ORDNANCE AND EXPLOSIVE
ENGINEERING EVALUATION/COST ANALYSIS

DRAFT FINAL REPORT

MAKAWAO GUNNERY SITE
Project No.: H09HI0009801
AND
OPANA POINT BOMBING RANGE
Project No.: H09HI027201

ISLAND OF MAUI, HAWAII

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Prepared for:

US ARMY ENGINEERING AND SUPPORT CENTER, HUNTSVILLE

4820 University Square
Huntsville, Alabama 35816-1822

by:

ZAPATAENGINEERING, P.A.
1100 Kenilworth Avenue
Charlotte, North Carolina 28204
Phone (704) 358-8240

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LIST OF ACRONYMS

A/E	Architect/Engineering
ARAR	Applicable or Relevant and Appropriate Requirement
ARPA	Archaeological Resources Protection Act
ATA	Austin, Tsutsumi and Associates
ATV	All Terrain Vehicle
bgs	Below Ground Surface
Blackhawk	Blackhawk GeoServices, Inc.
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CEPOH	US Army Corps of Engineers, Honolulu District, Pacific Ocean Division
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DAS	Data Analysis System
DDESB	Department of Defense Explosives Safety Board
DEI	Donaldson Enterprises, Inc.
DERP	Defense Environmental Restoration Program
DOD	Department of Defense
EE/CA	Engineering Evaluation/Cost Analysis
EM	Electromagnetic
EOD	Explosive Ordnance Disposal
FUDS	Formerly Used Defense Sites
GPO	Geophysical Prove-Out
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HFA	Human Factors Applications, Inc.
HSP	Hawaii State Plane
Hz	Hertz
INPR	Inventory Project Report
Mk	Mark
mm	millimeter
MSD	Minimum Separation Distance
MSL	Mean Sea Level
mV	millivolt
NAD83	North American Datum of 1983
NA	No Action
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NDAI	No Department of Defense Action Indicated
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
OE	Ordnance and Explosives
OERIA	Ordnance and Explosives Risk Impact Assessment
ORS	Ordnance Related Scrap
OSHA	Occupational Safety and Health Administration
QC	Quality Control

QCO	Quality Control Officer
QC/SO	Quality Control/Safety Officer
RAB	Restoration Advisory Board
RCRA	Resource Conservation and Recovery Act
ROM	Rough Order of Magnitude
RTK	Real-Time Kinematic
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SOW	Scope Of Work
SUXOS	Senior Unexploded Ordnance Supervisor
TBC	To Be Considered
USA	US Army
USACE	US Army Corps of Engineers
USAESCH	US Army Engineering and Support Center, Huntsville
USEPA	US Environmental Protection Agency
USGS	US Geological Survey
USMC	US Marine Corps
USN	US Navy
USSCS	US Soil Conservation Service
UXO	Unexploded Ordnance
WO&A	Wilson Okamoto and Associates

1.0 INTRODUCTION

1.0.1 The US Army Engineering and Support Center, Huntsville (USAESCH) and the US Army Corps of Engineers, Honolulu District, Pacific Ocean Division (CEPOH) have teamed to produce this Engineering Evaluation/Cost Analysis (EE/CA) for the Former Makawao Gunnery Site (Project Number: H09HI0009801) and Former Opana Point Bombing Range (Project Number: H09HI027201), Island of Maui, Hawaii. These projects are funded under the Defense Environmental Restoration Program – Formerly Used Defense Sites (DERP-FUDS). This EE/CA report documents the decision process to determine appropriate ordnance and explosives (OE) response actions for the Former Makawao Gunnery Site and Former Opana Point Bombing Range.

1.0.2 The results of the OE investigation conducted under the EE/CA were examined using the Ordnance and Explosives Risk Impact Assessment (OERIA). The OERIA provides a qualitative method of risk assessment for use during an EE/CA that can be easily communicated to stakeholders. OERIA uses analysis of site conditions and human issues to evaluate OE risk of the sites. The qualitative risk assessment evaluates the level of OE risk to the public in terms of the likelihood of exposure and the severity of exposure to OE. Exposure to OE does not indicate that an incident or injury will occur, rather it provides for an increased potential for an incident. An evaluation of the risk of OE exposure has been performed for the Makawao Gunnery Site and Opana Point Bombing Range and is discussed in Chapter 4.0.

1.0.3 An Action Memorandum will be prepared to document the selected OE response actions for the Makawao Gunnery Site and Opana Point Bombing Range. The CEPOH will maintain a residual responsibility to ensure that implemented OE response actions are effective in reducing the risk associated with OE by conducting recurring reviews (as outlined in Chapter 10).

1.1 PROJECT AUTHORIZATION

The work required under the Scope of Work (SOW), provided in Appendix A, falls under the DERP – FUDS Program. This action will be performed consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Sections 104 and 121: Executive Order 12580; and the National Oil and Hazardous Substance Contingency Plan (NCP), Section 300.400. All activities in areas potentially containing ordnance-related hazards were conducted compliant with USAESCH, CEPOH, and Department of Defense (DOD) requirements regarding personnel, equipment, and procedures.

1.2 BACKGROUND

In 2001, ZAPATAENGINEERING was contracted by the USAESCH to conduct an EE/CA for the Former Makawao Gunnery Site and Former Opana Point Bombing Range. The Makawao Gunnery Site and Opana Point Bombing Range are located approximately three miles northeast and five miles north-northeast, respectively, of the City of Makawao, Island of Maui, Hawaii (Figure 1-1). The US Marine Corps (USMC) used the Makawao Gunnery Site as an artillery impact area. The site is currently owned by the East Maui Irrigation Company, Ltd. and is primarily used for cattle grazing. The US Navy (USN) used the Opana Point Bombing Range as a target practice bombing range. The site is currently owned by the Opana Point Properties Company who have developed plans to construct a residential community on the property.

1.3 PURPOSE AND SCOPE

1.3.1 The purpose of the EE/CA is to evaluate potential ordnance risk and develop OE response-action alternatives to reduce the risk associated with OE. The scope of the EE/CA is to evaluate risk to human safety associated with the explosive hazards of OE.

1.3.2 The future development and use of the Makawao Gunnery Site and Opana Point Bombing Range have a direct influence on the life and livelihood of several stakeholders, including the public; landowners or those with a financial or business interest; and Federal, state, and local agencies. This EE/CA report includes consideration of the concerns of the stakeholders involved. Once the EE/CA has been completed, new information and discoveries will be evaluated by CEPOH by means of recurring reviews.

1.3.3 Close coordination and cooperation between the stakeholders and technical support personnel must occur for this process to be successful. Supporting the risk management effort for these sites, this EE/CA report identifies and evaluates reasonable alternatives and makes recommendations for OE response actions.

1.3.4 This EE/CA report documents the background, sampling approach, field activities, and the evaluation process for determining the potential risk that OE poses at the Makawao Gunnery Site and Opana Point Bombing Range. It also presents recommendations for future OE response actions.

1.3.5 Four OE response action alternatives are identified and evaluated in this EE/CA report. These include No Department of Defense Action Indicated (NDAI) and varying levels of risk-reduction actions:

- Alternative 1: NDAI;
- Alternative 2: Institutional Controls;
- Alternative 3: Surface Clearance; and
- Alternative 4: Clearance to Detectable Depth.

1.4 PROJECT TEAM

1.4.1 US Army Corps of Engineers, Honolulu District, Pacific Ocean Division (CEPOH)

The CEPOH is the sponsor of the EE/CA and responsibilities include overal project management, coordination for site access, review of project work plans and documents, communication with the public, and coordination with state and local regulatory agencies.

1.4.2 US Army Engineering and Support Center, Huntsville

The USAESCH is the implementing agency for this project, has approval authority for project execution, and provided expertise for OE-related activities. USAESCH responsibilities included the procurement of Architect/Engineer (A/E) services, direction of the A/E contractor, control of the budget and schedule, and coordination of document reviews.

1.4.3 ZAPATAENGINEERING, P.A.

ZAPATAENGINEERING is the prime contractor to USAESCH and provided all engineering support and services for the site investigation. ZAPATAENGINEERING was responsible for performance of the activities detailed in the SOW, Appendix A.

1.4.4 Blackhawk GeoServices, Inc.

Blackhawk GeoServices, Inc. (Blackhawk), a subcontractor to ZAPATAENGINEERING, collected and processed geophysical data from surveys of the Makawao Gunnery Site and Opana Point Bombing Range. The results of these surveys are discussed in detail later in this report. Also, during March 2002, Blackhawk conducted a geophysical prove-out (GPO) in direct coordination with the USAESCH. ZAPATAENGINEERING's Senior Geophysicist oversaw the GPO and data collection. The GPO Report and a brief Summary Report by the ZAPATAENGINEERING Senior Geophysicist are included as an appendix in the EE/CA Work Plan (ZAPATAENGINEERING, 2002).

1.4.5 Human Factors Applications, Inc.

Human Factors Applications, Inc. (HFA), a subcontractor to ZAPATAENGINEERING, performed OE sampling of anomalies identified during the geophysical investigation. HFA assisted ZAPATAENGINEERING in documenting and accounting for all discovered OE items in the Weekly Reports and was responsible for scrap management and demolition of any Unexploded Ordnance (UXO) discovered.

1.5 PROJECT OBJECTIVES

1.5.1 The objective of the EE/CA is to support an informed decision for determining the most appropriate OE response action(s) for the sites. The following points effectively summarize the objectives of this project:

- Characterize OE nature, location, and concentration;
- Describe OE-related limitations on use of the site(s);
- Evaluate reasonable risk-management alternatives; and
- Provide for the Administrative Record.

1.5.2 The objective of the EE/CA for the Makawao Gunnery Site and Opana Point Bombing Range has been accomplished by:

- Conducting geophysical surveys to detect and map anomaly sources and intrusively investigating those anomaly sources to identify the type and depth of any OE present;
- Determining the depth to which OE may be removed to reduce the risk associated with OE at the Makawao Gunnery Site and Opana Point Bombing Range, while taking into consideration current and future land use of the property;
- Involvement with the landowners concerning the progress and findings of the EE/CA investigation;
- Providing the public and local agencies the opportunity to review and comment on the EE/CA; and

- Performing an Institutional Analysis (Chapter 5.0) to identify and analyze the institutional framework necessary to support development of institutional controls as an effective OE response-action alternative for the Makawao Gunnery Site and Opana Point Bombing Range.

1.5.3 The level of OE risk associated with the Makawao Gunnery Site and Opana Point Bombing Range was evaluated using a qualitative risk assessment. OE response action alternatives were developed and evaluated based on the results of the qualitative risk assessment in Chapter 4.0, the decision criteria presented in Chapter 7.0, and the evaluation of the four OE response action alternatives in Chapter 8.0 with the recommended response-actions discussed in Chapter 9.0.

1.6 REPORT FORMAT

This report is organized as follows:

- **Chapter 1.0 - Introduction:** Discusses the objectives, purpose, and scope of the EE/CA, provides an outline of the project team, and presents the organization of the report.
- **Chapter 2.0 - Site Description and History:** Discusses the history and the types of ordnance reported to have been used at the sites. Provides a general discussion of the current status, existing facilities, and describes the natural features of the sites.
- **Chapter 3.0 - Site Characterization:** Provides a detailed description of EE/CA field activities including: surface clearance, geophysical investigation, OE sampling, visual reconnaissance, and UXO demolition procedures. This chapter presents the results of the EE/CA field investigation.
- **Chapter 4.0 - Risk Impact Evaluation:** Discusses the risk analysis process, including the qualitative risk evaluation approach of the Ordnance and Explosives Risk Impact Assessment (OERIA).
- **Chapter 5.0 - Institutional Analysis:** Documents local government agencies that have jurisdiction over lands within the project area and assesses their capability and willingness to assert controls to protect the public from OE.
- **Chapter 6.0 - Identification of Response Action Objectives:** Presents the process used to determine OE response action alternatives evaluated in this EE/CA report.
- **Chapter 7.0 - Identification and Analysis of OE Response Action Alternatives Criteria:** Presents the OE response action alternatives considered in this EE/CA report and a discussion of the evaluation criteria for each alternative.
- **Chapter 8.0 - Comparative Analysis of OE Response Action Alternatives:** Discusses the applicability of the various alternatives in terms of their effectiveness, implementability, and cost.
- **Chapter 9.0 - Recommended OE Response Action Alternatives:** Presents the recommended OE response actions (including estimated costs) for the Makawao Gunnery Site and Opana Point Bombing Range.
- **Chapter 10.0 - EE/CA Follow-on Activities and Recurring Reviews:** Presents the recommendations for residual risk-management activities and EE/CA follow-on activities for the Makawao Gunnery Site and Opana Point Bombing Range.

- **Chapter 11.0 - References:** Provides an inventory of the reference material used in preparation of this EE/CA report.
- **Chapter 12.0 - List of Preparers:** Includes a list of personnel who contributed to preparation of this EE/CA report.
- **Appendix A - EE/CA Contractor Scope of Work:** Includes the SOW for ZAPATAENGINEERING.
- **Appendix B - Geophysical Data:** Provides Geophysical Prove Out Report and a summary report of geophysical data collected during the EE/CA field investigation.
- **Appendix C - OE Investigation Results:** Provides a detailed list of the types of ordnance recovered in each grid and transect during the EE/CA field investigation.
- **Appendix D - Cost Comparison Data:** Provides the costs associated with the OE response-action alternatives evaluated and recommended in this EE/CA report.
- **Appendix E - Summary of Interviews Conducted in Support of the Institutional Analysis:** Includes interviews conducted in support of the Institutional Analysis.
- **Appendix F - OE Scrap Turn-In Documentation:** Provides documentation of the turn-in of all OE scrap recovered during the EE/CA field investigation.
- **Appendix G – Responsiveness Summary**

Figure 1-1

2.0 SITE DESCRIPTION AND HISTORY

2.1 LOCATION

The Makawao Gunnery Site and Opana Point Bombing Range are located approximately three miles northeast and five miles north-northeast, respectively, of the City of Makawao and approximately 12 and 14 miles east of Kahului, Island of Maui, Hawaii. The Opana Point Bombing Range is north of the Hana Highway and Makawao Gunnery Site is south of the Hana Highway, approximately two miles southeast of the Opana Point Bombing Range (Figure 1-1).

2.2 PHYSICAL DESCRIPTION

2.2.1 Makawao Gunnery Site

The Makawao Gunnery Site is comprised of approximately 1,002 acres. The site is south of the Hana Highway and extends approximately one mile to the south. The site is defined by the Hoolawanui Gulch on the east and the Halehaku Gulch to the west. These two north-south drainage features form relatively steep and wide canyons. Although the site is defined on the east by the Hoolawanui Gulch, all land area east of the Honopou Stream is covered by old-growth forest and was not investigated as part of this effort (Figure 2-1). The Makawao Gunnery Site is underlain on average by 12 or more inches of dark, grayish-brown to brown, strongly acidic, clay-rich soils of the Pauwela-Haiku association (below elevation 900 feet). Somewhat thinner, dark-brown, acidic, silty clays of the Kailua soil series underlay the site at the higher elevations (900 feet to 2,700 feet). Most of the study area is underlain by dark brown silt loam and dark yellowish-brown silty clay of the Honomanu-Amalu association. Permeability is moderate to high (USGS, 1999).

2.2.1.1 Topography

The Makawao site is located on the northern slopes of the East Maui Volcano (Haleakala) on the Island of Maui, Hawaii. This area is composed of gently sloping and hilly terrain with steep gulches and valleys that have been eroded by numerous streams located throughout. The elevation near the highest point of the Makawao site is approximately elevation 1,300 feet and drops to approximately elevation 600 feet at the northern portion of the site.

2.2.1.2 Vegetation

Makawao is located at an elevation that receives a large amount of rain and fog drip during the year. The site contains dense vegetation in some locations, although there is some grassland areas throughout used for cattle grazing.

2.2.1.3 Cultural Resources

An archaeological and cultural resources survey was performed during the summer of 2002 prior to field activities and the archaeologists found no archaeological sites within the Makawao Gunnery Site. However, a number of sites in areas nearby indicate that sites probably did exist at one time in the Gunnery Range area, but any surface signs have been disturbed over the years to the point where they are no longer recognizable. In addition to the survey, archaeological monitoring was performed during intrusive site activities and no evidence of archaeological

significant sites was found. (**This section will be updated upon completion of the USACE Archaeological Survey Report currently being developed.**)

2.2.2 Opana Point Bombing Range

The Opana Point Bombing Range, located on the Opana Point on the Island of Maui is comprised of approximately 52 acres, although approximately 86 acres were investigated for potential OE outside the 52-acre site. The original target location is in the northeastern section of the bombing range. The northern boundary of the project site is located along a cliff line, which is about 100 feet above Mean Sea Level (MSL). The Hana Highway is located to the south (Figure 2-2). The site has been terraced for cultivation and is generally free of thick vegetation. The site lies between the Holumalu Gulch (to the east) and the Manawal Gulch (to the west). The Opana Point site is underlain by dark, grayish-brown to brown, strongly acidic, clay-rich soils of the Pauwela-Haiku association (USGS, 1999).

2.2.2.1 Topography

The Opana Point site is located on the northern slopes of the East Maui Volcano (Haleakala) on the Island of Maui, Hawaii. This area is composed of gently sloping terrain typical of a shield volcano except for the steep sides of gulches and valleys that have been eroded by streams. Opana Point is located on the coast of the island where the terrain is relatively flat. The Opana Point site has been terraced and further flattened during cultivation.

2.2.2.2 Vegetation

Opana Point is located along the shoreline and was used until recently as a pineapple farm. The site is currently covered by grassland and scrub vegetation.

2.2.2.3 Cultural Resources

An archaeological and cultural resources survey was performed during the summer of 2002 prior to field activities and the archaeologists found no archaeological sites within Opana Point. However, a heiau (Walker's Site 62, Hawaii State Site No. 50-50-06-0062) formerly existed at Opana Point. In addition to the survey, archaeological monitoring was performed during intrusive site activities and no evidence of archaeological significant sites was found. (**This section will be updated upon completion of the USACE Archaeological Survey Report currently being developed.**)

2.3 HISTORY

2.3.1 Makawao Gunnery Site

2.3.1.1 Property Ownership

The Makawao Gunnery Site is a former USMC artillery impact area. Land for the site was obtained via a license with the East Maui Irrigation Company (Parcel 7; 897.8 acres) and the C.K.C. Rooke Estate (Parcel 16; 104.2 acres) on April 7, 1944. On December 14, 1945, the license was cancelled. A&B Properties, Inc., which manages East Maui Irrigation Company, Ltd. property, does not have a copy of the license or any other information pertaining to the use of the site by the USMC. Naval Facilities Engineering Command, Pacific Division records

indicate that the actual licenses and agreements were destroyed in the early 1970's when the Naval Facilities Engineering Command, Pacific Division, Real Estate Office relocated (USACE, 1997). For this reason, the history of the Makawao Gunnery Site cannot be confirmed with high degree of certainty.

2.3.1.2 Military Activity

The Makawao Gunnery Site was used as a firing range and maneuver training area for the USMC for 1-1/2 years during World War II. During the site walk-thru conducted as part of the Inventory Project Report (INPR), a "105mm HE Tank Piercing Artillery Shell with PD Fuse" was observed (USACE, 1997). Depressions in the ground surface that could possibly be bomb craters were also observed. Personnel working for the East Maui Irrigation Company, Ltd. have stated that during plowing activities, "smoke bombs" have been uncovered (USACE, 1997).

2.3.2 Opana Point Bombing Range

2.3.2.1 Property Ownership

USN records pertaining to the Opana Point Bombing Range indicate the lease on this property was cancelled on May 10, 1946. Between 1946 and 1978, property ownership is unclear because no records were found to document the transfer of land from the DOD to the landowners of the property surrounding the site; i.e., Libby, McNiell, and Libby (USACE, 1992). The Amfac Property Investment Corporation, Kaanapali, Island of Maui, Hawaii acquired the project site in 1978 and leased the property to the Maui Land and Pineapple Company, Inc. In 1981, pineapple cultivation, through the Maui Land and Pineapple Company, Inc., started on the project site (USACE, 1992). Currently, the site is not utilized for pineapple production. The Opana Point Properties Company purchased the site in September 2000 and has developed plans to construct a residential development on the property.

2.3.2.2 Military Activity

The site was used as a USN bombing range during World War II until as late as May 10, 1946. Limited surface sweeps conducted in April and June 1990 found several AN-Mk 23 3-pound practice bombs (USACE, 1992). In addition to these practice bombs, large metal fragments and what appeared to be bomb craters were also observed on site. This indicates that the site may have been used as a live bombing range or an ordnance disposal site (DEI, 1990).

2.4 DEMOGRAPHIC PROFILE OF MAUI COUNTY

2.4.1 According to the US Census Bureau, Census 2000, Maui County, which includes the Islands of Maui, Molokai, Lanai, and Kahoolawe, has a population of 128,094 or 110.5 persons per square mile. The population represents a 27.6 percent increase since 1990.

2.4.2 Tourism remains Maui's strongest economic sector. Through June 2000, Maui County overall visitor arrivals increased 1.5 percent and Maui led the state with a hotel occupancy rate of 82.3%. As a result, the primary industries in Maui County are retail, arts, entertainment, recreation, accommodation, and food services - accounting for approximately 38 percent.

2.5 CURRENT AND FUTURE LAND USE

2.5.1 Makawao Gunnery Site

Currently, the Makawao Gunnery Site is used for cattle grazing. According to the property owner, East Maui Irrigation Company, Ltd., they wish to continue to use the land for that purpose.

2.5.2 Opana Point Bombing Range

Except for a portion along the seaward cliff line, almost all the Opana Point Bombing Range was, until recently, cultivated for the production of pineapples. According to the property owner, Opana Point Properties Company, plans are currently underway to develop residential housing on Opana Point (Figure 2-3).

2.6 ANALYSIS OF HISTORIC RECORDS

Historical information pertaining to the Makawao Gunnery Site and Opana Point Bombing Range, other than the information provided in Section 2.3, has not been obtained. Extensive informational searches at the National Archives at College Park, Maryland and the State of Hawaii yielded no additional information.

2.7 PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS

2.7.1 Makawao Gunnery Site

On June 8, 1993, a site reconnaissance of the Makawao Gunnery Site was conducted by the CEPOH in preparation of the INPR. During this site investigation, Mr. Steven Cabral, a representative of the East Maui Irrigation Company, Ltd., met the investigation team and escorted them to an area where he had unearthed an unexploded 105mm artillery shell while plowing the site with a tractor. On August 18, 1995, a second site visit was conducted in an attempt to determine the potential cultural significance of the property. During this investigation, the CEPOH archeologist stated that he did not identify any sites of archaeological significance (USACE, 1997).

2.7.2 Opana Point Bombing Range

The CEPOH conducted a field investigation of the Opana Point Bombing Range in June 1990 in preparation of the INPR. During that investigation, sixteen AN-Mk 23 practice bombs, large metal fragments, and what appeared to be bomb craters were discovered on the surface within the boundaries of the bombing range. It is speculated that the practice bombs were probably placed at the location where they were found during ground clearance as part of pineapple cultivation work (WO&A, 1990). DEI performed a surface clearance of a portion of the site in 2001, recovering 88 OE items during the effort. Eighty-five Mk 5 and AN-Mk 23 3-pound practice bombs (27 possibly live) were located and disposed. Two live M49 series 60mm HE mortars and one live Mk 3 HE barrage rocket were also discovered and disposed.

3.0 SITE CHARACTERIZATION

3.0.1 The EE/CA field investigation for the Makawao Gunnery Site and Opana Point Bombing Range was initiated on August 9, 2002, and was completed on October 10, 2002. Using data collected during the EE/CA field investigation, a qualitative risk evaluation was performed (Chapter 4.0) to determine the most appropriate OE response actions for the sites. Characterization of the Makawao Gunnery Site and the Opana Point Bombing Range consisted of the following:

- Visual Reconnaissance;
- Surface Clearance;
- Geophysical Mapping;
- Visual Surface Search; and
- Intrusive OE Sampling.

3.0.2 Details concerning each of these tasks and the results of the EE/CA field investigation are discussed in the following sections.

3.0.3 The items recovered during the EE/CA field investigation were classified into one of three categories; i.e., Unexploded Ordnance (UXO), OE scrap, or non-OE scrap. UXO is commonly described as a subset of OE and is defined by the USAESCH as military munitions that have been primed, fuzed, 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.

3.0.4 OE is defined by the USAESCH as either: 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 the accountable record control of any DOD organization or activity.

3.0.5 OE scrap is nonhazardous and includes inert items such as shrapnel shells (expended), fuzes (expended), and fragments of functioned ordnance. Small arms do not indicate the potential for explosive hazard; subsequently, small arms are tallied separately and their locations are not included on the figures in this EE/CA report.

3.0.6 Non-OE scrap is non-ordnance related items that include, but are not limited to horseshoes, wire, banding material, aluminum cans, trash, auto parts, nails, etc.

3.1 SITE INVESTIGATIONS

3.1.1 Area of Investigation

3.1.1.1 Makawao Gunnery Site

3.1.1.1.1 The area of investigation illustrated on Figure 3-1 comprises approximately 1,002 acres. It is composed of 16 grids (approximately 13 acres) and approximately 13.0 linear miles of transect paths (about 5.1 acres) totaling approximately 18 acres situated between the Halehaku Gulch and the Honopou Stream. The area between the Honopou Stream and the Hoolawanui Gulch is a forest reserve covered with old growth forest and was not included in the field investigation. Grid locations and transect paths were selected to focus the geophysical investigation in areas that may contain a concentration of target anomalies. Additional areas within brush or canopy cover were visually inspected with the assistance of hand-held electromagnetic metal detectors.

3.1.1.1.2 The field team conducted digital geophysical surveying, mapping, and evaluation for the Makawao Gunnery Site and Opana Point Bombing Range. This mapping was followed by subsurface sampling of selected target anomalies identified from the geophysical survey. The USAESCH project team reviewed target anomalies selected by ZAPATAENGINEERING and their geophysical subcontractor, Blackhawk GeoServices.

3.1.1.2 Opana Point Bombing Range

The former Opana Point Bombing Range is approximately 52 acres. It is located on the Opana Point on the Island of Maui. The northern boundary of the site is along a cliff line, which is about 100 feet above Mean Sea Level (Figure 3-1). The area of investigation is composed of nine grids (approximately 8.6 acres) and approximately 3.7 linear miles of transects (about 1.5 acres) totaling approximately 10.1 acres. Grid Locations were placed in an area suspected as the former target location based on previous site work. Transects radiated from the midpoint of the grids to assist in identifying the extent of the OE items away from the target location. The area sampled within the radial transects extended beyond the boundary of the 52-acre site, covering an area of approximately 86 acres.

3.1.2 Geophysical Survey and Anomaly Reacquisition

3.1.2.1 Introduction to Geophysical Prove-out

3.1.2.1.1 A geophysical prove-out was performed to test and select the geophysical instrument best suited for data collection and target-anomaly discrimination at the Makawao Gunnery Site and Opana Point Bombing Range. Based on the geophysical prove-out, the Geonics EM61-MK2 metal detection system and 3.0 foot line spacing, was determined the most effective and efficient method to identify AN-MK 23 3-lb practice bombs and 105 mm projectiles, which were suspected present at the Makawao Gunnery Site and Opana Point Bombing Range. Because the initial prove out was not conducted using an all-terrain vehicle (ATV), the GPO was repeated using an ATV at the start-up of the field-data acquisition and mapping. These data were processed and compared with the results from the initial prove-out. The results of this second field test were consistent with the initial GPO.

3.1.2.2 Geophysical Equipment

3.1.2.2.1 The Geonics EM61-MK2 metal detection system consists of a single set of one by one-half meter coils. The coils measure 40-inches by 20-inches and were mounted on a wheeled cart that was pulled across the survey area by an ATV. When mounted in the wheel assembly, the transmitter coil and one receiver coil are located approximately 15 inches above the ground. The second receiver coil is located 11 inches above the main coil. The electronics are stored in a backpack that is worn by the equipment operator. The coils are oriented with the axis of the one-meter side perpendicular to the direction of travel, such that a one-meter swath is covered with each pass. To evaluate the effect of line spacing at the site, data were collected over the test lines with both 2.5 and 3-foot line spacing. Geophysical data were collected at a rate of 10 hertz (Hz) and stored on the field lap top computer for downloading at the end of the day. All data acquired for this survey used the 24-volt mode.

3.1.2.3 Geophysical Prove-out

3.1.2.3.1 Two prove-out transects were established at Opana Point by ZAPATAENGINEERING in March 2002. Parallel test lines that measured 200 feet and 300 feet were constructed to plant seed items representative of OE items suspected at both Opana Point Bombing Range and Makawao Gunnery Site. The test lines were positioned approximately 30 feet apart in relatively flat and open terrain, although the site had been plowed resulting in furrows and a rough ground surface. Geophysical data were collected four times over each test line, for a total of eight geophysical surveys. A summary of the data collection event is as follows:

1. 200 foot line with 2.5 feet line spacing, before emplacement of seeded items.
2. 200 foot line with 3.0 feet line spacing, before emplacement of seeded items.
3. 200 foot line with 2.5 feet line spacing, after emplacement of seeded items.
4. 200 foot line with 3.0 feet line spacing, after emplacement of seeded items.
5. 300 foot line with 2.5 feet line spacing, before emplacement of seeded items.
6. 300 foot line with 3.0 feet line spacing, before emplacement of seeded items.
7. 300 foot line with 2.5 feet line spacing, after emplacement of seeded items.
8. 300 foot line with 3.0 feet line spacing, after emplacement of seeded items.

3.1.2.3.2 200-Foot Test Line

3.1.2.3.2.1 Ten seed items, including 105 mm projectiles, 4.5 inch barrage rockets, and MK 23 and MK 5 practice bomb surrogates were buried at various depths and orientations as detailed in *Geophysical Equipment Test at Opana Point Bombing Range, Maui, Hawaii* (Blackhawk, 2002). Locations of the seed items were recorded by ZAPATAENGINEERING by interpolating from the survey line known end points. Details of six of the 10 seeded items were withheld from Blackhawk.

3.1.2.3.2.2 Geophysical data were collected over the prove-out transect using the Geonics EM61-MK2 before and after placement of the seed items. Blackhawk identified 34 and 36 anomalies, respectively, utilizing the Data Analysis System (DAS) at line spacing of 2.5 and 3.0

feet. All seed items were identified; the average location variance was 1.17 feet at line spacing of 2.5 feet and 1.15 feet at line spacing of 3.0 feet.

3.1.2.3.3 300-Foot Test Line

3.1.2.3.3.1 Twelve seed items, including 105 mm projectiles, 4.5 inch barrage rocket, MK 23 and MK 5, practice bomb surrogates were buried at various depths and orientations as detailed in *Geophysical Equipment Test at Opana Point Bombing Range, Maui, Hawaii* (Blackhawk, 2002). Locations of the seed items were recorded by ZAPATAENGINEERING by interpolating from the survey line known end points. Details of four of the 12 seeded items were withheld from Blackhawk.

3.1.2.3.3.2 Geophysical data were collected over the prove-out transect using the Geonics EM61-MK2 before and after placement of the seed items. Blackhawk identified 33 and 36 anomalies, respectively, utilizing the DAS at line spacing of 2.5 and 3.0 feet. All seed items were identified; the average location variance was 1.03 feet at line spacing of 2.5 feet and 1.12 feet at line spacing of 3.0 feet.

3.1.2.4 Positioning Equipment

3.1.2.4.1 Positioning of the sensors for the Geonics EM61-MK2 was determined with a Trimble 4700 real-time kinematic (RTK) global positioning system (GPS) capable of centimeter-level accuracy. Positional data were recorded on a Juniper Pro4000 computer system at a rate of one hertz and monitored by the equipment operator in real time. The GPS antenna (rover) was rigidly mounted above the geophysical sensors so the effect of the antenna was only a small, constant signal (DC offset) that was accounted for and corrected in data processing.

3.1.2.4.2 A GPS base station receiver was set up over a known control point with spatial position correction transmitted in real time to the GPS rover receiver via a radio modem. The GPS receivers require a minimum of four satellites to initialize and five satellites to collect data. The data collection schedule was adjusted as necessary to avoid periods of poor satellite coverage. The geographic and state plane coordinates for the control point utilized during the survey is shown in Table 3-1.

TABLE 3-1 GPS BASE STATION LOCATION

			NAD 83, Hawaii State Plane, Zone 2	
Point	**Latitude**	**Longitude**	**Northing (US ft)**	**Easting (US ft)**
Opana Point	25.148458794	160.953155417	221636.49	1771966.08

3.1.2.5 EE/CA Investigation Geophysical Survey

3.1.2.5.1 Geophysical surveying and mapping were conducted over approximately 18 acres at Makawao Gunnery Site and 10 acres at Opana Point Bombing Range using a combination of transects and grid methodology, as illustrated on Figures 3-1 and 3-2. The Geonics EM61-MK2, as described in Section 3.1.2.2, was used to meet the survey objectives.

3.1.2.5.2 In the transect mode of data collection, one pass was made with the sensor along the path at the Makawao Gunnery Site; two parallel passes were made with the sensor along the transect paths at Opana Point. The area covered along the path was equal to the sample width of

the sensor, which is 3.3 feet at Makawao, and approximately six feet at Opana Point. When collecting data using transect methodology, approximately 13.0 miles of data were collected at Makawao Gunnery Site and approximately 3.7 miles of data were collected at Opana Point Bombing Range. Given a sampling width of 3.3 feet, 13.0 miles and 3.7 miles is equivalent to approximately 5.2 acres and 1.5 acres of surveyed area, respectively. The 3.7 miles of data collected at Opana Point covered 1.85 miles of transect as shown on Figure 3-2. In the grid mode of data collection, parallel grid lines spaced three feet apart were surveyed resulting in 100% coverage of each grid. At Makawao Gunnery Site, sixteen grids totaling approximately 13.5 acres were surveyed and approximately 8.6 acres were surveyed at Opana Point Bombing Range in nine grids.

3.1.2.5.3 Blackhawk analyzed geophysical data and identified anomalies with peak amplitude responses greater than 10.0 mV with the bottom coil time gate centered at 216 microseconds (Channel 1). Results from the GPO indicate that based on the EM response from the known seeded items, an anomaly picking threshold of 10.0 mV would be sufficient to identify a MK23 or larger OE item buried at 24-inches below ground surface with three-foot line spacing. For each of the anomalies, target selections were determined by examining ranges of responses, anomaly characteristics including chosen profile curves, and geographical distributions.

3.1.2.5.4 Selected target anomalies were reviewed by the USAESCH before relocation. Field crews reacquired selected target anomalies and identified the precise location of the anomaly source on the ground as described below.

3.1.2.6 Anomaly Relocation

The Trimble 4700 RTK system used in the geophysical survey was also used in the relocation of anomalies. The interpreted anomaly location, thus obtained, was marked on the ground. The location was refined with a Fisher 1266XB EM detector. Of 6,358 anomalies identified at Makawao Gunnery Site and Opana Point Bombing Range meeting the peak amplitude threshold value of 10.0 mV (as determined during the geophysical prove-out) 1,235 target anomalies were selected for relocation and possible intrusive investigation. The Makawao Gunnery Site and Opana Point Bombing Range anomaly summary (Appendix B) lists the 1,235 relocated targets. The following process was used to select 1,235 target anomalies at the Makawao Gunnery Site and Opana Point Bombing Range from the 6,358 total anomalies:

- 6,358 anomalies were identified with peak amplitude responses greater than or equal to 10mV. Targets were then sorted in descending order and grouped within ranges based on peak amplitude response (mV).
- 802 of the 1,235 anomalies were picked as targets for reacquisition based on peak amplitude response, profile shape, location on the survey path line, and various geographic distribution criteria.

3.1.2.7 Data Review

The geophysical survey data summary and target lists containing anomaly ID number, position, and peak value for the Makawao Gunnery Site and Opana Point Bombing Range are provided in

Appendix B. Lists of selected anomalies were provided to the USAESCH geophysicists for review before relocation.

3.1.3 OE Intrusive Investigation

Subsurface OE investigations were conducted based on geophysical data collected, processed, and evaluated in coordination with (and reviewed by) the USAESCH. OE investigation field data were evaluated and used to refine the anomaly target selection process. ZAPATAENGINEERING communicated field validation, data processing, and re-evaluation updates to the USAESCH on a regular basis. The project team reacquired the selected anomalies and placed pin flags in the ground at the surface location of the anomaly. The intrusive investigation team mobilized to the site and began investigating the source of the selected anomalies. The area was checked again with a Fisher hand-held EM detector and the items were excavated using standard hand tools. The dig team verified removal of the anomaly source using Fisher hand-held EM detectors.

3.1.4 Turn-in of Recovered Inert OE and Ordnance-Related Scrap

3.1.4.1 Ordnance-related scrap (ORS) certification was an ongoing process throughout the project. All OE scrap was inspected before removal from the site. A three-step visual inspection process conducted by the Senior UXO Supervisor (SUXOS) and the UXO Quality Control/Safety Officer (QC/SO) confirmed that all OE and OE-related scrap was free of any explosive contamination and explosive residue. The SUXOS coordinated removal and delivery of all OE scrap to the Maui Scrap Metal Company on October 10, 2002. A Department of Defense (DOD) Form 1348-1 Issue Release/Receipt Document was completed for the scrap before delivery to Maui Scrap Metal Company (Appendix F) identifying the day of off-site removal, OE scrap weight, and signature of the recipient.

3.1.4.2 A total of 373[1] pounds of OE scrap was removed from Opana Point Bombing Range and Makawao Gunnery Site following the intrusive investigation (as weighed by Maui Scrap Metal Company). An estimated 35 pounds of OE scrap and an estimated 89 pounds of non-OE scrap were removed from Makawao Gunnery Site. An estimated 338 pounds of OE scrap and an estimated 292 pounds of non-OE scrap were removed from Opana Point Bombing Range. The OE scrap included such items as AN-MK 23 and MK 5 practice bomb bodies, mortar projectile tail booms, and OE fragment. The non-OE scrap included items such as nails, springs, bolts, lug nuts, sheet metal, spray paint cans, barbed wire, pliers, beverage cans, rebar, small arms cartridge cases, fence staples, and pieces of railroad track. The approximate weights of OE versus non-OE scrap are estimated values determined in the field by the UXO investigation team.

3.1.5 Quality Control

3.1.5.1 The Project Team implemented the Quality Control (QC) process as described in the approved Work Plan. QC procedures were implemented throughout all phases of the project, including document review and control; data collection, review, and analysis; and evaluation of areas of investigation in the field.

[1] Actual weight; values on Field Daily Reports are estimates

3.1.5.2 ZAPATAENGINEERING's Senior Geophysicist performed independent analyses of the geophysical data collected and processed by Blackhawk. He designed the geophysical prove-out test lines to include "blind tests" by burying a percentage of items with the locations unknown to Blackhawk. He was also on site during the GPO and the ATV-pulled prove-out line test, as well as the startup of the survey data collection.

3.1.6 Intrusive Investigation QC Tests

ZAPATAENGINEERING's Quality Control Officer (QCO) verified the dig team's intrusive investigations. Following the removal of the anomaly source from the ground, the UXO QCO searched the area with a Fisher hand-held EM detector to check for additional anomalies in proximity to the target anomaly location. If a subsurface metallic item was detected, it was excavated to determine if the intrusive team failed to locate and remove the target anomaly. When metallic items were found during the QC investigations, all pertinent data were recorded and included in dig results for the target.

3.1.7 Geophysical Quality Control

3.1.7.1 To ensure high-quality geophysical data, the data collection and processing steps were monitored by the ZAPATAENGINEERING Senior Geophysicist.

3.1.7.2 During data collection, the following steps were strictly followed for quality control:

- A 15-minute warm-up time was allowed for the geophysical sensors prior to data collection.
- After the warm-up period, data were recorded in a stationary mode for a minimum of three minutes to aid in identifying equipment problems and determining instrument drift.
- The GPS quality control index number and sensor data were monitored during data collection.
- Daily latency tests were performed by collecting data in two directions over an object at a known location to verify GPS positioning and sensor operation.
- Each day, a metal standard was placed in exactly the same position on the EM coils and data were recorded. Instrument readings of the standard were checked to make sure they were within +/- 20% of the average of all readings taken.
- The raw and post-processed geophysical data were delivered to the ZAPATAENGINEERING Senior Geophysicist to ensure the geophysical quality standards set forth in the SOW were met.

3.1.7.3 Data processing quality control steps included:

- Verification of positional data through GPS quality control index.
- Processing of latency test to verify GPS positioning, sensor operation, and latency value.
- Monitoring for time gaps in sensor data, which may indicate sensor failure.
- Monitoring data coverage for gaps and total acreage surveyed.
- Tracking data processing steps to ensure all data are processed in the same manner.
- Identifying additional processing (i.e., filtering) which may be useful in data analysis and target identification.

3.1.7.4 Static Tests

Prior to geophysical data collection, sensor data were recorded in a stationary mode for a minimum of three minutes. The purpose of these tests was to aid in identifying equipment problems and determining instrument drift.

3.1.7.5 Standard Tests

Each day, a metal standard was placed in exactly the same position beneath the EM coils and data were recorded. This was performed prior and subsequent to data collection. The magnitude of the standard readings (standard reading minus background) was checked to make sure it was within +/- 20% of the average of all standard readings made. All standard variances were within the guideline.

3.1.7.6 Latency Tests

3.1.7.6.1 Data were collected each day to verify GPS positioning (latency test) and sensor operation. Before beginning data collection, geophysically quiet areas were found at Makawao Gunnery Site and Opana Point Bombing Range and a metal stake was pounded into the ground. The latency stake locations are shown in Table 3-2.

TABLE 3-2 LATENCY STAKE LOCATIONS

Point	**NAD 83, Hawaii State Plane, Zone 2**	
	Northing (US ft)	**Easting (US ft)**
Makawao 1	208889.58	1777882.99
Makawao 2	208899.36	1777873.80
Opana Point	221719.45	1771934.97

3.1.7.6.2 Each day, data were collected with the EM system in two directions (N-S) over one of the latency stakes. Geophysical data collection was conducted at Makawao Gunnery Site during September 11-12, 2002 and at Opana Point Bombing Range during August 14 through September 3, 2002. Data processing was performed on the latency test data to verify GPS positioning, sensor operation, and latency value. GPS locations for the latency stakes were compared with MTADS detected locations, and the positional differences were computed. Table 3-3 summarizes the latency test data.

TABLE 3-3 LATENCY TEST DATA

Date	Latency Location (US Feet)		Peak Location (US Feet)		Difference (US Feet)	
	Northing	Easting	Northing	Easting	Northing	Easting
Makawao 1						
09/11/02	208889.58	1777882.99	208890.10	1777883.38	-0.52	-0.39
09/12/02	208889.58	1777882.99	208890.06	1777883.13	-0.48	-0.14
Makawao 2						
09/13/02	208899.36	1777873.80	208899.24	1777873.87	0.12	-0.07
09/14/02	208899.36	1777873.80	208899.26	1777873.77	0.10	0.03
09/17/02	208899.36	1777873.80	208899.27	1777873.82	0.09	-0.02
09/19/02	208899.36	1777873.80	208899.28	1777873.96	0.08	-0.16
09/20/02	208899.36	1777873.80	208899.24	1777874.23	0.12	-0.43
Opana Point						
08/16/02	221719.45	1771934.97	221719.52	1771934.67	-0.07	0.30
08/19/02	221719.45	1771934.97	221719.37	1771935.17	0.08	-0.20
08/20/02	221719.45	1771934.97	221719.45	1771934.60	0.00	0.37
08/21/02	221719.45	1771934.97	221719.75	1771935.23	-0.30	-0.26
08/22/02	221719.45	1771934.97	221719.58	1771934.68	-0.13	0.29
08/23/02	221719.45	1771934.97	221719.37	1771935.31	0.08	-0.34
08/27/02	221719.45	1771934.97	221719.19	1771935.16	0.26	-0.19
08/30/02	221719.45	1771934.97	221719.53	1771934.94	-0.08	0.03
09/03/02	221719.45	1771934.97	221719.30	1771934.97	0.15	0.00

Note:
NAD83, Hawaii State Plane, Zone 2

3.2 NATURE AND EXTENT OF OE

3.2.1 Makawao Gunnery Site

3.2.1.1 During the site walk-thru conducted as part of the INPR, an unexploded ordnance item was observed. This item was identified as a "105mm HE Tank Piercing Artillery Shell with PD Fuse" (USACE, 1997). Depressions in the ground surface that could possibly be bomb craters were also observed. Personnel working for the East Maui Irrigation Company, Ltd. have stated that during plowing activities, "smoke bombs" have been uncovered (USACE, 1997). No additional historical records indicating the precise use and delineation of the range have been found.

3.2.1.2 ZAPATAENGINEERING recovered five UXO items; two 105mm HE projectiles with point detonating fuzes, one 4.5 in. barrage rocket, and two 60mm HE projectiles with point detonating fuzes. Several small arms casings were also recovered.

3.2.1.3 Of the 348 anomalies intrusively investigated, three anomalies (0.8%) were UXO, 19 anomalies (5.5%) were OE scrap, and 326 anomalies (93.6%) were miscellaneous metal scrap, "hot rocks", or false positives (as defined in Chapter 12.0). All of the subsurface OE scrap and

UXO items had peak value responses equal to or greater than 23.22 mV and were an average of 6.3 inches below ground surface. The two 105 mm HE projectiles were located on the ground-surface during visual inspections. Based on data collected during the geophysical investigation of 18.5 acres, ZAPATAENGINEERING projects that additional ordnance items may be encountered at the Makawao Gunnery Site. All OE items were found in the northern portion of the site in an approximately 100-acre area between elevation 700 and 800 feet (Figure 3-3).

3.2.2 Opana Point Bombing Range

3.2.2.1 Limited surface sweeps conducted in April and June 1990 located several AN-MK 23 3-pound practice bombs (USACE, 1997). A limited surface clearance was conducted in the summer of 2000 and removed a number of AN-MK 23 and MK 5 practice bombs, as well as a 4.5" barrage rocket, and 60 mm and 81 mm mortars (DEI, 2000). No additional historical records indicating the precise use and delineation of the range has been found.

3.2.2.2 During the field investigation, ZAPATAENGINEERING found evidence of expended and unexpended AN-MK 23 and MK 5 practice bombs, two 60mm HE projectiles, and two 81 mm HE projectiles at Opana Point Bombing Range.

3.2.2.3 Of the 322 anomalies intrusively investigated, eight anomalies (2.5%) were UXO, 138 anomalies (42.8%) were OE scrap, and 176 anomalies (54.6%) were miscellaneous metal scrap, "hot rocks", or false positives (as defined in Chapter 12.0). Most of the OE scrap and UXO items discovered on-site were AN-MK23 and MK 5 practice bombs or scrap, although two unexploded 60 mm mortars and evidence of 81 mm mortars were recovered. All of the OE scrap and UXO items had peak value responses equal to or greater than 10.15 mV and were an average of 4.4 inches below ground surface. Based on data collected during the geophysical investigation, additional ordnance items are likely to be encountered at the Former Opana Point Bombing Range.

