Comprehensive Long-Term Environmental Action Navy (CLEAN) II
Contract No. N62742-94-D-0048
Contract Task Order No. 0072

Final Work Plan

Ordnance and Explosives Range Evaluation

IRP Site 1, Explosive Ordnance Disposal Range
Marine Corps Air Station, El Toro, California

Prepared for:

Department of the Navy
Commander, Southwest Division
Naval Facilities Engineering Command
San Diego, California 92132-5190

Prepared by:

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December 2001

DEPARTMENT OF THE NAVY
SOUTHWEST DIVISION
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5090
Ser 06CC.DG/1320
December 17, 2001

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Subject: FINAL WORK PLAN, ORDNANCE AND EXPLOSIVES RANGE EVALUATION, FOR IRP SITE 1, MARINE CORPS AIR STATION (MCAS) EL TORO

Dear Ms. Chesney:

Enclosed is the final version of the subject document. Changes are only administrative, as there were no public comments on Draft Final OE Range Evaluation Work Plan. Please contact either Mr. Gordon Brown at (619) 532-0791 or myself at (619) 532-0765 should you have any questions, or need additional information.

Sincerely,

DEAN GOULD
Base Realignment and Closure
Environmental Coordinator
By direction of the Commander

Enclosure: 1. Final Work Plan, Ordnance and Explosives Range Evaluation, for IRP Site 1, MCAS, El Toro

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DOCUMENT TRANSMITTAL

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Final Work Plan
Ordnance and Explosives Range Evaluation
Site 1-Explosive Ordnance Disposal Range
MCAS El Toro, California

Contract No. N62742-94-D-0048
Contract Task Order No. 0072

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ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
ASR	Archives Search Report
BCT	BRAC Cleanup Team
bgs	below ground surface
BIP	blow-in-place
BNI	Bechtel National, Inc.
BRAC	Base Realignment and Closure
CCBC	consolidate in controlled blast chamber
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CNDDB	California Natural Diversity Database
COSD	consolidate for offsite demolition
COTS	commercial off-the-shelf
CPR	cardiopulmonary resuscitation
CRWQCB	California Regional Water Quality Control Board
CSS	coastal sage scrub
CTO	Contract Task Order
CWM	chemical warfare material
CX	Center of Expertise
DHS	(California) Department of Health Services
DoD	Department of Defense
DoN	Department of the Navy
DoT	Department of Transportation
DTSC	Department of Toxic Substances Control
DQO	data quality objective
DRMO	Defense Reutilization Marketing Organization
Earth Tech	Earth Tech, Inc.
EM	electromagnetic
EOD	explosive ordnance disposal
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
FFA	Federal Facilities Agreement
FQCM	field quality control manager
FS	feasibility study
FS smoke	sulfur trioxide chlorosulfonic acid
GIS	Geographic Information System
GPS	global positioning system
HAZWOPER	Hazardous Waste and Operations and Emergency Response
HE	high explosive
HERO	hazards of electromagnetic radiation
HSP	health and safety plan
IC	institutional controls
IDW	investigation-derived waste
IRP	Installation Restoration Program
JATO	Jet-Assisted Take-Off

JEG	Jacobs Engineering Group
MCAS	Marine Corps Air Station
MCDA	move to a controlled demolition area
MCDA/EC	move to a controlled demolition area with engineering controls
mm	millimeter
MOU	Memorandum of Understanding
MSL	mean sea level
MSD	minimum separation distance
mV	millivolts
NA	no action
NAVFAC	Naval Facilities Engineering Command
NEESA	Naval Energy and Environmental Support Activity
NCP	National Contingency Plan
NCR	Nonconformance Report
NPL	National Priorities List
OE	ordnance and explosives
OESM	Ordnance and Explosives Safety Manager
OSHA	Occupational Safety and Health Administration
PACDIV	Pacific Division
PACNAVFACENGCOM	Pacific Division, Naval Facilities Engineering Command
PM	project manager
PPE	personal protective equipment
PRC	public resources code
PSO	project safety officer
PVC	polyvinyl chloride
O&M	operation and maintenance
QA	quality assurance
QCP	quality control plan
QC	quality control
QDN	Quality Deficiency Notices
RCRA	Resource Conservation and Recovery Act
RE	range evaluation
ROICC	resident officer in charge of construction
RI	remedial investigation
RPM	remedial project manager
R3M	Range Rule Risk Methodology
RTK	real-time kinematic
SARA	Superfund Amendments and Reauthorization Act
SOP	standard operating procedure
SOW	statement of work
SSO	site safety officer
SUXOS	Senior UXO Supervisor
SWDIV	Southwest Division, Naval Facilities Engineering Command
SWAT	solid waste assessment test
SUXOS	senior UXO supervisor
TBC	to be considered
TEM	transient or time-domain electromagnetic
THA	task hazard analysis
U.S.	United States
USACOE	United States Army Corps of Engineers
USAESCH	U.S. Army Engineering and Support Center, Huntsville

U.S.C	United States Code
USFWS	United States Fish and Wildlife Service
UXO	unexploded ordnance
UXOSM	UXO Safety Manager
VOC	volatile organic compound
WBS	work break-down structure

1. INTRODUCTION

This work plan details the objectives and procedures to conduct an ordnance and explosives (OE) Range Evaluation (RE) at Installation Restoration Program (IRP) Site 1, the Explosive Ordnance Disposal (EOD) Range, at the Marine Corps Air Station (MCAS), El Toro, California.

This work plan was prepared by Earth Tech, Inc. (Earth Tech) on behalf of the United States (U.S.) Department of the Navy (DoN), Southwest Division, Naval Facilities Engineering Command (SWDIV), as authorized by the U.S. Navy, Pacific Division, Naval Facilities Engineering Command (PACNAVFACENGCOM) under Contract Task Order (CTO) no. 0072 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) II program, contract no. N62742-94-D-0048.

The work plan complies with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) in Title 40 of the Code of Federal Regulations (CFR), Part 300, and the California Health and Safety Code, Section 6.8.

This work plan has been developed in accordance with the Department of Defense's (DoD) Interim *Range Rule Risk Methodology (R3M) Interim Procedures Manual* (DoD 2000), which is a process to effectively manage risks posed by unexploded ordnance (UXO) and other constituents often found on former military ranges (DoD 2000). The R3M process consists of the following seven steps: (1) range identification, (2) range assessment, (3) range evaluation, (4) response selection, (5) site-specific action, (6) recurring review, and (7) closeout.

A range identification and a preliminary range assessment was conducted by the U.S. Army Corps of Engineers (USACOE) for MCAS El Toro, including Site 1 (USACOE 1998). This work plan has been developed to conduct a more detailed study to further evaluate the explosives hazards based on the review of this identification and preliminary assessment and available records for Site 1.

This document was made available for public review and comment between November 3 and December 3, 2001. No comments were received.

1.1 KEY DEFINITIONS

This section presents definitions that are used throughout this work plan. The source of each definition is indicated in parentheses. Some definitions originate from the *R3M Interim Procedures Manual* (DoD 2000), which outlines procedures to assess and develop response actions at closed, transferred, and transferring ranges. Several of the definitions contained in the R3M manual originate from the U.S. Environmental Protection Agency's (EPA's) *Munitions Rule* (EPA 1997b). EPA's Munitions Rule was developed to identify when conventional and chemical military munitions become hazardous waste under RCRA, and to provide for protective storage and transportation of that waste. Other definitions originate from the USACOE's *Ordnance and Explosives Response Engineer Manual* (USACOE 2000), which provides personnel with procedures to be used to perform engineering and design activities for all phases of OE response actions.

Buffer Zone *(R3M)*-The area on a range extending beyond an impact area to provide a safety zone to contain ricochets, blast, and fragmentation from exploding ordnance.

Explosive Soil *(OE Response Manual)*–Explosive soil refers to mixtures of explosives in soil, sand, clay, or other solid media at concentrations such that the mixture itself is explosive. Soil containing 10 percent or more by weight of any secondary explosive or mixture of secondary explosives is considered "explosive soil." Explosive soil is considered to be OE.

Impact Area *(R3M)*-The area on a range within the limits of which all ordnance is intended to impact and/or detonate. An impact area includes the area containing the target plus the immediate area around the target, to contain rounds that miss the target.

Intrusive Activity *(OE Response Manual)*–An intrusive activity is one that involves or results in the penetration of the ground surface at an area known or suspected to contain OE. Intrusive activities can be of an investigative or removal action nature.

Military Munitions *(R3M/Munitions Rule)*–All ammunition products and components produced or used by or for the U.S. DoD or the U.S. Armed Services for national defense and security, including military munitions under the control of the DoD, the U.S. Coast Guard, the U.S. Department of Energy (DoE), and National Guard personnel. The term military munitions includes: confined gaseous, liquid, and solid propellants, explosives, pyrotechnics, chemical and riot control agents, smokes and incendiaries used by DoD components, including bulk explosives and chemical warfare agents, chemical munitions, rockets, guided and ballistic missiles, bombs, warheads, mortar rounds, artillery ammunition, small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges, and devices and components thereof. Military munitions do not include wholly inert items, improvised explosive devices, and nuclear weapons, nuclear devices, and nuclear components thereof. However, the term does include non-nuclear components of nuclear devices, managed under DOE's nuclear weapons program, after all required sanitation operations under the Atomic Energy Act of 1954, as amended, have been completed.

OE *(OE Response Manual)*-OE consists of ammunition, ammunition components, chemical or biological warfare material or explosives that have been abandoned, expelled from demolition pits or burning pads, lost, discarded, buried, or fired. Such ammunition, ammunition components, and explosives are no longer under accountable record control of any DoD organization or activity. Explosive soil (see definition above) is also considered to be OE.

OE Scrap *(site-specific definition)*-Objects that originated from OE but do not have any ordnance or explosive residual.

Range *(R3M/Munitions Rule)*-Any land mass or water body that is or was used for the conduct of training, research, development, testing, or evaluation of military munitions or explosives.

R3M *(R3M)*-A process developed by representatives from the DoD, EPA, state, and tribal regulatory authorities to effectively manage risks posed by UXO and other constituents found on former military ranges.

Safe-to-Move OE *(site-specific definition)*-OE that has been determined to be safe to move.

Unsafe-to-Move OE *(site-specific definition)*-OE that has been determined to be unsafe to move.

UXO *(R3M/Munitions Rule)*-Military munitions that have been primed, fused, armed, or otherwise prepared for action, and have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installation, personnel, or material and remain unexploded either by malfunction, design, or any other cause (for the purposes of this investigation, UXO will be referred to as unsafe-to-move OE).

1.2 PURPOSE AND SCOPE OF THE WORK PLAN

The purpose of this work plan is to characterize explosives safety risk at Site 1 due to remnant OE items originating from past EOD training so that response actions consistent with the anticipated reuse can be evaluated.

The scope of this investigation is to conduct a site characterization for OE items to complete the evaluation of the range (step 3 of the R3M process). The OE items encountered during this investigation will be considered as investigation-derived waste (IDW) and evaluated as to whether they are safe or unsafe to move. An evaluation of handling alternatives for both safe- and unsafe-to-move OE and consequent selection of an alternative is also presented. This work plan will be made available for public comment for at least 30 days. Responses to comments will be provided prior to implementation of field activities.

Procedures to perform fieldwork to delineate the lateral extent of "kick-outs" (live munitions that are not destroyed) due to demolition during EOD training and identification of the types and density of OE residuals that may be present are presented. Procedures to handle an OE item that is determined to be unsafe to move are also provided. These procedures will also be followed to provide OE safety and clearance support for the Phase II remedial investigation (RI) that will be conducted (Earth Tech 2000a).

1.3 MCAS EL TORO-DESCRIPTION AND BACKGROUND

MCAS El Toro is located in a semi-urban, agricultural area of southern California, approximately 8 miles south of Santa Ana and 12 miles northeast of Laguna Beach (Figure 1-1). MCAS El Toro covers approximately 4,740 acres. Land use around the MCAS includes commercial, light industrial, and residential. MCAS El Toro closed on 2 July 1999, as part of the Base Realignment and Closure (BRAC) Act.

Initial work conducted by the Department of the Navy (DoN) at MCAS El Toro included an *Initial Assessment Study* during 1985 (NEESA 1986).

MCAS El Toro was added to the National Priorities List (NPL) of the Superfund Program on 15 February 1990 due to volatile organic compounds (VOCs) contamination at the MCAS boundary and in the agricultural wells west of the MCAS. A Federal Facilities Agreement (FFA) was signed by the Marine Corps/DoN in October 1990 with the EPA Region 9, California Department of Health Services (DHS) (part of which is currently the Department of Toxic Substances Control [DTSC]), and the California Regional Water Quality Control Board, Santa Ana Region (CRWQCB).

In March 1993, MCAS El Toro was placed on the list of military facilities scheduled for closure under the BRAC Act. A BRAC Cleanup Team (BCT) including representatives from SWDIV, EPA, DTSC, and CRWQCB was formed to oversee implementation of the FFA.

Implementation of the FFA at MCAS El Toro included the following investigations and studies: Air Quality Solid Waste Assessment Test (Air SWAT), Phase I RI, Phase II RI, and a feasibility study (FS). Groundwater sampling is conducted station-wide on a routine basis by the Navy.

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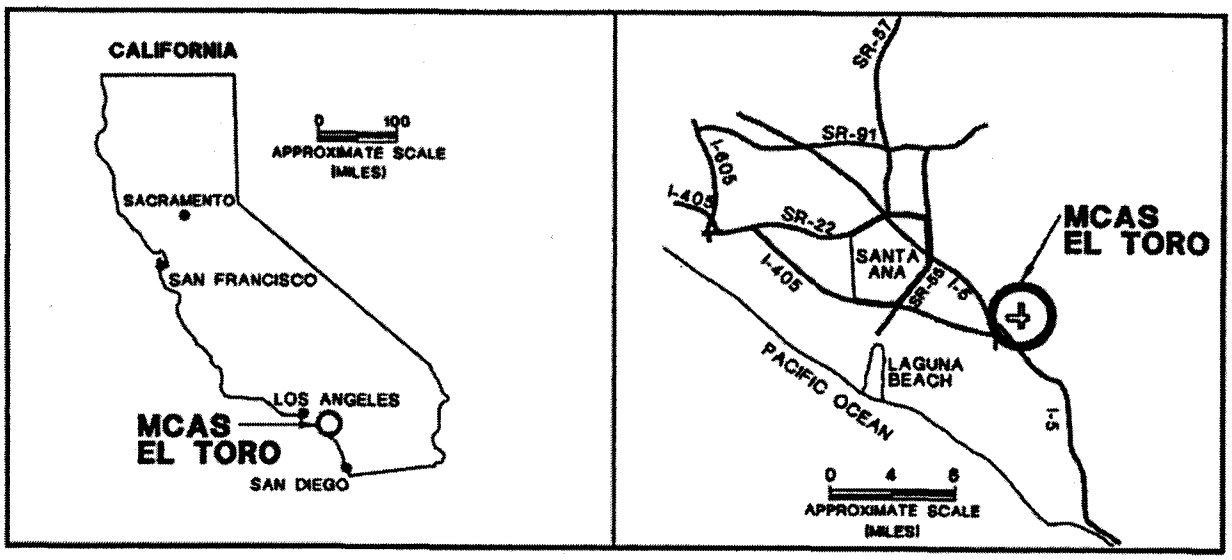
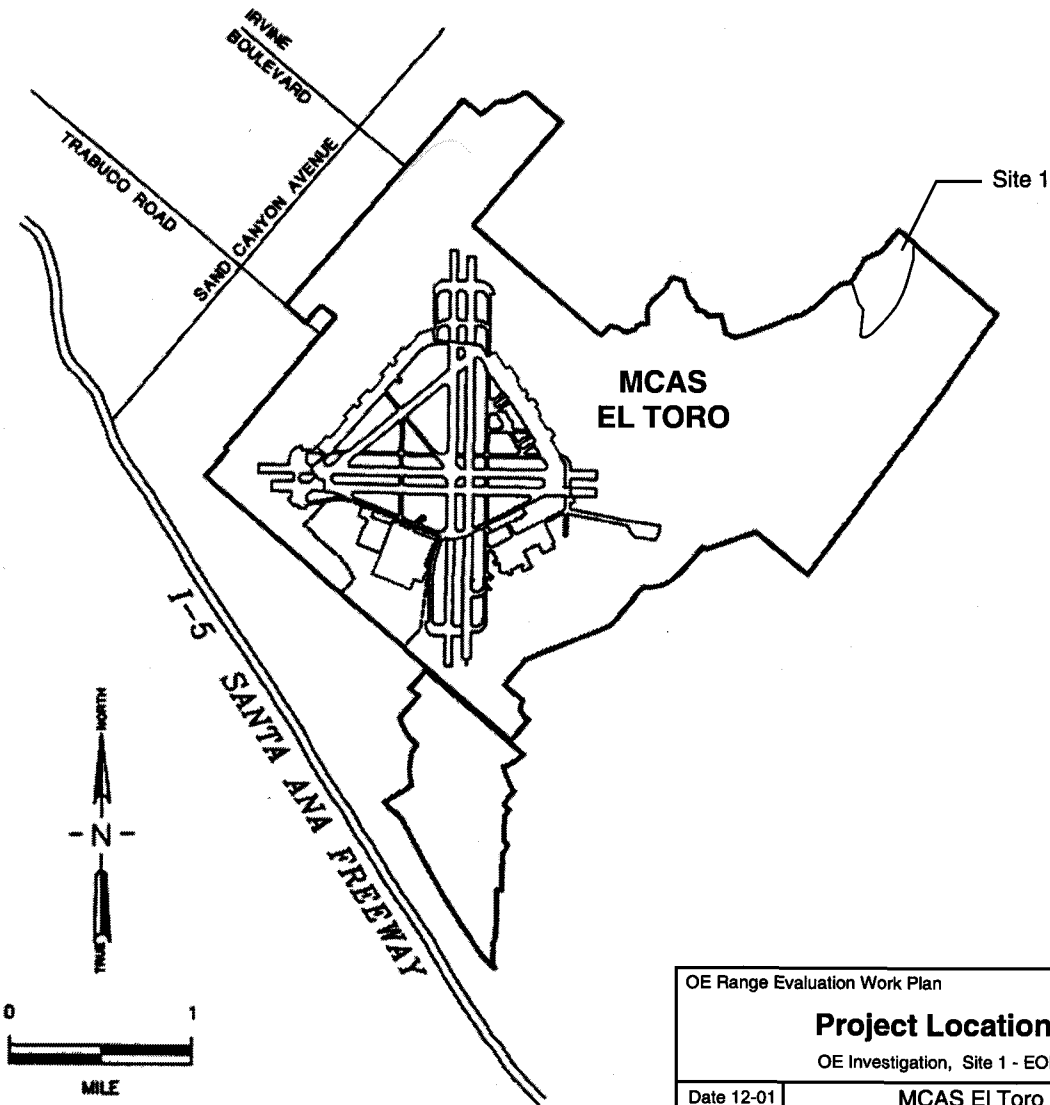




OE Range Evaluation Work Plan		Final
Project Location Map OE Investigation, Site 1 - EOD Range		
Date 12-01	MCAS El Toro	Figure 1-1
Project No. 36097	EARTH TECH A TYCO INTERNATIONAL LTD. COMPANY	

36097.00.22.02

2. SITE BACKGROUND AND SETTING

2.1 LOCATION

Site 1 is located in the northeast portion of MCAS El Toro in the foothills of the Santa Ana Mountains (see Figure 2-1). Site 1 is situated within a tributary canyon of Borrego Canyon Wash at elevations ranging from approximately 610 feet to 760 feet above mean sea level (MSL). Site 1 includes the Northern EOD Training Range (approximately 737,250 square feet [16.9 acres]), the Southern EOD Training Range (approximately 721,600 square feet [16.6 acres]), and an approximately 40-acre buffer zone, for a total of 73.7 acres (BNI 1995a).

A bermed retention pond is present in the northern portion of the site. Seasonal accumulations of rainwater have been observed in the retention pond during high precipitation events. The site has been characterized by fairly rapid groundwater recharge in response to storm events (JEG 1993).

2.2 EOD ACTIVITIES

Training for EOD and demolition of munitions has been conducted at Site 1 since 1952 (BNI 1995a). Use of the EOD Range has been discontinued with the closure of MCAS El Toro on 2 July 1999.

The majority of recent military EOD training took place at the Northern EOD Range, and EOD training by the Orange County Sheriff Department and federal agencies took place at the Southern EOD Range (BNI 1995a). Several demolition pits, a range building, and a former observation bunker constructed from metal ammunition cans were reported to be present. Many of these metal cans were reported to be filled with the burned residue of used munitions, such as cartridge-actuated devices and 20 millimeter (mm) ammunition (USACOE 1998).

Military ordnance used at the site includes hand grenades, land mines, cluster bombs, smoke bombs, and rocket warheads. Civilian and commercial explosives, such as dynamite, and plastic and gelatinous explosives have been used at the EOD Range. Munitions were detonated in trenches and pits, which were continually filled with soil and then reexcavated. In 1982, approximately 2,000 gallons of sulfur trioxide chlorosulfonic acid (FS smoke) were reportedly burned in trenches located in the northern portion of the site. An estimated 300,000 gallons of petroleum fuels were burned during disposal from 1952 through 1993 (JEG 1993). Perchlorate was identified as a potential contaminant of concern at Site 1, due to its use in explosives and propellants.

In addition, there are unconfirmed reports that low-level radioactive material was disposed at the site (NEESA 1986).

For many years, the FBI has used Site 1 for training purposes (FBI 2000). The EOD Range at Site 1 is a very important training asset for the FBI and its Laboratory Division. At no time during any of the EOD practices were materials discarded or disposed. Every reasonable effort was made to collect and preserve all explosives evidence during the FBI's training and emergency response operations.

The following paragraphs summarize the FBI's training and emergency response operations.

Bomb Technician Training. Bomb technician training consisted of "hands on" explosive training one day per month. Bomb technicians demonstrate proficiency in firing both an electrical and nonelectrical charge. This training also included testing of new explosive products to determine their applicability to EOD operations. Generally, this involved only a few ounces of the material, and demolition was initiated off the ground on a hard target surface.

Post-Blast Investigation Training. Post-blast investigation training was held about four times per year and emphasizes the identification, location, access, and recovery of explosive devices and any products surviving demolition. Various devices were detonated, and students secure and locate, collect, and identify the fragmentation and components from the devices for the purpose of reconstructing the devices.

Emergency Response Operations. The EOD Range at Site 1 served as a technical training area for the use and study of emergency explosive device responses. However, during emergency response operations, the FBI periodically transported improvised explosive devices to Site 1 and rendered them safe either by disassembly or by counter-charges. These types of operations occur intermittently, when devices were located by the FBI or by local law enforcement.

2.3 SUMMARY OF RANGE IDENTIFICATION AND ASSESSMENT

The EPA's identification of military munitions (on closed, transferring, or transferred ranges) as solid waste was postponed pursuant to the development of the "range rule" by the DoD. Consequently, to meet requirements of the DoD's proposed range rule, the U.S. Marine Corps contracted with the USACOE to prepare an Archives Search Report (ASR) and Range Identification and Preliminary Range Assessment Report to facilitate development of a comprehensive range inventory on Marine Corps installations. The USACOE coordinates with the U.S. Army Engineering and Support Center, Huntsville (USAESCH), which serves as the Center of Expertise (CX) and Design Center for OE.

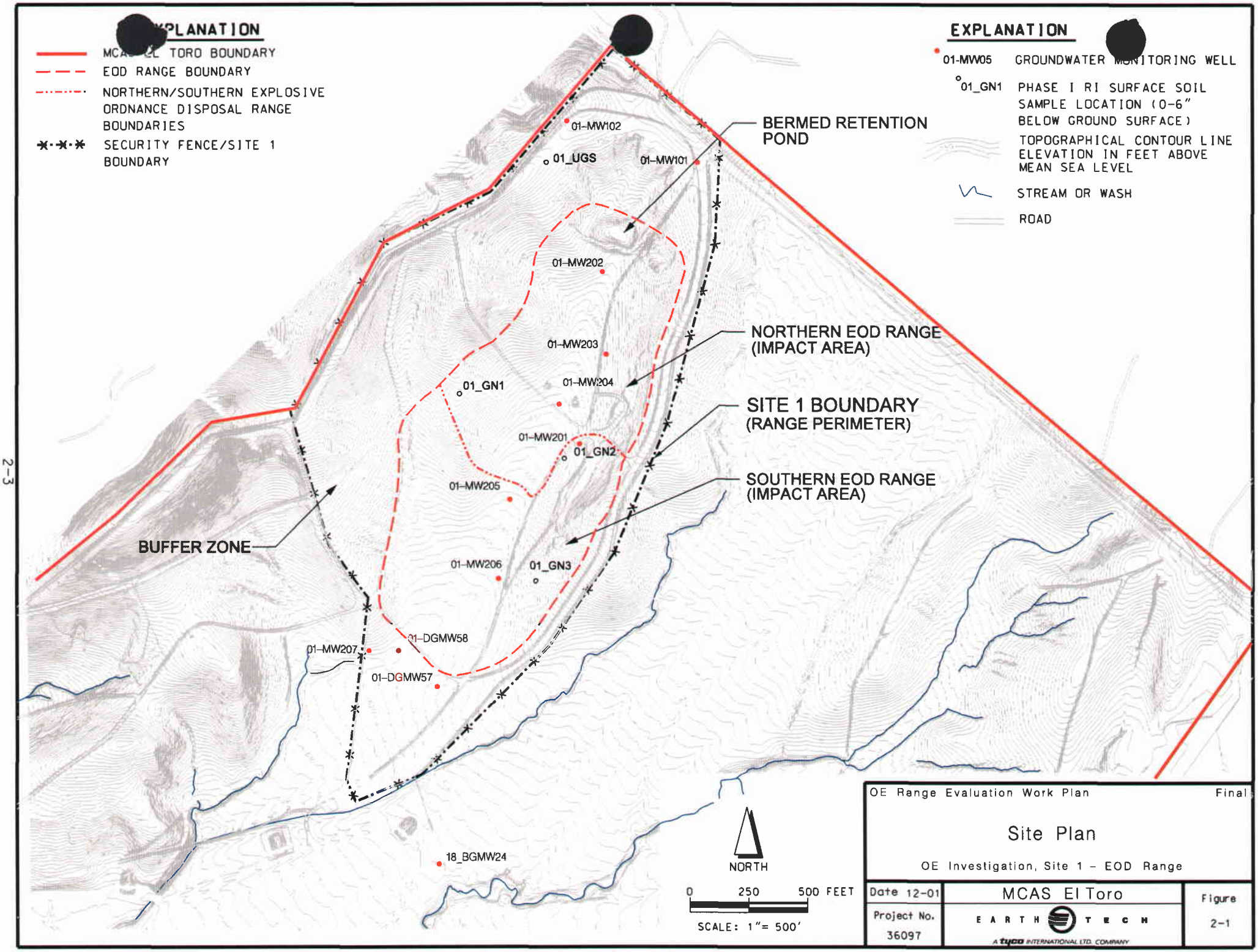
The *Range Identification and Preliminary Range Assessment* report (USACOE 1998) for MCAS El Toro includes Site 1, along with five other ranges located within the station. Table 2-1 lists the items that correspond to the munitions employed during training for the destruction of unserviceable items.

Table 2-1: Preliminary Range Assessment

Types of Munitions Employed	Quantities Used in 1976
Charge, Demolition: Block M112 (1¼-lbs Composition C-4), (M023)	317.5 lbs
Charge, Demolition: Block M5 and M5A1 (2½-lbs Composition C-4), (M038)	250 lbs
Charge, Demolition: Block (¼, ½, and 1 lb) TNT, (M030, M031, M032)	24.5 lbs
Fuse, Blasting, Time (Safety Fuse), (M670)	40 feet
Cord, Detonating, (M456)	1,660 feet
Igniter, Time Blasting Fuse: M60, weatherproof, (M766)	16
Cap, Blasting: electric, M6 (M130)	318
Cap, Blasting: non-electric, M7 (M131)	8
Grenade, Hand, Incendiary, TH-3, AN-M14 (G900)	20

The assessment also identified (by military grid and latitude and longitude) the locations within Site 1 where munitions were known to have been used. These locations were characterized as demolition pits and burning grounds. Additionally, the locations of an observation bunker and the area where propellant was burned were also identified.

The UXO (unsafe-to-move OE) density was estimated to be low, which is less than 1 per acre. The assessment indicated that there is a possibility of kick-outs caused by ejection from the demolition area. However, it was concluded that it was unlikely due to the periodic tilling of the range grounds.



OE Range Evaluation Work Plan — Final

Site Plan

OE Investigation, Site 1 – EOD Range

Date 12-01	MCAS El Toro	Figure 2-1
Project No. 36097	EARTH TECH, A tyco INTERNATIONAL LTD. COMPANY	

L:\REMEDIATION\NAVCLEAN\CTO-72\SITE 1 UXO EVALUATION\WORKPLAN\FINAL\FIGURES\FIGURE2-1.DGN

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The range area was reported to be plowed twice a year. The depth of munitions was estimated to be 18 inches or less.

The assessment reported that there are significant hazards associated with many of the munitions used at the range, especially those in a dud-fired or armed condition. However, it concluded that since the purpose of the range was to conduct training in destruction of these dangerous munitions, the likelihood of encountering intact munitions is remote.

2.4 MUNITIONS USED

A comprehensive inventory of every type of munition used in training at the EOD Range could not be developed. However, the following items comprise most of the munition types used:

- 20mm projectiles,
- 37mm projectiles,
- 40mm projectiles,
- 2.75-inch rocket warheads/motors,
- 3-inch projectile,
- 5-inch rocket warheads/motors,
- MK 45 flares,
- BDU 33s,
- 100-lb practice bombs,
- 750-lb practice bomb,
- JATO (Jet-Assisted Take-Off) bottles,
- SA 8 USSR rocket motor,
- Terrier rocket motor,
- Carts, cads, and seat rocket motors (used in base aircraft).

The smallest munition type used at Site 1 is the 20mm projectile (used for target practice, not high explosive).

2.5 CLOSE-OUT INSPECTION

A close-out inspection was conducted at MCAS El Toro on 24 February 1999 (DoN 1999) to inspect those potential explosion sites whose use was terminated as a result of the operational closure of MCAS El Toro. The EOD Range (Site 1) and all magazines and structures located in the El Toro Main Magazine Complex were inspected during this visit. The DoN conducted a thorough inspection of each location. No visible signs of any explosives, ammunition, or explosive residue were found at any of the locations inspected (including Site 1). No additional close-out work was recommended for Site 1, over and above that which is required by CERCLA.

2.6 ENVIRONMENTAL SETTING

2.6.1 Site Topography

Areas to be investigated occupy rolling terrain with significant topographic relief on three sides of the project area.

2.6.2 Geology

Subsurface lithology at Site 1 consists of unconsolidated sand, silt, and clay overlying sandstone and siltstone bedrock. The thickness of the unconsolidated sand, silt, and clay increases toward the southwest. Depth to bedrock is approximately 5 feet at 01_MW101 and 01_MW102, 17 feet at 01_MW201, 20 feet at 01_DGMW58, and 70 feet at 01_DGMW57. Site 1 is surrounded by ridges of sandstone bedrock, except for the southern boundary where the drainage converges with a tributary of Borrego Canyon Wash.

2.6.3 Biological Resources and Ecosystems

Animal and plant species that are known or have the potential to occupy habitat at MCAS El Toro were identified based on field reconnaissance surveys, California Natural Diversity Database (CNDDB) searches, U.S. Fish and Wildlife Service (USFWS) surveys and a Conservation Area Management Plan that was developed for a portion of MCAS El Toro (BNI 1995b).

The preliminary results of a habitat assessment conducted at Site 1 on 20 December 2000 were used to characterize the habitat and identify potential species, including any considered sensitive.

The dominant vegetation types at Site 1 consist of non-native grassland, coastal sage scrub (CSS), and toyon-sumac chaparral. Disturbed wetland occurs in the bottom of the bermed retention pond. There are approximately 0.29 acres of disturbed wetland at Site 1.

Previous dry and wet sampling that was conducted during 1996 in the bermed retention pond revealed the presence of the Riverside fairy shrimp (*Streptocephalus woottoni*), which is a federally threatened species (KEA 1998). The presence of this species confers a high degree of sensitivity on this pond and its watershed.

During December 2000, four coastal California gnatcatchers (*Polioptila californica californica*) which is a federally threatened species were documented onsite. They consisted of one pair and two separate individuals of unknown gender. Three individual cactus wren (*Campylorhynchus brunneicapillus*) were identified in a cactus patch within CSS in the northwestern quadrant of the site. This bird is also a federally regionally sensitive species. One non-vocalizing grasshopper sparrow (*Ammodramus savannarum*) was identified in non-native grassland in the north-central portion of the site. Two southern California rufous-crowned sparrows (*Aimophila ruficeps canescens*) were identified in CSS in the north-central portion of the site (federally regionally sensitive). Evidence (scat or feces) of the San Diego black-tailed jackrabbit (*Lepus californicus bennettii*) was found in non-native grassland in the western portion of site between two patches of CSS.

3. WORK PLAN APPROACH

3.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED CRITERIA

Remedial investigations must comply with CERCLA, as amended by SARA and the NCP (40 CFR Part 300). CERCLA requires cleanup response actions to protect human health and the environment, to be cost-effective, and to comply with the applicable or relevant and appropriate requirements (ARARs), and to-be-considered (TBC) criteria.

ARARs and TBCs governing actions at CERCLA sites fall into three categories, depending on the chemical contaminants, site characteristics, location, and proposed cleanup action:

- *Chemical-specific* ARARs and TBCs establish numerical standards limiting the concentration of substances in the medium of concern or medium affected by a cleanup action.
- *Location-specific* ARARs and TBCs refer to restrictions placed on the concentration of substances or conduct of a cleanup action due to site location.
- *Action-specific* ARARs and TBCs deal with technology- or activity-based restrictions controlling the performance and design standards of a specific cleanup action.

ARARs. Requirements may be either *applicable* or *relevant and appropriate*. Applicable requirements are federal, state, and local standards that regulate sampling, cleanup at the site. Applicable requirements meet all legal prerequisites and are site-specific. ARARs are identified based on the following considerations:

- The regulatory authority and the statute or regulation,
- The types of tasks the statute or regulation requires, directs, or prohibits,
- The types of substances or tasks falling under the authority of the requirement, and
- The period during which the statute or regulation is in effect.

When requirements do not apply directly to a site or task, they may still be relevant and appropriate if they pertain to problems resembling those at the site. Such requirements are identified by comparing the circumstances at the site with the requirements of a particular jurisdiction. It is possible for only a part of a requirement to be relevant and appropriate. Relevant and appropriate requirements are identified with some discretion based on the following considerations:

- Type of cleanup action,
- Contaminants present,
- Waste characteristics, and
- Physical characteristics of the site.

TBCs. TBCs are advisory, not mandatory, and their application is subject to discretion. TBCs are used when no requirements apply to the particular situation or circumstance. They may also be used to set standards when ARARs do not adequately protect human health or the environment. TBCs may become compliance standards for a proposed cleanup remedy.

Table 3-1 identifies the chemical-, location-, and section-specific ARARs and TBCs for IRP Site 1-EOD Range and defines them by the type to be evaluated.

Table 3-1: Potential Applicable or Relevant and Appropriate Requirements (ARARs)

ARAR/TBC[a]	Citation	Requirement or Description
	Chemical–Specific	
	Federal	
RCRA – Subpart M (Military Munitions Rule)	40 CFR Part 261.23	Identifies solid waste subject to regulation as hazardous; waste considered hazardous versus explosive would be handled as such.
OE Characterization	USACOE EM 1110-1-4009	Adopts criterion of 10 percent explosive content as a definition of explosive waste.
	State	
Hazardous Waste Control	Health and Safety Code, Division 20, CCR Title 22	Provides classification of hazardous waste. Regulates generators, transporters, and treatment, storage, and disposal facilities.
	Location-Specific	
	Federal	
Endangered Species Act	16 U.S.C. Sections 1531–1543	Prohibits actions from jeopardizing the continued existence of protected species or modifying critical habitat. Responsible agencies include the USACOE and USFWS.
	State	
California ESA	Fish and Game Code, Division 3	Requires state agencies to consult if impact to listed species could occur.
California Water Code	PRC Division 20	Identifies water quality policy, planning, and protection in California.
	Action-Specific	
	Federal	
Fish and Wildlife Coordination Act	16 U.S.C. Section 661, et seq.	If activities involve stream or river modification or affect fish or wildlife, actions must be taken to protect fish or wildlife from harm. The USACOE and USFWS are the responsible agencies.
Migratory Bird Treaty Act	16 U.S.C. Section 703, et seq. 50 CFR Parts 10, 16, 20, 21	Prohibits the taking, possession, buying, selling, or barter of any migratory bird listed, including feathers or other parts, nest eggs, or products, except as allowed by regulations. The USFWS is the responsible agency.
OSHA	29 CFR Part 1910.120	Defines worker protection requirements for personnel involved in hazardous waste and emergency response actions
Transportation of Hazardous Waste	49 CFR Parts 100–199	Considers OE as "hazardous material" for manifesting purposes under U.S. DoT regulations
Public Affairs	40 CFR Part 300	Public affairs coordination must be conducted in accordance with directives for CERCLA response actions.
Detection Technology	EP 110-1-16 (draft)	Provides guidance for selecting appropriate technology based on physical properties of ordnance and site conditions.

