition:	60 mm M49A5
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mortar
Munition Case Classification:	Robust

DODIC:	B632
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	9/4/2009
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	0.79
Diameter (in):	2.3622
Cylindrical Case Weight (lb):	1.76541
Maximum Fragment Weight (Intentional) (lb):	0.0206
Design Fragment Weight (95%) (Unintentional) (lb):	0.0036
Critical Fragment Velocity (fps):	6044

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	0.916
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	17
Public Traffic Route Distance (2.3 psi); K24 Distance:	23
Inhabited Building Distance (1.2 psi), K40 Distance:	39
Intentional MSD (0.0655 psi), K328 Distance:	319

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.901
Kinetic Energy 10^6 (lb-ft²/s²):	0.3763
Required Wall & Roof Sandbag Thickness (in)	20
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	184
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1070
MFD-V [Maximum Fragment Distance, Vertical] (ft):	845

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	5.47	2.68
Mild Steel:	1.02	0.51
Hard Steel:	0.84	0.42
Aluminum:	2.14	1.12
LEXAN:	5.65	3.69
Plexi-glass:	4.03	2.29
Bullet Resist Glass:	3.30	1.76

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	0.901
Kinetic Energy 106 (lb-ft²/s²):	0.3763
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	264/200

Item Notes

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Surface-Launched HE Rounds
Munition:	60 mm M49A2
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Mortar
Munition Case Classification:	Robust

DODIC:	B632
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	3/23/2010
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	0.34
Diameter (in):	2.3622
Cylindrical Case Weight (lb):	1.45420
Maximum Fragment Weight (Intentional) (lb):	0.0570
Design Fragment Weight (95%) (Unintentional) (lb):	0.0159
Critical Fragment Velocity (fps):	3982

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	0.340
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	13
Public Traffic Route Distance (2.3 psi); K24 Distance:	17
Inhabited Building Distance (1.2 psi), K40 Distance:	28
Intentional MSD (0.0655 psi), K328 Distance:	229

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.340
Kinetic Energy 10^6 (lb-ft²/s²):	0.4519
Required Wall & Roof Sandbag Thickness (in)	20
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	152
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1322
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1025

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	4.96	2.99
Mild Steel:	0.97	0.58
Hard Steel:	0.79	0.48
Aluminum:	1.97	1.23
LEXAN:	5.75	4.21
Plexi-glass:	4.14	2.74
Bullet Resist Glass:	3.47	2.19

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.340
Kinetic Energy 106 (lb-ft²/s²):	0.4519
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	264/200

Item Notes

Fragmentation Data Review Form

Database Revision Date 5/24/2011

Category:	Non-Fragmenting Rounds
Munition:	81 mm Practice M879
Case Material:	Steel, Mild
Fragmentation Method:	Non-Fragmenting
Secondary Database Category:	
Munition Case Classification:	Non-Fragmenting

DODIC:	C875
Date Record Created:	1/11/2010
Record Created By:	SDH
Last Date Record Updated:	
Individual Last Updated Record:	
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Flash Charge Composition
Explosive Weight (lb):	0.398917
Diameter (in):	3.1740
Cylindrical Case Weight (lb):	
Maximum Fragment Weight (Intentional) (lb):	
Design Fragment Weight (95%) (Unintentional) (lb):	
Critical Fragment Velocity (fps):	

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	0.399
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	13
Public Traffic Route Distance (2.3 psi); K24 Distance:	18
Inhabited Building Distance (1.2 psi), K40 Distance:	29
Intentional MSD (0.0655 psi), K328 Distance:	241

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.399
Kinetic Energy 10^6 (lb-ft²/s²):	
Required Wall & Roof Sandbag Thickness (in)	Non-Fragmenting
Expected Maximum Sandbag Throw Distance (ft):	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

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Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	
MFD-V [Maximum Fragment Distance, Vertical] (ft):	

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):		
Mild Steel:		
Hard Steel:		
Aluminum:		
LEXAN:		
Plexi-glass:		
Bullet Resist Glass:		

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	0.399
Kinetic Energy 106 (lb-ft²/s²):	
Water Containment System:	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

Item Notes

The TNT equivalent weight for flash charge composition is not known. However, due to the small explosive weight it is acceptable and conservative to assume the flash charge composition has a TNT equivalency of 1.0

APPENDIX P
TRANSECT SAMPLING FOR UNEXPLODED ORDNANCE (UXO) TARGET DETECTION

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Transect Sampling for Unexploded Ordnance (UXO) Target Detection

Summary
This report summarizes the probability of traversing and detecting a target area of specific size and shape for different transect spacings. Simulation details and a power curve estimate how well the specified design would detect the target. The selected design statement is:

> If 1 meter wide transects with a parallel pattern are spaced 35 meters between transects (36 meters on centers) over the entire site, these transects have an approximately 90% chance of traversing and detecting any 56.6928 meter diameter (28.3464 meter radius) circular target area having a bivariate normal distribution with an average density of 350 anomalies per acre above the background density of 15 anomalies per acre. This assumes the instrument false negative rate is 5% and flagged windows have at least 95% confidence they have density greater than background.

The following table summarizes the sampling design developed. A figure that shows the transect placement in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Ensure high probability of traversing and detecting a target area that has a specified size and shape
Required Probability of Traversing the Target	100%
TARGET AREA AND TRANSECT INPUTS	
Type of Sampling Design	Transects
Transect Pattern	Parallel
Transect Width	1 meters
Area of target area	27171.63 ft^2
Shape of target area of concern	Circular
Radius of target area of concern	28.3464 meters
SIMULATION PARAMETERS FOR PROBABILITY OF DETECTION	
Formula for calculating the probability of traversing and detecting target area	Monte Carlo Simulation (method described below)
Decision Rule	Flag if at least 95% confident an area has density greater than background density
Background Density of the Site	15 anomalies / acre
Expected Target Area Density Above Background	350 anomalies / acre Target average
Distribution of target area density above background	Bivariate Normal
Transect spacing evaluation range	20 to 50 meters
Instrument false negative rate	5%
Minimum precision	0.1
Maximum error	0.05
Search Window Diameter	15 meters
PROPOSED TRANSECT DESIGN AND COST INFORMATION	
Number of selected sample areas [a]	2
Specified sampling area [b]	424.86 acres

Computed spacing between transects	35 meters
Computed spacing between transect centers	36 meters
Number of transects to be surveyed	172
Transect Coverage	2.78% of total site area
Linear transect coverage	29.71 miles
Area of transect coverage	11.8146 acres
Total cost of sampling [c]	$66,012.15

[a] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[b] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[c] See the Cost of Sampling section for an explanation of the costs presented here.

Site Map With Proposed Transect Design

Primary Sampling Objective
The primary purpose of sampling at this site is to traverse and detect target areas of a given size and shape with required high probability. The transect design tools provide a statistically defensible method to use transect survey data that covers only a small proportion of the total study area.

Selected Sampling Approach
The specified sampling approach was random parallel transect sampling. If parameters change from those specified in the table above, then the probability of detecting the target area will be different from those computed by VSP and reported here.

Simulation Details
To generate an estimated probability on a graph, VSP runs a Monte Carlo simulation based on the entered parameters. For each iteration, VSP creates a square site with the target area centered at the origin and rotated at a random angle. A parallel transect pattern is placed randomly so that 1 meters wide transects are parallel to the x axis.

VSP calculates the total area of the site traversed by transects, A_b, which can vary for each iteration. The expected number of detected background anomalies, λ_b, is calculated as $\lambda_b = D_b A_b (1 - P_{fn})$ where D_b is the background density of 15 anomalies / acres and P_{fn} is the instrument false negative rate of 0.05. A random number of detected background anomalies is generated using a Poisson distribution with parameter λ_b. VSP randomly places these anomalies within the traversed areas of the site.