3.3 DESCRIPTION OF HAZARDS OF SPECIFIC OE ENCOUNTERED

3.3.1 Two 105mm HE projectiles with point detonating fuzes were located on the ground-surface (and did not require intrusive investigation), while one 4.5 inch barrage rocket and two 60mm HE projectiles with point detonating fuzes were located during intrusive operations at Makawao Gunnery Site. These items did not function as designed and could unintentionally detonate if exposed to heat, shock or friction.

3.3.2 Expended and unexpended MK 23 and MK 5 practice bombs and two 60mm HE projectiles were recovered at Opana Point Bombing Range. The practice bombs contain a signal cartridge similar to a 12-gauge shotgun. The cartridges were to function on impact allowing bomb crews and observers to see where the bombs were dropped. The projectiles contained high explosive filler with point detonating fuzing. These items that did not function as designed, could unintentionally detonate if exposed to heat, shock or friction.

4.0 ORDNANCE AND EXPLOSIVES RISK IMPACT ASSESSMENT

4.0.1 This qualitative evaluation of OE risk for the Makawao Gunnery Site and Opana Point Bombing Range was developed following protocols defined in the Ordnance and Explosives Risk Impact Assessment (OERIA). OERIA uses direct analysis of site conditions and demographics to evaluate OE risk. The results of this risk assessment were used to help determine the most appropriate OE response action for these sites.

4.0.2 Sections 4.1 through 4.4 discuss the risk factors and the approach and rationale used in this risk evaluation. Section 4.5 provides the risk impact assessment for the sites and Section 4.6 summarizes the results.

4.1 DEFINITION OF RISK FACTORS

The potential risk posed by OE at a site may be characterized by evaluating the likelihood of exposure to OE, the severity of exposure, and likelihood of detonation. These components can be further defined by a set of risk factors. For example, the type of OE and its sensitivity must be considered to evaluate the likelihood of detonation and severity of exposure. Similarly, the likelihood of exposure may be evaluated by considering the OE potential, the number of people using the site, the type of activities conducted, and the accessibility of the site. These risk factors are listed below and defined further in the following paragraphs.

- OE Factors (OE Type, OE Sensitivity, OE Exposure Potential, OE Depth);
- Site Characteristics Factors (Site Accessibility, Site Instability); and
- Demographic Factors (Site Activities, Site Population).

4.2 ORDNANCE AND EXPLOSIVES FACTORS

4.2.1 Types of Ordnance and Explosives

The type of OE affects the likelihood of an incident and the severity of an injury if OE functions when encountered by an individual. There are four categories of OE. These categories are presented in order from highest to lowest potential hazard in Table 4-1. The OE type for each site reflects the results of the EE/CA field investigation as well as the results of previous investigations. When multiple categories of OE types were discovered at a site, the highest hazard category is used in the risk assessment.

TABLE 4-1 OE TYPE RISK FACTOR DETERMINATION

OE Impact	Qualitative Risk Level
OE that will kill an individual if detonated by an individual's activities	High
OE that will cause major injury to an individual if detonated by an individual's activities	Moderate
OE that will cause minor injury to an individual if detonated by an individual's activities	Low
Inert OE (*i.e.*, OE scrap) will cause no injury	None

4.2.2 Sensitivity of Ordnance and Explosives

OE sensitivity affects the likelihood of an OE item functioning as designed when encountered by an individual. There are four categories of OE sensitivity presented in order from highest to lowest in Table 4-2. The OE sensitivity of specific OE recovered during the field investigation and the resulting hazards they present are outlined in Sections 4.5.3.1.2 and 4.5.4.1.2 of this document.

TABLE 4-2 OE SENSITIVITY RISK FACTOR DEFINITION

OE Impact	Qualitative Risk Level
OE that is highly sensitive	High
OE that is sensitive	Moderate
OE that may have functioned correctly or is unfuzed but has a residual risk.	Low
OE scrap (nonhazardous and, therefore, not sensitive)	None

4.2.3 Ordnance and Explosives Exposure Potential

The presence of UXO and/or OE scrap provides a means for determining the potential to encounter additional OE. There are three categories of OE Exposure Potential presented in order from highest to lowest in Table 4-3. Based on past military use of the site, there will always be a potential for OE, even in an area where there has been no evidence of OE found.

TABLE 4-3 OE EXPOSURE POTENTIAL RISK FACTOR DEFINITION

Evidence of OE	OE Exposure Potential
UXO was recovered during the EE/CA field investigation or during previous investigations	High
Only OE scrap was recovered during the EE/CA field investigation or during previous investigations	Moderate
No evidence of UXO or OE scrap during the EE/CA field investigation or during previous investigations	Low

4.2.4 Depth Range of Ordnance and Explosives

The depth of OE is related to the probability that an individual will be exposed to OE. The evaluated depth is based on the depth that OE is recovered during the EE/CA field investigation. In general, the deeper the OE item, the less likely a member of the public will encounter it.

4.3 SITE CHARACTERISTIC FACTORS

4.3.1 Site Accessibility

The accessibility of a site affects the likelihood of an individual being exposed to OE. Structural barriers (*e.g.*, fences) or natural barriers (*e.g.*, rough terrain) can limit site accessibility. Both structural and natural barriers at the site are considered when evaluating the site accessibility risk factor. The three categories within this risk factor are presented in order from highest to lowest in Table 4-4.

TABLE 4-4 SITE ACCESSIBILITY RISK FACTOR DEFINITION

Accessibility of Site	Description	Qualitative Risk Level
No restriction to site	No structural barriers; gently rolling terrain; no vegetation or water restricts access	High
Limited restriction to site	Remoteness of site; structural barriers; vegetation, water, or terrain restricts access.	Moderate
Complete restriction to site	All points of entry are controlled; locked and gated	Low

4.3.2 Site Instability

Site instability affects the potential for individuals to come into contact with OE by human or natural processes. Natural processes include reoccurring natural events (*e.g.*, erosion and soil movement) or extreme natural events (*e.g.*, volcanic eruptions and hurricanes). Human processes occur when a site experiences intentional land disturbances within its boundaries (*e.g.*, by means of trail blazing). The three categories within this risk factor are presented in order from highest to lowest in Table 4-5.

TABLE 4-5 SITE INSTABILITY RISK FACTOR DEFINITION

Site Instability	Description	Qualitative Risk Level
OE most likely to be exposed by natural or human events	Unstable	High
OE may be exposed by natural or human events	Moderately Stable	Moderate
OE not likely to be exposed by natural or human events	Stable	Low

4.4 HUMAN FACTORS

4.4.1 Site Activities

The likelihood of an individual coming into contact with OE is related to activities generally classified as recreational (*e.g.*, hiking, camping, biking) or occupational (*e.g.*, farming, construction), and are directly related to the depth of OE. There are three risk factors within this category that take into account depth of OE and activities at a site. For example, if OE is deeper than 1-foot bgs and only surface-impact activities are being performed, the activities are considered as low-impact activities with very little risk associated with OE exposure. On the other hand, where OE is on the surface, all activities that can affect OE on the surface have a high level of risk associated with OE exposure. Table 4-6 presents the definitions for this risk factor.

TABLE 4-6 SITE ACTIVITIES RISK FACTOR DEFINITION

Activities	Depth Activities Affect OE	Depth of OE (inches bgs)	Qualitative Risk Level
Child play, hiking, off-road driving, horseback riding	Surface	0 - 6 6 - 12 > 12	High Moderate Low
Ranching, camping, surveying, metal detecting (*i.e.*, treasure hunting)	Surface/ Subsurface up to 1 ft bgs	0 - 12 12 - 24 > 24	High Moderate Low
Construction, crop farming	Surface/ Subsurface, more than 1 ft bgs	0 - 24 24 - 48 > 48	High Moderate Low

4.4.2 Site Population

The number of people using a site and the frequency of that use affects the probability of whether OE will be encountered by an individual. Three categories within this risk factor are presented in order from highest to lowest in Table 4-7.

TABLE 4-7 SITE POPULATION RISK FACTOR DEFINITION

Number of People Using Site	Qualitative Risk Level
Public attraction such as tourist sites, parks, beaches, other	High
Public has access to land, but not an attraction to the public	Moderate
Public access is restricted; landowners sole users of land	Low

4.5 EVALUATION OF MAKAWAO GUNNERY SITE AND OPANA POINT BOMBING RANGE

4.5.1 This risk evaluation for the Makawao Gunnery Site and Opana Point Bombing Range uses data collected from the EE/CA field investigation, from previous investigations, documented reports of discovered OE, current and future land uses, and the decision criteria discussed in Sections 4.2, 4.3, and 4.4, to qualitatively assess the OE hazard level at the Makawao Gunnery Site and Opana Point Bombing Range.

4.5.2 Table 4-8 summarizes each risk evaluation area: total area evaluated, number of UXO and OE scrap recovered during the EE/CA field investigation, the potential for exposure to OE, and the rationale for determining the level of OE exposure potential for each site.

TABLE 4-8 ESTIMATING POTENTIAL FOR ORDNANCE AND EXPLOSIVES

OERIA Evaluation Site	Total Area (Acres)	UXO Recovered during EE/CA	OE Scrap Items Recovered during EE/CA	OE Exposure Potential	Rationale for Level of OE Potential
Makawao Gunnery Site	1,002	5	19	High	Presence of UXO.
Opana Point Bombing Range	52*	8	138	High	Presence of UXO.

* Total of 86 acres covered during field investigation

4.5.3 Makawao Gunnery Site Risk Evaluation

Results of the evaluation of the Makawao Gunnery Site are summarized in Table 4-10. A discussion of each risk factor for the Makawao Gunnery Site is provided in the following subsections.

4.5.3.1 Ordnance and Explosives Factors

4.5.3.1.1 Type of Ordnance and Explosives

Based on historical information, the 105mm artillery round was anticipated to be present at the Makawao Gunnery Site. During the OE investigation, ZAPATAENGINEERING found evidence of four types of OE items: the 4.5 inch Barrage Rocket Mk 3, the 105 mm projectile, the 81 mm mortar, and the 60mm mortar. One unexploded Mk 3 rocket, two unexploded 105 mm projectiles, and two unexploded 60mm mortars were recovered during the EE/CA field investigation. These types of OE are classified as high based on Table 4-1.

4.5.3.1.2 Sensitivity of Ordnance and Explosives

The 4.5-inch Barrage Rocket Mk 3, 105 mm projectile and the 60mm mortar rounds are highly sensitive to movement and extreme heat, thus producing a high OE sensitivity risk level as described in Table 4-2. A 30-06 civilian rifle round and a .45 caliber slug were also found, but do not have an OE sensitivity risk associated.

4.5.3.1.3 OE Exposure Potential

Because UXO items were discovered in this site investigation, the potential for exposure to OE at the Makawao Gunnery Site is high, as described in Table 4-3. It should be noted that all OE items recovered during the field activities were found in the northern portion of the site between elevations 700 and 800 feet. As shown on Figure 4-1, no OE related items were found above elevation 800 feet during visual surface investigations or during intrusive investigations of 120 target anomalies.

4.5.3.1.4 Quantity or Density

All UXO and OE scrap items were found in the northern portion of the Makawao Gunnery Site between elevations 700 and 800 feet in an area of approximately 100 acres. ZAPATAENGINEERING recovered 24 OE items including five UXO from the 5.3 acres sampled within the 100-acre portion identified in Figure 3-3. It should be noted that within this 100-acre area 193 (65%) of 298 targets meeting the target selection criteria established during the GPO were intrusively investigated.

4.5.3.1.5 Depth Range of Ordnance and Explosives

Based on the dig results 19 of the 24 OE items (79%) were less than or equal to six inches below the ground surface. The average depth of the 24 OE items is 5.25 inches below ground surface. Table 4-9 provides a description of the recovered OE items and the depth at which the item was found.

TABLE 4-9 SUMMARY OF OE ITEMS FOUND - MAKAWAO GUNNERY SITE

Item	Depth in inches	Location	UXO
105 mm projectile*	0	East of grid 4	✓
105 mm projectile*	0	North of Grid 6	✓
OE Scrap	0	Grid 3	
OE Scrap	4	Grid 3	
OE Scrap	6	Grid 3	
OE Scrap	2	Grid 3	
OE Scrap	8	Grid 3	
OE Scrap	0	Grid 4	
OE Scrap	6	Grid 4	
OE Scrap	8	East Road Transect	
4.5 inch rocket	24	Grid 8	✓
60 mm mortar	6	Grid 8	
OE Scrap	3	Grid 8	
OE Scrap	3	Grid 8	
OE Scrap	12	Grid 8	
OE Scrap	3	Grid 8	
OE Scrap	4	Grid 8	
60 mm mortar	2	Grid 15	✓
OE Scrap	4	Grid 15	
OE Scrap	13	Grid 15	
OE Scrap	6	Grid 15	
60 mm mortar	4	Grid 16	✓
OE Scrap	4	Grid 16	
OE Scrap	4	Grid 16	

* Discovered on the surface during visual reconnaissance, not a result of intrusive investigation.

4.5.3.2 Site Characteristic Factors

4.5.3.2.1 Site Accessibility

Due to locked and gated entry points along the perimeter fencing, rugged terrain and dense vegetation, the site is relatively inaccessible to the public. Based on Table 4-4, the site accessibility risk level for the Makawao Gunnery Site is low.

4.5.3.2.2 Site Instability

Naturally occurring events, such as erosion or soil movement, are not likely at the Makawao Gunnery Site due to dense vegetation throughout the site. However, OE items may be uncovered by owner activities, such as land clearing for grazing purposes, thereby classifying the site as moderately stable, with an associated moderate risk level (See Table 4-5).

4.5.3.3 Demographic Factors

4.5.3.3.1 Site Activities

Currently, the Makawao Gunnery Site is used for cattle ranching. During the Technical Project Planning (TPP) process, the property owner, East Maui Irrigation Company, Ltd., communicated that they wish to continue to use the land for that purpose. This current and future land use is classified as the second activity type listed in Table 4-6 (Ranching, camping, surveying, metal detecting). Depth of OE items found, in conjunction with the type of activities engaged in on site, determine the Site Activities Risk Factor for each item. Both 105mm projectiles, classified as UXO, have a depth of 0 inches bgs justifying a high Qualitative Risk Level. The 4.5-inch Barrage Rocket is located at 24 inches bgs, classifying it to have a low Qualitative Risk Level. The three 60 mm mortars are located at 2, 4 and 6 inches bgs resulting in a high Qualitative Risk Level. Each Qualitative Risk Level determination is based on Table 4-6.

4.5.3.3.2 Site Population

Site inaccessibility due to steep terrain and fencing contributes to a low frequency of use by local populations; the landowners are the sole users of this property. The Site Population Risk Factor is determined to be low based on Table 4-7.

4.5.3.4 Overall Ordnance and Explosives Risk Impact Assessment

Due to the number and depth of UXO recovered in the lower elevation portion of the site and the types of activities occurring in this area, it is likely that individuals will be exposed to OE during site activities. Since the level of risk associated with the type and sensitivity of OE is high, the OE hazard to the exposed individual is high. Although the site population risk factor is ranked at a low risk level, the types of OE found and activities conducted at the site (such as use of heavy equipment for clearing brush to provide grazing land, etc.), contribute to the high overall hazard level for the Makawao Gunnery Site.

TABLE 4-10 SUMMARY OF RISK FACTORS - MAKAWAO GUNNERY SITE

	OE Recovered	4.5-in. Barrage Rocket	105mm Projectile	60mm	Overall Site OE Hazard Level
Ordnance and Explosives Factors	Type	High	High	High	High
	Sensitivity	High	High	High	
	Exposure Potential	High	High	High	
	Site Density*	4.5 items/acre	4.5 items/acre	4.5 items/acre	
	Depth Range	24 in.	0 in.	2-6 in.	
Site Factor	Access	Low	Low	Low	
	Instability	Moderate	Moderate	Moderate	
Demographic Factors	Activity	Low	High	High	
	Population	Low	Low	Low	

* Site Density is based on 24 items over 5.3 acres.

4.5.4 Opana Point Bombing Range Risk Evaluation

Results of the evaluation of the Opana Point Bombing Range are summarized in Table 4-12. A discussion of each risk factor for the Opana Point Bombing Range is presented in the following subsections.

4.5.4.1 Ordnance and Explosives Factors

4.5.4.1.1 Type of Ordnance and Explosives

Based on historical documentation, the Mk 3 4.5-inch Barrage Rocket, the AN-Mk 23 and Mk 5 3lb. practice bombs, and 60mm and 81mm M375 mortars were anticipated to be present at the Opana Point Bombing Range. During the OE investigation, ZAPATAENGINEERING found evidence of four types of OE items: AN-Mk 23 and Mk 5 practice bombs and 60mm and 81mm mortars. The AN-Mk 23 and Mk 5 are classified as having a low OE Type Risk Factor due to the likelihood that these items will not function properly when encountered by an individual. The 60mm and 81mm M375 mortars are classified as having a high OE Type Risk Factor based on Table 4-1.

4.5.4.1.2 Sensitivity of Ordnance and Explosives

The AN-Mk 23 and Mk 5 3lb. practice bombs present a low OE sensitivity due to the presence of sediment buildup and possible corrosion surrounding the firing pin. As a result, the likelihood that these items will function as designed through human contact is unlikely. In some cases, the sediment between the signal cartridge and firing pin is compacted so tightly that significant effort is required to clear the area to allow for proper functionality. The 60mm mortar is highly sensitive to movement, therefore obtaining a high OE sensitivity factor. The 81mm M375 also

presents a high sensitivity to movement and is sensitive to static electricity which can be produced by dust storms, moving belts, and revolving automobile/truck tires. The OE sensitivity factor for the 81mm M375 is high. All three items may be subject to explosion under conditions of extreme heat. Other miscellaneous scrap items found on-site, such as rocks and steel cable, have no OE sensitivity.

4.5.4.1.3 Ordnance and Explosives Exposure Potential

Because UXO items were discovered in this site investigation, the potential for exposure to OE at Opana Point is high, as described in Table 4-3.

4.5.4.1.4 Quantity or Density

ZAPATAENGINEERING recovered 146 OE items including eight UXO items from the 10.1 acres sampled during the EE/CA field investigation (Figure 4-2). It should be noted that 322 (52%)of the 619 geophysical anomalies meeting the target selection criteria established during the GPO were intrusively investigated.

4.5.4.1.5 Depth Range of Ordnance and Explosives

ZAPATAENGINEERING evaluated the results of the intrusive investigations and determined that 83 of the 146 OE items (57%) were found less than six inches below the ground surface. 63 OE items (43%) including four UXO were found at depths from six to 24 inches below ground surface. The average depth of the 146 OE items was 4.4 inches below ground surface. Table 4-11 is a summary of OE items found and their associated depths within the grids.

TABLE 4-11 SUMMARY OF OE ITEMS - OPANA POINT BOMBING RANGE

	Number of OE Items[a]	Average Depth in Inches	Number of UXO Items
Grid 1	30	3.9	2
Grid 2	37	5.8	0
Grid 3	21	3.2	0
Grid 4	11	4.5	0
Grid 5	0	NA	0
Grid 6	7	4.9	5
Grid 7	23	4.3	0
Grid 8[b]	0	NA	0
Grid 9[c]	0	NA	0
Transects	17	3.8	1
Total	**146**	**4.42**	**8**

a Including UXO.
b One of thirteen target anomalies intrusively investigated.
c No intrusive investigations

4.5.4.2 Site Characteristic Factors

4.5.4.2.1 Site Accessibility

Opana Point is located on the coast of the Island of Maui where the terrain is relatively flat. It has been terraced and further flattened during previous pineapple cultivation. Access to Opana

Point is via the Hana Highway to the south of the site. One road leads onto the property and there are no public restrictions to the site. As described in Table 4-4, such conditions constitute a high Qualitative Risk Level.

4.5.4.2.2 Site Instability

Ordnance items may be uncovered by rain events, local residents who currently use the property for recreational activities, or by future residents of the site, thereby classifying the site as unstable with a high Qualitative Risk Level (See Table 4-5).

4.5.4.3 Demographic Factors

4.5.4.3.1 Site Activities

The local population currently uses the site for recreational activities such as hiking, motocross riding, and off-road driving. During field activities, crews monitored such activities and routinely stopped work as members of the public attempted to gain access to the site for recreational purposes. This current land use is classified as the first activity type listed in Table 4-6 (Child play, hiking, off-road driving, horseback riding). Depth of OE items found, in conjunction with the type of activities engaged in on site, determine the Site Activities Risk Factor for each item. The depth ranges of all four types of OE items found at the Opana Point Bombing Range justify a high Qualitative Risk Level. Depth ranges are presented in Table 4-12. Each Qualitative Risk Level determination is based on Table 4-6.

4.5.4.3.2 Site Population

Opana Point is used daily by the public for a variety of purposes, which would constitute a high frequency of use and therefore a high Qualitative Risk Level (Table 4-7).

4.5.4.4 Overall Ordnance and Explosives Risk Impact Assessment

The likelihood of exposure to OE at Opana Point is high given the type, sensitivity, and density of OE recovered during the EE/CA field investigation and the lack of access restrictions to the site. Based on the planned development activities and the evaluation of the OERIA risk factors, the overall OE hazard at Opana Point is high.

TABLE 4-12 SUMMARY OF RISK FACTORS - OPANA POINT BOMBING RANGE

	OE Recovered	AN-MK 23[a]	Mk 5[a]	60mm	81mm	Overall Site OE Hazard Level
Ordnance and Explosives Factors	Type	Low	Low	High	High	High
	Sensitivity	Low	Low	High	High	
	Exposure Potential	High	High	High	High	
	Site Density[b]	14.5 items/acre	14.5 items/acre	14.5 items/acre	14.5 items/acre	
	Depth Range	0-24 in.	0-12 in.	2-6 in.	4-6 in.	
Site Factors	Access	High	High	High	High	
	Instability	High	High	High	High	
Demographic Factors	Activity	High	High	High	High	
	Population	High	High	High	High	

a Nonfragmenting ordnance with either no or directional spotting charge (i.e., no explosive hazard)
b Site Density is based on 146 items over 10.1 acres.

4.6 RESULTS OF THE ORDNANCE AND EXPLOSIVES RISK IMPACT ASSESSMENT

4.6.1 Each response-action alternative discussed below is assigned an impact evaluation score using a numerical rank from 1 to 4 representing the relative impact of the response-action alternative, with 1 having the highest relative impact and 4 having no impact. The comparisons, Tables 4-13 and 4-14, provide a qualitative indication of the change in the potential for harm and level of protectiveness at the site for each response-action alternative that could be implemented and is independent of costs associated with each alternative.

4.6.1.1 Alternative 1: No Department of Defense Action Indicated (NDAI)

The NDAI alternative is included to provide a baseline comparison with other risk-reduction alternatives. No technology is associated with this alternative. No risk-reduction measure resulting in the treatment, containment, removal of or limited exposure to OE will be implemented. Therefore, potential OE will not be removed and no restriction will be placed on access to the site. The NDAI alternative is appropriate for sites where no OE has been found, where there is no documented evidence of OE usage, or where the nature and extent of the OE occurrence poses minimal threat to those who may encounter it. This alternative is not an acceptable alternative for either the Makawao Gunnery Site or the Opana Point Bombing Range.

4.6.1.2 Alternative 2: Institutional Controls

Institutional controls utilize education and land-use restrictions to minimize exposure of site users to OE. Institutional controls rely on behavior modification and site-access control

strategies to eliminate or minimize risk. Institutional-control strategies, including education and/or physical site-access controls, are appropriate where risk to the public has been documented as low and can be managed without the removal of OE. With the exception of digging for signpost installation, intrusive activity is not typically associated with this alternative. Such controls can be implemented with low capital cost and low subsequent annual operating costs.

4.6.1.3 Alternative 3: Surface Clearance

Surface clearance involves utilizing UXO technicians who are trained to recognize, handle, and dispose of ordnance, to perform a visual inspection of the entire surface of the site, and to remove OE from the ground surface. The UXO technicians are responsible to ensure proper disposal of the recovered material. This alternative is effective in minimizing the risk of incidental contact with OE in areas where intrusive activities are not likely.

4.6.1.4 Alternative 4: Clearance to a Detectable Depth

This alternative involves all activities necessary to fully locate, excavate and remove OE to a depth consistent with the expected land use, public access and overall health and safety of the affected community. Activities may potentially include vegetation clearance as necessary to conduct geophysical surveys, completion of geophysical investigations, excavation of anomalies, and destruction of OE. Technologies that may be used for this alternative include magnetic and/or electromagnetic geophysical investigative methods and management/disposal of OE (including detonation of UXO). This alternative includes surface clearance over the entire site and excavation and clearance in suspected impact areas.

4.6.2 The overall OERIA hazard level for both the Makawao Gunnery Site and the Opana Point Bombing Range is High. This conclusion was reached through evaluations of each site supported by criteria outlined in the March 27, 2001 Interim Guidance Ordnance and Explosives Risk Impact Assessment (OERIA). UXO was recovered on both sites during the EE/CA field investigation; due to past military use of the site, there is an increased potential to find additional UXO in these areas, as stated in Section 4.2.3. The high OE exposure potential suggests a greater likelihood of injury to persons who may come into contact with UXO. At the Opana Point Bombing Range, site activities present a high probability of human exposure to OE, while site activities at the Makawao Gunnery Site pose a risk when considering UXO items recovered on or near (0″-6″ bgs) the surface. The overall OERIA hazard level determined for each site is used in the analysis of the OE response action alternatives evaluated in Chapter 8.0 of this EE/CA report. Based on the OERIA, the Clearance to Detectable Depth response-action alternative would likely provide the largest risk-reduction impact, followed by (in order from most to least risk-reduction potential) Surface Clearance, Institutional Controls, and NDAI.

TABLE 4-13 OE RISK IMPACT ASSESSMENT (MAKAWAO GUNNERY SITE)

Alternatives[a]	Ordnance and Explosives Factors[b]				Site Characteristics[c]		Human Factors[d]		Overall Rank
	Type	Sensitivity	Density	Depth	Access	Stability	Activity	Population	
Baseline Risk Assessment (Existing Conditions)	High: Barrage Rocket Mk 3, 105mm projectile, 60mm mortar	High: Movement and extreme heat	0.24 items per acre or 24 over 5.3 acres	0”-6” (79%) >6” (21%)	Low: Public Restriction to Access	Moderate: Moderately Stable	Ranching/ Cattle grazing	Ranch workers and # of cattle	Overall Hazard: High
No DOD Action Indicated	4	4	4	4	4	4	4	4	4
Institutional Controls	4	4	4	4	3	3	3	3	3
Surface Clearance	4	2	2	2	2	2	2	2	2
Clearance to Detectable Depth	1	31	1	1	1	1	1	1	1

a Each response-action alternative is assigned an impact evaluation score with 1 having the highest relative impact and 4 having no impact.
b Ordnance and Explosive factors are discussed/defined in Section 4.2.
c Site Characteristics are discussed/defined in Section 4.3.
d Human Factors are discussed/defined in Section 4.4.

TABLE 4-14 OE RISK IMPACT ASSESSMENT (OPANA POINT BOMBING RANGE)

Alternatives[a]	Ordnance and Explosives Factors[b]				Site Characteristics[c]		Human Factors[d]		Overall Rank
	Type	Sensitivity	Density	Depth	Access	Stability	Activity	Population	
Baseline Risk Assessment (Existing Conditions)	High Mk23, Mk 5, 60mm and 81mm mortar	High Movement, extreme heat, static electricity	14.5 items per acre or 146 over 10.1 acres	0”-6” (57%) >6” (43%)	High No Restriction to Site	High Unstable	Hiking, off-road driving	Daily public use	Overall Hazard: High
No DOD Action Indicated	4	4	4	4	4	4	4	4	4
Institutional Controls	4	4	4	4	3	3	3	3	3
Surface Clearance	2	2	2	2	2	2	2	2	2
Clearance to Detectable Depth	1	1	1	1	1	1	1	1	1

a Each response-action alternative is assigned an impact evaluation score with 1 having the highest relative impact and 4 having no impact.
b Ordnance and Explosive factors are discussed/defined in Section 4.2.
c Site Characteristics are discussed/defined in Section 4.3.
d Human Factors are discussed/defined in Section 4.4.

5.0 INSTITUTIONAL ANALYSIS

This Institutional Analysis identifies and analyzes the institutional framework necessary to support the development of Institutional Controls as an effective Ordnance and Explosive (OE) response-action alternative for the Makawao Gunnery Site and Opana Point Bombing Range.

5.1 PURPOSE AND OBJECTIVES

The purpose of this analysis is to gather background information and document which public and private entities have jurisdiction over potentially OE contaminated lands and to assess the capability and willingness of those entities to assert Institutional Controls that would protect the public from explosive hazards at the sites. More specifically, this report:

- Identifies entities that have jurisdiction over the land within the EE/CA project boundary;
- Defines authority, responsibility, capability, resources, and the willingness of each entity to participate in institutional controls to protect the public from explosive hazards;
- Identifies potential institutional control strategies available to implement access controls and/or public-safety awareness actions for the property; and
- Defines and analyzes intergovernmental relationships, joint responsibilities, land use control functions, technical capabilities, and funding sources.

5.2 REGULATORY BACKGROUND

5.2.1 The following paragraphs provide a brief summary on existing regulations that result in the implementation of an Institutional Analysis.

5.2.2 In 1986, Congress enacted the Superfund Amendments and Reauthorization Act (SARA), which amended certain aspects of the CERCLA, some of which directly related to OE contamination. Chapter 160 of the SARA established the Defense Environmental Restoration Program (DERP). One of the goals specified for the DERP is "correction of environmental damage" (such as detection and disposal of UXO) that creates an imminent and substantial endangerment to public health/welfare or to the environment. The DERP requires that appropriate action consistent with CERCLA be undertaken whenever such "imminent and substantial endangerment" is found at a facility or site that is under the jurisdiction of the Secretary of Defense and is owned by, leased to, or otherwise possessed by the United States at the time of actions leading to contamination.

5.2.3 The Natural Oil and Hazardous Substance Pollution Contingency Plan (NCP) was established by the Clean Water Act (CWA) of 1972 and has been revised and broadened several times since then. Its purpose is to provide the organizational structure and procedures for remedial actions to be taken in response to the presence of hazardous substances, pollutants, and contaminants at a site. Section 105 of the 1980 CERCLA states that the NCP shall apply to all response actions taken as a result of CERCLA requirements. The March 1990 NCP, given in 40 Code of Federal Regulations (CFR) 300, is the latest version of the NCP. Paragraph 300.120 states that the "Department of Defense (DOD) will be the removal response authority with

respect to incidents involving DOD military weapons and munitions under the jurisdiction, custody, and control of DOD."

5.2.4 The NCP model requires that any government response be considered openly in coordination with stakeholders. Further, Federal decision making requires development of alternative response strategies to ensure that the most effective (and least objectionable) plans are implemented. OE response-action alternatives should be based on a variety of technologies or implementation strategies that are sufficiently different in effect to allow for technical discrimination in the assessment of plans, and to allow for real choice on the part of the stakeholders. A strategy that engages the presence of ordnance is a removal action.

5.2.5 Removal of OE is the traditional response action. In general, a plan of action involves developing and coordinating plans for worker and public safety during the action, site mobilization, operations, and site close out that may include continuing maintenance requirements. When a federal response action is complete, there is a natural tendency for stakeholders to assume that the site is clean. This happens no matter how clearly it is stated that no removal action is one hundred percent complete. Removal produces a condition of fewer ordnance items, but cannot guarantee that no ordnance items exist on the property. If human activity is the same before and after the removal, the assumption is that the risk has been reduced. However, if, as a result of the removal, human access is facilitated and/or behavior is less cautious, an unknown situation may arise that may pose greater risk. Institutional controls produce an additional action that uses governmental or other authorities in addition to the removal-action-response authority under the DERP.

5.3 INSTITUTIONAL CONTROLS

Institutional controls in this EE/CA report were developed using USACE guidance (EP 1110-1-24) for *Establishing and Maintaining Institutional Controls for Ordnance and Explosives Projects* (December 2000). Institutional controls (discussed in greater detail in Chapter 7.0) protect property owners and the public from hazards present at a site by warning of the potential OE hazard and/or limiting the access to or use of a site. Institutional controls include engineering controls, educational programs, legal mechanisms, and construction support. The overall effectiveness of Institutional Controls depends on the type of Institutional Controls being implemented and the support, involvement, and willingness of local agencies and landowners to enforce and maintain Institutional Controls that have been implemented to eliminate public interaction with OE. For Institutional Controls to be successful, the government, landowners, and local authorities who have jurisdiction over and the authority to enforce Institutional Controls must coordinate and agree on the types of Institutional Controls to be implemented, and who will be responsible for maintaining an enforcing them.

5.4 METHODOLOGY

5.4.1 Data used for this Institutional Analysis was collected from various sources, including site visits, record searches, and interviews conducted as part of both the TPP process and an Institutional Analysis. Interviews with property owners were conducted on October 24, 2002 prior to fieldwork and again on multiple occasions during the execution of the field investigation (Appendix E). Interviews were conducted on October 24, 2002 with individuals representing the

Maui County Department of Police and Department of public works and Waste Management. Records of communication from these interviews are provided in Appendix F.

5.4.2 Data collected during the interview and survey processes included jurisdictional boundaries, authorities, and responsibilities for land use and public safety, capabilities, resources, and the agencies' willingness to participate in Institutional Controls. Current and future capabilities for Institutional Controls, current and future responsibilities for land use, and public safety and capabilities in terms of authorities and resources were also investigated. The methods focused upon identification of Institutional Controls that would be protective and would fit the sites to which the controls were applied. The analysis focused upon the identification of Institutional Controls that could be included in a comprehensive risk management strategy for the sites that are potentially contaminated with OE.

5.5 SUMMARY OF INTERVIEWS

5.5.1 Department of Police

Lieutenant Randy Leval of the Maui police department was interviewed concerning the Institutional Controls for Makawao and Opana Point sites. He stated that they would be willing to implement the Institutional Controls stated for these sites. He also stated that the police department already responds to UXO-related calls for Maui, Lanai, and Molokai.

5.5.2 Department of Public Works and Waste Management

Milton Arkawa of the public works department was interviewed concerning possible Institutional Controls for Makawao and Opana Point sites. He stated that, if the option of construction support is selected, a formal request would need to be sent to the department for approval. Once approved, those requesting building permits for specific locations within these sites would be directed to contact US Army Corps of Engineers, Honolulu District, Pacific Ocean Division (CEPOH) who would determine if construction support is necessary and to what degree it would be provided.

5.5.3 East Maui Irrigation Company

Mr. Garrett Hew, Manager of the East Maui Irrigation Company (EMI), was interviewed concerning Institutional Controls for the Makawao Gunnery Site. He stated that EMI would be willing to participate in educational meetings to gain an understanding of potential hazards associated with any residual OE items at the site. Mr. Hew further stated that he does not disagree with the use of warning signs at across points, although he has some concern over maintenance needs and the possibility that signs may draw attention from members of the public including souvenir hunters.

5.5.4 Opana Point Property Management

Mr. Ron Serle indicated during the initial TPP meeting and on subsequent discussions that he was not in favor of posting signs at the Opana Point site because of the concern that they might attract tourist and local populations to look for such items. Mr. Serle is supportive of public outreach and educational programs that could elevate awareness for those who do access the site.

5.6 POSSIBLE INSTITUTIONAL CONTROLS

Institutional controls for Makawao Gunnery Site and Opana Point Bombing Range may include a variety of actions, such as educational meetings, warning signs, and permit requirements based on the current and future land use at these sites. These can offer a level of protection for possible occurrences of ordnance contact with the general public. Institutional controls can be implemented along with removal actions or as stand-alone actions to protect members of the public.

5.6.1 Makawao Gunnery Site

Due to the ranching and cattle grazing at Makawao, subsurface ordnance poses a risk to humans and animals. The property owner and their employees who work on the site should be made aware of the possibilities that they may come in contact with remaining ordnance. Therefore, an educational/information session is recommended for the property owner and their employees. This session should give vital information about what kind of ordnance that they may come in contact with, and the correct actions that they should take to protect themselves and others in the event ordnance is found. If an employee finds ordnance, it should be reported to the property owner immediately, who would then contact the Police Department who would, in turn, contact the local Explosive Ordnance Disposal (EOD) unit to dispose of the UXO.

5.6.1.1 Institutional Controls for the Makawao Gunnery Range may consist of construction support for future activities. This determination would be made by CEPOH on a case-by-case basis as discussed below for Opana Point.

5.6.2 Opana Point Bombing Range

The future use of Opana Point is for a residential development. Since the general public will use this site, it is likely that a clearance action will be performed at Opana Point. Surface clearance consists of UXO-qualified personnel walking a system of grids with the aid of a hand-held metal detector to visually clear any surface ordnance that can be seen. The metal detector will be used by the UXO personnel to assist them in locating items in vegetated areas as well as partly buried items. Ordnance found on the surface will be removed and properly disposed of. Subsurface removal consists of using geophysical instruments to detect anomalies located in subsurface soil. The geophysical data will be compiled to generate a geophysical map of the area that defines the locations of all anomalies that were detected. Qualified geophysics personnel will select anomalies that represent potential OE items as targets for investigation. A map with target coordinates will then be created and given to the UXO personnel. They will then investigate all selected anomalies defined as potential OE, and properly dispose of all anomalies found.

5.6.2.1 Institutional Controls for Opana Point may consist of construction support for the construction of the residential housing. After applying for a building permit, the construction company should contact the CEPOH and provide them with detailed maps of the construction area prior to construction operations. The maps of the construction area should consist of the known construction footprints and all intrusive work to be done on the site. The CEPOH will determine if construction support is necessary for that particular project and if necessary, would determine the level of support to be provided. For example, CEPOH may arrange for UXO safety support for the construction company during their operations. The UXO safety support could consist of UXO-qualified personnel who can meet with on-site management and

construction personnel and conduct a work and safety briefing before any construction activities begin (discussed in Section 7.1.2.4). They may monitor the contractor's subsurface activities (i.e., foundation-digging, fence erecting). If ordnance is found, the UXO support would determine the appropriate method of disposal.

6.0 IDENTIFICATION OF RESPONSE ACTION OBJECTIVES

6.0.1 An EE/CA is a non time-critical decision process by which the most applicable, technically feasible, and socially acceptable alternatives for remediating a site are evaluated for their effectiveness, implementability, and cost.

6.0.2 Removal of all OE is not feasible, given technical limitations and cost considerations. In addition, permanent exclusion of the public from areas that have the potential to contain OE is not practicable, given private land ownership, future land use, and the potential for inadvertent entry onto the Makawao Gunnery Site and Opana Point Bombing Range. The purpose of the EE/CA is to evaluate potential ordnance risk and develop alternative plans of action.

6.0.3 This chapter addresses the response-action objectives involved with the Makawao Gunnery Site and Opana Point Bombing Range in terms of detection, recovery, and disposal.

6.1 IDENTIFICATION OF RESPONSE ACTION TECHNOLOGIES

Potential technologies for the detection, recovery, and disposal of OE at the Makawao Gunnery Site and Opana Point Bombing Range are identified in the following sections. A UXO Supervisor should be involved with each of the activities described.

6.1.1 Detection

Several geophysical instruments and methods are available and are commonly used to detect buried ordnance. These instruments and methods are generally classified based on their detection methodology (i.e., physical, electrical, or chemical). Detection methodologies for buried ordnance include ground penetrating radar (GPR), electromagnetic induction, magnetometry, and chemical sniffing. The Geonics EM-61 MK II electromagnetic induction sensor and Fisher 1266XB EM detector were selected for the OE investigation at the Makawao Gunnery Site and Opana Point Bombing Range. Selection of these instruments was based upon direct, relevant experience on similar OE detection, location, the GPO, and characterization operations.

6.1.2 Recovery

During the OE investigation, anomaly targets were relocated using RTK GPS technology. OE items recovered from the investigation area were then excavated manually using shovels and trowels, if possible, and identified for the appropriate disposal method. For any future OE operations, qualified UXO personnel will perform all intrusive activities and handle OE material.

6.1.3 Disposal

Once OE is recovered and identified, it can be disposed of using conventional explosives in-situ (i.e., blow-in-place) or turned over to a recycler such as the Maui Scrap Metal Company and documented on a DD Form 1348-1, as discussed in Section 3.0.

6.1.3.1 Blow-in-Place

In-situ detonation is the destruction of OE prior to removal from the ground. The item is located, identified, and detonated in place. This is necessary when the item in question is deemed unsafe to remove from the original location. All other on-site detonation requires that the item be

removed from the original location and relocated at a predetermined and approved on-site disposal area for detonation.

6.2 ANALYSIS OF ALTERNATIVES

This section provides an analysis of risk-reduction alternatives for areas potentially containing ordnance and explosives. Effectiveness, implementation capability, and cost represent the primary criteria the analysis considers for each alternative. Each criterion is further divided into specific factors for a complete analysis of the alternatives, as discussed in the following paragraphs.

6.2.1 Effectiveness

This criterion refers to the ability of an alternative to reduce risk to the public and the environment. The following factors are considered during the effectiveness analysis.

6.2.1.1 Overall Protection to Human Health and the Environment

This evaluation criterion assesses the effectiveness of an alternative and its ability to meet the objective within the scope of the proposed alternative. It is discussed in terms of protectiveness of public health and the environment. Based on the OERIA presented in Chapter 4, which determined that each of these sites has a high overall hazard level based on the types of OE recovered during the investigation and the type of human activity conducted at each site, effectiveness to protect the public is a key factor when considering an alternative.

6.2.1.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

6.2.1.2.1 This evaluation criterion serves as a final check to assess whether an alternative meets all the potential federal and state ARARs. ARARs are "those cleanup standards, standards of control and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site" as defined in 40 CFR 300.5.

6.2.1.2.2 Selection of an ARAR is dependent upon the hazardous substances present at the site, site characteristics and location, and action selected for remediation. Chemical-specific ARARs are health- or risk-based concentration limits for specific hazardous substances. Location-specific ARARs address circumstances such as the presence of endangered species on the site or location of the site relative to a 100-year floodplain. Action-specific ARARs control or restrict specific types of actions selected as alternatives for site cleanup.

6.2.1.2.3 No chemical-specific ARARs exist for remediation of sites containing ordnance and explosives.

6.2.1.3 Long-Term Effectiveness

This evaluation criterion addresses the effectiveness of an alternative in terms of the risk remaining at the site after the risk-reduction objectives have been met. The magnitude of risk remaining due to untreated waste or treatment residuals following the completion of the alternative and the adequacy and reliability of the controls that are used to manage untreated wastes or residuals remaining at the site are considered for each alternative.

6.2.1.4 Short-Term Effectiveness

This evaluation criterion addresses the effects of the risk-reduction alternative during implementation, with respect to the effects on human health and the environment following implementation. The potential risk to the community and site visitors, the potential risk to workers implementing the risk-reduction alternatives, the potential for adverse impacts to the environment, and the time required to meet risk-reduction alternatives are addressed, as appropriate, for each alternative.

6.2.2 Implementability

This criterion refers to the technical and administrative feasibility of implementing the alternative and the availability of materials and services required for implementation. Stakeholder acceptance must be considered during the implementation analysis.

6.2.2.1 Technical Feasibility

The ability to implement the alternative, the reliability or ability of a technology to meet specified performance goals, the ability to undertake possible future risk-reduction actions and the ability to monitor the effectiveness of the alternative should be considered relative to the practicality of completing the alternative considering physical constraints and the previous use of established technologies.

6.2.2.2 Administrative Feasibility

This factor evaluates the activities required to coordinate with multiple offices and agencies (e.g., obtaining permits for off-site activities, right-of-way or alignment agreements, compliance with statutory limits) and private property owners.

6.2.2.3 Availability of Services and Materials

This factor evaluates the availability of technologies (materials and services) required to implement the alternative. The availability and capacity of off-site treatment, storage and disposal, the availability of personnel and technology to implement the alternative, the availability of prospective technologies and the availability of services and materials should be considered.

6.2.2.4 Stakeholder Acceptance

This factor evaluates the concerns and issues that the US Environmental Protection Agency, local government agencies, and the public may have regarding the alternative. Regulatory and community acceptance will be a factor in the final selection of the alternative(s) presented in the Action Memorandum.

6.2.3 Cost

The cost analysis includes estimated direct and indirect costs. Estimated costs for each alternative are provided in Section 8.0 with each alternative analysis for comparison purposes only. Additional information on the cost estimates is provided in Appendix D. The purpose of the cost analysis is to assist in determining cost-effective response alternatives.

7.0 IDENTIFICATION AND EVALUATION OF RESPONSE ACTION ALTERNATIVES

7.1 IDENTIFICATION OF RESPONSE ACTION ALTERNATIVES

7.1.1 The four OE response action alternatives identified and evaluated in this EE/CA report were developed to reduce public interaction with OE. These alternatives were selected because they generally provide discernible variability in their potential effectiveness, implementability, and cost. The alternatives are:

Alternative 1: NDAI;
Alternative 2: Institutional Controls;
Alternative 3: Surface Clearance; and
Alternative 4: Clearance to Depth.

7.1.2 Implementation of the NDAI alternative would involve no site-specific work. Implementation of Institutional Controls focuses on separating the public from OE and educating the public to recognize the hazards associated with OE. OE clearance alternatives include implementation of technologies for efforts associated with removal of OE from the surface and subsurface (i.e., Surface Clearance and Clearance to Depth). A combination of institutional controls and surface/subsurface clearance can also be implemented at the sites based upon the presence of UXO and the current and future land use.

7.1.3 Alternative 1: NDAI

The NDAI alternative is included to provide a baseline comparison with other risk reduction alternatives. No technology is associated with this alternative. No risk reduction measure resulting in the treatment, containment, removal of or limited exposure to OE will be implemented. Therefore, potential OE will not be removed and no restriction will be placed on access to the site. The NDAI alternative is appropriate for sites where no OE has been found, where there is no documented evidence of OE usage, or where the nature and extent of the OE occurrence poses minimal threat to those who may encounter it.

7.1.4 Alternative 2: Institutional Controls

7.1.4.1 Institutional controls utilize education and land-use restrictions to minimize exposure of site visitors to OE. Institutional controls rely on behavior modification and site access control strategies to eliminate or minimize risk. Institutional control strategies, including education and/or physical site access controls, are appropriate where risk to the public has been documented as low and can be managed without the removal of OE. With the exception of digging for signpost installation, no intrusive activity is associated with this alternative. Such controls can be implemented with low capital cost and low subsequent annual operating costs. The ultimate effectiveness of institutional controls depends entirely on local agencies and private landowner support, involvement, and willingness to enforce and maintain institutional controls implemented to eliminate public interaction with OE.