Table 3-1: Potential Applicable or Relevant and Appropriate Requirements (ARARs)

ARAR/TBC[a]	Citation	Requirement or Description
Safety Practices and Disposal	DoD 6055.9-STD	Requires specialized personnel in the detection, removal, and disposal of OE; stipulates required safety precautions and procedures for demolition.
	State	
Transportation	Title 22, CCR, Division 4.5, Section 66263	Regulates transport of hazardous substances in California.
Treatment of OE	Title 22, CCR, Section 66264.600, Article 16	Regulates treatment of OE.
Waste Management	PRC, Division 30	Regulates waste management practices in California.

Notes:

[a] Statutes and policies and their citations, if referenced, are provided to identify general categories of potential ARARs. The listings do not indicate that the Navy accepts entire statutes or policies as potential ARARs. Specific ARARs will be identified during the course of the investigation, in consultation with the BCT, and presented with the substantive requirements of the identified citations.

ARAR = applicable or relevant and appropriate requirement
BCT = BRAC Cleanup Team
CCR = California Code of Regulations
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
DoD = Department of Defense
DoT = Department of Transportation
EPA = U.S. Environmental Protection Agency
ESA = Endangered Species Act
OE = ordnance and explosives
OSHA = Occupational Safety and Health Administration
PRC = public resources code
RCRA = Resource Conservation and Recovery Act
RE = range evaluation
USACE = U.S. Army Corps of Engineers
USFWS = U.S. Fish and Wildlife Service
U.S.C. = U.S. Code

3.2 DATA QUALITY OBJECTIVES

3.2.1 Problem Statement

Background. Site 1 is an inactive range. The impact area within Site 1 was demarcated as the Northern and Southern EOD Ranges (Figure 2-1), and is located in a valley area at the central portion of the site. EOD training, which took place in the ranges, involved the demolition of munitions. The EOD training also used ordnance recovered during incident response. Site 1 has been inactive since MCAS El Toro was closed on 2 July 1999.

The byproducts or remnants of the training (OE items) may pose a risk to human health and/or the environment. The risk, if present, would be due to exposure to OE items or exposure to the chemical constituents of the explosives. This investigation addresses explosive safety hazard that is posed by the potential presence of OE. These items may include undetonated or unburned material in the pits or detonation (impact) areas as well as kick-outs. This work plan addresses the explosive safety risk evaluation only. The risk posed by chemical contamination of soil or groundwater is being assessed separately in accordance with the *Phase II RI Work Plan* (Earth Tech 2001a).

The Southern EOD Range was used by law enforcement agencies such as the FBI and the Orange County Sheriff's Department, for training activities. The anticipated reuse option for Site 1 is for similar use upon transfer to the FBI.

Statement. The explosives safety risk due to OE items from past EOD training needs to be characterized to evaluate response actions that are consistent with the anticipated reuse.

Upon transfer of Site 1, the FBI plans to use the property for purposes similar in nature to the past use for EOD training. Access to the majority of the property (all of Site 1 except a 3.3-acre portion designated for immediate use) will be prohibited and a new fence and security gate will be installed directly north of the 3.3-acre area. After the completion of the CERCLA process, the DoN will allow access and use of the entire 73.7-acre property by the FBI.

Various environmental documents were evaluated in the *Federal Agency-to-Agency Property Transfer Environmental Summary Document* (Earth Tech 2001c) to identify environmental factors that may warrant constraints in order to assure that the intended use of Site 1 is consistent with the protection of human health and the environment. The following require notifications:

- Presence of California gnatcatcher and Riverside fairy shrimp (federally threatened species) within the site;
- Bunker constructed of ammunition boxes filled with soil that may contain detonation residue;
- Possible asbestos-containing materials (located within a block concrete building that served as the range operation building, primarily used for administrative purposes);
- Perchlorate in groundwater;
- OE (including unsafe-to-move OE) buried in the subsurface and associated chemical contamination.

A Memorandum of Understanding (MOU) has been made by and between the DoN, acting by and through the Commander, Marine Corps Air Bases, Western Area and the Commander, Southwest Division, Naval Facilities Engineering Command (NAVFAC), and the DoJ, acting by and through the Director in Charge, FBI, Los Angeles. The obligations required by and restrictions placed on the FBI for the transfer of Site 1 from the DoN is stated in Section C of the agreement contained in the MOU. A copy of the draft MOU is included in Appendix B of the *Federal Agency-to-Agency Property Transfer Environmental Summary Document* (Earth Tech 2001c).

3.2.2 Project Decisions

Study Question: Does the site pose an unacceptable risk to human health or the environment? Is a remedial response consistent with CERCLA and the Navy's IRP/BRAC process required?

To resolve the principal study question, the following decision questions will be considered:

1. Does additional data need to be collected to characterize explosives risk and determine if response actions are required?
2. Have the extent of kick-outs been adequately evaluated, and are associated OE items present?
3. Are any OE items unsafe to move and, if so, do they require removal?

3.2.3 Decision Inputs

Elements required to estimate explosives safety risk include

1. Accessibility assessment

- Depth below surface
- Migration/erosion
- Intrusion level of activity

2. Overall hazard assessment
   - OE hazard type
   - Fusing
   - Amount of energetic material
3. Exposure Assessment
   - Frequency of entry
   - OE density
   - Intensity of activity
   - Portability

Previous geophysical surveys were completed using transient electromagnetic (TEM) metal detectors (Geonics, Ltd., EM61 High Sensitivity Metal Detector). During these surveys, numerous anomalous areas were identified that may be indicative of the presence of pits/trenches containing multiple metallic sources. A threshold of 50 millivolts (mV), as measured by the TEM metal detectors, was chosen as the initial demarcation of the boundaries of these anomalous areas, as opposed to outliers that may be representative of individual OE or OE scrap sources (kick-outs). All work will be in accordance with the Standard Operating Procedures (SOPs) detailed in Appendix A, Transient Electromagnetic Geophysical Investigation.

3.2.4 Study Boundaries

The physical boundaries are presented on Figure 2-1.

The investigation will address the current condition of the site, assuming any changes to the characterization will be the result of reuse.

Objects. OE items, including kick-outs, are the objects of interest to determine the explosive safety risk. Military ordnance detonated at the site includes hand grenades, land mines, cluster bombs, smoke bombs, and rocket warheads. The investigation will be designed to address these items.

Media. While surface and subsurface soil are the environmental media of concern, this investigation does not address contamination by residual chemicals. The investigation is solely focussed to determine the explosives safety.

Receptors. Site 1 is secured by a fence and a locked gate. Access is for authorized personnel only. There is no current land use since EOD training ceased in July 1999. Receptors to contamination by residual chemicals are addressed in the *Phase II RI Work Plan* (Earth Tech 2001a)

3.2.4.1 Temporal

Events or time-based activities that could affect the field sampling plan and schedule include:

Interactions between and overlapping of investigation activities for other constituents and explosives safety concerns will occur. The Phase II RI requires a three-tiered approach as described in the *Phase*

II RI Work Plan (Earth Tech, 2001a). Tiers 1 and 3 involve point sampling by advancing direct pushes and soil borings. Tier 2 involves sampling by trenching and potholing in areas of contamination identified during Tier 1 and at geophysical anomaly locations. Intrusive investigation activities at geophysical anomaly areas to characterize explosives safety risk will also provide soil samples (to assess chemical contamination impact) for the Phase II RI Tier 2 effort.

The study is intended to characterize the explosives risk due to EOD training that was conducted at Site 1 between 1952 and 1999.

3.2.4.2 SPATIAL (SECTORS)

The EOD Range at Site 1 was considered as one stratum or study area during the Phase I RI. The *Final Phase II RI/FS Work Plan* (BNI 1995a) divided the EOD Range at Site 1 into two units or study areas, and identified them as the Northern EOD Range and the Southern EOD Range (Figure 2-1). The combined areas of the two units have the same boundary as stratum 1 of the Phase I RI. This demarcation was made following MCAS El Toro employee interviews by the BCT team during May 1994 (BNI 1995a), which indicated that the majority of the recent military training exercises took place in the northern range and ordnance training by the Orange County Sheriff's Department and federal agencies took place at the southern range.

For characterizing OE, Site 1 is divided into the following sectors based on the equal likelihood of OE deposition:

Northern EOD Range. The geophysical survey of this range showed numerous anomalies greater than 50 mV. These anomalies seem to indicate alignments of trenches/pits where detonation of munitions was likely conducted. Intrusive investigation of selected anomalies will be conducted in accordance with the sampling design. The area of this range totals 16.9 acres.

Southern EOD Range. The geophysical survey of this range showed only one area where anomalies greater than 50 mV were present. Intrusive investigation of these anomalies will be conducted in accordance with the sampling design. The area of this range totals 16.6 acres.

Buffer Zone. The area surrounding the impact area (northern and southern ranges) served as the buffer zone for the EOD training. Representative surface sweep surveys followed by geophysical surveys, if required, will be conducted to evaluate kick-outs. Anomaly areas, if located, will be investigated intrusively in accordance with the sampling design.

Range Perimeter. The security fence enclosing Site 1 served as the range perimeter boundary. Representative surface sweep surveys followed by geophysical surveys, if required, will be conducted to evaluate kick-outs. Anomaly areas, if located, will be investigated intrusively in accordance with the sampling design.

3.2.4.3 ECOLOGICAL

Preliminary results of the habitat assessment indicate that the California gnatcatcher, which is a federally threatened species, is present at Site 1. Biological monitoring during field activities will be conducted to ensure that fieldwork will not have an adverse effect on the gnatcatcher or its habitat.

A bermed retention pond is present in the northern portion of the site, outside of the Northern EOD Range. The pond is a habitat for the Riverside fairy shrimp, which is also a federally threatened species. No intrusive sampling within the pond is planned.

3.2.5 Decision Rules

The decision rules used for this investigation are as follows:

1. Surface Surveys, Subsurface Geophysical Surveys, and Intrusive Investigations

   a. ***If*** during surface survey for kick-out evaluation, OE or OE scrap are discovered along the inside perimeter of Site 1, ***then*** a 50-foot wide path will be surveyed on the outside of the perimeter fence.

      Surface surveys will consist of visual survey and the use of an all-metals detector. A 50-foot width was chosen since that is the distance available between the perimeter fence and the brush line.

   b. ***If*** during the surface survey along the inside and/or outside perimeter, OE or OE scrap are discovered, ***then*** a subsurface geophysical survey will be conducted along a 30-foot-wide transect (for the inside and/or outside perimeter).

      The 30-foot width is the available width after subtracting 20-feet (from the 50-foot wide surface survey), which is the separation distance from the metal fence.

   c. ***If*** no OE or OE scrap are discovered during the initial survey of the inside perimeter, ***then*** a subsurface geophysical survey will be conducted along a 30-foot-wide transect inside the perimeter fence, to verify that kick-out items do not lay buried beyond the range of the detector used.

   d. ***If*** geophysical anomalies indicative of subsurface OE or OE scrap are found along the (30-foot-wide transect) inside of the fence, ***then*** a subsurface investigation of the anomaly will be conducted.

   e. ***If*** OE is detected in the subsurface anomaly, ***then*** the 30-feet-wide geophysical transect will be continued outside the perimeter fence.

      Geophysical surveys will be conducted with electromagnetic systems (EM) capable of detecting buried piles or accumulations of metallic debris/OE scrap at least 8–10 feet below the ground surface.

2. Evaluation of OE Item

   a. ***If*** an OE item is uncovered/encountered, ***then*** an evaluation will determine whether it is safe to move. A visual examination of the OE item will be made by OE specialists to make this determination.

   b. ***If*** the OE item is determined not to be unsafe to move, ***then*** the item will be removed to an onsite consolidation location.

   c. ***If*** the OE item is unsafe to move, ***then*** a removal notification will be issued and a BIP will be conducted.

      d. ***If*** the OE item is safe to move, ***then*** the item will be moved to secured onsite consolidation location.

3. Evaluation of Explosives Safety Risk

If sufficient information has been collected to apply scores to each of the data elements in the explosive safety risk tool (Appendix G), ***then*** a numerical estimation will be applied to determine the safety risk. If there is not sufficient information, additional data will be collected.

3.2.6 Decision Error Limits

The possible decision errors and the consequences are:

Rule	Possible Errors	Associated Consequences	Gray Areas	Methods to Control Error
1	Characterizing the site as free of explosive hazards when hazards exist	Unacceptable risk	Sensitivity of the detection methodology	Standardized operating procedures
2	Characterizing the site as containing explosive hazards when a hazard does not exist.	Unnecessary investigation or remedial actions	Uncertainty associated with characterizing found objects	

The limits of decision error for the explosives safety risk determination are qualitative, expressed as a narrative discussion of the uncertainty in making the determinations. The qualitative evaluation of the error will be based upon data used to make the decisions, the sources of this information, and the associated (relative) confidence levels.

3.2.7 Sampling Design

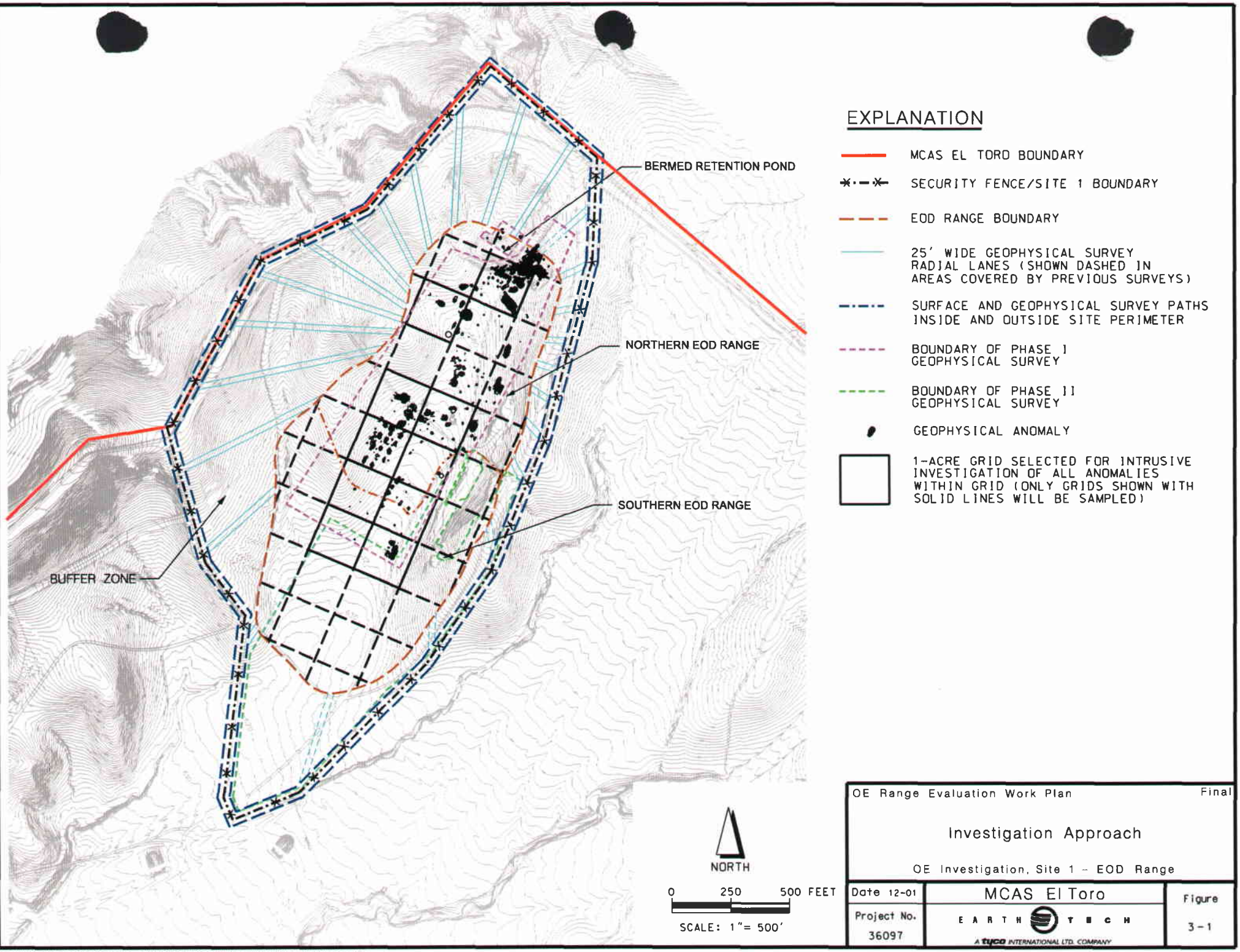
3.2.7.1 Sampling Within a Sector

Geophysical characterization of each sector will be conducted by probability sampling, investigating a representative portion of each sector. Figure 3-1 presents the investigation approach.

The percentage of each sector to be investigated was calculated using the UXO Calculator, a tool that was developed by the U.S. Army Engineering and Support Center. A synopsis of the UXO calculator is attached in Appendix G.

The assumed target density (sensitivity or resolution desired for the sampling results) is assigned based on anticipated reuse (activities similar in nature to past EOD training). A target density of 0.5 per acre (1 unsafe-to-move OE item per 2 acres) was used to calculate the size of the area to be sampled to achieve a 90 percent confidence level in the conclusion. The following areas were calculated for each of the sectors (total area to be sampled is shown in parenthesis): (1) Northern EOD Range (16.9 acres) – 4.1 acres; (2) Southern EOD Range (16.6 acres) – 4.1 acres; and (3) Buffer Zone (40.1 acres) – 4.4 acres. For the geophysical survey along the site perimeter to evaluate kick-outs, 100 percent of the perimeter length will be investigated.

Northern/Southern EOD Ranges. These sectors were characterized by previous geophysical surveys that covered a majority (greater than 85 percent) of the area and identified subsurface anomalies. Each sector will be divided into 1-acre grids (fixed pattern grid sampling). Nine grids (which are indicative of trenches/pits where detonation of munitions was likely conducted) have been selected to represent these sectors, to meet the required minimum area of 8.2 acres.



OE Range Evaluation Work Plan — Final

Investigation Approach

OE Investigation, Site 1 – EOD Range

Date 12-01	MCAS El Toro	Figure 3-1
Project No. 36097	EARTH TECH, A tyco INTERNATIONAL LTD. COMPANY	

L:\NAVCLEAN\CTO78\SITE 1 UXO EVALUATION\WORK PLAN\FINAL\FIGURES\FIGURE3-1.DGN

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An attempt will be made to define the actual boundaries of the former disposal pits/trenches during intrusive investigations. The investigations will be accomplished using TEM instrumentation. Typically, the grids would be randomly selected; however, in this case, the grids with the high densities of anomalies have been selected to obtain a worst-case estimation of the extent of buried OE items.

The nine grids are identified with a solid line on Figure 3-1. The grids that contain dashed boundaries will not be sampled, however; their contents will be assumed to be similar to the ones sampled and evaluated as such in the site characterization report that will be produced after the conclusion of fieldwork.

Buffer Zone. This sector will be characterized by the transects, which can be considered as very narrow, fixed pattern grids. Transects may be used to establish boundaries of impacted areas and, in this case, will serve to assess the lateral extent of kick-outs. Previous geophysical surveys encompassed the southern portion of the buffer zone and the strip of land between the Southern EOD Range and the site boundary to the east.

The transects originate from a central area of the Northern EOD Range and run towards the site boundary in all directions, at 15-degree intervals. However, only the transect segments from the boundary of the Northern/Southern EOD Ranges to the site boundary need be sampled, as shown on Figure 3-1. The minimum area required to be geophysically characterized for this sector is 4.4 acres. The cumulative length of the all transects is approximately 7,740 feet. Accordingly, the width of each transect will be 25 feet. The transects through areas covered by previous geophysical surveys will not be surveyed as part of the characterization of the buffer zone.

Range Perimeter. Previous geophysical surveys covered the southern portion of the site boundary. This length of the range perimeter will not be characterized again. The rest of the range perimeter will be surveyed using geophysical methods to complement the existing coverage.

3.2.7.2 Sampling Anomalies Within a Grid/Transect

The UXO Calculator does not require random selection of anomalies. For the selected grid all anomalies that are judged by the geophysicist to be indicative of OE (i.e. greater than 50 mV) will be evaluated.

The buffer zone transects and the perimeter geophysical survey along the site boundary will be sampled 100 percent for geophysical anomalies reported with coherent response signals greater than 5 mV above the background noise bandwidth.

3.3 Evaluation of Alternatives for Handling Investigation-Derived OE

The OE items encountered during the site investigation will require onsite handling and/or offsite disposal. The DoN proposes the following to meet the exclusion from HSC Section 25201 (requirements of the hazardous waste facility permit) since DTSC considers handling and disposal of OE items encountered during site characterization as treatment of hazardous waste (DTSC 2001):

1. The OE handling procedures presented in this work plan will meet the substantive requirements of a removal action work plan prepared pursuant to Section 25356.1.
2. The OE handling procedures presented in this work plan will comply with the applicable substantive requirements of rules, regulations, standards, and requirements, criteria, or limitations applicable to OE demolition procedures along with any actions necessary to protect public health and the environment.

This work plan will serve as the document that is substantively equivalent to a removal action work plan/remedial action plan, with respect to OE handling procedures.

3.3.1 Evaluation Criteria

The nine criteria that were developed by the U.S. EPA (1988) for evaluation of remedial action alternatives in making a CERCLA remedial decision have been used to evaluate and compare the OE handling alternatives.

The nine criteria are categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria. All threshold criteria must be satisfied in order for an alternative to be eligible for selection. The primary balancing criteria are used to distinguish and measure differences between alternatives. The modifying criteria will be taken into account after regulatory and public comments are received on this *Draft Final Ordnance and Explosives Range Evaluation Work Plan.*

3.3.1.1 Threshold Criteria

Overall Protection of Human Health and the Environment. This criterion assesses whether an alternative provides adequate public health protection and describes how explosives safety risks posed by the site will be eliminated, reduced, or controlled through disposal, engineering controls, or institutional and regulatory controls.

Compliance with ARARs. Compliance with ARARs addresses whether an alternative will meet all applicable or relevant and appropriate federal and state environmental statutes or requirements. This criterion considers how each alternative compares with respect to ARARs.

3.3.1.2 Primary Balancing Criteria

Long-Term Effectiveness and Permanence. This criterion addresses the ability of an alternative to maintain reliable protection of human health and the environment over time, based on the projected reduction in risk for explosives safety after the completion of the response.

Reduction of Toxicity, Mobility, or Volume. This criterion addresses the degree to which an alternative employs recycling or treatments that reduce toxicity, mobility, and volume.

Short-Term Effectiveness. The evaluation of short-term effectiveness addresses how well human health and the environment will be protected from impacts due to onsite disposal operations.

Implementability. Evaluation of implementability addresses the technical and administrative feasibility of implementing an alternative. It includes evaluation of the availability of technologies, services, and materials required during implementation.

Cost. Evaluation of cost addresses the total cost of the response action, including capital and operations and maintenance (O&M) costs.

3.3.1.3 Modifying Criteria

Acceptance by Appropriate Regulatory Agencies with Jurisdiction over Affected Resources. Evaluation of this criterion addresses the apparent preferences or concerns of a disposal alternative to EPA Region 9 and California state regulatory personnel.

Community Acceptance. Evaluation of this criterion addresses the apparent preferences of the surrounding community.

3.3.2 OE Handling Classifications

There are two basic classifications for OE items potentially located at Site 1: safe-to-move and unsafe-to-move. Safe-to-move OE items can be moved from their position and placed in temporary storage onsite for future disposal, or transported offsite for disposal. Unsafe-to-move OE items are almost always disposed of in place, in the position found. For both classifications, there are alternatives that can be employed to mitigate hazards that could occur during the handling of OE.

3.3.3 OE Disposal Alternatives

3.3.3.1 UNSAFE-TO-MOVE

Blow in Place (BIP). All OE items determined to be unsafe to move will be disposed of in place, in the position found.

Blow in Place with Engineering Controls (BIP/EC). All OE items will be detonated in place, in the position found, with engineering controls being employed.

Consolidate in Controlled Blast Chamber (CCBC). Utilizing a detonation chamber for unsafe-to-move OE would require field workers to extract, handle, transport and place the unsafe-to-move OE item into the chamber. The risk involved in this alternative would be unacceptable. Accordingly, this will not be considered as an alternative for further evaluation.

Institutional/Engineering Controls (IC). Provide for institutional or engineering controls to prevent contact with OE items.

No Action (NA). Take no action to prevent contact with OE items.

3.3.3.2 SAFE-TO-MOVE

Move to a Controlled Demolition Area with Engineering Controls (MCDA/EC). Move OE items that can be moved to a central area within the project site for safe handling/demolition, with engineering controls being employed.

Move to a Controlled Demolition Area (MCDA). Move OE items that can be moved to a central area within the project site for safe handling/demolition.

Consolidate in Controlled Blast Chamber (CCBC). Move OE items that can be moved to a central site within the project area for safe detonation in a controlled blast chamber. The purpose of a blast chamber is to provide an alternative to open demolition, provide temporary storage, and/or provide a method of transportation for recovered OE items or material to offsite locations for demolition. The blast chamber will capture and control all shock over-pressure and fragments from the OE item being destroyed. This alternative would only be appropriate for the handling of safe-to-move OE.

Consolidate for Offsite Disposal (COSD). Transport all OE that can be moved, and are certified as safe to ship offsite, to an approved offsite demolition facility.

Institutional/Engineering Controls (IC). Provide for institutional or engineering controls to prevent human contact with items located during the investigation.

No Action (NA). Take no action to prevent contact with OE items.

3.3.4 Evaluation of OE Handling Alternatives

The handling alternatives evaluated meet or exceed the overall protection of human health and the environment, and are in compliance with ARARs. The alternatives have been evaluated as to their long-term effectiveness and permanence, reduction of toxicity/mobility/or volume, short-term effectiveness, implementability, and cost as they pertain to Site 1. Each alternative has positive and negative aspects, and was not selected or rejected due to one requirement category; rather, it was assigned a numerical value for each alternative that when totaled indicates the best option for this site. The lower the total score the higher the evaluation rating. The evaluations of unsafe-to-move OE and safe-to-move OE are shown in Tables 3-2 and 3-3, respectively. State and community acceptance preferences or concerns will be sought through the comment and review period of the document.

3.3.4.1 UNSAFE-TO-MOVE

Table 3-2: Evaluation of Alternatives for Unsafe-to-Move OE

	A	B	C	D	E	F	G	H	I	Score	Rank
I	1	1	1	1	1	4	4	0	0	13	1
II	2	1	2	1	2	3	3	0	0	14	2
III	3	3	3	4	4	2	2	0	0	21	3
IV	4	4	4	4	4	1	1	0	0	22	4

Notes:
Ranking from best to worst: best = 1. worst = 4.
I = Blow in Place with Engineering Controls
II = Blow in Place
III = Institutional Controls
IV = No Action

A. Overall Protection of Human Health and the Environment
B. Compliance with ARARs
C. Long-Term Effectiveness and Permanence
D. Reduction of Toxicity, Mobility, or Volume of Contaminants
E. Short-Term Effectiveness
F. Implementability
G. Cost
H. State Acceptance
I. Community Acceptance

Alternatives I and II meet the requirements of the threshold criteria, are satisfactory methods of OE handling, and can be employed with reliable degrees of environmental and safety risks, all of which are well within federal, state, and local guidelines. Alternatives III and IV are not feasible due to project-specific conditions, such as reuse and DoN's preferred position for transferring sites. Future use of the site is to be similar in nature to past uses. It is not safe, nor is it standard practice, to leave ordnance encountered during any investigation in place. Institutional or engineering controls cannot be put in place at each location that OE is encountered due to the need to provide continuous access to the entire site during future use for OE training.

As Alternatives I and II would be acceptable under the threshold criteria, they will both be evaluated here. Alternatives III and IV will not be further evaluated for reasons discussed above.

3.3.4.2 SAFE-TO-MOVE

Table 3-3: Evaluation of Alternatives for Safe-to-Move OE

	A	B	C	D	E	F	G	H	I	Score	Rank
I	3	1	1	1	4	3	3	0	0	16	1
II	1	1	1	1	5	4	4	0	0	17	2
III	1	1	1	1	3	6	6	0	0	19	3
IV	4	1	1	1	6	5	5	0	0	23	4
V	5	5	5	5	1	2	2	0	0	25	5
VI	6	6	6	6	1	1	1	0	0	27	6

Notes:
Ranking from best to worst: best = 1. worst = 6.
I = Move to a Controlled Demolition Area with Engineering Controls
II = Move to a Controlled Demolition Area
III = Consolidate in Controlled Blast Chamber
IV = Consolidate for Offsite Disposal
V = Institutional Controls
VI = No Action

A. Overall Protection of Human Health and the Environment
B. Compliance with ARARs
C. Long-Term Effectiveness and Permanence
D. Reduction of Toxicity, Mobility, or Volume of Contaminants
E. Short-Term Effectiveness
F. Implementability
G. Cost
H. State Acceptance
I. Community Acceptance

Alternatives I and II, and III all meet the requirements of the threshold criteria, are satisfactory methods of handling, and can be employed with reliable degrees of environmental and safety risks, all of which are well within federal, state, and local guidelines. Alternative IV is also deemed a satisfactory method of handling; however, due to available onsite handling options, the liability due to safety issues of transporting damaged OE offsite will be of concern.

Alternatives V and VI are not feasible due to the project-specific conditions, such as reuse and DoN's preferred position for transferring sites. Future use of the site is to be similar in nature to past uses. It is not safe, nor is it standard practice, to leave ordnance encountered during any investigation in place. Institutional or engineering controls cannot be put in place at each location that OE is encountered due to the need to provide continuous access to the entire site for future OE training.

As Alternatives I, II, and III would all be acceptable under the threshold criteria, they will all be evaluated here. Alternatives IV, V, and VI will not be evaluated here, for reasons as discussed above. Alternative III was not evaluated due to non-availability. Presently, there are two mobile blast chambers that are operational. Both chambers are presently employed at long-term OE sites and are not available.

3.3.5 Ranking of Alternatives

3.3.5.1 UNSAFE-TO-MOVE

Long-Term Effectiveness and Permanence. Alternatives I and II would provide the same final outcome; all hazards associated with located OE items or material would be removed from the site. Both alternatives ranked equally.

Reduction of Toxicity, Mobility, or Volume of Contaminants. Alternatives I and II would allow the safe destruction of all located OE items to the same levels. Both alternatives ranked equally.

Short-Term Effectiveness. In terms of risk to onsite workers, the community, and the environment, during the implementation of disposal alternatives, Alternative I ranked first, as the community and onsite workers would be protected by the MSD and engineering controls. Alternative II ranked slightly lower due to the possibility of fragments being blown outside the immediate area of the blast.

Implementability. The implementability of Alternative II was ranked slightly higher than Alternative I due to added effort and cost for the engineering controls.

Cost. Alternative II was evaluated to be slightly less expensive to implement than Alternative I due to the additional cost of engineering controls.

Alternatives I and II are considered very similar in nature. However, Alternative I has been selected over Alternative II, due to site location, which is in proximity to populated areas, as this alternative will provide complete fragment mitigation.

3.3.5.2 SAFE-TO-MOVE

Long-Term Effectiveness and Permanence. Alternatives I, II, and III would all provide the same final outcome, all hazards associated with located OE items or material would be removed from the site. All alternatives ranked equally.

Reduction of Toxicity, Mobility, or Volume of Contaminants. Alternatives I, II, and III would all allow the safe destruction of all located OE items to the same levels. All alternatives ranked equally.

Short-Term Effectiveness. In terms of risk to onsite workers, the community, and the environment, during the implementation of disposal alternatives, Alternative III ranked first, as the community and onsite workers would be protected by the controlled blast chamber. Alternative II ranked second and will be employed to protect the community and onsite workers for OE items that are safe to move; this alternative ranks second with regards to movement of OE items. Alternative I ranked third due to potential safety issues.

Implementability. The implementability of the OE handling alternatives are ranked as follows; Alternative II ranked first as it is the easiest and most cost-effective to implement. Alternative I is ranked second do to added effort, risks to onsite workers, and cost in providing engineering controls. Alternative III ranked third, due to availability and cost.

Cost. Alternative II was evaluated to be slightly less expensive to implement than Alternative I due to the additional cost of engineering controls. Alternative III was significantly more expensive than Alternative I or Alternative II.

Alternatives I and II are considered very similar in nature. However, Alternative I was selected above Alternative II due to site location, which is in close proximity to populated areas, as this alternative will provide complete fragment mitigation for OE items that are safe to move. If OE items are moved onsite, they will be moved to a designated area well inside the minimum separation distance (MSD).

3.3.6 Summary

In summary, the short-term effectiveness, implementability, and cost had the greatest effect on the evaluation of OE handling alternatives. The alternatives were selected using these criteria, as the rest of the criteria used in this evaluation were equal. The alternatives for unsafe-to-move OE and safe-to-move OE are ranked as indicated in Tables 3-2 and 3-3, respectively. State and community acceptance criterion were not evaluated. The preferred alternative for dealing with unsafe-to-move OE is BIP, with engineering controls. The preferred alternative for dealing with safe-to-move OE is safe to move to a Controlled Demolition Area.

4. FIELD SAMPLING PLAN

4.1 SAMPLING OBJECTIVES

Sampling objectives for the OE Range Evaluation are

1. Assess, by surface surveys and subsurface geophysical surveys, if kick-outs are contained within the boundaries of Site 1.
2. Delineate the lateral extent of kick-outs in the buffer zone by surface surveys followed by subsurface geophysical surveys.
3. Investigate geophysical anomalies by intrusive investigation.
4. Characterize OE items encountered during the investigation and determine if they are safe or unsafe to move.
5. BIP all unsafe-to-move OE items encountered during the investigation; conduct soil sampling to evaluate releases as a result of BIP.
6. Remove and consolidate onsite all safe-to-move OE items encountered during the investigation for onsite demolition. Conduct soil sampling, if required, to (a) evaluate releases as a result of demolition, and (b) characterize sandbag contents if impacted by the demolition.

4.2 MOBILIZATION

Personnel and equipment will be mobilized, as required, when requested by the Earth Tech project manager. The goal of mobilization is to ensure that all project personnel are prepared and properly resourced to perform applicable field activities. Actions performed during mobilization include

- Packaging, shipping, and inventorying required project equipment,
- Coordinating upcoming field activities with key project personnel,
- Coordinating with site personnel (e.g., security, safety),
- Setting up a site command post,
- Organizing support facilities and testing communications equipment,
- Identifying and procuring any additional supplies and equipment required to perform the work, and
- Conducting site-specific training.

4.2.1 OE Personnel and Qualifications

The RE site will be supported by a Senior UXO Supervisor (SUXOS), a UXO site safety Officer (SSO), and two UXO specialists. OE qualifications include

- **Senior UXO Supervisor (SUXOS)** – The SUXOS will be a graduate of the U.S. Army Bomb Disposal School, Aberdeen Proving Grounds, Maryland, or the U.S. Naval EOD School, Indian Head, Maryland. This individual will have a minimum of 15 years of EOD and UXO experience combined, and be qualified to perform all functions for the following positions: UXO Sweep Personnel, and UXO Technicians I, II, III.
- **UXO Safety Officer (UXO SSO)** – The UXO SSO will be a graduate of the U.S. Army Bomb Disposal School, Aberdeen Proving Grounds, Maryland, or the U.S. Naval EOD

School, Indian Head, Maryland. This individual will have the same minimum qualifications as a UXO Technician III. In addition, this individual will have specific training, knowledge, and experience necessary to implement the site-specific *Health and Safety Plan (HSP)* (Earth Tech 2001b) and verify compliance with applicable safety and health requirements, and be qualified to perform all functions for the following positions: UXO Sweep Personnel, and UXO Technicians I, II, III.

- **UXO Technician II (UXO II)** – The UXO II will be a graduate of the U.S. Army Bomb Disposal School, Aberdeen Proving Grounds, Maryland, or the U.S. Naval EOD School, Indian Head, Maryland. This individual must be qualified to perform all the functions for the following positions: UXO Sweep Personnel, UXO Technician I, and UXO Escort.

4.2.2 Project Equipment

During mobilization, project personnel will

- Package and ship corporate equipment items to the project site;
- Coordinate with selected vendors for direct shipment of supplies and equipment;
- Coordinate with Earth Tech for communications, administrative, and other support;
- Coordinate with personnel and agencies to accommodate site-specific security requirements (e.g., vehicle inspections); and
- Perform maintenance and quality checks of the equipment to ensure that it is operationally ready.