To simulate the number of additional anomalies in the target area, VSP uses an approximation technique to randomly place additional detected anomalies in the traversed areas of the target area. Portions of transects overlapping the target area are divided into small sections. For each section, the quantile of the target area in which it lies is determined, the expected number of additional anomalies is determined, and a random number of detected anomalies is determined using a Poisson distribution and placed within the section.

VSP uses a moving window along each transect to determine which areas have density significantly greater than background density. The window moves 1/6 of the search window diameter for each iteration. Where D_a is the actual density for the current window, the null and alternative hypotheses for determining if the area inside the window has density significantly greater than background density, D_b, are as follows:

Null Hypothesis: $H_o : D_a \le D_b$

Alternative Hypothesis: $H_a : D_a > D_b$

VSP checks each window to see if the actual number of detected anomalies is significantly greater than the expected number of anomalies for a Poisson distribution. If any windows intersecting the target area are flagged as significant, then we determine the target area has been detected.

250 iterations are run to begin the simulation to estimate a probability of detection. If the specified Maximum Error has not been achieved, additional iterations are run until the Maximum Error is met. If the total number of iterations is *n* and the proportion of target areas detected is *p*, then another iteration is run if

Maximum Error < $1.96 * \sqrt{\frac{p(1-p)}{n}}$

The quantity $1.96 * \sqrt{\frac{p(1-p)}{n}}$ is the 95th percentile of the standard error of the mean for a binomial distribution. We are 95% certain that the estimated probability is close to the true probability (within the maximum error). When all iterations are completed, VSP tabulates the estimated probability the target area has been detected, *p* / *n*. VSP repeats this process for a number of transect spacings determined by simulation results and the minimum precision specified.

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number and length of the transects. Based on the number of transects determined above, the estimated total cost of surveying this site is $66,012.15, which averages out to a per transect cost of $383.79. Note: these costs are for the geophysical survey only, and do not include any excavation or follow-up investigations. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Cost / Unit**	**Units**	**Total**
Collection costs	$1.00 / meter	47812.15 meters	$47,812.15
Setup costs	$100.00 / transect	172 transects	$17,200.00
Fixed planning and validation costs			$1,000.00
Total cost			**$66,012.15**

Transect Sampling for Unexploded Ordnance (UXO) Target Detection

Summary
This report summarizes the probability of traversing and detecting a target area of specific size and shape for different transect spacings. Simulation details and a power curve estimate how well the specified design would detect the target. The selected design statement is:

> If 1 meter wide transects with a parallel pattern are spaced 72 meters between transects (73 meters on centers) over the entire site, these transects have an approximately 90% chance of traversing and detecting any 103.327 meter diameter (51.6636 meter radius) circular target area having a bivariate normal distribution with an average density of 350 anomalies per acre above the background density of 15 anomalies per acre. This assumes the instrument false negative rate is 5% and flagged windows have at least 95% confidence they have density greater than background.

The following table summarizes the sampling design developed. A figure that shows the transect placement in the field and a table that lists the transect placement coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Ensure high probability of traversing and detecting a target area that has a specified size and shape
Required Probability of Traversing the Target	100%
TARGET AREA AND TRANSECT INPUTS	
Type of Sampling Design	Transects
Transect Pattern	Parallel
Transect Width	1 meters
Area of target area	90258.74 ft^2
Shape of target area of concern	Circular
Radius of target area of concern	51.6636 meters
SIMULATION PARAMETERS FOR PROBABILITY OF DETECTION	
Formula for calculating the probability of traversing and detecting target area	Monte Carlo Simulation (method described below)
Decision Rule	Flag if at least 95% confident an area has density greater than background density
Background Density of the Site	15 anomalies / acre
Expected Target Area Density Above Background	350 anomalies / acre Target average
Distribution of target area density above background	Bivariate Normal
Transect spacing evaluation range	60 to 90 meters
Instrument false negative rate	5%
Minimum precision	0.1
Maximum error	0.05
Search Window Diameter	101 meters
PROPOSED TRANSECT DESIGN AND COST INFORMATION	
Number of selected sample areas [a]	1
Specified sampling area [b]	1060.88 acres

Computed spacing between transects	72 meters
Computed spacing between transect centers	73 meters
Number of transects to be surveyed	48
Transect Coverage	1.37% of total site area
Linear transect coverage	36.53 miles
Area of transect coverage	14.5284 acres
Total cost of sampling [c]	$64,594.26

[a] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[b] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[c] See the Cost of Sampling section for an explanation of the costs presented here.

Site Map With Proposed Transect Design

Summary of Transect Survey Design for Area: Area 24						
(All measurements are in meters)						
Start Coordinate		**End Coordinate**		**Transect**		
X	**Y**	**X**	**Y**	**Width**	**Length**	**ID**
420926.2266	3858891.9481	421007.5189	3858891.9481	1.0000	81.2923	0
420884.0137	3858964.9481	421133.7526	3858964.9481	1.0000	249.7390	0
420841.8007	3859037.9481	421259.9864	3859037.9481	1.0000	418.1857	0
420799.5878	3859110.9481	421386.2202	3859110.9481	1.0000	586.6323	0
420757.3749	3859183.9481	421512.4539	3859183.9481	1.0000	755.0790	0
420715.1620	3859256.9481	421638.6877	3859256.9481	1.0000	923.5257	0
420672.9491	3859329.9481	421198.1101	3859329.9481	1.0000	525.1610	0

421219.7254	3859329.9481	421764.9215	3859329.9481	1.0000	545.1961	0
420630.7362	3859402.9481	421077.2879	3859402.9481	1.0000	446.5517	0
421242.2681	3859402.9481	421891.1552	3859402.9481	1.0000	648.8871	0
420588.5233	3859475.9481	421000.5284	3859475.9481	1.0000	412.0051	0
421264.8108	3859475.9481	422017.3890	3859475.9481	1.0000	752.5782	0
420546.3104	3859548.9481	421038.8783	3859548.9481	1.0000	492.5679	0
421224.0604	3859548.9481	422143.6228	3859548.9481	1.0000	919.5623	0
420504.0975	3859621.9481	421077.2281	3859621.9481	1.0000	573.1307	0
421088.3804	3859621.9481	422269.8565	3859621.9481	1.0000	1181.4761	0
420461.8845	3859694.9481	422396.0903	3859694.9481	1.0000	1934.2057	0
420420.0817	3859767.9481	422522.3241	3859767.9481	1.0000	2102.2423	0
420413.7036	3859840.9481	422511.1240	3859840.9481	1.0000	2097.4204	0
420407.3254	3859913.9481	422468.9107	3859913.9481	1.0000	2061.5853	0
420380.2810	3859986.9481	422426.6974	3859986.9481	1.0000	2046.4164	0
420290.8830	3860059.9481	422384.4841	3860059.9481	1.0000	2093.6011	0
420208.6070	3860132.9481	422342.2708	3860132.9481	1.0000	2133.6637	0
420166.3941	3860205.9481	422300.0575	3860205.9481	1.0000	2133.6633	0
420124.1812	3860278.9481	422257.8442	3860278.9481	1.0000	2133.6629	0
420081.9683	3860351.9481	422215.6308	3860351.9481	1.0000	2133.6625	0
420039.7554	3860424.9481	422173.4175	3860424.9481	1.0000	2133.6621	0
419997.5425	3860497.9481	422131.2042	3860497.9481	1.0000	2133.6617	0
419955.3296	3860570.9481	422088.9909	3860570.9481	1.0000	2133.6613	0
419913.1167	3860643.9481	422046.7776	3860643.9481	1.0000	2133.6609	0
419906.5790	3860716.9481	422004.5643	3860716.9481	1.0000	2097.9853	0
419909.1365	3860789.9481	421962.3510	3860789.9481	1.0000	2053.2145	0
419911.6940	3860862.9481	421920.1377	3860862.9481	1.0000	2008.4437	0
419914.2515	3860935.9481	421877.9244	3860935.9481	1.0000	1963.6729	0
419935.7483	3861008.9481	421835.7111	3861008.9481	1.0000	1899.9628	0
420061.9844	3861081.9481	421793.4978	3861081.9481	1.0000	1731.5134	0
420188.2204	3861154.9481	421751.2845	3861154.9481	1.0000	1563.0640	0
420314.4565	3861227.9481	421709.0712	3861227.9481	1.0000	1394.6147	0
420440.6926	3861300.9481	421666.8578	3861300.9481	1.0000	1226.1653	0
420566.9286	3861373.9481	421624.6445	3861373.9481	1.0000	1057.7159	0
420693.1647	3861446.9481	421582.4312	3861446.9481	1.0000	889.2665	0
420819.4007	3861519.9481	420911.3485	3861519.9481	1.0000	91.9477	0
420962.1056	3861519.9481	421540.2179	3861519.9481	1.0000	578.1123	0
420972.3729	3861592.9481	421498.0046	3861592.9481	1.0000	525.6318	0
421071.8730	3861665.9481	421443.5243	3861665.9481	1.0000	371.6513	0
421198.1090	3861738.9481	421361.0540	3861738.9481	1.0000	162.9450	0
421324.3451	3861811.9481	421351.4558	3861811.9481	1.0000	27.1107	0