7.1.4.2 An Institutional Analysis (Chapter 5.0) was performed to identify local agencies and private landowners to determine how institutional controls could be implemented at the Makawao Gunnery Site and Opana Point Bombing Range. The analysis identified which of the described institutional controls were applicable as well as the agencies or entities that would be responsible for implementing, maintaining or enforcing them. Institutional controls may be recommended in conjunction with a surface and/or subsurface clearance, or may be recommended as a stand-alone OE response action. The following paragraphs describe in detail the applicable institutional controls for these sites.

7.1.4.3 Institutional Controls

7.1.4.3.1 Institutional controls are designed to limit public access to a site or limit public exposure to OE that may remain on-site. Institutional controls include a variety of options and are often developed to meet site-specific conditions. Examples of institutional controls that have historically been effective in limiting access and reducing exposure to OE are warning signs, fences, and security patrols.

7.1.4.3.2 Institutional controls protect against inadvertent access or exposure to the hazards associated with a site. Once they are in place they do not require human interaction to maintain effectiveness, other than routine inspection and maintenance. Institutional controls provide a restraint to those who potentially may come into contact with OE by either limiting access or providing a description of the nature of the hazards at a site.

7.1.4.3.3 Fences and Barricades

7.1.4.3.3.1 Fences are commonly used to restrict public access to a site that poses a threat to human safety. Fences physically restrict access to a site and vary in effectiveness based upon the type of the fence installed. Fences are considered for use in areas where OE is present and where public access would likely result in potential exposures. At sites where the risk of OE exposure is low, fencing may not be necessary. Fences would not be appropriate as a permanent method of exposure prevention because they require continual maintenance and repair. A barbed-wire fence affixed with warning signs is considered an effective temporary measure to restrict access to OE sites. This type of fence would prevent individuals from inadvertently accessing an OE site.

7.1.4.3.3.2 Barricades are effective in closing roads or trails that access OE sites. Forms of barricades include rock or timber barriers. As with fences, barricades are generally more effective when combined with warning signs.

7.1.4.3.4 Warning Signs

Warning signs provide notice and information regarding the OE hazard present at a site. They can be installed at major access points and along perimeter fencing if fencing exists. Given the potential for public access to an area containing OE, warning signs communicating a hazard to the public are useful and have been proven effective at similar sites. The posted warning signs can inform the public of potential safety hazards and communicate the following information:

- Nature of the OE hazard at the site;
- Why a safety hazard exists in the context of the history of the military installation or training area;
- How to avoid encountering an OE item; and
- What to do and whom to contact if an OE item is encountered.

7.1.4.4 Educational Programs

7.1.4.4.1 The use of educational programs is an effective means to reduce risk from public exposure to OE. Education can be tailored to meet site-specific needs. Examples of educational programs include public notices and formal education sessions.

7.1.4.4.2 Educating the local community is an important aspect of any institutional control program. Public awareness of the hazards associated with a site will encourage the public to take the necessary precautions to avoid exposure. Educational programs may be audience specific and can be performed as often as necessary to educate those with the greatest risk for exposure to OE (*e.g.*, local homeowners, farmers, children, and developers). Educational efforts can be a stand-alone institutional control, but it can also improve the effectiveness of other controls.

7.1.4.4.3 Public Notices

The local community can be educated through implementation of a public-notice campaign that may include mailings of informational pamphlets, installation of display cases, public service announcements, or recurrent notices in local newspapers. These educational media can serve to educate the local community and visitors to the area. A method that can been used at sites with a high public turnover rate is to notify any new residents to the area once they have contacted the local utility to start a new service. Once the utility company has received the request for the new service, they can provide (in their initial mailing to new customers) a brochure outlining the site-specific hazards and what should be done in the event of an emergency. The following paragraphs provide details concerning various types of public notices that can be used to educate and inform local communities.

7.1.4.4.3.1 Real Estate Environmental Notices

The State of Hawaii requires real estate disclosure statements on residential real property proposed for transfer. The requirement calls for disclosure of matters relating to the physical condition of the property to be transferred, including the presence of hazardous materials or substances.

7.1.4.4.3.2 Community Awareness Meetings

Community awareness meetings are normally held when significant site remediation documents are released to the public and provide information regarding:

- How this information was evaluated in the EE/CA report;
- OE previously recovered at the site;
- Options available to remove ordnance (if required) and enhance public safety; and
- Recommendations being made to address a particular site.

7.1.4.4.3.3 Letter Notifications, Informational Pamphlets, and Fact Sheets

7.1.4.4.3.3.1 Letter notifications (US certified mail) are an effective means of informing local property owners of the results of the EE/CA investigation and the types of ordnance that have been found. Letter notifications can be mailed to each landowner within or adjacent to an OE site to inform them of the EE/CA investigation results and the proposed recommendations for the area.

7.1.4.4.3.3.2 Informational pamphlets and fact sheets can be developed and distributed to support safety briefings and/or speaking engagements and can be effective as stand-alone educational materials. Informational pamphlets and fact sheets can warn the public of the hazards of OE and provide information relating to the former military operations that occurred at a site. Informational pamphlets and fact sheets can be mailed to residents in the vicinity of an OE site or they can be distributed from central locations such as libraries, or posted at strategic locations (*e.g.*, US Post Office). Effective pamphlets or fact sheets contain photographs and/or drawings of typical ordnance items that the public might encounter and previously recovered OE locations on a map. A telephone number for the appropriate local authority should be included in the informational pamphlet or fact sheet.

7.1.4.4.3.4 World Wide Web

Web sites are a proven means for disseminating public information. A web site allows the reader opportunity to review in-depth materials, and can provide links to additional web sites to help the reader gain a better understanding OE issues. Web sites are accessible through public Web browsers in local libraries and educational institutions and from the home or workplace. Web sites also allow for posting a large amount of information that can be updated on a regular basis.

7.1.4.4.4 Formal Education Sessions

Formal education sessions may include community education classes. The classes can be given to a variety of audiences including public forums, local government, emergency response personnel, property owners, developers and real estate agents, and children at the local schools. The training sessions can be tailored to meet the specific interests/concerns of the audience, and can be an effective method to communicate the nature and extent of the hazards associated with OE and the precautions to be taken in the event a person comes into contact with OE. The training sessions may either be provided live by personnel knowledgeable in the site-specific conditions or through the distribution of OE safety awareness training pamphlets or videos to local organizations and public libraries. To be effective, educational sessions need to be recurrent (*e.g.*, every six months) so the public does not become complacent about the hazards associated with OE. Formal education sessions that are consistently performed are also successful in educating new homeowners and visitors to the area.

7.1.4.5 Legal Mechanisms

7.1.4.5.1 Specific legal approaches including restrictive covenants, zoning, permitting, and sitting restrictions have been used for many purposes other than limiting exposure to environmental risks such as OE. Legal mechanisms are particularly effective types of institutional controls because:

- They do not require the maintenance necessary for other types of institutional controls, such as engineering controls; and
- Title recording systems, local planning commissions, and other administrative systems and associated staff already exist in most jurisdictions and can be used to implement a legal mechanism.

7.1.4.5.2 Legal mechanisms require continuous oversight and support to remain effective. Administrative programs capable of implementing and enforcing legal mechanisms are already in place; however, they are sometimes not effective in protecting against inappropriate land use and should be used in conjunction with other programs. Legal mechanisms are categorized into two broad areas: proprietary controls and local government controls.

7.1.4.5.3 Proprietary Controls

Proprietary controls are those institutional controls that are associated with ownership of the land and are, therefore, often included in the deed for the land.

7.1.4.5.4 Local Government Controls

Local government controls provide potential avenues for implementation of institutional controls at sites that are contaminated with OE. Potential controls on land use that local governments have the power to impose and enforce include zoning restrictions and permitting programs.

7.1.4.5.4.1 Permitting Programs

Permitting programs are another means that local governments have to limit land use. In establishing a permit program, the permitting agency determines specific conditions that must be met before a certain use or action is allowed on a property. Existing permit programs include building permits, water/sewer connection permits, and state well drilling permitting systems that have been developed to protect the quality and use of groundwater. Permit programs have also been developed to help ensure that site developers are aware of and comply with special procedures that are required in the development of a parcel (*e.g.,* requiring a builder to replace the existing soil on a parcel because of its poor structural characteristics). Historically, permit programs have been developed in areas where special requirements are necessary to protect human safety and the environment because of residual contamination that remains on a property. For example, a permit program can be established for the Former Opana Point Bombing Range that would require a developer or builder to contact the CEPOH, to provide construction support by clearing the construction footprint of an area (if necessary) prior to excavation for footings or foundations. Construction support would likely require anomaly detection and excavation similar to that of a Clearance to Depth that is discussed later in this section.

7.1.4.6 Construction Support

7.1.4.6.1 Construction support may include a Clearance to Depth of limited footprints in areas where construction would occur. Construction support of this type is an option in areas that have not been recommended for a subsurface clearance. These are areas where there is a very low probability of subsurface ordnance being present. Other UXO support during construction activities may include the following:

- UXO safety support; or
- A complete subsurface clearance response

7.1.4.6.2 If the probability of encountering OE is low, only UXO safety support may be required. Once a determination is made by CEPOH that the probability of encountering OE is moderate to high, UXO-qualified personnel may conduct a Clearance to Depth of the known construction footprint and remove all discovered OE. The level of effort for construction support is both site-specific and task-specific and should be determined on a case-by-case basis.

7.1.4.6.3 Construction support could be implemented at the time of construction. It should be noted that construction support may be initiated if the following two conditions exist:

- The area identified for construction will be excavated deeper than that anticipated for the land use; and
- OE is suspected in the area of anticipated ground disturbance associated with construction.

7.1.4.6.4 UXO Safety Support

Qualified UXO personnel may provide safety support during construction activities in areas potentially contaminated with OE. They would review any archival information available regarding the area of the proposed construction activities. If possible, they should determine the probable types of OE at the site and the specific safety considerations. UXO personnel should meet with on-site management and construction personnel and conduct a safety briefing prior to any on-site activities, and monitor all excavation activities. If the construction contractor encounters suspect OE, all excavation activities will cease. UXO personnel will assess the condition of the OE item and determine the appropriate disposal method.

7.1.5 Alternative 3: Surface Clearance

7.1.5.1 This OE response action alternative includes the location and removal of ordnance from the ground surface. For surface clearance, teams of UXO-qualified personnel use visual identification, aided by hand-held metal detectors, to search for ordnance. The surface clearance would be conducted by establishing a system of grids within a series of sweep lanes. These lanes are typically 5 feet in width, depending on the geophysical instrumentation used.

7.1.5.2 UXO recovered during the surface clearance would be detonated in place if not safe to move to an on-site area specifically designated for destruction of recovered UXO items. Surface clearance and detonation of UXO would occur within public-safety exclusion zones (which vary in size) depending on the maximum fragmentation range of the item requiring disposal by detonation. OE-related scrap would be removed and turned in to a scrap-metal recycler.

7.1.5.3 An estimated cost[2] to perform a Surface Clearance of OE at the Makawao Gunnery Site and Opana Point Bombing Range is provided in Appendix D. Institutional Controls are included with Surface Clearance at both sites.

[2] Estimated cost is for comparison purposes in evaluating response actions and is not considered a Government estimate to carry out the response action.

7.1.6 Alternative 4: Clearance to Depth

7.1.6.1 This OE response action alternative includes the subsurface excavation and clearance of all detected ordnance items using geophysical instrumentation within a specified OE site. Risk reduction benefits and costs increase as the depth of clearance increases. Clearance to Depth removes detectable hazards and provides effective risk reduction for areas subject to both surface and limited intrusive activities (e.g., recreational activities and fence post installation). Clearance to Depth would require teams of UXO-qualified personnel to excavate all detected subsurface anomaly sources that are deemed to potentially be ordnance, based on geophysical characteristics, and to dispose of all OE items discovered. Geophysical methods would be used to map and identify anomalies in the proposed clearance areas. The geophysical methods that would be used to detect subsurface ordnance for a clearance action would be very similar to those employed for the EE/CA field investigation. The subsurface source locations of anomalies identified through processing of the geophysical data would be re-located and marked with pin flags. UXO-qualified personnel would intrusively investigate the marked locations to identify the source of the anomalies. Depending on the expected OE density on the surface, a surface clearance may be necessary prior to geophysical mapping and subsequent removal of detectable ordnance. UXO recovered during the intrusive investigation would be detonated in place after establishment of a public-safety exclusion zone sized to provide a safe fragmentation distance from the item being detonated.

7.1.6.2 Clearance to Depth does not address unlimited intrusive activities because detection, mapping, and clearance of OE based on aboveground-deployed detection methods cannot be 100 percent effective. Intrusive activities requiring excavations below the level of OE clearance in known OE areas should be evaluated and, if necessary, performed only in conjunction with construction support as discussed above.

7.1.6.3 An estimated cost[3] to perform a Clearance to Depth at the Makawao Gunnery Site and Opana Point Bombing Range is provided in Appendix D. Institutional controls are included for the Makawao Gunnery Site.

7.2 OE RESPONSE ACTION ALTERNATIVE EVALUATION CRITERIA

This section describes the evaluation criteria and process used to determine the most appropriate OE response actions for the Makawao Gunnery Site and Opana Point Bombing Range. The results of the qualitative risk analysis in Chapter 4.0 are used as a basis for the evaluation of the four OE response-action alternatives in Chapter 8.0. The evaluation and determination of the most appropriate OE response action alternative for each site is used to form the basis for the specific recommendations made for the Makawao Gunnery Site and Opana Point Bombing Range (Chapter 9.0).

7.2.1 For the OERIA evaluation for each site, OE response-action alternatives are evaluated in terms of their effectiveness, implementability, and cost. The purpose of this evaluation is to identify the most appropriate OE response action alternatives to render each site compatible with its current and projected future land use. For effectiveness, the ranking considers protection of

[3] Estimated cost is for comparison purposes in evaluating response actions and is not considered a Government estimate to carry out the response action.

human safety, compliance with ARARs, and long- and short-term effectiveness. For implementability, the alternatives are ranked by technical and administrative feasibility, agency and community acceptance, and availability of services and materials. Cost considerations are made using detailed costing assumptions and costing backup (Appendix D). The exception is the NDAI alternative, which has no associated cost.

7.2.2 Effectiveness

Effectiveness is a measure of an alternative's ability to reduce the potential for exposure to OE, thereby protecting public safety. Effectiveness is also evaluated in terms of long and short-term practicality.

7.2.2.1 Protection of Human Safety

7.2.2.1.1 This factor is a measure of how well an alternative reduces the public's potential exposure to OE, thereby reducing the possible injury or death, and how well the alternative protects the environment. As such, it considers the following:

- The net reduction in OE;
- The estimated quantity of OE remaining;
- The expected depth of potential remaining OE;
- The potential exposure pathway between humans (considering future land use) and OE; and
- The potential for an individual to encounter OE.

7.2.2.1.2 Effectiveness rankings are based mainly upon whether OE was recovered during the EE/CA field investigation (or during previous investigations) and the probability of exposure to OE based on population data and current and future land uses. For Institutional Controls (Alternative 2), it is difficult to account for the benefit in reduction of exposure as a result of display board placement, community awareness outreach programs, or educational media. In concept, the effectiveness of Institutional Controls in protecting human safety would be greater than NDAI (Alternative 1), but less than Surface Clearance (Alternative 3) or Clearance to Depth (Alternative 4).

7.2.2.2 Consistent with ARARs

7.2.2.2.1 This factor measures how well the alternative meets the identified chemical, action, and location-specific ARARs (Federal, state, and local). Currently, no chemical-specific ARARs exist for ordnance sites.

7.2.2.2.2 Recommended OE response actions will be conducted in accordance with appropriate regulations. An analysis of the ARARs for the Makawao Gunnery Site and Opana Point Bombing Range is presented in Section 7.3.

7.2.2.3 Long-Term Effectiveness

This factor measures how well the OE response action alternative protects human safety once it has been implemented. The remaining potential for exposure to OE is characterized by the following factors:

- The magnitude of potential exposures following implementation of the alternative;
- The permanence of the exposure reduction due to implementation of the alternative; and
- The reliability of the controls and maintenance measures in managing residual OE following implementation of the alternative.

7.2.2.4 Short-Term Effectiveness

This factor measures how well the alternative meets the exposure reduction objectives during its implementation, such as:

- The ability of the alternative to reduce risk during implementation;
- The potential for adverse effects on the environment during implementation;
- The time required to implement the alternative; and
- The potential for adverse effects on humans, including the community and personnel involved in implementation.

7.2.3 Implementability

Implementability is a measure of whether an OE response action alternative can be physically and administratively implemented. It is also a measure of the availability of the services and materials needed to implement the alternative. Other considerations regarding implementability include landowner, local agency and community acceptance of the alternative.

7.2.3.1 Technical Feasibility

This factor refers to:

- The reliability of the action with regard to implementation;
- The actual ease of field implementation (*e.g.,* construction, clearance action);
- The ease in undertaking future actions related to the initial undertaking; and
- The ability to monitor the effectiveness of the action.

7.2.3.2 Administrative Feasibility

This factor measures the ease with which an alternative can be implemented in terms of permits and rights-of-entry, coordination of services to support the action, or the procurement of services.

7.2.3.3 Availability of Services and Materials

This factor measures the availability of goods and services needed to support implementation of the alternative. Examples include the availability of specialized personnel, equipment, and explosives for removal and demolition purposes, and the availability of a suitable disposal facility for the ordnance scrap. It also includes the condition of the existing infrastructure to allow ingress and egress of personnel and material to and from the project site.

7.2.3.4 Local Agency Acceptance

What is the level of acceptance of the alternative by applicable state, county, and city agencies? Rankings of alternatives under this criterion are marked under the "Agency Acceptance" column

in the tables provided in Chapter 8.0 showing rankings of implementability. Local agency acceptance has been established based on information gathered during interaction with local agencies to date, and may be updated at any time during the EE/CA review process.

7.2.3.5 Community Acceptance

This criterion relates to the degree of acceptance of the alternative by the community, including owners of the subject properties as well as owners of property adjacent to the Former Makawao Gunnery Site and Opana Point Bombing Range. Public sentiment expressed during public workshops or meetings or institutional analysis is a means of determining community acceptance. Alternatives under this criterion are marked under the "Community Acceptance" column in the tables in Chapter 8.0 showing rankings of implementability. Community acceptance has been established based on information gathered during meetings with the landowners prior to and during the EE/CA study and interviews conducted during the institutional analysis, and may be updated at any time during the EE/CA review process.

7.2.4 Cost

7.2.4.1 Estimated cost of implementing each of the OE response action alternatives has been estimated for comparison purposes and is not considered a government estimate. The exception is NDAI, which has no associated cost. A detailed summary of these costs and costing assumptions is presented in Appendix D. For Institutional Controls (Alternative 2), the costs include those associated with access controls (*e.g.*, warning signs), community awareness outreach programs (*e.g.*, periodic community awareness meetings, informational pamphlets, and permit programs to facilitate construction support), construction support, and associated administration and maintenance. For Surface Clearance (Alternative 3) and Clearance to Depth (Alternative 4), the costs are one-time capital costs and do not include monitoring for sensitive species or habitat restoration.

7.2.4.2 Examples of capital costs include those incurred by the UXO-qualified contractor for conducting the field activities (*i.e.*, surface clearance, geophysical mapping, intrusive OE sampling, and demolition activities) associated with implementing a subsurface clearance. Examples of operation and maintenance costs would include repairing and replacing perimeter signs and educational display boards over a specified length of time.

7.2.4.3 The benefit of the investment in reducing risk is also considered when ranking the OE response-action alternatives. This involves identifying the overall reduction in risk to the public versus the cost of implementing the alternative. For example, if two alternatives provide an equal or comparable amount of protection, the less expensive alternative would provide the greater benefit relative to cost and, therefore, would be ranked as the better alternative in terms of cost benefit.

7.2.5 Example of Alternative Evaluation Process

7.2.5.1 Table 7-1 provides an example evaluation of the four OE response action alternatives, as presented in Chapter 8.0. Each alternative is ranked according to the factors presented in Sections 7.2.2, 7.2.3, and 7.2.4. The alternative that is determined to be the best alternative when assessed with the criteria receives a numerical ranking of 1, the second best a numerical ranking of 2, and so forth. Once the numerical ranking has been determined for the three criteria

(effectiveness, implementability, and cost) for each of the alternatives, the overall score is determined by adding up the individual numerical rankings for each alternative. For example, NDAI received a ranking of "4" for effectiveness, a ranking of "1" for implementability, and a ranking of "3 " for cost producing a final score of "8." This is continued for each of the four alternatives until all of the individual rankings have been added up and the totals have been placed into the column marked "Overall Score."

TABLE 7-1 EXAMPLE OF ALTERNATIVE EVALUATION PROCESS

Alternative	Effectiveness Rank	Implementability Rank	Cost Rank	Overall Score	Overall Rank
1. NDAI	4	1	3	8	3
2. Institutional Controls	3	2	1	6	1
3. Surface Clearance	2	3	2	7	2
4. Clearance to Depth	1	4	4	9	4

Note:
Ranking from most to least; best = 1

7.2.5.2 Using the overall score, an overall ranking of the four alternatives is determined. The alternative with the lowest score is ranked 1 (most effective), the alternative with the second lowest score is ranked 2, and the alternative with the highest score is ranked 4 (least effective). As shown in Table 7-1, Institutional Controls (Alternative 2) ranked as the best alternative (ranked 1) in this example/hypothetical evaluation based on its effectiveness, implementability, and cost.

7.2.5.3 Using this comparative evaluation and ranking process, an analysis of the four OE response action alternatives was performed for the Makawao Gunnery Site and Opana Point Bombing Range (Chapter 8.0).

7.3 ASSESSMENT OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

7.3.1 Section 121 of CERCLA requires that site cleanups comply with federal ARARs, or state ARARs in cases where these requirements are more stringent than Federal requirements. Under CERCLA Section 121(d)(2), the Federal ARARs for remedial action could include requirements under any of the federal environmental laws such as the Clean Water Act, Clean Air Act, etc.

7.3.2 State ARARs include promulgated requirements under state environmental or facility siting laws that are more stringent than federal ARARs. A requirement may be either "applicable" or "relevant and appropriate."

7.3.3 Applicable requirements are defined as those cleanup standards or other environmental protection requirements promulgated under federal or state laws. Applicable requirements are identified on a site-specific basis by determination of whether the jurisdictional prerequisites of a requirement fully address the circumstances at the site or the proposed response alternative. All pertinent jurisdictional prerequisites must be met for the requirement to be applicable. These jurisdictional prerequisites are as follows:

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

7.3.4 If not applicable, a requirement may be relevant and appropriate if circumstances at the site are sufficiently similar to the problems or situations regulated by the requirement. "Relevant and appropriate" refers to those clean-up standards, or other environmental protection requirements, promulgated under Federal or state law, that, while not necessarily applicable, address problems or situations sufficiently similar to those at the site, and whose use is appropriate. The relevance and appropriateness of a requirement can be judged by comparing a number of factors including the characteristics of the response action, the contaminants in question, or the physical circumstances of the site, with those addressed in the requirement. If there is sufficient similarity between the requirements and the site, the requirement is determined to be relevant and appropriate.

7.3.5 Determining whether a requirement is both relevant and appropriate is a two-step process. To determine relevance, a comparison must be made between the response action, location, or contaminant covered by the requirement and conditions at the site, or response action. A requirement is relevant if it pertains to these conditions. Second, to determine whether the requirement is appropriate, the comparison is further refined by focusing on the nature of the items, the characteristics of the site, and the proposed response action. The requirement is appropriate if, based on such a comparison, its use is compatible to the particular site.

7.3.6 There are certain circumstances under which ARARs may be waived. CERCLA Section 121(d) allows the selection of alternatives that will not attain ARAR status if any of six conditions for a waiver of ARARs exists. However, the selected alternative must be protective even if an ARAR is waived. Only five of the conditions for a waiver may apply to a DOD site. The conditions for a waiver are as follows:

- The clearance action selected is only part of a total response action that will attain such level or standard of control when completed;
- Compliance with such a requirement at a particular site will result in greater risk to human safety and the environment than alternative options;
- Compliance is technically impracticable from an engineering perspective;
- The clearance action selected will result in a standard of performance that is equivalent to an applicable requirement through the use of another method or approach;
- A state requirement has not been equitably applied in similar circumstances on other clearance actions within the state; and
- A fund-financed clearance action does not provide a balance between available monies and the need for protection of public safety and the environment at sites where the need is more immediate (not applicable to DOD sites).

7.3.7 ARARs that govern actions at CERCLA sites fall into three categories based upon the contaminants present, site characteristics, and alternatives proposed for cleanup. These three categories are described in the following subsections.

7.3.8 Chemical-Specific ARARs

Chemical-specific ARARs include those environmental laws and regulations that regulate the release to the environment of materials with certain chemical or physical characteristics or that contain specified chemical compounds. No chemical-specific ARAR is associated with OE.

7.3.9 Location-Specific ARARs

Location-specific ARARs govern activities in certain environmentally sensitive areas. These requirements are triggered by the particular location such as sensitive ecosystems or habitats. Location-specific ARARs also focus on wetland or floodplain protection areas, or on archaeologically significant areas.

7.3.10 Action-Specific ARARs

7.3.10.1 Action-specific ARARs are restrictions that define acceptable treatment and disposal procedures for hazardous substances. These ARARs generally set performance, design, or other similar action-specific controls or restrictions on particular kinds of activities. An example might be a state Air Quality Management Authority that sets limitations on fugitive dust generated during grading and excavation activities during a clearance action.

7.3.11 Potential ARARs

In determining whether a requirement was pertinent to future OE response actions (*i.e.*, Surface Clearance, Clearance to Depth), potential ARARs were initially screened for applicability. If determined not to be applicable, the requirement was then reviewed for both relevance and appropriateness. Requirements that are considered relevant and appropriate command the same importance as applicable requirements. Potential Federal and state ARARs determined to be specific to the Makawao Gunnery Site and Opana Point Bombing Range are listed in Table 7-2.

TABLE 7-2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

Requirement	Citation	Description	Type	Comments
Federal				
RCRA Subpart M (Military Munitions Rule)	40 CFR 266	Identifies when military munitions become a solid waste, and, if these wastes are hazardous, the management standards that apply.	Contaminant specific	Recovery, collection, and on-range destruction of UXO and munition fragments are not subject to hazardous waste regulations or permits. OE discovered in burial pits or trenches could be considered solid waste in accordance with the rule. However, this requirement is not applicable until the state implements the Federal Military Munitions Rule as a state-implemented Federal requirement.
RCRA	40 CFR 261.23	Identifies characteristics of reactivity including explosives.	Contaminant specific	Solid waste that meets the characteristics of reactivity will be treated as hazardous.
RCRA, Identification and Listing of Hazardous Wastes	40 CFR 261.3	Requires waste be analyzed to determine if it represents RCRA hazardous waste based on established lists and hazardous characteristics.	Action specific	If hazardous constituents are suspected, an analysis of excavated soils may be required to determine if they are classified as a RCRA hazardous waste.
Endangered Species Act	16 USC 1533	Prohibits federal actions from modifying critical habitats or jeopardizing the continued existence of protected endangered or threatened species.	Location specific	Prior to and throughout the field activities, all steps necessary will be conducted to minimize the impacts to listed plant and animal species and their habitats. All on-site employees will undergo a briefing regarding the species present and measures for precluding impacts to those species and their habitat.
Archaeological Resources Protection Act (ARPA)	16 USC 470	Prohibits unauthorized excavation of and sets standards for protection of archaeological resources. Prohibits disclosure of archaeological resources by Federal agencies.	Location specific	If any sites are uncovered or affected by the fieldwork, proper procedures must be in place under the ARPA to evaluate and protect cultural resources.
National Historic Preservation Act (NHPA)		Requires action to be taken to locate, identify, evaluate, and protect cultural resources.	Location specific	If additional properties are uncovered or existing sites are affected by intrusive OE sampling, conditions of the NHPA must be followed.

Requirement	Citation	Description	Type	Comments
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	42 USC 9601 - 11,050	Legislation that finances remediation and creates a national policy to identify and clean up sites contaminated by the release of hazardous substances.	Action specific	Provides factors to be considered in determining the appropriate removal action and conducting public affairs. The OE process at FUDS is conducted in accordance with CERCLA.
Occupational Safety and Health Administration (OSHA)	29 CFR 1910.120	Defines the manner in which hazardous waste and emergency response actions must be carried out. Covers emergency response operations for the release of or substantial threat of hazardous substances without regard to the location of the hazard.	Action specific	The possibility of a fire or explosion will exist during intrusive OE sampling activities. All site personnel must be in compliance with 29 CFR 1910.120, requiring workers to be 40-hour health and safety trained with an 8-hour refresher. An annual medical surveillance examination is also required.
Hazard Communication	29 CFR 1910.1200	Specifies hazards associated with all chemicals be evaluated, and information concerning their hazards be transmitted to employees.	Action specific	All employees and visitors are made aware of the hazards associated with OE clearance and UXO demolition activities.
Hazardous Substance	49 CFR 172.101	Details DOT classification of hazardous materials.	Action specific	Transportation of explosives to be used in the detonation of UXO as a means of on-site disposal must comply with DOT regulations. UXO-qualified personnel must inspect the loading and unloading of the explosives, and the transport vehicle must be properly maintained and placarded.
National Oil and Hazardous Substances Pollution Contingency Plan (NCP)	40 CFR 300.120(c), 300.400 (e)	Defines format for response from planning to decision making to post-removal monitoring.	Action specific	Permitting is not required for on-site CERCLA response actions.
Transportation	49 CFR 100 - 199	Regulates transport of hazardous substances in Hawaii.	Action specific	Provisions of this code should be followed.

Requirement	Citation	Description	Type	Comments
Federal Transportation Act	49 CFR 172.101	The DOT considers OE "hazardous material" for manifesting purposes under the DOT regulations.	Action specific	Transportation of explosives to be used in the detonation of OE as a means of on-site disposal must comply with DOT regulations. UXO-qualified personnel must inspect the loading of the explosives, and the transport vehicle must be appropriately placarded.
OSHA	29 USC 651 - 678	Regulates worker health and safety.	Action specific	Under 40 CFR 300.38, requirements of the act apply to all response activities under the NCP.
Superfund Amendments and Reauthorization Act (SARA)	Chapter 160	Authorizes the DERP-FUDS that calls for "correction of environmental damage creating an imminent and substantial endangerment to the public health or environment."	Action specific	SARA authorizes the DERP-FUDS program.
State				
Hazardous Waste	Hawaiian Revised Statute (HRS) 342J	Provides classification of hazardous waste. Regulates generators, transporters, and treatment, storage, or disposal facilities.	Contaminant specific	Solid waste that poses a substantial existing or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of or otherwise managed, will be treated as hazardous.
Historic Preservation	HRS 6E	Requires preservation, restoration, and maintenance of historic and cultural property.	Location specific	Activities may occur, possibly affecting historic property, aviation artifacts, or a burial site. Activities within potential areas of historic and cultural resources may require review and comment by the State Historic Preservation Officer (SHPO).
Forest Reservations, Water Development, Zoning	HRS 183C	Regulates land within the state that contains important natural resources essential to the preservation of the state's water supply.	Location specific	Activities may occur that require issuance of site plan approvals.
Transporting of Explosives	HRS 396 - 399	Establishes regulations for the use, storage, and transportation of explosives.	Location specific	Activities may occur requiring the use of explosives for disposal of UXO. These activities will require a certificate of fitness.

Requirement	Citation	Description	Type	Comments
Transportation of Hazardous Materials, Hazardous Waste, and Etiologic Agents	HRS 286-211 to 227	Regulates transport of hazardous substances in Hawaii.	Action specific	Activities may occur that require transportation of hazardous material that meets the Federal and State criteria for a hazardous material. Materials must be handled and transported according to the appropriate requirements of the Federal hazardous materials regulations and additional requirements of this regulation.

8.0 COMPARATIVE ANALYSIS OF OE RESPONSE ACTION ALTERNATIVES

8.0.1 This chapter describes the evaluation process for determining the most appropriate OE response action alternatives for the Makawao Gunnery Site and Opana Point Bombing Range. The evaluation criteria used to assess the alternatives are presented in Chapter 7.0. The results of the qualitative risk assessment in Chapter 4.0 and the comparative analysis of the four OE response action alternatives in this chapter to form the basis for the recommendations made for the Makawao Gunnery Site and Opana Point Bombing Range, which are presented in Chapter 9.0, Recommended OE Response Action Alternatives.

8.0.2 Prior to conducting this comparative analysis of the four OE response action alternatives, the level of hazard that OE presents at each site was determined during the OE Risk Impact Assessment (Chapter 4.0) based on current and future land uses, results of the EE/CA field investigation (Chapter 3.0), and previously documented reports of discovered OE. Using this information, and the three risk factors (OE Factors, Site Characteristics Factors, and Demographic Factors) evaluated in the OE Risk Impact Assessment, the hazard level that OE presents to the public was qualitatively assessed. The OERIA hazard level for each site (Table 8-1) was used in this comparative analysis to help determine the most appropriate OE response action alternatives for the Makawao Gunnery Site and Opana Point Bombing Range.

TABLE 8-1 OERIA EVALUATION SITES AND HAZARD LEVEL RESULTS

OERIA Evaluation Site	OERIA Hazard Level
Makawao Gunnery Site	High
Opana Point Bombing Range	High

8.0.3 This chapter analyzes the effectiveness, implementability, and cost of each OE response action alternative for Makawao Gunnery Site and Opana Point Bombing Range. Effectiveness includes protection of human safety, compliance with ARARs, and both long- and short-term effectiveness. Implementability includes technical and administrative feasibility, availability of services and materials, and both local agency and community acceptance. Local agency and community acceptance of the various alternatives was rated based on meetings with stakeholders and interaction with local agencies and the community to date. Cost includes both the value of the investment and its corresponding benefit.

8.0.4 The two sites were evaluated using this comparative analysis of the four OE response-actions to help identify the best OE response-action alternative(s) to render the areas compatible with the projected future use. Alternatives were ranked in numerical order, with "1" being the best alternative for that criterion. The alternative with the lowest ranking score is considered the best in terms of these evaluation criteria.

8.0.5 Institutional Controls, although evaluated as a separate OE response action alternative in this comparative analysis, may be recommended in conjunction with a surface and/or subsurface clearance or may be recommended as a stand-alone OE response action.

8.1 MAKAWAO GUNNERY SITE

The overall OERIA hazard level in this area is high based on the results of the EE/CA field investigation and evaluation of the three risk factors defined in the qualitative risk assessment (Chapter 4.0). Using this information, the four OE response action alternatives evaluated in this EE/CA report are comparatively analyzed in the following subsections to determine the most appropriate OE response action alternative for the Makawao Gunnery Site.

8.1.1 Effectiveness

The effectiveness criteria evaluation consists of protection of human health, compliance with ARARs, long-term effectiveness, and short-term effectiveness. The evaluation of each alternative based on protection of human safety considers the amount of risk posed to the public. Compliance with ARARs evaluates each alternative in relation to cleanup standards, standards of control and other substantive environmental protection requirements, criteria, or limitations. Long-term and short-term effectiveness of an alternative determines the most effective course of action based on longevity. Table 8-2 provides the effectiveness criteria of the four alternatives for the Makawao Gunnery Site. The evaluation of each of these alternatives is presented below.

TABLE 8-2 EFFECTIVENESS CRITERIA EVALUATION FOR THE MAKAWAO GUNNERY SITE

	Effectiveness					
Alternative	**Protection of Human Health**	**Compliance with ARARs**	**Long-Term**	**Short-Term**	**Score**	**Rank**
1. NDAI*	NA	NA	NA	NA	NA	NA
2. Institutional Controls	3	1	3	1	8	3
3. Surface Clearance	2	1	2	2	7	2
4. Clearance to Depth of Detection	1	1	1	3	6	1

Note: Ranking from most effective to least effective; most effective = 1.
* NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.1.1.1 Protection of Human Safety

NDAI is not considered an acceptable alternative for the Makawao Gunnery Site because it does not meet the minimum threshold criterion for the protection of human safety. Clearance to Depth of Detection is ranked 1 (most effective) for protection of human safety due to the reduction of OE on-site. Surface Clearance is ranked 2 in terms of human safety because of its ability to provide reduction in risk associated with OE on the surface. Institutional Controls is ranked 3 because it does not provide for the removal of OE and is therefore less protective of human safety in a high hazard area where OE items have been found.

8.1.1.2 Compliance with ARARs

Compliance with ARARs has been ranked equally between Alternatives 2 through 4, as compliance with the ARARs is expected with minimal impact on the environment.

8.1.1.3 Long-Term Effectiveness

Clearance to Depth of Detection in an area with a high OERIA hazard level would be the most effective alternative over the long term because it would provide the maximum protection of human safety and support a variety of future land use options. Surface Clearance is ranked 2

(second best) because it would be more effective over the long term than Institutional Controls, but less effective than Clearance to Depth of Detection. Institutional Controls are ranked 3 (last) because it would not be effective over the long term in reducing the risk associated with the high OERIA hazard level at the Makawao site. NDAI is not considered an acceptable alternative due to the high OERIA hazard level associated with the Makawao Gunnery Site.

8.1.1.4 Short-Term Effectiveness

Since the OERIA hazard level of the Makawao Gunnery Site is high, Institutional Controls would be the most effective alternative over the short term because of current land use. The site consists of one land owner and because of site restrictions, Institutuional Controls would be most effective over the short term. Surface Clearance is ranked 2 (second) because it would take less time to implement than a Clearance to Depth of Detection and would reduce the risk associated with surface OE items. Clearance to Depth of Detection is ranked 3 (last) for short-term effectiveness because it would take significantly more time to implement than a Surface Clearance. This is due to the fact that Clearance to Depth of Detection requires geophysical mapping equipment and expertise, as well as excavation equipment for OE removal. NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.1.1.5 Overall Effectiveness Ranking for Alternatives 1 through 4

Clearance to Depth of Detection (Alternative 4) is ranked the most effective OE response action alternative when considering overall effectiveness based upon its ability to reduce the risk associated with the high OERIA hazard level and because it provides the most protection to the public from OE. Because the OERIA hazard level is high and there is OE present on-site, NDAI is not considered an acceptable alternative. Surface Clearance (Alternative 3) is ranked second because it would reduce the risk associated with OE on the surface and reduce the risk associated with the overall OERIA hazard level. Institutional Controls (Alternative 2) is ranked third (last) because the level of protection to the public is less than both alternatives requiring removal of OE.

8.1.2 Implementability

The implementability criteria evaluation consists of technical feasibility, administrative feasibility, services and materials, local agency acceptance, and community acceptance. The evaluation of each alternative based on technical and administrative feasibility considers the extent of logistical and managerial support. Service and materials evaluates each alternative in relation to the extent of personnel and supplies required. Local agency and community acceptance of an alternative is based on interviews with entities affected by activity on-site. Table 8-3 provides the implementability criteria of the four alternatives for the Makawao Gunnery Site. The evaluation of each of these alternatives is presented below.

TABLE 8-3 IMPLEMENTABILITY CRITERIA EVALUATION FOR THE MAKAWAO GUNNERY SITE

ALTERNATIVE	Implementability					Score	Rank
	Technical Feasibility	Administrative Feasibility	Services and Materials	Local Agency Acceptance	Community Acceptance		
1. NDAI*	NA	NA	NA	NA	NA	NA	NA
2. Institutional Controls	3	3	1	3	3	13	3
3. Surface Clearance	1	1	2	2	2	8	1
4. Clearance to Depth of Detection	2	2	3	1	1	9	2

Note: Ranking from most effective to least effective; most effective = 1.
* NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.1.2.1 Technical and Administrative Feasibility

8.1.2.1.2 NDAI is not considered an acceptable alternative due to the overall high hazard level associated with the site. Implementing Institutional Controls would require more logistical and management support than a clearance action because the process must be conducted in close coordination with local agencies, landowners, and the community. Although the supplies and personnel needed to install and maintain warning signs, conduct educational programs, and implement and oversee use restrictions are readily available, the amount of time necessary to maintain a long term Institutional Controls action would be greater than the relatively short amount of time required to implement a clearance action. Therefore, Institutional Controls are ranked 3 (least effective) from a technical and administrative feasibility standpoint.

8.1.2.1.3 Implementation of a Surface Clearance would be the most feasible from a technical and administrative perspective, although the Surface Clearance Alternative requires specially trained and qualified UXO-personnel and a means of OE disposal, this alternative requires less resources than the Clearance to Depth of Detection Alternative. Therefore, Surface Clearance is ranked 1 (best) for technical and administrative feasibility.

8.1.2.1.4 Implementation of the Clearance to Depth of Detection Alternative generally requires less logistical and management support than a long-term Institutional Controls program but requires more than a Surface Clearance. Unlike a Surface Clearance, Clearance to Depth of Detection requires geophysical mapping equipment and expertise, as well as excavation equipment, in addition to specially trained and qualified UXO-personnel and a means of OE disposal, which are required for all clearance actions. Therefore, Clearance to Depth of Detection is ranked 2, as it would take more time and effort to implement than a Surface Clearance.

8.1.2.2 Services and Materials

Institutional Controls is ranked 1 because the supplies and personnel needed to install and maintain warning signs, conduct educational programs, and implement and oversee use restrictions are readily available. Surface Clearance is ranked 2 because it would require qualified UXO-personnel as well as the means of disposing OE. Unlike a Surface Clearance, implementation of the Clearance to Depth of Detection Alternative requires geophysical

mapping equipment and expertise, as well as excavation equipment, in addition to UXO - personnel and a means of OE disposal. Therefore, Clearance to Depth of Detection is ranked 3 for availability of services and materials. NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.1.2.3 Local Agency Acceptance

Based on interaction with agency representatives to date, it has been determined that local agencies are likely to consider the Clearance to Depth of Detection Alternative as the most appropriate and acceptable alternative for the Makawao site based on the high overall hazard level and current and projected site activities. Therefore Clearance to Depth of Detection is ranked 1 and Surface Clearance is ranked 2 based on its ability to reduce the risk associated with OE on the surface. Institutional Controls are ranked 3 for this area, considering the current and projected land use at the Makawao Gunnery Site and the presence of OE.

8.1.2.4 Community Acceptance

Based on interaction with the landowner and tenant during the Technical Project Planning (TPP) process and the EE/CA investigation, they are likely to consider Surface Clearance as an acceptable alternative in this area based on the OERIA hazard level and planned future use, however, they would be more likely to consider Clearance to Depth of Detection as a preferred alternative over Surface Clearance due to the near-surface (2-4 inch bgs) items recovered during the field investigations. Also during discussions of Institutional Controls, the land owner expressed concern about the potential for drawing attention to the site with warning signs and potentially drawing souvenir seekers. They also expressed concern over maintenance and theft of signage. Therefore, Clearance to Depth of Detection is ranked 1 (most effective), Surface Clearance is ranked 2 and Institutional Controls is ranked 3. NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.1.2.5 Overall Implementability Ranking for Alternatives 1 through 4

Based on implementability rankings in areas of technical feasibility, administrative feasibility, services and materials required, local agency acceptance, and community acceptance, Surface Clearance ranked 1 (most effective). Because of the amount of services and materials required, Clearance to Depth of Detection was ranked 2 in terms of implementability. Institutional Controls was ranked 3 and NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.1.3 Cost

The cost criteria evaluation consists of actual cost, investment, and benefit. The cost of each alternative is reflective of the Cost Analysis results (Appendix D). Investment evaluates each alternative in terms of monetary investment required. The benefit of an alternative considers the most effective means of risk reduction for the cost required to perform the action. Table 8-4 provides the cost criteria of the four alternatives for the Makawao Gunnery Site. The evaluation of each of these alternatives is presented below.

TABLE 8-4 COST CRITERIA EVALUATION FOR THE MAKAWAO GUNNERY SITE

ALTERNATIVE	Cost			Score	Rank
	Cost	Investment	Benefit		
1. NDAI*	NA	NA	NA	NA	NA
2. Institutional Controls	$8,501	1	3	4	2
3. Surface Clearance	$223,576	2	1	3	1
4. Clearance to Depth of Detection	$878,992	3	2	5	3

Note: Ranking from most effective to least effective; most effective = 1.
* NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.1.3.1 Investment and Benefit

NDAI is not considered an acceptable alternative due to the high hazard level associated with the site. The cost associated with Institutional Controls is considerably lower than the two clearance options and therefore receives a ranking of 1 in terms of investment and a rank of 3 when considering level of protection produced for the cost. Surface Clearance ranks 2 in investment while producing the most benefit for the investment. When considering the cost to perform a Surface Clearance and the level of protection provided by its implementation compared to the level of protection provided by Institutional Controls and Clearance to Depth of Detection, this alternative is more cost effective than the other two alternatives. The Clearance to Depth of Detection alternative ranks 2 in benefit when considering the current and projected land use of the site.

8.1.3.2 Overall Cost Ranking for Alternatives 1 through 4

Due to the ability to reduce the OE hazard and potential for exposure to OE, the Surface Clearance alternative is ranked as the best OE response alternative in terms of cost for the Makawao Gunnery Site (Table 8-4). Institutional Controls ranked second and the Clearance to Depth of Detection alternative received a rank of 3 in terms of cost. NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.1.4 Overall Ranking of Alternatives

The overall ranking of the different alternatives in terms of their effectiveness, implementability, and cost is presented in Table 8-5. The alternative with the lowest score is considered the best for each criterion (effectiveness, implementability, and cost) evaluated.

TABLE 8-5 ALTERNATIVE EVALUATION FOR THE MAKAWAO GUNNERY SITE

ALTERNATIVE	Alternative			Overall Score	Overall Rank
	Effectiveness Rank	Implementability Rank	Cost Rank		
1. NDAI*	NA	NA	NA	NA	NA
2. Institutional Controls	3	3	2	8	3
3. Surface Clearance	2	1	1	4	1
4. Clearance to Depth of Detection	1	2	3	6	2

Note: Ranking from most effective to least effective; most effective = 1.
* NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.2 OPANA POINT BOMBING RANGE

The overall OERIA hazard level at this site is high based on the results of the EE/CA field investigation and evaluation of the three risk factors defined in the qualitative risk assessment (Chapter 4.0). Using this information, the four OE response-action alternatives evaluated in this EE/CA report are comparatively analyzed in the following subsections to determine the most appropriate OE response action alternative for the Opana Point Bombing Range.

8.2.1 Effectiveness

The effectiveness criteria evaluation consists of protection of human health, compliance with ARARs, long-term effectiveness, and short-term effectiveness. The evaluation of each alternative based on protection of human safety considers the amount of risk posed to the public. Compliance with ARARs evaluates each alternative in relation to cleanup standards, standards of control and other substantive environmental protection requirements, criteria, or limitations. Long-term and short-term effectiveness of an alternative determines the most effective course of action based on longevity. Table 8-6 provides the effectiveness criteria of the four alternatives for the Opana Point Bombing Range. The evaluation of each of these alternatives is presented below.