4.2.3 Site-Specific Training

As part of the mobilization process, Earth Tech will perform site-specific OE training for all personnel assigned to this project. The purpose of this training is to ensure that all personnel fully understand the procedures and methods that will be used to perform operations at the project site, their individual duties and responsibilities, and all safety and environmental practices and procedures associated with operations. All personnel will be trained as they arrive, and they will not be allowed onto the project site until they have received site-specific training. Training topics/issues and responsibilities are as follows:

1. UXO technicians will receive operational briefings and training on their duties and responsibilities. All project personnel will receive ordnance recognition and OE safety precaution briefings. Earth Tech's Ordnance and Explosives Technical Director or his or her designated representative will perform this training.
2. All personnel will receive additional training on the equipment they will operate onsite.

Prior to mobilization, all project personnel will receive Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training, and annual 8-hour refresher training, as required. Additionally, all onsite personnel must participate in a medical surveillance program and have completed a pre-placement or annual physical examination that complies with the requirements of 29 CFR Part 1910.120. Project personnel will be certified as fit to work by an occupational physician certified in occupational medicine by the American Board of Preventive Medicine or one who, by necessary training and experience, is board-eligible. Documentation of the medical qualifications of personnel will be maintained on file.

4.3 OE Specialized Requirements

All OE operations at the site will be performed under the supervision and direction of qualified UXO technicians. Initially, an MSD of 200 feet will be established at each intrusive sampling; however, if it becomes necessary to increase the site risk from low to moderate or high at anytime while conducting field work, the MSD will be increased as required to meet safety requirements based on the largest OE item found. Non-UXO-qualified personnel will be prohibited from performing operations in an exclusion area unless they are accompanied and supervised by a UXO technician. Throughout operations, all onsite personnel will strictly adhere to the OE safety precautions and procedures provided in this document and in the site-specific *HSP* (Earth Tech 2001b).

4.3.1 Work Hours/Site Access

Operations will be conducted during daylight hours only.

Earth Tech will control access into operating areas and will limit access to only those personnel necessary to accomplish the specific operations or to those who have a specific purpose and authorization to be at the site. No hazardous operations will be conducted when unauthorized persons are in the vicinity of the investigation and clearance areas.

4.3.2 Handling of Ordnance and Explosives

If handling of OE items is required, this activity will be performed by qualified UXO technicians only. Non-UXO site personnel will be instructed and closely supervised to ensure that they do not handle any OE. OE scrap will not be handled or touched until checked by a UXO technician to assure the item is not explosive or does not have explosive residue.

4.3.3 Compliance with Plans and Procedures

UXO personnel will conduct operations at the site in a systematic manner using proven operating methods and techniques. All activities will be conducted under the direction, supervision, and observation of the SUXOS (or a UXO technician during UXO escort activities). 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 the SUXOS in close liaison with the UXO SSO and project manager (PM). Approved changes will be submitted as a field change with justification for approval to the Navy. Approved changes will be implemented in a manner that will ensure uniformity in procedures and end-product quality on the part of the UXO team.

4.3.4 Chemical Warfare Material

The ASR, Range Identification and Preliminary Range Assessment and discussions with the Navy have indicated that the identified fieldwork areas are not suspected of containing chemical warfare material (CWM). OE that is thin-cased and designed in a manner that could contain a liquid filler and cannot be positively identified as an explosive-filled ordnance item should be evaluated as potential CWM until proven otherwise. If site personnel identify any items potentially containing CWM, field operations will cease, the subject area will be marked accordingly, all personnel will exit the area upwind, and the Navy will be notified immediately. UXO technicians will secure the area from access until relieved by local military representatives. Fieldwork will not resume until it has been determined safe to do so.

4.3.5 Equipment Checks

All instruments and equipment that require maintenance and/or calibration will be checked prior to the start of each workday. If equipment field checks indicate that any piece of equipment is not operating correctly, and field repair cannot be made, the equipment will be tagged and removed from service, and a request for replacement equipment will be placed immediately. Replacement equipment will meet the same specifications for accuracy and precision as the equipment removed from service.

Instrumentation that will be used for either surface or subsurface OE detection will be tested daily at the project site to verify that the instrument performance meets or exceeds that necessary to ensure safe performance of work. Instrument performance criteria include

1. Instrumentation to be used for avoidance of surface OE which will be capable of detecting a hollow-steel cylinder (nominally equivalent to a 20mm high explosive [HE] projectile) at a depth of 4 to 6 inches below ground surface (bgs).
2. Instrumentation to be used to clear locations for intrusive fieldwork that will penetrate no more than 8 inches into the ground (such as setting sampling location stakes), which will be capable of detecting a hollow-steel cylinder (nominally equivalent to a 20mm HE projectile) at a depth of 8 inches bgs.

Instrumentation used to verify that all sources for the identified geophysical anomalies have been removed from each intrusive sampling location will provide detection performance equal to that of the selected geophysical instrument, as verified at the field equipment test plot.

4.4 FIELD METHODS AND PROCEDURES

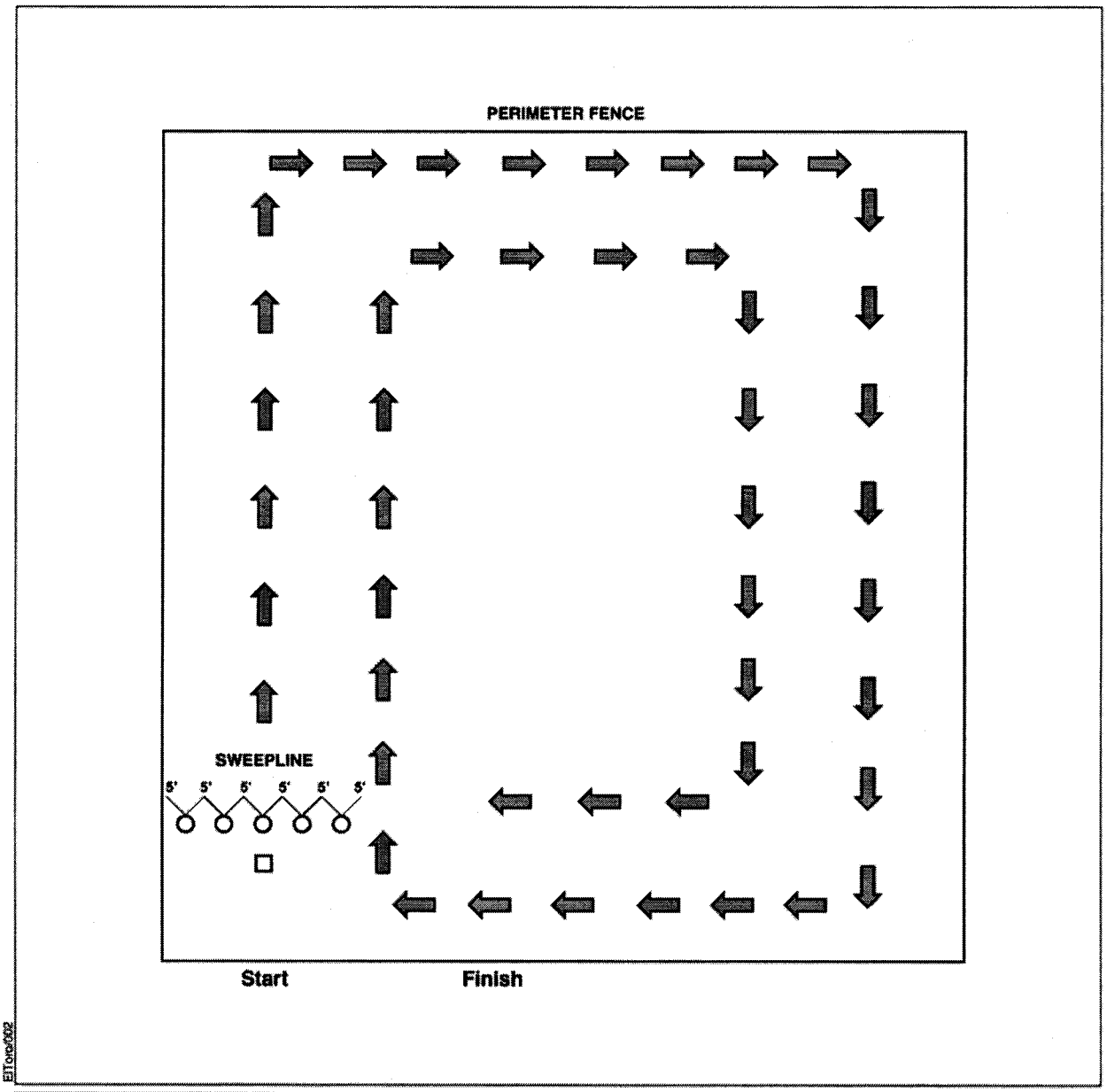
4.4.1 Surface Surveys

A surface survey will be conducted along the inside perimeter of Site 1 (i.e., inside the fence; see Figures 3-1 and 4-1). The survey perimeter will be a 50-foot wide path. If OE or OE scrap are discovered along this pathway, a survey path 50 feet wide will be surveyed on the outside of the perimeter fence to identify any areas with kick-out.

Surface surveys will be conducted using an OE surface clearance walking sweepline. Sweep personnel will use the perimeter fence as their starting boundary and sweep systematically using a 5-foot distance between each sweeper (Figure 4-1). All sweepline personnel will be outfitted with a hand-held all-metals detector, and one global positioning system (GPS) unit per sweep team. The hand-held all-metals detector will be used as an aid in locating surface debris in areas of heavy vegetation, and the GPS unit will be used for marking the surface survey areas, OE, and OE scrap locations during sweep operations.

The surface survey consists of a visual survey of the surface terrain to locate and remove OE, OE scrap, and metallic debris larger than 1 inch by 2 inches that would interfere with geophysical mapping and be a physical hazard to the crew, and to clear the site of significant surface anomalies for subsurface mapping.

The visual survey relies on a systematic progressive search pattern within the delineated search lanes or grids. OE sweep personnel will assemble in line formation and advance in a slow, continuous pace (Figure 4-1), visually inspecting the surface of the search lane for OE, OE scrap, and any metallic debris.



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EXPLANATION

- ○ UXO Tech with an "all metals detector"
- □ UXO Supervisor with GPS

Notes: (1) For the range perimeter survery, two passes along the fence will cover 50'.
(2) For the buffer zone survey, one pass will cover 25'.

OE Range Evaluation Work Plan		Final
OE Surface Clearance Walking Sweepline (Conceptual) OE Investigation, Site 1-EOD Range		
Date 12-01	MCAS El Toro	Figure 4-1
Project No. 36097	EARTH TECH A TYCO INTERNATIONAL LTD. COMPANY	

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4.4.2 Geophysical Investigation

The geophysical investigations will be performed under the direction of a registered geophysicist with at least 5 years of field experience in designing, conducting, and interpreting the data from geophysical investigations.

Range Perimeter. Geophysical methods will be used to map the subsurface along a 30-foot-wide transect inside the perimeter fence to verify if significant kick-out items may lay buried at or near the site boundary. If subsurface OE or OE scrap is discovered during this geophysical survey, the subsurface investigation will be continued outside the perimeter fence, again mapping a 30-foot-wide path encircling the former EOD training area.

Buffer Zone. To assess OE and OE scrap density within the buffer zone of Site 1, a 25-foot-wide geophysical investigation along radial paths will be conducted. The radial paths evenly spaced at 15-degree intervals and beginning at the center of the likely demolition pit area (Figure 3-1) will progress outward to the perimeter fence.

The radial-path surveys will not cover areas where a geophysical survey was previously conducted. If OE or OE scrap is located at the perimeter fence, the path will be extended until a clear area is encountered.

4.4.2.1 Objectives

The purpose of the geophysical investigation is to identify potential locations where OE may lie buried. The objective will be to define boundaries of pits/trenches and/or discrete anomaly locations that may be representative of buried OE locations.

4.4.2.2 Methodology

Geophysical investigations will be performed with EM systems capable of detecting buried piles or accumulations of metallic debris/OE scrap at least 8 feet to 10 feet below the ground surface. Test plots for equipment verification will be conducted as described in Appendix A and will ensure that, at a minimum, individual projectiles would be detected at the appropriate performance criterion threshold and buried debris in disposal pits will be detectable at 36–48 inches bgs. This range is the depth to which kick-outs are anticipated to be encountered.

Prior to investigating the survey areas, a geophysical equipment verification test will be conducted to identify the performance capabilities and limitations of the equipment and procedures to be used at the former EOD training range. After data have been collected and processed, anomalies will be identified for intrusive exploration.

Processing of digital data will include a symbol posting of centerline locations of the sensor array and production of profiles of the data along survey transects. Color images of the geophysical response data that are representative of the investigative swath will be generated. An ASCII format tabulation of the anomalies identified in the geophysical data will be generated. The table will include an anomaly number, easting and northing (in state-plane coordinates), anomaly amplitude, and other anomaly attributes (i.e., depth estimate).

4.4.2.3 Equipment

Transient or TEM metal detector methods will be used for the geophysical investigation because these systems have been shown to provide (1) better resolution of small, shallowly buried (1 foot or less) OE than is provided by magnetometry; and (2) a geophysical response that is much less complex than that recorded by magnetometers and one that can be more readily recognized in the

field. Additionally, magnetometer systems cannot detect the nonferrous OE components that may be present in the EOD training range.

The Geonics, Ltd., EM61 High Sensitivity Metal Detector will be used to digitally capture the geophysical response to subsurface metallic objects that may be OE or OE scrap. The EP61 was used in the previous work at this site, as well as in similar investigations at other ordnance sites. The EM61 has been demonstrated to detect metallic debris and OE scrap 8 feet to 10 feet bgs, and has proven to be capable of detecting 20mm and 37mm projectiles at 1 foot to 1.5 feet bgs; this range is well below the depth such OE would penetrate if kicked out of a pit by explosive demolitions.

In a report prepared for the U.S. Army Corps of Engineers, Huntsville, Alabama, ECG Incorporated analyzed the possibility of instrument electromagnetic fields causing ordnance fuses to activate. The report stated that the Geonics EM61 is safe and will not cause fuses to activate if the unit is carted at 0.42 meters off the ground (ECG 1997), which is the standard configuration of the EM61 system. Consequently, there is no danger of ordnance detonations caused by the EM61.

Differentially corrected global positioning systems will be used to track and record locations of the geophysical data relative to the state plane grid coordinate system.

4.4.2.4 Data Resolution (Line Spacing)

The line spacing for geophysical data collection will be determined during planned geophysical equipment tests. Data resolution will be sufficient to discriminate the smallest individual OE of concern. At a minimum, pass/fail performance criteria for the geophysical methodologies should be as follows:

- All OE targets (real or simulated) buried at the calculated performance depth must be detected.
- Mapped locations must be within 1.3 feet of the actual location.

4.4.2.5 Data Density

Survey coverage shall be such that data are recorded at a sampling density that reflects a station interval sufficient to define the smallest objects of concern along each transect. Time and distance data will be reviewed to identify the interpolated station intervals. Encoder-triggered data will be inspected to determine the "rubber rulering," or stretching of the data over the referenced fiducial distances. GPS-referenced data will be plotted to determine measured station intervals.

Anticipated OE Type, Composition, and Quantity. No OE has been found in the near-surface during previous investigations; only inert OE or OE scrap are anticipated during this site characterization.

Anticipated OE Depth Distribution. OE scrap may lie as deep as 6 feet to 8 feet bgs.

4.4.2.6 Geophysical Environment

Background Gradient. No significant background geophysical gradient is expected for the TEM systems to be used.

Utilities. No utility lines are known or anticipated for the investigation areas.

Structural Clutter. It is expected that scattered metallic debris will be found based on use of the site. Buildings associated with EOD training and possibly monitoring wells may affect data collection, but no other structural clutter is anticipated.

4.4.3 Intrusive Investigation of Subsurface OE

An anomaly investigation team will identify the anomaly locations, using an all-metals detector meeting the SOP performance criteria detailed in Appendix A to ensure personnel safety during intrusive fieldwork. The survey team will locate the identified anomalies using real-time kinematic (RTK) GPS, sweep the ground surface with the EM system or magnetometer to identify the anomaly centroid, and mark the center of the particular anomaly with paint and a high-visibility clay pigeon or polyvinyl chloride (PVC) pinflags.

Anomalies will be investigated either by conducting trenching or by potholing lengthwise and across each selected anomaly. Trenches or potholes will be excavated until the bottom of the anomaly source is located. During the excavation process, all located OE or OE scrap data will be logged and soil samples will be collected in accordance with procedures located in the *Phase II RI Work Plan* (Earth Tech 2001a).

Data describing anomaly sources (i.e., OE or OE scrap) discovered during the intrusive investigation will be recorded, to include size, estimated weight, orientation, depth bgs, and description of the item excavated.

Range Perimeter/Buffer Zone. All geophysical anomalies identified in these sectors will be intrusively investigated.

Impact Area. The Northern and Southern EOD Ranges have been divided into 1-acre grids. To meet the sampling design criteria, selected grids will be intrusively investigated as shown on Figure 3-1. All identified geophysical anomalies (greater than 50 mV) within each of these selected grids will be investigated for OE characterization.

4.4.3.1 Location and Marking

General. Location and marking tasks will entail using GPS surveying equipment to locate and install semipermanent markers. The areas of concern enclosed by the stakes will become the planning and recording basis for surface clearance, geophysical mapping, and subsurface clearance operations to be performed, if required.

Investigation Location Procedures. Following the evaluation of the geophysical survey data, surveyors will install semipermanent markers (36-inch nonmetallic survey stakes) at locations selected for further evaluation.

UXO personnel will be required to escort the surveyors during this task, using OE avoidance techniques. The escorts will visually check the surface (using all-metals detectors) along the paths the surveyors use to transit the property for OE and check the subsurface area (also using the all-metals detectors) where the stakes will be driven for anomalies.

Locations will be staked at a safe distance (24 to 36 inches) from the anomaly during installation of survey stakes. OE encountered during visual sweeps will be marked and reported to the project manager for recording and disposal.

The survey stakes will be painted with a biologically safe fluorescent orange paint to provide easy visual location, and the southwest corner stake for each grid, trench, or pothole will have a number assigned and will be marked for grid/trench/pothole identification.

Once the grid, trench, or pothole locations are investigated, maps illustrating the locations will be developed. All field books, sketches, and computation sheets will be maintained in the project documentation files.

4.4.3.2 OE Surface Clearance

General. If required, once the grids, trenches, or potholes have been established, a surface clearance will be conducted. The sweep team will use hand-held all-metals detectors and visual search methods to clear the area of OE, OE scrap, and metallic debris that would be a hazard to the mapping crews and to clear the site of significant surface anomalies for the subsurface mapping. All OE scrap and metallic debris larger than 1 inch by 2 inches will be removed. All OE scrap and metallic debris will be placed outside the southwestern corner of each trench.

The sweep team will remove all OE scrap and metallic materials from the southwest corner of the trench. All OE that is determined unsafe to move will be blown in place (BIP) by the UXO team, using procedures outlined in Section 4.4.4 and Appendix C.

Quality Control. The UXO SSO will perform a random sweep quality control (QC) inspection over 10 percent of each grid, trench, or pothole. The 10-percent QC inspections will be conducted before unescorted personnel are allowed access to the grids, trenches, or potholes. The grid/trench/potholes that fail the QC inspection will require another complete surface clearance if any of the following occurs:

- OE is found;
- OE scrap or metallic debris greater than 1 inch by 2 inches is found.

4.4.3.3 Geophysical Mapping and Anomaly Reacquisition

Geophysical mapping and anomaly reacquisition will be conducted in accordance with Section 4.4.2 and the SOP in Appendix A of this work plan.

4.4.3.4 Equipment

The equipment requirements for this activity include

- Instrumentation (hand-held EM conductivity meters or magnetometers) used to assess proximity to subsurface metallic anomalies and/or OE during progress of excavation,
- Miscellaneous common hand tools (i.e., screwdrivers, digging implements),
- Forms and logbooks to record activities and contamination levels,
- Backhoe,
- Demolition equipment and explosives required for OE disposal (if necessary).

4.4.3.5 Anomaly Excavation and OE Characterization

All anomaly locations selected from the geophysical data evaluation will be intrusively investigated, unless removal of surface metallic debris can be verified as accounting for the mapped geophysical anomaly.

The subsurface anomalies will be excavated by carefully removing the earth overburden using a hand shovel or trowel or other small digging implement.

Throughout the excavation, the UXO Specialists will use a conductivity meter or magnetometer to check and verify the proximity of the anomaly. If the anomaly is deeper than 3 feet, a backhoe will be used to continue the excavation. When all OE has been located, OE scrap, and other debris will be logged on a Grid Operations Record form (Appendix E).

Prior to the arrival of the heavy equipment, the UXO Supervisor will ensure that a cleared entrance and egress path is available and marked in accordance with Section 5.4 of this work plan for the heavy equipment.

Heavy equipment (operated by either a qualified OE Specialist or certified heavy equipment operator) will be used to excavate the earth overburden in 6-inch lifts. After each lift, all located OE, OE scrap and other debris will be logged on a Grid Operations Record form (Appendix E). This process will continue until the bottom of the anomaly source has been located. If it becomes necessary to excavate below 4 feet, the excavation construction guidelines located in the site-specific *HSP* and Section 7 of this work plan will be strictly observed.

When a UXO Specialist is checking backhoe excavations for suspected OE source proximity, the backhoe bucket will be placed on the ground, and the operator will keep his or her hands clear of the operating controls.

The backhoe operator will resume excavation operations only after the UXO Specialist is clear of the excavation and outside of the bucket swing area.

4.4.3.6 OE Quality Control Surveys

A QC specialist will verify that all sources for the identified geophysical anomalies have been removed from each intrusive investigation site. The QC specialist will perform the clearance surveys using a hand-held EM61. QC survey data will be recorded in a field logbook and will include grid, trench, or pothole identity, an anomaly identification number, and survey results. Logbook entries will be signed and dated by the SUXOS. Anomalies discovered during a QC survey will be reported to the PM, SUXOS, and UXO SSO, and will be further evaluated.

4.4.4 OE Handling, Demolition, and Notifications

When the UXO team locates an OE item, the team will identify the specific item and determine the appropriate handling method in accordance with procedures detailed on Figure 4-2. Items that are considered unsafe to move will be BIP, using appropriate protective works, and all items determined to be safe to move will be moved to an onsite temporary storage location for demolition at the end of the project. All BIP and demolition operations will be followed by OE scrap recovery operations.

4.4.4.1 Evaluation of OE

Each OE item will be inspected to determine if it is armed or unarmed, and if it is unsafe to move due to damage. An item is considered potentially armed if it has been fired or used for its intended purpose. The determination that it is armed or unarmed is, in part, based on the follow criteria:

1. Proper identification of ordnance item and fuzing. Using the applicable technical manuals, the item will be identified based on size, shape, and any visible markings. Items unable to be positively identified will not be moved and will be BIP.

2. The item will be examined for indications of arming. For example, projectile rotating bands would be scored if fired. Mortars would have an impinged percussion primer. Grenades would have a missing safety pin and spoon.

An item, either armed or unarmed, may have been rendered unsafe to move due to damage. Types of damage that may render an item unsafe to move could include, but are not limited to, the following:

1. Dents in the body or fusing system,
2. Holes or rips in the body or fusing systems,
3. Burns. If there is visible scorching and/or soot present.

4.4.4.2 Removal and Handling of OE (Unsafe-to-Move)

OE that is determined to pose an immediate hazard will be BIP in accordance with Appendix C and appropriate fragmentation mitigation methods (Appendix D). A detailed description of the OE item, its location, the proposed schedule for demolition by BIP, and the documentation of the required notifications will be provided to SWDIV. UXO technicians will BIP OE that cannot be moved safely only after receiving proper authorization from SWDIV. The demolition will be accomplished by qualified and licensed Earth Tech UXO technicians in accordance with Section 4.4.4.5.

4.4.4.3 Removal and Handling of OE (Safe-to-Move)

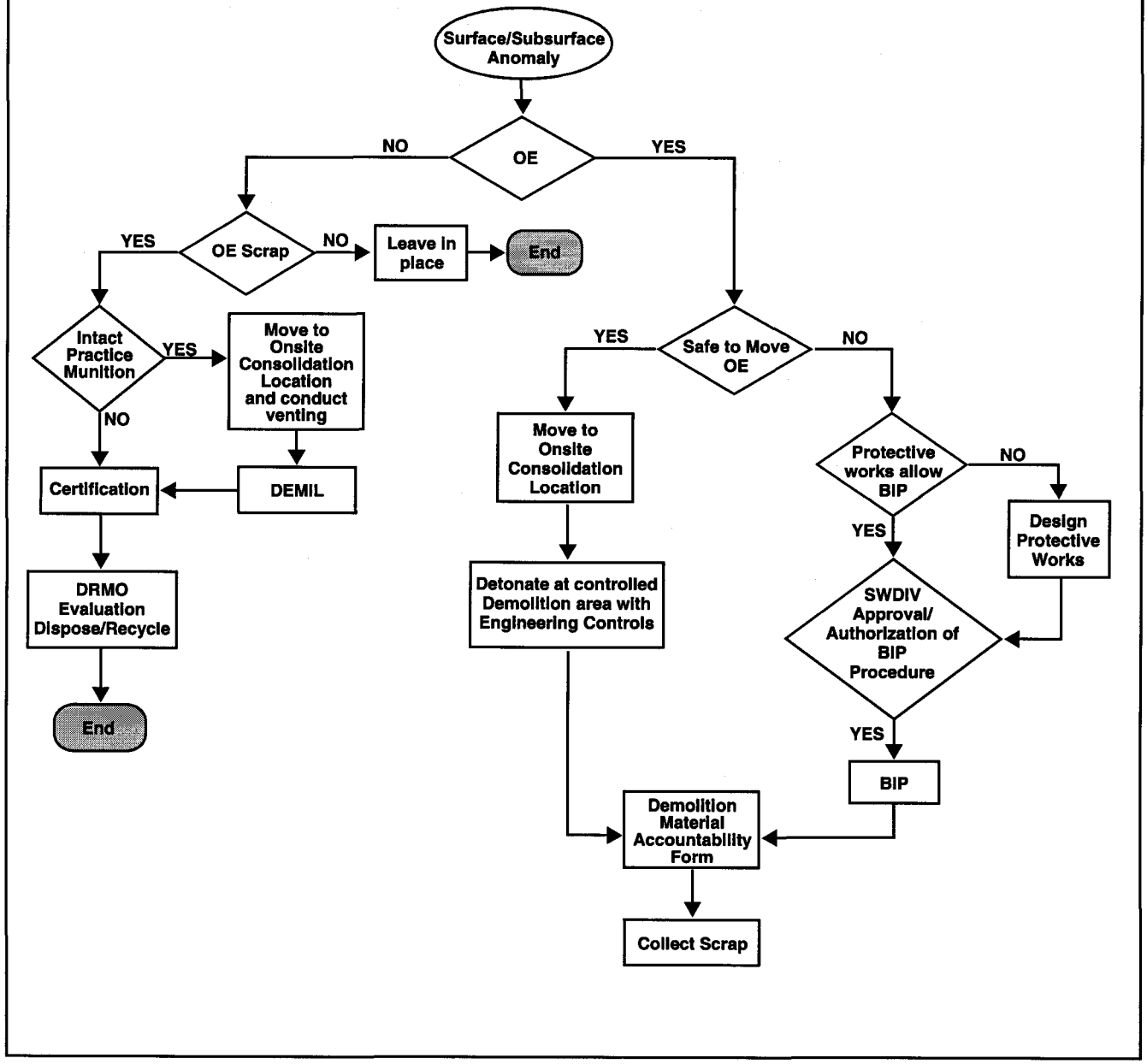
OE that is not considered an immediate threat to the safety of site workers (or public) will be moved to an onsite consolidation location in accordance with Section 4.4.4.7 and Figure 4-2. OE that has been moved to the onsite consolidation location will be vented prior to demolition to ensure that the OE is not explosively charged. The demolition will be accomplished by qualified and licensed Earth Tech UXO technicians in accordance with Section 4.4.4.5, Appendix C, and Appendix D.

The onsite consolidation and storage location will be in the northern area, away from other site activities. Items to be consolidated will be covered with sandbags for safety reasons. At the end of sampling activities, venting and/or demolition activities will occur, and items will be certified and evaluated for disposal and/or recycling.

4.4.4.4 Removal and Handling of OE Scrap

Items determined to not be OE, but that are OE scrap, will be inspected to determine whether they are intact practice munitions. Items determined to be intact practice munitions will be moved to an onsite temporary storage location and will be vented. Venting consists of opening the intact munition to allow the UXO technicians to see all sides of the item (including inside). Venting is always done remotely, either by mechanical means (remote-operated drill press) or by the use of a small explosive charge. After venting is completed, the item will be demilitarized (defacing the item so that it no longer looks like OE, which is normally accomplished with explosives), followed by certification and evaluation for disposal or recycling.

The SUXOS will establish temporary, nonhazardous OE scrap and metallic debris collection points for each clearance path, trench, or pothole and mark the area with a red 36-inch stake. Before OE scrap and metallic debris are moved to these designated collection points, it will be inspected by the SUXOS and determined to be free of any explosive hazards. The material at these temporary collection points will be transported to a predesignated central scrap collection point upon completion of operations in that path, trench, or pothole area.



EXPLANATION:

BIP	Blow in Place
OE	Ordnance and Explosives
DEMIL	Demilitarized (to render unusable)
DRMO	Defense Reutilization Marketing Office
SWDIV	Southwest Division, Naval Facilities Engineering Command

OE Range Evaluation Work Plan		Final
Process Flowchart OE Investigation, Site 1-EOD Range		
Date 12-01	MCAS El Toro	Figure **4-2**
Project No. 36097	EARTH TECH A Tyco INTERNATIONAL LTD. COMPANY	

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As the material is being loaded for transport to the central scrap collection point, the SUXOS will perform a second inspection of the material to ensure that it is free of explosives and other hazardous elements. All inert or empty ordnance items will be stored in the project area that is a secure area. The first inspection of the scrap will be by the SUXOS, the second by the SUXOS.

The SUXOS and UXO SSO will perform a third and final inspection of the scrap at the central collection point and will certify it to be free of any explosive hazard. The SUXOS and UXO SSO will sign and annotate a Release/Receipt Document with the following statement: "This document certifies and verifies that the OE scrap listed has been 100 percent inspected and, to the best of our knowledge and belief, are inert and/or free of explosives and related materials."

When certified free of explosive hazards and closed, each drum will be affixed with a tamperproof seal. The drummed, nonhazardous recyclable scrap will be transported to a local Defense Reutilization Marketing Office (DRMO) for recycling at no cost to the government.

4.4.4.5 Demolition Operations

Demolition operations will involve the following: (1) BIP of unsafe-to-move OE, and (2) Demolition of all the consolidated safe-to-move OE at an onsite location.

The SUXOS and UXO SSO will be onsite at all times during demolition operations. These operations will be performed under the direction and supervision of the SUXOS, who is charged with the responsibility of ensuring that procedures contained in this work plan and referenced documents are followed. The UXO SSO will monitor compliance with the safety measures contained in the site-specific *HSP* and associated documents. In case of noncompliance, the UXO SSO is authorized to stop or suspend operations. Demolition is inherently hazardous and requires strict adherence to approved safety and operational procedures. Violations of procedures by site personnel may result in immediate removal from this project.

Prior to the start of demolition, the UXO SSO will verify that the area around the operating site is clear of all nonessential personnel. The MSD will be established for demolitions and maintained in the vicinity of the disposal site. The minimum intentional demolition MSD is based on data obtained from Use of Sandbags for Mitigation of Fragmentation and Blast Effects due to Intentional Detonation of Munitions (HNC-ED-CS-S-98-7) (Appendix D). Personnel remaining onsite will be limited to those needed to safely and efficiently prepare the item(s) for destruction. Engineering controls for blast and fragment mitigation will be used for BIP work.

While preparing OE for demolition, the SUXOS and the UXO SSO will ensure that the number of personnel onsite is kept to the minimum required to safely accomplish the disposal. Authority to initiate disposal operations will rest solely with the SUXOS. Prior to authorizing the demolition of explosive charges, the SUXOS is responsible for ensuring that all personnel have been evacuated from the intentional demolition MSD, all personnel have been accounted for, all pertinent parties have been notified of an impending demolition shot, and the area is secure. Prior to priming demolition shots, the SUXOS will direct all nonessential personnel to withdraw outside the intentional demolition MSD. Upon priming demolition shots and prior to detonating demolition shots, all remaining personnel will withdraw outside the demolition MSD.

Upon completion of demolition operations, including appropriate wait periods, the UXO team will visually inspect each demolition shot. Upon completion of this inspection, and assuming there are no residual hazards, the SUXOS will authorize the resumption of site operations and soil sampling to evaluate releases. OE scrap collection will be performed following each successful demolition (safe-to-move OE and unsafe-to-move OE).

Fire Safety. The SUXOS will notify the local fire department of the location and approximate times prior to demolition. The PM will notify the local fire department approximately 10 minutes before a demolition.

Notifications, Evacuation, and Site Control. Site 1 is currently secured by a fence, and access is only for authorized personnel. Prior to initiation of demolition operations, notifications will be made to the SWDIV resident-officer-in-charge of construction (ROICC), who will coordinate with the Orange County Sheriff's Department (caretakers of MCAS El Toro). Additional local agencies who will be notified include law enforcement, fire, medical, and Federal Aviation Administration (FAA) for Los Angeles control. For demolitions, all nonessential field personnel will be evacuated to a distance greater than the MSD. Prior to priming the demolition charges, all avenues of ingress will be physically blocked by project personnel. Radio communications will be maintained among all concerned parties. Avenues of ingress will not be opened without the express permission of the SUXOS and the UXO SSO. A constant state of vigilance will be maintained by all personnel to detect any intrusion into the demolition MSD.

Explosives Accountability. Earth Tech will obtain and document all explosives used for the disposal of OE discovered onsite in accordance with procedures described in Section 5.15, and using applicable references listed in Appendix F, and the administrative record list. All unused explosives will be returned to the explosives supplier at the completion of each day's operations.

4.4.4.6 Sampling to Evaluate Releases Caused by Demolition

As part of the RI (which will be conducted concurrent with this OE Range Evaluation), Site1 will be characterized for chemical contamination. During intrusive investigations at geophysical anomaly areas by trenching and potholing by UXO personnel to characterize explosive safety risk, soil samples will be collected to evaluate chemical contamination in accordance with the methods and procedures in the Phase II RI Work Plan (Earth Tech 2001a).

BIP Locations. BIP will be conducted on unsafe-to-move OE items that are revealed upon investigating geophysical anomalies. To evaluate any chemical contamination due to these OE items, soil samples are required. Since these items have been determined to be unsafe to move, soil samples will be collected after BIP is conducted. At each location where BIP is conducted, one soil sample will be collected and analyzed for the full suite of analyses as specified in the RI Work Plan (Earth Tech 2001a). These samples will also evaluate any releases caused by the BIP demolition.

Onsite Consolidation Location. After demolition activities are conducted at the onsite consolidation location, all sandbags will be inspected for ruptures. Any ruptured sandbag will be sampled for explosives and will be characterized and disposed of appropriately, based on the results of the analyses. Soil sampling will only be conducted at areas determined to be impacted from demolition activities at the onsite consolidation location and analyzed for explosives only.

4.4.4.7 Onsite OE Transportation and Storage

Transportation of OE and explosives will comply with all federal, state, and local regulations. Transportation of explosives and OE onsite will comply with the following:

1. Vehicles will be inspected using Daily Vehicle Inspection Checklists and will be properly placarded;
2. Explosives will be transported in open vehicles;
3. Vehicle engines will not be running. Wheel chocks and brakes will be set when loading or unloading explosives;

4. Beds of vehicles will have dunnage or sandbags to protect the explosives from contacting the metal bed and fittings;
5. Vehicles transporting explosives will have a first-aid kit, two 10-pound-rated fire extinguishers, and communications capabilities;
6. Items that initiate explosives, such as detonators, will remain separated at all times;
7. Compatibility requirements will be observed;
8. Any operator transporting explosives will have a valid California driver's license.

Drivers will comply with posted speed limits, but will not exceed a safe and reasonable speed for conditions. Vehicles transporting explosives off-road will not exceed 10 miles per hour.

4.4.4.8 Management and Storage of Demolition Materials

Specific procedures apply to explosives management on sites contaminated with OE. These responsibilities include acquisition, licenses or permits, initial receipt, storage, removal notification, explosives compatibility, inventory, transportation, and audit criteria. Management and storage of demolition materials will be conducted in accordance with Appendix F.

4.4.4.9 Records

The SUXOS will prepare and submit to the PM a daily detailed accounting of activities performed over each grid, trench, or pothole, using the Grid/Trench Operations Record (Appendix E) for each grid, trench, or pothole anomaly to be intrusively investigated. In addition, the SUXOS will provide the PM with a daily summary of the following information:

- The date and time operations began;
- The date and time operations were completed;
- The number of hours, by labor category, expended in performing operations;
- The type(s) and amounts of explosives used;
- The number, type, and description of OE items encountered; and
- An estimated weight, in pounds, of the OE scrap and metallic debris removed from the site.

4.4.5 Surveying

4.4.5.1 Existing Survey Control

The benchmarks to be used are classified as Class I, *Third Order*. Horizontal control will be based on the English system and referenced to NAD83 and Zone 6 of the California State Plane Coordinate Grid System. Horizontal accuracy of the roving units will be ±1 foot. The locations of all known survey benchmarks and established grid corners and other relevant sampling locations will be plotted on the field maps.