421679.9179	3862468.9481	421914.8162	3862468.9481	1.0000	234.8983	0

Primary Sampling Objective
The primary purpose of sampling at this site is to traverse and detect target areas of a given size and shape with required high probability. The transect design tools provide a statistically defensible method to use transect survey data that covers only a small proportion of the total study area.

Selected Sampling Approach
The specified sampling approach was random parallel transect sampling. If parameters change from those specified in the table above, then the probability of detecting the target area will be different from those computed by VSP and reported here.

Simulation Details
To generate an estimated probability on a graph, VSP runs a Monte Carlo simulation based on the entered parameters. For each iteration, VSP creates a square site with the target area centered at the origin and rotated at a random angle. A parallel transect pattern is placed randomly so that 1 meters wide transects are parallel to the x axis.

VSP calculates the total area of the site traversed by transects, A_b, which can vary for each iteration. The expected number of detected background anomalies, λ_b, is calculated as $\lambda_b = D_b A_b (1 - P_{fn})$ where D_b is the background density of 15 anomalies / acres and P_{fn} is the instrument false negative rate of 0.05. A random number of detected background anomalies is generated using a Poisson distribution with parameter λ_b. VSP randomly places these anomalies within the traversed areas of the site.

To simulate the number of additional anomalies in the target area, VSP uses an approximation technique to randomly place additional detected anomalies in the traversed areas of the target area. Portions of transects overlapping the target area are divided into small sections. For each section, the quantile of the target area in which it lies is determined, the expected number of additional anomalies is determined, and a random number of detected anomalies is determined using a Poisson distribution and placed within the section.

VSP uses a moving window along each transect to determine which areas have density significantly greater than background density. The window moves 1/6 of the search window diameter for each iteration. Where D_a is the actual density for the current window, the null and alternative hypotheses for determining if the area inside the window has density significantly greater than background density, D_b, are as follows:

Null Hypothesis: $H_o : D_a \le D_b$

Alternative Hypothesis: $H_a : D_a > D_b$

VSP checks each window to see if the actual number of detected anomalies is significantly greater than the expected number of anomalies for a Poisson distribution. If any windows intersecting the target area are flagged as significant, then we determine the target area has been detected.

250 iterations are run to begin the simulation to estimate a probability of detection. If the specified Maximum Error has not been achieved, additional iterations are run until the Maximum Error is met. If the total number of iterations is *n* and the proportion of target areas detected is *p*, then another iteration is run if

Maximum Error < $1.96 * \sqrt{\frac{p(1-p)}{n}}$

The quantity $1.96 * \sqrt{\frac{p(1-p)}{n}}$ is the 95th percentile of the standard error of the mean for a binomial distribution. We are 95% certain that the estimated probability is close to the true probability (within the maximum error). When all iterations are completed, VSP tabulates the estimated probability the target area has been detected, *p* / *n*. VSP repeats this process for a number of transect spacings determined by simulation results and the minimum precision specified.

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that

are based on the number and length of the transects. Based on the number of transects determined above, the estimated total cost of surveying this site is $64,594.26, which averages out to a per transect cost of $1,345.71. Note: these costs are for the geophysical survey only, and do not include any excavation or follow-up investigations. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Cost / Unit**	**Units**	**Total**
Collection costs	$1.00 / meter	58794.26 meters	$58,794.26
Setup costs	$100.00 / transect	48 transects	$4,800.00
Fixed planning and validation costs			$1,000.00
Total cost			**$64,594.26**

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Software and documentation available at http://vsp.pnl.gov

* - The report contents may have been modified or reformatted by end-user of software.

Transect Sampling for Unexploded Ordnance (UXO) Target Detection

Summary

This report summarizes the probability of traversing and detecting a target area of specific size and shape for different transect spacings. Simulation details and a power curve estimate how well the specified design would detect the target. The selected design statement is:

> If 1 meter wide transects with a parallel pattern are spaced 134 meters between transects (135 meters on centers) over the entire site, these transects have an approximately 90% chance of traversing and detecting any 168.25 meter diameter (84.1248 meter radius) circular target area having a bivariate normal distribution with an average density of 350 anomalies per acre above the background density of 15 anomalies per acre. This assumes the instrument false negative rate is 5% and flagged windows have at least 95% confidence they have density greater than background.

The following table summarizes the sampling design developed. A figure that shows the transect placement in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Ensure high probability of traversing and detecting a target area that has a specified size and shape
Required Probability of Traversing the Target	100%
TARGET AREA AND TRANSECT INPUTS	
Type of Sampling Design	Transects
Transect Pattern	Parallel
Transect Width	1 meters
Area of target area	239313.96 ft^2
Shape of target area of concern	Circular
Radius of target area of concern	84.1248 meters
SIMULATION PARAMETERS FOR PROBABILITY OF DETECTION	
Formula for calculating the probability of traversing and detecting target area	Monte Carlo Simulation (method described below)
Decision Rule	Flag if at least 95% confident an area has density greater than background density
Background Density of the Site	15 anomalies / acre
Expected Target Area Density Above Background	350 anomalies / acre Target average
Distribution of target area density above background	Bivariate Normal
Transect spacing evaluation range	120 to 150 meters
Instrument false negative rate	5%
Minimum precision	0.1
Maximum error	0.05
Search Window Diameter	101 meters
PROPOSED TRANSECT DESIGN AND COST INFORMATION	
Number of selected sample areas [a]	1
Specified sampling area [b]	11453.42 acres

Computed spacing between transects	134 meters
Computed spacing between transect centers	135 meters
Number of transects to be surveyed	146
Transect Coverage	0.74% of total site area
Linear transect coverage	213.59 miles
Area of transect coverage	84.9398 acres
Total cost of sampling [c]	$359,339.08

[a] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[b] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[c] See the Cost of Sampling section for an explanation of the costs presented here.

Site Map With Proposed Transect Design

Primary Sampling Objective
The primary purpose of sampling at this site is to traverse and detect target areas of a given size and shape with required high probability. The transect design tools provide a statistically defensible method to use transect survey data that covers only a small proportion of the total study area.

Selected Sampling Approach
The specified sampling approach was random parallel transect sampling. If parameters change from those specified in the table above, then the probability of detecting the target area will be different from those computed by VSP and reported here.

Simulation Details
To generate an estimated probability on a graph, VSP runs a Monte Carlo simulation based on the entered parameters. For each iteration, VSP creates a square site with the target area centered at the origin and rotated at a random angle. A parallel transect pattern is placed randomly so that 1 meters wide transects are parallel to the x axis.