TABLE 8-6 EFFECTIVENESS CRITERIA EVALUATION FOR THE OPANA POINT BOMBING RANGE

ALTERNATIVE	Effectiveness				Score	Rank
	Protection of Human Health	Compliance with ARARs	Long-Term	Short-Term		
1. NDAI[a]	NA	NA	NA	NA	NA	NA
2. Institutional Controls	3	1	3	2	9	3
3. Surface Clearance	2	1	2	1	6	2[b]
4. Clearance to Depth of Detection	1	1	1	3	6	1[b]

Note: Ranking from most effective to least effective; most effective = 1.
a NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.
b The increased level of protection associated with Clearance to Depth of Detection makes it a more desirable choice than Surface Clearance.

8.2.1.1 Protection of Human Safety

The overall OERIA hazard level for the Opana Point Bombing Range is high, and public safety is of utmost importance for future land use. Therefore, Clearance to Depth of Detection is ranked 1 (most effective) because of reduction of OE on-site and the ability to provide the highest level of protection of human safety. Surface Clearance is ranked 2 in terms of human safety because of its ability to provide reduction in risk associated with surface ordnance. Institutional Controls is ranked 3 because it does not provide for the removal of OE in a high hazard area where OE items have been found. NDAI is not considered an acceptable alternative.

8.2.1.2 Compliance with ARARs

Compliance with ARARs has been ranked equally among Alternatives 2, 3, and 4, as compliance with the ARARs is expected with minimal impact on the environment.

8.2.1.3 Long-Term Effectiveness

Clearance to Depth of Detection, in an area with a high OERIA hazard level, would be the most effective alternative over the long term because it would provide for the maximum protection of human safety especially when considering the planned future residential development on this site. Surface Clearance is ranked 2 (second) because it would be more effective over the long term than Institutional Controls, but less effective than the Clearance to Depth of Detection Alternative. Institutional Controls are ranked 3 because it would not be effective over the long term in reducing the risk associated with the high OERIA hazard level at Opana Point. NDAI is not considered an acceptable alternative.

8.2.1.4 Short-Term Effectiveness

Since the OERIA hazard level of the Opana Point Bombing Range is high, Surface Clearance would be the most effective alternative over the short term because of current land use. The site is utilized by the public on a regular basis, and therefore removal of surface items would reduce the risk associated with surface items. Institutional Controls is ranked 2 because it does not provide the same reduction in risk as the Surface Clearance Alternative, but for a short term may inform site users and heighten awareness of OE present at the site. However, it should be noted that during the TPP process, the land owner expressed concern about using warning signs. He felt that this may attract souvenir hunters and cause them to conduct activities that may expose them more than the typical recreational user of the site. Clearance to Depth of Detection is ranked 3 because it would take longer to implement than the Surface Clearance Alternative and Institutional Controls. NDAI is not considered an acceptable alternative.

8.2.1.5 Overall Effectiveness Ranking for Alternatives 1 through 4

Clearance to Depth of Detection (Alternative 4) and Surface Clearance (Alternative 3) are ranked as the most effective OE response action alternatives when considering overall effectiveness. However, because Clearance to Depth of Detection provides greater risk reduction, it is ranked as 1, with Surface Clearance as 2. Institutional Controls is ranked third because it does not provide for removal of OE items from the site which is necessary considering current land use, the high OERIA hazard level, and the planned development of the Opana Point site. Because the OERIA hazard level is high and there is OE present on-site, NDAI is not considered an acceptable alternative.

8.2.2 Implementability

The implementability criteria evaluation consists of technical feasibility, administrative feasibility, services and materials, local agency acceptance, and community acceptance. The evaluation of each alternative based on technical and administrative feasibility considers the extent of logistical and managerial support. Service and materials evaluates each alternative in relation to the extent of personnel and supplies required. Local agency and community acceptance of an alternative is based on interviews with entities affected by any activity on-site. Table 8-7 provides the implementability criteria of the four alternatives for the Opana Point Bombing Range. The evaluation of each of these alternatives is presented below.

TABLE 8-7 IMPLEMENTABILITY CRITERIA EVALUATION FOR THE OPANA POINT BOMBING RANGE

ALTERNATIVE	Implementability					Score	Rank
	Technical Feasibility	Administrative Feasibility	Services and Materials	Local Agency Acceptance	Community Acceptance		
1. NDAI*	NA	NA	NA	NA	NA	NA	NA
2. Institutional Controls	3	3	1	3	3	13	3
3. Surface Clearance	1	1	2	2	2	8	1
4. Clearance to Depth of Detection	2	2	3	1	1	9	2

Note: Ranking from most effective to least effective; most effective = 1.
* NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.2.2.1 Technical and Administrative Feasibility

8.2.2.1.2 NDAI is not considered an acceptable alternative due to the overall high hazard level associated with the site. Implementing Institutional Controls would require more logistical and management support than a clearance action because the process must be conducted in close coordination with local agencies, landowners, and the community. Although the supplies and personnel needed to install and maintain warning signs, conduct educational programs, and implement and oversee use restrictions are readily available, the length of time necessary to coordinate the implementation of Institutional Controls would be greater than the relatively short length of time required to implement a clearance action. Therefore, Institutional Controls are ranked 3 (least effective).

8.2.2.1.3 Implementation of a Surface Clearance would be the most feasible from a technical and administrative perspective, although the Surface Clearance Alternative requires specially trained and qualified UXO-personnel and a means of OE disposal, this alternative requires less resources than the Clearance to Depth of Detection Alternative. Therefore, Surface Clearance is ranked 1 (best) for technical and administrative feasibility.

8.2.2.1.4 Implementation of the Clearance to Depth of Detection Alternative generally requires less logistical and management support than a long-term Institutional Controls program but requires more logistical and management support than Surface Clearance. Unlike a Surface Clearance, Clearance to Depth of Detection requires excavation equipment, in addition to specially trained and qualified personnel and a means of OE disposal, which is required for all clearance actions. Therefore, Clearance to Depth of Detection is ranked 2 in terms of technical and administrative feasibility, as it would take more time and effort to implement than a Surface Clearance, but less time and effort to implement than Institutional Controls.

8.2.2.2 Services and Materials

Institutional Controls is ranked 1 (best) because the supplies and personnel needed to install and maintain warning signs, conduct educational programs, and implement and oversee use restrictions are readily available. Surface Clearance is ranked 2 because it would require specially trained and qualified personnel as well as the means of disposing of any encountered OE. Unlike a Surface Clearance, implementation of the Clearance to Depth of Detection

Alternative requires excavation equipment, in addition to specially trained and qualified personnel and a means of OE disposal. Therefore, Clearance to Depth of Detection is ranked 3 for availability of services and materials. NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.2.2.3 Local Agency Acceptance

Based on interaction with agency representatives to date, it has been determined that local agencies are likely to consider Clearance to Depth of Detection as the most acceptable alternative in this area, considering the high OERIA hazard level and the planned development at the Opana Point site; therefore, Clearance to Depth of Detection is ranked 1 (most effective) in terms of local agency acceptance. Local agencies would be more likely to consider Surface Clearance as an acceptable alternative over Institutional Controls due to the high OERIA hazard level in this area and the current and planned land use. Therefore, Surface Clearance is ranked 2 and Institutional Controls is ranked 3. NDAI is not considered an acceptable alternative at this site.

8.2.2.4 Community Acceptance

Based on interaction with the landowner and members of the community who routinely access the property for recreational use during the TPP process and the EE/CA investigation, the community is likely to consider Clearance to Depth of Detection as the most acceptable alternative in this area based on the high OERIA hazard level; therefore, Clearance to Depth of Detection is ranked 1 (most effective). The community is more likely to consider a Surface Clearance over Institutional Controls because the removal of surface OE would provide a reduction in the risk associated with OE items on the surface. Therefore, Surface Clearance is ranked 2 and Institutional Controls is ranked 3. NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.2.2.5 Overall Implementability Ranking for Alternatives 1 through 4

Based on implementability rankings in areas of technical feasibility, administrative feasibility, services and materials required, local agency acceptance, and community acceptance, Surface Clearance is ranked the highest. Because of the amount of services and materials required, Clearance to Depth of Detection was ranked 2 in terms of implementability with Institutional Controls receiving a ranking of 3. NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

8.2.3 Cost

The cost criteria evaluation consists of actual cost, investment, and benefit. The cost of each alternative is reflective of the Cost Analysis results (Appendix D). Investment evaluates each alternative in terms of monetary investment required. The benefit of an alternative considers the most effective means of risk reduction for the cost required to perform the action. Table 8-8 provides the cost criteria of the four alternatives for the Opana Point Bombing Range. The evaluation of each of these alternatives is presented below.

TABLE 8-8 COST CRITERIA EVALUATION FOR THE OPANA POINT BOMBING RANGE

ALTERNATIVE	Cost			Score	Rank
	Cost	Investment	Benefit		
1. NDAI[a]	NA	NA	NA	NA	NA
2. Institutional Controls	$8,501	1	3	4	3
3. Surface Clearance	$222,248	2	2	4	2[c]
4. Clearance to Depth of Detection	$551,294	3	1	4	1[b]

Note: Ranking from most effective to least effective; most effective = 1.
a NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.
b The increased level of protection associated with Clearance to Depth of Detection makes it a more desirable choice than Surface Clearance.
c The increased level of protection associated with Surface Clearance makes it a more desirable choice than Institutional Controls.

8.2.3.1 Investment and Benefit

NDAI is not considered an acceptable alternative due to the high hazard level associated with the site. The cost associated with Institutional Controls is considerably lower than the two clearance options and therefore receives a ranking of 1 in terms of investment and a rank of 3 when considering level of protection produced for the cost because no OE is removed. Surface Clearance ranks 2 in investment and benefit. When considering the cost to perform a Surface Clearance and the level of protection provided by its implementation compared to the level of protection provided by Institutional Controls, this alternative is more cost effective. The Clearance to Depth of Detection alternative ranks 1 in benefit when considering the current and projected land use of the site.

8.2.3.2 Overall Cost Ranking for Alternatives 1 through 4

Clearance to Depth of Detection is ranked 1 as the best OE response action alternative based on cost due to the protection provided by this alternative. The Surface Clearance alternative received a score of 2 when considering cost; it is ranked higher than the Institutional Controls alternative. Based on the benefit resultant from and the cost of implementing Institutional Controls at Opana Point, this alternative is ranked 3 (least effective) in terms of cost.

8.2.4 Overall Ranking of Alternatives

The overall ranking of the different alternatives in terms of their effectiveness, implementability, and cost is presented in Table 8-9. The alternative with the lowest score is considered most effective for each criterion (effectiveness, implementability, and cost) evaluated.

TABLE 8-9 ALTERNATIVE EVALUATION FOR THE OPANA POINT BOMBING RANGE

ALTERNATIVE	Alternative			Overall Score	Overall Rank
	Effectiveness Rank	Implementability Rank	Cost Rank		
1. NDAI*	NA	NA	NA	NA	NA
2. Institutional Controls	3	3	3	9	3
3. Surface Clearance	2	1	2	5	2
4. Clearance to Depth of Detection	1	2	1	4	1

Note: Ranking from most effective to least effective; most effective = 1.
* NDAI is not considered an acceptable alternative due to the high hazard level associated with the site.

9.0 RECOMMENDED OE RESPONSE ACTION ALTERNATIVES

9.0.1 This chapter presents the recommendations for reducing OE risk at the Makawao Gunnery Site and Opana Point Bombing Range, Island of Maui, Hawaii.

9.0.2 The OERIA evaluation areas developed in Chapter 4.0 to evaluate the level of OE hazard were used in Chapter 8.0 to compare the effectiveness, implementability, and cost of the four OE response-action alternatives identified in this EE/CA report. The OE hazard level (determined in Chapter 4.0), the best-ranking OE response action alternative (determined in Chapter 8.0) for each site, and land owner input gathered during the TPP process were used to help develop and recommend the most appropriate OE response actions for the Makawao Gunnery Site and Opana Point Bombing Range.

9.0.3 The recommended OE response actions were developed considering the following: type, quantity, location, and depth of UXO and OE recovered during the EE/CA field investigation; documented records of previous OE recovered at the sites; past, current, and future land use; input from local agencies, and the landowners; and the Institutional Analysis (Chapter 5.0). The primary goals of these recommendations are to provide: (1) the most effective protection to the public and the environment from OE, (2) a plan for managing risk associated with exposures to and interaction with OE, and (3) support the site closeout statements for the Makawao Gunnery Site and Opana Point Bombing Range. The Site Closeout Statements were developed in coordination with each property owner, CEPOH, and USAESCH during the TPP process (ZAPATAENGINEERING, 2002). The CEPOH will maintain its responsibilities for the residual risk that remains once the recommended OE response actions have been implemented by performing recurring reviews. Those involve returning to the site five years after the recommended OE response actions have been initiated to assess their effectiveness and reliability. After the initial review has been conducted, recurring reviews will be performed at five-year intervals. The need for recurring reviews will be coordinated with regulators and stakeholders and justified in each recurring review report (as outlined in Chapter 10).

9.0.4 Final recommendations for the site will be documented in an Action Memorandum (as outlined in Chapter 10). A Removal Design will be prepared in accordance with the decisions documented in the Action Memorandum and will provide specific details on how the OE response actions will be implemented. An Explosives Safety Submission (ESS) document, which summarizes the Removal Design, will be prepared and submitted to the DOD Explosives Safety Board (DDESB) for their review and approval prior to implementation of any OE response action.

9.1 RECOMMENDED RESPONSE ACTIONS

9.1.1 Makawao Gunnery Site

9.1.1.1 Clearance to Depth of Detection is recommended for the 100-acre portion of the Makawao Gunnery Site located between the Halehaku Gulch and the Honopuo Stream and the 700 and 800 elevations as depicted on Figure 9-1. Institutional Controls are also recommended for the entire site, as there may be OE outside this 100-acre area as well as in the subsurface. The 100-acre area designated for clearance is bracketed by the following coordinate sets:

Point	NAD 83, Hawaii State Plane, Zone 2	
	Northing (US ft)	Easting (US ft)
Makawao	209394.88	1777630.85
Makawao	208490.15	1777630.85
Makawao	208490.15	1779854.24
Makawao	207620.90	1781202.47
Makawao	209394.88	1781202.47

9.1.1.2 The clearance recommendation is based on the following:

- This 100-acre area encompasses all sample locations that produced OE-related items.
- All UXO, surface and subsurface, were recovered within this area. The surface UXO items found were 105 mm projectiles that have the potential to cause a fatal injury if detonated by an individual's activities or potentially being disturbed by livestock.
- OE had been previously reported in this area (105mm projectiles discovered during land clearing activities and recovered during the field investigation).
- Future land use is primarily for continued cattle ranching, which provides for exposure hazard to OE on or near the surface.
- Based sample results, there is sufficient evidence to exclude the remaining portion of the Makawao Gunnery Site from clearance activities.

9.1.1.3 Institutional Controls are recommended for the entire Makawao Gunnery Site. These institutional controls include the following:

- Letter notifications to landowners, residents, and local businesses.
- A community awareness meeting.
- Worker/resident OE safety awareness education by means of one training session.

9.1.1.4 The use of warning signs was considered initially as an institutional control, however, following discussion with the property owner, display of warning signs would be ineffective and possibly detrimental to public safety. Letter notifications to landowners, community awareness meeting, and worker/resident education will, however, provide effective risk management by educating the local community concerning the dangers associated with potential OE at the Makawao Gunnery Site. It is recommended that informational pamphlets (detailing the types of ordnance used at the site, the hazards associated with these types of ordnance, and whom to contact if ordnance is found) be distributed to all adjacent landowners and employees of the East Maui Irrigation Company. Additional copies of the informational pamphlets should be distributed to local police and fire departments and public libraries, where they will be available to the public. Letter notifications detailing the findings and recommendations of the EE/CA investigation should be mailed to landowners adjacent to the site. It is recommended that a community-awareness meeting be conducted in Haiku or Paia and that worker-education training be provided to the East Maui Irrigation Company.

9.1.1.5 The estimated cost to implement these alternatives is $878,992 at the Makawao Gunnery Site. Long-term implementation of institutional controls will be the responsibility of landowners and local agencies. Costing assumptions and costing backup for the recommended response actions are presented in detail in Appendix D.

9.1.2 Opana Point Bombing Range

9.1.2.1 Clearance to Depth is recommended for the Opana Point Bombing Range. The clearance area includes the approximately 90-acre area encompassed by the planned residential development as shown on Figure 9-2 and covers the area where evidence of ordnance items was recovered during the field investigation. Sets of coordinates that approximate the irregularly shaped clearance area are as follows:

	NAD 83, Hawaii State Plane, Zone 2	
Point	**Northing (US ft)**	**Easting (US ft)**
Opana	221781.89	1770769.15
Opana	222073.56	1771550.40
Opana	222229.81	1771654.57
Opana	222229.81	1771748.32
Opana	221865.23	1772050.40
Opana	221500.64	1772581.65
Opana	221063.14	1772623.32
Opana	220750.64	1772779.57
Opana	220646.48	1772550.40
Opana	220333.98	1772612.90
Opana	220031.89	1772550.40
Opana	219865.23	1772592.07
Opana	219688.14	1772144.15
Opana	219854.81	1772019.15
Opana	220011.06	1771331.65
Opana	220438.14	1770737.90
Opana	220781.89	1770706.65
Opana	220928.35	1770842.07
Opana	221386.06	1770706.65

9.1.2.2 Based on the types and number of ordnance recovered prior to the EE/CA investigation, sufficient information existed to suspect that a clearance action would be necessary. However, the pre-existing data were based on results from a limited, visual surface clearance conducted with the assistance of hand-held magnetic detection instruments, and therefore gained no data related to the potential number of subsurface items. Also, based on the type of hand-held detection equipment used during this removal action, non-ferrous items such as the Mk 5 practice bomb would not have been detected unless it was visually spotted.

9.1.2.3 The recommendation for the Opana Point Bombing Range is based on the following:

- Eight UXO items were recovered during the EE/CA field investigation, including two 60 mm mortars that have the potential to cause fatal injuries if detonated by an individual's activity. Additionally, the field crews recovered evidence of OE scrap, including 81 mm mortars, throughout the area.
- Future land use at the Opana Point site is for a planned residential community consisting of approximately 18 home sites and a common area or park.

- OE has been previously reported in this area, including unexploded 81mm mortars and a 4.5 in barrage rocket (DEI, 2001)

9.1.2.4 The estimated cost to implement this recommended OE response action is $461,294. Costing assumptions and backup for the recommended response action is presented in detail in Appendix D.

10.0 EE/CA FOLLOW-ON ACTIVITIES AND RECURRING REVIEWS

Once the EE/CA is approved by the USAESCH, follow-on activities will be implemented. These activities will include developing Action Memorandum for each site and Recurring Reviews.

10.1 ACTION MEMORANDUM

Following the Final EE/CA Report, an Action Memorandum will be prepared for each site to document the decision by the Government regarding the selected OE response action(s) for the Makawao Gunnery Site and Opana Point Bombing Range.

10.2 RECURRING REVIEWS

10.2.1 The CEPOH will maintain its responsibilities for the residual risk once the recommended OE response actions (Chapter 9.0) have been implemented, by performing recurring reviews. This involves returning to the site five years after OE response actions have been conducted to assess their continued effectiveness. After the initial review has been conducted, recurring reviews will be performed at five-year intervals. The need for recurring reviews will be coordinated with regulators and stakeholders, and justified in each recurring review report. The primary objective of the recurring review is to ensure the OE response actions implemented as a result of the EE/CA have remained effective and continue to provide protection against OE.

10.2.2 The recurring review process that the CEPOH will implement to assess the continued effectiveness of the implemented OE response actions includes, but is not limited to:

- Evaluate if changes have occurred in current and/or future land uses and their effect, if any, on selected OE response actions;
- Investigate reported OE encounters that may have occurred since completion of the OE response actions;
- Conduct visual spot inspections at each site to evaluate erosion effects, condition of warning signs, and the status of community awareness outreach programs and educational media.

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12.0 GLOSSARY OF TERMS

Anomaly. A significant deviation from the background geophysical response indicative of a buried item that might be OE.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Federal law passed on 11 December 1980 that provides a series of programs addressing clean up of hazardous waste disposal and spill sites.

Cultural resources. Prehistoric and historic districts, sites, buildings, objects, or any other physical evidence of human activity considered important to a culture, subculture, or a community for scientific, traditional, religious, or any other reason.

Dig team. A team of UXO specialists that excavate geophysical anomaly sources.

Electromagnetic (EM). A geophysical survey instrument that uses the rate which electromagnetic signals in the ground decrease to detect and map metallic objects below ground surface.

Explosive Soil. Explosive soil refers to mixtures of explosives in soil sand, clay, or other solid media at concentrations such that the mixture itself is explosive.

Exposure. An "exposure" to OE is defined as occurring when the person traversing or working on the site is in "close proximity" to ordnance, whether or not the person knows the ordnance is present (it could be buried). An accident or injury is not necessarily assumed to occur when an exposure takes place. The definition of "close proximity" varies depending on the specific activity.

Fuze. A device with explosive components designed to initiate a train of fire or detonation in an item of ammunition by an action such as hydrostatic pressure, electrical energy, chemical action, impact, mechanical time, or a combination of these.

Heiau. A platform or enclosure structure used for traditional Hawaiian religious purposes.

National Oil and Hazardous Substance Pollution Contingency Plan (NCP). The NCP is the Environmental Protection Agency's (EPA's) blueprint for implementing a Superfund law that addresses the legal requirements for responding to a potential hazard at a CERCLA site. The plan defines responsibilities and activities of affected parties within the site (which could include a Superfund site). The NCP is also the process used to address non-Superfund contaminated sites.

OE clearance. The surface or subsurface removal of identified OE from a defined area.

OE scrap. Includes those items which are fragments of functioned ordnance, as designed or intentionally destroyed, and which contain no explosive or other items of a dangerous nature. OE scrap is inert and does not pose a safety risk.

Ordnance and explosives (OE). OE consists of either (1) or (2): (1) Ammunition, ammunition components, chemical or biological warfare material or explosives that have been fired, armed or deployed, or abandoned, expelled from demolition pits or burning pads, lost, discarded, or buried. Such ammunition, ammunition components, and explosives are no longer under accountable record control of any Department of Defense organization or activity; (2) Explosive Soil (see definition under "Explosive Soil").

Risk. Exposures to the chance of injury or loss, or a function of the probability that an accident (or adverse situation) will occur within a certain time, as well as the accident's consequences to people, property, or the environment.

Small arms. Small arms ammunition consists of cartridges and shells used in rifles, pistols, machine guns, and shotguns.

State plane coordinates. A mapping system that measures in distance the position or coordinates of objects north and east of a known position in any given state.

Subsurface OE investigation. Consists of excavating to a prescribed depth to identify potential subsurface OE.

Surface clearance. The process in which OE are visually searched for and removed from the ground surface, without conducting any intrusive activities.

Time-Critical Removal Action (TCRA). A TCRA is a clean-up or stabilization action to a release (in this case, OE) that must be initiated to reduce the risk to public health and/or the environment posed by the release.

Unexploded Ordnance (UXO). Military munitions that have been primed, fuzed, 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.

13.0 LIST OF PREPARERS

Burkett, Timothy, GIS Analyst, ZAPATAENGINEERING
M.S., Geography and Regional Planning, 1995, Indiana University of Pennsylvania
B.S., Geography, 1994, University of Pittsburgh at Johnstown
Years of Experience: 7

Cantor-McKinney, Suzy, Vice President OE Programs, ZAPATAENGINEERING
M.S., Land and Water Resource Management, 1983, University of North Texas
B.S., Biology, 1982, Marshall University
Years of Experience: 20

Gilbert, Neil, P.E., P.G., Senior Engineer, ZAPATAENGINEERING
MS, Engineering Science (Civil Engineering), University of California, Berkeley, 1973
MA, Geology, University of California, Berkeley, 1969
AB, Geology, University of California, Berkeley, 1967
AA, Geology, College of San Mateo (California), 1964
Years of Experience: 28

Johnson, Kurtis, Engineer, ZAPATAENGINEERING
B.S., Mechanical Engineering, 1996, University of South Alabama
Years of Experience: 6

Ray, R. Marty, Project Manager/Environmental Scientist, ZAPATAENGINEERING
B.S., Biology, 1993, University of South Carolina, Aiken
Years of Experience: 9

Reel, Nathan, Environmental Technician, ZAPATAENGINEERING
A.S., Environmental Engineering, 1999, Augusta Technical College, Augusta, GA
Years of Experience: 3

Rose, Charles, UXO Specialist, ZAPATAENGINEERING
B.S., Political Science, 1997, Athens State College
Explosive Ordnance Disposal, 1986, United States Army
Years of Experience: 16

Sanders, Lori, Engineering Tech I, ZAPATAENGINEERING
B.S., Computer Engineering, University of North Carolina at Charlotte (Pending)
Years of Experience: 2

Smith, David, Senior Geophysicist, ZAPATAENGINEERING
B.S., Earth Physics and Exploration Geophysics, 1960, University of California at Los Angeles
Years of Experience: 32

Wolf, David, Environmental Scientist, ZAPATAENGINEERING

B.S., Earth Science, University of North Carolina at Charlotte, 1998
B.A., Mathematics, University of North Carolina at Charlotte, 1998
Years of Experience: 5

APPENDIX A

SCOPE OF WORK

SCOPE OF WORK
FOR
ORDNANCE AND EXPLOSIVE (OE)
ENGINEERING EVALUATION/COST ANALYSIS (EE/CA)
AT
MAKAWAO GUNNERY SITE & OPANA POINT BOMBING RANGE
ISLAND OF MAUI, HAWAII
Site No. H09HI009801 & H09HI027201
6 December 2001

1.0 BACKGROUND AND OBJECTIVE

1.1 The objective of this delivery order is for the Contractor to prepare an Engineering Evaluation/Cost Analysis (EE/CA) report. The report shall allow and document meaningful stakeholder participation that: characterizes ordnance and explosives (OE) nature. location and concentration; provides a description of the OE related problems affecting human use of the site; identifies and analyzes reasonable risk management alternatives; provides a convenient record of the process for use in final decision making and judicial review, if necessary. The Contractor is expected to use geophysical techniques to identify anomalies in the subsurface for subsequent OE sampling. The Contractor shall conduct OE sampling and dispose of the UXO and other scrap uncovered during the OE sampling.

1.2 OE is a safety hazard and constitutes an imminent and substantial endangerment to site personnel and the local population. This action will be performed in a manner consistent with the Comprehensive Environmental Response. Compensation, and Liability Act (CERCLA), Sections 104 and 121; Executive Order 12580; the National Contingency Plan (NCP). In addition, all activities involving work in areas potentially containing unexploded ordnance hazards shall be conducted in full compliance with CEHNC, USACE, DA and DoD requirements regarding personnel, equipment and procedures. 29 CFR 1910.120 shall apply to all actions taken at this site.

1.3 The work required under this Scope of Work (SOW) falls under the Defense Environmental Restoration Program (DERP) and the Formerly Used Defense Site (FUDS) program. Ordnance and Explosives (OE) may exist on property that was formerly owned, used or controlled by the Department of Defense. The framework underlying this response is the National Contingency Plan (NCP).

1.4 Others will accomplish the Archeological Survey to identify potential archeological sites. The Government will provide this survey for the Contractor to consider in preparing the Work Plan. The Contractor shall provide awareness training to all personnel involved with fieldwork. as outlined in the approved Work Plan. The archeological survey includes all areas that will be (or potentially could be) subjected to ground disturbing of any form which may require examination by qualified archeologists (provided by the Government). This will ideally take place prior to any ground disturbing taking into consideration safety issues and approval by the USACE OE Safety Specialist. The location of archeological sites is confidential. Site locations will be provided to the Contractor for planning purposes. The Contractor will not disclose locations of archeological sites. A Government Archeologist will provide the Contractor with a briefing on cultural resources related to the project area. No Contractor personnel will remove any artifacts or bones from the property subject to penalties under federal law. The Government Archeologist will brief the Contractor accordingly. Archeological surveys may be performed in conjunction with field work performed by the Contractor. Efforts will be made, if safety allows, to re-locate UXO away from archeological sites. If detonation in-situ is necessary, Government Archeologists will examine the area post-disposal to record any possible damage to archeological sites.

1.5 Others will identify endangered/threatened species of concern. The Government will provide information that identifies areas of concern. The Contractor shall consider this information in preparing the Work Plan. The Contractor shall provide awareness training to all personnel involved with the field investigation. Work shall comply with the National Environmental Policy Act (NEPA).

2.0 INTRODUCTION

2.1 Background.

2.1.1 Gunnery Site, Makawao: The Gunnery Site, Makawao, was ascertained from a Tax Map book dating back to the 1940's. The U.S. Marine Corps (USMC) via a license with East Maui Irrigation Co., Ltd. for 897.8 acres in April 1944, and the C.K.C. Rooke Estate for 104.2 acres obtained the site for use until December 1945. The site was used as a USMC artillery impact area, and unexploded 105mm artillery shells have been found on the site by field teams. Several trenches and circular pits in the same area are suggestive of holes for training and artillery impact craters.

2.1.2 Opana Point Bombing Range: The former Opana Point Bombing Range project site is approximately 52 acres. Access to the project site is located about 1.1 miles north of Hana Road and 16 road miles east of Kahului, Maui, on land currently owned by Amfac Property Investment Corporation, Kaanapali, Maui, Hawaii and leased to the Maui Land & Pineapple Company, Inc., Paia, Maui, Hawaii. Except for a portion along the seaward cliff line, almost all of the former bombing range (currently called Field 212) is under cultivation for the production of pineapples. The site is located on the Opana Point at an elevation of above 120 feet above Mean Sea Level (MSL). The northern boundary of the project site is located along the cliff line, which is about 100 feet above MSL. The surface of the project site have been cleared and graded to meet the requirements for cultivation of pineapples. During one field investigation of the site in June 1990, sixteen (16) Mark 23 practice bombs were discovered on the surface within the boundaries of the Bombing Range. These were probably placed at this location during ground clearance as part of the pineapple cultivation work.

2.2 Chemical Warfare Materiel (CWM). CWM activities were not associated with the training activities at any of the sites listed in this SOW. The site is not suspected to contain Chemical Warfare Materiel (CWM). However, if suspect CWM is encountered during any phase of site activities the Contractor shall withdraw upwind from the work area, secure the site and contact CEHNC.

3.0 SPECIFIC REQUIREMENTS

3.1 (Task 1) Project Planning, Site Visit and Records Review & Search, and Base Map Development.

3.1.1 (Task 1a) Site Visit and Records Review & Search. The Contractor shall make a site visit, review pertinent records (see Paragraph 6.0), accomplish an additional historical records search and interview personnel knowledgeable of site conditions. The purpose of this task is to permit the Contractor's staff with direct project responsibility to gain necessary information about site conditions. It is intended that this task be an additional "records locating task " where new information will be located or developed. Prior to the site visit (2 Weeks for 3 persons) the Contractor must obtain a Government approved abbreviated Site Safety and Health Plan (ASSHP). The proposed team shall include the Project Manager, a UXO Technician, and the Lead Geophysicist assigned to the project. In addition to safety and health procedures, the ASSHP shall document the proposed agenda, target documents, and proposed interviewees for contact during the Site Visit and Records Search. A qualified UXO specialist must escort site visitors to areas potentially contaminated with OE. The Contractor shall ensure that the site visit is fully coordinated and that all members of the site visit team maintain compliance with the ASSHP. A site visit letter report shall be provided to the Contracting Officer after the site visit, listing the persons who attended the Site Visit, persons interviewed and documents recovered, along with findings and outstanding issues that must be resolved prior to field investigation activities (Tasks 4 through 8).

3.1.2 (Task 1b) Work Task Proposal. The Contractor shall develop a work task proposal (WTP) to describe and plan the accomplishment of the related activities described in this SOW. Prior to initiating work on any task after this sub-task, the Contractor shall submit, for Government concurrence, a WTP. The proposal shall be submitted for Contracting Officer (CO) for review and concurrence. The WTP shall describe the work to be accomplished, recommendations on approach, coordination, organization, methods, personnel, schedule and estimated budget. The WTP shall identify the various elements of the work plans. The WTP is intended to be a brief description of the Contractor's understanding of the proposed work. See paragraph 6.0 of the SOW for a listing of the many references required.

3.2 (Task 2) Technical Project Planning. The Contractor shall prepare a technical project-planning document for both the former Opana Point Bombing Range and Gunnery Site, Makawao in accordance with DID OE-001 and OE-005-02. This effort will be accomplished in four phases as described below. **The goal of this effort is to start the project with all stakeholders agreeing on the end goal.** This task requires the Contractor to schedule and facilitate meetings and provide project worksheets for project team decision points. The Contractor shall provide the following requirements or seek the appropriate input from others. The Contractor shall consider all stakeholder input when developing the project recommendations. The Government will direct the Contractor on any issues not resolved upon task completion. The Government does not expect the length of this document to exceed 30 pages.

3.2.1 Phase I, Identify Current Project & Develop a Conceptual Site Model: Using whatever past historical information that can be obtained, the Contractor shall identify;

- The decision makers (USACE, land owner(s), regulatory agencies.)
- Project Objectives, which includes the decision makers' perspectives and community needs and interests as it relates or might impact this project.
- Site constraints and dependencies.
- Legal and regulatory constraints.
- Conceptual Site Model (known impact areas, disposal sites, other OE issues; all potential types of UXO expected at the site; geological setting; estimate of maximum probable depth for sampling.)
- Site closeout statement for each land use category or sector as appropriate.

The closeout statement shall consider the current and future land use, current technology can't guarantee a "clean site", incorporate local initiatives, enlist community support, and encourage recurring reviews. The closeout statement may identify more than one process to achieve site closure but must identify decision points associated with each process alternative.

3.2.2 Phase II, Data Needs: The Contractor shall identify the data need requirements, intended use of the data, and appropriate sampling and analysis methods, and identify data quality objectives for each data type. Some general types of site data include; 1- physical nature of the site, 2- nature and extent of UXO, 3- regulatory framework, 4- demographics and land use. The Contractor must define the data needs, evaluate the usability of existing data, and identify the data gaps that must be filled. Generally this phase must document:

- "Who" needs the data?
- "What" data is needed?
- "What" project objectives will the data help to satisfy?
- "What" are the intended data uses?
- "What" number of samples is required to satisfy the intended uses?
- "What" are the performance requirements?
- "Where" is the priority/area/location/depth of interest?

3.2.3 Phase III, Data Collection Options: The Contractor shall develop and document data sampling, gathering and analysis strategies. Items that should be presented include sampling strategy constraints, use of probabilistic or non-probabilistic sampling, and whether we intend to use field screening and analysis techniques. Data types and needs should be categorized as screening data or definitive data. Data quality should be defined for each data type that is based upon the intended use of the data and accepted practices. Once the data "world" is defined for the project each

data set shall be classified as "basic" (required data), "optimum" (data would facilitate better decisions and is cost effective to gather), and "excessive" (data would be nice to have but may not be worth the cost to gather the data).

3.2.4 Phase IV, Data Collection Program Design: The Contractor shall present the data collection program requirements as options and schedules with the budget effects for the various options. Other items such as constraints and uncertainties and regulatory factors must be presented. The Contractor must clearly present the "preferred" data collection plan that ties together the data need requirements, data sampling and analysis methods, and the intended use of the data in satisfying the closeout statements established in Phase I.

3.3 (Task 3) - EE/CA Work Plan. The Contractor shall prepare an EE/CA Work Plan in accordance with DID OE-001. The Contractor shall include the following aspects in Chapter 11 of the work plan.

Quality Control Plan (QCP) and Quality Assurance. the Contractor shall describe the Contractor's Quality Control and the expected Government's Quality Assurance roles and responsibilities for this project. Note that the Contractor is responsible for developing and implementing only the project QCP. The Government will perform Quality Assurance. However, the plan shall describe both activities. The QCP shall specifically address digital data delivered in the OE GIS data standard format with communications, transmissions and receipt by the various participants. A flow chart may be used to identify the data collection, analysis, storage, transfer and QA/QC process to generate the final dig-sheets. The Contractor shall ensure that the corporate quality policy is understood, implemented, and maintained at all levels in the organization. The Contractor shall propose a system to manage, control, and document the performance of these tasks. The Quality Control Plan shall include:

Location Surveying and Mapping QC,
Geophysical QC,
Data QC: digital data (communications; transmissions and receipt), along with all analog data (administrative; contractual; survey and geophysical field notes).
GIS System QC
Anomaly reacquisition QC
Variance of surface & subsurface influence on geophysical data output across the site.

The most critical component in this project is the geophysical data. The Contractor shall perform continuous tracking, checks, representations, adjustments and visualization of the field data daily for quality control and to establish efficient field procedures. In addition, the Government may resurvey a portion (approximately 2 to 4%) of the site, and analyze and compare resurvey results to the Contractor's results. The methodology to accomplish the quality control shall be proposed in the WP in accordance with DID OE-005-11, which identifies the minimum QC activities. The QC activities shall be documented and included in the final investigation report.

3.4 (Task 4) - Location Surveys and Mapping. The Contractor shall perform topographic and location surveys as described in the approved Work Plan and in accordance with DID OE-005-07. The Contractor shall perform all location surveys and mapping required to establish boundaries of areas. All location surveying and mapping shall be performed in the Hawaii State Plane Grid Coordinate System, NAD 83 Datum, in US Survey feet. Grid corners shall be located using precision surveying methods. Each corner of each grid area shall be located by establishing the appropriate State Plane Coordinate grid system to the closest 1-foot and shall be both tabulated and shown on maps of the site. Other coordinate systems and accuracy specifications are not acceptable and shall not be used. The Contractor shall survey and mark the corners of the designated grids with stakes or other visible temporary markers that can be relocated at a later date. The depth below ground of all UXO shall be measured.

3.5 (Task 5) - Establishment and Management of GIS. The Contractor shall take the GIS Tri-Service Spatial Data Standard data, manual, file, and database structures from the Huntsville Center Ordnance GIS standard and apply it to this project. The Government will provide a digital copy of the required data structure. The standard will be used to create project-specific GIS for the specific OE investigative needs of this site. The GIS shall be assembled and used to direct the daily geophysical investigative activities and to compile and analyze the daily digital data into the GIS. Any changes from the standard shall be proposed to the contracting officer with fully documented changes and the

reason or benefit of the proposed change. The Contractor shall establish and manage the GIS as described in the approved Work Plan and in accordance with DID OE-005-14.

3.6 (Task 6) - Geophysical Equipment Test and Investigation. The Contractor shall implement geophysical investigations as described in the approved Work Plan and in accordance with DID OE-005-05. The Contractor shall provide all necessary qualified personnel and equipment to perform surface preparation, as well as surface OE identification, removal and disposal on the sampling grids (approximately 30 acres) where subsequent site activities are scheduled to occur under this contract. The Contractor shall perform the minimum amount of work necessary to clear the areas of vegetation, surface OE and OE scrap where these impede the progress, effectiveness or safety of the geophysical investigation team. Trees three inches in diameter or greater shall not be cut unless specifically approved in writing by the Government. All OE-related activities shall be performed in accordance with applicable sections of the approved work plan.

3.6.1 (Task 6a) Geophysical Equipment Test. The Contractor shall design and construct a test plot at the site to test various geophysical methods and equipment in order to establish the methods, equipment and procedures best suited to the site. The Contractor shall test various geophysical methods and equipment in order to establish the methods, equipment and procedures best suited to the site. During prove out, the Contractor shall coordinate with CEHNC to ensure that a CEHNC representative will be on site for verification and quality assurance. The Contractor shall use the information gathered in this phase of work to evaluate the relative efficiencies of potentially appropriate geophysical investigation procedures. Various procedures must be defined such as, but not limited to, daily equipment standardization, data quality checks and data error resolution process. Afterwards, the Contractor shall propose specific geophysical methods, equipment and personnel appropriate and necessary to accomplish the required geophysical investigations. The results of the test shall be documented in a letter report and submitted to the Government for concurrence. The Contractor shall incorporate the appropriate methods and equipment into the work plan once Government concurrence is received.

3.6.1.1 The Contractor shall describe the test plot design and operation, in detail, in the WP. This will include an idealized map of the target items showing the: proposed items to bury in the test plot, proposed spatial location, their proposed depth of burial and orientation with respect to magnetic north. The Contractor shall establish a test site on property identified by the CEHNC representative that is generally configured to include inert targets and clutter items of similar size, depth and composition as are expected at the site. The test plot shall be approximately ¼ acre in size and contain an appropriate number of seeded inert items to document the maximum consistent depth of detection for each class of items. The specific layout shall be described in the Work Plan. An Excel spreadsheet that contains the unique identifying number for each buried item, the X, Y and Z location, and the inclination and declination of the items (or survey information on the nose, tail and center point of the buried items where applicable). A representative digital picture of each class of buried items should also be included in the Geophysical Prove-Out Report. Mobilization for the test plot installation shall not occur until the Government accepts the Geophysical Prove-Out Plan.

3.6.1.2 The proposed test plot will be geophysically surveyed with each detector type before seeding target items to collect existing background data for the proposed site and verify the suitability of the proposed site. During test plot construction, the contractor shall survey the location of each item, and the four corner stakes, to the nearest 0.1 ft. The contractor shall use UXO avoidance techniques to ensure the location of the excavation for each surrogate and corner is clear of metallic anomalies. The test plot shall be used to demonstrate and document the performance of the geophysical/navigation hardware, data analysis system, data transfer system, and contractor Quality Control system. The site-specific test-grid shall be geophysically mapped and re-acquired in the same detail and with the same procedures as planned for the remaining project area. The contractor will test each applicable detector/navigation system to validate which system(s) are optimal for detecting the target objectives at this site. The contractor shall utilize the test plot to demonstrate that all aspects of the geophysical mapping and analysis system are working and performance of the integrated system is acceptable to the government. This includes the survey platform, detectors, navigation system, data acquisition, data transfer, final data processing system, and the production of dig sheets that

can be easily viewed to identify the best overall survey system for the project. **The contractor may not proceed with production geophysical mapping until the Government accepts the test plot results.**

3.6.2 (Task 6b) Investigation. The total cumulative area to be Geophysically investigated and evaluated under this SOW consists of approximately 30 acres composed of individual grids and random path geophysical investigations. These will be broken down to 10 acres for the Opana Point Bombing Range, and 20 acres for the Gunnery Site, Makawao. Actual number and location of grids and/or meandering paths may increase or decrease based upon conditions encountered in the field, if so directed by the Contracting Officer. All aspects of anomaly evaluation, selection, and dig-sheet production shall be routinely reported in a weekly field activity report. See section 4.0 for additional reporting requirements and schedule.

3.6.2.1 Geophysical and Navigation Data Integration. The geophysical mapping system shall correlate all sensor response data with navigational data (DGPS or equivalent) based upon a local third-order control point at a nearby location.

3.6.2.2 Evaluation. After the site is Geophysically mapped, the Contractor shall utilize a qualified geophysicist to check and evaluate the geophysical data collected. The geophysicist shall make a professional determination regarding the identification of anomalies at the site. Based on this determination, the Contractor shall provide a "dig-sheet" showing predicted location and character of all suspected anomalies to the CEHNC Project Manager and OE support staff. In addition, the Contractor shall continually compare predicted results with actual results so that the Contractor's geophysical evaluation methodology is constantly refined over the life of the project.

3.6.2.3 Geophysical Mission Planning Software. The Contractor may perform the investigation and analysis utilizing the "Meandering Path" software provided by the Government. Note that this software package is not "stand-alone". It is an application that runs within Intergraph MicroStation 5.0 or MicroStation 95 for NT. A "*mission plan*" that identifies the expected survey areas shall be included within the Work Plan. Daily field progress will be plotted on this digital map during actual mapping operations to ensure compliance with the original Workplan and easily identify any major discrepancies between initial plan and the execution of the fieldwork.

3.6.2.4 Anomaly Selection. Note that not all geophysical anomalies meeting the criteria to be considered a potential UXO will be dug. Representative anomalies will be excavated in order to characterize geophysical anomalies and to provide information necessary to estimate location, concentration and nature of UXO present at the site. The Contractor shall propose methodology for selection of anomalies to be excavated. This might be based on UXO calculator, percentages of anomalies, a specific number of excavations, anomaly apparent size, workdays, statistical approaches, or some other approach or combination of approaches. Also, the approach for individual anomalies might differ from the approach used for pits/trenches. Generally the Government expects more anomalies selected for sampling at the beginning of the effort with the amount of samples selected for digging reduced over the duration of the sampling effort. The particular approach for this project shall be described in the work plan.

3.6.2.5 Data Format and Storage. The Contractor shall utilize an appropriate data format and storage system for geophysical mapping data that is consistent with CEHNC computer/CADD systems in accordance with DID OE-005-05 and as described in the approved Work Plan. In addition the Contractor shall maintain the data in such a way that the Government can remotely access any individual file or multiple files as necessary without day or time restrictions. See Section 4.0 for additional data requirements.

The approved geophysical instruments shall digitally capture instrument readings into a file coincident with State Plane grid coordinates. Navigation and instrument position data shall be referenced to established grid corner points and survey monuments. This field data shall be checked, corrected, and processed into ASCII files. Data submissions shall include raw digital data and final processed data files. The final processed data files shall have all appropriate corrections such as for navigation, instrument bias and diurnal magnetic shift applied. All corrections shall be documented within the project reports. Raw and final processed geophysical data shall be in column delineated ASCII files in the format X, Y, V1, V2... where X=Easting Coordinate, Y=Northing Coordinate, V1= top sensor

reading, V2=next lower (spatially) co-located sensor reading, etc. The data shall be in the standard State Plane coordinate system. All digital data, including initial threshold analysis, and color contour plot maps shall be provided to the Government by E-mail, Internet connection and on CD to CEHNC-ED-CS-G and CEHNC-ED-CS-D in a time frame as identified in the DIDs (Data Item Descriptions). Note - this requires draft geophysical data to be submitted to CEHNC within 36 hours of initial collection. Post processed and analyzed data shall be accompanied by a Microsoft Word 6.0 (or higher) file that documents the field activities associated with the data and the processing performed (readme file). Additional data such as scanned photos, or annotated CADD and mapping data shall be provided to accurately document field activities. The locations of the day's work shall be represented either by outlining the limits on a coincident CADD file representing the area, plotting of new data on the Base map file or by a scanned hard copy map. An archive copy on PC-CD Rom format shall be provided to CEHNC within 7 calendar days from completion of the previous weeks survey.

The Contractor shall analyze the geophysical data, identify anomalies that may represent buried UXO, and provide "anomaly identification-sheets" containing the following information:

- unique target identification number
- easting, in State Grid Plane Coordinates, US feet;
- northing, in State Grid Plane Coordinates US feet;
- instrumental readings (filtered & total response);
- estimated target size or mass and/or approximate depth;
- Identity of source (fence, tin can, automobile, suspected ordnance, etc.)