4.4.5.2 Plotting, Mapping, and Digital Data

All plotting, mapping, and digital data will be collected, processed, and delivered in formats compatible with the existing Geographic Information Systems (GIS) for MCAS El Toro.

4.5 DEMOBILIZATION

After completion of all investigation and clearance activities, project personnel will remove all operational capability from the area. Demobilization is anticipated to take two working days and will be conducted under the direction of the PM and either the SUXOS or the UXO SSO.

Demobilization will include, but not be limited to

- Removal of all personnel and equipment from the project area,
- Closeout of files and records,
- Return of all equipment furnished by others, and
- Notification of all appropriate points of contact and support organizations of departure.

4.6 SCHEDULE

The investigation will span approximately 1 month. The schedule on Figure 4-3 is for planning purposes only and will be revised as needed.

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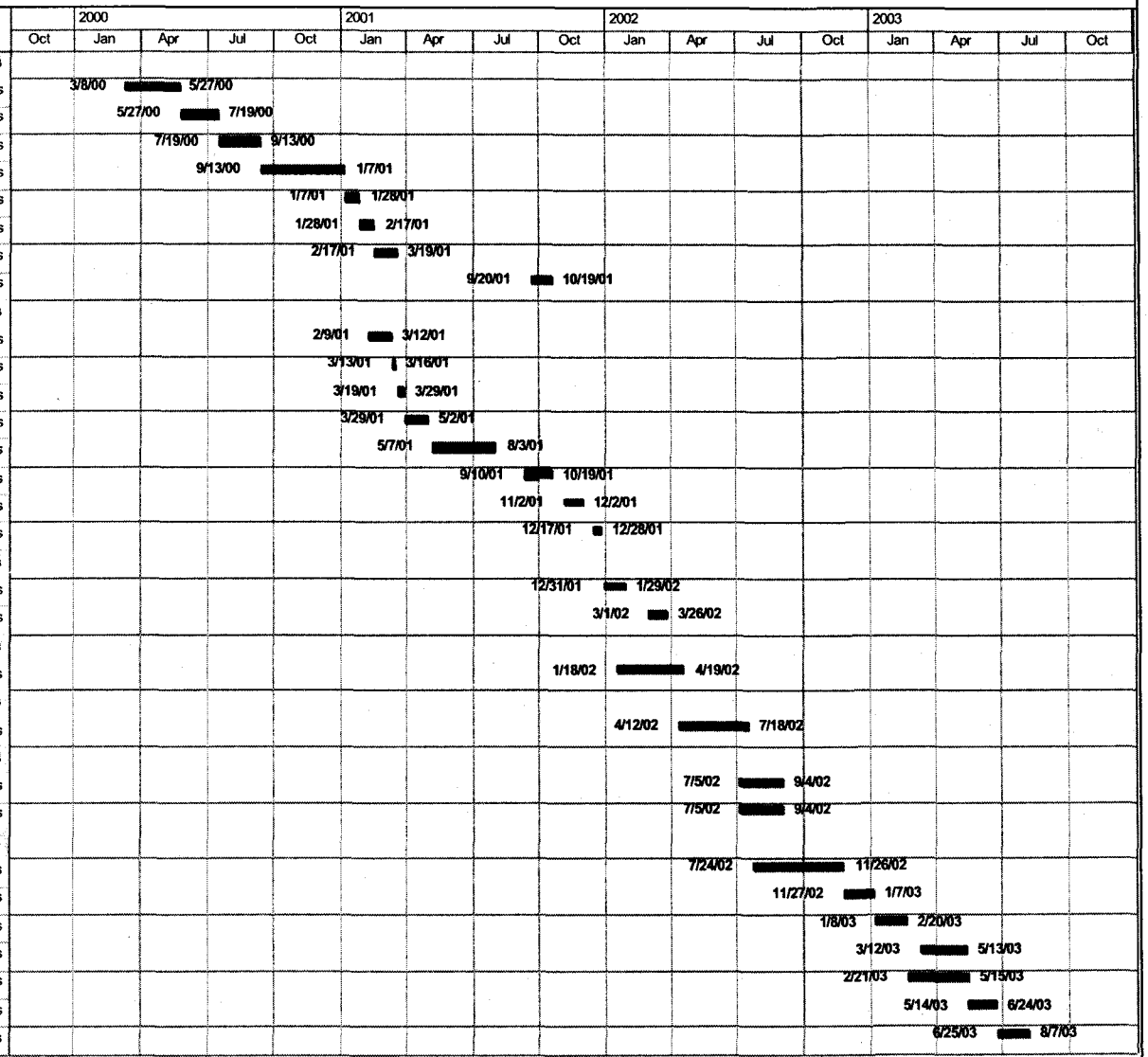
Figure 4-3
Project Schedule
Draft Final Work Plan - OE Range Evaluation
Site 1 - EOD Range, MCAS El Toro

ID	Task Name	Duration
	Task 22 - Work Plan	**423 days**
1	Preliminary Draft Work Plan/SAP	80 edays
2	Navy Review	53 edays
3	Draft Work Plan/SAP	56 edays
4	BCT Review	116 edays
5	Response to Comments	21 edays
6	Draft Final Work Plan/SAP	20 edays
7	BCT Review	30 edays
8	Final Work Plan/SAP	22 days
	Task 22.1 - OE Range Evaluation Work Plan	**231 days**
9	Preliminary Draft UXO Evaluation Work	22 days
10	Navy Review	4 days
11	Draft UXO Evaluation	9 days
12	BCT Review	34 edays
13	Response to Comments	65 days
14	Draft Final Work Plan	30 days
15	Public Notice	30 edays
16	Final UXO Evaluation Work Plan	10 days
	Task 30 - Field Investigation	**62 days**
17	Field Investigation at Site 1 - Tier I & II / OE Investigation	22 days
18	Field Investigation at Site 1 - Tier III	18 days
	Task 46 - Laboratory Analysis	**66 days**
19	Laboratory Analysis	66 days
	Task 51 - Data Evaluation	**70 days**
20	Data Evaluation	70 days
	Task 53 - Risk Assessment	**44 days**
21	Human Health Risk Analyses (PRE)	44 days
22	Ecological Risk Assessment	44 days
	Task 67 - Report Preparation	**272 days**
23	Prelim. Draft RI Report	90 days
24	Navy Review	30 days
25	Draft RI Report	32 days
26	Draft Final RI Report	45 days
27	BCT Review	60 days
28	BCT Review	30 days
29	Final RI Report	32 days



Project:Phase II RI EOD Range, Site 1
Print Date: Fri 10/5/01
Contract No: N62742-94-D004/CTO72

Task — Milestone — Project Summary
Progress — Summary

5. QUALITY CONTROL PLAN

5.1 INTRODUCTION

5.1.1 Policy Statement

It is Earth Tech policy to perform all field investigations in conformance with applicable standards of quality. The procedures specified in this quality control plan (QCP) will be considered minimum acceptable standards for Earth Tech. Additional requirements that exceed the stringency of this QCP may be specified by SWDIV or regulatory agencies. Procedures less stringent than those specified in this document shall not be adopted without prior written authorization from SWDIV, the program manager, and the corporate QC manager.

It is the personal responsibility of all personnel involved in site investigation to understand and maintain the QC issues applicable to their work.

This QCP has been developed to comply with appropriate industry and regulatory standards. It will be used as a management tool to ensure that OE range evaluation-related activities are conducted in a planned and controlled manner, that the product of those activities conforms to SWDIV contract requirements, and that appropriate documentation exists to support each activity for which Earth Tech is responsible.

5.1.2 Scope

This QCP consists of the plans, procedures, and organization necessary to produce an end product that meets the requirements specified in CLEAN II Contract No. N62742-94-D-0048 contract task order No. 0072, and the Statement of Work (SOW) addressing IRP Site 1, Explosive Ordnance Disposal Range, Marine Corps Air Station, El Toro, California. This plan includes a designated QC organization with the authority to enforce all provisions. The plan governs all operations by Earth Tech and its subcontractors, both onsite and offsite. It covers submittals, field activity control, field changes, equipment standardization and maintenance, audits, deficiencies and noncompliance, and associated documentation and recordkeeping. The QCP is designed to follow the sequence of field operations.

5.1.3 Quality Assurance

Quality assurance consists of an evaluation of the geophysical paths and collected surface and subsurface data by an independent party. The purpose of the evaluation is to assess whether the geophysical investigation area coverage and data collection meet the specification of the SOW.

5.2 SITE-SPECIFIC QUALITY CONTROL PLAN

This QCP describes the QC procedures to be followed during the geophysical investigation data collection at Site 1 and documentation associated with the RE assessment. Site-specific information includes, but is not limited to, project personnel, definable features of work, required control operations, equipment tests, specific equipment calibration and response check procedures, and SWDIV or regulatory agency requirements.

Notification of Changes

After acceptance of the site-specific QCP, Earth Tech will notify SWDIV in writing, using the field change form in Appendix E, a minimum of 7 days prior to implementing proposed changes. Proposed changes will be subject to acceptance by SWDIV's and Earth Tech's QC managers.

5.3 QUALITY CONTROL ORGANIZATION

Earth Tech has selected a project team to provide the specific technical and management capabilities and qualifications to perform the contract work. The project organization will ensure that all project objectives are met in a timely and cost-effective manner. Key Earth Tech QC personnel and their titles and telephone numbers are listed in Table 5-1.

Table 5-1: Earth Tech Quality Control Organization

Title	Earth Tech Personnel	Telephone Number
Program Manager	Ken Vinson	808-471-0111
Project Manager	Crispin Wanyoike	562-591-2057
Quality Control Manager	Greg Peterson	909-554-5047
Health and Safety Manager	Robert Poll	562-951-2242
Field Quality Control Manager	Buzz Barton/ John Dickerson	909-554-5006/ 5023
GIS Manager	Julie Abinto	909-554-5001
Project Geophysicist	John Dickerson	909-554-5023
Project Safety Officer	Wayne Snowbarger	909-554-5057

These key QC personnel will not be replaced without the approval of SWDIV. The QC manager will provide the names, qualifications, duties, and responsibilities of each proposed replacement to SWDIV.

An organization chart showing the lines of authority for implementation of a multiphase control system for monitoring QC activities is shown on Figure 5-1. The job requirements, responsibilities, duties, and authorities of key QC personnel are discussed below.

Program Manager

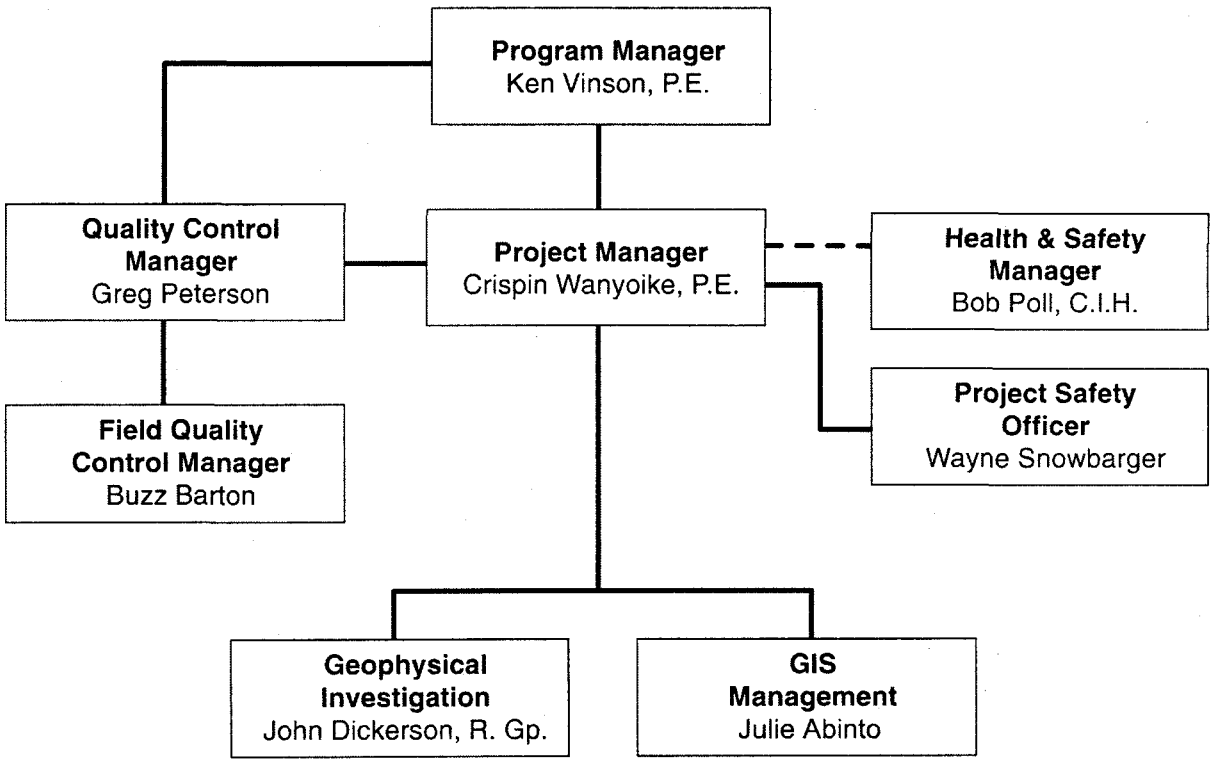
The program manager is responsible for overall direction, coordination, technical consistency, and review of the contract. Responsibilities and authorities include

- Final approval and review of work plans, project deliverables, schedules, contract changes, and labor allocations, approval of budgets and schedules, and changes in budgets and schedules;
- Ensuring availability of personnel assigned to the project for the duration of the contract;
- Overseeing coordination between management, field teams, and support personnel to ensure consistency of performance;
- Communicating, as necessary, with SWDIV to evaluate the progress of the program and to facilitate the avoidance of any potential problem.

Project Manager

The PM has the responsibility and authority for day-to-day management of all operations, including

- Review and approval of sampling, testing, and field investigation methods and QCP, including designs, schedules, and labor allocations;
- Preparation of progress reports with the assistance of key support personnel;
- Management of funds for labor and materials procurement;



P.E. = Professional Engineer
C.I.H. = Certified Industrial Hygienist
C.S.P. = Certified Safety Professional
R.Gp. = Registered Geophysicist

OE Range Evaluation Work Plan — Final

Earth Tech Quality Control Organization

OE Investigation, Site 1-EOD Range

Date 12-01	MCAS El Toro	Figure 5-1
Project No. 36097	EARTH TECH	

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- Technical review of all project deliverables;
- Establishment and enforcement of work element milestones to ensure timely completion of project objectives;
- Frequent communication with SWDIV regarding day-to-day progress of the project.

Quality Control Manager

Earth Tech's QC manager will perform duties independent of any cost, scheduling, and other performance constraints. These issues are the responsibility of the program manager or the PM. The QC manager will be responsible for reviewing and updating the QCP as needed and for verifying compliance with the plan. Compliance will be verified through audits of project activities by the QC manager, who has the authority to require corrective actions and stop work (work stoppage will be coordinated with SWDIV), as needed, to ensure compliance with the QCP.

Health and Safety Manager

Earth Tech's health and safety manager will be responsible for implementing the corporate health and safety program, reviewing and monitoring compliance with the site-specific *HSP*, implementing corrective measures for health and safety deficiencies, and ensuring required training and medical monitoring of personnel. The health and safety professional has the authority to require corrective measures related to health and safety issues and to stop work, if required, to ensure a safe working environment.

Field Quality Control Manager

Requirements for this position include proven technical competency in the areas of work for the assigned project and a minimum of 3 years of field investigation experience on projects similar to those required by the contract. The field quality control manager (FQCM) reports directly to Earth Tech's QC manager and is responsible for managing all Earth Tech activities at the site, implementing the QCP, and

- Implementing field investigation QC activities including field management of ground reconnaissance and environmental protection programs;
- Ensuring that field investigations comply with contract requirements, including enforcement up to and including work stoppage;
- Scheduling to ensure that the FQCM or the FQCM alternate is onsite during all field activities;
- Coordinating with Earth Tech field teams to verify that the appropriate personnel are being used during all field investigation activities, all work phases, and work shifts;
- Implementation and documentation of QC activities. This work will be completed daily by the FQCM, or designee, at the job site. The FQCM will review the markups daily to ensure that they are complete and correct and will confer with Earth Tech's project geophysicist, Earth Tech's health and safety professional, site supervisor, and the subcontractor field supervisors to stay informed on project performance;
- Delegation of QC duties to qualified staff members. The QC staff will report to and be supervised by the FQCM.

Field Quality Control Manager Alternate

When the FQCM is not onsite, the Earth Tech onsite manager will serve as the FQCM alternate. The requirements and responsibilities of this position are identical to those of the FQCM.

Project Geophysicist

Requirements for this position include proven technical competency in the areas of work for the assigned project, and a minimum of 5 years of geophysical investigation experience, including OE detection and mapping investigations. The project geophysicist reports directly to the FQCM and is responsible for the following:

- Evaluating results of the geophysical equipment field test and technology evaluation;
- Designing geophysical data collection and reduction processes;
- Reviewing geophysical field data;
- Verifying validity of measurement methods, data consistency, and reproducibility.

Project Safety Officer

The Earth Tech project safety officer (PSO) is responsible for performing the routine duties for health and safety, with the assistance of the designated health and safety professional. The PSO will administer the site-specific *HSP* and addenda. These responsibilities include

- Performing regular and frequent site inspections to find hazards and observe personnel at work,
- Stopping work when necessary to prevent injury or illness,
- Ensuring personal and environmental health and safety,
- Investigating all injuries and illnesses,
- Developing and implementing corrective action plans to eliminate or mitigate hazards.

5.4 FIELD INVESTIGATION QUALITY CONTROL PERSONNEL QUALIFICATIONS

A summary of qualifications of Earth Tech QC personnel is included in Table 5-2.

Table 5-2: Qualifications of Earth Tech Quality Control Personnel

Name	Position	Qualifications/Degree
Ken Vinson, P.E.	Program Manager	M.S. Environmental Engineering B.S. Civil Engineering
Crispin Wanyoike, P.E.	Project Manager	M.S. Civil Engineering B.S. Civil Engineering
Buzz Barton	FQCM	B.S. Business Management and Administration, U.S. Navy (retired), Master EOD Technician
Greg Peterson	Quality Control Manager	U.S. Navy (retired), Master EOD Technician
Robert Poll, C.I.H., C.S.P.	Health and Safety Professional	Certified Industrial Hygienist - B.S. Nuclear Engineering
Julie Abinto	GIS Manager	B.S. Computer Science
John Dickerson, R.Gp	Project Geophysicist/FQCM	B.S. Geology B.A. History

Name	Position	Qualifications/Degree
Wayne Snowbarger	Project Safety Officer	HAZMAT Supervisor M.S. Civil Engineering B.S. Civil Engineering

Earth Tech and the site manager maintain personnel files for each employee. These records include copies of licenses, training records, and certificates of qualifications that support employees' placement and position. Prior to an employee's initial assignment or any change in duties or assignments, the PM physically reviews the employee's licenses, training records, and certificates to ensure that the employee is qualified. Because ordnance firms typically rely upon temporary-status employees to fill field positions for UXO-qualified personnel, Earth Tech will ensure that all UXO-qualified personnel meet DoD standards prior to mobilizing to the site.

All training and health records for field personnel will be maintained onsite, including the 40-hour Occupational Safety and Health Administration (OSHA) health and safety training certificates; 8-hour supervisor training records; the 8-hour annual refresher course; certificate of medical clearance and annual physical exam; the current certificate for cardiopulmonary resuscitation (CPR) training and first aid; and other applicable certifications.

Specific training for field equipment, including GPS and magnetometer operations and procedures, will be provided to all personnel during the initial safety briefing and site-specific training.

5.5 FIELD ACTIVITY CONTROL

Earth Tech will perform inspection and surveillance of all work areas to maintain control over field activities identified in the work plan.

The controls will ensure that qualified personnel and approved procedures and equipment are used and that specified process parameters and environmental conditions are maintained. In addition, the controls will ensure that all requirements of the contract are met.

5.5.1 Project Site Inspection

The FQCM, or designee, will perform periodic inspections of job site activities. Appropriate technical assistance will be provided to perform the inspections, as necessary, for the specific field investigation being performed. The inspections will include, but not be limited to, the following

- Examination of the quality of workmanship;
- Compliance with contract requirements;
- Compliance with approved, required submittals;
- Verification that all required equipment calibration and response checks have been performed and that results comply with contract requirements and the work plan;
- Check for defective or damaged equipment;
- Verification, inspection, and documentation of delivery and storage of material and equipment to the site;
- Performance of followup checks and correction of all deficiencies prior to the start of additional features of work that may be affected by the deficient work; Earth Tech will not conduct field operations using nonconforming investigative work methods.

5.5.2 Final Inspection

At the completion of all fieldwork or any defined increment of the fieldwork, the FQCM will conduct a completion inspection of the work and develop an inventory checklist of any items that do not conform to the contract requirements. Such a list will be included in the QC documentation and will include the estimated date by which the deficiencies will be corrected. The PM and FQCM will make a second completion inspection to ascertain that all deficiencies have been corrected. The completion inspection and any required deficiency corrections will be accomplished within the time specified for completion of the work in the contract.

5.5.3 Control Documentation

All inspection and surveillance documentation will be maintained in the project files and will include

- QC reports (blanks in Appendix E),
- All equipment calibration/response equipment maintenance results,
- QC-related meeting minutes,
- All nonconformance and corrective action documents as well as audit documentation.

These documents will include the following information:

- Earth Tech personnel and their area of responsibility;
- Weather conditions;
- Operating equipment with hours worked, idle, or down for repair;
- Work performed each day including location, description, and worker(s);
- Test and/or control activities performed with results and references to contract requirements. Deficiencies should be noted along with corrective action;
- Quantity of materials received at the site with statement as to acceptability, storage, and reference to contract requirements;
- Submittals reviewed with contract reference, by whom it was submitted, and action taken;
- Job safety evaluations stating what was checked, results, and instructions or corrective actions;
- Instructions given or received and conflicts (if any) with contract requirements;
- Contractor's verification statement.

The QC Report, which is to be kept onsite, will be the primary document, with all other applicable reports and forms attached to it. Copies of the reports will be available to SWDIV upon request. All calendar days will be accounted for throughout the life of the contract. Reports will be signed and dated by the FQCM. The report from the FQCM will also include copies of any reports prepared by subordinate QC personnel.

5.6 Field Data Control

5.6.1 GIS System

To be consistent with field procedures and SWDIV requirements, Earth Tech will maintain all data in the North American Datum of 1983 California State Plane feet.

As data are collected in the field, they will be integrated into the GIS. A GIS daily log will be maintained to include the following:

- Identify data provided to GIS;
- Identify the nature of the data;
- Identify relevant file names;
- Identify new data layers created (by name and location);
- Identify when data layers are backed up/transported to Earth Tech office.

Data will be maintained as "incoming" (copies of data as provided to GIS), "working" (incoming data manipulated to review, analyze, or create GIS products), and "final" (ready to be transmitted to SWDIV).

File maintenance and naming conventions will be used as follows:

- Logical directory structures (Windows "folders") will be established and maintained throughout the project;
- Interim files will be named by data type and general location (i.e., by field reconnaissance area, sector, grid, or other unit as applicable);
- Ad hoc files (e.g., to support map graphics creation) will be maintained in a separate location from formal data;
- Files for formal transmittal will follow SDS/OE-GIS naming conventions.

GIS data will be maintained on a field computer specifically provided for the project. Commercial-off-the-shelf (COTS) software, or software provided by SWDIV will be used for all GIS processing. Data will be backed up on secondary media (either ZIP Disk, writeable CD-ROM, or secured FTP site) daily to minimize data loss. Data will be transmitted to Earth Tech's Colton, California, office, weekly to enable support by offsite personnel and to ensure data security.

5.6.2 Geophysical Data Evaluation

Field data will be reviewed to ensure complete coverage, measurement precision, representativeness, and geophysical reasonableness of the survey results. A field sketch map of mapped survey grids and paths will be made as the geophysical data collection progresses. All activities related to geophysical data collection will be documented in the daily log. Field maps will note date and time of the survey, area covered, and the location and description of noise sources that will affect interpretations. These will be reviewed daily. Daily logs will record

- Morning pre-survey checks of instrument and batteries,
- Safety and planning briefing,
- Identification of traverse segment(s) to be mapped,
- Equipment setup,
- Definition data file names,
- Initialization of data logger(s) to record geophysical response,
- Performance of instrument standardization,

- Traverse of survey paths to collect data, and verification of complete investigation of all segments,
- Delivery of digital survey data to the site manager at the completion of each survey day.

5.6.2.1 PERFORMANCE CRITERIA

Locational Accuracy. Survey lane segments must correspond to the areas actually investigated by the geophysical teams. Further, the data acquired along each survey lane must be accurately located relative to state plane coordinates to assure proper characterization of the sectors. Achievable tolerances for positional accuracy for the geophysical investigation will be extrapolated from the control plot survey, geophysical anomaly profiles, and target location maps to be provided through the above tasks.

The state plane coordinates recorded for each transect will be compared with a master listing to ensure that the sampling data are accurately located within the study area. The field logs will also be reviewed each day to verify that data were collected following a continuous progression along the transects. If the survey progression was interrupted for a particular segment because of terrain or other considerations, the causes of the deviation and the actual mode of progression should be fully described in the daily log notes. Plots of the survey progress will be updated each day and transferred to a site map to aid in tracking the actual search areas.

Instrument Precision. Proper operation and function of the geophysical survey system will be checked and documented in the field log each day by a standardization process prior to beginning the day's geophysical surveys. Instrument standardization responses will vary by no more than ±10 percent of standard response obtained for each deployed geophysical system. The acceptance range will be specified at ±10 percent of the standard response (calculated mean residual anomaly). Field log entries will be inspected to ensure that instrument performance meets the standardization criterion.

Completeness. Data must be collected in such a manner that a data mesh specific to the targets of concern could be generated for the transect survey. Field logs will be reviewed, and digital data will be posted to a segment track map to determine if there are any missing data stations not accounted for in the field notes.

The field review will ensure that the transect investigation was complete by verifying that the data volume for each receiver array is comparable (±1 percent) and that the spatial data density (measurements per unit distance) is representative of the mapping effort described in the daily log. Survey data will be captured such that 98 percent of the measurements are recorded at increments of 1 foot or less along each transect. Field notes will be compared to the downloaded digital file data to assure correspondence between transects searched and transects recorded.

Geophysical Reasonableness. Given the existing geological environment and prior land use of the survey area, the recorded geophysical responses must reflect the physical properties of conductive materials at the near-surface. Data will be inspected to ensure anomaly responses caused by small, finitely bounded concentrations of conductive soils or minerals are differentiable in the recorded data. Noise levels in the data will be analyzed to ensure that they are sufficiently low to allow adequate signal-to-noise differentiation of pertinent anomalies, based on static and translational noise tests conducted during the equipment field tests.

5.6.2.2 CORRECTIVE MEASURES

Corrective measures will be determined on a case-by-case basis, as necessary.

5.6.2.3 QUALITY CONTROL SUMMARY

The quality assurance (QA)/QC results of the geophysical survey will be tracked on a master spreadsheet that will tabulate survey area identification, coordinates, and date surveyed. A QC summary will be prepared and submitted to the SWDIV Project Manager at the completion of the field effort. The summary will include the items delineated in the following subsections.

Precision

A mean deviation from the standard response will be calculated for each instrument used. This will be reported in a progressively updated table.

Accuracy

Any discrepancies in positional or locational accuracy of the data noted during the field review will be described, including steps taken to correct or resolve any such QC issues.

Completeness

The percentage of coverage of each investigated segment will be tabulated. Significant lack of coverage (> 2 percent missed) will be flagged and annotated with the steps to be taken to resolve the missed coverage. Unavoidable obstacles will have been mapped on the field sketches and should result in direct correspondence with missing data. Data dropouts or inexplicable data shortages, if not detected during the field review, will be discussed with personnel onsite to identify the root problem and steps needed for resolution.

Reasonableness

Any variations or results not compatible with prior results or expectations will be reviewed with the subcontractor geophysicist to determine causative features that may be present. These field contacts will be summarized and included in the weekly QC summary report.

5.7 EQUIPMENT CALIBRATION/RESPONSE CHECK

This section applies to all tools, instruments, and equipment used in the field for OE safety support and related activities affecting quality. Rulers, tape measures, levels, and other such devices need not be standardized if normal commercial equipment provides adequate accuracy, but will be maintained in good working condition.

5.7.1 Weekly Calibration/Response Check Log

All safety equipment will require a daily calibration and response check against a known source to ensure that quality standards are maintained. The weekly calibration and response log (blanks in Appendix E) will be used to document these checks. The records will indicate the time and date of the last calibration and response check, the item name, and serial number or identification number. Each completed weekly log will be dated and signed.

5.7.2 Metal Detector Checks

All metal detectors will be checked daily against a known metallic anomaly source. Prior to UXO escort activities, a check bed will be "blind seeded" by burying three to four steel simulators approximating the size and nominal equivalence of a 20mm projectile (the smallest OE item expected to be located at Site 1) at a density of 6 per acre and to a depth of 8 inches bgs. Metal detectors are checked against these sources to ensure that they are operational and capable of

detecting targets of concern. To ensure that instruments remain operational during field operation, UXO personnel will periodically check all instruments against a surface anomaly (i.e., keys, watch, leatherman).

5.7.3 Maintenance

Equipment will be protected from dust and contamination and visually checked for damage prior to use.

Periodic maintenance on the safety equipment will be performed on a regular basis according to the manufacturer's operating instructions. All maintenance will be recorded in the Equipment Calibration Log.

Critical spare parts will be kept on hand to minimize downtime.

5.7.3.1 Shipping of Equipment

Equipment sensitive to temperature changes will be properly insulated. Equipment will be adequately packaged to prevent damage from jarring, shock, or vibration.

5.7.3.2 Records

Records pertaining to calibration/response checks include

- Daily Field Activity Report entries,
- QC Report,
- Equipment Calibration and Response check log entries,
- OE logbook.

5.8 Field Change Control

5.8.1 Responsibilities

5.8.1.1 General

Any individual, including the PM, assigned to perform or supervise a task, who recognizes the necessity for a field change, is responsible for instigating appropriate field changes and completing and submitting the Field Change Request form for review and approval.

5.8.1.2 Project Manager

The PM is responsible for

- Evaluating validity and acceptability of the field change request with respect to the contract requirements;
- Evaluating and documenting the effect of the field change on project costs;
- Accepting, qualifying, or rejecting the field change;
- Soliciting and obtaining approval (from SWDIV) of any changes to the contract or costs prior to performance of any work affected by the changes.

5.8.1.3 Field Quality Control Manager

The FQCM is responsible for evaluating and approving the changes to ensure that all QC requirements are met and that all changes to the contract are properly reviewed and approved by the responsible personnel (Earth Tech and SWDIV). The FQCM will assist the PM in negotiation of changes to the contract scope with respect to QC.

5.8.2 Procedure

5.8.2.1 Recognition of Necessity for Field Changes

During the course of the field investigation, approved work plans, technical procedures, and design documents will be followed unless some unforeseen contingency occurs. In this instance, the performer of the task is required to determine the best approach toward satisfactory completion of the task through the following actions:

- If warranted, stop affected activities until the PM and/or acting FQCM evaluates the situation,
- Instigate field changes for approval.

5.8.2.2 Instigation of Field Changes

Field changes and major project impacts will be defined as follows:

- A Minor Change is defined as a field change that would not adversely affect the quality of the data or product in the field, the rationale for the field procedures, or costs. Examples of minor changes are as follows:
  a. Changing the sequence of the field activities,
  b. Changing any of the administrative requirements relative to a remedial effort with the exception of those requirements mandated by federal or state regulations (e.g., chain-of-custody procedures).
- A Major Change is defined as a field change that will adversely affect the quality of field activities, cause a significant change in the cost or the scope of the activity, or cause significant delays in the schedule. Examples of major changes are as follows:
  1. Significantly changing the area of sampling to be investigated,
  2. Repairs or relocation of utilities not anticipated,
  3. Significantly relocating a plant or animal species not defined in the contract.
- A change with Major Project Impact is defined as a change that has a major impact on project cost, schedule, and/or technical performance. Some changes defined as major changes may have major project impact.

Field changes will be documented by completing the Field Change Request form (Appendix E), and describing the reasons for the change, the recommended disposition, cost impact, impact on previous work, and type of change (Minor, Major, Major Project Impact). The signed and dated form will be immediately provided to the PM and FQCM for review.

Minor changes may be implemented prior to approval by the PM and the FQCM.

5.8.2.3 FINAL DISPOSITION

After completion of the review and approval process, the Field Change Request Form will be forwarded by the PM to personnel responsible for conducting the work and the FQCM, with the following action requested:

- If approved, the personnel responsible for the work will implement the change;
- The FQCM will note final disposition of the field change request (e.g., change incorporated and work completed, change rejected and work performed per original requirements) on the Field Change Request form;
- The FQCM will verify that all changes to the SOW are marked on all copies in use in the field and on file;
- The completed Field Change Request form will be submitted to the project file;
- The PM will incorporate any approved cost adjustments into the budget and work breakdown structure (WBS).

If an implemented Minor Field Change is not approved by one of the reviewers, it will be deemed a nonconforming condition and, as such, will be treated as directed by the procedures for Nonconformance and Corrective Action.

5.8.3 Records

Records pertaining to Field Change Control will include

- Field Change Request Form (Appendix E),
- Field Change Request Log (Appendix E).

5.9 AUDITS

An audit is an examination and evaluation performed to determine whether applicable elements of the site-specific QCP and work plan have been performed, documented, and effectively implemented in accordance with specified requirements. In accordance with the SOW, the QC Specialist's responsibility is not envisioned as a full-time onsite position. Therefore, the QCM will conduct one onsite QC audit during the two-week field activity, using the Audit Schedule Checklist (Appendix-F).

5.9.1 Responsibilities

The program manager will be responsible for reviewing audit results.

The QC Manager is responsible for

- Implementing and conducting an audit program of Earth Tech activities per the requirements of this procedure,
- Reporting quality deficiencies to management,
- Reviewing and evaluating audit reports to determine if quality deficiency trends are developing,
- Evaluating the implementation and effectiveness of the QCP on a regular basis.

The PM is responsible for

- Implementing corrective action in response to Quality Deficiency Notices (QDNs),
- Responding to QDNs within 5 days, or as stipulated in the audit report.

5.9.2 Procedure

5.9.2.1 Objectives

Audit objectives are as follows:

- To verify by evaluating objective evidence that the QCP and work plan are being implemented;
- To assess the adequacy, effectiveness, and thoroughness of the QCP and work plan;
- To verify conformance with approved procedures, work plans, drawings, specifications, and procurement documents;
- To identify quality deficiencies;
- To verify correction of previously identified quality deficiencies.

5.9.2.2 Scheduling Requirements

The QC manager will audit project-related activities at least semiannually. Field activities will require an audit at least once for each complete or partial month of field activity. Re-auditing to verify implementation and satisfactory completion of recommended corrective actions will be performed as deemed necessary.

5.9.2.3 Unscheduled Audits

Unscheduled audits may be performed if the following occurs:

- Significant changes are made in functional areas of the QCP such as significant reorganization or procedure revisions;
- There is evidence of a serious breakdown in the implementation of the QCP;
- A systematic, independent assessment of program effectiveness is necessary;
- It is necessary to verify implementation of recommended corrective actions.

5.9.2.4 Report

An audit report will be prepared and signed by the QC manager and will include the following:

- Audit scope,
- Audit date,
- Auditor identification,
- Controlling documents,
- Personnel contacted,
- Audit result summary, including an evaluation statement of elements audited,
- Identification of any QDNs.

The report, with attached QDNs, will be distributed to responsible management. The audit report will be issued within 5 days of the audit.

5.9.2.5 FOLLOWUP

Project Manager. The PM will review the audit report and any QDNs. If a QDN has been issued, the PM will determine and schedule appropriate corrective action including action, to prevent recurrence. The PM will describe the corrective action taken on the QDN and submit the notice to the QCM within the designated time frame, which should not be more than 5 days after audit report issuance.

QC Manager. The QC Manager will

- Verify that the PM completes the appropriate sections of the QDN and submits the form within the designated time;
- Review the response and determine whether it is satisfactory;
- Evaluate evidence of completion of corrective action to determine whether the action taken is satisfactory;
- Request an additional response if the response and/or corrective action is unsatisfactory;
- Close the QDN, if the response and/or corrective action is satisfactory;
- Complete the Audit Closure blocks.

5.9.3 Records

Records pertaining to audits will include

- A QC Audit Report (Appendix E).

5.10 NONCONFORMANCE/CORRECTIVE ACTION

5.10.1 Purpose

The purpose of this section is to

- Verify that conditions adverse to quality (nonconformances) are identified and reported to appropriate management levels;
- Verify that nonconforming items (e.g., test data, analyses) are appropriately marked and/or segregated and not used until corrective action has been completed;
- Verify that appropriate corrective actions or dispositions (i.e., accept, reject, repair, rework) have been recommended, approved, and implemented;
- Provide a system for the review and analysis of conditions adverse to quality (nonconformance) to determine their causes and trends, and to verify that corrective actions will preclude recurrence of adverse conditions.