VSP calculates the total area of the site traversed by transects, A_b, which can vary for each iteration. The expected number of detected background anomalies, λ_b, is calculated as $\lambda_b = D_b A_b (1 - P_{fn})$ where D_b is the background density of 15 anomalies / acres and P_{fn} is the instrument false negative rate of 0.05. A random number of detected background anomalies is generated using a Poisson distribution with parameter λ_b. VSP randomly places these anomalies within the traversed areas of the site.

To simulate the number of additional anomalies in the target area, VSP uses an approximation technique to randomly place additional detected anomalies in the traversed areas of the target area. Portions of transects overlapping the target area are divided into small sections. For each section, the quantile of the target area in which it lies is determined, the expected number of additional anomalies is determined, and a random number of detected anomalies is determined using a Poisson distribution and placed within the section.

VSP uses a moving window along each transect to determine which areas have density significantly greater than background density. The window moves 1/6 of the search window diameter for each iteration. Where D_a is the actual density for the current window, the null and alternative hypotheses for determining if the area inside the window has density significantly greater than background density, D_b, are as follows:

Null Hypothesis: $H_o : D_a \leq D_b$

Alternative Hypothesis: $H_a : D_a > D_b$

VSP checks each window to see if the actual number of detected anomalies is significantly greater than the expected number of anomalies for a Poisson distribution. If any windows intersecting the target area are flagged as significant, then we determine the target area has been detected.

250 iterations are run to begin the simulation to estimate a probability of detection. If the specified Maximum Error has not been achieved, additional iterations are run until the Maximum Error is met. If the total number of iterations is *n* and the proportion of target areas detected is *p*, then another iteration is run if

Maximum Error < $1.96 * \sqrt{\frac{p(1-p)}{n}}$

The quantity $1.96 * \sqrt{\frac{p(1-p)}{n}}$ is the 95th percentile of the standard error of the mean for a binomial distribution. We are 95% certain that the estimated probability is close to the true probability (within the maximum error). When all iterations are completed, VSP tabulates the estimated probability the target area has been detected, *p* / *n*. VSP repeats this process for a number of transect spacings determined by simulation results and the minimum precision specified.

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number and length of the transects. Based on the number of transects determined above, the estimated total cost of surveying this site is $359,339.08, which averages out to a per transect cost of $2,461.23. Note: these costs are for the geophysical survey only, and do not include any excavation or follow-up investigations. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Cost / Unit**	**Units**	**Total**
Collection costs	$1.00 / meter	343739.08 meters	$343,739.08
Setup costs	$100.00 / transect	146 transects	$14,600.00
Fixed planning and validation costs			$1,000.00
Total cost			**$359,339.08**

Transect Sampling for Unexploded Ordnance (UXO) Target Detection

Summary

This report summarizes a transect sampling design where transects were manually placed on the specified sampling area(s). Simulation details and a power curve estimate how well the specified design would detect the target. If previous transect and anomaly data was collected, this is not included in the simulations.

The following table summarizes the sampling design developed. A figure that shows the transect placement in the field and a table that lists the transect placement coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Manually place transects
TARGET AREA AND TRANSECT INPUTS	
Type of Sampling Design	Transects
Transect Pattern	Parallel
Transect Width	1 meters
Area of target area	27171.63 ft^2
Shape of target area of concern	Circular
Radius of target area of concern	28.3464 meters
PROPOSED TRANSECT DESIGN AND COST INFORMATION	
Number of selected sample areas [a]	1
Specified sampling area [b]	7.55 acres
Computed spacing between transects	15.24 meters
Computed spacing between transect centers	16.24 meters
Number of transects to be surveyed	13
Transect Coverage	6.13% of total site area
Linear transect coverage	1.16 miles
Area of transect coverage	0.4626 acres
Total cost of sampling [c]	$4,172.24

[a] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[b] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[c] See the Cost of Sampling section for an explanation of the costs presented here.

Site Map With Proposed Transect Design

Summary of Transect Survey Design for Area: Area 3						
(All measurements are in meters)						
Start Coordinate		End Coordinate		Transect		
X	Y	X	Y	Width	Length	ID
422896.5724	3864228.3920	422907.1596	3864228.3920	1.0000	10.5872	0
422829.5172	3864244.6320	422911.0324	3864244.6320	1.0000	81.5152	0
422762.4620	3864260.8720	422914.9053	3864260.8720	1.0000	152.4433	0
422721.9152	3864277.1120	422918.7781	3864277.1120	1.0000	196.8629	0
422725.7461	3864293.3520	422922.6510	3864293.3520	1.0000	196.9048	0
422729.5771	3864309.5920	422926.5238	3864309.5920	1.0000	196.9467	0
422733.4080	3864325.8320	422930.3967	3864325.8320	1.0000	196.9887	0
422737.2389	3864342.0720	422934.2695	3864342.0720	1.0000	197.0306	0
422741.0699	3864358.3120	422938.1424	3864358.3120	1.0000	197.0725	0
422744.9008	3864374.5520	422942.0152	3864374.5520	1.0000	197.1144	0
422748.7317	3864390.7920	422905.5340	3864390.7920	1.0000	156.8023	0
422752.5627	3864407.0320	422835.4870	3864407.0320	1.0000	82.9244	0
422756.3936	3864423.2720	422765.4401	3864423.2720	1.0000	9.0465	0

Primary Sampling Objective
The primary purpose was to manually place transects on the site.

Selected Sampling Approach
The specified sampling approach was random parallel transect sampling. If parameters change from those specified in the table above, then the probability of detecting the target area will be different from those computed by VSP and reported here.

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that

are based on the number and length of the transects. Based on the number of transects determined above, the estimated total cost of surveying this site is $4,172.24, which averages out to a per transect cost of $320.94. Note: these costs are for the geophysical survey only, and do not include any excavation or follow-up investigations. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Cost / Unit**	**Units**	**Total**
Collection costs	$1.00 / meter	1872.24 meters	$1,872.24
Setup costs	$100.00 / transect	13 transects	$1,300.00
Fixed planning and validation costs			$1,000.00
Total cost			**$4,172.24**

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APPENDIX Q
RISK ASSESSMENT WORK PLAN

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Risk Assessment Work Plan

Former Camp Croft
Spartanburg, South Carolina

Prepared under:
Contract No. W912DY-10-D-0028
Task Order No. 0005

Prepared for:
Zapata, Incorporated
6302 Fairview Road, Suite 600
Charlotte, NC 28210

Prepared by:
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July 2011

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Acronyms and Abbreviations

AE	Assessment Endpoint
AoPI	Areas of Potential Interest
ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	Agency for Toxic Substances and Disease Registry
Black & Veatch	Black & Veatch Special Projects Corp.
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chemical of concern
COCP	Chemical of potential concern
COPEC	Chemical of potential ecological concern
EcoSSL	Ecological Soil Screening Level
EPA	United States Environmental Protection Agency
EPC	Exposure point concentration
ERA	Ecological Risk Assessment
FUDS	Formerly-used defense site
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
IRIS	Integrated Risk Information System
LOAEL	Lowest Observed Adverse Effect Level
MC	Munitions Constituents
MRL	Minimal Risk Level
MRS	Munitions Response Sites
NOAEL	No Observed Adverse Effect Level
OSWER	Office of Solid Waste and Emergency Response
PEF	particulate emission factor
ppm	parts per million
PPRTVs	Provisional Peer-Reviewed Toxicity Values
RAGS	Risk Assessment Guidance for Superfund
RfD	Reference Dose
SLERA	screening-level ecological risk assessment
RI/FS	Remedial investigation and feasibility study (RI/FS)
SF	Slope Factor
TRV	toxicity reference value
USACE	US Army Corps of Engineers
USAESCH	US Army Corps of Engineers, Engineering and Support Center, Huntsville
ZAPATA	Zapata Incorporated

1.0 Introduction

The US Army Corps of Engineers, Engineering and Support Center, Huntsville (USAESCH) has initiated a remedial investigation and feasibility study (RI/FS) for the Former Camp Croft Site, located in Spartanburg County, South Carolina. The Former Camp Croft is a formerly-used defense site (FUDS) within the US Army Corps of Engineers (USACE) Charleston District.