The anomaly identification sheets shall be provided to CEHNC and CENWO as hard copies and digitally as a Microsoft Excel 97 spreadsheet. In addition, the Contractor shall provide color contour maps, survey trace maps (coverage or track maps), physical features (utility lines, reinforced concrete, etc. if present) map overlays and other related information that describes site activities and analyses.

If the Contractor chooses to use proprietary post processing software, then the data must be provided in this proprietary and in non-proprietary format as raw and post-processed data files. The Contractor shall perform data analysis as necessary to produce color contour maps showing predicted anomalies per acre and UXO per acre, digital target tables, target maps, and survey data suitable for integration into Intergraph and GIS workstations.

3.7 (Task 7) Intrusive Investigations (OE Sampling). The Contractor shall, utilizing qualified personnel, implement site OE sampling as specified in the approved work plan. The Contractor shall provide all necessary qualified personnel and equipment to perform surface and subsurface OE access, evaluation and management. All aspects of the activities related to this task shall be reported in a weekly field activity report including DRMO turn in forms. This task shall be accomplished as follows:

3.7.1 Accessing Anomalies. The Contractor shall investigate anomalies identified by the geophysical investigations and as directed by the Contracting Officer. The Contractor shall, using qualified UXO personnel, determine whether the OE can be moved or destroyed in-place. This is a safety-driven decision that will be based solely on DoD munitions safety standards and requirements.

3.7.1.1 Anomaly Reacquisition. The Contractor shall use precision surveying methods to reacquire the geophysical anomalies identified on the dig-sheets. Anomaly reacquisition is a two-step process. The first step is to locate the ground position as specified on the dig-sheet. The second step is to use appropriate hand-held geophysical instruments to identify the precise location on the ground where excavation for the anomaly should occur. The Contractor shall flag the actual field location of each anomaly with its unique anomaly identification number shown on the dig-sheets and paint the ground at the flag location with high-visibility paint. The flags shall also have the unique anomaly Identification number recorded on it in waterproof, permanent ink. The Contractor shall report any anomalies that could not be reacquired.

3.7.2 **OE Destruction.** The Contractor shall be responsible for the destruction, if required, of all OE including UXO and scrap encountered during site investigations and characterizations utilizing qualified personnel and in accordance with all aspects of the project Work Plan. The Contractor shall establish in the Work Plan a method of disposal, if required, for all OE.

3.7.3 **Backfilling Excavations.** All access/excavation/detonation holes shall be back-filled by the Contractor. The Contractor shall restore such areas to their prior condition.

3.7.4 **OE Accountability.** The Contractor shall maintain a detailed accounting of all OE items/components encountered. This accounting shall include the amounts of OE, the identification and condition, depth located, disposition and location. The accounting system shall also account for all demolition materials utilized to detonate OE on-site. This accounting shall be a part of an appendix to the EE/CA report.

3.7.4.1 **DD Form 1348-1.** The Contractor shall complete a DD Form 1348-1A as turn-in documentation. Instructions for completing this form are contained in the Defense Utilization and Disposal Manual, DoD 4160.21-M. The Senior UXO Supervisor shall sign a certificate as follows:

"I certify that the property listed hereon has been inspected by me and, to the best of my knowledge and belief, contains no items of a dangerous nature."

DRMO turn-in documentation receipts shall be submitted as an appendix to the EE/CA Report.

3.7.4.2 **UXO Quality Control (QC) Specialist.** UXO QC shall be a separate function and is not envisioned as a full-time position. The UXO QC Specialist shall meet the minimum prerequisites of an UXO Supervisor and have the training, knowledge and experience necessary to implement the Contractor's QC plan as outlined in DID OE-025. The Contracting Officer must approve any exceptions.

3.7.4.3 **Quality Assurance Sampling Areas.** In order to evaluate the effectiveness of the geophysical investigation and evaluation methods utilized by the Contractor, the Contracting Officer may direct an independent Contractor provided by the government or may provide Government personnel to independently map, locate and access some detected subsurface anomalies as deemed necessary.

3.8 (Task 8) **Prepare Institutional Analysis, Impact Analysis and EE/CA Report.**

3.8.1 **(Task 8a) Institutional Analysis.** The Contractor shall perform an institutional analysis, using as much of the existing data collected for the TPP process, in accordance with DID OE-100. This report, which should be submitted in draft form for review by the Government, with the final report included in the EE/CA Report, will be a brief report presenting site conditions, in relation to ownership, zoning, future development plans (including replenishment) and Local and State participation in planning activities.

3.8.2 **(Task 8b) Impact Analysis.** The Contractor shall refine the Ordnance and Explosives Risk Impact Assessment (OERIA) to determine the base line public exposure and the predicted risk reduction for the selected risk reduction option for any areas recommended for removal action as a result of the EE/CA. The OERIA model may be adapted to address site-specific conditions. These refinements will be provided CEHNC for approval before use. Although OECert will not be used for this task, the Contractor shall write a risk report in accordance with the OECert Standing Operating Procedure that supports the EE/CA report and that determines the base line public exposure and the resultant public exposure for each alternative under consideration. Guidance is provided in the CEHNC document Interim Guidance Ordnance and Explosives Risk Impact Assessment dated 27 March 2001.

3.9 (Task 9) Prepare EE/CA Report. The Contractor shall prepare and submit an EE/CA report fully documenting the field work and subsequent evaluations and recommendations made by the Contractor. The textual portions of the report shall be fully supported with accompanying maps, charts, and tables as necessary to fully describe and

document all work performed and all conclusions and recommendations presented. The EE/CA Report shall follow guidance given in DID OE-010 - Engineering Evaluation/Cost Analysis (EE/CA) Report.

3.10 (Task 10) Prepare Action Memorandum. The Contractor shall, based upon close consultation with the Contracting Officer, prepare an Action Memorandum in accordance with applicable CEHNC guidance documents.

3.11 (Task 11) Community Relations Support. The Contractor shall attend and participate in public meetings as directed by the Contract Officer. The support shall include preparation and delivery of briefings, graphics and presentations, and participation in site visits. The actions are independent of the field activities that involve interaction with the community.

3.12 (Task 12) Meetings and Project Management. The Contractor shall perform project management functions, as necessary to maintain project control and to meet required reporting requirements. See the schedule for the number of meetings that are planned.

4.0 SUBMITTALS AND CORRESPONDENCE

4.1 Format and Content of Engineering Reports. Engineering Reports presenting all data, analyses, and recommendations shall be prepared and submitted by the Contractor. All drawings shall be of engineering quality in drafted form with sufficient detail to show interrelations of major features. The contents and format of the engineering reports shall be arranged in accordance with all pertinent guidance documents. When drawings are required, data may be combined to reduce the number of drawings. Reports shall consist of 8-1/2 inch by 11-inch pages with drawings other than the construction drawing folded, if necessary, to this size. A decimal paragraphing system shall be used, with each section and paragraph of the reports having a unique decimal designation. The report covers for each submittal shall consist of durable 3-ring binders and shall hold pages firmly while allowing easy removal, addition, or replacement of pages. A report title page shall identify the site, the Contractor, the local Corps of Engineers District, Huntsville Center, and the date. The Contractor identification shall not dominate the title page. All data, including raw analytical and electronic data, generated under this delivery order are the property of the DoD and the government has unlimited rights regarding its use.

4.2 Computer Files. All final text files generated by the Contractor under this contract shall be furnished to the Contract Officer in MS Word 6.0 or higher software, IBM PC compatible format. All final CADD/GIS data, design drawings and survey data generated by the Contractor under this delivery order shall be submitted in the proper format and media that will permit their loading, storage, and use without modification or additional software on the Huntsville Center CADD/GIS workstations.

4.3 HTML Deliverables. In addition to the paper and digital copies of submittals identified above, the final version of the EE/CA and the Action Memorandum shall be submitted, uncompressed, on one floppy disk or CD ROM in hypertext markup language (HTML) along with a linked table of contents, linked tables, linked photographs, linked graphs and linked figures included and suitable for viewing on the Internet.

4.4 Review Comments. Various reviewers will have the opportunity to review submittals made by the Contractor under this contract. The Contractor shall review all comments received through the CEHNC Project Manager and evaluate their appropriateness based upon their merit and the requirements of the SOW. The Contractor shall issue to the Project Manager a formal, annotated response to each in accordance with the schedule in paragraph 4.12.

4.5 Draft Reports. Each page of draft reports shall be stamped "DRAFT". Submittals shall include incorporation and notation of all previous review comments accepted by the Contractor.

4.6 Identification of Responsible Personnel. Each report shall identify the specific members and title of the Contractor's staff and subcontractors that had significant, specific input into the reports' preparation or review. The registered Professional Engineer-In-Charge shall seal all final submittals.

4.7 Project Control and Reporting. The Contractor shall prepare and submit a master network schedule (using Microsoft "Project" software), cost and manpower plan, monthly status reports, technical progress reports, monthly individual performance reports and cost/schedule variance report, work task proposal plan, and a program control plan.

4.8 Monthly Status Report. The monthly progress report shall describe the work performed since the previous report, work currently underway and work anticipated. This report shall show the earned value curves for the amount of funds obligated, planned and actually spent to date on the project. This will allow the continuous tracking of the actual cost versus the proposed cost at the beginning of the project. The report shall state whether current work is on schedule. If the work is not on schedule, the Contractor shall state what actions are anticipated in order to get back on-schedule. A summary of the phone conversations, minutes of meetings, and written correspondence shall be provided in accordance with DIDs OE-045 and OE-055, and submitted with the monthly progress report. The report shall be submitted in accordance with DID OE-085.

4.9 Weekly Status Report. Weekly status reports shall be submitted in accordance with DID OE-080, starting when the Contractor mobilizes for fieldwork and ending with demobilization.

4.10 Public Affairs. The Contractor shall not publicly disclose any data generated or reviewed under this contract. The Contractor shall refer all requests for information concerning site conditions to the local Corps District's Public Affairs Office, with a copy furnished to the CEHNC Project Manager. Reports and data generated under this contract are the property of the DoD and distribution to any other source by the Contractor, unless authorized by the Contract Officer, is prohibited.

4.11 Addresses. The following addresses shall be used in mailing submittals:

ADDRESSEE	QUANTITY
Commander US Army Corps of Engineers, Huntsville Center ATTN: CEHNC-OE-DC (Mr. Robert Nore) P.O. Box 1600 Huntsville, Alabama 35807-4301	4
Commander US Army Corps of Engineers, Honolulu District ATTN: CEPOH-PM, Ms. Helene Takemoto Bldg. 230 Fort Shafter, HI 96858-5440	4

4.12 Schedule and Submittals. The Contractor shall submit all deliverable data to the Contracting Officer and other reviewers shown in Paragraph 4.11 in accordance with the following schedule. All submittals shall be delivered to all addressees no later than the close of business on the day indicated in this paragraph. In addition, registered mail or other method where a signed receipt is obtained indicating the date received and the individual accepting the submittal shall be used to ship submittals to regulatory reviewers.

DOCUMENT	DATE DUE
Targeted date of award	14 Dec 01
WTP	21 Jan 02
ASSHP	Prior to site visit
Site Visit Letter Report	3 working days after site visit
Draft Geophysical Test Plot Plan	28 Jan 02
Final Geophysical Test Plot Plan	21 Feb 02
TPP Phase I & II Partnering Meeting	TBD
TPP Phase I Worksheet(s)	11 Feb 02
TPP Phase II Worksheet(s)	11 Feb 02
TPP Phase III & IV Partnering meeting	TBD
TPP Phase III Summary Table(s)	08 April 02
TPP Phase IV Data Collection Program Design	06 May 02
TPP Final Meeting	TBD
EE/CA Work Plan, Draft	28 June 02
EE/CA Work Plan, Draft Final	29 July 02
Geophysical Equipment Test Report	27 May 02
EE/CA Work Plan, Final	19 August 02
Government approval to commence fieldwork.	26 August 02
Weekly Field Report *	Every Monday for the previous week
Monthly Progress Report	NLT 10th of the following month
EE/CA Report, Draft	29 Jan 03
EE/CA Report, Draft Final	10 March 03
Public Meeting	21 March 03
Draft Action Memorandum	10 March 03
EE/CA Report, Final	02 May 03
Final Action Memo & Responsiveness Summary	02 May 03
Project Meeting, Alabama	TBD
Project Meeting, Contractor Office	TBD
Minutes of Meetings	NLT 10 days after each meeting

The overall completion date of this delivery order is 30 June 2003.

5.0 SAFETY AND HEALTH PROGRAM The Contractor shall develop and maintain a Health and Safety Program (HSP) in compliance with the requirements of OSHA standards 29CFR1910.120(b)(1) through (b) (4). The Contractor shall provide written certification the HSP has been submitted to the CO and make the HSP available upon request by the Government. The SSHP required by 29CFR1910.120(b)/29CFR1926.65(b)(4), and as defined by DID OE-005-06, shall be prepared and submitted with the Work Plan for approval. On-site activities shall not commence until the plan has been reviewed and accepted. The Contractor's Site Safety and Health Officer (SSHO) shall have the training, knowledge and experience necessary to implement the SSHP and have the same minimum qualifications as an UXO Supervisor.

6.0 REFERENCES.

6.1 National Contingency Plan, 40 CFR 300.

6.2 Federal Acquisition Regulation, F.A.R. Clause 52.236-13: Accident Prevention.

6.3 Army Corps of Engineers Safety and Health Requirements Manual.

6.4 EM-385-1-1, 3 September 1996.

6.5 Army Corps of Engineers, ER-385-1-92, Appendix B, Safety and Occupational Health Document Requirements for Hazardous Toxic and Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OE) Activities, 1 September 2000.

6..6 Occupational Safety and Health Administration (OSHA) General Industry Standards, 29 CFR 1910 and Construction Industry Standards, 29 CFR 1926; especially 196.120/29CFR1926.65-"Hazardous Waste Site Operations and Emergency Response."

6.7 NIOSH/OSHA/USCG/EPA, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities", October 1985. (DHHS(NIOSH) Publication No. 85-115).

6.8 CEHNC 1115-3-86, "Ordnance and Explosives Cost-Estimating Risk Tool (OECert) Standing Operating Procedure (SOP)", November 1996.

6.9 Explosives Safety Submission format, CEHNC, October 1998.

The following CEHNC Data Item Description references are available on the CEHNC Web Page at http://www.hnd.usace.army.mil/oew/policy/dids/didindx.html

Type I Work Plan	OE-001
Technical Management Plan	OE-005-02
Explosives Management Plan	OE-005-03
Explosives Siting Plan	OE-005-04
Geophysical Investigation Plan	OE-005-05
Site Safety and Health Plan	OE-005-06
Location Surveys and Mapping Plan	OE-005-07
Work, Data, and Cost Management Plan	OE-005-08
Property Management Plan	OE-005-09
Quality Control Plan	OE-005-11
Environmental Protection Plan	OE-005-12
Geographical Information System Plan	OE-005-14
Engineering Evaluation/Cost Analysis (EE/CA) Report	OE-010
Accident/Incident Reports	OE-015
Personnel/Work Standards	OE-025
Report/Minutes, Record of Meetings	OE-045
Telephone Conservation/Correspondence Records	OE-055
Conventional Explosives Safety Submission (ESS)	OE-060
Monthly Status Report	OE-080
Weekly Status Report	OE-085
Ordnance Filler Report	OE-090
Analysis of Institutional Controls	OE-100

7.0 GOVERNMENT-FURNISHED.

7.1 Inventory Project Report for Site No. H09HI027201, Maui Opana Point Bombing Range, dated 6 April 1992.

7.2 Inventory Project Report for Site No. H09HI009801, Gunnery Site, Hamakuapoko, Makawao, dated September 1995.

APPENDIX B

GEOPHYSICAL DATA

APPENDIX B-1

GEOPHYSICAL PROVE-OUT RESULTS

Geophysical Prove-Out Results for Opana Point Bombing and Makawao Gunnery Ranges, Maui, Hawaii

1. INTRODUCTION

During the period 25 to 27 March 2002, a geophysical prove-out (GPO) was conducted at Opana Point, Maui, Hawaii in preparation for a forthcoming EE/CA to be carried out by ZAPATAENGINEERING and Blackhawk UXO Services at the former Opana Point Bombing Range and the former Makawao Gunnery Site.

Data acquisition and processing steps carried out during the prove-out are described in enclosed report titled, "Geophysical Equipment Test at Opana Point Bombing Range, Maui, Hawaii," submitted by Blackhawk UXO Services Project Number 2721BX1, April 26, 2002.

2. SITE DESCRIPTION

A brush-free area was located on the Opana Point site. Although the ground had been plowed, the surface was quite rough and covered with cobble to boulder-size hard dirt clods. The survey lines were run in a N70W direction, as parallel as possible to irregular furrows and ruts made by the plow and tractor.

3. QUALITY CONTROL

EM and GPS data-collection quality-control steps specified in the Geophysical Prove-out Work Plan were carried out by Blackhawk and monitored by the ZAPATAENGINEERING Senior Geophysicist and by the USACE Project Geophysicist Jon Durham. Blackhawk complied with all QC procedures.

The field crew monitored the GPS quality control index during acquisition to assure basic data quality. Data acquisition/processing quality was monitored each evening and/or next morning following fieldwork. The subcontractor's normal field and data processing methods were followed and satisfied or exceeded the requirements of the Work Plan.

During field processing of the Opana Point background data acquired on March 25, 2002, GPS gaps were found along the survey lines. The cause was found to be a second GPS data stream, which interfered with recording. In addition, rough ground surface degraded background data quality. The field-plotted data were deemed adequate to select clear areas for seeding. The superfluous GPS data stream was removed; EM and GPS acquisition rates were increased from 5 Hz to 10 Hz and from 1 Hz to 5 Hz, respectively. These changes resulted in well-defined targets with a much improved and acceptable background.

4. CONCLUSION

All seeded items were detected at both the 2.5-foot and 3.0-foot line spacings. The smaller line spacing did not consistently improve detection. The 3.0-foot line spacing shows slightly better target definition on the 200-foot line, and indicates better lateral target detection than the smaller spacing, an important factor if meandering path detection is required in some portions of the geophysical investigation areas. The 2.5-foot line spacing seems to provide marginally better target resolution on the 300-foot line.

The GPO shows that the EM and GPS equipment selected for OE detection at Opana Point and Makawao will be satisfactory to detect expected ordnance at those sites. EE/CA procedures will utilize the faster acquisition rates, at 3.0-foot line.

David A. Smith
Senior Geophysicist,
Zapata Engineering

APPENDIX B-2

GEOPHYSICAL EQUIPMENT TEST

APPENDIX B-3

GEOPHYSICAL SURVEY

GEOPHYSICAL SURVEYS
AT OPANA POINT BOMBING RANGE AND
MAKAWAO GUNNERY SITE
MAUI, HAWAII

Blackhawk UXO Services Project Number 2721BX1

Prepared For:

ZAPATA ENGINEERING
1100 Kenilworth Avenue
Charlotte, North Carolina 29204
704-358-8240 • Fax 704-358-8342

Prepared By:

BLACKHAWK UXO SERVICES
301 Commercial Road, Suite B
Golden, Colorado 80401
303-278-8700 • Fax 303-278-0789

December 17, 2002

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1.0 INTRODUCTION

An Engineering Evaluation/Cost Analysis (EE/CA) will be done by Zapata at Opana Point Bombing Range (Opana) and Makawao Gunnery Site (Makawao), Maui, Hawaii. In support of this EE/CA, a geophysical survey was conducted by Blackhawk UXO Services (Blackhawk) at Opana and at Makawao. Approximately 10 acres were surveyed at Opana and 20 acres at Makawao. The acreage was divided up between small (< 1 acre) grids and meandering path transects at both sites.

Blackhawk used a Geonics EM61-MK2 system to collect geophysical data. The EM61-MK2 was towed over the grids and transects with an All Terrain Vehicle (ATV). Positioning data were acquired with a Trimble RTK Global Positioning System (GPS). Blackhawk and Zapata personnel relocated target anomaly picks using RTK GPS and a Fisher 1266XB Metal Detector.

2.0 SURVEY LOGISTICS

2.1 Site Description

2.1.1 Opana Point Bombing Range

Nine small grids and seventeen meandering path transects were constructed by Zapata at Opana. The site was however, plowed recently resulting in parallel furrows and a rough irregular ground surface. Geophysical data were collected over each grid using a three foot line spacing and along single survey lines for each transect. A total of 8.64 acres were surveyed as grids and 1.45 acres as transects. A summary of the data collection is shown in Tables 2-1 and 2-2. Transect acreage was calculated using a sampling width of 3.28 ft.

Table 2-1
Opana Point Data Collection (Transects)

Transect ID	Total Length (ft)	Acres
TL-1	698	0.05
TL-2	595	0.04
TL-3	730	0.05
TL-4	1500	0.11
TL-5	1500	0.11
TL-6	1500	0.11
TL-7	1500	0.11
TL-8	1500	0.11
TL-9	1500	0.11
TL-10	1200	0.09
TL-11	1200	0.09
TL-12	1100	0.08
TL-13	1000	0.08
TL-14	1000	0.08
TL-15	1000	0.08
TL-16	1000	0.08
TL-17	800	0.06

Table 2-2
Opana Point Data Collection (Grids)

Grid ID	AREA (ft^2)	Acres
1	43874	1.01
2	45112	1.04
3	27192	0.62
4	44379	1.02
5	42648	0.98
6	22539	0.52
7	59973	1.38
8	17241	0.40
9	73285	1.68

2.1.2 Makawao Gunnery Site

Sixteen small grids and fourteen meandering path transects were constructed by Zapata at Makawao. Geophysical data were collected over each grid using a three foot line spacing and along single survey lines for each transect. A total of 13.53 acres were surveyed as grids and 4.49 acres as transects collecting data either along single survey lines or along multiple adjacent survey lines with a three foot line spacing. A summary of the data collection is shown in Tables 2-3 and 2-4. Transect acreage was calculated using a sampling width of 3.28 ft.

Table 2-3
Makawao Data Collection (Transects)

Transect ID	Length (ft)	Acres
TS1-WEST	8101	0.61
TS1-EAST	15273	1.15
TSA1	1992	0.15
TSA2	7171	0.54
PATH B	2125	0.16
PATH C	797	0.06
PATH D	3984	0.3
PATH E	3320	0.25
PATH F	7570	0.57
PATH G	1461	0.11
PATH H	1992	0.15
PATH I	1062	0.08
PATH J	1328	0.1
ROAD_DATA	3453	0.26

Table 2-4
Makawao Point Data Collection (Grids)

Grid ID	AREA (ft^2)	Acres
1	30008	0.69
3	40833	0.94
4	44088	1.01
5	39202	0.90
6	42187	0.97
7	45805	1.05
8	48293	1.11
9	12756	0.29
10	32025	0.74
12	42836	0.98
13	15614	0.36
15	45519	1.04
16	45483	1.04
19	11784	0.27
20	47309	1.09
21	45602	1.05

2.2 Geophysical Equipment

2.2.1 EM61-MK2

The Geonics EM61-MK2 metal detection system consists of a single set of one by one-half meter coils. When mounted in the wheel assembly, the bottom coil is located 45 centimeters (cm) above the ground. The bottom coil functions as a transmitter coil and as a receiver coil. The second receiver coil is located 28 cm above the bottom coil. The electronics are stored in a backpack that is attached to the ATV. The coils are oriented with the axis of the one-meter side perpendicular to the direction of travel, such that a one-meter swath is covered with each pass. Geophysical data were collected at a rate of 10 hertz (Hz) and stored in the PRO4000 field computer for downloading at the end of the field day.

The TDEM method generates an electromagnetic (EM) pulse in the transmitter coil, causing eddy currents to flow both within the ground and within metal objects. When the EM pulse is terminated, the eddy currents decay and induce a secondary magnetic field. In the MK2 system, four separate time channels of secondary response are measured by the receiver coils and recorded in millivolts (mV). The equipment operator has the option of collecting four channels of bottom coil response, or three channels of bottom coil and one channel of top coil response. The first (earliest) time gate of bottom coil response (Channel 1 – 216 usec) was utilized for data interpretation based on the results of the geophysical prove out. The data from this time gate has the highest signal to noise ratio and is the best at identifying metal targets.

This system is designed so that a low level and/or constant signal is received when no metal is present. When metal is present, an increased signal is received. This signal is generally

highest, for larger objects, when the coils are located directly over the object. This results in "bulls-eye" type anomalies for isolated metal objects and simplifies data analysis.

2.2.2 Sensor Positioning

Sensor positioning was accomplished with the Trimble 4700 RTK differential global positioning system (DGPS). With this system, the center points of sensor readings have a location precision of six inches. Target anomalies are expected to have location precision between six and 18 inches due to the geophysical sensor width and line spacing. Positional data are recorded in the PRO4000 computer as WGS-84 latitude and longitude coordinates at a rate of 1 Hz.

The DGPS base station is generally located within one to two miles, line of site, from the survey area. The DGPS base station receiver is set up over a known control point and a spatial position correction is transmitted in real time to the DGPS rover receiver via a radio modem. Table 2-5 lists the stations and their coordinates used for the DGPS base station at Opana Point and Makawao.

Table 2-5
GPS Base Station Coordinates
(NAD83 Hawaii Zone 2 State Plane, US Survey Feet)

Opana Point		**Makawao**	
Station 1	Coordinates	Station 1 (9-11 and 9-12)	Coordinates
Easting	1771966.08	Easting	1777930.594
Northing	221636.49	Northing	209153.675
		Station 20 (9-13 to 9-30)	
		Easting	1779076.521
		Northing	208821.904

2.3 Quality Control

To ensure high-quality geophysical data, the data collection and processing steps were monitored. During data collection, the following steps were performed for quality control:

- A 15-minute warm-up was allotted for the geophysical sensors prior to data collection.
- After the warm-up period, data were recorded in a stationary mode for two to three minutes to aid in identifying equipment problems and determining instrument drift.
- Daily latency tests were performed to verify GPS positioning, lag correction, and sensor operation.
- Daily standard tests were performed to verify sensor operation in static mode.
- A dynamic test was performed to verify sensor operation in dynamic mode.
- The GPS quality control index number and sensor data were monitored during data collection.

During data processing the following quality control steps were performed:

- Dynamic and static tests were reviewed for proper sensor operation.
- Daily latency tests were processed to verify GPS positioning, lag value, and sensor operation.
- The positional data were verified through the GPS quality control index.
- Data processing steps were tracked to ensure all data were processed in the same manner.
- Raw and processed geophysical data were posted on the Blackhawk FTP site for downloading by appropriate parties.

2.4 Static Tests

Prior to and after geophysical data collection, sensor data were recorded in a stationary mode for two to three minutes. The deviation of the instrument readings was monitored by the field crew.

2.5 Standard Tests

At the beginning and end of each field day, the geophysical sensors were zeroed. A metal standard was placed in exactly the same position on the geophysical sensors and data were recorded with the instrument in static mode. The magnitudes of these standard readings are listed in Appendix A.

2.6 Latency Tests

Latency tests were performed daily to verify GPS positioning and lag adjustment. This was accomplished by passing over a metal stake in two or more directions. The geophysical data were checked for positional accuracy, lag correction, and sensor operation. The results of these tests are listed in Appendix B.

3.0 DATA PROCESSING

3.1 Geophysical Data

The geophysical data were processed and interpreted using the MTADS data analysis system (DAS). All processing and data analysis steps were recorded on an MTADS DAS Tracking Sheet (Appendix C).

The processing stream consisted of the following steps:

- Raw geophysical and GPS data for the system were downloaded from the field computers or data loggers and combined in the DAS preprocessor.
- The QC standard tests were evaluated and sensor readings tabulated.
- The latency tests were evaluated and the necessary lag corrections were applied to the sensor data.
- The dynamic test was evaluated for positional accuracy and sensor operation.
- Individual geophysical data streams were evaluated for spikes, time gaps, and sensor failure.
- Low quality DGPS data points were edited or removed.
- The field notes were evaluated for recorded cultural features and equipment problems. Copies of the field notes are located in Appendix D
- A demedian filter was applied to the geophysical data to remove sensor drift and level the data to a zero baseline. A 200-point demedian filter was used for the EM61-MK2 data.
- The sensor data were gridded with a .2m cell size and displayed on the screen in gridded and pixel format.
- Processed data were output in XYZ ASCII format. Positioning data were reported in NAD83 State Plane Coordinates, Hawaii Zone 2, US Survey Feet. Preliminary data sets were posted on Blackhawk's FTP site.
- Final data sets were posted on Zapata's web page site after the geophysical investigation. Additionally, final data sets are included on the enclosed CD.
- Target anomalies were selected from the gridded geophysical data in the DAS. A peak-picking algorithm within the DAS was used as the initial step in target identification. A threshold value of 10 mV was applied to the bottom coil (Channel 1) of the EM61-MK2 data. Target lists were output for QC in Oasis montaj.
- Target selections were QCed in Oasis montaj. Anomalies not selected by the peak-picker were added to the target lists. The Data QC person looked for round "bulls-eye" anomalies that were detected on adjacent survey passes. Targets attributed to single point data spikes, system noise, and gridding effects were removed.

- Final target lists were generated. Positioning data were reported in NAD83 State Plane Coordinates, Hawaii Zone 2, US Survey Feet. Hard copies of the target reports are located in Appendix E and electronic files are included on the attached CD.

4.0 SURVEY RESULTS

4.1 Opana Point Bombing Range

Tables 4-1 and 4-2 list each transect and grid collected at Opana Point respectively. A total of 8.64 acres were collected in grids and 1.45 acres were collected along the transects for a total of 10.09 acres. The table also shows the number of anomaly picks by Blackhawk and the total actually relocated.

Table 4-1

Opana Point Data Collection (Transects)

Transect ID	Acres	Total Anomalies	Relocated	Reacquired	No Contact
TS-1	0.05	10	3	3	0
TS-2	0.04	26	13	13	0
TS-3	0.05	24	10	10	0
TS-4	0.11	37	0	0	0
TS-5	0.11	58	9	9	0
TS-6	0.11	53	2	2	0
TS-7	0.11	6	0	0	0
TS-8	0.11	19	4	4	0
TS-9	0.11	30	3	3	0
TS-10	0.09	25	2	2	0
TS-11	0.09	6	2	1	1
TS-12	0.08	46	2	2	0
TS-13	0.08	35	2	1	1
TS-14	0.08	21	0	0	0
TS-15	0.08	28	4	4	0
TS-16	0.08	31	4	3	1
TS-17	0.06	10	0	0	0
Totals	1.45	465	60	57	3

Table 4-2

Opana Point Data Collection (Grids)

Grid ID	Acres	Total Anomalies	Relocated	Reacquired	No Contact
1	1.01	396	83	70	13
2	1.04	502	66	59	7
3	0.62	205	53	52	1
4	1.02	229	59	23	36
5	0.98	270	71	37	34
6	0.52	90	41	37	4
7	1.38	251	66	59	7
8	0.40	88	26	18	8
9	1.68	497	94	86	8
Totals	8.64	2510	559	441	118

Figure 4-1 shows data collected over Grid 1. The data collected with the ATV during the actual survey tended to be noisier than the data collected over the proveout. The noise in the data has been attributed to two items;

1. The electrical system of the ATV was identified to cause ~3-5 mV of noise in the EM61-MK2 system. The field crew was unable to disconnect the electrical system or isolate the EM61-MK2 console.
2. Data collection during the proveout was done by hand-pulling the EM61-MK2 coil. Data were collected during the survey by towing the coil with an ATV. Data in the production survey were noisier than the GPO data because the terrain in the plowed fields was rougher than the area of the prove out lines.

Figure 4-2 shows data collected over the test plot on Mar 27th, '02 and Aug 14th, '02. Data from Mar 27th were collected with a hand towed EM61-MK2 using the wheel mode. Data from Aug 14th were collected with the EM61-MK2 in the automatic mode and towed by the ATV. The figure illustrates the slightly higher noise levels evident in the ATV towed data. The data displayed were collected along the same line in the test plot.

Zapata selected all targets for relocation. Grid 1 was used to help determine the amount of noise in the system and the impact on anomaly picks near and at the 10 mV threshold. Approximately 42% (35 of 83) of targets selected for relocation in Grid 1 were below 20 mV. Of these 35 targets, 12 were listed as No Contact. Appendix F contains a copy of the field notes generated during reacquisition. Appendix G contains maps for all grids and transects from Opana Point.

4.2 Makawao Gunnery Site

Tables 4-3 and 4-4 list each transect and grid collected at Makawao respectively. A total of 13.53 acres were collected in grids and 4.49 acres were collected along the transects for a total of 18.02 acres. The table also shows the number of target anomaly picks by Blackhawk and the number of target picks relocated for investigation.

Table 4-3

Makawao Data Collection (Transects)

Transect ID	Acres	Total Anomalies	Relocated	Reacquired	No Contact
TS1-WEST	0.61	259	33	28	5
TS1-EAST	1.15	245	18	8	10
TSA1	0.15	52	23	9	14
TSA2	0.54	56	21	2	19
PATH B	0.16	125	9	0	9
PATH C	0.06	36	8	3	5
PATH D	0.3	183	10	2	8
PATH E	0.25	180	10	7	3
PATH F	0.57	281	17	4	13
PATH G	0.11	25	8	2	6
PATH H	0.15	85	9	0	9
PATH I	0.08	27	7	3	4
PATH J	0.1	36	16	0	16
ROAD_DATA	0.26	109	9	4	5
Totals	4.49	1703	198	72	126

Table 4-4

Makawao Point Data Collection (Grids)

Grid ID	Acres	Total Anomalies	Relocated	Reacquired	No Contact
1	0.69	69	23	9	14
3	0.94	102	38	37	1
4	1.01	78	18	17	1
5	0.90	82	22	0	22
6	0.97	66	29	2	27
7	1.05	58	35	33	2
8	1.11	98	33	32	1
9	0.29	168	9	0	9
10	0.74	170	30	15	15
12	0.98	316	38	14	24
13	0.36	41	14	9	5
15	1.04	174	24	10	14
16	1.04	191	38	29	9
19	0.27	20	20	8	12
20	1.09	23	23	6	17
21	1.05	24	24	11	13
Totals	13.53	1680	418	232	186

Appendix F contains a copy of the field notes generated during reacquisition. Appendix H contains maps generated for all grids and transects from Makawao.

The high percentage of No Contacts (51%) at the Makawao site is likely the result of super paramagnetic soils. This soil can form during lateritic weathering of mafic rocks, such as basalts. At Makawao, the UXO dig teams encountered soils at numerous target locations

that gave an EM response with Fischer instruments but had no associated metal objects present. A brick-red soil horizon, exposed along roads, showed a significant EM response.

During data collection of Transect D at Makawao on September 17th, Blackhawk field personnel noted a large drift in the data set. Data collection was ceased on Sept 17th to identify the problem. The drift was attributed to a small crack developing in the lamination of the coil. Moisture was seeping into the crack and coming in contact with the metal wire inside the coil. A replacement coil was sent to the field crew. On Sept 19th as a system verification test, the field crew recollected data over Transects A1, A2, B, C, and D that had previously been collected on Sept 17th. This data was processed and compared with previously collected data. Figure 4-3 shows a comparison between data collected on the 17th and with data collected on the 19th over Transect A1. The same anomaly has been circled on both contour maps. A circle has been placed on the profile plots where the anomaly appears. There is approximately a 10% difference in the response between the two coils. The figure illustrates that the new coil is responding in the same manner as the original coil.

Upon further investigation of Path F, Blackhawk processors found some questionable GPS data points. For the final map these points were removed. Removal of these GPS points has resulted in a decrease in the total number of target anomalies selected. Target ID's 33, 34, 55, and 56 were selected over data that has been removed. These four targets have been removed from the final target anomaly files.

Transects A1, A2, B, and E at Makawao were collected to increase the total sampled acreage. These transects consist of multiple survey lines rather than a single survey line along the transect.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The Geonics EM61-MK2 proved to be an effective tool at detecting buried metal at the Opana Point Bombing Range and the Makawao Gunnery Site. In all, a total of 10.1 acres were surveyed at Opana Point and 18.03 acres at Makawao. The geophysical surveys identified a total of 2,975 targets, ~295/acre, at Opana Point. Of these 2,975 targets, 619 were selected for investigation. A total of 498 targets (80%) were reacquired with the Fisher while there were 121 No Contacts (20%). A total of 3,379 targets, ~188/acre, were mapped at the Makawao Gunnery Site. Of these 3,379 targets, 616 were selected for investigation. A total of 304 targets (49%) were reacquired with the Fisher while there were 312 No Contacts (51%). The higher percentage of No Contacts at Makawao is likely caused by the occurrence of super paramagnetic soils. These soils were not a significant problem at the Opana Point site.

APPENDIX A
EM STANDARD TESTS

6

Hawaii Standard Tests
MK2 EM Array

	Average (mV)			
	Ch1	Ch2	Ch3	Ch4
Bottom	136	76	36	196

		Ch1	Ch2	Ch3	Ch4
Sum of Measurements	Bot	4352	2446	1151	6287
Number of Measurements		32			

		Background (mV)				Standard (mV)				Magnitude (mV)				% Difference			
Date	Coil	Ch1	Ch2	Ch3	Ch4	Ch1	Ch2	Ch3	Ch4	Ch1	Ch2	Ch3	Ch4	Ch1	Ch2	Ch3	Ch4
8/16/02	Bottom	1	1	1	-1	134	75	36	195	133	75	35	196	2%	3%	2%	0%
8/16/02	Bottom	1	1	1	2	135	76	35	197	134	75	35	196	1%	2%	4%	0%
8/19/02	Bottom	1	1	1	2	134	76	36	196	133	76	36	195	2%	1%	1%	1%
8/19/02	Bottom	1	2	1	2	135	77	36	194	134	76	36	193	1%	1%	1%	2%
8/20/02	Bottom	1	1	1	2	140	77	37	199	139	76	36	197	2%	1%	0%	0%
8/20/02	Bottom	1	1	1	2	137	76	36	198	136	76	36	197	0%	1%	1%	0%
8/21/02	Bottom	1	1	1	1	139	76	37	199	139	75	37	198	2%	2%	2%	1%
8/21/02	Bottom	1	1	-1	2	137	77	36	198	137	77	37	197	0%	0%	2%	0%
8/22/02	Bottom	-1	1	0	1	135	76	37	198	136	76	37	197	0%	1%	3%	0%
8/22/02	Bottom	1	1	1	-1	137	77	36	197	136	77	36	198	0%	0%	1%	1%
8/23/02	Bottom	1	1	1	1	138	77	36	196	138	76	36	195	1%	1%	1%	1%
8/23/02	Bottom	1	1	1	-1	138	78	37	199	137	77	37	200	1%	1%	2%	2%
8/27/02	Bottom	1	1	1	1	139	76	37	198	138	75	37	197	1%	2%	2%	0%
8/27/02	Bottom	1	1	1	1	136	75	36	194	135	74	36	193	1%	3%	1%	2%
8/30/02	Bottom	2	1	1	2	138	77	37	195	137	76	37	194	0%	1%	2%	2%
8/30/02	Bottom	1	1	1	2	137	78	36	196	136	78	36	195	0%	1%	1%	1%
9/3/02 -	Bottom	-1	1	1	-1	137	78	37	197	138	78	37	198	1%	1%	2%	1%
9/3/02 -	Bottom	1	-1	-1	1	137	76	36	196	136	77	37	195	0%	0%	3%	1%
9/11/02	Bottom	-1	1	1	-1	133	75	36	195	134	75	36	196	1%	3%	1%	0%
9/11/02	Bottom	1	1	0	1	137	79	37	201	137	79	37	200	0%	3%	3%	2%
9/12/02	Bottom	2	1	1	2	140	79	36	199	139	78	35	198	2%	2%	3%	1%
9/12/02	Bottom	1	1	1	-1	138	78	36	197	137	78	35	198	1%	1%	3%	1%
9/13/02	Bottom	-1	1	0	1	138	78	36	197	139	77	36	196	2%	1%	0%	0%
9/13/02	Bottom	1	1	1	1	136	76	37	197	136	76	36	196	0%	1%	0%	0%
9/14/02	Bottom	1	1	1	1	141	79	36	199	140	79	36	198	3%	3%	1%	1%
9/14/02	Bottom	1	1	1	2	138	78	37	197	137	78	36	196	1%	1%	0%	0%
9/17/02	Bottom	1	1	1	1	139	79	37	200	138	78	37	199	1%	2%	2%	1%
9/17/02	Bottom	2	1	1	1	137	76	36	195	135	76	36	194	1%	1%	1%	1%
9/19/02	Bottom	1	1	1	1	130	77	37	199	130	77	37	198	5%	0%	2%	1%
9/19/02	Bottom	1	1	1	1	135	79	37	199	135	79	37	198	1%	3%	2%	1%
9/20/02	Bottom	1	1	0	-1	139	78	37	199	138	78	37	200	1%	1%	3%	2%
9/20/02	Bottom	1	1	1	1	132	78	36	195	131	78	36	194	4%	1%	1%	1%

APPENDIX B
EM LATENCY TESTS

Appendix B

Latency Stake Locations

	Easting	Northing
	(US Feet)	(US Feet)
Opana Point	1771934.97	221719.45
Makawao 1	1777882.99	208889.58
Makawao 2	1777873.80	208899.36

Positional Tests

MK2 EM Array

(NAD83 State Plane, Hawaii 2)

	Detected	Detected	Difference	Difference
Date	**Easting (US Feet)**	**Northing (US Feet)**	**Easting (ft)**	**Northing (ft)**
Opana Point				
8/16/02 - am	1771934.67	221719.52	0.30	-0.07
8/19/02 - am	1771935.17	221719.37	-0.20	0.08
8/20/02 - am	1771934.60	221719.45	0.37	0.00
8/21/02 - am	1771935.23	221719.75	-0.26	-0.30
8/22/02 - am	1771934.68	221719.58	0.29	-0.13
8/23/02 - am	1771935.31	221719.37	-0.34	0.08
8/27/02 - am	1771935.16	221719.19	-0.19	0.26
8/30/02 - am	1771934.94	221719.53	0.03	-0.08
9/3/02 - am	1771934.97	221719.30	0.00	0.15
Makawao 1				
9/11/02 - am	1777883.38	208890.10	-0.39	-0.52
9/12/02 - am	1777883.13	208890.06	-0.14	-0.48
Makawao 2				
9/13/02 - am	1777873.87	208899.24	-0.07	0.12
9/14/02 - am	1777873.77	208899.26	0.03	0.10
9/17/02 - am	1777873.82	208899.27	-0.02	0.09
9/19/02 - am	1777873.96	208899.28	-0.16	0.08
9/20/02 - am	1777874.23	208899.24	-0.43	0.12

APPENDIX C
MTADS DAS TRACKING SHEET

Maui, Hawaii														
Opana Pt.														
Processing Log														

Collection Date	Data Type	Raw Data File	Description	Pre-Processing Date	Geometry Correction	Processed File	Processing Date	Processing System	Demedian Window	Grid Cell Size	Analytical Signal Calculated	Raw Data Map	Map Threshold	Comments
8/14/02	EM-MK2	81402A	STATIC 1	8/15/02	YES	2226642	8/15/02	MTADS DAS		0.2	No	LB_G3_RAW.jpeg		
8/14/02	EM-MK2	81402B	STANDARD 1	8/15/02	YES	2226646	8/15/02	MTADS DAS		0.2	Yes	LB_G4_RAW.jpeg		
8/14/02	EM-MK2	81402C	LATENCY 1	8/15/02	YES	2226652	8/15/02	MTADS DAS	300					LATENCY -250
8/14/02	EM-MK2	81402D	PROVEOUT	8/15/02	YES	2226656	8/15/02	MTADS DAS	300	0.2		LB_Q14_LN20-70_RAW.jpeg	10Mv	PROVEOUT
8/14/02	EM-MK2	81402E	PROVEOUT	8/15/02	YES	2226692	8/15/02	MTADS DAS	300				10Mv	PROVEOUT
8/14/02	EM-MK2	81402F	STANDARD 2	8/15/02	YES	2226709	8/15/02	MTADS DAS		0.2		LB_T4_LN1_RAW.jpeg		
8/14/02	EM-MK2	81402G	LATENCY 2	8/15/02	YES	2226711	8/15/02	MTADS DAS	300	0.2		LB_T4_LN2_RAW.jpeg		LATENCY -400
										0.2	Yes	LB_G5_RAW.jpeg		
8/16/02	EM-MK2	81602A	STATIC 1	8/19/02	YES	2228507	8/19/02	MTADS DAS						
8/16/02	EM-MK2	81602B	STANDARD 1	8/19/02	YES	2228510	8/19/02	MTADS DAS						
8/16/02	EM-MK2	81602C	LATENCY 1	8/19/02	YES	2228513	8/19/02	MTADS DAS	300					
8/16/02	EM-MK2	81602D	GRID 3	8/19/02	YES	2228520	8/19/02	MTADS DAS	300	0.2	Yes	LB_T5_LN1_RAW.jpeg	10Mv	GRID 3
8/16/02	EM-MK2	81602E	GRID 3	8/19/02	YES	2228563	8/19/02	MTADS DAS	300	0.2	Yes	LB_T5_LN2_RAW.jpeg	10Mv	GRID 3
8/16/02	EM-MK2	81602F	STATIC 2	8/19/02	YES	2228615	8/19/02	MTADS DAS		0.2	No	LB_G6_RAW.jpeg		
8/16/02	EM-MK2	81602G	STANDARD 2	8/19/02	YES	2228616	8/19/02	MTADS DAS		0.2	No	LB_G7_RAW.jpeg		
8/19/02	EM-MK2	81902A	STATIC 1	8/20/02	YES	2231529	8/20/02	MTADS DAS						
8/19/02	EM-MK2	81902B	STANDARD 1	8/20/02	YES	2231532	8/20/02	MTADS DAS						
8/19/02	EM-MK2	81902C	LATENCY 1	8/20/02	YES	2231534	8/20/02	MTADS DAS	300					Latency -300
8/19/02	EM-MK2	81902D	GRID 1	8/20/02	YES	2231536	8/20/02	MTADS DAS	300				10Mv	
8/19/02	EM-MK2	81902E	GRID 1	8/20/02	YES	2231582	8/20/02	MTADS DAS	300				10Mv	
8/19/02	EM-MK2	81902F	STATIC 2	8/20/02	YES	2231639	8/20/02	MTADS DAS						
8/19/02	EM-MK2	81902G	STANDARD 2	8/20/02	YES	2231640	8/20/02	MTADS DAS						
8/20/02	EM-MK2	82002A	STATIC 1	8/21/02	YES	2232380	8/21/02	MTADS DAS						
8/20/02	EM-MK2	82002B	STANDARD 1	8/21/02	YES	2232383	8/21/02	MTADS DAS						
8/20/02	EM-MK2	82002C	LATENCY 1	8/21/02	YES	2232386	8/21/02	MTADS DAS	300					Latency -300
8/20/02	EM-MK2	82002D	GRID 2	8/21/02	YES	2232392	8/21/02	MTADS DAS	300				10Mv	GRID 2
8/20/02	EM-MK2	82002E	GRID 2	8/21/02	YES	2232447	8/21/02	MTADS DAS	300				10Mv	GRID 2
8/20/02	EM-MK2	82002F	STATIC 2	8/21/02	YES	2232626	8/21/02	MTADS DAS						
8/20/02	EM-MK2	82002G	STANDARD 2	8/21/02	YES	2232627	8/21/02	MTADS DAS						
8/21/02	EM-MK2	82102A	STATIC 1	8/22/02	YES	2233347	8/22/02	MTADS DAS						
8/21/02	EM-MK2	82102B	STANDARD 1	8/22/02	YES	2233350	8/22/02	MTADS DAS						
8/21/02	EM-MK2	82102C	LATENCY 1	8/22/02	YES	2233354	8/22/02	MTADS DAS	100					Latency -300
8/21/02	EM-MK2	82102D	GRIDS 3&4	8/22/02	YES	2233362	8/22/02	MTADS DAS	100				10Mv	
8/21/02	EM-MK2	82102E	GRIDS 3&4	8/22/02	YES	2233407	8/22/02	MTADS DAS	100				10Mv	
8/21/02	EM-MK2	82102F	GRIDS 3&4	8/22/02	YES	2233529	8/22/02	MTADS DAS	100				10Mv	
8/21/02	EM-MK2	82102G	GRIDS 3&4	8/22/02	YES	2233576	8/22/02	MTADS DAS	100				10Mv	
8/21/02	EM-MK2	82102H	STATIC 2	8/22/02	YES	2233626	8/22/02	MTADS DAS						
8/21/02	EM-MK2	82102I	STANDARD 2	8/22/02	YES	2233627	8/22/02	MTADS DAS						