5.10.2 Responsibility

All Earth Tech project team personnel will be responsible for identifying and reporting nonconformance.

The supervisor of the activity is responsible for

- Evaluating nonconformances to determine if the work should be stopped,
- Proposing corrective action,

- Implementing corrective action,
- Evaluating nonconformance impact on prior work or on previously obtained data (if any) and notifying all individuals and organizations that may be affected by the nonconformance and resulting data.

The PM and FQCM are responsible for

- Evaluating nonconformances to determine if the work should be stopped and/or if the nonconformance should be reported to SWDIV,
- Approving the proposed corrective action or disposition,
- Verifying that the corrective action or disposition has been satisfactorily implemented,
- Providing (if necessary) SWDIV with a written report of any nonconformance.

The QC manager is responsible for reviewing nonconformances to determine if trends adverse to quality are developing, and proposing and implementing long-term corrective action to prevent recurrence of any identified nonconformance trends.

5.10.3 Procedure

5.10.3.1 Identification and Reporting of Nonconformances

A nonconformance exists if there is a deviation from or noncompliance with the contract SOW and contract requirements, the QCP, approved procedures, work plans, or other project requirements. Nonconformances also include major errors in documented analysis, data or results, and deficiencies in documentation or any other aspect of the project that affects quality. Personnel who identify a nonconformance will report the condition by

- Completing Part A of the Nonconformance Report (NCR) (Appendix E);
- Requesting an NCR number from the FQCM, who will enter the NCR on the log;
- Distributing the NCR to the PM and QC manager.

5.10.3.2 Evaluation of Nonconformance Report

The FQCM, PM, and QC Manager will review the NCR to determine if

- Ongoing work should be stopped. (If work stoppage is required, work will be stopped as outlined in Section 5.10.3.5.).
- The nonconformance constitutes a significant condition adverse to quality, and in such a case, will determine the cause of the condition. Examples of significant conditions adverse to quality are failures to implement the QCP, major errors in data or analyses that had previously been approved, major deviation from the contract or SWDIV-approved work plans, major deviations from the SOW, and conditions that may affect the cost or schedule of the work. Nonconformances that constitute significant conditions adverse to quality will be reported to SWDIV as discussed in Section 5.10.3.1.
- The nonconformance has any impact on previously obtained data or reports submitted to SWDIV or another organization. If affected, the PM will note the impact in the Remarks section of the NCR and notify in writing all individuals and organizations that may be affected by the nonconformance and resulting data.

The evaluation will be documented through completion of Part B of the NCR.

5.10.3.3 Recommendation of Corrective Action or Disposition

Persons determining corrective action or disposition will have demonstrated competence, will have an adequate understanding of the requirement, and will have access to pertinent background information (e.g., the engineer responsible for the work plan). The FQCM will recommend corrective action or disposition to resolve the nonconformance by completing Part C of the NCR.

In the case of a nonconformance, the corrective action will be such as to preclude recurrence of the nonconformance.

The recommended corrective action or disposition will be reviewed and approved by the PM and FQCM.

5.10.3.4 Corrective Action Implementation and Verification of Implementation

The approved corrective action or disposition will be implemented by appropriate personnel. When completed, Part D of the NCR will be signed and dated by personnel performing the corrective action.

- Corrective action or disposition implementation and NCR closeout will be reviewed and approved by the PM and FQCM.
- The identification, cause, and corrective action for a nonconformance that is adverse to quality will be reported to the QCM.
- The completed NCR will be given to the FQCM for logging into the NCR Log and filing in the QC records.

5.10.3.5 Work Stoppage

If it is determined that work will be stopped, it will be noted in Part B of the NCR; the conditions necessary for work to resume will be noted in the Remarks section of Part B of the NCR, and coordinated with SWDIV.

The supervisor will direct project personnel to stop all affected work. Work will not be restarted until the conditions required to restart work have been satisfied and written approval has been received from the FQCM.

All work stoppages will be reported to SWDIV, as discussed in Section 5.10.3.6.

5.10.3.6 Notification to SWDIV

If SWDIV notification is required, the PM will submit a written report of the nonconformance to SWDIV and will obtain concurrence from SWDIV with the proposed corrective action or disposition.

5.10.3.7 Tracking of Nonconformance Reports

The QC manager will monitor nonconformance reports to determine if trends adverse to quality are developing. If such trends are developing (e.g., repetitive NCR related to a particular activity, organization), the QC manager will issue a written report identifying the problem to the program manager.

The program manager will evaluate the identified problem, propose, and implement a written corrective action program to prevent recurrence of the nonconformance.

5.10.4 Records

Records pertaining to Nonconformance/Corrective Action will include

- NCR (Appendix E),
- NCR Log,
- Documentation of Notification to SWDIV of Nonconformance,
- Evaluation of NCR trends,
- Corrective Action Report for NCR trends.

5.10.5 Lessons Learned

During the course of field activities, data or information may be exposed that could have eliminated or at least reduced challenges met while implementing the work plan at Site 1. These lessons learned will be valuable tools in updating plans and procedures for subsequent field activities to include further ground reconnaissance increments and geophysical or intrusive investigations. To provide a method of capturing and documenting lessons learned, they will be documented in the weekly reports submitted during the field activities.

6. SUPPLEMENTAL SAFETY REQUIREMENTS

Safety requirements for fieldwork pertaining to the tasks described in this work plan will be conducted in accordance with the site-specific *Health and Safety Plan* (Earth Tech 2001b), and the *Phase II RI, IRP Site 1, MCAS El Toro* (Earth Tech, 2001a).

For tasks identified in this work plan and not covered in the site-specific *HSP* (primarily related to OE investigation), task hazard analyses (THA) have been prepared and included in Appendix B.

6.1 SAFETY TRAINING/BRIEFING

All onsite project personnel will routinely participate in two types of safety briefings: a daily general briefing and a daily tailgate safety briefing. In addition, the SUXOS may hold a safety stand-down at any time, to address a degradation of an OE-related safety issue that has occurred. All safety training and briefings will be conducted in accordance with the site-specific *HSP* and Section 7 of this work plan.

The daily general briefing will be conducted for all onsite project team personnel at the command post prior to work. The briefing will cover general hazards for the project and any new safety issues or hazards that were identified after the last briefing. The PM will conduct the briefing, with input from the SUXOS and UXO SSO.

The SUXOS and UXO SSO will conduct daily tailgate safety briefings before starting work onsite. Written records of these briefings and the signatures of personnel attending briefings will be maintained. The briefings will focus on specific hazards anticipated at each work site during that day's operations, and safety measures will be used to eliminate or mitigate hazards. It will also refer to other ongoing operations within the area whose proximity may have safety issues. As work progresses, any corresponding changes in ingress or egress and emergency evacuation routes will also be reviewed during the tailgate briefing.

Visitor Safety Briefing. Site visitors must receive a safety briefing prior to entering the operating area and must be escorted at all times by UXO-qualified individual. All visitors entering the project area must sign in at the command post.

Environmental Awareness. Promotion of environmental awareness will be an ongoing part of daily general and tailgate safety briefings.

Safety and Environmental Violations. Safety violations or unsafe acts will be reported immediately to the SUXOS and UXO SSO. Failure of personnel to comply with safety rules/regulations or failure to report violations may result in immediate termination of employment. Reckless interference with sensitive species or blatant disregard for the environment will likewise not be tolerated.

6.2 WORK CLOTHING AND FIELD SANITATION

Work clothing will be appropriate for the conditions encountered. In most cases, this will be Modified Level D personal protective equipment (PPE), as follows:

a. Short- or long-sleeve cotton coveralls or work clothing;

b. Sturdy footwear (e.g., ankle-high work boots). UXO personnel will not wear steel-toed safety boots when using geophysical equipment;

c. Hand protection will consist of leather work gloves. Rubber inner or outer gloves may be required where increased protection is needed;

d. Respiratory protection, safety glasses, hearing protection, and hard hats will be available and worn during activities for which their use is required. Hard hats will not be worn by personnel directly involved in the excavation and demolition of OE items due to the hazards of the hard hat falling onto a hazardous explosive item and causing an unintentional detonation.

The team will be outfitted with field decontamination equipment, which will consist of portable eyewash kits, containers of wash water, paper towels, and soap. Prior to the start of daily work, these facilities will be in place and ready for use in the vicinity of the work area as needed. Good housekeeping and decontamination measures will be practiced.

6.3 MANAGEMENT OF OE HEALTH AND SAFETY RESPONSIBILITIES

Project and field-level management of health and safety requires that a management organization be established for each project. The personnel listed in the *HSP* and the associated responsibilities will remain the same for the following positions: (1) CLEAN Program Manager; (2) CLEAN Health and Safety Manager; (3) CTO Manager (Project Manager); (4) Field Manager; and (5) Site Safety Officer.

The following positions/responsibilities are described below, in addition to the above-listed positions, towards the management of the health and safety responsibilities for the OE investigation. Figure 6-1 presents the organization chart depicting the lines of authority for the management of health and safety of Earth Tech personnel during field activities for OE investigation. The Phase II RI activity, which will require UXO safety and handling support, is listed as a parallel effort with respective positions identified.

6.3.1 Unexploded Ordnance Safety Manager (UXOSM)

The UXOSM will be appointed by the PM to be principally responsible for execution of all OE operations during field activities.

The UXOSM will have knowledge of all requirements mandated by OSHA, the USACOE, EPA, 8 CCR, and Earth Tech's Corporate Environmental, Health and Safety Program. The UXOSM will be directly responsible to the PM.

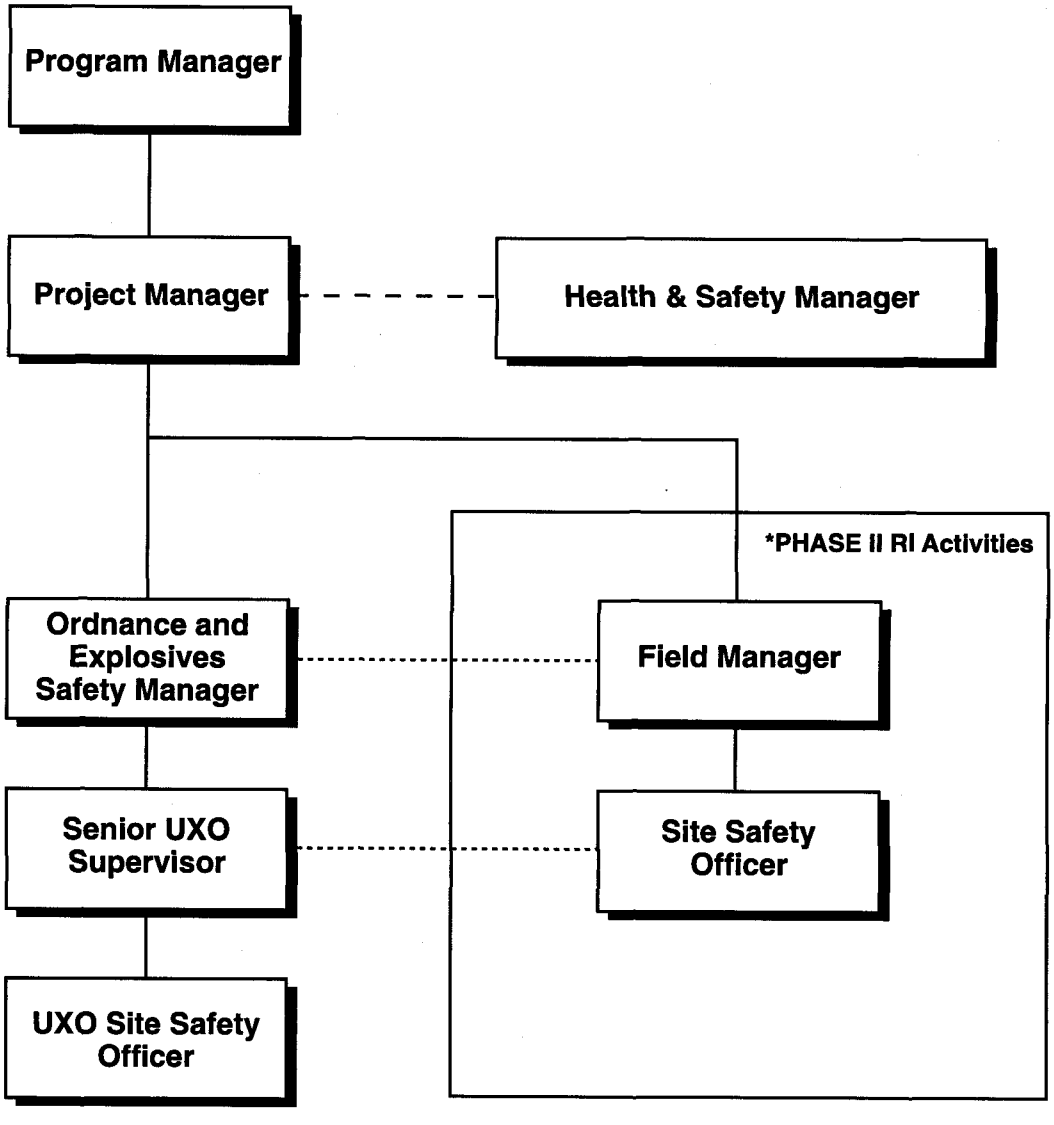
The UXOSM is responsible for the implementation of the *HSP* and will provide overall direction of the project OE functions for field activities.

The UXOSM, or his or her designee, will interface with the SSO on OE safety functions of the project and will coordinate activities with the PM.

In addition, the UXOSM will, as necessary, perform audits, surveillance, document reviews, and other OE safety functions as required to determine the continued effectiveness of the *HSP*.

The UXOSM will, as necessary, audit compliance with the site-specific *HSP* and will perform OE safety reviews of selected project tasks. Other responsibilities will include, but will not be limited to

- Developing and implementing corrective action plans to eliminate or mitigate hazards associated with OE,



UXO = Unexploded Ordnance

RI = Remedial Investigation

* = Implementation of Phase II RI activities will require OE support

OE Range Evaluation Work Plan		Final
OE Health and Safety Responsibilities		
OE Investigation, Site 1-EOD Range		
Date 12-01	MCAS El Toro	Figure 6-1
Project No. 36097	EARTH TECH, A Tyco International Ltd. Company	

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- Providing the OE safety portions of training sessions or briefings for site and visitor personnel,
- Ensuring the proper use of PPE, and
- Ensuring that all OE-related site operations are conducted in accordance with this document and with other relevant safety and health regulations and standards.

6.3.2 Senior UXO Supervisor (SUXOS)

The SUXOS will manage the onsite manpower and equipment necessary to safely conduct the OE portion of the site operations, as well as the safety and health responsibilities listed below:

- Review and become familiar with the project plans, and ensure that all OE safety concerns are adequately addressed and controlled;
- Provide the OE safety portion of any training sessions or safety briefings;
- Ensure that all OE-related site operations are conducted in accordance with this document and all other relevant safety and health regulations and standards; and
- Directly interface with, and relay safety and health concerns to the SSO.

6.3.3 UXO Site Safety Officer (UXO SSO)

The UXO SSO assigned to this project will be responsible for implementing and enforcing the OE safety and health requirements of the site-specific *HSP* with his or her team.

- Review and become familiar with the project plans, and ensure that all OE safety concerns are adequately addressed and controlled;
- Provide the OE safety portion of any training sessions or safety briefings; and
- Ensure that all OE-related site operations are conducted in accordance with this document and all other relevant safety and health regulations and standards.

6.4 PLANNED WORK ACTIVITIES

6.4.1 Scope of Investigation

OE Range Evaluation. OE Range Evaluation field activities will be implemented at Site 1 to evaluate the density and distribution of OE within the EOD Training Range and to evaluate the lateral extent of kick-outs associated with EOD training.

Field investigation activities will be conducted in accordance with this work plan and the site-specific *HSP* (Earth Tech 2001b).

OE Support for Phase II RI. The Phase II RI field activities will be implemented at Site 1 to evaluate the lateral and vertical extent of potential chemical contamination associated with EOD training activities as part of a separate investigation.

Field investigation activities will be conducted in accordance with the *Phase II RI Work Plan* (Earth Tech 2001a) and the site-specific *HSP* (Earth Tech 2001b). In addition, during the implementation of Phase II RI, all issues related to OE, including safety and handling, will be in accordance with this work plan and its appendixes.

Tier 2 of the Phase II RI, which will involve intrusive sampling in the geophysical anomaly areas by trenching, will be done concurrently with the subsurface investigation for OE evaluation.

6.4.2 Investigation Tasks

Surface Surveys. A surface survey will be conducted along the inside (and outside, if required) perimeter of Site 1 (inside the fence); the width of the survey path will be 50 feet. The survey will involve the visual inspection of the ground surface and the use of hand-held all-metals detectors.

Geophysical Investigation. Geophysical investigation will involve traversing of transects using appropriate equipment and instruments to collect data. Transects will be accomplished using lane markings.

Location Survey and Marking. Areas of concern identified during the surface and geophysical subsurface surveys will be located in the field by installing semipermanent markers.

Subsurface Investigation. Selected anomaly areas will be excavated manually using appropriate implements and tools to investigate the presence of OE. If the anomaly is deeper than 3 feet, a backhoe will be used to continue the excavation.

OE Identification and Handling. UXO-qualified personnel will inspect visually (using appropriate instrumentation) all OE and OE scraps to evaluate if the item is unsafe to move.

Inert Ordnance and OE Scrap Disposal. Non-hazardous OE scrap and metallic debris collection points will be established at each area of investigation during surface surveys and subsurface anomaly investigations. The material will be stored in drums and transported to a central predesignated scrap collection point. Inspection of the material will be performed at each of these locations to verify that it is free of any explosive hazard. The material, upon a subsequent inspection and certification, will be transported to a local DRMO for recycling.

OE Transportation. OE items encountered during the investigation will be transported on site for accumulation and disposal purposes.

Explosives Handling. Explosives will be required to destroy OE items that cannot be safely moved. Explosives will be procured from an authorized vendor, transported to Site 1, and used in demolition firing trains that will be constructed for the purpose of counter-charging or venting of OE items.

OE Destruction (BIP). OE that cannot be safely moved will be destroyed on site by BIP, by placing in explosive firing trains.

7. EXPLOSIVES SAFETY RISK EVALUATION

The explosives safety risk will be estimated in accordance with R3M guidance (DoD 2000).

Explosives safety risks will be presented in qualitative terms using a scale that ranges from A (lower) to E (higher). The estimation methods have been developed primarily to characterize risks to individual human receptors.

At Site 1, it is proposed that the risks be evaluated separately for each of the following sectors:

- Northern EOD Range,
- Southern EOD Range, and
- Buffer Zone.

This will allow for response actions, if required, to be evaluated for each of the sectors separately and to be consistent with anticipated reuse.

The critical elements which form the basis for assessing explosives safety risks are

- Potential accessibility of receptors to OE,
- Overall OE hazard, and
- Relative exposure potential.

The input variables and the scoring criteria to evaluate the explosives risk are presented in work sheets in the R3M Interim Procedures Manual (DoD 2000) and are included in Appendix G.

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Appendix A
Transient Electromagnetic Geophysical Investigation
Standard Operating Procedures

APPENDIX A

TRANSIENT ELECTROMAGNETIC GEOPHYSICAL INVESTIGATION STANDARD OPERATING PROCEDURES

This procedure details the methods and equipment to be used to collect, process, and interpret transient electromagnetic data. Transient electromagnetic data refers to the way in which the instrument records the response measurement (timed) to follow the transmission of an EM pulse. Highly conductive objects (metal) retain electrical current longer than soil materials. The electrical potential measured at the receiver above ground is initially strong, then diminishes to nothing over time as the amplitude of the current decays. The time interval during which the measurements are taken is that which best shows the persisting signal from the highly conductive target and misses the early, fast-diminishing returns from soil.

Background response levels for the measurement system to be deployed derive primarily from the characteristics of near-surface soils. The wavelengths of background responses are relatively much longer than those of finite-dimensioned objects and can be readily distinguished from the short, spike-like character of metallic (OE-target) anomalies. The instrumentation, although affected by soil conductivity, is configured such that anomaly responses caused by small, finitely bounded concentrations of conductive soils or minerals are not recorded in the data.

The transmitter generates 150 pulses per second, and induced signals are measured during off time between pulses. Potential measurements are stacked yielding effective sampling at 10 cycles per second. The electrical potential of the secondary signal is measured (in millivolts) at each of the two receivers. Because the baseline response of each of the ganged systems may differ, the background response will be biased to a common modal value. This allows direct comparison of the signal characteristics between two or more EM61s.

The geophysical methods and equipment to be used will be tested at the project site to ensure the methods, equipment, and procedures are suited to the site and will provide good quality data. The test plot will be used throughout the investigation to ensure equipment and procedures are functioning properly.

Anomaly discrimination is accomplished by identification of discrete, sharp peaks above background response levels caused by metallic sources buried in the near-surface (or twin peaks in the case of sources that are much smaller than the EM61 antenna widths). Having a pair of receiving antennas allows different measurements to be made that can be used to estimate depth-to-target and reject surface clutter.

Procedures

Geophysical data are to be digitally captured into a file with coordinates recorded relative to the state plane grid coordinate system using the standard operating procedures provided by the instrument manufacturer's user manuals. Navigation and instrument position within the investigation area will be tracked and recorded using precision surveying with state-of-the-art digital global positioning system instrumentation.

The geophysical survey team will continuously track and monitor the position of the instrumentation array during data collection to assure complete coverage of the areas of interest. This will be accomplished through the use of lane markings and by maintaining alignment of the instrument array relative to transect waypoints (e.g., brush cut pathway and/or traffic cones). Data

will be collected at 1.0-foot (0.3-meter) (or less) increments along each survey lane and automatically recorded in the data logger coincident with the California State Plane coordinates.

A daily log will be maintained that details pertinent activities, transect features, and field conditions encountered in the performance of the geophysical investigation. A field sketch map of mapped transects will be made as or before the geophysical data collection progresses/begins. All activities related to geophysical data collection will be documented in the daily log. Field maps will note date and time of the survey, area covered, and the location and description of noise sources that will affect interpretations.

Geophysical data (amplitude and location) and global positioning system data (time, position, and Position Degradation of Precision) will be downloaded periodically to avoid possible data loss or corruption. The geophysical data will be checked, edited for corrections, and processed into ASCII files. The data shall be presented in delineated fields as x, y, and z, where x and y are survey lane coordinates in easting and northing, and z is the instrument reading. Where multiple instrument values are recorded, the data will be presented as x, y, z1, and z2 in the same ASCII file.

Elements of a survey day include:

- Morning pre-survey checks of instrument and batteries
- Safety and planning briefing
- Identification of traverse segment(s) to be mapped
- Equipment setup
- Definition data file names
- Initialization of data logger(s) to record geophysical response
- Performance of instrument standardization
- Traverse of transects to collect data and verification of complete investigation of all segments
- Delivery of digital survey data to the Earth Tech site manager at the completion of each survey day on 3.5-inch, IBM-compatible microcomputer diskettes in ASCII format. The diskettes will be labeled with transect identifications and date.

Personnel

A project geophysicist will oversee the entire geophysical effort, including collection, processing, and interpretation of the geophysical data.

Production Rates

Production rates will vary depending on the instrumentation and area being investigated. All systems are expected to provide at least 5-6 line miles per day of survey coverage.

Data Resolution (Line Spacing/Grid Dimensions)

The line spacing to be used to collect geophysical data will be determined during planned geophysical equipment tests to be conducted the first day on-site. Data resolution needs to be sufficient to discriminate individual OE items.

Data Density

Initial line spacing for perimeter surveys will be 2.5 feet; station intervals along the lines will be ± 1.0 foot.

Data Processing

Geophysical data will be downloaded from field data loggers/recorders using software provided by the instrument manufacturer. These data will be uploaded to processing software specific to the instrumentation for editing the data to assign fiducials or line and station coordinates. Profiles will be generated either in provided instrument software or in a Microsoft Excel spreadsheet. Perimeter path data will be gridded and analyzed using Golden Software SURFER (GeoSoft Oasis Montaj may be used as an alternative for processing and identifying anomalies along transect lanes).

Location Surveying, Mapping, and Navigation

Field Surveying/Navigation

The survey team will navigate over the areas of investigations using a real-time kinematic global positioning system (e.g., Trimble Pro XRS and Trimble Trim Talk 900 or other systems with ± 20-cm precision).

The geophysical survey team will continuously track and monitor the position of the instrumentation array during data collection to assure complete coverage of the areas of interest. This will be accomplished through the use of lane markings and by maintaining alignment of the instrument array relative to transect waypoints (e.g., nails, flagging).

System Requirements

The roving real-time kinematic global positioning system unit used by the survey team will be referenced to a global positioning system base station that will be established at known benchmarks.

System Limitations (e.g., Global Positioning System Satellite Coverage)

With the exception of weather interference, signals from six to nine satellites will typically be captured for the fieldwork. Position Degradation of Precision, both vertical and horizontal, will be monitored to ensure the satellite geometries are sufficient to acquire useful positional data. No data will be collected with Position Degradation of Precision greater than six. The survey will be planned with reference to structures, trees, or topography that would obscure the sky and degrade satellite coverage at the sites to be investigated.

Instrument Standardization

Standardization Procedures

Proper operation and function of the instruments used will be checked and documented in the field log each day by a standardization process prior to beginning the day's geophysical surveys. The first day on site for geophysical personnel (other than for project orientation) will be used to establish baseline responses and standardization acceptance ranges for each mapping system deployed.

Standardization procedures and standard response (for each system) will be established before any geophysical mapping is performed. This will be accomplished by establishing a target and a background reference geometry and by determining the numerical difference between target-anomaly high and background response of each system. Multiple anomaly-versus-background measurements will be made to allow computation of a mean residual (anomaly response) and calculation of a standard deviation specific to the system.

Before and after each area is surveyed, the geophysical equipment will be deployed to a geophysically "quiet" area near the grid. Before the grid is surveyed, any drift compensation (DC) bias will be removed, as specified in the instrument manuals. The data logger will then be set to record over time at 4 hertz. Cable connections will be checked while monitoring the digital displays to identify and secure interfering cables and/or loose connections.

Standardization Checks

The standardization checks will be accomplished using a portable target in a fixed geometry with each receiver antenna. The portable target will be a 3-inch carbon steel sphere.

The geophysical system will record 20 seconds of data without the standard source (background reference); the source will then be introduced and an additional 20 seconds of data recorded. Finally, the source will be removed and 20 more seconds of background data recorded (in data logger). The recorded data will be visually inspected and average values for each stage of the check recorded in a field notebook assigned to the particular instrument.

Standardization consists of comparing the residual anomaly to an acceptance range and recording the values in the daily logs. Acceptance range is specified at ± 10 percent of the standard response (calculated mean residual anomaly).

Instrument Response to a Known Standard

The standardization response and acceptance range shall be recorded in the field logbooks assigned to each antenna component receiver. If a system component does not respond within the acceptance range, the standardization measurements will be repeated. Three sequential failures will cause the system to be removed from service. Any failed component must be replaced/repaired and a new standard response (with a new standard deviation and acceptance range) calculated before the component is redeployed to the field.

All instrumentation will be tested and the data reviewed to establish a baseline response and validate instrument performance prior to use for collecting field data. The standard baseline responses will be recalculated whenever any critical component of the instrumentation system is repaired or replaced, or as changing survey conditions warrant.

Instrument Drift (DC Offset)

As part of the QA/QC protocol, the first line of each grid will be repeated to enable measurement drift compensation. Significant (>5°) drift offsets will be linearly interpolated on a tilted sheet and subtracted from the field data, as necessary.

Data Processing, Correction, and Analysis

The field data will first be imported into the processing software and demoded (as necessary) and processed. Data will be corrected for navigation errors, instrument bias, and measurement drift.

All corrections, edits, filtering, or normalization of the data used to identify potential OE anomaly locations will be fully documented in a data processing log. A grid mesh corresponding to the survey grid or lane will be generated.

The data will be processed and plotted to identify significant anomaly locations/trenches. Field data will include raw and edited data, and a symbol posting of transect paths underlain by a color image/contour plot of the data.

Complete field data will be corrected for navigation errors, instrument bias, and measurement drift. The geophysical data will be checked, edited for corrections, and processed into ASCII files. The data shall be presented in delineated fields as x, y, and z, where x and y are transect coordinates in easting and northing, and z is the instrument reading. Where multiple instrument values are recorded, the data will be presented as x, y, $z_1 \ldots z_n$ in the same ASCII file.

Initial processing will be limited to a symbol posting of the measurement stations along the transects and generation of simple profiles of the data measured at each of the geophysical receivers. A visual inspection of data will be performed to identify any single-point anomalies, steps in response, or incoherent signal/excessive noise bandwidth. All such events will be noted and described in the daily logs.

Instrument Drift

Instrument drift corrections identified from duplicate survey lines will be linearly interpolated over time and applied to the data.

Diurnal Drift Correction

Diurnal drift will be removed from magnetic data using a synchronous magnetic base station or tie line to identify the correction. Diurnal corrections will be algebraically added to the field data.

Digital Filtering and Data Enhancement

Anomaly discrimination is accomplished by identification of discrete response parameters as distinct from background response levels. Geophysical data (amplitude and location) will be downloaded periodically to avoid possible data loss or corruption. No digital filtering or data enhancement is anticipated; however, the field tests and actual data may require some manipulations. The necessity for filtering/normalization will be assessed and determined during the on-site geophysical equipment tests. All corrections, edits, filtering, or normalization of the data used to identify potential OE anomaly locations will be fully documented in a data processing log.

Correlation with Ground Truth

Comparison of field anomaly map, digital data image, and OE sampling results for each area investigated will be performed to ensure the discovered sources are representative of the anomalies.

Data Transfer

Copies of all processed digital data will be made and stored in a fireproof location. These data will include

- Field notes (including copy of field maps)

- Standardization data
- Digital data

Data tracking documentation will be completed each day and a copy included in the weekly transmittal.

Quantitative Interpretation and Dig Sheet Development

Data resolution will be such that anomaly locations can be identified to within a 3-foot radius of the source location for trenches, pits, or dumped piles of ammunition, and to 40 cm for individual discrete anomaly sources. Processing of digital data will include a symbol posting of centerline locations of the sensor array and production of color plots of the data mesh over the survey area. Anomaly symbols and identification numbers will be superimposed on these plots. An ASCII-format tabulation of the anomalies will also be generated. The table will include anomaly number, longitude and latitude (in state plane coordinates), anomaly amplitude, and other anomaly attributes (i.e., depth estimate).

Anomaly Reacquisition

Anomaly locations will be recovered using real-time kinematic/ global positioning system capable of sub-meter accuracy to relocate the coordinates of the center of each identified anomaly. Identified anomalies within the project site may also be recovered by measuring from appropriate fiducials using survey tapes. The anomaly reacquisition team will refine the anomaly location using the same instrumentation that was used to geophysically map the area, and record the peak recovered anomaly value and relative background response in a field logbook.

The location of the recovered anomaly peak will be marked with offset wood lathes, a plastic pin flag, or a clay pigeon. If the anomaly is not recovered by the reacquisition team, the anomaly coordinate location will be marked for further investigation.

Feedback Process (Comparison of Dig-sheet/ground truth)

Intrusive investigation results will be compared with detection and mapping data to continually improve the OE discrimination process used in data analysis.

Quality Control

A separate review and verification of the geophysical data will be performed by the project geophysical personnel. Data will be audited by processing data from randomly selected grids using Golden Software SURFER, Microsoft Excel, and/or Geosoft Mapping and Processing System and UXO Target Analysis. QA processing of digital data will include production of representative profiles. The raw data from the data loggers will be used to create image plots; the data will not be filtered unless background noise levels are excessive (this will be determined during the first week of the field effort). The images will be used as a QA tool to compare visually discriminated locations with those anomaly locations identified by the automated (digital) target picking routines used to generate the anomaly "dig" lists.

Field data will be reviewed daily. Unusable or incomplete data delivered for any transect will be reacquired.

The field review will ensure that precise measurements of the geophysical response were obtained by verifying that instrument performance during standardization fell within the

established ±10 percent acceptance range. Daily standardization measurements and results are to be completely documented in the daily field log. The daily logs will be reviewed to ensure proper implementation of the quality controls.

The state plane coordinates recorded for each transect will be compared with a master listing to ensure that the sampling data are accurately located within the study area. The field logs will also be reviewed each day to verify that data were collected following a continuous progression along the transects. If the survey progression was interrupted for a particular segment because of terrain or other considerations, the causes of the deviation and the actual mode of progression should be fully described in the daily log notes.

The field review will ensure that the transect investigation was complete by verifying that the data volume for each receiver array is comparable (±1 percent) and that the spatial data density (measurements per unit distance) is representative of the mapping effort described in the daily log. Field notes will be compared to the downloaded digital file data to assure correspondence between transects searched and transects recorded.

QA will comprise the following activities

- Review of daily field QA documentation (e.g., maps, field notes),
- Review of standardization results (instrument precision),
- Derivation of data statistics and measurement coordinates (location accuracy),
- Posting of data for each segment (survey/coverage completeness),
- Generation of contour/image/profile plots (representativeness/reasonableness),
- Comparison of geophysical profiles with field anomaly map (detection performance).

Digital data will be archived to (1) document the geophysical investigation, including thoroughness of the survey, detection efficiency, and locations of identified anomalies; (2) provide a means of quantifying the confidence that can be applied to the results; and (3) preserve and document the extent, precision, accuracy, and quality of the geophysical investigation.

Quality Assurance Summary

The QA/QC results of the geophysical survey will be tracked on a master spreadsheet that will tabulate survey area identification, coordinates, and date surveyed. A QA summary will be prepared and submitted to the project manager at the completion of the field effort. The summary will include

- **Precision** - A mean deviation from the standard response will be calculated for each instrument used. This will be reported in a progressively updated table.
- **Accuracy** - Any discrepancies in positional or locational accuracy of the data noted during the field review will be described, including steps taken to correct or resolve any such QA issues.
- **Completeness** - The percentage of coverage of each investigated segment will be tabulated. Significant lack of coverage (> 2 percent missed) will be flagged and annotated with the steps to be taken to resolve the missed coverage. Unavoidable obstacles will have been mapped on the field sketches and should result in direct correspondence with missing data. Data drop-outs or inexplicable data shortages, if not detected during the field review

and scheduled for reacquisition, will be discussed with personnel on site to identify the root problem and steps needed for resolution.

- **Representativeness** - A table will be developed and progressively updated that presents pertinent anomaly data (e.g., anomaly identity, amplitude, width, potential source, depth to target).
- **Reasonableness** - Any variations or results not compatible with prior results or expectations will be reviewed with the subcontractor geophysicist to determine causative features that may be present. These field contacts will be summarized and included in the weekly QA summary report.

Corrective Measures

To be determined, as necessary.

Records Management

All daily notes will be recorded in bound field notebooks. Digitally captured data will be copied to archive disks, and all data files will be accompanied by Microsoft Word documents detailing file content, file naming, and data processing performed on the field data.

Deliverables

Upon completion of the field effort, Earth Tech will complete QA/QC data; copy and index all appropriate field data, and deliver a geophysical investigation report that includes

- A CD-ROM containing all "raw" digital and edited ASCII format x, y, z files;
- Profile/image plots of the digitally recorded data;
- Daily field logs of the geophysical investigation activities;
- Standardization response documentation;
- Field notes, including a sketch map of the surveyed area;
- A posted symbol map for data collected to date in each area;
- ASCII data (digital files) providing data logger files and/or downloaded raw data and edited/corrected data files giving State Plane x, y coordinates;
- Target anomaly listings;
- A QA summary.

These data will be transmitted to the project manager no later than 30 days after demobilization from the field has been completed.

Geophysical Investigation Performance Goals

OE Detection

Depth Performance

Geophysical investigation detection depth performance will be as follows:

- Depth for transient EM systems: k x Log (depth in meters) = 1.002 x log (target diameter in millimeters) - 1.961

- Depth for total magnetic field systems: k x Log (depth in meters) = 1.354 x log (target diameter in millimeters) –2.655

k = scaling factor based on the aspect ratio of the OE item, as follows:

1:1	0.6
1:2	0.7
1:3	0.8
1:4	0.9
1:5	1.0

Detection Efficiency

All anomaly sources lying at or above the performance criteria depth must be detected and mapped for subsequent intrusive investigation.

Horizontal Accuracy

Laterally, 98 percent of all excavated items near surface must lie within a 40-cm radius of the mapped surface location of the anomaly, as mapped and marked in the field after reacquisition. Trench and/or pit or piles must be mapped to within 3 feet of the actual position.

False Positives

There may be no more than 15 percent "false positives," where anomalies reacquired do not result in discovery of any metallic material during the intrusive interrogation of the anomaly location.

Equipment Tests

Equipment field tests will be conducted on the first field day at the site to verify that the methodology and approach meet the performance criteria established. Geophysical data will be digitally captured into a file with coordinates recorded relative to the established southwestern corner of the test plot and referenced to state plane coordinates. The digital data will be processed to produce profiles that identify the background followed by the seeded characteristics of the test plot.