Zapata Incorporated (ZAPATA) will prepare a RI Report in accordance with the guidelines specified in their work plan. As part of the planning process, Black & Veatch Special Projects Corp. (Black & Veatch) was tasked to prepare this Risk Assessment work plan that describes the various steps that will be undertaken to characterize potential risks to human health and the environment.

This risk assessment work plan consists of two parts: Section 1 addresses the Human Health Risk Assessment (HHRA) and Section 2 addresses the ecological risk assessment.

1.1 Overview

This work plan was developed to characterize the exposure setting and receptor characteristics associated with the site. This work plan identifies the potential exposure pathways by which identified populations may be exposed. Exposure pathways were identified based on considerations of the sources and locations of contaminants on the site, the likely environmental fate of the contaminants, and the location and activities of the potentially exposed populations. This work plan identifies exposure points and routes of exposure for each exposure pathway, as well as assumptions regarding receptor characteristics and behavior (e.g., body weight, ingestion rate, exposure frequency).

In preparation of this work plan, Black & Veatch reviewed the available information obtained from Zapata pertaining to the site. Present and future-use exposure pathways and receptors are tentatively identified. Exposure variables that will be used for the calculation of daily intakes and carcinogenic and noncarcinogenic toxicity values for contaminants of potential concern and the sources of these values are presented in subsequent sections. Note that it is not anticipated that a comprehensive HHRA will be required; however, the data management and exposure assumptions that will be used are included should a comprehensive HHRA be warranted based on the outcome of the field investigations.

The purpose of the HHRA is to evaluate the potential risks to human health and the environment due to releases of munitions constituents (MC) at the site. The main objective of this HHRA will be to provide the information necessary to assist in the decision-making process. The specific objectives of the HHRA are to:

- Identify and provide analysis of baseline risks (defined as risks that might exist if no remediation or institutional controls were applied at the site) and help determine what action is needed.
- Provide a basis for determining the levels of chemicals that can remain onsite and still not adversely impact public health and the environment.
- Provide a basis for comparing potential health and environmental impacts of various remedial alternatives.

The HHRA results will be used to document the magnitude of potential risk at the site and associated cause(s) of that risk. Finally, the results of the HHRA will help determine what, if any, remedial response actions may be necessary and assist in establishing the remediation goals that will be presented in the feasibility study.

The work plan is developed in accordance with EPA and USACE guidance set forth in the following documents:

- EPA, 1989. *Risk Assessment Guidance (RAGS), Volume I: Human Health Evaluation Manual (Part A)*, Interim Final, Office of Emergency and Remedial Response, Washington, DC, EPA/540/1-89/002, 1989.
- EPA, 1991. *RAGS, Volume I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors*, Interim Final, Office of Solid Waste and Emergency Response (OSWER), OSWER Directive: 9285.6-03, 1991.
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  http://www.epa.gov/region4/waste/oftecser/healtbul.htm
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- EPA, 2011a. Regional Screening Levels for Chemical Contaminants at Superfund Sites,http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm, May.
- EPA, 2011b. Integrated Risk Information System (IRIS), Online, National Center for Environmental Assessment, Cincinnati, Ohio, 2011.
- USACE, 1999. Human Health Evaluation, Volume I, EM 200-1-4, 1999.

1.2 Site Location, Description, History

This information may be found in the main body of the RI/FS work plan.

1.3 Demography and Land Use

This information may be found in the main body of the RI/FS work plan.

1.4 Data Collection and Evaluation

This step in the risk assessment process involves gathering and analyzing the site data relevant to the human health evaluation and identifying the chemicals present at the site that will be included in the risk assessment process (EPA, 1989).

The presence of chemicals of potential concern (COPCs) for human health is unknown given that there are no existing chemical analytical data from previous investigations. Pending the results of the geophysical surveys and supplemental discrete sampling to determine the presence or absence of MC, a human health screening will be performed. The HHRA will be prepared as an appendix to the RI report and summarized in the main body of the RI report.

Per risk assessment guidance, RAGS Part D tables will list all chemicals that have been analyzed for in at least one sampling location. The RAGS tables will also contain statistical information about the chemicals detected in each medium, the detection limits of chemicals analyzed, risk-based screening values for COPC selection, and rational for the selected or deletion of the chemical as COPCs. The following screening criteria will be used to select or eliminate each chemical:

- Surface soil concentrations will be compared to the EPA Regional Screening Levels (RSL) for residential soil (EPA, 2011a).

The maximum concentration for each constituent will be compared to the applicable screening criteria. If a duplicate sample is collected, the average of a parent and duplicate sample will be used. If the constituent was detected in both samples, the detection will be used if only one of the samples detected the constituent. If the concentration used for screening for a constituent exceeds the conservative risk-based screening level, then the chemical is retained as a COPC and evaluated further in the risk assessment.

1.5 Human Exposure Pathways

Potential human exposure pathways for the site were defined based on current and potential future uses of the site. Each potential pathway was then evaluated considering site-specific conditions to determine if the pathway could be present at the site. The area demography and land-use characteristics were taken into consideration when the pathways were developed. If a pathway potentially could be complete between the source of contamination and a human receptor, it was retained for further evaluation.

1.5.1 Identification of Exposure Pathways

This section identifies the most significant potential pathways through which individuals may be exposed to the contaminants of concern at the site. Both current and potential future land use of the site and surrounding area were considered during exposure pathway identification.

As defined in the Risk Assessment Guidance for Superfund Part A (RAGS 1989), an exposure pathway is composed of the following elements:

- A source and mechanism of chemical release to the environment
- An environmental transport medium (e.g., groundwater) for the released chemical and/or mechanism of transfer of the chemical from one medium to another
- A point of potential contact by humans with the contaminated medium

- A route of exposure (i.e., ingestion, inhalation, or dermal contact)

In this risk assessment, pathways will be identified for the No Action alternative, assuming no site remediation occurs. This assessment also assumes that no additional restrictions to site access or use exist. The goal of this discussion is to establish whether it is feasible for individuals to engage in activities resulting in exposure to site-related contaminants.

There are three general routes through which individuals could potentially be exposed to chemical contamination: ingestion, inhalation, and dermal contact. The following sections describe the possible sources, receptors, and exposure pathways considering both current and potential future land use. An identified pathway does not imply that exposures are actually occurring, only that the potential exists for the pathway to be complete.

1.5.2 Characterization of Potentially Exposed Populations

Table 1 in the RI/FS work plan defines potentially exposed populations by MRS unit. These include: residents, workers, and recreational users.

1.5.2.1 Residents. Residents may come into contact with contaminants in soil through incidental ingestion, dermal contact, and inhalation of fugitive dust. For this risk assessment, exposure to adults and young children (0 to 6 years) will be examined as the most conservative potential exposure pathways. They will be examined using default parameters recommended by EPA (1989, 1991, 1997a, 2004) described below.

1.5.2.2 Site Workers. Workers may come into contact with contaminants in soil through incidental ingestion, dermal contact, and inhalation of fugitive dust. Workers will be examined using default parameters recommended by EPA (1989, 1991, 1997a, 2002, 2004) described below.

1.5.2.3 Recreational Users. Recreational users could be exposed to contaminants in soil through incidental ingestion, dermal contact, and inhalation of fugitive dust. Recreational users will be examined using the assumptions described below.

1.5.3 Summary of Exposure Pathways

The following exposure pathways were considered to be complete and will be evaluated as part of the assessment of exposure to contaminants:

- (Adults and Young Children [0-6 yrs])
  - Surface Soil
    - - incidental ingestion
    - - dermal contact
    - - inhalation of fugitive dust

- Site Worker (Adults)
  - Surface Soil
    - - incidental ingestion
    - - dermal contact
    - - inhalation of fugitive dust
- Recreational users (Adults)

Surface Soil
- incidental ingestion
- dermal contact
- inhalation of fugitive dust

1.5.4 Exposure Units

Three Munitions Response Sites (MRSs) will be evaluated. The three MRSs include the Gas Chamber (MRS 1), the Grenade Court (MRS 2), and the Land Range Complex (MRS 3).