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Processing Log														

Collection Date	Data Type	Raw Data File	Description	Pre-Processing Date	Geometry Correction	Processed File	Processing Date	Processing System	Demedian Window	Grid Cell Size	Analytical Signal Calculated	Raw Data Map	Map Threshold	Comments
8/22/02	EM-MK2	82202A	STATIC 1	8/23/02	YES	2234397	8/23/02	MTADS DAS						
8/22/02	EM-MK2	82202B	STANDARD 1	8/23/02	YES	2234400	8/23/02	MTADS DAS						
8/22/02	EM-MK2	82202C	LATENCY 1	8/23/02	YES	2234402	8/23/02	MTADS DAS	100					Latency -250
8/22/02	EM-MK2	82202D	GRID 6	8/23/02	YES	2234411	8/23/02	MTADS DAS	100				10Mv	
8/22/02	EM-MK2	82202E	TRANSECT 1	8/23/02	YES	2234522	8/23/02	MTADS DAS	100				10Mv	
8/22/02	EM-MK2	82202F	TRANSECT 2	8/23/02	YES	2234529	8/23/02	MTADS DAS	100				10Mv	
8/22/02	EM-MK2	82202G	TRANSECT 3	8/23/02	YES	2234536	8/23/02	MTADS DAS	100				10Mv	
8/22/02	EM-MK2	82202H	TRANSECT 4	8/23/02	YES	2234542	8/23/02	MTADS DAS	100				10Mv	
8/22/02	EM-MK2	82202I	TRANSECT 5	8/23/02	YES	2234578	8/23/02	MTADS DAS	100				10Mv	
8/22/02	EM-MK2	82202J	TRANSECT 6	8/23/02	YES	2234604	8/23/02	MTADS DAS	100				10Mv	
8/22/02	EM-MK2	82202K	STATIC 2	8/23/02	YES	2234620	8/23/02	MTADS DAS						
8/22/02	EM-MK2	82202L	STANDARD 2	8/23/02	YES	2234622	8/23/02	MTADS DAS						
8/23/02	EM-MK2	82302A	STATIC 1	8/26/02	YES	2235568	8/26/02	MTADS DAS						
8/23/02	EM-MK2	82302B	STANDARD 1	8/26/02	YES	2235570	8/26/02	MTADS DAS						
8/23/02	EM-MK2	82302C	LATENCY 1	8/26/02	YES	2235572	8/26/02	MTADS DAS	100					Latency -400
8/23/02	EM-MK2	82302D	TRANSECT 7	8/26/02	YES	2235578	8/26/02	MTADS DAS	100				10Mv	
8/23/02	EM-MK2	82302E	TRANSECT 8	8/26/02	YES	2235589	8/26/02	MTADS DAS	100				10Mv	
8/23/02	EM-MK2	82302F	TRANSECT 9	8/26/02	YES	2235600	8/26/02	MTADS DAS	100				10Mv	
8/23/02	EM-MK2	82302G	STATIC 2	8/26/02	YES	2235611	8/26/02	MTADS DAS						
8/23/02	EM-MK2	82302H	STANDARD 2	8/26/02	YES	2235612	8/26/02	MTADS DAS						
8/27/02	EM-MK2	82702A	STATIC 1	8/28/02	YES	2239509	8/28/02	MTADS DAS						
8/27/02	EM-MK2	82702B	STANDARD 1	8/28/02	YES	2239511	8/28/02	MTADS DAS						
8/27/02	EM-MK2	82702C	LATENCY 1	8/28/02	YES	2239515	8/28/02	MTADS DAS	100					Latency -200
8/27/02	EM-MK2	82702D	TRANSECT 10	8/28/02	YES	2239518	8/28/02	MTADS DAS	100				10Mv	
8/27/02	EM-MK2	82702E	TRANSECT 11	8/28/02	YES	2239523	8/28/02	MTADS DAS	100				10Mv	
8/27/02	EM-MK2	82702F	TRANSECT 12	8/28/02	YES	2239527	8/28/02	MTADS DAS	100				10Mv	
8/27/02	EM-MK2	82702G	TRANSECT 13	8/28/02	YES	2239543	8/28/02	MTADS DAS	100				10Mv	
8/27/02	EM-MK2	82702H	TRANSECT 14	8/28/02	YES	2239551	8/28/02	MTADS DAS	100				10Mv	
8/27/02	EM-MK2	82702L	TRANSECT 15	8/28/02	YES	2239636	8/28/02	MTADS DAS	100				10Mv	
8/27/02	EM-MK2	82702M	TRANSECT 16	8/28/02	YES	2239643	8/28/02	MTADS DAS	100				10Mv	
8/27/02	EM-MK2	82702N	TRANSECT 17	8/28/02	YES	2239650	8/28/02	MTADS DAS	100				10Mv	
8/27/02	EM-MK2	82702O	STATIC 2	8/28/02	YES	2239653	8/28/02	MTADS DAS						
8/27/02	EM-MK2	82702P	STANDARD 2	8/28/02	YES	2239654	8/28/02	MTADS DAS						

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Collection Date	Data Type	Raw Data File	Description	Pre-Processing Date	Geometry Correction	Processed File	Processing Date	Processing System	Demedian Window	Grid Cell Size	Analytical Signal Calculated	Raw Data Map	Map Threshold	Comments
8/30/02	EM-MK2	83002A	STATIC 1	9/2/02	YES	2242434	9/2/02	MTADS DAS						
8/30/02	EM-MK2	83002B	STANDARD 1	9/2/02	YES	2242436	9/2/02	MTADS DAS						
8/30/02	EM-MK2	83002C	LATENCY 1	9/2/02	YES	2242438	9/2/02	MTADS DAS	100					Latency -200
8/30/02	EM-MK2	83002D	GRID 7	9/2/02	YES	2242443	9/2/02	MTADS DAS	100				10Mv	
8/30/02	EM-MK2	83002E	GRID 7	9/2/02	YES	2242517	9/2/02	MTADS DAS	100				10Mv	
8/30/02	EM-MK2	83002F	GRID 8	9/2/02	YES	2242590	9/2/02	MTADS DAS	100				10Mv	
8/30/02	EM-MK2	83002G	STATIC 2	9/2/02	YES	2242628	9/2/02	MTADS DAS						
8/30/02	EM-MK2	83002H	STANDARD 2	9/2/02	YES	2242630	9/2/02	MTADS DAS						
9/3/02	EM-MK2	90302A	STATIC 1	9/4/02	YES	2246438	9/4/02	MTADS DAS						
9/3/02	EM-MK2	90302B	STANDARD 1	9/4/02	YES	2246441	9/4/02	MTADS DAS						
9/3/02	EM-MK2	90302C	LATENCY 1	9/4/02	YES	2246443	9/4/02	MTADS DAS	100					Latency -250
9/3/02	EM-MK2	90302D	GRID 9	9/4/02	YES	2246450	9/4/02	MTADS DAS	100				10Mv	
9/3/02	EM-MK2	90302E	GRID 9	9/4/02	YES	2246539	9/4/02	MTADS DAS	100				10Mv	
9/3/02	EM-MK2	90302F	OOP OF ROAD	9/4/02	YES	2246601	9/4/02	MTADS DAS	100				10Mv	
9/3/02	EM-MK2	90302G	STATIC 2	9/4/02	YES	2246622	9/4/02	MTADS DAS						
9/3/02	EM-MK2	90302H	STANDARD 2	9/4/02	YES	2246624	9/4/02	MTADS DAS						
Makawao														
9/11/02	EM-MK2	91102A	STATIC 1	9/12/02	YES	2254396	9/12/02	MTADS DAS						
9/11/02	EM-MK2	91102B	STANDARD 1	9/12/02	YES	2254399	9/12/02	MTADS DAS						
9/11/02	EM-MK2	91102C	LATENCY 1	9/12/02	YES	2254402	9/12/02	MTADS DAS	100					
9/11/02	EM-MK2	91102D	GRID 6	9/12/02	YES	2254409	9/12/02	MTADS DAS	100				10Mv	
9/11/02	EM-MK2	91102E	GRID 4	9/12/02	YES	2254509	9/12/02	MTADS DAS	100				10Mv	
9/11/02	EM-MK2	91102F	GRID 3	9/12/02	YES	2254600	9/12/02	MTADS DAS	100				10Mv	
9/11/02	EM-MK2	91102G	STATIC 2	9/12/02	YES	2254666	9/12/02	MTADS DAS						
9/11/02	EM-MK2	91102H	STANDARD 2	9/12/02	YES	2254668	9/12/02	MTADS DAS						
9/12/02	EM-MK2	91202A	STATIC 1	9/13/02	YES	2255346	9/13/02	MTADS DAS						
9/12/02	EM-MK2	91202B	STANDARD 1	9/13/02	YES	2255349	9/13/02	MTADS DAS						
9/12/02	EM-MK2	91202C	LATENCY 1	9/13/02	YES	2255352	9/13/02	MTADS DAS	100					Latency -250
9/12/02	EM-MK2	91202D	GRID 21	9/13/02	YES	2255375	9/13/02	MTADS DAS	100				10Mv	
9/12/02	EM-MK2	91202E	GRID 20	9/13/02	YES	2255461	9/13/02	MTADS DAS	100				10Mv	
9/12/02	EM-MK2	91202F	GRID 19	9/13/02	YES	2255577	9/13/02	MTADS DAS	100				10Mv	
9/12/02	EM-MK2	91202G]	STATIC 2	9/13/02	YES	2255627	9/13/02	MTADS DAS						
9/12/02	EM-MK2	91202H	STANDARD 2	9/13/02	YES	2255629	9/13/02	MTADS DAS						

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Collection Date	Data Type	Raw Data File	Description	Pre-Processing Date	Geometry Correction	Processed File	Processing Date	Processing System	Demedian Window	Grid Cell Size	Analytical Signal Calculated	Raw Data Map	Map Threshold	Comments
9/13/02	EM-MK2	91302A	STATIC 1	9/16/02	YES	2256363	9/16/02	MTADS DAS						
9/13/02	EM-MK2	91302B	STANDARD 1	9/16/02	YES	2256366	9/16/02	MTADS DAS						
9/13/02	EM-MK2	91302C	LATENCY 1	9/16/02	YES	2256368	9/16/02	MTADS DAS	100					Latency -250
9/13/02	EM-MK2	91302D	GRID 5	9/16/02	YES	2256443	9/16/02	MTADS DAS	100				10Mv	
9/13/02	EM-MK2	91302E	WEST SIDE	9/16/02	YES	2256534	9/16/02	MTADS DAS	100				10Mv	
9/13/02	EM-MK2	91302F	GRID 7	9/16/02	YES	2256618	9/16/02	MTADS DAS	100				10Mv	
9/13/02	EM-MK2	91302G	STATIC 2	9/16/02	YES	2256682	9/16/02	MTADS DAS						
9/13/02	EM-MK2	91302H	STANDARD 2	9/16/02	YES	2256684	9/16/02	MTADS DAS						
9/14/02	EM-MK2	91402A	STATIC 1	9/16/02	YES	2257335	9/16/02	MTADS DAS						
9/14/02	EM-MK2	91402B	STANDARD 1	9/16/02	YES	2257338	9/16/02	MTADS DAS						
9/14/02	EM-MK2	91402C	LATENCY 1	9/16/02	YES	2257339	9/16/02	MTADS DAS	100					Latency -200
9/14/02	EM-MK2	91402D	GRID 16	9/16/02	YES	2257367	9/16/02	MTADS DAS	100				10Mv	
9/14/02	EM-MK2	91402E	GRID 8	9/16/02	YES	2257452	9/16/02	MTADS DAS	100				10Mv	
9/14/02	EM-MK2	91402F	STATIC 2	9/16/02	YES	2257629	9/16/02	MTADS DAS						
9/14/02	EM-MK2	91402G	STANDARD 2	9/16/02	YES	2257630	9/16/02	MTADS DAS						
9/16/02	EM-MK2	91602A	STATIC 1	9/17/02	YES	2259364	9/17/02	MTADS DAS						
9/16/02	EM-MK2	91602B	STANDARD 1	9/17/02	YES	2259367	9/17/02	MTADS DAS						
9/16/02	EM-MK2	91602C	LATENCY 1	9/17/02	YES	2259368	9/17/02	MTADS DAS	100					Latency -300
9/16/02	EM-MK2	91602D	GRID 9	9/17/02	YES	2259423	9/17/02	MTADS DAS	100				10Mv	
9/16/02	EM-MK2	91602E	GRID 13	9/17/02	YES	2259504	9/17/02	MTADS DAS	100				10Mv	
9/16/02	EM-MK2	91602F	GRID 10	9/17/02	YES	2259560	9/17/02	MTADS DAS	100				10Mv	
9/16/02	EM-MK2	91602G	GRID 10	9/17/02	YES	2259603	9/17/02	MTADS DAS	100				10Mv	
9/16/02	EM-MK2	91602H	STATIC 2	9/17/02	YES	2259665	9/17/02	MTADS DAS						
9/16/02	EM-MK2	91602I	STANDARD 2	9/17/02	YES	2259666	9/17/02	MTADS DAS						
9/17/02	EM-MK2	91702A	STATIC 1	9/18/02	YES	2260323	9/18/02	MTADS DAS						
9/17/02	EM-MK2	91702B	STANDARD 1	9/18/02	YES	2260327	9/18/02	MTADS DAS						
9/17/02	EM-MK2	91702C	LATENCY 1	9/18/02	YES	2260328	9/18/02	MTADS DAS	100					Latency -200
9/17/02	EM-MK2	91702D	GRID D	9/18/02	YES	2260349	9/18/02	MTADS DAS	100				10Mv	
9/17/02	EM-MK2	91702E	GRID E	9/18/02	YES	2260372	9/18/02	MTADS DAS	100				10Mv	
9/17/02	EM-MK2	91702I	STATIC 2	9/18/02	YES	2260579	9/18/02	MTADS DAS						
9/17/02	EM-MK2	91702J	STANDARD 2	9/18/02	YES	2260580	9/18/02	MTADS DAS						
9/12/02	EM-MK2	91202E	GRID 20	9/13/02	YES	2255461	9/13/02	MTADS DAS	100				10Mv	
9/12/02	EM-MK2	91202F	GRID 19	9/13/02	YES	2255577	9/13/02	MTADS DAS	100				10Mv	
9/12/02	EM-MK2	91202GJ	STATIC 2	9/13/02	YES	2255627	9/13/02	MTADS DAS						
9/12/02	EM-MK2	91202H	STANDARD 2	9/13/02	YES	2255629	9/13/02	MTADS DAS						

Maui, Hawaii

Makawao

Processing Log

Collection Date	Data Type	Raw Data File	Description	Pre-Processing Date	Geometry Correction	Processed File	Processing Date	Processing System	Demedian Window	Grid Cell Size	Analytical Signal Calculated	Raw Data Map	Map Threshold	Comments
9/19/02	EM-MK2	91902A	STATIC 1	9/20/02	YES	2262373	9/20/02	MTADS DAS						
9/19/02	EM-MK2	91902B	STANDARD 1	9/20/02	YES	2262377	9/20/02	MTADS DAS						
9/19/02	EM-MK2	91902C	LATENCY 1	9/20/02	YES	2262378	9/20/02	MTADS DAS	100					Latency -250
9/19/02	EM-MK2	91902D	GRID D	9/20/02	YES	2262391	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902E	GRID E	9/20/02	YES	2262403	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902F	GRID F	9/20/02	YES	2262419	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902G	GRID G	9/20/02	YES	2262432	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902H	GRID H	9/20/02	YES	2262456	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902I	GRID I	9/20/02	YES	2262474	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902J	GRID 12	9/20/02	YES	2262518	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902K	PATH F	9/20/02	YES	2262584	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902L	PATH G	9/20/02	YES	2262652	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902M	PATH H	9/20/02	YES	2262665	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902N	PATH I	9/20/02	YES	2262678	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902O	PATH J	9/20/02	YES	2262686	9/20/02	MTADS DAS	100				10Mv	
9/19/02	EM-MK2	91902P	STATIC 2	9/20/02	YES	2262704	9/20/02	MTADS DAS						
9/19/02	EM-MK2	91902Q	STANDARD 2	9/20/02	YES	2262708	9/20/02	MTADS DAS						
9/20/02	EM-MK2	92002A	STATIC 1	9/23/02	YES	2263350	9/23/02	MTADS DAS						
9/20/02	EM-MK2	92002B	STANDARD 1	9/23/02	YES	2263352	9/23/02	MTADS DAS						
9/20/02	EM-MK2	92002C	LATENCY 1	9/23/02	YES	2263355	9/23/02	MTADS DAS	100					Latency -300
9/20/02	EM-MK2	92002D	GRID D	9/23/02	YES	2263379	9/23/02	MTADS DAS	100				10Mv	
9/20/02	EM-MK2	92002E	PATH E	9/23/02	YES	2263470	9/23/02	MTADS DAS	100				10Mv	
9/20/02	EM-MK2	92002F	GRID F	9/23/02	YES	2263580	9/23/02	MTADS DAS	100				10Mv	
9/20/02	EM-MK2	92002G	STATIC 2	9/23/02	YES	2263642	9/23/02	MTADS DAS						
9/20/02	EM-MK2	92002H	STANDARD 2	9/23/02	YES	2263643	9/23/02	MTADS DAS						
9/17/02	EM-MK2	91702A	STATIC 1	9/18/02	YES	2260323	9/18/02	MTADS DAS						
9/17/02	EM-MK2	91702B	STANDARD 1	9/18/02	YES	2260327	9/18/02	MTADS DAS						
9/17/02	EM-MK2	91702C	LATENCY 1	9/18/02	YES	2260328	9/18/02	MTADS DAS	100					Latency -200
9/17/02	EM-MK2	91702D	GRID D	9/18/02	YES	2260349	9/18/02	MTADS DAS	100				10Mv	
9/17/02	EM-MK2	91702E	GRID E	9/18/02	YES	2260372	9/18/02	MTADS DAS	100				10Mv	
9/17/02	EM-MK2	91702I	STATIC 2	9/18/02	YES	2260579	9/18/02	MTADS DAS						
9/17/02	EM-MK2	91702J	STANDARD 2	9/18/02	YES	2260580	9/18/02	MTADS DAS						
9/12/02	EM-MK2	91202E	GRID 20	9/13/02	YES	2255461	9/13/02	MTADS DAS	100				10Mv	
9/12/02	EM-MK2	91202F	GRID 19	9/13/02	YES	2255577	9/13/02	MTADS DAS	100				10Mv	
9/12/02	EM-MK2	91202GJ	STATIC 2	9/13/02	YES	2255627	9/13/02	MTADS DAS						
9/12/02	EM-MK2	91202H	STANDARD 2	9/13/02	YES	2255629	9/13/02	MTADS DAS						

APPENDIX D
FIELD NOTES

303.278.0789

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Bottom 0214 Top 1050S Date: 8/14/02 Page: 1 of 3

Blackhawk Field Personnel

Weather CLOUDY, WINDY ~ 79°

R. BLOHM, B. KONSHAK

GPS Base Station Setup
Base Location: OPANO POINT (STA 3)
Frequency: 461.1000 MHz Setup Time: 8:00

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 10:00/10:15
BATTERY: 12.2 V

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings) GPS QC: PDOP 2.9 6 SATS

	Reading (mV)
Channel 1 - Bottom	0.5
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.2
Channel 4 - Top	0.5

18 READINGS/SEC
GPS @ 1 HERTZ
ATV RUNNING

File Folder: OPANA POINT File Name: 081402A Time: 11:22

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	135
Channel 2 - Bottom	76
Channel 3 - Bottom	37
Channel 4 - Top	194

File Folder: OPANA POINT File Name: 081402B Time: 11:27

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: OPANA POINT File Name: 081402C Time: 11:36

East/West Collection

Data Collection: Date: 08/14/02 Page: 2 of 3

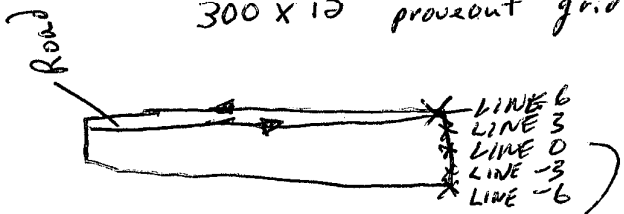
Area: Opana Point

Instrument Operator: R. [redacted] Blohm

Folder: Opana Point File: 081402D Start/End Time: 11:40 – 11:55 Am Am

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

300' x 12' proveout grid – start → W at NE corner



3' line spacing

5 lines total

LINE 0 East end = GPS station 5

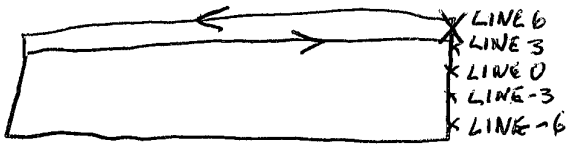
Data Collection:

Area: Opana Point

Instrument Operator: R. Blohm

Folder: Opana Point File: 081402E Start/End Time: 12:32 – 12:45 pm

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):



200' x 12' proveout grid

Start at NE corner

heading → W 1st line

3' linespacing

Line 0 East end = GPS Station 4

PM Standardization Tests: Date: 08/14/02 Page 3 of 3

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	-1
Channel 2 - Bottom	1
Channel 3 - Bottom	1
Channel 4 - Top	1.5

GPS QC: PDOP 2.4 8 Satellites

ATV Running at Idle

GPS 1 Hertz

EM61 18 Hertz

Battery 12.4

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	134
Channel 2 - Bottom	76
Channel 3 - Bottom	35
Channel 4 - Top	199

File Folder: Opana Point File Name: ~~081402F~~ 081402F Time: 12:51 pm - 12:58 pm

4) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Opana Point File Name: ~~081402G~~ 081402G Time: ~~12:53~~ 1:00 pm

← N

Data Collection: Date: _____ Page:____of_____

Area:_____

Instrument Operator: _____

Folder: _____ File: _____ Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Data Collection:

Area: _____

Instrument Operator: _____

Folder: _____ File: _____ Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

****
*** TX REPORT ***
****

TRANSMISSION OK

TX/RX NO	1196
CONNECTION TEL	13032780789
SUBADDRESS	
CONNECTION ID	
ST. TIME	08/14 16:20
USAGE T	01'05
PGS.	3
RESULT	OK

EM61-MK2 Data Acquisition Daily Log and QC Testing

303.278.0789

System: S/N Bottom 0214 Top 1050 Date: 8/14/02 Page: 1 of 3

Blackhawk Field Personnel

Weather CLOUDY, WINDY ~ 79°

R. BLOHM, B. KONSHAK

GPS Base Station Setup

Base Location: OPANA POINT (STA 3)

Frequency: 461.1000 MHz Setup Time: 8:00

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 10:00/10:15

BATTERY: 12.2 V

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.

(Enter Background coil readings)

GPS QC: PDOP 2.9 6 SATS

18 READINGS/SEC

GPS @ 1 HERTZ

ATV RUNNING

	Reading (mV)
Channel 1 - Bottom	0.5
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.2
Channel 4 - Top	0.5

File Folder: OPANA POINT File Name: 0814D2A Time: 11:22

4) Position Standard Board on coils and record data for 1 minute.

(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	135
Channel 2 - Bottom	76

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top - 10505 Bottom - 0214 Date: 08/16/02 Page: 1 of 3

Blackhawk Field Personnel

R. Blohm B. Konshak

Weather Windy / Sunny

GPS Base Station Setup
Base Location: Opana Point - Station 3
Frequency: 461.1 MHz Setup Time: 3 hours

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 9Am - Noon

2) Null coils prior to tests. ATV Idling

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.8
Channel 4 - Top	-1.0

GPS QC:
Satt : 7
POOP : 2.4
Batt : 12.14

File Folder: Opana Point File Name: 081602A Time: 12:09 - 12:11

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	134
Channel 2 - Bottom	75
Channel 3 - Bottom	36
Channel 4 - Top	195

File Folder: Opana Point File Name: 081602B Time: 12:B - 1214

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Opana Point File Name: 081602C Time: 12:18 - 1230

Data Collection: Date: 08/16/02 Page: 2 of 3

Area: OPANA POINT GRID 3

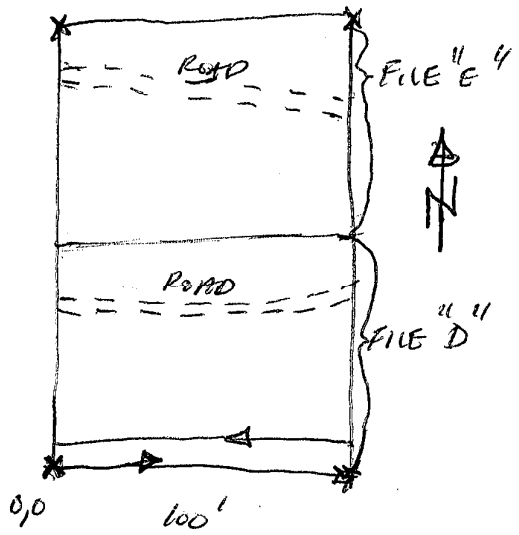
Instrument Operator: R. Bloom

Folder: OPANA POINT File: 081602D Start/End Time: 12:27 / 13:28

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

100' x 200' GRID, START AT SW CORNER
RUN LINES E-W, LINES 0-99

- REPEAT LINE 36, OFFLINE DUE TO FURROWS
- REPEAT LINES 96, DUE TO EDGE OF ROAD (STEEP)
- ROAD ON LINES 78 TO 88
- ROAD ON LINES 164 TO 174
- REPEAT LINE 123, DUE TO STEEP TERRAIN



Data Collection:

Area: OPANA POINT GRID 3

Instrument Operator: R. Bloom

Folder: OPANA POINT File: 081602E Start/End Time: 13:30 / 14:16

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

CONTINUE WITH GRID 3, RUN LINES E-W, START ON LINE 102 ON WEST SIDE OF GRID. CONTAINS LINES 102-204 (SEE MAP ABOVE)

PM Standardization Tests: Date: 08/16/02 Page 3 of 3

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	1.0
Channel 3 - Bottom	0.5
Channel 4 - Top	1.5

GPS QC: PDOP 2.4
Satt: 7
Battery: 12.14
ATV Idling

File Folder: Opana Point Time: 1443
File Name: 081602F -1444

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	135
Channel 2 - Bottom	76
Channel 3 - Bottom	35
Channel 4 - Top	197

File Folder: Opana Point File Name: 081602G Time: 1447-1448

4) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: NA File Name: NA Time: NA

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N TOP-1050S BST-0214 Date: 8/19/02 Page: 1 of 3 ✓

Blackhawk Field Personnel

R. BLOHM B. KONSHAK

Weather PARTLY CLOUDY, WINDY

GPS Base Station Setup
Base Location: OPANA POINT STATION 3
Frequency: 461.1 MHz Setup Time: 9:20

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 1000 – 1240 ~~1240 – 1243~~ ATV IDLING

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

GPS QC: PDOP: 2.3 – 8 Satts
Batt - 12.14

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.5

File Folder: OPANA POINT File Name: 081902A Time: 1240 - 1243

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	134
Channel 2 - Bottom	76
Channel 3 - Bottom	36
Channel 4 - Top	196

File Folder: OPANA POINT File Name: 081902B Time: 1246 - 1247

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: OPANA POINT File Name: 081902C Time: 1249 - 1251

Data Collection: Date: 08/19/02 Page: 2 of 3 ✓

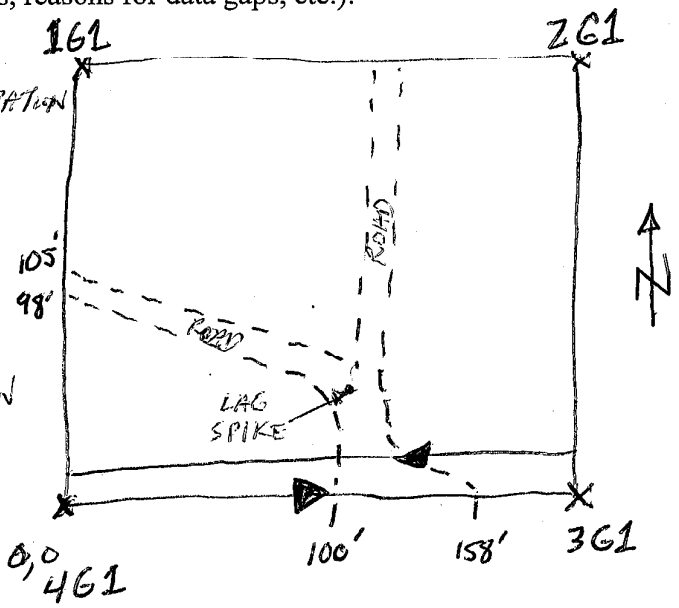
Area: OPANA POINT GRID 1

Instrument Operator: R. Blohm

Folder: OPANA POINT File: 081902D Start/End Time: 1251-1357

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' grid, run lines E-W, start at SW corner, 3 FT LINE SEPARATION



* Lines 0-99 – File 081902D
* Lines 102-201 – File 081902E
* REPEAT LINE 201
* WEST EDGE OF GRID CONTAINS A PORTION OF PROVE-OUT 300' & 200' LINES.

Data Collection:

Area: Opana Point Grid 1

Instrument Operator: R. Blohm

Folder: Opana Point File: 081902E Start/End Time: 1358-1502

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

CONTINUE DATA ON NORTHERN HALF OF GRID 1. FILE CONTAINS LINES 102 THRU 201, ON 3 FT LINE SPACING.

PM Standardization Tests: Date: 081902 Page 3 of 3 ✓

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute. 15:17-1518

GPS QC: PDP: 2.5 Satts: 7

Batt: 12.14

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	1.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.5

FILE: 081902F

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	135
Channel 2 - Bottom	77
Channel 3 - Bottom	36
Channel 4 - Top	194

081902G

File Folder: ~~0819021~~ File Name: ~~081902F~~ Time: 1522-1523

4) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: N/A File Name: N/A Time: _____

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top- 10505 Bottom- 0214 Date: 08/20/02 Page: 1 of 3

Blackhawk Field Personnel

B. Konshak R. Blohm

Weather Partly Cloudy, Windy

GPS Base Station Setup
Base Location: Opana Point - Station 3
Frequency: 461.1 MHz Setup Time: 30 minutes (08:00)

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0830 - 0900

2) Null coils prior to tests. BATT: 12.3V

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

GPS QC: PDOP: 3.5
Satellites: 6

ATV Idling

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	1.0
Channel 3 - Bottom	1.0
Channel 4 - Top	2.0

File Folder: Opana Point File Name: 082002A Time: 0907 - 0910

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	140
Channel 2 - Bottom	77
Channel 3 - Bottom	32
Channel 4 - Top	199

File Folder: Opana Pt. File Name: 082002B Time: 0910 - 0911

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Opana Pt. File Name: 082002C Time: 0914 - 0915

Data Collection: Date: 08/20/02 Page: 2 of 3 x

Area: Opana Point - Grid 2

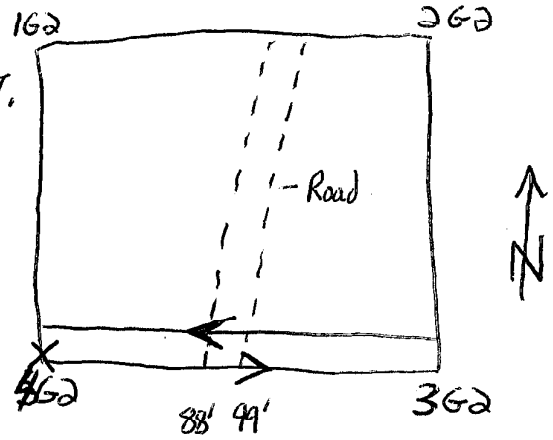
Instrument Operator: R. Blohm

Folder: Opana Point File: 082002D Start/End Time: 0923 - 1028

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, Run lines E-W, Start at SW corner, LINES 3' APART.

* File 082002 D - Lines 0-102
* File 082002E - Lines 105-201



Data Collection:

Area: Opana Pt. - Grid 2

Instrument Operator: R. Blohm

Folder: Opana Point File: 082002E Start/End Time: 1029 - 1145

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

* Battery - 12.3
* Repeated line 201
* FINISH GRID 2 (NORTHERN HALF), 3 FT LINE SPACING.

PM Standardization Tests: Date: 08/22/02 Page 3 of 3x

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.2
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.5

GPS QC: PDOP = 2.7
SATELLITES: 7
BATT: 12.2 V

FILE NAME: 082002F

3) Center Standard Board on coils and record data for 1 minute (~~use same file for both data sets~~).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	137
Channel 2 - Bottom	76
Channel 3 - Bottom	36
Channel 4 - Top	198

File Folder: DANA POINT File Name: 082002G Time: 1504

4) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: N/A File Name: N/A Time: N/A

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil: 10505 Bottom Coil: 0214 Date: 08/21/02 Page: 1 of 4

Blackhawk Field Personnel: B. Konshak, R. Blohm

Weather: Partly Cloudy, Windy

GPS Base Station Setup
Base Location: Opana Point - Station 3
Frequency: 461.1 MHz Setup Time: 30 minutes

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0750 - 0810

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

GPS QC: PDOP - 2.9
Satellites - 7
Battery - 12.29

	Reading (mV)
Channel 1 - Bottom	0.5
Channel 2 - Bottom	1.0
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

File Folder: Opana Pt. File Name: 082102A Time: 0818 - 0821

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	139
Channel 2 - Bottom	76
Channel 3 - Bottom	37
Channel 4 - Top	199

File Folder: Opana Pt. File Name: 082102B Time: 0823 - 0824

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Opana Pt. File Name: 082102C Time: 0825 - 0828

Data Collection: Date: 8/21/02 Page: 2 of 4 ✓

Area: Opana Point Grid 5

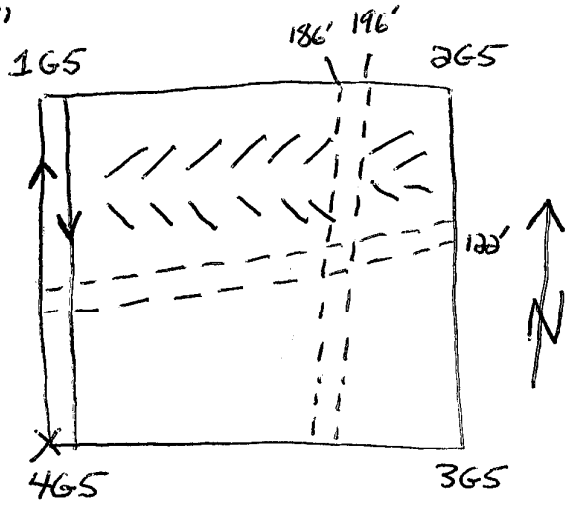
Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082102D Start/End Time: 0845-0944

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, Data collected N-S, Started at SW corner

* Lines 0-102 = File 082102D
* Lines 105-204 = File 082102E
* Repeated line 95, 102



Data Collection:

Area: Opana Point Grid 5

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082102E Start/End Time: 0945-1140

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

= = = = - Road

/ / / - Ridge

Data Collection: Date: 8/21/02 Page: 3 of 4

Area: Opana Point - Grid 4

PDOP: 2.3
Satellites: 8

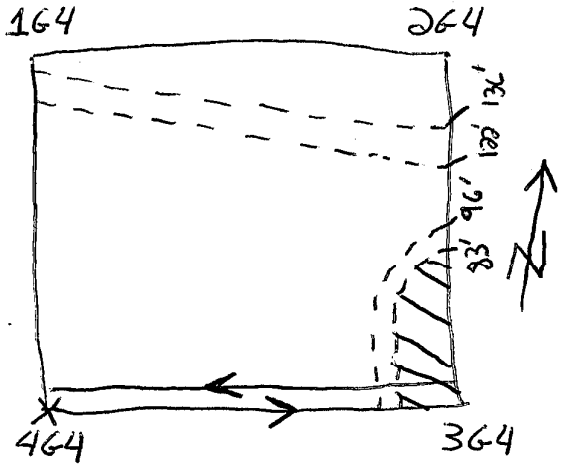
Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082102F Start/End Time: 1240-1346

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, Lines run E-W,
Started at SW corner

* File 082102F - lines 0-99
* File 082102G - lines 102-
* Repeated line 24
* Extra line for terrain appox, 118
* Extra line at line 129



--- - Road

/// - Excluded Area - Steep

Data Collection:

Area: Opana Pt. - Grid 4

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082102G Start/End Time: 1348

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

PM Standardization Tests: Date: 08/21/02 Page 4 of 4

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	0.5
Channel 2 - Bottom	0.5
Channel 3 - Bottom	-0.5
Channel 4 - Top	1.5

GPS QC: PDOP: 2.6
Satellites: 7
Battery: 12.1

Time: 1501 - 1502
File Name: 082102H

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	137
Channel 2 - Bottom	77
Channel 3 - Bottom	36
Channel 4 - Top	198

File Folder: Opana PH. File Name: 082102I Time: 1503 - 1504

4) ~~Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: File Name: Time:~~

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil: 10505 Bottom Coil: 0214 Date: 08/22/02 Page: 1 of 6

Blackhawk Field Personnel: B. Konshak R. Blohm

Weather: Sunny, Windy

GPS Base Station Setup
Base Location: Opana Point Station 3
Frequency: ~~460.1~~ 462.125 MHz Setup Time: 30 minutes

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0830 - 0930

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

GPS QC: POOP: 2.6
Satellites: 6
Battery: 12.29

	Reading (mV)
Channel 1 - Bottom	-0.5
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0
Channel 4 - Top	1.0

File Folder: Opana Pt. File Name: 082202A Time: 0932 - 0935

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	135
Channel 2 - Bottom	76
Channel 3 - Bottom	37
Channel 4 - Top	198

File Folder: Opana Pt. File Name: 082202B Time: 0936-0937

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Opana Pt. File Name: 082202C Time: 0938 - 0940

Data Collection: Date: 08/22/02 Page: 2 of 6

Area: Opana Point Grid 6

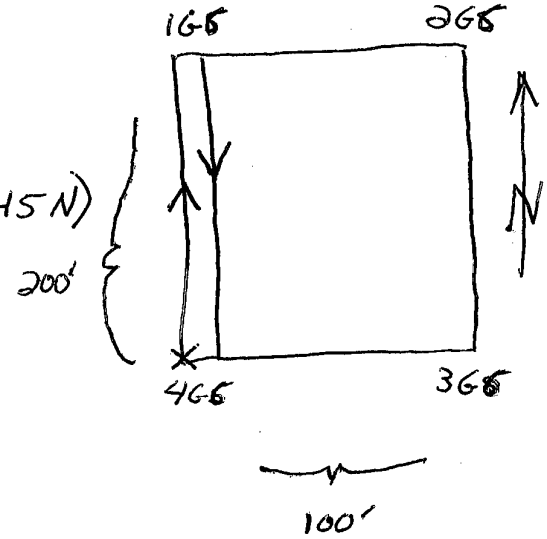
Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082202D Start/End Time: 0948-1115

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

100'x200' Grid, Ran lines N-S, Started at SW corner

* Fill lines at 40, 55, 70 for terrain
* Cement block in path at (90 E, 145 N)
  - Fill in line at 91



Data Collection:

Area: Opana Point Transect 1

PDOP: 2.4
Satellites: 8

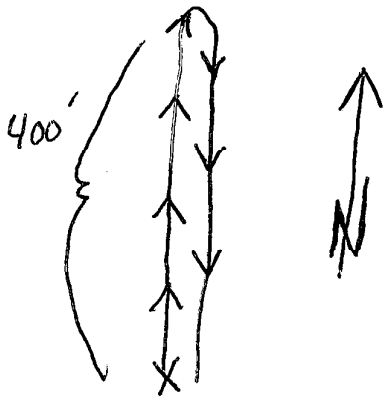
Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082202E Start/End Time: 1230-1237

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

400' Transect N-S

~~A = grid start~~



Data Collection: Date: 08/22/02 Page: 3 of 5

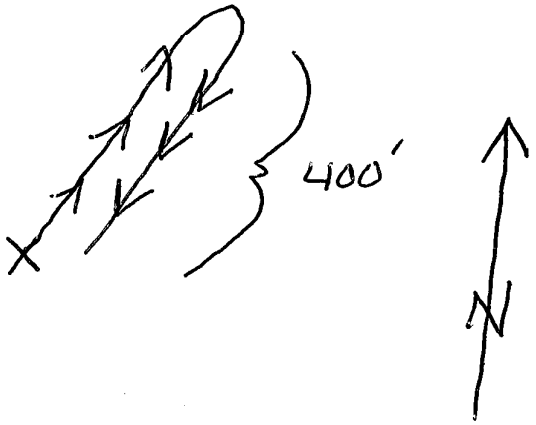
Area: Opana Point Transect 2

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082202F Start/End Time: 1238-1247

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

400' Transect NE-SW



Data Collection:

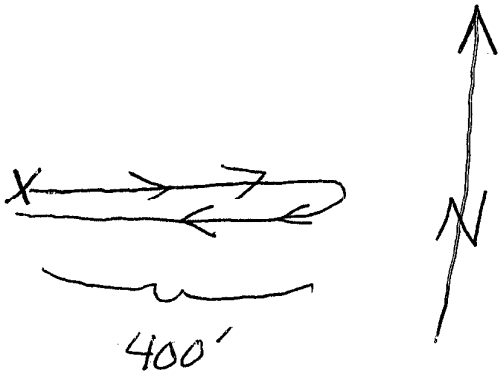
Area: Opana Point Transect 3

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082202G Start/End Time: 1249-1256

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

400' Transect E-W



Data Collection: Date: 08/22/02 Page: 4 of 6

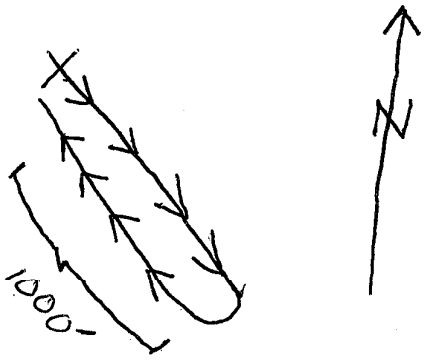
Area: Opana Point Transect 4

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082202H Start/End Time: 1300 - 1313

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

1000' Transect SE - NW



Data Collection:

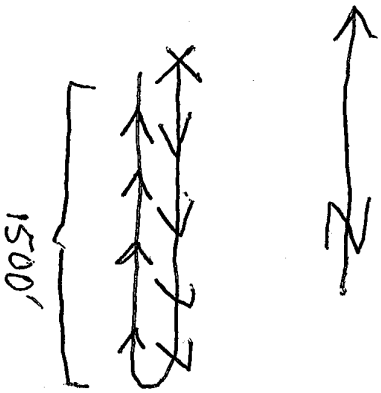
Area: Opana Point Transect 5

Instrument Operator: R. Blohm

Folder: Opana Point File: 082202I Start/End Time: 1350 - 1412

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

1500' Transect S - N



Data Collection: Date: 08/22/02 Page: 5 of 6

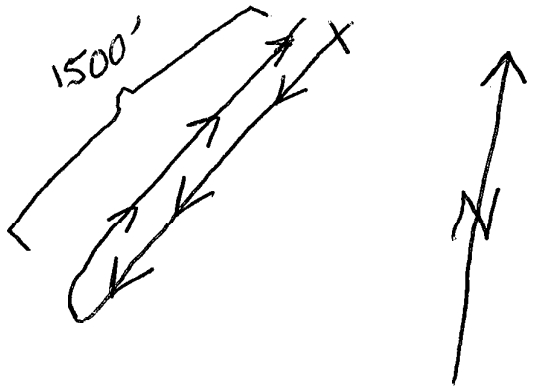
Area: Opana Point Transect 6

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082202J Start/End Time: 1415 - 1435

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

1500' Transect SW



Data Collection:

Area: N/A

Instrument Operator: _____

Folder: _____ File: N/A Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

PM Standardization Tests: Date: 08/22/02 Page 5 of 6

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	-1.0

GPS QC: PDOP: 2.7
Satellites: 7
Battery: 12.1

Time: 1453-1454
File Name: 082202K

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	137
Channel 2 - Bottom	77
Channel 3 - Bottom	36
Channel 4 - Top	197

File Folder: Opana Pt. File Name: 082202L Time: 1455

~~4) Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: _____ File Name: _____ Time: _____~~

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil - 1050S Bottom Coil - 0314 Date: 08/23/02 Page: 1 of 4

Blackhawk Field Personnel

R. Blohm B. Konshak

Weather Windy, Cloudy

Battery 12.2

GPS Base Station Setup

Base Location: Opana Point Station 3

Frequency: 462.125 MHz Setup Time: 30 min

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 1310 - 1336

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.

(Enter Background coil readings)

GPS QC: PDOP: 2.0

Satellites: 8

	Reading (mV)
Channel 1 - Bottom	0.5
Channel 2 - Bottom	1.0
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

File Folder: Opana Pt. File Name: 082302A Time: 1336 - 1339

4) Position Standard Board on coils and record data for 1 minute.