Equipment Verification Test Bed Construction

The actual location of the test plot will be determined onsite. The plot will nominally consists of three parallel transects in a 0.25-acre area (100 feet by 125 feet). The actual shape of the test bed and length of each transect may vary to accommodate the available site.

The test bed will be constructed by excavating potholes to varying depths, after first performing a background survey over the area selected for the test site to characterize the test environment. Multiple targets of the same types will be laid out at multiple depths. The plot will document depth of detection for (1) the smallest target of concern; (2) mid-range targets; and (3) large targets. Excavations for the targets will be made by hand shovel and backhoe (if necessary).

Targets will be oriented horizontally, parallel and transverse to the survey line to both optimize and minimize the inductive coupling between the instrument's transmitted signal and the targets. This yields a best/worst case scenario for target detection, providing the greatest certainty of achieving the requisite detection performance. The target locations will be measured from corner stakes set to mark the test plot; measured locations will be accurate to ± 6 inches. Target

excavations will be backfilled and the ground surface restored to as near pre-excavation conditions as is reasonably achievable.

The corners of the investigative plot will be marked with metal rods driven into the ground with a 2 to 6 inches appearing aboveground stick and witness stakes. The aboveground stick shall be painted with a high-visibility orange or pink paint. These established corners shall be used as the basis for documenting the locations of the seeded targets.

An example layout of the field test bed is shown in Table A-1 (actual targets and grid dimensions may differ, based on ordnance expected for site). Use of three burial depths allows the maximum depth of detection for each target type in a particular environment to be extrapolated because the signal fall-off rate is a known function with distance. The burial depths provide overlap of detection performance versus response for differing targets. The response over the different-dimensioned targets then allows interpolation of detection performance for intermediate targets based on surface area or solid volume of the items. Inert items taken from the scrap pile at the site will be used (or cylinders of similar dimensions if sufficient inert items cannot be recovered).

The target locations will be measured from corner stakes set to mark the test plot; measured locations will be accurate to ± 6 inches. Target excavations will be backfilled and the ground surface restored to as near pre-excavation conditions as is reasonably achievable. The corners of the investigative plot will be marked with rebar driven into the ground with a 2-to 6-inch stick above ground and witness stakes. The aboveground stick shall be painted with a high-visibility orange or pink paint. These established corners are to be used as the basis for documenting the locations of the seeded targets.

An as-built map will be generated that shows the test bed and lane boundaries and any planimetric features such as roads, buildings, and fences. A coincident reference table shall be attached to the base file providing item description, depth, coordinates, and other pertinent information.

The test plot will be left in place until the fieldwork has been completed and there is no further need to verify or test equipment performance. After the intrusive investigations have been completed, the field team will remove the test bed targets.

Data Collection

Geophysical measurements will be collected at the test plot by centering the instrument over the seeded lines and recording the responses directly over the targets, followed by offsetting the instrument along lines paralleling the target line. Five lines spaced 2.5 feet apart will be collected over/parallel to trench debris transects. Lines paralleling transects over individual targets will be spaced 1 foot apart; at least five lines will be surveyed for each projectile transect (as depicted on Figure 6-2 by dashed lines). The data will be digitally recorded at no greater than 1-foot station intervals and will be processed to produce geophysical profile plots that identify the target-anomaly characteristics of the test plot. These traverses will yield optimal and minimal responses to the buried targets, and will allow a determination of the line spacing required to properly detect the various targets.

The data will be collected using standard sensor/coil configurations as identified by the equipment manufacturer. The field data shall be checked, corrected, and processed into digital ASCII files. Data may be filtered to remove spurious responses; however, no filtering or

normalization of the raw data set will be performed. All edits and manipulation will be performed on a copy of the data, and all corrections will be fully documented. The data shall be presented in delineated fields as x, y, and z, where x and y are state grid plane coordinates in easting and northing, and z is the instrument reading. Where multiple instrument values are recorded, each channel of the data will be presented as x, y, z1...zn, in a single data file.

Table A-1. Geophysical Equipment Test Plot Lay-Out

Grid East (feet)	Grid North (feet)	Depth to Target (inches)	El Toro Test Target Description
0	0	NA	SW Corner (origin)
0	100	NA	NW Corner
20	20	24	Representative debris and OE scrap collected from site
20	60	48	Representative debris and OE scrap collected from site
20	100	72	Representative debris and OE -scrap collected from site
40	10	3	small, e.g., 0.75–1.5-inch projectile, parallel to track of survey
40	30	6	small, e.g., 0.75–1.5-inch projectile, parallel to track of survey
40	50	12	small, e.g., 0.75–1.5-inch projectile, parallel to track of survey
40	70	12	small, e.g., 0.75–1.5-inch projectile, perpendicular to track
40	90	12	small, e.g., 0.75–1.5-inch projectile, vertical along track
70	25	12	medium, e.g., 2.75–3.0-inch warhead or projectile, parallel to track
70	55	24	medium, e.g., 2.75–3.0-inch warhead or projectile, parallel to track
70	85	24	medium, e.g., 2.75–3.0-inch warhead or projectile, perpendicular to track
70	115	24	medium, e.g., 2.75–3.0-inch warhead or projectile, vertical
70	145	6	medium, e.g., 2.75–3.0-inch warhead or projectile, parallel to track
110	30	48	large, e.g., 5-inch warhead or projectile, parallel to track
110	70	48	large, e.g., 5-inch warhead or projectile, perpendicular to track
110	110	48	large, e.g., 5-inch warhead or projectile, vertical
110	150	24	large, e.g., 5-inch warhead or projectile, parallel to track
140	50	12	large, e.g., 5-inch warhead or projectile, parallel to track
160	0	NA	SE Corner
160	180	NA	NE Corner

Notes:
NA not applicable
NW northwest
SE southeast
NE northeast

The equipment test plot data will be used to generate site-specific detection performance curves. The curves will ensure that, at a minimum, individual projectiles would be detected at the appropriate performance criterion threshold and buried debris in disposal pits will be detectable at 36–48 inches bgs.

Checks for Sources of Measurement Error

Heading Error (Azimuth Tests)

Static tests to determine heading errors will be performed with each magnetometer sensor to be deployed. The sensor will be held steady over a known target as the instrument operator pivots 360° around the target. The instrument operator will electronically mark the data coincident with the orientation of the sensor (i.e. pointed north or south).

Positional Error

On the first day on site, field personnel will follow these steps to determine allowable positional error.

1. Lay out a 100-foot-long non-metallic tape.
2. Run sensor over 100 feet of the line in one direction (N).
3. Run sensor over 100 feet of the line in the opposite direction (S).
4. Repeat Steps 2 and 3 to check data repeatability.
5. Place a target on the line over a clear area.
6. Run sensor over 100 feet of the line in one direction.
7. Run sensor over 100 feet of the line in the opposite direction.
8. Check repeatability.
9. Repeat Step 6 walking very quickly.
10. Repeat Step 7 walking very slowly.
11. Compare the location of the target with the data peak.

Any difference in location between the target and the data peak is typically caused by the temporal time lag of the detector (usually the problem) or the spatial correction due to placement of the locational device (rare).

To test the positional errors of global positioning system equipment, field personnel will traverse a meandering path over three known monuments and fixed points.

Evaluation of Performance

Achievable tolerances for positional accuracy for the geophysical investigation will be extrapolated from the control plot survey, geophysical anomaly profiles, and target location maps to be provided through the above tasks. At a minimum, pass/fail performance criteria for the geophysical methodologies should be as follows:

All simulated trench debris targets must be detected. Mapped locations must be within ± 1.33 feet of the actual location for shallow (≤3 feet bgs) and ±3 feet for targets 4–8 feet bgs.

The multiple lines of data will be manipulated in a spreadsheet to determine the greatest station and line spacing at which the performance criteria will be met. These will be the station and line spacing to be used during the geophysical investigation of the project site.

A letter report describing the geophysical equipment, field test results, and survey methodology will be submitted to the project manager. The letter report shall document all activities performed to create the test plot and investigate the technology and methodology for site-wide geophysical survey and quality control. The letter report will also provide an estimate of the geophysical response parameters to be expected for each anticipated OE-associated anomaly. Earth Tech will provide all digital data from the investigations and analysis, including the letter report on CD-ROM.

Geophysical Mapping Data

Data Requirements

All sensor data will be correlated with navigational data based on a local third-order control point.

Geophysical data will be digitally captured into a file and referenced to coincident state plane coordinates.

Sensor data will be preprocessed for offsets (demoded), diurnal magnetic variations, and correlated with navigational data. All corrections will be documented in a Microsoft Word file accompanying the digital data.

Data will be checked and presented in ASCII files formatted in the format used by the project GIS. The data will be provided in delineated fields as x, y, z where x is easting, y is northing, and z is the instrument reading.

Each grid (or other coherent grouping of data) will be logically and sequentially named so that the file name can be correlated with the grid (grouping) name used by other project personnel.

Geophysical Data Analysis

Anomaly Discrimination

Anomalies with characteristics that could be representative of targets of interest (e.g., OE projectiles) will be discriminated by experienced geophysicists using both visual and computer-aided differentiation techniques. The process will be limited to differentiation of anomalies that "could be targets of concern" versus those that "cannot be," based on the available geophysical, visual, and historical data.

Anomalies of concern will yield a signal-to-noise ratio sufficient to discriminate target responses in the data. Minimally, the signal-to-noise ratio should be at least 1.5 times greater than the background threshold level.

Target Data Tabulation

Hard copy and digital "Dig-Sheets" will be provided to the project manager presenting the following information:

- Project site
- Date
- Responsible geophysicist
- Sector/area

- Grid number/transect
- Anomaly number
- State plane coordinate location (northing and easting)
- Estimated depth to top of item

Anomaly Location Reacquisition and Marking

Identified anomaly locations will be recovered (reacquired) using survey methods with equal precision to those used to collect the geophysical data. This will ensure that the anomalies reacquired are coincident with those presented on the target lists ("dig sheets"). The coordinate locations (in state plane feet) will be recovered and marked with high-visibility materials, such as clay pigeons, survey flagging, pin flags, or painted lath. A table of dig results will be maintained and continually updated that correlates the anomalies with actual target source parameters (as recorded on the dig sheets).

Appendix B
OE Health and Safety – Task Hazard Analyses

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

TASK HAZARD ANALYSIS (THA)
ORDNANCE EXPLOSIVES (OE) RANGE EVALUATION
IRP SITE 1 – EOD TRAINING RANGE
MCAS, EL TORO, CALIFORNIA

EVALUATED BY: GREG PETERSON

DATE: OCTOBER 2001

TASK NAME

EXPLOSIVES HANDLING

TASK DESCRIPTION	CHEMICAL EXPOSURE HAZARDS
Explosives will be used to destroy OE materials that cannot be safely moved. Explosives will be procured from an authorized vendor and transported to the Site 1 and used in demolition firing trains that will be constructed for purpose of counter charging or venting of OE items.	• None

PPE	OTHER SAFETY EQUIPMENT	PHYSICAL HAZARDS
Level D Ensemble • Short Sleeve Shirt • Full-length Pants • Leather Boots (for UXO personnel) • Safety Glasses	• Hand/face washing supplies (One 5-gallon bucket, soap, paper towels). • First aid kit (located in vehicle) • Fire extinguisher (located in vehicle)	• Explosives • OE • Weather-related: wind, rain, heat, cold • Walking surfaces: uneven ground, ground squirrel holes

APPLICABLE PROJECT SAFETY PROCEDURES	ADDITIONAL CONSIDERATIONS
• Explosive Safety (Site 1 OE/RE Work Plan, Sections 5.2.3, 5.2.6, 5.10, 5.11, and 7.0 and Appendix D) • OE Safety (Site 1 OE/RE Work Plan, Sections 5.2.3, 5.2.6 and 7.0) • Slips, Trips, Falls, Protruding Objects (Site 1 HSP Section 6.1)	• None

MONITORING PROCEDURES

• None

EARTH TECH
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TASK HAZARD ANALYSIS (THA)
ORDNANCE EXPLOSIVES (OE) RANGE EVALUATION
IRP SITE 1 – EOD TRAINING RANGE
MCAS, EL TORO, CALIFORNIA

EVALUATED BY: GREG PETERSON

DATE: OCTOBER 2001

TASK NAME

GEOPHYSICAL INVESTIGATION

TASK DESCRIPTION

Geophysical investigation will involve traversing of transects using appropriate equipment and instruments to collect data. Transects will be accomplished using lane markings.

CHEMICAL EXPOSURE HAZARDS

- None

PPE

Level D Ensemble

- Short Sleeve Shirt
- Full-length Pants
- Leather Boots (for geophysical personnel)
- Safety Glasses

OTHER SAFETY EQUIPMENT

- Hand/face washing supplies (One 5-gallon bucket, soap, paper towels).
- First aid kit (located in vehicle)
- Fire extinguisher (located in vehicle)

PHYSICAL HAZARDS

- OE
- Weather-related: wind, rain, heat, cold
- Walking surfaces: uneven ground, ground squirrel holes

APPLICABLE PROJECT SAFETY PROCEDURES

- OE Safety (Site 1 OE/RE Work Plan, Sections 5.2.3, 5.2.6 and 7.0)
- Slips, Trips, Falls, Protruding Objects (Site 1 HSP Section 6.1)

ADDITIONAL CONSIDERATIONS

- None

MONITORING PROCEDURES

- None

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

TASK HAZARD ANALYSIS (THA)
ORDNANCE EXPLOSIVES (OE) RANGE EVALUATION
IRP SITE 1 – EOD TRAINING RANGE
MCAS, EL TORO, CALIFORNIA

EVALUATED BY: GREG PETERSON

DATE: OCTOBER 2001

TASK NAME

OE IDENTIFICATION AND HANDLING

TASK DESCRIPTION

UXO-qualified personnel will inspect visually and using appropriate instrumentation all OE and OE scraps to evaluate if the item is unsafe to move.

CHEMICAL EXPOSURE HAZARDS

- None

PPE

Level D Ensemble

- Short Sleeve Shirt
- Full-length Pants
- Leather Boots (for UXO personnel)
- Safety Glasses
- Leather/Cotton work gloves

OTHER SAFETY EQUIPMENT

- Hand/face washing supplies (One 5-gallon bucket, soap, paper towels).
- First aid kit (located in vehicle)
- Fire extinguisher (located in vehicle)

PHYSICAL HAZARDS

- OE
- Weather-related: wind, rain, heat, cold
- Walking surfaces: uneven ground, ground squirrel holes

APPLICABLE PROJECT SAFETY PROCEDURES

- OE Safety (Site 1 OE/RE Work Plan, Sections 5.2.3, 5.2.6 and 7.0)
- Slips, Trips, Falls, Protruding Objects (Site 1 HSP Section 6.1)
- Underground Utilities (Site 1 HSP Section 6.3)

ADDITIONAL CONSIDERATIONS

- None

MONITORING PROCEDURES

- None

EARTH TECH
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TASK HAZARD ANALYSIS (THA)
ORDNANCE EXPLOSIVES (OE) RANGE EVALUATION
IRP SITE 1 – EOD TRAINING RANGE
MCAS, EL TORO, CALIFORNIA

EVALUATED BY: GREG PETERSON

DATE: OCTOBER 2001

TASK NAME

LOCATION SURVEY AND MARKING

TASK DESCRIPTION	CHEMICAL EXPOSURE HAZARDS
Areas of concern identified during the surface and geophysical subsurface surveys will be located in the field by installing semi-permanent markers.	• None

PPE	OTHER SAFETY EQUIPMENT	PHYSICAL HAZARDS
Level D Ensemble • Short Sleeve Shirt • Full-length Pants • Leather Boots (for UXO personnel) • Safety Glasses	• Hand/face washing supplies (One 5-gallon bucket, soap, paper towels). • First aid kit (located in vehicle) • Fire extinguisher (located in vehicle)	• OE • Weather-related: wind, rain, heat, cold • Walking surfaces: uneven ground, ground squirrel holes

APPLICABLE PROJECT SAFETY PROCEDURES	ADDITIONAL CONSIDERATIONS
• OE Safety (Site 1 OE/RE Work Plan, Sections 5.2.3, 5.2.6 and 7.0) • Slips, Trips, Falls, Protruding Objects (Site 1 HSP Section 6.1) • Underground Utilities (Site 1 HSP Section 6.3)	• None

MONITORING PROCEDURES

• None

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

TASK HAZARD ANALYSIS (THA)
ORDNANCE EXPLOSIVES (OE) RANGE EVALUATION
IRP SITE 1 – EOD TRAINING RANGE
MCAS, EL TORO, CALIFORNIA

EVALUATED BY: GREG PETERSON

DATE: OCTOBER 2001

TASK NAME

INERT ORDNANCE AND OE SCRAP DISPOSAL

TASK DESCRIPTION

Non-hazardous OE scrap and metallic debris collection points will be established at each area of investigation during surface surveys and subsurface anomaly investigation. The material will be stored in drums and transported to a central pre-designated scrap collection point. Inspection of the material will be performed at each of these locations to verify it to be free of any explosive hazard. The material upon a subsequent inspection and certification will be transported to a local DRMO for recycling.

CHEMICAL EXPOSURE HAZARDS

- None

PPE

Level D Ensemble

- Short Sleeve Shirt
- Full-length Pants
- Leather Boots (for UXO personnel)
- Safety Glasses
- Leather/Cotton work gloves

OTHER SAFETY EQUIPMENT

- Hand/face washing supplies (One 5-gallon bucket, soap, paper towels).
- First aid kit (located in vehicle)
- Fire extinguisher (located in vehicle)

PHYSICAL HAZARDS

- OE
- Weather-related: wind, rain, heat, cold
- Walking surfaces: uneven ground, ground squirrel holes

APPLICABLE PROJECT SAFETY PROCEDURES

- OE Safety (Site 1 OE/RE Work Plan, Sections 5.2.3, 5.2.6 and 7.0)
- Slips, Trips, Falls, Protruding Objects (Site 1 HSP Section 6.1)

ADDITIONAL CONSIDERATIONS

- None

MONITORING PROCEDURES

- None

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

TASK HAZARD ANALYSIS (THA)
ORDNANCE EXPLOSIVES (OE) RANGE EVALUATION
IRP SITE 1 – EOD TRAINING RANGE
MCAS, EL TORO, CALIFORNIA

EVALUATED BY: GREG PETERSON

DATE: OCTOBER 2001

TASK NAME

SUBSURFACE INVESTIGATION

TASK DESCRIPTION	CHEMICAL EXPOSURE HAZARDS
Selected anomaly areas will be excavated manually using appropriate implements and tools to investigate the presence of OE. If the anomaly is deeper than 3 feet a backhoe will be used to continue the excavation (THA for excavation is included in the HSP).	• None

PPE	OTHER SAFETY EQUIPMENT	PHYSICAL HAZARDS
Level D Ensemble • Short Sleeve Shirt • Full-length Pants • Leather Boots (for UXO personnel) • Safety Glasses • Leather/Cotton work gloves	• Hand/face washing supplies (One 5-gallon bucket, soap, paper towels). • First aid kit (located in vehicle) • Fire extinguisher (located in vehicle)	• OE • Weather-related: wind, rain, heat, cold • Walking surfaces: uneven ground, ground squirrel holes

APPLICABLE PROJECT SAFETY PROCEDURES	ADDITIONAL CONSIDERATIONS
• OE Safety (Site 1 OE/RE Work Plan, Sections 5.2.3, 5.2.6 and 7.0) • Slips, Trips, Falls, Protruding Objects (Site 1 HSP Section 6.1) • Underground Utilities (Site 1 HSP Section 6.3)	• None

MONITORING PROCEDURES

• None

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

TASK HAZARD ANALYSIS (THA)
ORDNANCE EXPLOSIVES (OE) RANGE EVALUATION
IRP SITE 1 – EOD TRAINING RANGE
MCAS, EL TORO, CALIFORNIA

EVALUATED BY: GREG PETERSON

DATE: OCTOBER 2001

TASK NAME

GEOPHYSICAL INVESTIGATION

TASK DESCRIPTION

Geophysical investigation will involve traversing of transects using appropriate equipment and instruments to collect data. Transects will be accomplished using lane markings.

CHEMICAL EXPOSURE HAZARDS

- None

PPE

Level D Ensemble

- Short Sleeve Shirt
- Full-length Pants
- Leather Boots (for geophysical personnel)
- Safety Glasses

OTHER SAFETY EQUIPMENT

- Hand/face washing supplies (One 5-gallon bucket, soap, paper towels).
- First aid kit (located in vehicle)
- Fire extinguisher (located in vehicle)

PHYSICAL HAZARDS

- OE
- Weather-related: wind, rain, heat, cold
- Walking surfaces: uneven ground, ground squirrel holes

APPLICABLE PROJECT SAFETY PROCEDURES

- OE Safety (Site 1 OE/RE Work Plan, Sections 5.2.3, 5.2.6 and 7.0)
- Slips, Trips, Falls, Protruding Objects (Site 1 HSP Section 6.1)

ADDITIONAL CONSIDERATIONS

- None

MONITORING PROCEDURES

- None

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

TASK HAZARD ANALYSIS (THA)
ORDNANCE EXPLOSIVES (OE) RANGE EVALUATION
IRP SITE 1 – EOD TRAINING RANGE
MCAS, EL TORO, CALIFORNIA

EVALUATED BY: GREG PETERSON

DATE: OCTOBER 2001

TASK NAME

OE TRANSPORTATION

TASK DESCRIPTION	CHEMICAL EXPOSURE HAZARDS
OE items encountered during investigation activities will be transported to an onsite consolidation location for accumulation and disposal purposes.	• None

PPE	OTHER SAFETY EQUIPMENT	PHYSICAL HAZARDS
Level D Ensemble • Hard Hat • Short Sleeve Shirt • Full-length Pants • Leather Boots (for UXO personnel) • Safety Glasses • Leather/Cotton work gloves	• First aid kit (located in vehicle) • Fire extinguisher (located in vehicle)	• OE • Weather-related: wind, rain, heat, cold

APPLICABLE PROJECT SAFETY PROCEDURES	ADDITIONAL CONSIDERATIONS
• OE Safety (Site 1 OE/RE Work Plan, Sections 5.2.3, 5.2.6 and 7.0) • Slips, Trips, Falls, Protruding Objects (Site 1 HSP Section 6.1)	• None

MONITORING PROCEDURES

• None

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

TASK HAZARD ANALYSIS (THA)
ORDNANCE EXPLOSIVES (OE) RANGE EVALUATION
IRP SITE 1 – EOD TRAINING RANGE
MCAS, EL TORO, CALIFORNIA

EVALUATED BY: GREG PETERSON

DATE: OCTOBER 2001

TASK NAME

UNSAFE TO MOVE OE DISPOSAL BLOW IN PLACE (BIP)

TASK DESCRIPTION

Onsite disposal of OE that cannot be safely moved will be blown in place by placing in explosive firing trains.

CHEMICAL EXPOSURE HAZARDS

- None

PPE

Level D Ensemble

- Short Sleeve Shirt
- Full-length Pants
- Leather Boots (for UXO personnel)
- Safety Glasses

OTHER SAFETY EQUIPMENT

- Hand/face washing supplies (One 5-gallon bucket, soap, paper towels).
- First aid kit (located in vehicle)
- Fire extinguisher (located in vehicle)

PHYSICAL HAZARDS

- Explosives
- OE
- Weather-related: wind, rain, heat, cold
- Walking surfaces: uneven ground, ground squirrel holes

APPLICABLE PROJECT SAFETY PROCEDURES

- Explosive Safety (Site 1 OE/RE Work Plan, Sections 5.2.3, 5.2.6, 5.10, 5.11, and 7.0 and Appendix D)
- OE Safety (Site 1 OE/RE Work Plan, Sections 5.2.3, 5.2.6 and 7.0)
- Slips, Trips, Falls, Protruding Objects (Site 1 HSP Section 6.1)

ADDITIONAL CONSIDERATIONS

- None

MONITORING PROCEDURES

- None

Appendix C
OE Operations - Demolition/Disposal Operations
Standard Operating Procedure

APPENDIX C

OE OPERATIONS - DEMOLITION/DISPOSAL OPERATIONS STANDARD OPERATING PROCEDURE

1. PURPOSE

The purpose of this standard operating procedure (SOP) is to provide the minimum procedures and safety and health requirements applicable to the conduct of demolition/disposal operations on sites contaminated with ordnance and explosives (OE).

2. SCOPE

This SOP applies to all site personnel, including contractor and subcontractor personnel, involved in the conduct of OE demolition/disposal operations on an OE-contaminated site. This SOP is not intended to contain all of the requirements needed to ensure complete compliance, and should be used in conjunction with project plans and applicable federal, state, and local regulations.

3. REGULATORY REFERENCES

Applicable sections and paragraphs in the documents listed below will be used as references for the conduct of OE demolition/disposal operations:

- OSHA General Industry Standards, 29 CFR 1910;
- OSHA Construction Standards, 29 CFR 1926;
- CEHNC Safety Concepts and Basic Considerations for Unexploded Ordnance;
- USACE EM 385-1-1, Safety and Health Requirements Manual;
- DoD 4145.26-M, Contractor's Safety Manual for Ammunition and Explosives;
- DoD 4160.21-M, Defense Reutilization and Marketing Manual;
- DoD 6055.9-STD, DoD Ammunition and Explosives Safety Standards;
- AR 385-64, Ammunition and Explosive Safety;
- AR 385-10, Army Safety Program;
- DA PAM 385-64, Ammunition and Explosives Safety Standards;
- TM 9-1300-206, Ammunition and Explosive Standards;
- TM 9-1300-200, Ammunition General;
- TM 9-1300-214, Military Explosives;
- TM 60A-1-1-31, EOD Disposal Procedures;
- AR 190-11, Physical Security of Arms, Ammunition and Explosives;
- ATF 5400.7, Alcohol Tobacco and Firearms Explosives Laws and Regulations; and
- Applicable sections of DOT, 49 CFR Parts 100 to 199.

4. RESPONSIBILITIES

4.1 PROJECT MANAGER

The project manager (PM) shall be responsible for ensuring the availability of the resources needed to implement this SOP, and shall also ensure that this SOP is incorporated in plans, procedures and training for sites where this SOP is to be implemented.

4.2 SENIOR UXO SUPERVISOR

The senior UXO supervisor (SUXOS) will be responsible for assuring that adequate safety measures and housekeeping are taken during all phases of site operation, to include demolition activities, and shall visit site demolition locations as deemed necessary to ensure that demolition operations are carried out in a safe, clean, efficient and economical manner.

4.3 DEMOLITION SUPERVISOR

Prior to initiation of demolition operations, the SUXOS shall designate an experienced and trained UXO supervisor to act as the demolition supervisor. The demolition shall then be conducted under the direct control of the demolition supervisor, who will have the responsibility of supervising all demolition operations within the area. The demolition supervisor shall be responsible for training all on-site OE personnel regarding the nature of the materials handled, the hazards involved and the precautions necessary. The demolition supervisor will also ensure that the Daily Operational Log, Ordnance Accountability Log, Demolition Shot Records and inventory records are properly filled and accurately depict the demolition events and demolition material consumption for each day's operations. The demolition supervisor shall be present during all demolition operations or designate a competent, qualified person to be in charge during any absences.

4.4 SITE SAFETY AND HEALTH OFFICER

The site safety and health officer (SSHO) for the site is responsible for ensuring that all demolition operations are being conducted in a safe and healthful manner and is required to be present during all OE demolition operations. The only exception to this rule is when the project site has multiple sites conducting various types of OE investigation and remediation operations being conducted concurrently with periods where there may be continuous demolition operations throughout the day. In that event, a demolition team SSHO will be designated. This individual will report to the SSHO and assume the SSHO's responsibilities at the demolition range. In this situation, the SSHO will conduct periodic safety audits of the demolition team and assist the demolition team SSHO in the performance of his duties.

4.5 QUALITY CONTROL SPECIALIST

The quality control specialist (QCS) is responsible for ensuring the completeness of demolition operations and for weekly inspecting the Ordnance Accountability Log, the Daily Operational Log, the Demolition Shot Record and the inventory of OE and demolition material. The QCS, assisted by demolition team personnel, will inspect each demolition pit and an area of up to 250 feet in radius after each demolition shot to ensure there are no kick-outs, hazardous OE components or other hazardous items. In addition, the pit will be checked with a magnetometer and large metal fragments 4 inches or greater, and any hazardous debris will be removed on a per use basis. Any OE discovered during the QC check will be properly stored for destruction later.

Extreme caution must be exercised when handling OE, which has been exposed to the forces of detonation.

5. GENERAL OPERATIONAL AND SAFETY PROCEDURE

All personnel, including contractor and subcontractor personnel, involved in operations on OE contaminated sites shall be familiar with the potential safety and health hazards associated with the conduct of demolition/disposal operations, and with the work practices and control techniques used to reduce or eliminate these hazards. During demolition operations, general safety provisions listed below shall be followed by all demolition personnel, at all times. Noncompliance with the general safety provisions listed may result in positive discipline, to include termination of employment:

- All safety regulations applicable to demolition range activities and demolition and OE materials involved shall be complied with.
- Demolition of any kind is prohibited without the express permission from the client.
- The use of sandbags for mitigation of fragmentation and blast effects due to intentional detonation of munitions will be required for all demolition shots conducted IAW Appendix D. The quantity of OE to be destroyed will be kept to a minimum to reduce noise travel into residential areas.
- In case of an electrical storm, or heavy snow or dust storms, immediate action will be taken to cease all demolition range operations and evacuate the area.
- In case of a fire or unplanned explosion, if possible, put out the fire, if unable to do so, notify the fire department and evacuate the area. If injuries are involved, remove victims from danger, administer first aid and seek medical attention.
- The demolition supervisor is responsible for reporting all injuries and accidents, which occur to the SSHO.
- Employees will not tamper with any safety devices or protective equipment.
- Any defect or unusual condition noted that is not covered by this attachment will be reported immediately to the demolition supervisor or SSHO.
- Methods of demolition shall be conducted in accordance with IAW this procedure and approved changes thereto.
- Fire prevention procedures for disposal operations contained in paragraph 5.1 will be enforced during all demolition operations.
- Adequate first-aid equipment shall be provided at all times.
- All personnel engaged in the destruction of OE shall wear under and outer garments made of natural fiber, close-weave clothes, such as cotton. Synthetic material such as nylon is not authorized.
- Care will be taken to minimize exposure to the smallest number of personnel, for the shortest time, to the least amount of hazard, consistent with safe and efficient operations.
- Work locations will be maintained in a neat and orderly condition.
- All hand tools shall be maintained in a good state of repair.
- Each piece of heavy equipment and/or vehicle operator will have in his possession a valid operator's permit, i.e., state driver's license.

- Equipment and other lifting devices designed and used for lifting will have the load rating and date of next inspection marked on them. The load rating will not be exceeded and the equipment will not be used without a current inspection date.
- Leather or leather-palmed gloves will be worn when handling wooden boxes, munitions or OE.
- Lifting and carrying require care. Improper methods cause unnecessary strains. Observe the following preliminaries before attempting to lift or carry:
  - When lifting, keep your arms and back as straight as possible, bend your knees and lift with your leg muscles; and
  - Be sure you have good footing and hold, and lift with a smooth, even motion.
- The demolition range shall be provided with telephone and/or radio communication.
- Motor vehicles and material handling equipment used for transporting OE or demolition materials must meet the following requirements:
  - Exhaust systems shall be kept in good mechanical repair at all times.
  - Lighting systems shall be an integral part of the vehicle.
  - One Class ABC rated, portable fire extinguisher shall, if possible, be mounted on the vehicle outside of the cab, on the driver's side, and one Class ABC fire extinguisher shall be mounted inside the cab.
  - Wheels of carriers must be checked and brakes set during loading and unloading.
  - No demolition material or OE shall be loaded into or unloaded from, motor vehicles while their motors are running.
- Motor vehicles and material handling equipment used to transport demolition material and OE shall be inspected prior to use to determine that
  - Fire extinguishers are filled and in good working order.
  - Electrical wiring is in good condition and properly attached.
  - Fuel tank and piping are secure and not leaking.
  - Brakes, steering, and safety equipment are in good condition.
  - The exhaust system is not exposed to accumulations of grease, oil, gasoline, or other fuels, and has ample clearance from fuel lines and other combustible materials.
- Employees are required to wear leather or rubber gloves when handling demolition materials. The type of glove worn is dependent on the type of demolition material.
- An observer will be stationed at a location where there is a good view of the air and surface approaches to the demolition range before material is detonated. It shall be the responsibility of the observer to order the demolition supervisor to suspend firing if any aircraft, vehicles or personnel are sighted approaching the general demolition area.
- Two-way radios shall not be operated at the disposal site while the pit is primed or during the priming process. The charts shown in Tables C-1 and C-2 shall be used for determining the safe distances from transmitter antennas.
- No demolition operation will be left unattended during the active portion of the operation (i.e., during the burn or once any explosives or OE are brought to the range).

- No demolition activities will be conducted if there is less than a 2,000-foot ceiling or if wind velocity is in excess of 10 mph.
- Demolition shots must be fired during daylight hours (i.e., between 30 minutes after sunrise and 30 minutes before sunset).
- No more than two persons shall ride in a truck transporting demolition material or OE, and no person shall be allowed to ride in the trailer/bed.
- Vehicles shall not be refueled when carrying demolition material or OE, and must be 100 feet from magazines or trailers containing such items before refueling.
- All explosive vehicles will be cleaned of visible explosive and other contamination before releasing the vehicles for other tasks.
- Prior to conducting any other task, personnel shall wash their face and hands after handling demolition material or OE.
- Disposal sites shall be spaced at least 50 feet apart, with no more than 10 pits prepared for a series of shots at any one time.

5.1 FIRE PREVENTION FOR DISPOSAL OPERATIONS

Due to the high fire potential season anticipated at the site, the following procedures will be adhered to on each disposal shot conducted at the site:

- OE that is moved for disposal will be taken to a location that will provide the most protection from fires and provide the easiest access by fire fighting vehicles if required.
- For OE that cannot be moved, measures will be taken to carefully plan fire suppression accesses and procedures prior to detonating shots. All disposal and safety personnel will be fully briefed on fire suppression procedures.
- Immediately after the detonation, all safety personnel will report status of the disposal site and the presence absence of fires.
- If fire or smoke in the vegetation surrounding the site is present, the demolition team will proceed immediately to the site with field fire suppression equipment and attempt to suppress any fires present.
- If a fire becomes uncontrollable, emergency notifications to local fire agencies will be made, and all field workers will stand by to assist as necessary.

The fire prevention goals are to plan effectively for all potential fire suppression obstacles, effectively mitigate the disposal shot and surrounding vegetation with water, ensure prevailing winds are not going to take potential smoke towards populated areas, ensure that adequate fire suppression equipment is on site, and keep vigilant communications with the local fire department during all disposal operations.

6. SPECIAL REQUIREMENTS FOR DEMOLITION

The following safety and operational requirements shall be followed during demolition. Any deviations from this procedure shall be allowed only after receipt of written approval from the Earth Tech site manager and the client. Failure to adhere to the requirements and procedures listed in the paragraphs below could result in serious injury or death, therefore, complete compliance with these requirements will be strictly enforced.

6.1 GENERAL REQUIREMENTS

The general disposal operations requirements listed below shall be followed at all times:

1. Material awaiting destruction shall be stored at not less than intra-line distance, based on the largest quantity involved, from adjacent explosive materials and from explosives being destroyed. The material shall be protected against accidental ignition or explosion from fragments, grass fires, burning embers or detonating impulses originating in materials being destroyed.
2. Detonations will be counted to ensure detonation of all pits. After each series of detonations, a search shall be made of the surrounding area for unexploded OE and OE. Items such as lumps of explosives or unfuzed ammunition, may be picked up and prepared for the next shot. Fuzed ammunition or items that may have internally damaged components will be detonated in place, if possible.
3. Prevailing weather condition information will be obtained from the U.S. Weather Service and the data logged in the Demolition Shot Log before each shot or round of shots.
4. All shots shall be dual primed.
5. A minimum of 30 seconds will be maintained between each detonation.
6. After each detonation and at the end of each day's operations, surface exposed scrap metal, casings, fragments, and related items shall be recovered from the demolition range and disposed of in accordance with OE scrap procedures, as well as all applicable environmental regulations. All collected scrap metal will be 100% inspected for absence of explosive materials by OE personnel and certified by the SUXOS.
7. When operated in accordance with the conditions of this procedure the demolition range should not present a noise problem to the surrounding community. However, if a noise complaint is received, the name, address and phone number of the complainant should be recorded and reported to the SUXOS, who in turn, will report it to the Earth Tech site manager.
8. Prior to and after each shot, the Demolition Shot Record is to be filled out by the demolition supervisor with all applicable information. This record will be kept with the Ordnance Accountability Log and will reflect each shot.

6.2 ELECTRIC DETONATOR USE

The following requirements are necessary when using electric detonators and blasting circuits:

1. Electric detonators and electric blasting circuits may be energized to dangerous levels from outside sources such as static electricity, induced electric currents and radio communication equipment. Safety precautions will be taken to reduce the possibility of a premature detonation of the electric detonator and explosive charges of which they form a part. Radios will not be operated while the pit is primed or during the priming process.
2. The shunt shall not be removed from the leg wires of the detonator until the continuity check of the detonator.