The Gas Chambers Area is an approximate 24-acre area that was used to train soldiers on the effects of gas munitions; CS smoke pots/grenades are believed to be the primary training item used at this site. The data collected from within MRS 1 will be evaluated collectively as a single exposure unit.

The Grenade Court (MRS 2) is north of the primary firing line, which existed immediately south of and along Dairy Ridge Road. The grenade court is approximately 25-acres in size. The data collected from within MRS 2 will be evaluated collectively as a single exposure unit.

The Range Complex (MRS 3) is a 12,102-acre area composed of 15 ranges and two lakes. MRS 3 is divided into two areas. Sub-area 1 represents all areas within former range fans where MK II grenades, 37mm, or 60mm mortars have been found. Sub-area 2 represents all remaining portions of MRS 3, beyond documented range fans, where only sporadic and small quantities of munitions have been found. Sub-areas 1 and 2 will be evaluated as separate exposure units.

1.5.5 Calculation of Exposure Point Concentrations

Exposure point concentrations (EPCs) will be calculated for each exposure unit. The 95% Upper Confidence Limit (UCL) will be used for data sets of 10 or more samples. These data will be used to assess exposure for residents, workers, and recreational users. The UCL provides a conservative estimate of the mean concentration, such that randomly drawn subsets of site data will have means that are equal to or less than the UCL 95 percent of the time. The 95%UCL will be calculated using EPA's ProUCL software, Version 4.00.05.

1.5.6 Quantification of Exposure

The following basic equation will be used to calculate human intake of a COPC (EPA, 1989):

$$DI = C \times HIF \qquad \text{Eq. 1}$$

Where:

DI = Daily Intake [milligram (mg) of chemical per kg of body weight per day].
C = Concentration of the chemical in mg/kg parts per million (ppm)].
HIF = Human Intake Factor (kg of medium per kg body weight per day).

Each intake variable in the above equation has a range of values. The intake variable values for a given pathway were selected so that the combination of intake variables results in an estimate of the RME that can be expected to occur (EPA, 1989). This section describes the method by which the exposure concentrations and the HIFs will be derived. An example of how a HIF is derived is listed below:

$$\text{HIF for a child resident ingesting soil} = \frac{IR \times EF \times ED \times CF \times FI}{BW \times AT} \qquad \text{Eq. 2}$$

Where:

IR	=	Ingestion Rate of Soil	(mg/day)	200
EF	=	Exposure Frequency	days/year	350
ED	=	Exposure Duration	years	6
CF	=	Conversion Factor	kg/mg	1×10^{-6}
FI	=	Fraction Ingested	unitless	1
BW	=	Body Weight	kg	15
AT-N	=	Averaging Time (Non-Cancer)	days	2,190

In this case, the HIF is 1.3E-05 milligrams per kilogram per day (mg/kg-day).

1.5.7 Estimation of Chemical Intakes and Exposure Assumptions

The amount of chemical that is taken into a person's body following exposure is referred to as chemical intake. Intake is expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg-day), and is referred to as chronic daily intake (CDI). CDI depends on the concentration of chemicals in media at the point of human contact (exposure point concentration), and exposure assumptions specific to the receptor population, including frequency and duration of exposure, body weight, and contact rate.

The current and future residential scenario assumed that individuals live in the same residence for 30 years. In addition, it was assumed that residents take about two weeks of vacation per year, spending 350 days per year at home.

As a measure of conservatism and to avoid redundancy, the most sensitive receptor was used to calculate non-cancer hazards and excess cancer risk levels. In the case of non-carcinogens, a child resident is the most sensitive receptor, owing to its lower body mass relative to the amount of chemical intake. For carcinogens, a resident from child through adult (lifetime) is the most sensitive receptor because the excess cancer risk for the child (exposure duration of six years) is assumed to be additive to that of an adult (exposure duration of 24 years). For this reason, no calculations of excess cancer risk will be included for child residents and no calculations of non-cancer hazards will be included for lifetime residents. The following subsections present the assumptions that will be used to calculate chronic daily intakes (i.e., doses) of chemicals of COPCs for the remaining receptors through the applicable exposure routes.

The worker scenario assumed that an individual works at the site for 25 years. This value represents the 95th percentile for time spent working at one location (EPA, 1997a). It was further assumed that the site worker is at work five days per week for 50 weeks per year (250 days total) (EPA, 1997a).

It was assumed that recreational users would visit the site over a span of 10 years.

1.5.6.1 Incidental Ingestion of Surface Soil. Incidental ingestion of surface soil can result from placing soil-covered hands or objects in the mouth. Surface soil ingestion is a potential route of exposure for residents, site workers, and recreational users.

Residents will be assumed to be exposed to surface soil during outdoor activities, such as yard work or recreational activities. An exposure period of 350 days per year was assumed (EPA, 1997a). It has been estimated that children ages 1 to 6 incidentally ingest 200 mg of surface soil on a daily basis and that individuals over the age of 6 ingest 100 mg of surface soil per day (EPA, 1997a). A lifetime average daily dose was calculated to reflect these varying ingestion rates.

The surface soil ingestion rate that was assumed for site workers will be 100 mg/day (EPA, 2001). It will be assumed that a site worker is exposed to COPCs in surface soil five days per week for 50 weeks per year (a total of 250 days per year) for 25 years.

It will be assumed that a recreational user is exposed to COPCs in surface soil one day per week for a period of 10 years at a rate of 100 mg/day.

1.5.6.2 Dermal Absorption from Soil. Dermal contact with soil could result in absorption of chemicals through the skin. Dermal absorption of chemicals from soil is a potential exposure route for residents, site workers, and recreational users. The exposed skin areas that were used to evaluate dermal contact with surface soil are outlined below:

- Adult resident will be based on gardeners/grounds keeper activity and assumes face, forearms, hands, and lower legs (5,700 centimeters squared [cm^2)]) are exposed.
- Child resident will be based on children playing in wet soil and assumes face, forearms, hands, lower legs, and feet (2,800 cm^2) are exposed (EPA, 2004).
- A lifetime average daily dose will be calculated to reflect these varying dermal exposure rates.
- Site worker will be based on the adult male utility worker activity and assumes face, forearms, and hands (3,300 cm^2) are exposed (EPA, 2004). It is expected that all other body areas will be covered while working on the site and that there is minimal contact with soil (EPA, 1997a).
- Recreational user will be based on an adult resident.

In the absence of chemical-specific absorption factors, an absorption factor of 0.1 percent will be used for inorganics. A soil adherence factor of 0.2 milligrams per centimeter squared (mg/cm^2) will be used for all receptors.

1.5.6.3 Inhalation of Particulate Emissions from Soil. Inhalation of chemicals absorbed to respirable particles will be assessed using the EPA default particulate emission factor (PEF) equal to 1.36E+09 cubic meter per kilogram (m^3/kg). The PEF relates the contaminant concentration in soil with the concentration of respirable particles in air due to fugitive dust emissions from contaminated soils.

1.6 Toxicity Assessment

The toxicity assessment determines the types of adverse health effects associated with chemical exposures, the relationship between magnitude of exposure and adverse effects, and the related uncertainties involved. Risk assessments rely heavily on existing toxicity information developed for specific chemicals. In accordance with EPA guidance (2003), the primary source (Tier 1) for this information will be the Integrated Risk Information System (IRIS) database. However, additional secondary sources will also be used including, Provisional Peer-Reviewed Toxicity Values (PPRTVs) (Tier 2 Values) and Other Tier 3 values which includes Agency for Toxic Substances Disease, Registry (ATSDR), Minimal Risk Levels (MRLs), and Health Effects Assessment Summary Tables (HEAST) (EPA, 1997b).