(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	138
Channel 2 - Bottom	77
Channel 3 - Bottom	36
Channel 4 - Top	196

File Folder: Opana Pt File Name: 082302B Time: 1340 - 1341

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Opana Pt File Name: 082302C Time: 1342 - 1344

Data Collection: Date: 08/23/02 Page: 2 of 4

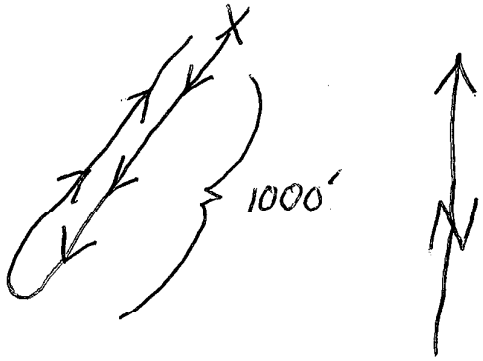
Area: Opana Point Transect 7

Instrument Operator: R. Blohm

Folder: Opana Point File: 082302 D Start/End Time: 1348 - 1404

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

1000' Transect SW - NE



Data Collection:

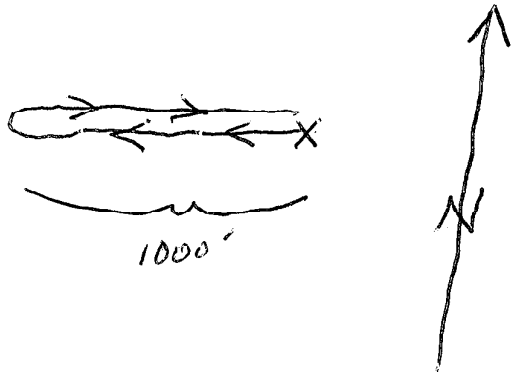
Area: Opana Point Transect 8

Instrument Operator: R. Blohm

Folder: Opana Point File: 082302 E Start/End Time: 1407 - 1420

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

1000' Transect W - E



* Road at 150'

Data Collection: Date: 08/23/02 Page: 3 of 4

Area: Opana Point Transect 9

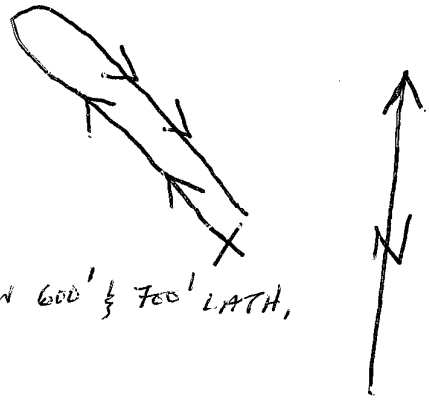
Instrument Operator: R. Blohm

Folder: Opana Point File: 082302F Start/End Time: 1423 - 1434

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

700' Transect NW - SE

* Road at 185', 440', 550'
* Transect crosses proveout grid 200' & 300' (NEAR ROAD)



* LARGE BOULDERS IN TRANSECT PATH BETWEEN 600' & 700' PATH, FORCED TO GO AROUND.

Data Collection:

Area: N/A

Instrument Operator: _____

Folder: _____ File: N/A Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

PM Standardization Tests: Date: 08/23/05 Page 4 of 4

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	1.0
Channel 3 - Bottom	0.5
Channel 4 - Top	-1.0

GPS QC: PDOP: 2.7
Satellites: 7
Battery: 12.3

File Name: 082302G

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	138
Channel 2 - Bottom	78
Channel 3 - Bottom	37
Channel 4 - Top	199

File Folder: Opana Pt. File Name: 082302H Time: 1440 - 1441

4) ~~Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder:~~ _____ ~~File Name:~~ _____ ~~Time:~~ _____

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil - 10505 Bottom Coil - 0214 Date: 08/27/02 Page: 1 of ~~X~~ 10

Blackhawk Field Personnel

R. Blohm B. Konshak

Weather Sunny, Windy

GPS Base Station Setup
Base Location: Opana Point Station 3
Frequency: 462.125 MHz Setup Time: 8:30 (30 minutes)

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 1145 - 1212

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

GPS QC: PDOP: 2.8
Satellites: 7
Battery: 12.1

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	1.0
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

File Folder: Opana Pt. File Name: 082702A Time: 1212 - 1215

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	139
Channel 2 - Bottom	76
Channel 3 - Bottom	37
Channel 4 - Top	198

File Folder: Opana Pt. File Name: 082702B Time: 1216 - 1217

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Opana Pt. File Name: 082702C Time: 1220 - 1222

Data Collection: Date: 08/27/02 Page: 2 of 10

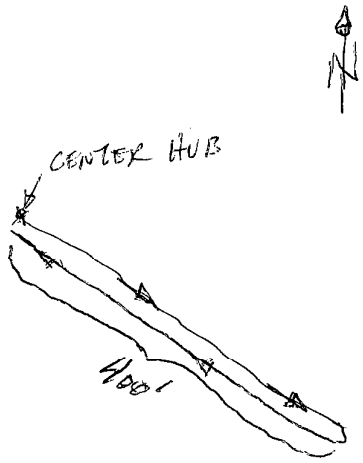
Area: OPANA POINT TRANSECT 10

Instrument Operator: R. BLOHM

Folder: OPANA POINT File: 082702D Start/End Time: 12:20 - 12:30

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

- 400' TRANSECT, START AT CENTER HUB, RUN ~ SE DIRECTION.
- RUN 2 PASSES (1 OUT, 1 BACK), 3' APART



Data Collection:

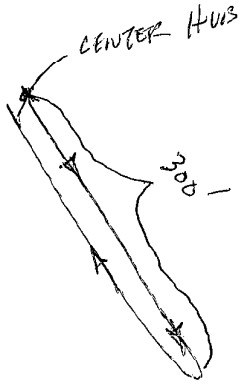
Area: OPANA POINT TRANSECT 11

Instrument Operator: R. BLOHM

Folder: OPANA POINT File: 082702E Start/End Time: 12:32 - 12:36

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

- 300' TRANSECT, START AT CENTER SURVEY HUB.
- 2 PASSES SPACED 3' APART



Data Collection: Date: 08/27/02 Page: 3 of ~~6~~ 10

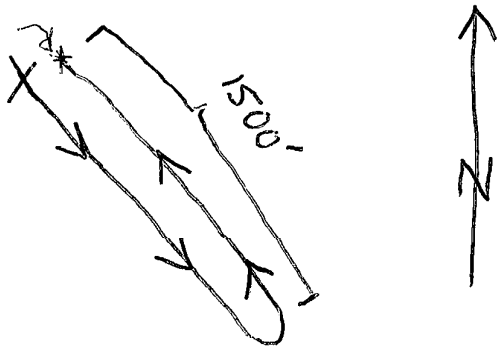
Area: Opana Point Transect 12

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082702F Start/End Time: 1238-1254

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

- 1500' Transect
- RUN 2 LINES FROM CENTER HUB



Data Collection:

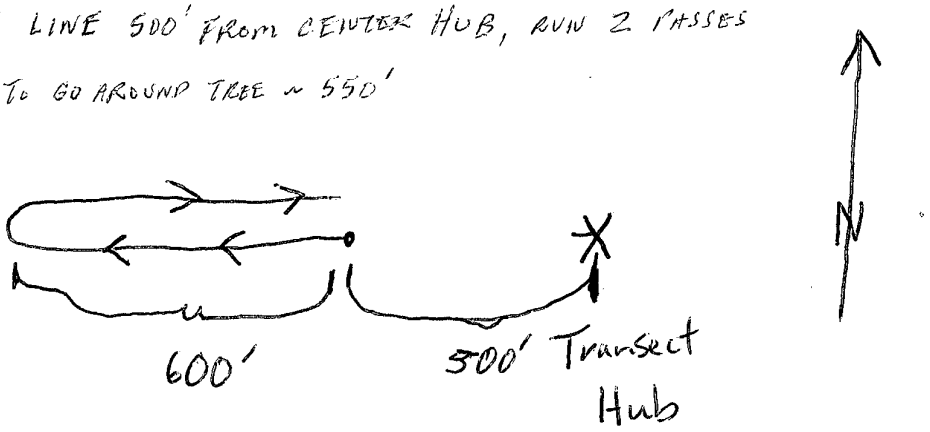
Area: Opana Point Transect 13

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082702G Start/End Time: 1258-1309

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

- 600' Transect
- START LINE 500' FROM CENTER HUB, RUN 2 PASSES
- FORCED TO GO AROUND TREE ~ 550'



Data Collection: Date: 08/27/02 Page: 4 of ~~8~~ 10

Area: Opana Point Transect 14

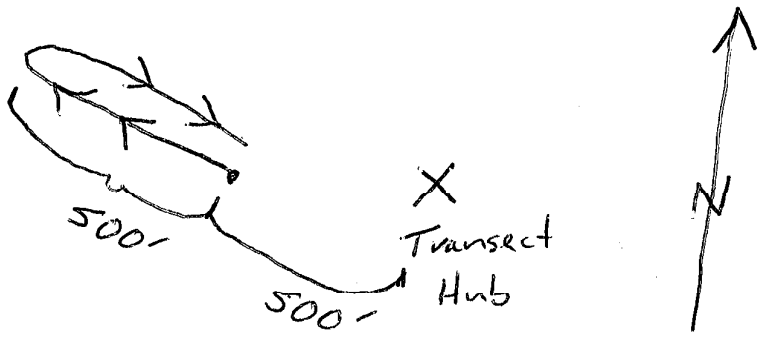
Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082702H Start/End Time: 1311 - 1320

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

500' Transect

- START DATA 500' FROM CENTER HUB.



Data Collection:

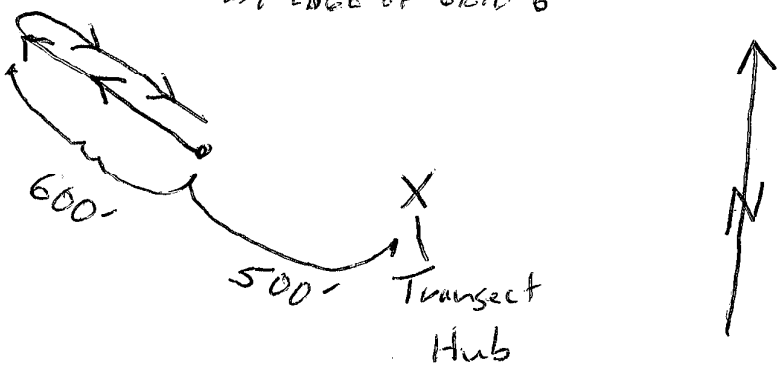
Area: Opana Point Transect 15

Instrument Operator: R. Blohm

Folder: Opana Pt File: 082702I Start/End Time: 1321-1332

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

600' Transect, START & END DATA 500' FROM CENTER HUB ON WEST EDGE OF GRID 6



* DATA WAS NOT CAPTURED IN PRO HOOD, NEED TO REDO. (SEE FOLLOWING NOTES)

Data Collection: Date: 08/27/02 Page: 5 of ~~X~~ 10

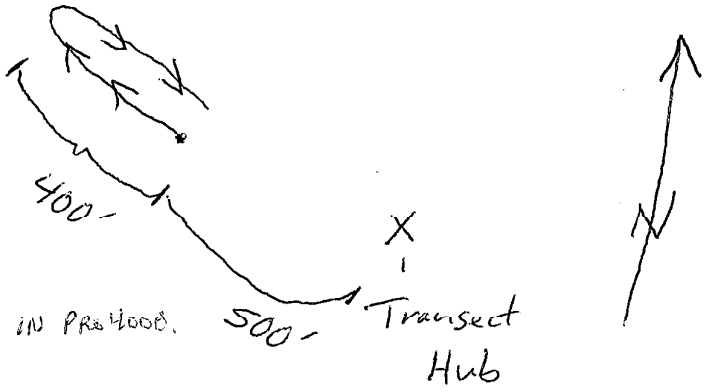
Area: Opana Point Transect 16

Instrument Operator: R. Blohm

Folder: Opana Pt File: 082702J Start/End Time: 1335- 1347

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

400' Transect, START & END DATA 500' FROM CENTER HUB.



* DATA WAS NOT CAPTURED IN PROGOOD. NEED TO RETAKE.

Data Collection:

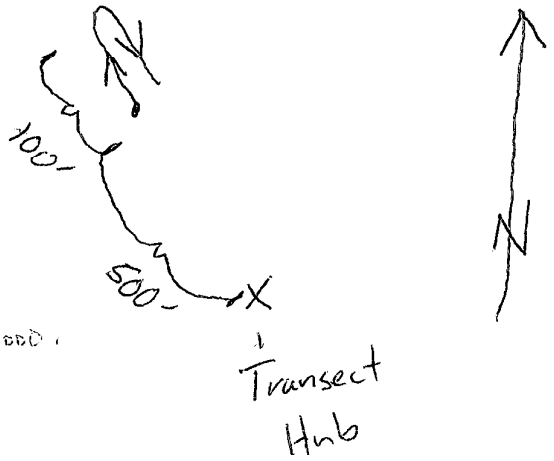
Area: Opana Point Transect 17

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082702K Start/End Time: 1351 - 1354

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

100' Transect, START & END DATA 500' FROM CENTER HUB.



* DATA WAS NOT CAPTURED IN PROGOOD. NEED TO RETAKE.

PM Standardization Tests: Date: 08/27/02 Page 6 of ~~X~~ 10

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	0.5
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

GPS QC: PDOP: 2.3
Battery: 12.1
Satellites: 7

Time: 1356-1357
File Name: 0827021

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	135
Channel 2 - Bottom	75
Channel 3 - Bottom	36
Channel 4 - Top	197

* THESE DATA FILES WERE NOT CAPTURED IN PRO4000, NEED TO RETAKE.

File Folder: Opana Pt. File Name: 082702m Time: 1358-1359

4) ~~Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: File Name: Time:~~

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil: 10505 Bottom Coil: 0214 Date: 08/27/02 Page: 7 of 10

Blackhawk Field Personnel: B. Konshak, R. Blohm

Weather: Sunny, Windy

2nd QC Initial Test

GPS Base Station Setup
Base Location: Opana Point Station 3
Frequency: 462.125 MHz Setup Time: 30 minutes

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 1145 - 1212

2) Null coils prior to tests. (EM61 running all day)

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

GPS QC: PDOP: 2.4
Satellites: 7
Battery: 12.1

	Reading (mV)
Channel 1 - Bottom	-1.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

File Folder: Opana Pt. File Name: 082702I Time: 1504 - 1507

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	135
Channel 2 - Bottom	75
Channel 3 - Bottom	36
Channel 4 - Top	197

File Folder: Opana Pt. File Name: 082702J Time: 1509 - 1510

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Opana Pt. File Name: 082702K Time: 1511 - 1513

Data Collection: Date: 08/27/02 Page: 8 of 10

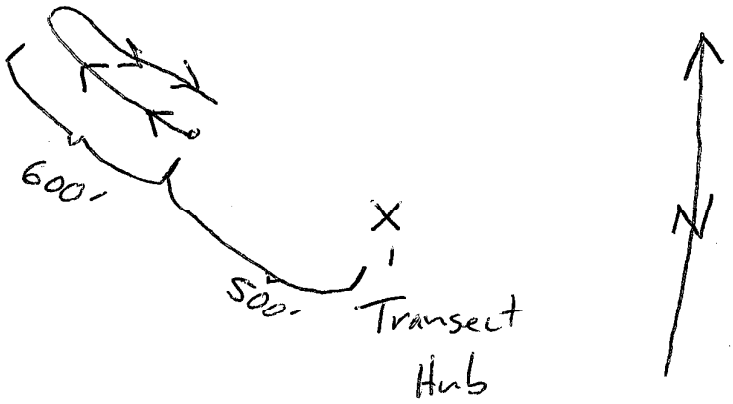
Area: Opana Point Transect 15 Redo

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082702L Start/End Time: 1516 - 1522

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

600' Transect



* Redo for file loss

Data Collection:

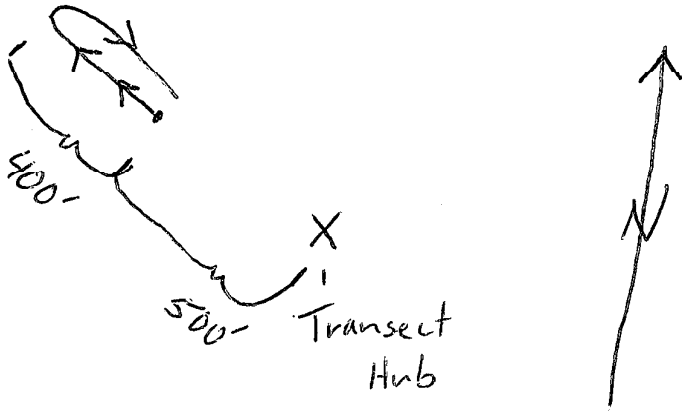
Area: Opana Point Transect 16 Redo

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082702M Start/End Time: 1504 - 1530

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

400' Transect



* Redo for file loss

Data Collection: Date: 08/22/02 Page: 9 of 10

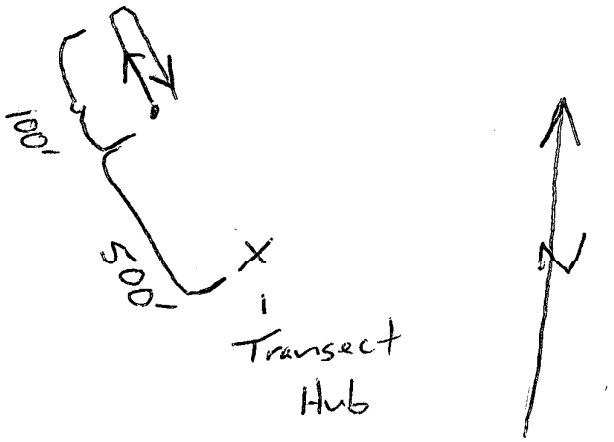
Area: Opana Point Transect 17 Redo

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 082702N Start/End Time: 1533-1536

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

100' Transect



* Redo for data loss

Data Collection:

Area: _____

Instrument Operator: _____

Folder: _____ File: _____ Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

PM Standardization Tests: Date: 08/27/02 Page 10 of 10

2nd PM QC

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

GPS QC: PDOP: 1.9
Satellites: 7
Battery: 12.1

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	1.0
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

Time: 1538-1539
File: 082702 0

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	136
Channel 2 - Bottom	75
Channel 3 - Bottom	36
Channel 4 - Top	194

File Folder: Opana Pt. File Name: 082702 P Time: 1540 - 1541

~~4) Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: File Name: Time:~~

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil - 10505 Bottom Coil - 0214 Date: 08/30/02 Page: 1 of 4

Blackhawk Field Personnel

B. Konshak R. Blohm

Weather Sunny, Windy

GPS Base Station Setup
Base Location: Opana Point - Station 3
Frequency: 462.125 MHz Setup Time: 30 minutes

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 930 - 1025

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

GPS QC: PDOP: 3.1
Satellites: 6
Battery: 12.1

ATV in idle

	Reading (mV)
Channel 1 - Bottom	1.5
Channel 2 - Bottom	1.0
Channel 3 - Bottom	0.5
Channel 4 - Top	1.5

File Folder: Opana Pt File Name: 083002A Time: 1026 - 1029

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	138
Channel 2 - Bottom	77
Channel 3 - Bottom	37
Channel 4 - Top	195

File Folder: Opana Pt. File Name: 083002B Time: 1029 - 1030

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Opana Pt. File Name: 083002C Time: 1032 - 1034

Data Collection: Date: 08/30/02 Page: 2 of 4

Area: Opana Point Grid 7

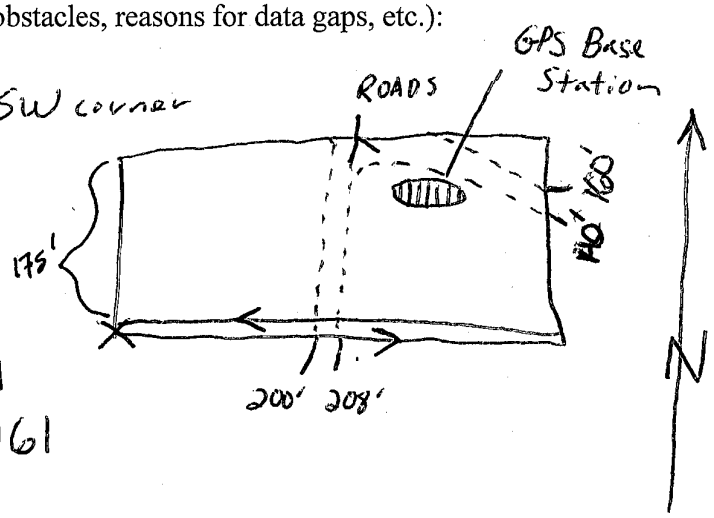
Instrument Operator: R. Blohm

Folder: Opana Pt. File: 083002D Start/End Time: 1040 - 1200

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

175' x 325' Grid, Ran lanes E-W, started at SW corner
LINES ARE SPACED 3' APART

* File 083002D lines 0 - 90
* File 083002E lines 93 - 175
* GPS Base centered on line 141
* Fill in - extra line on 130 & 161



Data Collection:

Area: Opana Point Grid 7

Instrument Operator: R. Blohm

Folder: Opana Pt File: 083002E Start/End Time: 1222 - 1345

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

* Battery: 12.1 Satellites: 7

* CONTAINS NORTHERN HALF OF GRID 7, LINES 93 - 175

Data Collection: Date: 08/30/07 Page: 3 of 4

Area: Opana Point - Grid 8

Instrument Operator: R. Blohm

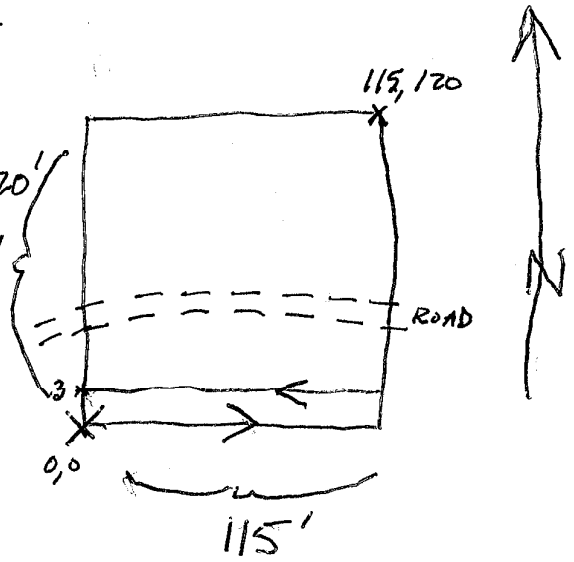
Folder: Opana Pt. File: 083002F Start/End Time: 1410 - 1500

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

115' x 120' Grid,
Ran lanes E-W, 3' APART
Started at SW corner

* File 083002F lines 0-120'

* Fill-in lines at 52.5 & 55.5 120'
~~150'~~, ~~155'~~
DUE TO ROAD BERM (~2' HIGH)



Data Collection:

Area: _____

Instrument Operator: _____

Folder: _____ File: _____ Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

PM Standardization Tests: Date: 08/30/02 Page 4 of 4

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

GPS QC: PDOP: 2.3
Battery: 12.1
Satellites: 6

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.5

File Name: 083002G

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	137
Channel 2 - Bottom	78
Channel 3 - Bottom	36
Channel 4 - Top	196

File Folder: Opana PT, File Name: 083002H Time: 1506-1507

4) ~~Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: _____ File Name: _____ Time: _____~~

#7-106
303.278.0789

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil: 10505 Bottom Coil: 0214 Date: 09/03/02 Page: 1 of 4

Blackhawk Field Personnel: R. Blohm B. Konshuk

Weather: Sunny

GPS Base Station Setup
Base Location: Opana Point Station 3
Frequency: ~~42.125~~ MHz Setup Time: 30 min.

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0930 - 1030

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

GPS QC: PDOP: 3.5 Sat.: 7
Battery: 12.1
ATV in idle.

	Reading (mV)
Channel 1 - Bottom	-.5
Channel 2 - Bottom	.5
Channel 3 - Bottom	.5
Channel 4 - Top	-.5

File Folder: Opana Pt. File Name: 090302A Time: 1031 - 1034

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	137
Channel 2 - Bottom	78
Channel 3 - Bottom	37
Channel 4 - Top	197

File Folder: Opana Pt. File Name: 090302B Time: 1035 - 1036

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Opana Pt. File Name: 090302C Time: 1037 - 1039

Data Collection: Date: 09/03/02 Page: 2 of 4

Area: Opana Point Grid 9

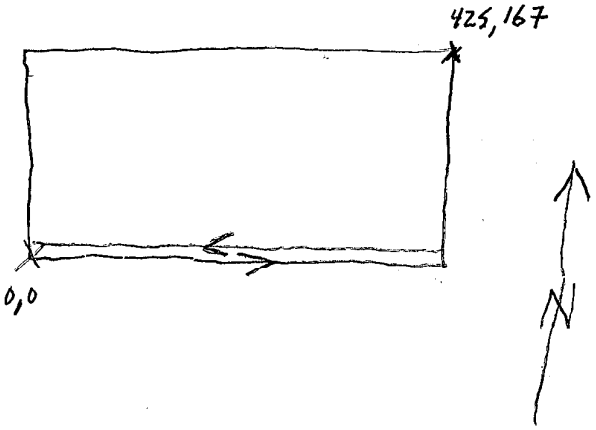
Instrument Operator: R. Blohm

Folder: Opana Pt. File: 090302D Start/End Time: 1051 - 1217

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Grid approx. 425' x 165'

* File 090302D = lines 0 - 87, 3' LINE SPACING, START DATA ON SW CORNER.
* Fill in extra 125' line 30 E side of grid (300'-425')
* Fill in complete line 80



Data Collection:

Area: Opana Point Grid 9

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 090302E Start/End Time: 1256 - 1415

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

* File 090302E = line 90 - 167
* Fill in complete line 109 1/2
* Large rocks at East end of lines 147, 144, detours in line path.

Data Collection: Date: 09/03/02 Page: 3 of 4

Area: Opana Point Roads

Instrument Operator: R. Blohm

Folder: Opana Pt. File: 090302F Start/End Time: 1425 - 1454

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Loop of roads in investigation area.

• START ON SOUTH BOUNDARY OF AREA, TAKE DATA OVER "LAG SPIKE" IN ROAD.

Data Collection:

Area: _____

Instrument Operator: _____

Folder: _____ File: _____ Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

PM Standardization Tests: Date: 09/03/02 Page 4 of 4

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	-.5
Channel 3 - Bottom	-1.0
Channel 4 - Top	1.0

GPS QC: PDOP : 2.2 Sat #: 6

Battery 12.1

ATV in idle.

File : 0903026 Time : 1457

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets). -1458

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	137
Channel 2 - Bottom	76
Channel 3 - Bottom	36
Channel 4 - Top	196

File Folder: Opana Pt File Name: 090302H Time: 1458-1459

4) ~~Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: _____ File Name: _____ Time: _____~~

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil: 10505 Bottom Coil: 0214 Date: 9/11/02 Page: 1 of 4

Blackhawk Field Personnel: R Blohm B. Konshak

Weather: Sunny

GPS Base Station Setup
Base Location: Makawao - MG 1
Frequency: 462.125 MHz Setup Time: 45 minutes

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0900-0930

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings) GPS QC: PDOP: 3.0 Satellites: 6

	Reading (mV)
Channel 1 - Bottom	-1.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	-1.0

Battery 12.1
ATV IN IDLE.

File Folder: Makawao File Name: 091102A Time: 0930-0933

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	133
Channel 2 - Bottom	75
Channel 3 - Bottom	36
Channel 4 - Top	195

File Folder: Makawao File Name: 091102B Time: 0934-0937

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Makawao File Name: 091102C Time: 0938-0940

Data Collection: Date: 09/11/02 Page: 2 of 4

Area: Makawao Grid 6

Instrument Operator: R. Blohm

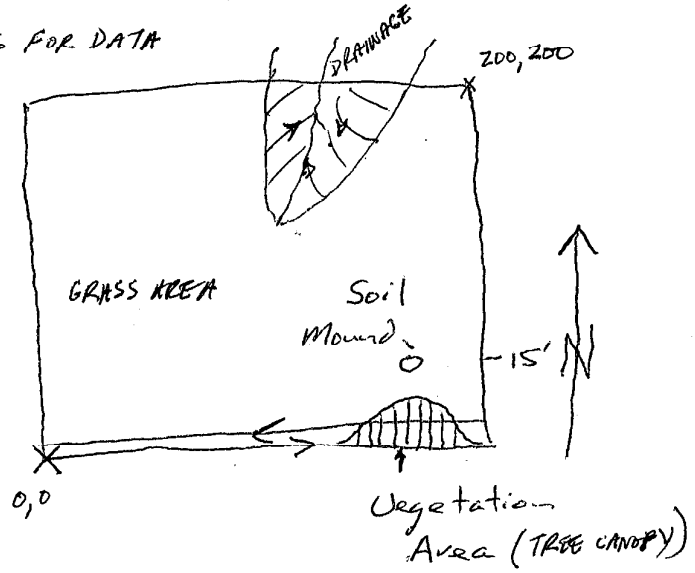
Folder: Makawao File: 091102D Start/End Time: 0950-1130

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, 3 FT LINE SPACING FOR DATA
Data Collection E-W
Started at SW Corner

* All lines (0-201) in file 091102D

* Fill-in extra line at 15', DUE TO VEGETATION IN SE CORNER (LARGE TREES).



Data Collection:

Area: Makawao Grid

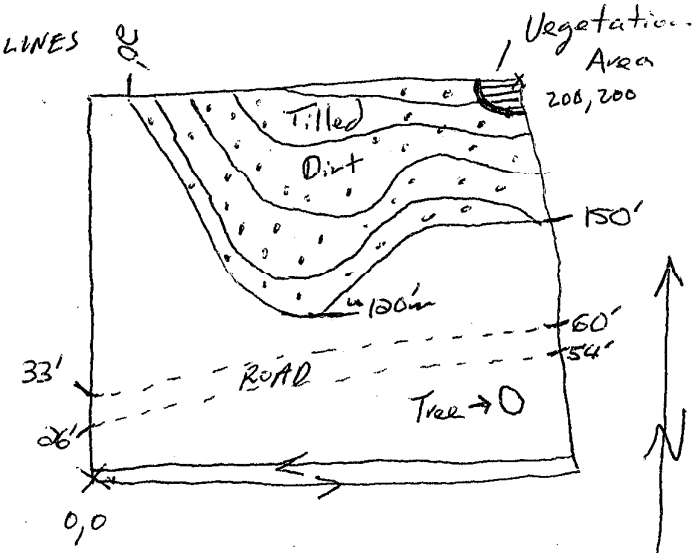
Instrument Operator: R. Blohm

Folder: Makawao File: 091102E Start/End Time: 1215-1350

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, 3 FT DATA LINES
Data Collection E-W
Started at SW Corner

* All lines (0-201) in file 091102E
* Repeat at line 72' for error
* Tree at 160'E, 14'N



Data Collection: Date: 09/11/02 Page: 3 of 4

Area: Makawao Grid 3

Instrument Operator: R. Blohm

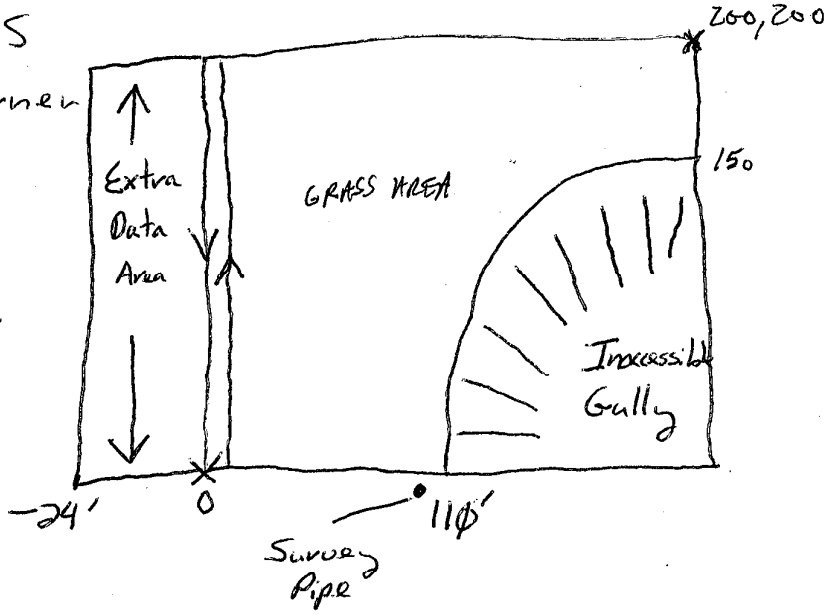
Folder: Makawao File: 091102F Start/End Time: 1423-1550

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, PATH ON 3 FT LINE SPACING

Data Collection N-S

Started at SW corner



* Repeat line 48

* Extra data area West for excluded gully area

Data Collection:

Area: _____

Instrument Operator: _____

Folder: _____ File: _____ Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

PM Standardization Tests: Date: 09/11/02 Page 4 of 4

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

GPS QC: PDOP: 3.9
Battery: 12.14
ATV IN IDLE

	Reading (mV)
Channel 1 - Bottom	0.5
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0
Channel 4 - Top	1.0

File: 091102G 1558 - 1559

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	137
Channel 2 - Bottom	79
Channel 3 - Bottom	37
Channel 4 - Top	201

File Folder: Makawao File Name: 091102H Time: 1600-1601

4) ~~Latency Test: Collect~~ data over standard line ~~(with spike) in 2 directions~~.

~~File Folder: File Name: Time:~~

EM61-MK2 Data Acquisition
Daily Log and QC Testing

303.278.0789

Top Coil: 10505

System: S/N Bottom Coil: 0214 Date: 9/12/02 Page: 1 of 4

Blackhawk Field Personnel

Weather Cloudy ~87°

R. Blohm B. Konshak

GPS Base Station Setup
Base Location: Makawao - MG1
Frequency: 462.125 MHz Setup Time: 15 minutes

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0730 - 0815

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.5
Channel 2 - Bottom	1.0
Channel 3 - Bottom	1.0
Channel 4 - Top	1.5

GPS QC: PDOP: 2.6
Satellites: 6
Battery: 12.29
ATV in idle.

File Folder: Makawao File Name: 091202A Time: 0818 - 0821

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	140
Channel 2 - Bottom	79
Channel 3 - Bottom	36
Channel 4 - Top	199

File Folder: Makawao File Name: 091202B Time: 0823 - 0824

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Makawao File Name: 091202C Time: 0825 - 0827

Data Collection: Date: 09/12/02 Page: 2 of 4

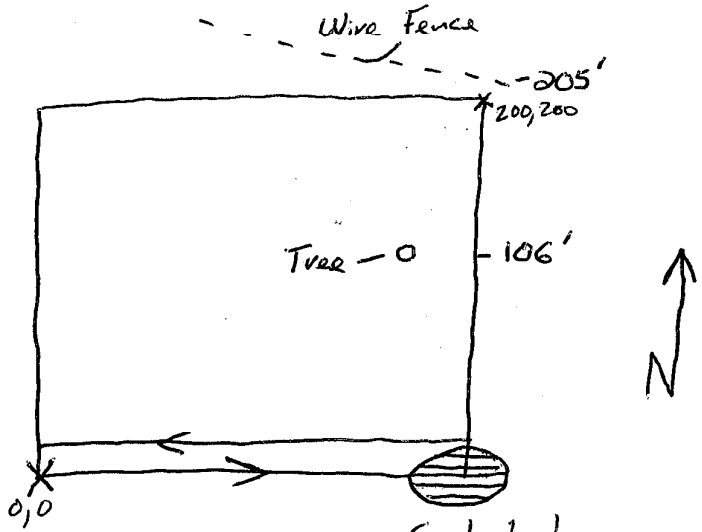
Area: Makawao Grid 21

Instrument Operator: R. Blohm

Folder: Makawao File: 091202D Start/End Time: 0900 - 1030

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid
Collected Data E-W
Started at SW corner
3' lane spacing



Data Collection:

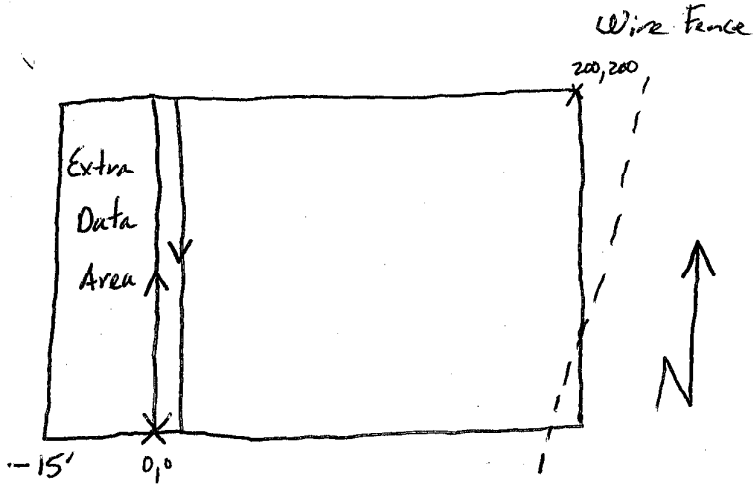
Area: Makawao Grid 20

Instrument Operator: R. Blohm

Folder: Makawao File: 091202E Start/End Time: 1100 - 1300

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid
Data Collection N-S
Started at SW Corner
3' Line Spacing



1057 PDOP: 2.4
Satellites: 8

Data Collection: Date: 09/12/02 Page: 3 of 4

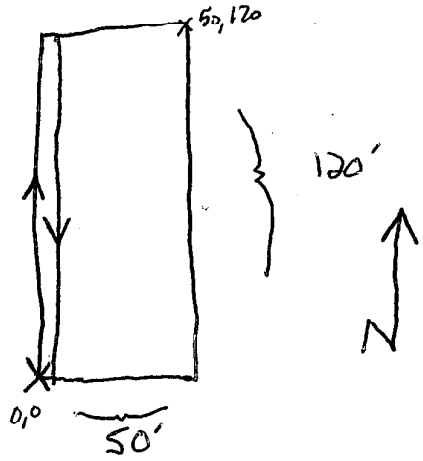
Area: Makawao Grid 19

Instrument Operator: R. Blohm

Folder: Makawao File: 091202F Start/End Time: 1350

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Approx. 50' x 120' Grid
Collected Data N-S
Started at SW corner
3' Lane Spacing
Battery : 12.1
Satellites : 7



* Extra data on W & E of grid where terrain allowed collection

Data Collection:

Area: _____

Instrument Operator: _____

Folder: _____ File: _____ Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

PM Standardization Tests: Date: 09/12/07 Page 4 of 4

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	1.0
Channel 4 - Top	-1.0

GPS QC: PDOP: 1.8 Satellites: 9

Battery: 12.1

ATV is in idle.

File: 091202G Time: 1503

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets). -1504

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	138
Channel 2 - Bottom	78
Channel 3 - Bottom	36
Channel 4 - Top	197

File Folder: Makawao File Name: 091202H Time: 1505-1506

4) ~~Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: File Name: Time:~~

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil : 10505 Bottom Coil : 0214 Date: 9/13/02 Page: 1 of 4

Blackhawk Field Personnel: R. Blohm B. Konshak

Weather: Sunny ~88°

GPS Base Station Setup
Base Location: Makawao - Station 20
Frequency: 462.125 MHz Setup Time: 30 minutes

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0800 - 0837

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

GPS QC: Satellites: 5 PDOP: 3.0

Battery: 12.3

ATV is in idle

	Reading (mV)
Channel 1 - Bottom	-1.0
Channel 2 - Bottom	1.0
Channel 3 - Bottom	0
Channel 4 - Top	1.0

File Folder: Makawao File Name: 091302A Time: 0843 - 0846

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	138
Channel 2 - Bottom	78
Channel 3 - Bottom	36
Channel 4 - Top	197

File Folder: Makawao File Name: 091302B Time: 0847 - 0848

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Makawao File Name: 091302C Time: 0850 - 0852

Data Collection: Date: 9/13/02 Page: 2 of 4

Area: Makawao - Grid 5

Instrument Operator: R. Blohm

Folder: Makawao File: 091302 D Start/End Time: 1040 - 1215

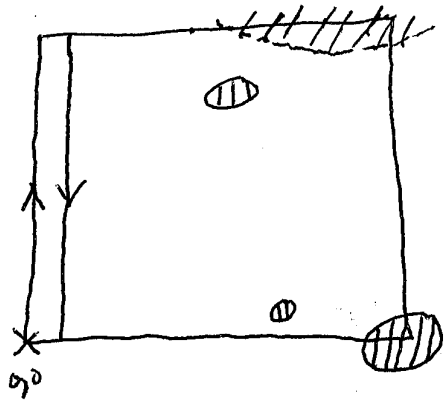
FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, Data Collection N-S
Started at SW corner, 3' Line Spacing

→ Repeated Lines 90, 108

→ Trees at (120'E, 150'N) (200'E, 0'N)
(140'E, 10'N)

* VERY LUMPY GRASS FIELD, SPEND 9:00 - 10:30 BRUSHING GRID



⓪ - Tree Area

Data Collection:

Area: Makawao W side

Instrument Operator: R. Blohm

Folder: Makawao File: 091302 E Start/End Time: 1240 - 1415

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Meandering Path along road (dirt), started at W1 (SOUTH END)
Two Passes N-S from
investigation boundaries

→ Tree Canopy at W-[redacted], W-60, W-29, W-32-33, W-35-36, W-42-43

→ Metal Gates at W-62, W-78

Data Collection: Date: 9/13/02 Page: 3 of 4

Area: Makawao Grid 7

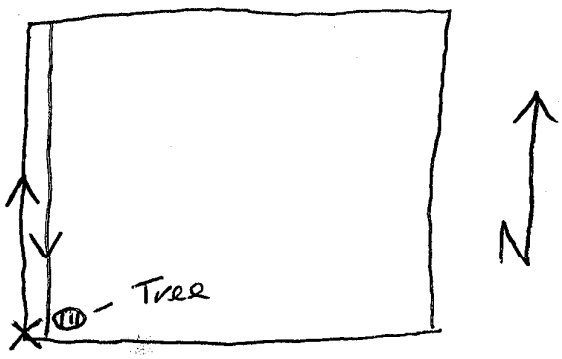
Instrument Operator: R. Blohm

Folder: Makawao File: 091302F Start/End Time: 1445-1615

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, N-S Data Collection,
Started at SW Corner, 3' Line Spacing

→ Battery 12.1, 7 Satellites



Data Collection:

Area: _____

Instrument Operator: _____

Folder: _____ File: _____ Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

PM Standardization Tests: Date: 09/13/02 Page 4 of 4

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

Satellites : 7

GPS QC: PDOP: 2.4

Battery : 12.1

ATV IN IDLE

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	.5
Channel 2 - Bottom	.5
Channel 3 - Bottom	1.0
Channel 4 - Top	1.0

Time : 1622 - 1623

File : 091302G

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	136
Channel 2 - Bottom	76
Channel 3 - Bottom	37
Channel 4 - Top	197

File Folder: Makawao File Name: 091302H Time: 1623-1624

4) ~~Latency Test: Collect data over standard line (with spike)~~ in 2 directions.

~~File Folder:~~ ~~File Name:~~ ~~Time:~~

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil: 10505 Bottom Coil: 0214 Date: 09/14/02 Page: 1 of 3

Blackhawk Field Personnel: R. Blohm B. Konshak

Weather: Sunny

GPS Base Station Setup
Base Location: Makawao Station 20
Frequency: 462.125 MHz Setup Time: 20 minutes

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0730 - 0800

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

GPS QC: Satellites: 6
PDOP: 2.6
Battery: 12.2
ATV is in idle.

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

File Folder: Makawao File Name: 091402A Time: 0802 - 0805

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	141
Channel 2 - Bottom	~~36~~ 79
Channel 3 - Bottom	36
Channel 4 - Top	199

File Folder: Makawao File Name: 091402B Time: 0806 - 0808

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Makawao File Name: 091402C Time: 0808 - 0810

Data Collection: Date: 09/14/02 Page: 2 of 3

Area: Makawao - Grid 16

Instrument Operator: R. Blohm

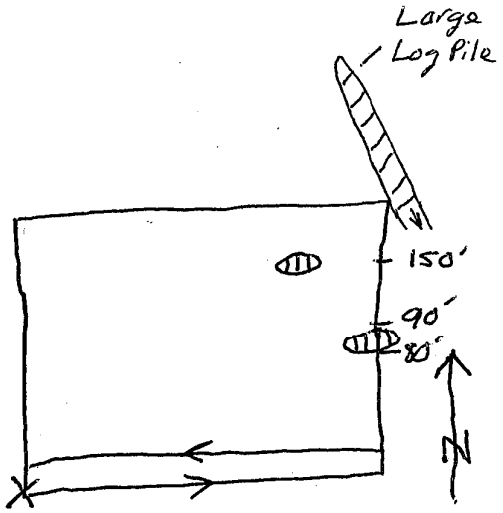
Folder: Makawao File: 091402D Start/End Time: 0848 - 1020

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, Data Collection E-W,
Started at SW Corner, 3' Line Spacing

→ Grid Surface - Grass Pasture
w/ scattered wood & mounds (1'-2')

→ Wood Piles at (200'E, 85'N)
(150'E, 140'N)



Data Collection:

Area: Makawao - Grid 8

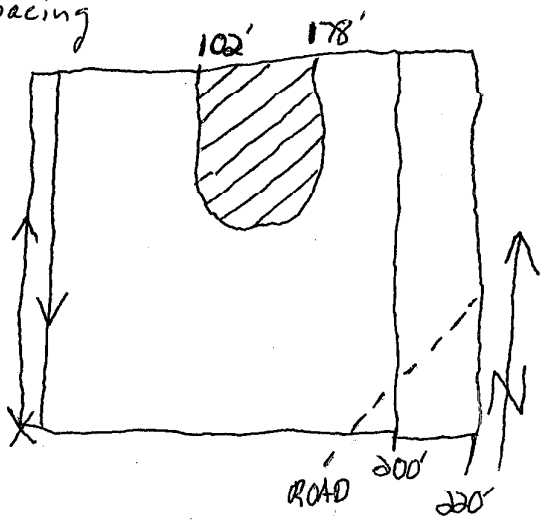
Instrument Operator: R. Blohm

Folder: Makawao File: 091402E Start/End Time: 1050-1215

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, Data Collection N-S,
Started at SW Corner, 3' Line Spacing

→ Grid Surface - Grass Pasture
w/ numerous wood debris piles



PM Standardization Tests: Date: 9/14/02 Page 3 of 3

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

Satellites: 8

GPS QC: PDOP: 2.1

Battery: 12.1

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.5
Channel 2 - Bottom	1.0
Channel 3 - Bottom	0.5
Channel 4 - Top	-1.0

ATV in idle.