3. When uncoiling or straightening the detonator leg wires, keep the explosive end of the detonator pointing away from the body and away from other personnel. When straightening the leg wires, do not hold the detonator itself; rather hold the detonator leg wires approximately one inch from the detonator body. Straighten the leg wires by hand, do not throw or wave the wires through the air to loosen them.

4. Prior to use, the detonators shall be tested for continuity. To conduct the test, place the detonators in a pre-bored hole in the ground or place them in a sand bag, and walk facing away from the detonators and stretch the wires to their full length, or to 50 feet, whichever is less, being sure to not pull the detonators from the hole or sand bag. With the leg wires stretched to their full length, test the continuity of the detonators one at a time by un-shunting the leg wires and attaching them to the galvanometer and checking for continuity. After the test, re-shunt the wires by twisting the two ends together. Repeat this process for each detonator until all detonators have been tested. This process shall be accomplished at least 50 feet from any OE or demolition materials and out of the demolition range personnel and vehicle traffic flow pattern. In addition, all personnel on the demolition range shall be alerted prior to the test being conducted.

5. At the power source end of the blasting circuit, the ends of the wires shall be shorted or twisted together (shunted) at all times, except when actually testing the circuit or firing the charge. The connection between the detonator and the circuit firing wires must not be made unless the power end of the firing wires are shorted and grounded or the firing panel is off and locked.

6. The firing line will be checked using prearranged hand signals or using two-way radios if the demolition pit is not visible from the firing point. If radios are used, communication shall be accomplished a minimum of 25 feet from the demolition pit and detonators. The firing line will be checked for electrical continuity in both the open and closed positions, and will be closed/shunted prior to connecting the detonator leg wires.

7. OE to be detonated/vented shall be placed in the demolition pit and the demolition material placed/attached in such a manner as to ensure the total detonation/venting of the OE. Once the OE and demolition material is in place and the shot has been tamped, the detonators will be connected to the demolition material. Prior to handling any detonators that are connected to the firing line, personnel shall ensure that they are grounded. The detonators will then be carried to the demolition pit with the end of the detonators pointed away from the individual. The detonators are then connected to the detonation cord (i.e., Non-El) ensuring that the detonator is not covered with tamping material to allow for ease of recovery/investigation in case of a miss-fire.

Note: When testing the detonator, prior to connecting the detonator to the firing circuit, the leg wires of the detonator must be shunted by twisting the bare ends of the wires together immediately after testing. The wires shall remain short-circuited until time to connect them to the firing line.

1. Prior to making connections to the blasting machine, the entire firing circuit shall be tested with a galvanometer for electrical continuity and ohmic resistance to ensure the blasting machine has the capacity to initiate the shot.

2. The individual assigned to make the connections at the blasting machine or panel will not complete the circuit at the blasting machine or panel and will not give the signal for detonation until satisfied that all personnel in the vicinity have been evacuated to a safe distance. When in use, the blasting machine or its actuating device shall be in the blaster's possession at all times. When using the panel, the switch must be locked in the open position until ready to fire, and the single key must be in the blaster's possession.
3. Prior to initiating a demolition shot(s), a warning will be given the type and duration of such will be determined by the prevailing conditions at the demolition range. At a minimum, this should be an audible signal using a siren, air horn or megaphone, which is sounded for a duration of one minute, five minutes prior to the shot and again one minute prior to the shot.

6.3 DETONATING CORD USE

The following procedures are required when using detonating cord (det cord):

1. Det cord should be cut using approved crimpers and only the amount required should be removed from inventory.
2. When cutting det cord, the task should be performed outside the magazine.
3. For ease of inventory control, only remove det cord in one-foot increments.
4. Det cord should not be placed in clothing pockets or around the neck, arm or waist, and should be transported to the demolition location in either an approved "day box" or a cloth satchel, depending upon the magazine location and proximity to the demolition area.
5. Det cord should be placed at least 25 feet away from detonators and demolition materials until ready for use. To ensure consistent safe handling, each classification of demolition material shall be separated by at least 25 feet until ready for use.
6. When ready to "tie in" either the det cord to demolition materials, or det cord to detonator, the det cord will be connected to the demolition material and secured to the OE. The cord is then strung out of the hole and secured in place with soil, being sure to leave a one-foot tail exposed outside the hole.
7. Once the hole is filled, make a loop in the det cord that is large enough to accommodate the det cord detonator, place the detonator in the loop and secured it with tape. The explosive end of the detonator will face down the det cord toward the demolition material or parallel to the main line.
8. In all cases, ensure there is sufficient det cord extending out of the hole to allow for ease of detonator attachment and detonator inspection/replacement should a misfire occur.
9. If the det cord detonators are electric, they will be checked, tied in to the firing line and shunted prior to being taped to the loop. If the det cord detonators are non-electric, the time/safety fuse will be prepared with the igniter in place prior to taping the detonators to the det cord loop. If the det cord detonators are Non-El, simply tape the detonators into the loop as described above.
10. In the event that a time/safety fuse is used, and an igniter is not available and a field expedient initiation system is used (i.e., matches), do not split the safety fuse until the detonator is taped into the det cord loop.

6.4 TIME/SAFETY FUSE USE

The following procedures are required when using a time/safety fuse:

1. Prior to each daily use, the burn rate for the time/safety fuse must be tested to ensure the accurate determination of the length of time/safety fuse needed to achieve the minimum burn time of five minutes needed to conduct demolition operations.
2. To ensure both ends of the time/safety fuse are moisture free, use approved crimpers to cut 6 inches off the end of the time/safety fuse roll and place the 6-inch piece in the time/safety fuse container.
3. If quantity allows, accurately measure and cut off a three-foot-long piece of the time/safety fuse from the roll.
4. Take the three-foot section out of the magazine and attach a fuse igniter.
5. In a safe location, removed from demolition materials and OE, ignite the time/safety fuse, measure the burn time from the point of initiation to the "spit" at the end, and record the burn time in the demolition supervisor's Log
6. To measure the burn time, use a watch with a second hand or chronograph.
7. To calculate the burn rate in seconds per foot, divide the total burn time (in seconds) by the length (in feet) of the test fuse.
8. Whenever using time/safety fuse for demolition operations, the minimum amount of fuse to be used for each shot will be the amount needed to permit a minimum burn time of five minutes.

6.5 PERFORATOR USE

The following procedures are required when using perforators:

1. Only remove from inventory the number of perforators required to perform the task.
2. Transport perforators in an approved "day box," cloth satchel or plastic container, depending upon magazine location and proximity to the demolition operations.
3. Keep perforators stored at the demolition site at least 25 feet away from detonators and demolition materials until ready for use.
4. When ready to use, place the det cord through the slot on the perforator and knot the det cord, ensuring the cord fits securely and has good continuity with the perforator.
5. Once the det cord is secure, place the perforator in the desired location and secure it in place.
6. Proceed from this point as described in paragraph 6.3.

6.6 USE OF TWO-COMPONENT EXPLOSIVES

The following procedures are required when using two-component explosives as demolition material:

1. Only remove from inventory the amount of two-component required to perform the task.

2. When transporting the solid and liquid, they need only be placed apart in the bed of a truck.
3. Do not mix the solid and liquid components until certain that they will be used, since the resulting mixture is classified as a Class 1.1 explosive by Department of Transportation.
4. When mixing the solid and liquids components, follow the manufacturer's instructions, while being sure to wear rubber gloves and goggles. Mix components in an area away from other demolition materials, the OE, and if possible, sheltered from the wind.
5. Once the components have been mixed, it is essential that the lid to the solid bottle is put on securely as soon as possible after mixing to prevent evaporation of the liquid.
6. Attach the det cord as recommended by the manufacturer, place the assembled unit in the desired location in the hole and secure the unit.
7. Proceed from this point as described in para 6.3.

7. METEOROLOGICAL CONDITIONS

In order to control the effects of demolition operations and to ensure the safety of site personnel, the following meteorological limitations and requirements shall apply to demolition operations:

1. Demolition operations will not be conducted during electrical storms or thunderstorms.
2. No demolition operations shall be conducted if the surface wind speed is greater than 10 miles per hour.
3. Demolition operations will not be conducted during periods of visibility of less than one mile caused by, but not limited to, dense fog, blowing snow, rain, sand or dust storms.
4. Demolition shall not be carried out on extremely cloudy days, which are defined as overcast (more than 80 percent cloud cover) with a ceiling of less than 2,000 feet.
5. Demolition operations will not be conducted during any atmospheric inversion condition (low or high altitude).
6. Demolition operations will not be conducted during periods of local air quality advisories.
7. Demolition operations will not be initiated until 30 minutes after sunrise, and will be secured at least 30 minutes prior to sunset.

8. PRE-DEMOLITION/DISPOSAL PROCEDURES

8.1 PRE-DEMO/DISPOSAL OPERATIONAL BRIEFING

The demolition supervisor will brief all personnel involved in range operations in the following areas:

- Type of OE being destroyed;
- Type, placement and quantity of demolition material being used;
- Use of sandbags for mitigation of fragmentation and blast effects;
- Method of initiation (electric, non-electric or Non-El);
- Means of transporting and packaging OE;

- Route to the disposal site;
- Equipment being used (e.g., galvanometer, blasting machine, firing wire);
- Misfire procedures;
- Fire prevention procedures;
- Post-shot cleanup of range.

8.2 PRE-DEMO/DISPOSAL SAFETY BRIEFING

The SSO will conduct a safety brief for all personnel involved in range operations in the following areas:

- Care and handling of explosive materials;
- Personal hygiene;
- Two-man rule and approved exceptions;
- Potential trip/fall hazards;
- Horseplay on the range;
- Alertness for any explosive hazards on the range;
- Location of emergency shelter (if available);
- Parking area for vehicles (vehicles must be positioned for immediate departure, with the keys in the ignition);
- Location of range emergency vehicle (keep engine running);
- Wind direction (to assess potential toxic fumes);
- Location of first-aid kit and fire extinguisher;
- Route to nearest hospital or emergency aid station;
- Type of communications in event of an emergency;
- Storage location of demolition materials and OE awaiting disposal.

8.3 TASK ASSIGNMENTS

Individuals with assigned tasks will report the completion of the task to the demolition supervisor. The types of tasks, which may be required, are

- Contacting local police, fire personnel, U.S Coastal Guards and Federal Aviation Administration as required;
- Contacting hospital/emergency response personnel if applicable;
- Securing all access roads to the range area;
- Visually checking range for any unauthorized personnel;
- Checking of firing wires for continuity and shunt;
- Preparation designated pits as required;
- Checking continuity of detonators;

- Check of time and safety fuse and its burn rate;
- Designation of a technician to maintain custody of blasting machine, fuse igniters or Non-El initiator;
- Securing of detonators in a safe location;
- Placement of OE in pit and place charge in desired location.

8.4 PREPARING EXPLOSIVE CHARGE FOR INITIATION

To prepare the explosive charge for initiation, the procedures listed below will be followed:

- Insure firing wire is shunted.
- Connect detonator to the firing wire.
- Isolate or insulate all connections.
- Place demolition charge on OE.
- Prime the demolition charge.
- Depart to firing point (if using non-electric firing system, obtain head count, pull igniters and depart to designated safe area).
- Obtain a head count.
- Give 1-minute warning signal, using a bullhorn or siren, five minutes prior to detonation, and again at 1-minute prior to detonation.
- Yell, "*fire in the hole*" three times (or an equivalent warning) and take cover.
- If using electric firing system, connect firing wires to blasting machine and initiate charge.
- Remove firing wires from blasting machine and shunt.
- Remain in designated safe area until demolition supervisor announces "All Clear". This will occur after a post-shot waiting period of 5-minutes and the demolition supervisor has and inspected the pit(s).

9. POST DEMOLITION/DISPOSAL PROCEDURES

Do not approach a smoking hole or allow personnel out of the designated safe area until cleared to do so, and follow the below listed procedures:

- After the "*All Clear*" signal, check pit for low orders, kick outs, and fires.
- Mag pit and remove any large fragmentation.
- Back fill hole as necessary.
- Police up all equipment.
- Notify police, fire, etc. that the operation is complete.

10. MISFIRE PROCEDURES

A thorough check of all equipment, firing wire and detonators will prevent most misfires. However, if a misfire does occur, the procedures outlined below shall be followed.

10.1 ELECTRIC MISFIRES

To prevent electric misfires, one technician will be responsible for all electrical wiring in the circuit. If a misfire does occur, it must be cleared with extreme caution, and the responsible technician will investigate and correct the situation, using the steps outlined below:

1. Check firing line connections to the blasting machine and make a second attempt to initiate charge.
2. If unsuccessful, disconnect and connect to another blasting machine (if available) and attempt to initiate charge.
3. If unsuccessful, commence a 30-minute wait period.
4. After the maximum delay predicted for any part of the shot has passes, the designated technician will proceed down range to inspect the firing system, and a safety observer must watch from a protected area.
5. Disconnect and shunt the detonator wires, connect a new detonator to the firing circuit and prime the charge without disturbing the original detonator (replacement detonator must have been checked for continuity as outlined in Paragraph 6.2, after disconnecting the defective detonator).
6. Follow normal procedures for effecting initiation of the charge.

10.2 NON-ELECTRIC MISFIRES

Working on a non-electric misfire is the most hazardous of all operations. Occasionally, despite all painstaking efforts, a misfire will occur. Investigation and corrective action should be undertaken only by the technician that placed the charge, using the following procedure:

1. If charge fails to detonate at the determined time, initiate a 60-minute wait period plus the time of the safety fuse, i.e., 5-minute safety fuse plus 60 minutes for a total of 65-minute wait period.
2. After the wait period has expired, a designated technician will proceed down range to inspect the firing system. A safety observer must watch from a protected area.
3. Prime the shot with a new non-electric firing system and install a new fuse igniter.
4. Follow normal procedures for initiation of the charge.

The use of a shock tube for blast initiation can present misfires, which require the following actions:

1. If charge fails to detonate, it could be the result of the shock tube not firing. Visually inspect the shock tube, if it is not discolored (i.e., slightly black), it has not fired.
2. If it has not fired, cut a one-foot piece off the end of the tube, re-insert the tube in the firing device and attempt to fire again.

3. If the device still does not fire, wait 30 minutes and proceed down range to replace the shock tube per instructions outlined below.
4. If the tube is slightly black, then a "Black Tube" misfire has occurred, and the shock tube will have to be replaced. When replacing the shock tube, be sure to remove the tube with the detonator in place. Without removing the detonator from the end of the tube, repackage the defective tube and return it to the supplier for credit.

10.3 DETONATING CORD MISFIRE

Det cord will be used to tie in multiple demolition shots and to ensure that electric detonators are not buried. Since det cord initiation will be either electrical or non-electrical, the procedures presented in paragraphs 10.1, 10.2, or 10.3, as appropriate to the type of detonator used, will be used to clear a det cord misfire. In addition, the following will be conducted:

1. If there is no problem with the initiating system, wait the prescribed amount of time and inspect the initiator to the cord connection to ensure it is properly connected. If it was a bad connection simply attach a new initiator and follow the appropriate procedures in paragraph 6.0.
2. If the initiator detonated and the cord did not, inspect the cord to ensure it is det cord and not time fuze. Also, check to ensure there is PETN in the cord at the connection to the initiator.
3. At this point, it may be necessary to uncover the det cord and replace it. If this is required, it must be accomplished carefully to ensure that the demolition charge and the OE item are not disturbed.

10.4 PERFORATOR MISFIRE

The use of perforators is both cost-effective and considerably safer than the use of C-4 and many other demolition materials. If the perforator is not initiated properly, it could malfunction. Since the perforator is covered with tamping material, det cord is used as the initiator. Therefore, in case of a misfire, the procedures presented in paragraph 10.4 will be followed, along with the items presented below.

- If everything went but the perforator, one of four things has occurred:
  1. Det cord grain size was insufficient to initiate the perforator.
  2. The det cord was dislodged from the perforator when placing tamping materials.
  3. The perforator was defective.
  4. The perforator was moved during the placement of tamping materials.
- Check to ensure the grain size of the det cord is sufficient, with 80-grain size or greater being the recommended size.
- If the det cord connection to the perforator was the problem, ensure that the next connection is secure (use duct tape if necessary).
- If it is evident that the perforator was moved, then ensure it is properly secured for the next shot.

- If cord size and connection are sufficient, replace the perforator, leaving the defective one on the shot

11. RECORDKEEPING REQUIREMENT

To document the demolition operations procedures and the completeness of the demolition of OE, the following record keeping requirements shall be met:

1. The Earth Tech personnel will obtain and maintain all required permits.
2. The demolition supervisor will ensure the accurate completion of the logs, and the SUXOS will monitor the entries in the log for completeness, accuracy and compliance with meteorological conditions.
3. The demolition supervisor shall enter the appropriate data on the Ordnance Accountability Log and the Demolition Shot Record, to reflect the OE destroyed, and shall complete the appropriate information on the Explosives Accountability Log (i.e., the Magazine Data Card) which indicates the demolition materials used to destroy the OE.
4. The quantities of OE recovered must also be the quantities of OE destroyed or disposed of as scrap.
5. Earth Tech will retain a permanent file of all Demolition Records, including permits, Magazine Data Cards, training records, inspector reports, waste manifests if applicable, and operating logs.
6. Copies of ATF license and any state or local permits must be on hand.

12. SAFETY AND PPE REQUIREMENTS

The following safety measures and personal protective equipment shall be used in preventing or reducing exposure to the hazards associated with OE demolition/disposal operations. These requirements will be implemented unless superseded by site-specific requirements stated in the SSHSP.

1. Steel-toed safety boots will not be worn by personnel conducting demolition/disposal operations, unless a toe crush hazard exists, in which case personnel will wear boots with plastic or fiber toed safety toes.
2. Unless a serious head, eye or face hazard exists, OE personnel will not be required to wear hard hats, safety glasses or face shields when conducting operations involving the handling of demolition explosives or OE. and
3. In the event that a serious head, eye or face hazard does exist, OE personnel will wear the required PPE, but positive means shall be required to secure the PPE and prevent it from falling and causing an accidental detonation.

13. AUDIT CRITERIA

The following items related to demolition/disposal operations on an OE-contaminated site will be audited to ensure compliance with this SOP:

1. The Demolition Shot Record.
2. The Site Daily Operational and Safety Logs.
3. The OE Operations Daily/Weekly Report.

4. The Safety Training Attendance Forms, for the initial site hazard training.
5. The Safety Training Attendance Forms, for the Daily Tailgate Safety Briefings.
6. The Daily Safety Inspection and Audit Log.

Table C-1. Minimum Safe Distance from Transmitter Antennas

Average or Peak Transmitter Power in Watts	Minimum Distance to Transmitter in Meters / Feet
0 – 5	7.5 / 25
6 – 30	30 / 98.4
31 – 50	50 / 164.1
51 – 100	110 / 360
101 – 250	160 / 525
251 – 500	230 / 755
501 – 1,000	305 / 1,000
1,001 – 3,000	480 / 1,575
3,001 – 5,000	610 / 2,001
5,001 – 20,000	915 / 3,002
20,001 – 50,000	1,530 / 5,020
50,001 – 100,000	3,050 / 10,007
100,001 – 400,000	6,100 / 20,014
400,001 – 1,600,000	12,200 / 40,028
1,600,001 – 6,400,000	24,400 / 80,056

Note: When the transmission is a pulsed or pulsed continuous wave type and its pulse width is less than 10 microseconds, the power column indicates average power. For all other transmissions, including those with pulse widths greater than 10 microseconds, the power column indicates peak power.

Table C-2. Minimum Safe Separation Formulas

Unknown (Worst Case)	Without Metal Pack		With Metal Pack	
	Frequency	Formula	Frequency	Formula
Use Table 120D-1-1	≤2.3 kHz	$D = 0.093 \times (PG)^{0.5}$	≤73 kHz	$D = 0.093 \times (PG)^{0.5}$
	2.3 kHz – 0.45 MHz	$D = 39.7 \times F \times (PG)^{0.5}$	73 kHz - 0.45 MHz	$D = 126 \times F \times (PG)^{0.5}$
	0.45 MHz– 400 MHz	$D = 18 \times (PG)^{0.5}$	0.45 MHz - 400 MHz	$D = 0.6 \times (PG)^{0.5}$
	400 MHz – 75 GHz	$D = (7137 / F) \times (PG)^{0.5}$	400 MHz - 2.4 GHz	$D = (226 / F) \times (PG)^{0.5}$
	>75 GHz	$D = 0.093 \times (PG)^{0.5}$	>2.4 GHz	$D = 0.093 \times (PG)^{0.5}$

Where:

D = Safe distance to the transmitter in feet (multiply feet by 0.305 to obtain meters)

P = Output power of the transmitter in watts

G = Numerical gain of transmitter antenna

F = Frequency in MHz (divide kHz by 1,000 to obtain MHz, and multiply GHz by 1,000 to obtain MHz)

To properly use this table, the following assumptions are made:

1. The no-fire current of the electro-explosive devices is 10 mA.
2. At least 10 dB below the no-fire current in electro-explosive devices is considered safe.
3. The metal pack provides at least 30 dB of shielding.
4. Non-metal packs provide no shielding.
5. A 1-volt/meter field intensity is considered safe.
6. At no time should personnel or munitions be exposed to more than 200 volts/meter.

Appendix D
Use of Sandbags for Mitigation of Fragmentation and Blast Effects

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

Use of Sandbags for Mitigation of Fragmentation and Blast Effects Due to Intentional Detonation of Munitions

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August 1998

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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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FINAL WORK PLAN ORDINANCE AND EXPLOSIVES RANGE EVALUATION IRP SITE 1

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FINAL WORK PLAN ORDINANCE AND EXPLOSIVES RANGE EVALUATION IRP SITE 1

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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.

APPENDIX D
USE OF SANDBAGS FOR MITIGATION OF FRAGMENTATION AND BLAST EFFECTS
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FINAL WORK PLAN ORDINANCE AND EXPLOSIVES RANGE EVALUATION IRP SITE 1

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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.

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USE OF SANDBAGS FOR MITIGATION OF FRAGMENTATION AND BLAST EFFECTS
PAGE 5

FINAL WORK PLAN ORDINANCE AND EXPLOSIVES RANGE EVALUATION IRP SITE 1

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1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132
TELEPHONE: (619) 532-3676

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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USE OF SANDBAGS FOR MITIGATION OF FRAGMENTATION AND BLAST EFFECTS
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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%.

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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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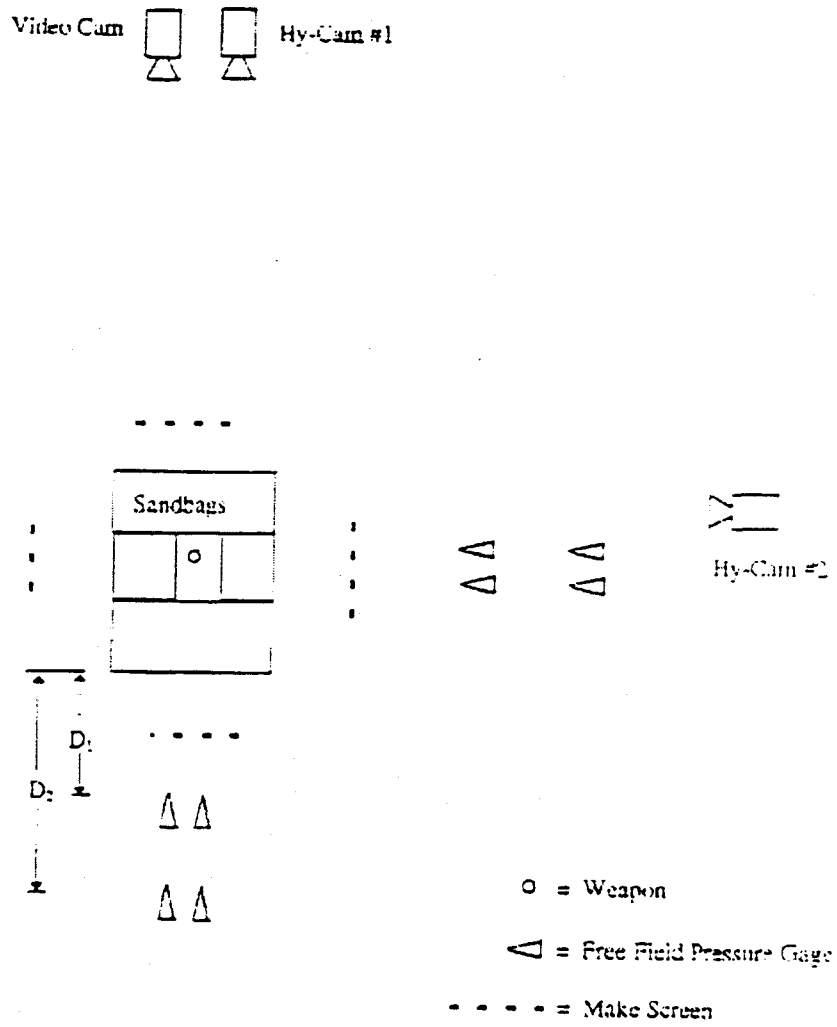

Figure 1 – Site Layout for Tests of Sandbag Enclosures

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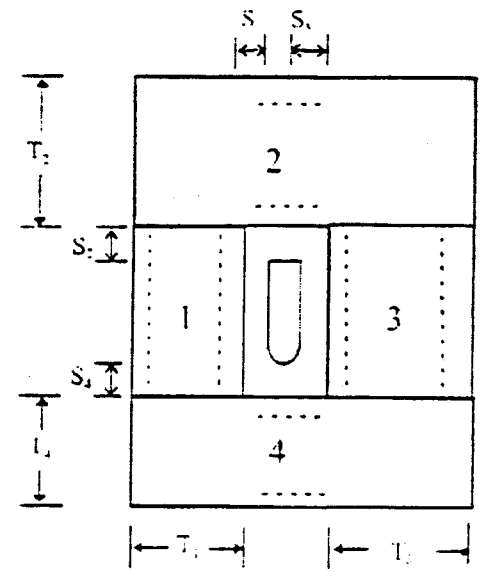
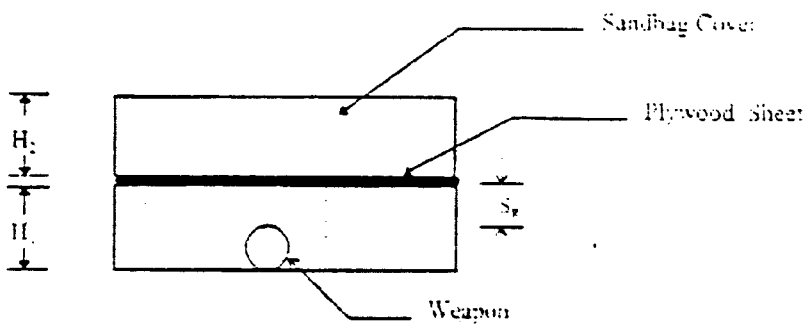


PLAN



ELEVATION

Figure 3 – Sandbag Enclosure Configuration for Horizontal Weapon Tests

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Figure 5 – Sandbag Enclosure for an 81 mm M374A2 mortar.

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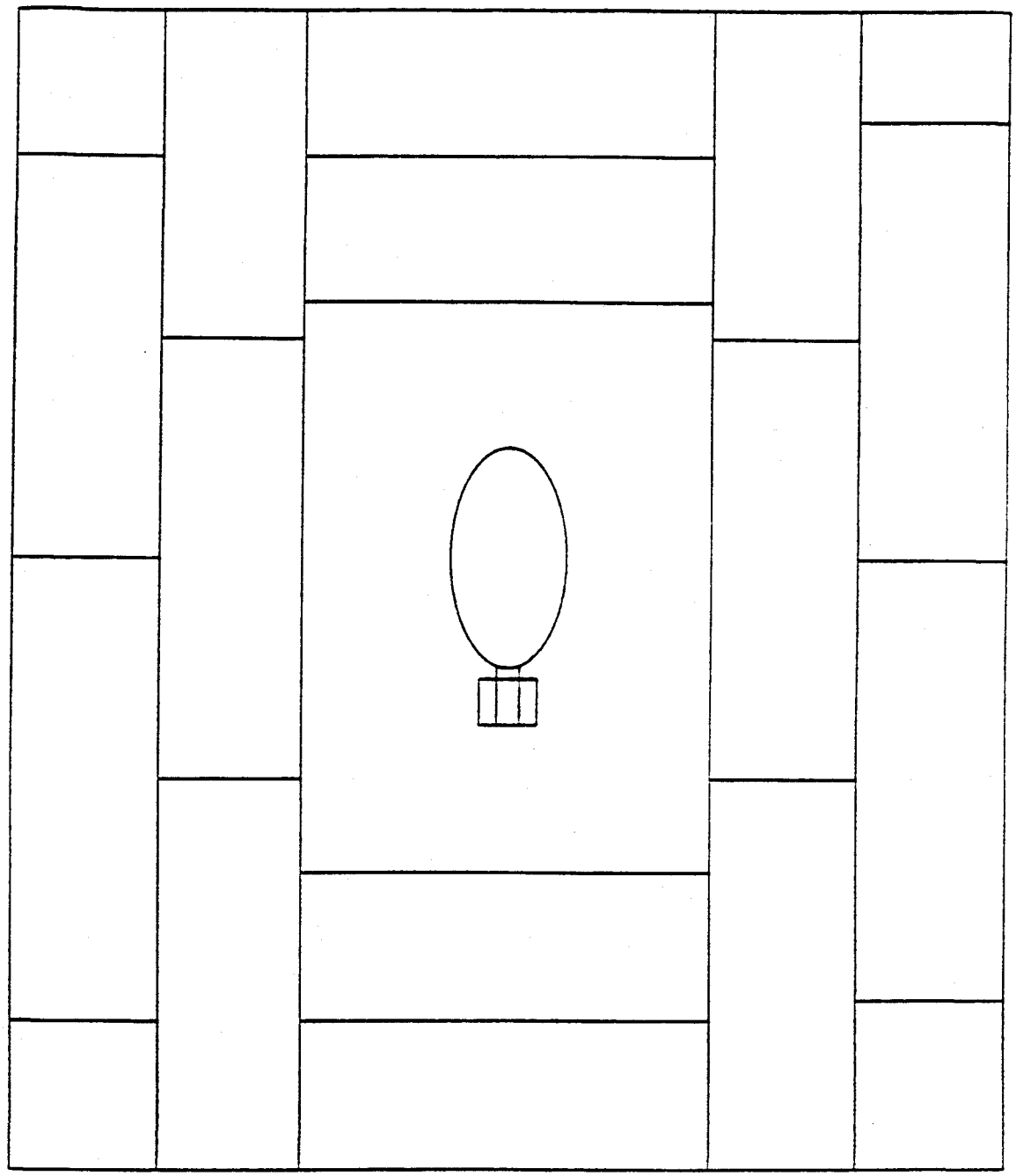


Figure 7 - Configuration for 12" Wall Enclosures

Appendix E
Earth Tech Forms

EARTH TECH FORMS

1. Daily Field Activity Report
2. Site Safety Meetings
3. Visitor's Log
4. Weekly Equipment Calibration/Response Check Log
5. Vehicle Inspection Checklist
6. Grid/Trench Operations Record
7. OE Item Continuation Sheet
8. Demolition Shot Record
9. Supervisor's Report of Incident
10. Field Change Request
11. Field Change Request Log
12. Audit Schedule Check List
13. Quality Inspection Record (Grid/Trench)
14. Quality Control Report (Part I, II, and III)
15. Quality Deficiency Notice (Part I and II)
16. Nonconformance Report (NCR)
17. Nonconformance Report Log

Daily Field Activity Report

Page _____ of _____

Date _____

Project Name _____ Weather

_____

Project Number _____ Site Conditions _____

Visitors

_____

Work Force		Remarks
Earth Tech		
Subcontractors		
Equipment		

Description of site activities

Materials delivered to the site _____

_____

Safety _____

_____

Areas of concern _____

_____

Subcontractor work tickets reviewed _____ Approved _____ Attached _____

Prepared by _____ Date _____ Title _____

Site Safety Meetings
Site 1, MCAS El Toro

Tailgate Safety Briefing Sign-in Log

Date: _____ **Time:** _____

Briefing Conducted By:	Signature:	Company Name:

This sign-in log documents the tailgate safety briefing conducted in accordance with 29 CFR 1910.120 "Hazardous Waste Operations and Emergency Response" as well as other applicable regulatory requirements. Personnel who perform work operations onsite are required to attend each safety briefing and acknowledge receipt of such briefings daily or as required.

TOPICS COVERED:

~ General PPE usage	~ Decontamination Procedures	~ Emergency Procedures
~ Respiratory Protection	~ Smoking Eating and Drinking	~ Existing Work Zones
~ Hearing Conservation	~ Slips, Trips, and Falls	~ Lockout/Tagout
~ Personal Hygiene	~ Heat and Cold Stress	~ Excavation/Confined Spaces
~ Exposure Guidelines	~ Site Control	~ New Work Procedures

PERSONNEL SIGN-IN LIST

Printed Name	Signature	Company Name

EARTH TECH, INC. SITE VISITORS LOG

Location: _____ Site: _____

Name	Title	Company	Phone Number	Time In	Time Out	Date

EARTH TECH DAILY EQUIPMENT CALIBRATION/RESPONSE CHECK LOG

Location:		Contract No.:				Delivery Order No.:			QCS:
Equipment Nomenclature	Serial Number	Calibration / Response Check Test Date							Remarks
		SUN	MON	TUE	WED	THUR	FRI	SAT	
		Initials of Person Conducting Calibration / Response Check							

Team # _____

EARTH TECH VEHICLE INSPECTION CHECKLIST

(To be used weekly for all vehicles EXCEPT explosive carriers, which must be inspected prior to each explosives, transport)

Site Name / Location: _____

SUXOS: _____ Inspector: _____ Vehicle: _____ (MAKE & LICENSE PLATE #)

Date Inspected: _____ Mileage: _____ Owner: _____ (RENTAL, EODT, GFE, CONTRACT)

USE ✓ FOR PASS, X FOR DISCREPANCY

1. DOCUMENTATION:	Pass	Fail	2. BRAKES:		
Registration	[ ]	[ ]	Hand/Emergency	[ ]	[ ]
Insurance	[ ]	[ ]	Service	[ ]	[ ]
Emergency Route Map and Phone Numbers	[ ]	[ ]			
3. TIRES:			4. BELTS:		
Pressure	[ ]	[ ]	Proper tension	[ ]	[ ]
Condition	[ ]	[ ]	Condition	[ ]	[ ]
5. EQUIPMENT:			6. LIGHTS:		
Fire extinguishers*	[ ]	[ ]	Headlights (high & low)	[ ]	[ ]
First Aid/CPR/Burn	[ ]	[ ]	Brake Lights	[ ]	[ ]
Eyewash kits	[ ]	[ ]	Parking	[ ]	[ ]
Emergency Breakdown	[ ]	[ ]	Back-up	[ ]	[ ]
Kit	[ ]	[ ]	Turn Signals	[ ]	[ ]
Spare Tire	[ ]	[ ]	Emergency Flashers	[ ]	[ ]
Tire Changing Equipment	[ ]	[ ]			
Tie downs*	[ ]	[ ]			
Chocks*	[ ]	[ ]			
Placards*					
7. FLUID LEVELS:			8. GENERAL:		
Oil	[ ]	[ ]	Windshield Wipers	[ ]	[ ]
Coolant	[ ]	[ ]	Windshield/Windows	[ ]	[ ]
Brake	[ ]	[ ]	Seat Belts	[ ]	[ ]
Steering	[ ]	[ ]	Steering	[ ]	[ ]
Transmission	[ ]	[ ]	Horn	[ ]	[ ]
Windshield Wiper	[ ]	[ ]	Gas Cap	[ ]	[ ]
Fluid Leaks	[ ]	[ ]	Mirrors	[ ]	[ ]
			Cleanliness	[ ]	[ ]
			Exhaust system*	[ ]	[ ]

(Note: Items marked with * are required for explosive carriers and must be inspected prior to each use)

Description of deficiencies: _____

_____

Deficiencies corrected by: _____ Date _____

Grid Operations Record

Contract Number:

OPERATIONS

Date:	Vegetation Removal Team	UXO	Rat Nest	Back-Hoe	Survey	Sub-Contractor
Site/Grid Number/WAD:		START:	STOP:	Complete? Yes No		

PERSONNEL DATA

NAME	START	STOP	START	STOP	START	STOP	TOTAL
//////////	//////////	//////////	//////////	//////////	//////////	**TOTAL**	

SCHEDULING DATA	**PERFORMANCE DATA**
Rat Nest Required: Yes Amount _____	Rat Nest Completed: Date: Initials:
Back-Hoe Required Yes No. of Digs _____	Back-Hoe Completed: Date: Initials:

ANOMALY INVESTIGATION (BGS)

Surface	Surface to 12"	12" to 24"	24" to 36"	36" to 48"

Pounds of Ordnance Scrap	Pounds of Other Scrap

GRID CHARACTERISTICS

Slope in %:	Type Vegetation:	Other:
Comments:		

ADMINISTRATIVE DATA

Grid Reviewed/Posted by: (Initials & Date)	SUXOS	Safety	Quality Control	Data Entered in Computer

Name of Team Leader	**Signature**

OE ITEM CONTINUATION SHEET

Page __ of __ pages

Date: **Site:** **Grid:** **Team:**

N	E	QTY	Depth	OE Items	UXO/Ordnance Scrap	Disposition

EARTH TECH DEMOLITION SHOT RECORD

Site Name/Location:		Date:
Shot Location (OB/OD Range or Grid No.):	Demolition Supervisor:	State License # (if applicable):
Type of UXO/OE Destroyed, Vented, or Burned:	Firing Method:	Time of Shot:
Direction and Distance to Nearest Building, Road, Utility Line, etc.:	Temp: _____ Wind Dir./Speed: _____ Ceiling: _____ Clouds/$ Sun: _____	
Type and Amount of Tamping Used:		Mat or Other Protection Used (list):
Seismographic/Sound Level Meter Used: Yes ☐ No ☐	Readings/Results:	

Demolition Materials Used

Description	Amount	Description	Amount
Perforator		Time Fuze	
Det Cord		Squibs	
Electric Detonator		Black/Smokeless Powder	
Non-Electric Detonator		Two Component	
Non-El Detonator		Other (list)	

Certification

I certify that the explosives listed were used for their intended purpose, and that the UXO/OE listed were rendered inert/destroyed.