The toxicity component in a risk assessment falls into two categories, those related to noncarcinogenic hazards and those related to carcinogenic risks. To evaluate noncarcinogenic hazards, the intake of a chemical will be compared to the corresponding reference dose (RfD) of that compound. The RfD used in the risk assessment is a best estimate of the level at which there will be no observed adverse effects to the exposed population. To evaluate carcinogenic risks, the intake of a chemical will be factored with the slope factor (SF) for that contaminant. The slope factor used in the risk assessment represents the 95 percent UCL for the best estimate of the carcinogenic potency of a compound, or its ability to cause cancer in an exposed population. For humans, both the RfDs and slope factors are usually derived from animal dose-response relationships and sometimes human epidemiology studies (EPA, 1989).

1.7 Risk Characterization

The risk characterization section of the risk assessment will summarize and combine the exposure and toxicity assessments to characterize baseline risks, both quantitatively and qualitatively. During risk characterization, chemical-specific toxicity information will be compared with the estimated exposure levels to determine whether chemicals at the site pose current or future risks that are of a magnitude to cause concern. This subsection will include an uncertainty analysis that shows that the calculated risks are relative in nature and do not present an absolute quantification.

1.7.1 Methods for Non-Carcinogenic Risk Estimation

Should the data indicate that a comprehensive risk assessment is warranted, the potential for non-carcinogenic health effects due to chemical exposure will be evaluated by comparing intake (usually expressed in milligrams per kilogram per day [mg/kg/day]) with an RfD (also usually expressed in mg/kg/day). This comparison, or unitless ratio, is called the hazard quotient (HQ) and is expressed as the following equation:

Hazard Quotient (HQ) = Chronic daily intake (CDI) / Chronic RfD

The hazard quotient for ingestion pathway will be estimated by dividing the estimated intake by the oral RfDs developed from administered dose toxicity studies. To estimate the hazard quotient for dermal absorption pathways, the estimated dermal absorbed dose will be divided by the adjusted dermal RfD. The adjusted dermal RfD will be calculated by multiplying the oral RfD by the oral-to-dermal adjustment factor. The oral-to-dermal adjustment factor will be obtained from the Agency for Toxic Substance and Disease Registry (ATSDR) toxicity profile for the chemical or, if unavailable, will be assumed to equal 1. Inhalation hazard quotients will be calculated using the methodology in RAGS Part F.

1.7.2 Methods for Carcinogenic Risk Estimation

Should the data indicate that a comprehensive risk assessment is warranted, the risk for chemicals that are potential carcinogens will be estimated as the incremental probability of a receptor developing cancer over a lifetime as a result of exposure via each identified exposure pathway. The slope factor converts estimated daily intakes to the incremental risk of a receptor developing cancer. The following equation (i.e., the linear low-dose cancer risk equation) will be used to compute chemical-specific cancer risk:

Risk = Chronic daily intake or dermal absorbed dose (mg/kg/day) x
slope factor (mg/kg/day)-1

Cancer risks for lifetime exposure scenarios will be calculated by combining the estimated cancer risks for the adult and child.

To estimate the risk for the ingestion pathway, the daily intake will be multiplied by the oral slope factor determined from administered dose toxicity studies. Dermal risk will be calculated by multiplying the estimated dermal absorbed dose by the adjusted dermal cancer slope factor. The adjusted dermal cancer slope factor will be calculated by dividing the oral slope factor by the oral-to-dermal adjustment factor. The oral-to-dermal adjustment factor will be obtained from the ATSDR toxicity profile for the chemical or, if unavailable, will be assumed to equal 1. Inhalation cancer risk will be calculated using the methodology in RAGS Part F.

1.8 References

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USACE, 2010. Risk Assessment Handbook: Volume II – Environmental Evaluation EM 200-1-4, 2010.

2.0 Ecological Risk Assessment Methods

2.1 Site Location, Description, History

This information may be found in the main body of the RI/FS work plan.

2.2 Demography and Land Use

This information may be found in the main body of the RI/FS work plan.

2.3 Habitats and Biota

The site landscape is consistent with the Piedmont physiographic province, with rolling hills, many tributary channels, and iron-rich clay overburden soils. The FUDS property occupies approximately 19,044 acres, the majority of which includes Croft State Natural Area. Much of the land surface is wooded. The highest elevation is approximately 800 ft above mean sea level. Topography varies only by several hundred feet. There are two man-made lakes within Croft State Natural Area: Lake Johnson and Lake Craig.

Croft State Natural Area occupies 7,054 acres of the 19,044-acre FUDS property. The diverse park covers nearly 12 miles of rolling, wooded terrain that also provides habitat for a wide variety of flora and fauna. Terrestrial habitats at the site include open fields, shrub/scrub, as well as both upland and lowland forests. In the northern portion of the FUDS boundary, there are numerous small wetlands and riparian areas identified; those types include Freshwater Emergent, Freshwater Forested/Shrub, Freshwater Pond, Riparian Forested/Shrub. Those areas range in size from a 4.79-acre Freshwater Forested/Shrub located south of AoPI 3 to a 0.10-acre Freshwater Pond located north of AoPI 11D, near the FUDS boundary. The southern portion of the FUDS boundary is dominated by numerous larger wetlands, primarily the Freshwater Forested/Shrub type, along Fairforest Creek. The largest wetland in the southern portion of the FUDS is 82.85 acres and is located southwest of Lake Craig.

Flora species include a diverse variety of grasses, shrubs and trees. Wildlife species in the area include soil and aquatic invertebrates, fish, amphibians, reptiles, small mammals, and birds. The site is widely used for hunting and game species such as turkey and deer are common.

The following sections provide the methods to be used in conducting the ecological risk evaluation for the Camp Croft site. The ecological risk assessment is a qualitative and quantitative appraisal of the actual or potential impacts of contaminants on wildlife species.

The basic components of the ecological risk evaluation are listed below:

- Problem Formulation
- Characterization of Exposure
- Characterization of Ecological Effects
- Risk Characterization.

2.4 Problem Formulation

Problem formulation is the first step of the ecological risk assessment process, and establishes the goals, breadth, and focus of the assessment (EPA 1992a). It provides an evaluation of the data (including an assessment of data usability), contaminants of potential concern, habitats, receptors, exposure pathways, ecotoxicity, and determines endpoints (if any) for further study. The product of the problem formulation is a site conceptual model, which identifies the potential chemical transport pathways, receptors, and the areas of primary concern to be addressed in the ecological risk assessment. Following are descriptions of the assessment components that will be addressed as part of the problem formulation.

2.4.1 Data Evaluation and Reduction

The objectives of the data evaluation and reduction process will be to review and summarize the analytical data for each medium sampled that is of ecological concern associated with the areas investigated at the Camp Croft site, as well as to select chemicals of potential ecological concern (COPECs).

Data that will be used in the ecological risk evaluation include analytical results from environmental samples collected from the Camp Croft site during the remedial investigation. The COPECs will be selected based on an analysis of the analytical data using the following screening criteria:

- A chemical will be excluded as a COPEC for a medium if it is not detected in any sample from that medium.

- A chemical will be excluded as a COPEC for a medium if the range of detected concentrations does not exceed the ecological screening levels to be developed for the medium, and it was not selected as a COPEC for any other medium.

The presence of COPCs for ecological receptors is unknown given that there are no existing chemical analytical data from previous investigations. A screening level ecological risk assessment (SLERA) will be developed based on the existing data and all subsequent data collected from the various MRS to determine the presence/absence of MC. Once any contamination is determined to be present, maximum detected concentrations will be compared to ecological screening values. Ecological risk-based soil screening values will be selected based on the hierarchy presented below.

Per EPA's guidance document, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments - Interim Final*, the maximum detected concentration of analytes in soils will be compared to the most conservative soil screening values for the screening-level ecological risk assessment (SLERA).