Signature of Demolition Supervisor: _____ Date:

Site Name/Location:		Date:
Shot Location (OB/OD Range or Grid No.):	Demolition Supervisor:	State License # (if applicable):
Type of UXO/OE Destroyed, Vented, or Burned:	Firing Method:	Time of Shot:
Direction and Distance to Nearest Building, Road, Utility Line, etc.:	Temp: _____ Wind Dir./Speed: _____ Ceiling: _____ Clouds/% Sun: _____	
Type and Amount of Tamping Used:		Mat or Other Protection Used (list):
Seismographic / Sound Level Meter Used: Yes ☐ No ☐	Readings/Results:	

Demolition Materials Used

Description	Amount	Description	Amount
Perforator		Time Fuze	
Det Cord		Squibs	
Electric Detonator		Black/Smokeless Powder	
Non-electric Detonator		Two Component	
Non-El Detonator		Other (list)	

Certification

I certify that the explosives listed were used for their intended purpose, and that the UXO/OE listed were rendered inert/destroyed.

Signature of Demolition Supervisor: _____ Date: _____

Supervisor's Report of Incident

This is an official document to be initiated by the injured employee's Supervisor. Please answer all questions completely. Fax to your Region's EHS Manager within 24 hours of the injury. See reverse side for instructions.

Section 1: Employee (Must complete each item or processing delays will occur) - Print Clearly

SCMS Claim#: _____ WC Location Code: _____

SCMS: (877)261-8926

Employee Data		S.S. No.	Sex	Birth Date
Injured's Name		Home Phone	Marital Status	No. Dependents
Home Address		City	State	Zip Code
Job Title	Dept No.	Office Location/Address		
Injury Illness Vehicle Injury Near Miss			Hire Date	Hourly Wage

Section 2: Supervisor (Must complete each item or processing delays will occur) - Print Clearly

Date of Incident	Time	Date Reported	To Whom
Client Name	Job Assignment at Time of Incident		Time Shift Began
Exact Location & Address of Incident		Did injured leave work? Yes No When?	
Has injured returned to work? Yes No		Did employee miss a regularly scheduled shift? Yes No	
Doctor/Hospital Name		Address of Hosp.	
Witness Name		Statements Attached Yes No	
Nature of Injury		Body Part	
Medical Treatment Received			
Describe Incident			
What caused the incident?			
Corrective Action(s) to Prevent Future Occurrence:			
Supervisor/Foreman (Print Name)	Signature Date		Telephone

Section 3: Manager

Comments on incident and corrective action		
Manager (Print Name)	Signature Date	Telephone

Section 4: Environmental, Health and Safety

Concur with action taken? Yes No Remarks:		
OSHA Recordable No Pending Yes - Type : Incident only First aid Medical Fatality Lost work days _____ Days of restricted activity _____		
EHS Professional (Print Name)	Signature Date	Telephone

Field Change Request

Field Change No. _____

Page _____ of _____

Project Name _____

Contract Number _____ Project Number

_____

Applicable Document _____ Date _____

DESCRIPTION

Minor Change ~ Major Change ~ Major Project Impact ~

Requested by

_____

REASON FOR CHANGE

RECOMMENDED DISPOSITION

IMPACT ON PRESENT AND COMPLETED WORK

Cost Impact

_____

Accepted ~ Rejected ~ Signature _____ Date _____

Project Manager

Accepted ~ Rejected ~ Signature _____ Date _____

Project QC Manager

(For changes to engineering drawings and construction specifications)

Accepted ~ Rejected ~ Rework ~ Signature _____ Date _____

Responsible Engineer

Remarks:

FINAL DISPOSITION

Signature _____ Date _____

Field Change Request Log

Project Name _____

Contract Number_____ Project Number

_____

Field Change Request No.	Level of Change*	Activity	Date initiated	Final Disposition	Remarks

* Min C = Minor Change
Maj C = Major Change
MPI = Major Project Impact

AUDIT SCHEDULE CHECK LIST

PROJECT:

AUDIT/INSPECTION DATE:

QA/QC CHECK LIST

CHECK	SKD	REFERENCE	YES	NO	N/A	COMMENTS
A. Review Scope of work and OE RDD						
1. Clearance area and objectives clearly identified.	A					
2. All modifications and changes added and up to date.	M					
3. Work plan current and all changes posted.	M					
4. Depth of clearance identified.	A					
5. Minimum Separation Distance (MSD) established based on the Most Probable Munition (MPM)	A	DOD 6055.9 STG				
6. Proper target OE identified and test sources/test plot established.	A					
7. Maps identifying the proper MSD located in the OE RDD for each clearance area.	A					
8. Standards for the turn-in of OE scrap located in the OE RDD.	A	DOD 4160.21 M 1				
9. Copy of the Explosive Safety Submission (ESS) located at the project site.	A	IGD 98 10 Ch. 10				
B. Documentation Requirements on Site:	SKD		YES	NO	N/A	COMMENTS
1. WORKPLAN	A					
2. SSHSP	A					
3. Letter authorizing project start-up.	A					
4. Department of Defense Notice to Airmen (NOTAM) FWD to the area Federal Aviation Administration (FAA).	A	AR 95 10, AFR 11 208				
5. Contract and all modifications and change orders.	M					
6. First Aid and CPR training certificate (required to have a minimum of two qualified personnel on site when field activities are taking place.	M	EM 385 1 1, Sec. 03.A.02				
7. File on all UXO qualified personnel to include: NAVSCOLEOD cert., up to date physical, 40 HR HAZWOPER cert., up to date 8 HR HAZWOPER cert.,	M	29 CFR 1910.120 (f)(e)				

QA/QC CHECK LIST

8. File on SUXOS, QC, SSO, and all UXOSs, a copy of an 8 HR HAZWOPER supervisor cert.	M					
9. QA/QC files established.	M					
10. Daily Field logs established for all on site supervisors and above, and maintained as project property and reviewed daily by the site manager or his representative.	A					
C. Safety Requirements:	S K D		Y E S	N O	N / A	COMMENTS
1. Hazard Analysis and Risk Assessment for all project tasks and on-site equipment.	A					
2. Personnel protective equipment (PPE) for all on-site personnel to include visitors.	M	EM 385 1 1, 29 CFR 1910.120/134				
3. First Aid equipment immediately available to all on-site personnel.	M	EM 385 1 1				
4. Emergency eye wash immediately available to all on-site personnel.	M	ANSI 385.1				
5. Fire extinguishers posted as required in all on-site vehicles, and in all on site buildings.	M	DID OT 005 06, EM 385 1 1				
6. Ongoing Safety and Health (S&H) training program.	M	On-Site SSHSP				
7. Emergency Notification List (ENL) posted and available to all on-site personnel.	M					
8. Emergency Route Maps provided to all on-site personnel.	M					
9. Work task identified in Hazardous Analysis.	A					
10. Copies of MSDSs for all hazardous substances used and /or stored on-site.	M					
D. Facilities:	S K D	EM 385 1 1	Y E S	N O	N / A	COMMENTS
1. Adequate work space and restroom facilities.	M					
2. Good housekeeping maintained.	D					
3. Approved containers for flammable storage used.	W					
4. Approved explosive storage facilities used on-site.	W					
5. Fire exits marked and not blocked.	D					
6. Maximum personnel occupancy limits maintained at on-site office facilities.	D					

QA/QC CHECK LIST

E. Equipment	SKD		YES	NO	N/A	COMMENTS
1. Tools adequate and serviceable.	W					
2. PPE adequate and serviceable and used.	D					
3. Equipment calibrated and tested	M					
4.GPS systems inspected and serviceable.	W					
5. Geophysical equipment on-site inspected, tested, serviceable and identified in the work plan.	W					
6. Demolition equipment inspected and serviceable.	D					
7. Two separate means of on-site communications inspected and serviceable.	W					
8. Heavy Equipment inspected and serviceable.	D					
9. Hand and power tools inspected and serviceable.	W					
F. Transportation of Explosive Materials	SKD	DOT 49 CFR Parts 100 to 199, AR 385 64, EM 385 1 1 Sec. 29	YES	NO	N/A	COMMENTS
1. Motor vehicle inspection performed.	D					
2. Vehicles transporting explosives display all required placards, lettering, and numbers required.	D					
3. Compatibility requirements maintained.	D					
4. Load blocked and braced.	D					
5. First aid kit and 2 10 lb. Fire extinguishers rated for BC fires maintained in the vehicle.	D					
6. Vehicle communications inspected and serviceable.	D					
7. Operators conducting transport will have a valid drivers license and current CDL	D					
8. No flame producing articles in transport vehicle or on persons conducting transport, or handling the explosives.	D					
G. Explosive Management Plan:	SKD	ATF 5400.7, DOT REG., AR 190 11	YES	NO	N/A	COMMENTS
1. Licenses and permits as required.	A					
2. Proper magazine type used.	A					

QA/QC CHECK LIST

3. Explosive acquisition plan in place before starting field operations.	A					
4. Explosive compatibility maintained.	W					
5. Initial receipt procedures and documentation procedures on-site and followed.	M					
6. Fire fighting control plan established and posted	A					
7. Proper fire division symbol at entrance to storage site.	A					
8. Area around magazine free of rubbish, brush, dry grass, trees for a minimum of 25 feet.	M					
9. Physical security and key control plan in place.	A					
10. Magazine site meets all BATF, state, and local requirements	A					
11. Magazine NEW is maintained at or below the established weight at all times.	W					
12. Receipt procedures accounting for each explosive item received have been established.	A					
13. A list of persons authorized to receive, issue and transport explosives will be maintained on-site.	M					
14. End user is certifying use in writing.	W					
15. Explosives inventory conducted weekly.	W					
16. Magazine Data Cards maintained.	W					
H. GIS System	SKD		YES	NO	N/A	COMMENTS
I. Quality Control Plan	SKD		YES	NO	N/A	COMMENTS
1. QC audits/inspections completed, and recorded as required.	M					
2. QC training conducted as required.	M					
3. Results of QC checks being properly recorded.	M					
J. Vegetation Removal	SKD		YES	NO	N/A	COMMENTS
1. Equipment operated to prevent impact with OE.	D					
2. UXO personnel monitoring removal operation.	D					
3. If OE is discovered it is marked and handled appropriately.	D					

QA/QC CHECK LIST

4. Vegetation cleared IAW site work plan.	D					
K. Survey and Mapping	S K D		Y E S	N O	N / A	COMMENTS
1. OE escort provided.	D					
2. Grid stake locations checked by the OE escort with Geophysical equipment prior to driving stakes.	D					
3. Grids marked IAW site work plan.	W					
4. Grids documented IAW site work plan.						
L. OE Surface Clearance	S K D		Y E S	N O	N / A	COMMENTS
1. Operation being conducted IAW site work plan.	D					
2. SUXOS on site during all field operations.	D					
3. SUXOS , UXOSSO, UXOQC, and UXOS maintaining proper field logs.	W					
4. MSD established prior to conducting OE operations.	D					
5. UXOS conducted and documented Tailgate Safety Brief prior to starting work.	W					
6. PPE being provided and used properly on site.	D					
7. OE scrap and metallic debris larger that 1" by 2" removed and placed in the SW corner of the grid.	W					
8. Was all OE, and OE scrap processed IAW the OE Process Flowchart, and procedures established in the work plan.	W					
M. Location Surveys	S K D		Y E S	N O	N / A	COMMENTS
1. Was location and surveys conducted IAW the site work plan.	A					
2. Class 1, Third Order or better used to established for the network monuments.	A					
3. Control points identified on a map by name and number.	A					
N. Geophysical Systems/ Operations	S K D		Y E S	N O	N / A	COMMENTS
O. Anomaly Reacquisition	S K D		Y E S	N O	N / A	COMMENTS
1. OE escort provided.	D					

QA/QC CHECK LIST

2. Relocate with at least 20-cm accuracy.	D					
P. OE Subsurface clearance and Disposal	S K D		YES	NO	N/A	COMMENTS
1. MSD established based on the MPM.	D					
2. Near surface anomalies are being excavated using hand tools.	D					
3. Hand held metal detector used to check and verify the location of the anomaly being excavated.	D					
4. When heavy equipment is used to excavate subsurface anomalies the entrance and egress path is cleared and marked prior to its arrival.	S					
5. Heavy equipment is used IAW the procedures established in the site work plan.	S					
6. OE identification and disposal conducted by the Disposal Operations Team.	S					
7. Are OE items being properly identified.	S					
8. Is determination of safe to move being made IAW the on-site work plan.	S					
9. Is OE disposal being conducted IAW the on-site work plan.	S					
10. Are all demolition operations being conducted IAW USACE approved procedures.	S					
11. Is the OE Disposal Operations Team organized IAW the on-site work plan	S					
12. OE demolition site selected and prepared prior to the start of field operations.	A					
Q. OE Scrap Disposal	S K D		YES	NO	N/A	COMMENTS
1. Removal and disposal of OE scrap conducted IWA the on-site work plan.	S					

S - Situational (as required)
A - Annual (or once at the start of a project)
M - Monthly
W - Weekly
D - Daily

QC Inspection Record

Contract Number:

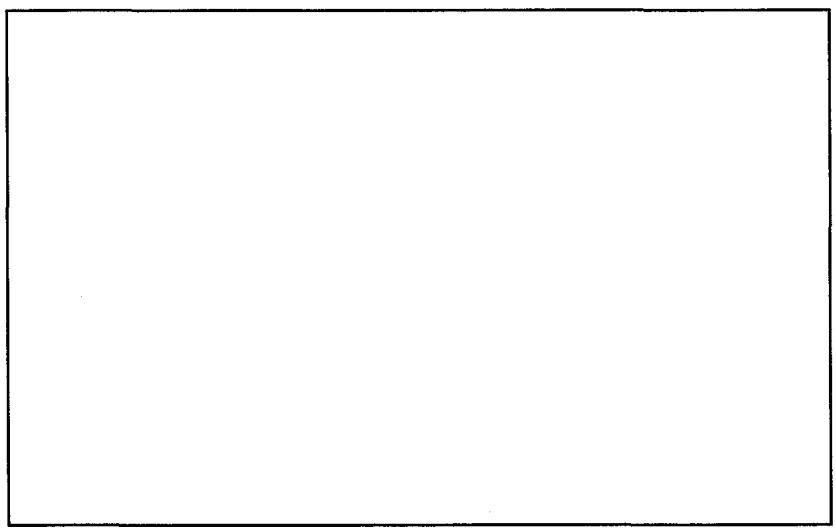
Work Area:	Grid Number/Team Number:	Date:
Start (Date/Time)	Completed (Date/Time):	Page _ of _ pages

Personnel Position	Name	Hours
QC Officer		
UXO Supervisor		
Laborer		
Laborer		
Laborer		
Laborer		

Quality Control Results			
Item:	YES	NO	Quantity
OEW Encountered			
Anomalies Detected			
Passed Inspection			

Remarks

Draw the approximate location(s) of above items that were answered yes



Southwest Corner

Name of QC Officer	Signature

Quality Control Report

(Part I)

Report Number _____ Date

_____

Contract Number

_____

Name and Location of Project

_____

Weather: (Clear) (P. Cloudy) (Cloudy)

Temperature_____

CONTRACTOR/SUBCONTRACTORS	AREA OF RESPONSIBILITY
a.	
b.	
c.	
d.	
e.	
f.	
1. Work performed today (Indicate location and description of work performed. Refer to work performed by prime and/or subcontractors by letter in table above).	
2. Preparatory inspection for next item of work (Materials/shop drawings approved, required control testing arranged, all preliminary work has been accomplished as per plans and specifications).	

Quality Control Report

(Part II)

3. Initial inspection (Address quality of workmanship, assure control testing and materials being used in all work are in compliance with plans and specifications.
4. Follow-up inspection (Assure control testing performed as required and all work performed continues to be in compliance with plans and specifications).
5. Verbal instructions received (List any instructions given by government personnel on construction deficiencies, retesting required, etc., with action taken).
6. Remarks (Cover any conflicts in plans, specifications, instructions, or any delay to the job attributable to weather conditions).

Quality Control Report

(Part III)

7. Results of safety inspection (Note safety violations and corrective action taken. Indicate phase of work where violations occurred).
8. Upcoming work (Indicate next major phase of work anticipated and approximate date of Preparatory Inspection meeting to cover this work).
9. Equipment data (Indicate items of construction equipment, other than hand tools, at the job site and whether or not used).

Earth Tech verification: The above report is complete and correct and all material and equipment used and work performed during this reporting period are in compliance with the contract plans and specifications except as noted above.

_____

Earth Tech Approved/Authorized Representative

Quality Deficiency Notice

(Part I)

QDN Number _____

Project Name _____ Project Number _____

Activity _____ Location _____

Controlling Document:
Requirement
Description of Deficiency
Reported by _____ Date _____ Discussed with _____ Date _____
Response
This section to be completed by responsible organization and returned to the Earth Tech QC Manager or designated representative by _____ (Date).
Corrective Action (including action to prevent recurrence and root cause determination)
Scheduled Completion Date _____ Signed _____ Date _____

Quality Deficiency Notice

(Part II)

Evaluation of Response QDN Number _____

This section to be completed by the Quality Control Manager		
First Response	~ Satisfactory	~ Unsatisfactory
Remarks		
Evaluated by _____	Date _____	
Second Response	~ Satisfactory	~ Unsatisfactory
Remarks		
Evaluated by _____	Date _____	
Third Response	~ Satisfactory	~ Unsatisfactory
Remarks		
Evaluated by _____	Date _____	
Corrective action verified	~ Yes	~ N/A
Remarks		
Verified by _____	Date _____	
Quality deficiency notice closed on _____	By _____	

Nonconformance Report

NCR No. _____

(NCR)

Project _____ Project Number

_____

Activity _____ Location

_____

Part A
Description of nonconformance

Nonconformance reported by _____ Date _____

Part B
Evaluation of nonconformance

Significant condition adverse to quality ~ Yes ~ No

Work stoppage required ~ Yes ~ No

Impacts previous data/reports ~ Yes ~ No

Remarks:

Evaluated by _____ Date _____ Title _____

Approved by _____ Date _____ _____ Date _____

Project Manager QC Manager

Part C
Recommended corrective action/disposition

Evaluated by _____ Date _____ Title _____

Approved by _____ Date _____ _____ Date _____

Project Manager QC Manager

Part D
Corrective action/disposition

Completed by _____ Date _____

Remarks:

Corrective action approved and NCR closed by:

_____ Date _____ _____ Date _____

Project Manager QC Manager

Nonconformance Report Log

NCR No.	Project/Activity	Date initiated (Part A)	Date NCR closed (Part D)	Remarks

Appendix F

OE Operations - Management/Storage of Demolition Materials Standard Operating Procedure

APPENDIX F

OE OPERATIONS - MANAGEMENT/STORAGE OF DEMOLITION MATERIALS STANDARD OPERATING PROCEDURE

1. PURPOSE

The purpose of this standard operating procedure (SOP) is to provide the minimum procedures and requirements applicable to the conduct of management and storage of demolition materials in support of sites contaminated with ordnance and explosives (OE) or unexploded ordnance (UXO).

2. SCOPE

This SOP applies to all site personnel involved in the conduct of explosives management on a site with UXO contamination. This SOP is not intended to contain all requirements needed to ensure compliance and should be used in conjunction with project plans and applicable federal, state and local regulations.

3. REFERENCES

The following documents were used in preparing this plan.

ATF P 5400.7, ATF-Explosives Law and Regulations

DAPAM 385-64, Ammunition and Explosives Safety Standards

AR 190-11, *Physical Security of Arms, Ammunition and Explosives*

Basic Safety Concepts and Considerations for Ordnance and Explosives, May 22, 2000

DA PAM 385-64, *Ammunition and Explosives Safety Standards*

DOD 6055.9-STD, *Ammunition and Explosives Safety Standards*

DOT, 49 CFR Parts 100 to 199, *Transportation* (applicable sections)

OSHA, 29 CFR 1910, *Occupational Safety and Health Standards*

OSHA, 29 CFR 1926, *Construction Standards*

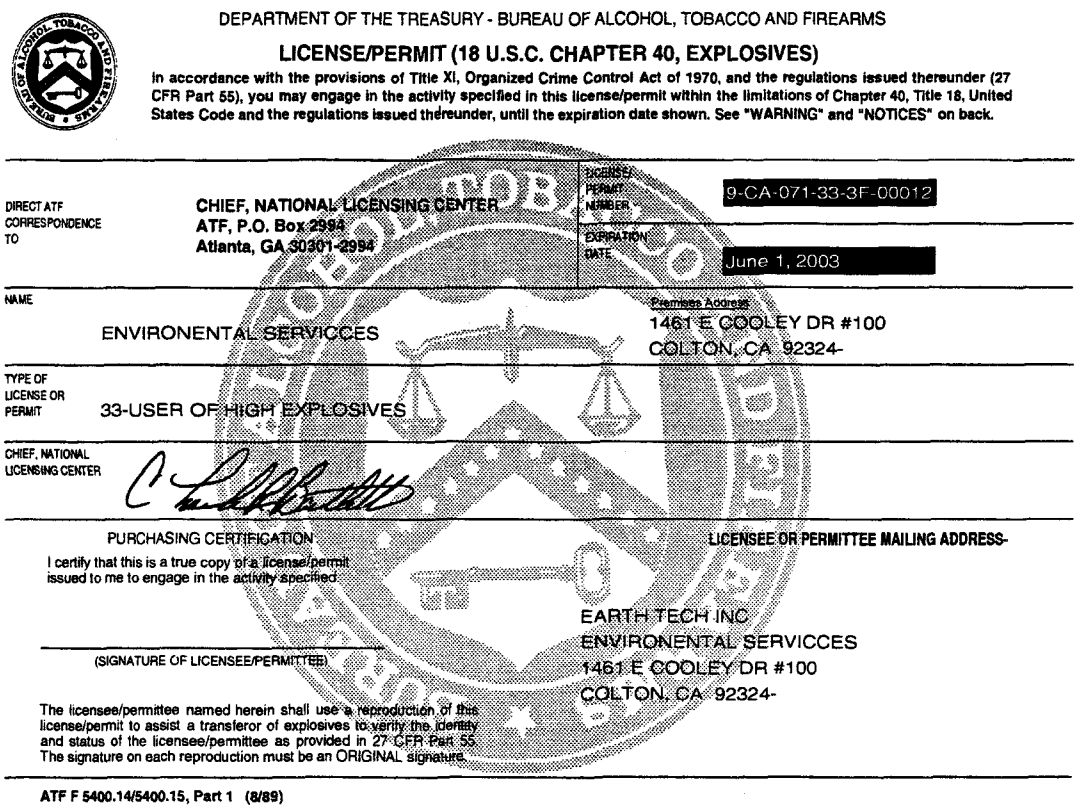
TM 9-1300-200, *Ammunition General.*

4. RESPONSIBILITIES

The PM, in conjunction with the SUXOS, is responsible for the initial quantity and type of demolition material ordered. The SUXOS will be responsible for all subsequent requisitions for demolition materials. This will be accomplished by submitting a purchase order request through the PM.

4.1.1 Acquisition

Earth Tech has a Bureau of Alcohol, Tobacco and Firearms (BATF) permit (Figure 4-1) to purchase and use explosives, and will supply commercial demolition material for disposal operations, if required, at Site 1. This permit will be available on site for local, state, or federal inspection.



DEPARTMENT OF THE TREASURY - BUREAU OF ALCOHOL, TOBACCO AND FIREARMS

LICENSE/PERMIT (18 U.S.C. CHAPTER 40, EXPLOSIVES)

In accordance with the provisions of Title XI, Organized Crime Control Act of 1970, and the regulations issued thereunder (27 CFR Part 55), you may engage in the activity specified in this license/permit within the limitations of Chapter 40, Title 18, United States Code and the regulations issued thereunder, until the expiration date shown. See "WARNING" and "NOTICES" on back.

DIRECT ATF CORRESPONDENCE TO: **CHIEF, NATIONAL LICENSING CENTER ATF, P.O. Box 2994 Atlanta, GA 30301-2994**

LICENSE/PERMIT NUMBER: 9-CA-071-33-3F-00012

EXPIRATION DATE: June 1, 2003

NAME: ENVIRONENTAL SERVICCES

Premises Address: 1461 E COOLEY DR #100 COLTON, CA 92324-

TYPE OF LICENSE OR PERMIT: 33-USER OF HIGH EXPLOSIVES

CHIEF, NATIONAL LICENSING CENTER

PURCHASING CERTIFICATION

I certify that this is a true copy of a license/permit issued to me to engage in the activity specified.

(SIGNATURE OF LICENSEE/PERMITTEE)

LICENSEE OR PERMITTEE MAILING ADDRESS-

EARTH TECH INC
ENVIRONENTAL SERVICCES
1461 E COOLEY DR #100
COLTON, CA 92324-

The licensee/permittee named herein shall use a reproduction of this license/permit to assist a transferor of explosives to verify the identity and status of the licensee/permittee as provided in 27 CFR Part 55. The signature on each reproduction must be an ORIGINAL signature.

ATF F 5400.14/5400.15, Part 1 (8/89)

Figure 4-1. BATF License/Permit

Accountability and use of the explosives will remain with Earth Tech unless custody is transferred to the Government or another contractor with a current BATF explosives license.

4.1.1.1 Acquisition Source

Earth Tech will purchase explosives from a licensed commercial supplier. The UXOS/SSO will be authorized to request and receive explosives from the commercial supplier.

4.1.1.2 Listing of Proposed Explosives

The types of explosives that may be used are

Charge Demo C-4, if available

Charge 3/4-lb Booster

Cap, Blasting Nonelectric

Cap, Blasting Electric

Shape Charges

Detonating Cord

Fuse, Time Blasting

Igniter, Time Fuse

4.1.2 State Blaster's License/State or County Permits

A California State Blaster's License and BATF Permit are required for the purchase of operations explosives at Site 1. Earth Tech holds the necessary license and permits to conduct explosive operations.

4.1.3 Initial Receipt

Only those individuals named on the authorization list (Figure 4-2) may sign for explosives received from the shipper. In order to ensure the quantity shipped is the same as the quantity listed on the shipping documents, two OE personnel will inventory the shipment prior to signing for any demolition materials.

4.1.4 Receipt Procedures

Explosive shipments generally are accompanied by the explosive supplier's bill of lading and the freight company's shipping document. The initial inventory will include reconciling of the two documents with the actual shipment received.

Regardless of the outcome of the initial inventory, one copy of the bill of lading and the freight company shipping document will be attached to a copy of the Purchase Order request and the Purchase Order. One copy of each of these four documents will be kept on file at the site field office, and one complete copy should be forwarded to the corporate office.

4.1.5 Explosives Receipt Discrepancy

In the event that there is a discrepancy between the amount of explosives shipped and the amount received, the UXOS or TOM will immediately contact the explosives supplier and indicate the discrepancy. It is the responsibility of the supplier and shipper to rectify the situation and inform Earth Tech of the results. The supplier and/or shipper must then correct their documents and forward same to the site. Only the actual amount received will be signed for on the bill of lading.

4.1.6 Storage

Storage of explosives is not planned or anticipated. Demolition explosives will be delivered on an "as needed" basis by a certified local vendor.

4.1.7 Magazine Placard Requirements

Not required.

4.1.8 Magazine Lightning Requirements

Not required.

4.1.9 Receipt/Return of Explosive Material

Following each receipt or return of explosive material, the UXO SSO will conduct a joint inventory in conjunction with the demolition team leader. Unused demolition explosives will be returned to the vendor.

4.1.10 Lost/Stolen or Unauthorized Use of Explosives

In the event, that there is a discrepancy during any inventory, the item will be recounted a minimum of two additional times. If the discrepancy is not resolved, the SWDIV contracting officer, Earth Tech project manager, and BATF will be notified immediately.

EARTH TECH EXPLOSIVES PURCHASE/RECEIPT/TRANSPORTATION
AUTHORIZATION LIST

Address and County (Home Office): 1461 East Cooley Drive, Suite 100, Colton, CA 92324, San Bernardino County

Address and County: (Field Office)

Federal License #: Expiration Date:

The following persons are agents, employees, or representatives of the undersigned, and authorized to order or acquire explosive materials on behalf of EARTH TECH, INC.:

Name and Home Address	Driver's License No.	Soc. Sec. Number	Place of Birth

The undersigned certifies the foregoing information to be be true and correct to the best of his knowledge and believe, and that he will communicate any additions or deletions to the foregoing list to Earth Tech, Inc.

Corporate Officer | Date

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

ETToro/005

Authorization List

Figure 4-2

Appendix G
OE Sampling and R3M Risk Evaluation Guidance

Actual Data:
Information contained in documents, surveys or researched documentation. Actual Data is based on fact and is weighed higher than Best Professional Judgment

Best Professional Judgment:
Decisions based on reviewing all available information or documentation. This decision is based on expertise and experience to form a conclusion rather than fact.

WORKSHEET 39 - EXPLOSIVES SAFETY RISK TOOL

Based on information gathered above, the Project team can now assess the explosives safety hazard use the following worksheet starting with #1 for each scale and assign the first score that applies. In some cases the score at the bottom of each scale will encompass all the scores above it.

ACCESSIBILITY ASSESSMENT

Depth below surface = ____	1) All UXO > 10 feet. 2) All UXO > 4 feet. 3) All UXO > 2 feet. 4) All UXO ≥ 1 foot. 5) Any UXO < 1 foot.	☐ Actual Data ☐ Best Professional Judgment
Migration / Erosion = ____	1) Very Stable: no UXO will migrate 2) Minor Migration: UXO not expected to migrate due to reoccurring natural events (e.g., freeze-thaw processes); extreme natural events (e.g., tornado) may cause migration 3) Moderate migration: UXO may surface over long period of time and/or through recurring natural events 4) Significant Migration: Recurring and extreme natural events will bring UXO to surface 5) Highly dynamic: UXO will surface within first recurring review	☐ Actual Data ☐ Best Professional Judgment
Level of Activity (Intrusion) = _____	1) Non-intrusive: on surface only 2) Minor intrusions: active on surface and w/ hand tool to 1 foot 3) Moderate intrusion: ground disturbance w/ equipment to 2 feet 4) Significant intrusion: ground disturbance w/ equipment to 4 feet 5) Highly intrusive: ground disturbance more than 4 feet	☐ Actual Data ☐ Best Professional Judgment
Use above scores to give an **Accessibility Score:**_____ (Conversion is weighted for depth w/migration and intrusion as modifiers.)	1) Depth =1, Migration ≤2, Intrusion ≤ 2 2) Depth =1, Migration ≤5, Intrusion ≤ 5 or Depth =2, Migration ≤3, Intrusion ≤ 3 3) Depth =2, Migration ≤5, Intrusion ≤ 5 or Depth =3, Migration ≤4, Intrusion ≤ 4 or Depth =4, Migration ≤2, Intrusion ≤ 2 4) Depth ≤ 4, Migration ≤5, Intrusion ≤ 5 5) Depth =5, Migration ≤5, Intrusion ≤ 5	

OVERALL HAZARD ASSESSMENT[20]		
UXO Hazard Type = ____	1) Explosives substance or article, very or extremely insensitive (DOD Class 1 Divisions 1.5 and 1.6)[21] 2) Moderate fire, no blast or fragment (1.4) 3) Mass Fire, minor blast, or fragment (1.3) 4) Non-mass explosion, fragment producing (1.2) 5) Mass explosion (1.1)	☐ Actual Data ☐ Best Professional Judgment
Fuzing = ____	1) Non-fuzed (low sensitivity) 2) Fuzed (high sensitivity)	☐ Actual Data ☐ Best Professional Judgment
Amount of Energetic Material (Impact Scale) = _____	1) <0.5 lbs. 2) 0.5 to 1 lbs. 3) 1 to 10 lbs. 4) 10 to 100 lbs. 5) >100 lbs.	☐ Actual Data ☐ Best Professional Judgment
Use above scores to give an **Overall Hazard Score:** _____	1) Overall UXO Hazard =1, Energetic Material ≤ 3 2) Overall UXO Hazard ≤2, Energetic Material ≤ 4 3) Overall UXO Hazard ≤3, Energetic Material ≤ 5 4) Overall UXO Hazard ≤4, Energetic Material ≤ 5 5) Overall UXO Hazard ≤5, Energetic Material ≤ 5 **(Overall UXO Hazard = UXO Hazard Type + Fuzing** **Maximum Score = 5, Minimum Score = 1)**	

[20] For ranges where rounds containing chemical warfare material may be present, risks will be calculated for explosives safety separately from risks for other potentially hazardous material. Both analyses will be used as a baseline in **Step 4 – Site-Specific Action.**

[21] DoD Ammunition and Explosives Hazard Classification Procedures: Joint Technical Bulletin, DoD 1998

EXPOSURE ASSESSMENT

Frequency of Entry = _____	1) Rare : ≤ 1 entry /month 2) Occasional: 2 – 8 entries/month 3) Often: 9-15 entries/month 4) Frequent: 16 – 22 entries/month 5) Very Frequent: >22 entries/month *(One entry=one person visiting per day over course of month regardless of how many entries per day)*	☐ Actual Data ☐ Best Professional Judgment
UXO Density = _____	1) <2 per acre 2) 2-10 per acre 3) 11-50 per acre 4) 50-100 per acre 5) >100 per acre	☐ Actual Data ☐ Best Professional Judgment
Intensity of Activity = _____	1) Very low: < 1 hour/day and light activity 2) Low: ≤ 3 hours/day and light activity 3) Moderate: ≤ 6 hours/day and light/moderate activity 4) High: ≤ 9 hours/day or moderate activity 5) Very High: > 9 hours/day or heavy activity *(e.g., Light=walking, hiking & bird watching; Moderate= bicycling, horse back riding, etc.; High=off-roading in motorized vehicles)*	☐ Actual Data ☐ Best Professional Judgment
Portability = _____	1) Not Portable 2) Portable by motorized vehicle/livestock (very low portability) 3) Portable by 2 adults (low portability) 4) Portable by 1 adult (moderately portable) 5) Portable by a child (easily portable)	☐ Actual Data ☐ Best Professional Judgment
Use above scores to give an **Exposure Score:** _____	1) Frequency ≤ 2, Density ≤ 2, Intensity ≤4, Portability ≤ 4 2) Frequency ≤ 3, Density ≤ 3, Intensity ≤5, Portability ≤ 5 3) Frequency ≤ 4, Density ≤ 4, Intensity ≤5, Portability ≤ 5 4) Frequency ≤ 5, Density ≤ 5, Intensity ≤4, Portability ≤ 4 5) Frequency ≤ 5, Density ≤ 5, Intensity ≤5, Portability ≤ 5	

EXPLOSIVES SAFETY RISK ASSESSMENT

Record the Accessibility, Overall Hazard, and Exposure Scores here and use them to give an Explosives Safety Risk score: Accessibility = ____ Overall Hazard = ____ Exposure = ____ **Explosives Safety Risk:** _____	A) Accessibility ≤ 2, Overall Hazard ≤ 3, Exposure ≤ 2 B) Accessibility ≤ 2, Overall Hazard ≤ 5, Exposure ≤ 2 or Accessibility ≤ 3, Overall Hazard ≤ 3, Exposure ≤ 3 C) Accessibility ≤ 4, Overall Hazard ≤ 3, Exposure ≤ 4 or Accessibility ≤ 3, Overall Hazard ≤ 5, Exposure ≤ 3 or Accessibility = 5, Overall Hazard ≤ 3, Exposure ≤ 2 or Accessibility ≤ 2, Overall Hazard ≤ 3, Exposure = 5 D) Accessibility ≤ 4, Overall Hazard ≤ 5, Exposure ≤ 4 or Accessibility ≤ 5, Overall Hazard ≤ 3, Exposure ≤ 5 E) Accessibility ≤ 5, Overall Hazard ≤ 5, Exposure ≤ 5