- EPA Ecological Soil Screening Levels (EcoSSL, EPA 2011) will be used preferentially over other sources of screening values. EPA has derived soil screening levels for many metals for various ecological trophic levels. The most conservative value available will be selected from the EcoSSLs to be protective of the most sensitive trophic level.

- If EPA EcoSSLs are not available, screening levels obtained from alternate sources will be used. Alternate screening levels will be selected from the following documents:

    - Preliminary Remediation Goals for Ecological Endpoints (Efroymson et al., 1997c)

    - Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision (Efroymson et al., 1997a)

    - Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision (Efroymson et al, 1997b), which includes benchmarks for wildlife, soil invertebrates and plants.

    - EPA Region IV Ecological Screening Levels (ESL) These can be found at http://www.epa.gov/region4/waste/ots/epatab4.pdf.

    - EPA Region V Resource Conservation and Recovery Act Ecological Screening Levels (ESL) (EPA 2003)

    - Los Alamos National Laboratory (LANL) Ecological Screening Levels (ESL) for Soil (LANL 2005). This may be the only source of screening values for many of the high explosives-associated organics that may have been used at the Former Camp Croft site.

- If multiple screening levels for a constituent are available from the alternate sources, the lowest (most conservative) screening level will be selected for comparison to site data.

A review of existing information as to the potential for sensitive habitats in the affected areas will be included. It is assumed that the ERA process will not continue beyond the SLERA. The principal guidance documents that will be used in conducting the ecological risk assessment include, but are not limited to: EM 200-1-4, Volume II Environmental Evaluation (USACE, 2010), Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (EPA, 1997), and SC DHEC guidance. If recommended by the PDT, a baseline risk assessment will be conducted.

2.4.2 Characterization of Habitats

Characterization of habitats is another component of the problem formulation and is presented in this work plan (see Section 2.3 above) to provide some ecological background on the site.

2.4.3 Identification of Ecological Receptors

A wide variety of terrestrial and semi-aquatic wildlife species are known or expected to occur in the Camp Croft area. Mammal species likely to live in the area include the fox, raccoon, skunk, cottontail rabbit, and whitetail deer. Several state-listed species of concern may be present in the vicinity of Camp Croft (see Table 22 of the RI/FS Work Plan).

Numerous other species of birds, reptiles and amphibians are known or expected to exist in the area.

The receptors of concern will include aquatic and semi-aquatic organisms that either live in the ponds, lakes or creeks, or use these water bodies for habitat or food. Terrestrial organisms are also receptors of concern because they may potential come into direct contact with contaminants in soil or may be indirectly exposed through food-chain uptake. For this assessment, ecological receptors may also include aquatic animals (non-specific fish, amphibian larvae, and aquatic invertebrates) if contaminants migrate to water bodies.

2.4.4 Identification of Exposure Pathways

A complete exposure pathway requires (1) a source of the chemical and mechanism of release of the chemical, (2) a transport or retention medium, (3) a point of exposure or contact with the chemical, and (4) an exposure route (e.g., ingestion, dermal contact) to the receptor. An exposure pathway is considered to be potentially complete if the ecological receptor can have contact with COPECs in a medium. Terrestrial organisms have direct contact with soil. Aquatic organisms have direct contact with surface water and sediment. The exposure pathways for terrestrial and semi-aquatic wildlife species include ingestion of surface water, ingestion of sediments, and ingestion of COPECs in food (plants, soil invertebrates, small mammals, fish, and aquatic invertebrates). Ingestion is considered to be the major exposure route for all of the wildlife species. Although dermal contact and inhalation of COPECs are possible, these exposure routes are considered minor relative to ingestion.

2.4.5 Selection of Assessment and Measurement Endpoints

Assessment endpoints for this ecological evaluation will be any adverse effects on ecological receptors, where receptors are plant and animal populations and communities, habitats, and sensitive environments. Adverse effects on populations can be inferred from measures related to impaired reproduction, growth, and survival. Adverse effects on communities can be inferred from changes in community structure and function. Adverse effects on habitats can be inferred from changes in composition and characteristics that reduce a habitat's ability to support plant and animal populations and communities.

Example Assessment and Measurement Endpoints:

- Assessment Endpoint 1: Protection of populations of terrestrial plants.
- Measurement Endpoint 1: Comparison of soil concentrations with soil benchmarks for the protection of plants.
- Assessment Endpoint 2: Protection of populations of soil invertebrates.
- Measurement Endpoint 2: Comparison of soil concentrations with soil benchmarks for the protection of soil invertebrates.
- Assessment Endpoint 3: Protection of populations of terrestrial herbivores.
- Measurement Endpoint 3: Comparison of estimated exposure dose for a terrestrial herbivore (mammal and bird) due to ingestion of soil and food, with a toxicity reference value.
- Assessment Endpoint 4: Protection of populations of terrestrial insectivores.
- Measurement Endpoint 4: Comparison of estimated exposure dose for a terrestrial insectivore (mammal and bird) due to ingestion of soil and food, with a toxicity reference value.

- Assessment Endpoint 5: Protection of populations of terrestrial carnivores.
- Measurement Endpoint 5: Comparison of estimated exposure dose for a terrestrial carnivore (mammal and bird) due to ingestion of soil and food, with a toxicity reference value.

2.5 Characterization of Exposure

For this ecological evaluation, the EPCs will be the maximum and mean concentrations detected in the medium. Exposures to COPECs will be quantified for each of the selected receptor species. The equations to estimate exposure doses are specific for the animals that are selected to be representative of each assessment endpoint (e.g. herbivores, insectivores or carnivores).

2.6 Characterization of Ecological Effects

In the ecological effects characterization, information on the toxicity of the COPECs to ecological receptors will be presented. Toxicity information will be used to develop toxicity reference values (TRVs) for selected indicator species or communities. TRVs represent no observed adverse effect levels (NOAELs) and lowest observed adverse effect levels (LOAELs) as media concentrations or doses. For some chemicals, the TRVs are true NOAELs, and for other chemicals, TRVs are developed as NOAELs using available toxicity information and extrapolation factors.

2.7 Ecological Risk Characterization

The ecological risk characterization will integrate information from the problem formulation and the exposure and ecological effects characterization to estimate the nature and extent of ecological risk or threat. The ecological risk characterization will be based on a weight-of-evidence approach, where multiple lines of evidence will be presented and evaluated. The potential risk posed to ecological receptors will be assessed by comparing estimated daily doses or media-specific concentrations with TRVs. This comparison, described as a hazard quotient (HQ), will be made for each chemical and is expressed as:

$HQ = C_{med} / Benchmark_{med}$

Where:

C_{med} = Concentration of a chemical in soil (for terrestrial organisms) surface water (for aquatic life) or sediment (for sediment-dwelling organisms or benthic invertebrates)

$Benchmark_{med}$ = Toxicity benchmark for soil (for terrestrial organisms) surface water (for aquatic life) or sediment (for sediment-dwelling organisms or benthic invertebrates)

or:

$HQ = Dose / TRV_{ing}$

Where:

Dose = Estimated daily dose for the representative receptor species for a chemical through a specific exposure route (i.e., soil, surface water, sediment, or food ingestion) (mg/kg/day)

TRV_{ing} = Toxicity Reference Value for the representative receptor species for the same chemical through the ingestion route (mg/kg/day)

If the calculated hazard quotient exceeds unity (i.e., >1), then it simply indicates the species of concern may be at risk to an adverse effect from that chemical through that exposure route. Because TRVs incorporate a number of extrapolation factors, if a TRV is exceeded (i.e., the hazard quotient exceeds unity), it does not necessarily indicate that an adverse effect will occur. Since different chemicals affect different target organs through various mechanisms, hazard quotients for different chemicals may not always be additive. Hazard indices will only be added across chemicals for those chemicals with similar toxic effect mechanisms.

2.8 References

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