Time:

File: 091402F 1506-1507

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	140
Channel 2 - Bottom	38
Channel 3 - Bottom	37
Channel 4 - Top	194

File Folder: Makawao File Name: 091402G Time: 1507-1508

~~4) Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: Makawao File Name: 091402H Time:~~

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Rm # 7-106

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil: 10505 Bottom Coil: 0214 Date: 09/16/03 Page: 1 of 4

Blackhawk Field Personnel

B. Konshak R. Blohm

Weather Sunny / Rainy

GPS Base Station Setup

Base Location: Makawao - Station 20

Frequency: 462.125 MHz Setup Time: 30 minutes

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0800

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes. Satellites: ~~5~~ 6

(Enter Background coil readings) GPS QC: PDOP: ~~3.0~~ 2.5

	Reading (mV)
Channel 1 - Bottom	1.5
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

ATV is in idle

File Folder: Makawao File Name: 091602A Time: 0843-0846

4) Position Standard Board on coils and record data for 1 minute.

(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	139
Channel 2 - Bottom	78
Channel 3 - Bottom	37
Channel 4 - Top	198

File Folder: Makawao File Name: 091602B Time: 0848-0849

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Makawao File Name: 091602C Time: 0850-0852

Data Collection: Date: 09/16/07 Page: 2 of 4

Area: Makawao - Grid 9

Instrument Operator: R. Blohm

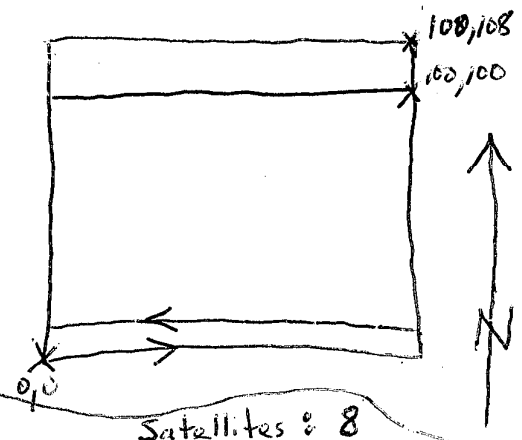
Folder: Makawao File: 091602D Start/End Time: 1000 - 1100

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

100' x 100' Grid, Data Collection E-W,
3' Line Spacing, Started at SW corner

→ Grid Surface - Grass w/ 1-2.5' Lumps throughout grid

→ Extra data N of Grid



Data Collection:

Area: Makawao - Grid 13

Instrument Operator: R. Blohm

Folder: Makawao File: 091602E Start/End Time: 1200 - 1230

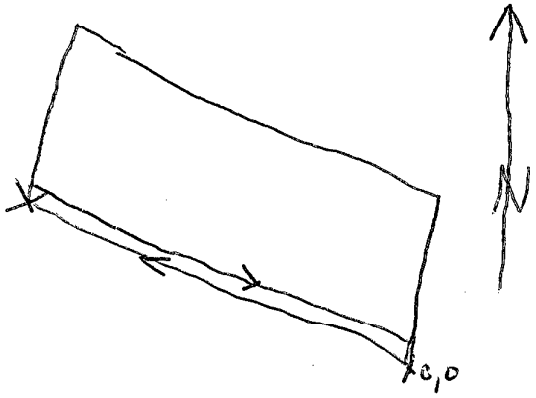
Satellites: 8
PDOP: 2.0
Battery: 12.1

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

50' x 200' Grid, Data Collection E-W
3' Line Spacing, Started at SW corner

→ Grid Surface - Flat Grass

→ Extra data N & S of grid



PM Standardization Tests: Date: 09/16/09 Page 4 of 4

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

Satellites: 7
GPS QC: PDOP: 3.4
Battery: 12.1

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	1.0
Channel 4 - Top	1.5

Time: 15:57 - 15:58
File: 091602H

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	138
Channel 2 - Bottom	78
Channel 3 - Bottom	37
Channel 4 - Top	197

File Folder: Makawao File Name: 091602I Time: 15:59 - 16:00

~~4) Lateney Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: Makawao File Name: 091702I Time:~~

Data Collection: Date: 09/16/02 Page: 3 of 4

Area: Makawao - Grid 10

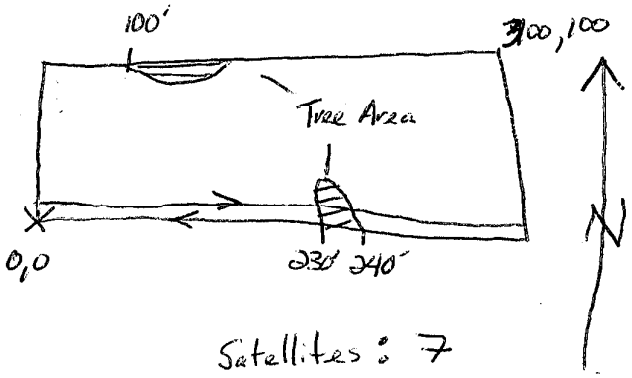
Instrument Operator: R. Blohm

Folder: Makawao File: 091602F Start/End Time: 1330 - 1400

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

100' x 300' Grid, Data Collection E-W
3' Line Spacing, Started at SW Corner

→ File 091602F - Lines 0 - 24
→ File 091602G - Lines 27 - 10
→ Lost power to Pro-4000 on Line 27 - started new file



Data Collection:

Satellites: 7
PDOP: 1.9

Area: Makawao - Grid 10

Instrument Operator: R. Blohm

Folder: Makawao File: 091602G Start/End Time: 1430 - 1515

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

303.278.0789

EM61-MK2 Data Acquisition
Daily Log and QC Testing

System: S/N Top Coil: 10505 Bottom Coil: 0214 Date: 9/17/02 Page: 1 of 5

Blackhawk Field Personnel: R. Blohm B. Konshak

Weather: Cloudy

GPS Base Station Setup
Base Location: Makawao - Station 20
Frequency: 462.125 MHz Setup Time: 20 minutes

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0715 - 0742

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

GPS QC: Satellites: 6 PDOP: 2.6 Battery: 12.3

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	1.0
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

File Folder: Makawao File Name: 091702A Time: 0744 - 0747

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	139
Channel 2 - Bottom	79
Channel 3 - Bottom	37
Channel 4 - Top	200

File Folder: Makawao File Name: 091702B Time: 0749 - 0750

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Makawao File Name: 091702C Time: 0751 - 0752

Data Collection: Date: 09/17/02 Page: 2 of 5

Area: Makawao – Meandering Path A1

Instrument Operator: R. Blohm

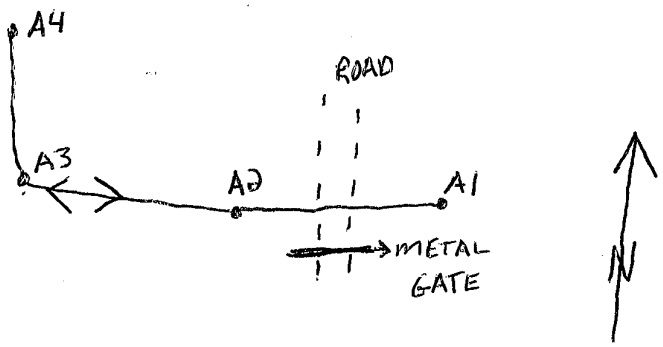
Folder: Makawao File: 091702D Start/End Time: 0822 - 0846

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

A1 - A4 Meandering Path - 400' Total

→ Approx. 15 passes w/ complete coverage of area

→ Tree canopy near A4



Data Collection:

Area: Makawao – Meandering Path A2

Instrument Operator: R. Blohm

Folder: Makawao File: 091702E Start/End Time: 0855 - 0940

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Extra data - connecting A1 to Grid 5 - SW Corner

Started at A1 → W5 - multiple passes

Data Collection: Date: 09/17/09 Page: 3 of 5

Area: Makawao - Meandering Path B

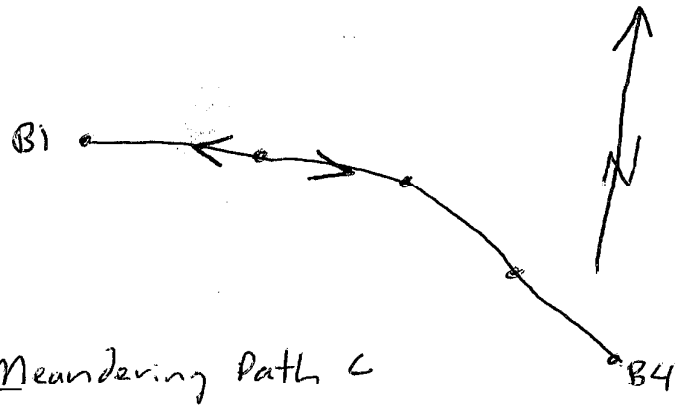
Instrument Operator: R. Blohm

Folder: Makawao File: 091709F Start/End Time: 1036- 1050

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

B1 - B5 Meandering Path 500'

→ 4 passes of data collection



Data Collection:

Area: Makawao - Meandering Path C

Instrument Operator: R. Blohm

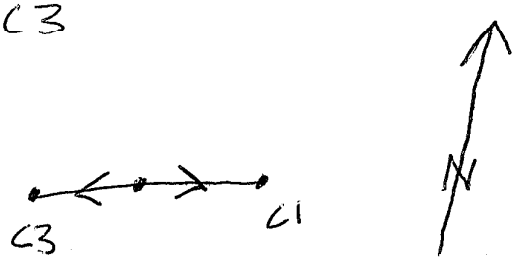
Folder: Makawao File: 091709G Start/End Time: 1110- 1126

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

C1-C3 Meandering 300'

→ 4 passes of data collection

→ Tree Canopy near C3



Data Collection: Date: 09/17/09 Page: 4 of 5

Area: Makawao - Meandering Path D

Instrument Operator: R. Blohm

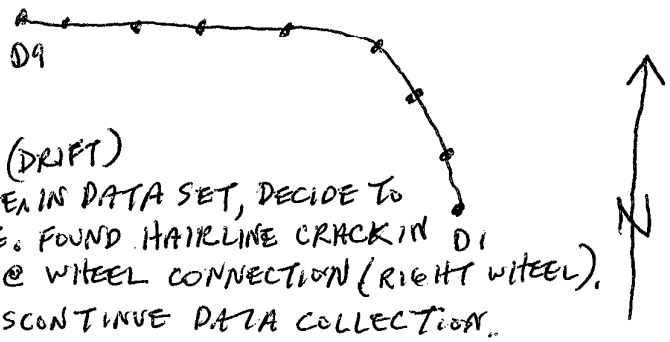
Folder: Makawao File: 091709H Start/End Time: 1155 - 1221

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

D1 - D9 Meandering Path 900'

→ 3 Passes of data collection
(Lanes 0 - 15, 3' Line Spacing)

→ Canopy
near D5 - D6



* EXCESSIVE BACKGROUND NOISE IN DATA SET, DECIDE TO CHECK COIL @ STATIC SITE. FOUND HAIRLINE CRACK IN D1 LOWER COIL @ WHEEL CONNECTION (RIGHT WHEEL). DECIDE TO DISCONTINUE DATA COLLECTION.

Data Collection:

Area: _____

Instrument Operator: _____

Folder: _____ File: _____ Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

PM Standardization Tests: Date: 09/17/02 Page 5 of 5

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

Satellites: 6
GPS QC: PDOP: 2.3
Battery: 12.1

ATV is in idle

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	2.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

Time: 1353-1354
File: 091702I

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	137
Channel 2 - Bottom	76
Channel 3 - Bottom	36
Channel 4 - Top	195

File Folder: Makawao File Name: 091702S Time: 1356-1357

~~4) Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: _____ File Name: _____ Time: _____~~

Fax # 303.278.0789

EM61-MK2 Data Acquisition Daily Log and QC Testing

Top Coil: 10505

System: S/N Bottom Coil: 10505 Date: 09/19/02 Page: 1 of 8

Blackhawk Field Personnel Weather Sunny

B Konshak R. Blohm

GPS Base Station Setup
Base Location: Makawao - Station 20
Frequency: 462.125 MHz Setup Time: 20 minutes

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0830-0857

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

Satellites: 6
GPS QC: PDOP: 3.1
Battery: 12.2

	Reading (mV)
Channel 1 - Bottom	0.5
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

File Folder: Makawao File Name: 091902A Time: 0858-0901

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	130
Channel 2 - Bottom	77
Channel 3 - Bottom	37
Channel 4 - Top	199

File Folder: Makawao File Name: 091902B Time: 0902-0903

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: Makawao File Name: 091902C Time: 0904-0906

Data Collection: Date: 09/19/02 Page: 2 of 8

Area: Makawao Meandering Path A

Instrument Operator: R. Blohm

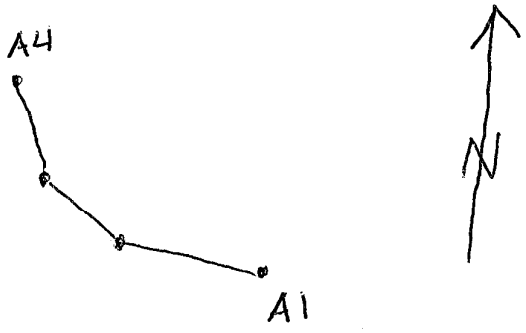
Folder: Makawao File: 091902D Start/End Time: 0924-0936

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

400' Meandering Path A1-A4

→ A4 is in tree canopy

→ 12 passes of data collection



Data Collection:

Area: Makawao Meandering Path B

Instrument Operator: R. Blohm

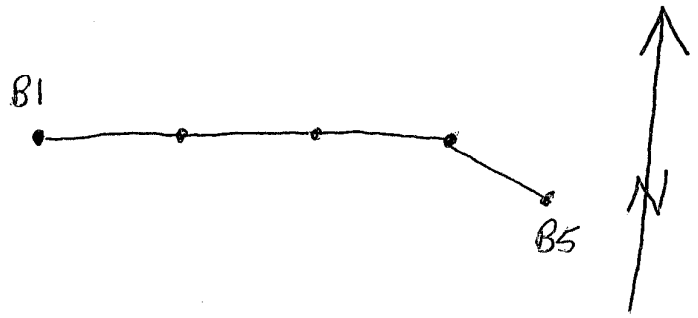
Folder: Makawao File: 091902E Start/End Time: 0940-0955

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

500' Meandering Path B1-B5

→ B2 is in tree canopy

→ 10 passes of data collection



Data Collection: Date: 09/19/07 Page: 3 of 8

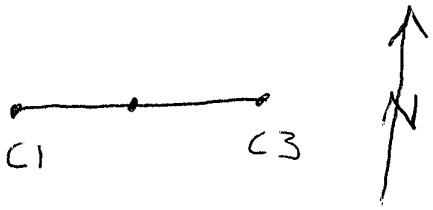
Area: Makawao Meandering Path C

Instrument Operator: R. Blohm

Folder: Makawao File: 091902F Start/End Time: 1003 - 1015

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

300' Meandering Path C1-C3



Data Collection:

Area: Makawao Meandering Path D

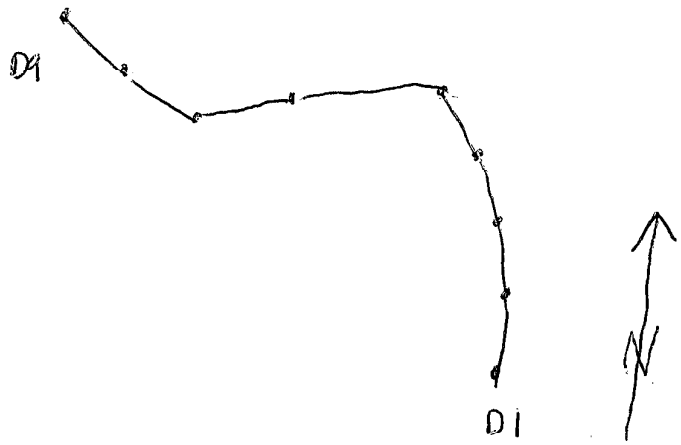
Instrument Operator: R. Blohm

Folder: Makawao File: 091902G Start/End Time: 1022 - 1048

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

900' Meandering Path
D1 - D9

→ 4 passes of
data collection



Data Collection: Date: 09/19/03 Page: 4 of 8

Area: Makawao Meandering Path E

Instrument Operator: R. Blohm

Folder: Makawao File: 091903H Start/End Time: 1055-1118

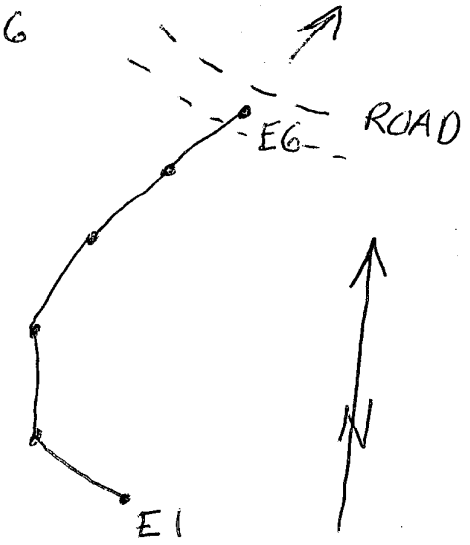
G1

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

600' Meandering Path E1 - E6

→ Collected data to SW Corner of grid 1

→ 6 passes of data collection



Data Collection:

Area: Makawao Road Data

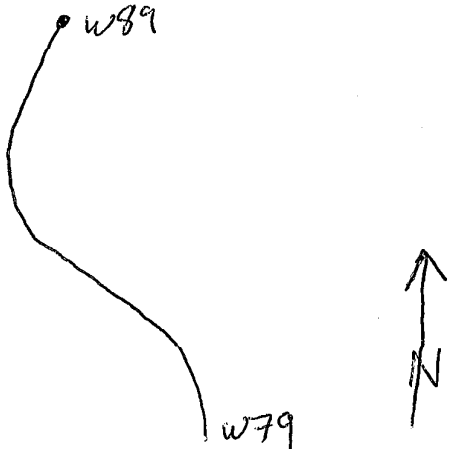
Instrument Operator: R. Blohm

Folder: Makawao File: 091903I Start/End Time: 1122-

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Road Data from W79 - W89

→ Data collection on grass / pasture road surface



Data Collection: Date: 09/19/02 Page: 5 of 8

Area: Makawao – Grid 12

Instrument Operator: R. Blohm

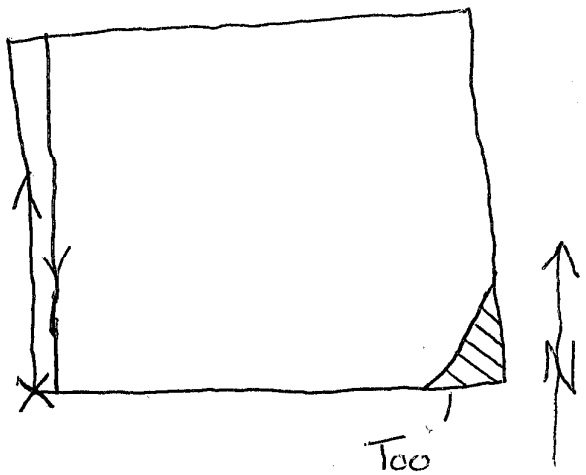
Folder: Makawao File: 091902J Start/End Time: 1225 – 1346

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, Collected Data N-S,
Started at SW corner, 3' Line Spacing

→ Grid surface – thick 2' grass

→ Rocks / Wood debris in SE corner of grid lanes 70-88



Data Collection:

Area: Makawao Meandering Path F

Instrument Operator: R. Blohm

Folder: Makawao File: 091902K Start/End Time: 1402 – 1450

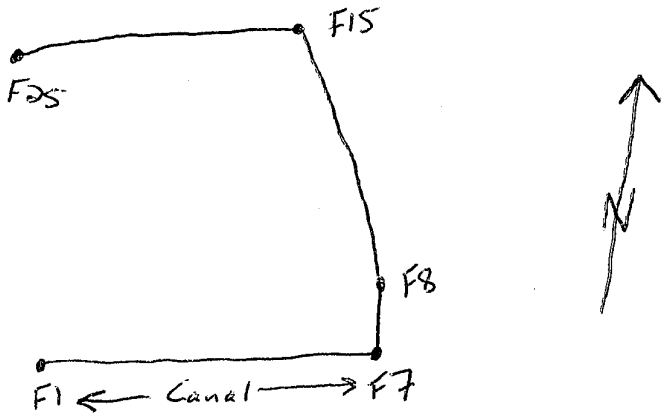
FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Meandering Path F1 – F25

→ Tree canopy F1 – F8

→ 4 Passes F7 – F25

→ 3 Passes F1 – F7



Data Collection: Date: 09/19/03 Page: 6 of 8

Area: Makawao - Meandering Path G

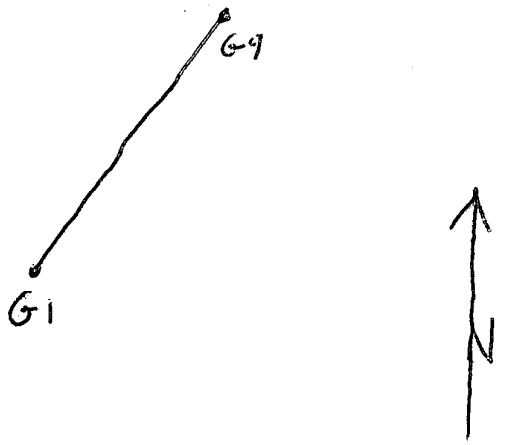
Instrument Operator: R. Blohm

Folder: Makawao File: 091903L Start/End Time: 1540-1550

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Meandering Path G1-G9
Along grass/brush road.

→ 2 passes of data collection



Data Collection:

Area: Makawao Meandering Path H

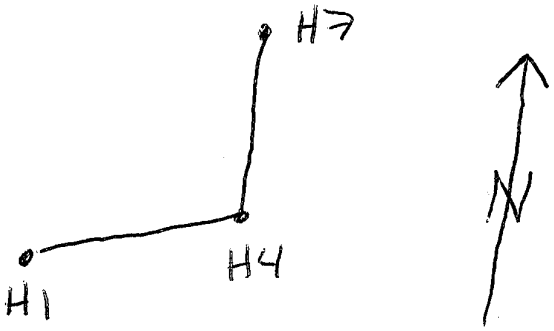
Instrument Operator: R. Blohm

Folder: Makawao File: 091903m Start/End Time: 1558-1610

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Meandering Path H1-H7

→ 4 passes of data collection



Data Collection: Date: 09/19/02 Page: 7 of 8

Area: Makawao - Meandering Path I

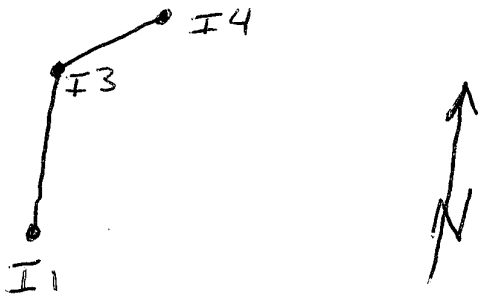
Instrument Operator: R. Blohm

Folder: Makawao File: 091902N Start/End Time: 1617-1622

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Meandering Path I1 - I4

→ 4 passes of data collection



Data Collection:

Area: Makawao - Meandering Path J

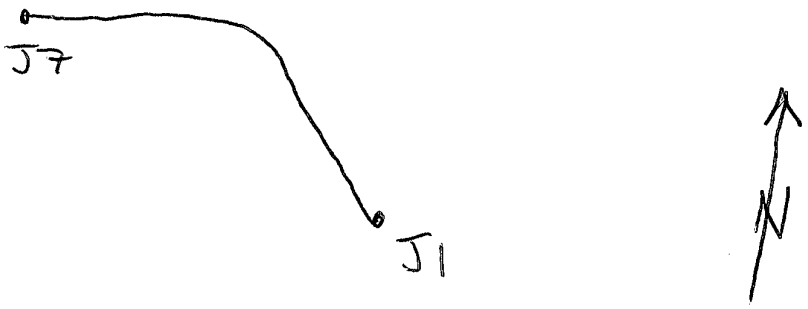
Instrument Operator: R. Blohm

Folder: Makawao File: 091902O Start/End Time: 1627-1637

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

Meandering Path J1 - J7

→ 4 passes of data collection



PM Standardization Tests: Date: 09/19/02 Page 8 of 8

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

Satellites: 8

GPS QC: PDOP: 1.7

Battery: 12.1

ATV is in idle.

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	0.5
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

File: 091902P Time: 1656-1657

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	135
Channel 2 - Bottom	79
Channel 3 - Bottom	37
Channel 4 - Top	199

File Folder: Makawao File Name: 091902Q Time: 1657-1658

~~4) Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: File Name: Time:~~

FAX # 303.278.0789

EM61-MK2 Data Acquisition
Daily Log and QC Testing

Top / Bottom

Rm 7-106

System: S/N Coil : 10505 Date: 9/20/02 Page: 1 of 4

Blackhawk Field Personnel

R. Blohm B. Konshak

Weather Sunny

GPS Base Station Setup
Base Location: Makawao Station 20
Frequency: 462.125 MHz Setup Time: 30 minutes
8:20

AM Quality Control/Standardization Tests

1) Warm up EM instrument for 15 minutes. Start/End Time: 0730 - 0820

2) Null coils prior to tests.

3) Collect Background data in a static mode for 3 minutes.
(Enter Background coil readings)

Satellites: 5
GPS QC: PDOP: 3.0
Battery: 12.2

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.0
Channel 4 - Top	-1.0

File Folder: MAKAWAO File Name: 092002A Time: 09:24 - 8:27

4) Position Standard Board on coils and record data for 1 minute.
(Enter Standard board coil readings)

	Reading (mV)
Channel 1 - Bottom	139
Channel 2 - Bottom	78
Channel 3 - Bottom	37
Channel 4 - Top	199

File Folder: MAKAWAO File Name: 092002B Time: 08:28 - 08:29

5) Latency Test: Collect data over standard line (with spike) in 2 directions.

File Folder: MAKAWAO File Name: 092002C Time: 08:30 - 08:32

Data Collection: Date: 9/20/02 Page: 2 of 4

Area: Makawao - Grid 15

Instrument Operator: R. Blohm / B. Konshack

Folder: Makawao File: 092002D Start/End Time: 0906 - 1046

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

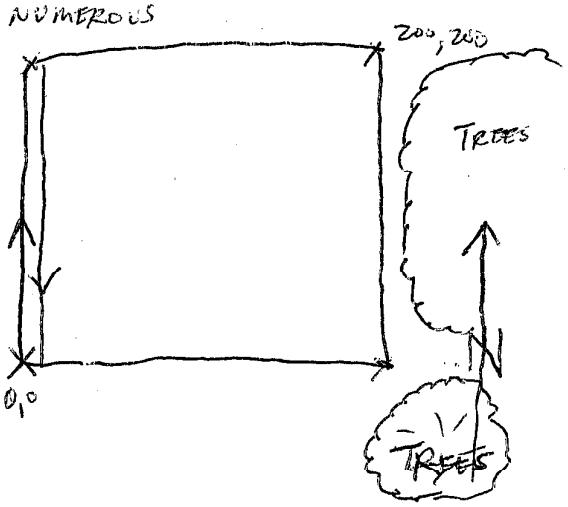
200' x 200' Grid, Collected Data N-S

3' Line Spacing, Started at SW Corner

N

* GRID AREA WAS CLEARED OF TREES, LEAVING NUMEROUS DIRT MOUNDS + STUMPS (1' TALL), ROUGH GROUND SURFACE 90% GRASS COVER, 10% DIRT

BEN ON ATV FROM 105'-201'



Data Collection:

Area: MAKAWAO - EAST ROAD

Instrument Operator: B. KONSHACK

Folder: MAKAWAO File: 092002E Start/End Time: 11:17 - 12:50

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

- START AT LATH RD 1 - RD 77 7 SATELLITES PDOP 2.3
- RD 2 - RD 4 HAS TREE CANOPY
- RD 34 & 37 THROUGH 41.5 HAS TREE CANOPY
- RD 52.5 IS FENCE + GATE + TREE CANOPY
- RD 56.25 METAL FENCE + WIRE GATE + SHEET METAL
- RD 66 - 67 HAS METAL FENCE ~ 15' EAST
- 3 Passes of data collection

Data Collection: Date: 9/20/07 Page: 3 of 4

Area: Makawao – Grid 1

Instrument Operator: R. Blehm

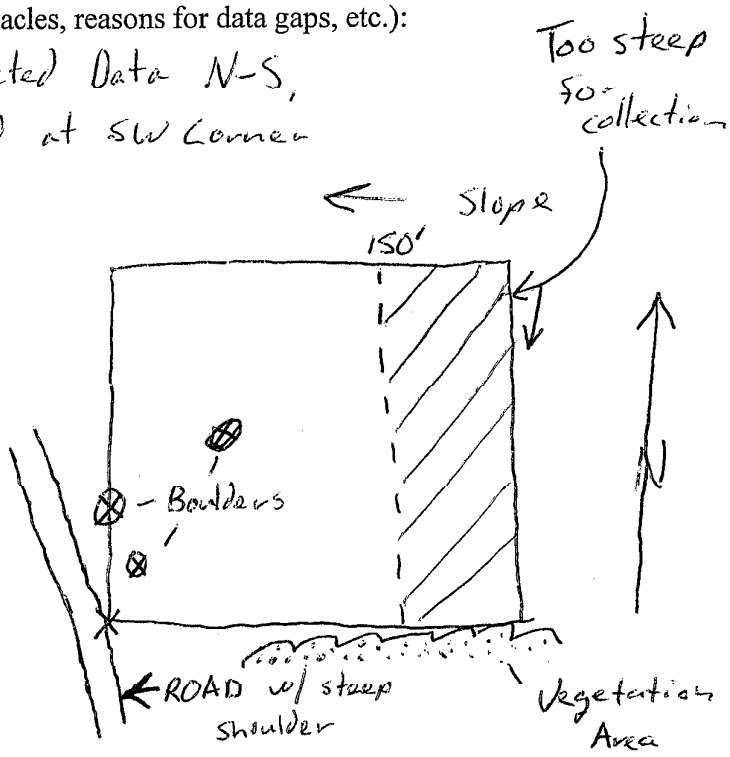
Folder: Makawao File: 092007F Start/End Time: 1354 – 1500

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

200' x 200' Grid, Collected Data N-S, 3' Line Spacing, Started at SW Corner

→ 100% grass grid surface w/ occasional rocks & grass clumps 1'-2'

→ Repeat Line 117, 132



Data Collection:

Area: _____

Instrument Operator: _____

Folder: _____ File: _____ Start/End Time: _____

FIELD NOTES (site map and conditions, obstacles, reasons for data gaps, etc.):

PM Standardization Tests: Date: 09/20/02 Page 4 of 4

1) Null coils prior to tests.

2) Record Background data (static mode) for 1 minute.

Satellites: 7
GPS QC: PDOP: 3.9
Battery: 12.1

(Enter Background coil readings)

	Reading (mV)
Channel 1 - Bottom	1.0
Channel 2 - Bottom	0.5
Channel 3 - Bottom	0.5
Channel 4 - Top	1.0

File: 0920026 Time: 1505 - 1526

3) Center Standard Board on coils and record data for 1 minute (use same file for both data sets).

(Enter Standard Board coil readings)

	Reading (mV)
Channel 1 - Bottom	132
Channel 2 - Bottom	78
Channel 3 - Bottom	36
Channel 4 - Top	195

File Folder: Makawao File Name: 0920027H Time: 1527 - 1528

~~4) Latency Test: Collect data over standard line (with spike) in 2 directions.~~

~~File Folder: _____ File Name: _____ Time: _____~~

APPENDIX E
TARGET LISTS
(unavailable)

APPENDIX F
REAQUISITION FIELD NOTES

Opana Point

Grid 1

ID	EASTING	NORTHING	mV	Comment	% No contacts	15.7%
560	1771913.09	221849.53	10.18	No contact		
349	1771952.28	221746.55	10.38	Reacquired	% Reacquired	84.3%
555	1771865.8	221846.94	10.64	Reacquired-W 18"		
361	1771929.05	221683.86	10.87	Reacquired		
469	1771865.23	221807.56	11.14	No contact		
562	1771894.09	221851.78	11.24	Reacquired		
337	1771972.52	221829.63	11.88	Reacquired		
617	1771932.94	221870.62	11.91	No contact		
336	1771921.89	221732.55	11.91	Reacquired-road		
411	1771993.52	221739.38	11.93	Reacquired		
412	1771853.06	221738.15	12.16	Reacquired-N 18"		
715	1771929.56	221773.61	12.31	Reacquired		
406	1771960.57	221730.02	12.35	No contact		
427	1772024.63	221757.97	12.36	Reacquired		
513	1771826.67	221818.62	12.52	No contact		
332	1771942.06	221720.44	12.55	Reacquired		
558	1771829.75	221849.43	12.64	Reacquired		
557	1771971.46	221846.71	12.69	No contact		
416	1771835.43	221744.31	12.94	No contact		
512	1771904.08	221816.18	13.26	Reacquired		
325	1771912.78	221737.93	13.55	Reacquired-road		
519	1771901.53	221821.47	13.58	Reacquired		
518	1771875.93	221821.19	13.72	Reacquired-W 6" - large response 24"		
324	1771971.52	221806.01	13.77	Reacquired		
405	1771866.14	221734.67	13.97	Reacquired-SW 20"		
721	1771840.72	221753.26	14.08	Reacquired-E 10" - large response NW 20"		
500	1772002.42	221809.5	14.17	No contact		
358	1772012.31	221678.06	14.57	No contact		
447	1771953.99	221774.1	14.74	Reacquired		
687	1771907.52	221791.64	14.78	Reacquired		
706	1772014.52	221798.6	14.85	Reacquired		
303	1772010.93	221672.82	14.86	No contact		
438	1771871.24	221769.39	14.91	Reacquired-SE 10"		
542	1771927.34	221836.2	14.98	No contact		
580	1771870.05	221867.88	17.76	No contact		
665	1771869.41	221831.54	20.24	Reacquired		
673	1771844.69	221800.42	21.64	No contact		
693	1771922.82	221806.5	22.48	Reacquired		
528	1771988.92	221829.39	23.11	Reacquired-E 12"		
504	1771862.11	221818.76	24.27	Reacquired-W 12"		
360	1772000.07	221693.33	25.25	Reacquired-SW 14"		
740	1772012.47	221702.88	26.21	Reacquired-SW 12"		
487	1771831.73	221805.42	27.55	Reacquired		
312	1771918	221735.89	28.47	Reacquired-road W 10"		
392	1771999.16	221720.92	29.43	Reacquired		
408	1772002.6	221732.03	30.49	Reacquired-N 16"		
384	1772039.69	221710.48	38.57	Reacquired-outside grid		
656	1771902.44	221848.11	39.36	Reacquired- 12"		
410	1771988.86	221734.86	41.84	Reacquired		

772	1771848.66	221757.73	41.85	Reacquired
433	1772024.08	221765.2	43.93	Reacquired-S 12"
451	1771926.51	221779.75	44.46	Reacquired-NW 6"
641	1771945.24	221814.7	44.84	Reacquired-SE 12"
300	1771896.75	221673.83	45.18	Reacquired
786	1771968.56	221704.83	46.15	Reacquired-E 10"
395	1772034.76	221732.22	54.93	Reacquired-outside grid - trash
415	1772012.63	221745.01	57.03	Reacquired
515	1771851.67	221822.85	59.01	Reacquired
310	1771936.06	221714.62	65.17	Reacquired-Road
404	1771859.54	221732.14	74.85	Reacquired
414	1772017.17	221741.01	77.15	Reacquired
713	1771990.58	221776	77.26	Reacquired
453	1771866.28	221789.16	78.51	Reacquired-SE 18"
779	1771935.29	221717.12	80.92	Reacquired-Road
437	1771944.07	221768.33	81.5	Reacquired-S 4"
783	1771971.71	221695.6	86.29	Reacquired-N 12"
778	1771935.34	221720.4	86.38	Reacquired-lag spike
771	1771847.38	221760.38	88.65	Reacquired-SW 18"
782	1771970.44	221698.9	90.99	Reacquired-S 12"
308	1771923.98	221695.76	99.61	Reacquired
757	1771981.66	221838.43	104.72	Reacquired
458	1772031.62	221786.75	107.39	Reacquired-outside grid
407	1772019.66	221731.78	112.67	Reacquired
364	1771967.87	221690.52	116.51	Reacquired
299	1771973.51	221672.06	151.05	Reacquired
541	1771890.63	221839.36	155.54	Reacquired - SW 12"
362	1771858.89	221687.51	177.25	Reacquired
403	1771820.9	221737.96	193.93	Prove out-gps st.4
547	1771963.51	221841.58	201.07	Reacquired
775	1771814.23	221735.28	232.45	Reacquired
306	1771929.28	221699.62	236.75	Reacquired-SE 14"
567	1771869.29	221860.67	257.81	Reacquired-(3lb oe scrap collected during transect layout)
417	1771867.03	221751.07	313.91	Prove out

Grid 2

ID	EASTING	NORTHING	mV	Comment
294	1772134.59	221504.17	11.81	No contact
151	1772137.19	221457.55	11.95	No contact
88	1772046.72	221416.22	12.69	No contact
435	1772129.69	221573.13	13.26	Reacquired
302	1772097.37	221515.86	14.27	Reacquired-S 14"
118	1772005.11	221441.75	15.19	Reacquired-outside grid 14' W
365	1772079.27	221534.5	15.53	Reacquired
408	1772087.51	221559.31	15.83	Reacquired
136	1772122.91	221468.25	15.95	Reacquired
372	1772185.54	221534.92	16.88	No contact
375	1772073.46	221540.49	17.39	Reacquired-N 19"
93	1772006.79	221422.05	19.14	Reacquired-oustide grid 12' W
2	1772111.78	221379.18	19.35	No contact
247	1772225.54	221488.41	19.56	No contact
275	1772234.02	221485.66	19.57	Reacquired
83	1772199.44	221408.09	19.7	Reacquired
589	1772031.31	221485.9	19.76	Reacquired
310	1772081.05	221521.35	19.86	Reacquired-SE 14"
300	1772076.34	221512.89	22.42	Reacquired-E 12"
117	1772232.66	221437.13	22.97	Reacquired
114	1772063.43	221437.62	24.26	Reacquired
332	1772198.02	221536.05	24.64	Reacquired
131	1772129.88	221451.09	25.35	Reacquired
368	1772106.86	221536.72	25.74	Reacquired
27	1772200.62	221398.88	26.53	Reacquired
73	1772024.87	221402.1	27.46	Reacquired
581	1772163.77	221484.63	28.23	Reacquired
290	1772010.6	221503.35	28.45	Reacquired-outside grid N 15"
238	1772184.43	221503.44	28.96	No contact
122	1772053.03	221444.34	29.82	Reacquired
126	1772151.54	221452.09	29.82	Reacquired
282	1772100.26	221488.92	31.07	Reacquired
96	1772061.24	221422.57	31.53	Reacquired
110	1772172.91	221432.75	34.9	Reacquired
317	1772018.11	221523.58	35.44	Reacquired-N 14"
226	1772174.98	221529.82	36.59	Reacquired
225	1772154.92	221503.87	37.92	Reacquired
165	1772136.02	221467.4	45.3	Reacquired
276	1772070.29	221503.14	46.01	Reacquired-S 10"
220	1772161.32	221537.89	54.13	Reacquired
410	1772168.85	221559.44	61.4	Reacquired
217	1772180.38	221495.63	61.44	Reacquired
347	1772069.36	221529.39	62.75	Reacquired-W 36"
351	1772218.27	221529.85	64.41	Reacquired
20	1772232.89	221407.6	66.27	Reacquired
462	1772098.69	221564.28	67.14	Reacquired-S 12"
102	1772159.72	221428.35	70.14	Reacquired
194	1772231.87	221473.22	72.63	Reacquired
597	1772186.91	221452.15	75.43	Reacquired

% No contacts	10.6%
% Reacquired	89.4%

125	1772162.07	221454.56	77.23	Reacquired
274	1772110.07	221486.81	78.41	Reacquired
44	1772082.69	221408.48	91.6	Reacquired
322	1772198.81	221545.22	91.65	Reacquired-S 12"
190	1772152.06	221487.51	95.82	Reacquired
116	1772228.1	221439.16	99.04	Reacquired
208	1772189.11	221509.28	123.54	Reacquired-S 18"
171	1772034.77	221496.44	128.06	Reacquired-S 15"
43	1772136.78	221429.34	134.21	Reacquired
303	1772140.04	221517.87	147.23	Reacquired
273	1772116.6	221485.4	185.3	Reacquired
454	1772164.63	221498.39	191.48	Reacquired
418	1772171	221571.87	201.8	Reacquired
170	1772044.89	221515.32	202.57	Reacquired-SW 10"
84	1772145.71	221412.15	319.95	Reacquired
90	1772206.27	221426.36	553.62	Reacquired-S 15"
526	1772055.93	221509.81	1125.71	Reacquired

Grid 3

ID	EASTING	NORTHING	mV	Comment	% No contacts	1.9%
177	1772331.53	221402.94	12.92	Reacquired		
181	1772369.07	221410.92	14.97	No contact	% Reacquired	98.1%
35	1772405.74	221315.23	16.14	Reacquired-2' N		
102	1772354.55	221360.6	18.01	Reacquired		
37	1772438.54	221313.44	18.44	Reacquired-E of grid		
118	1772341.18	221389.01	24.35	Reacquired		
182	1772406.51	221413	25.64	Reacquired		
13	1772320.6	221283.65	26.35	Reacquired		
164	1772392.52	221398.77	29.77	Reacquired		
187	1772331.13	221420.66	32.64	Reacquired		
62	1772325.33	221337.4	33.2	Reacquired		
108	1772384.88	221370	34.69	Reacquired		
124	1772435.28	221404.71	35.64	Reacquired		
65	1772377.33	221347.14	37.17	Reacquired		
103	1772323.21	221372.21	37.49	Reacquired-outside grid		
98	1772387.3	221355.53	40.28	Reacquired		
123	1772435.77	221393.54	42.27	Reacquired-edge of furrow-2' S		
105	1772367.06	221363.04	44.45	Reacquired		
160	1772399.87	221407.85	44.5	Reacquired-on road		
159	1772362.02	221422.84	44.56	Reacquired-in road		
157	1772390.9	221422.41	48.05	Reacquired-edge of road		
121	1772422.07	221399.65	52.19	Reacquired-edge of road		
213	1772424.92	221428.96	52.6	Reacquired		
155	1772340.25	221415.28	56.15	Reacquired		
154	1772377.07	221419.33	59.57	Reacquired		
153	1772351.64	221431.52	59.76	Reacquired-on road 2' S		
97	1772384.74	221360.16	60.46	Reacquired		
152	1772392.3	221428.96	61.18	Reacquired-16" SW		
151	1772380.62	221438.32	62.68	Reacquired		
150	1772358.65	221416.98	63.41	Reacquired-edge of road		
212	1772422.99	221431.61	65.98	Reacquired		
80	1772422.56	221387.83	66.02	Reacquired		
70	1772362.18	221344.08	67.2	Reacquired		
149	1772379.13	221425.87	67.53	Reacquired-edge of road		
39	1772367.16	221324.98	68.64	Reacquired		
260	1772428.41	221353.48	71.14	Reacquired-E edge-2.8' S		
198	1772317.55	221441.67	71.85	Reacquired-outside grid NW corner, road		
211	1772373.95	221441.5	72.22	Reacquired-18" N		
148	1772373.18	221422.67	87.53	Reacquired-12" W		
147	1772344.26	221420.47	88.83	Reacquired-edge of road		
32	1772405.34	221332.29	89.1	Reacquired		
146	1772363.46	221431.35	89.31	Reacquired-edge of road		
202	1772330.57	221434.92	103.8	Reacquired-on road		
49	1772434.84	221329.9	107.65	Reacquired		
183	1772429.54	221416.6	131.03	Reacquired		
136	1772396.85	221425.61	147.2	Reacquired		
69	1772357.68	221350.05	155.69	Reacquired		
10	1772429.48	221277.47	158.7	Reacquired-E edge of road		
135	1772346.48	221437.5	176.88	Reacquired-edge of road		

134	1772348.06	221411.23	191.12	Reacquired
78	1772406.02	221378.88	211.58	Reacquired
24	1772424.83	221318.89	216.98	Reacquired
228	1772396.29	221354.61	251.07	Reacquired

Grid 4

ID	EASTING	NORTHING	mV	Comment		
30	1772021.8	221023.95	10.01	No contact	% No conta	61.0%
193	1772059.1	221199.28	10.02	No contact	% Reacquir	39.0%
162	1772166.5	221189.84	10.03	No contact		
123	1772009.8	221148.81	10.1	No contact		
25	1772081.2	221048.02	10.15	No contact		
557	1772055.2	221160.48	10.15	Reacquired		
77	1772164.8	221114.4	10.17	No contact		
565	1772076.6	221148.36	11.61	No contact		
544	1772089.2	221199.34	13.02	No contact		
648	1771960.5	221190.72	13.03	No contact		
136	1772092.1	221169.92	13.1	No contact		
92	1772096	221120.65	13.34	No contact		
148	1772174.8	221172	13.34	No contact		
135	1772085.6	221170.02	13.36	No contact		
56	1771957.9	221051.13	13.72	No contact		
70	1771962.5	221098.97	13.75	Reacquired		
602	1772064.3	221023.28	14.27	Reacquired		
66	1772003.7	221089.84	14.28	No contact		
577	1772131.4	221123.96	14.28	No contact		
160	1772173.9	221202.85	14.85	Reacquired		
195	1771966	221201.95	15.03	Reacquired		
198	1772158.3	221208.33	15.03	No contact		
90	1772100.4	221154.71	15.06	No contact		
35	1772139	221055.06	15.58	Reacquired		
599	1772044.6	221018.32	15.61	No contact		
11	1772063.4	221042.38	16.11	No contact		
158	1772169.9	221198.32	16.14	Reacquired		
129	1772070.3	221154.49	16.53	No contact		
643	1772177.1	221202.65	17.17	Reacquired		
543	1772078.7	221202.11	17.9	No contact		
634	1771953.5	221204.59	18.09	No contact		
65	1772100	221083.18	18.81	Reacquired		
34	1772138.7	221031.44	19.4	Reacquired		
587	1772132.4	221062.95	20.42	No contact		
10	1772058	221035.24	21.53	No contact		
693	1772060	221042.36	25.39	No contact		
7	1772062.4	221018.11	28.33	No contact		
83	1772100.9	221140.92	28.74	No contact-berm		
650	1772117.8	221141.86	29.59	No contact		
58	1772126.5	221051.3	30.16	No contact		
174	1772028.1	221191.2	31.29	Reacquired		
592	1772036.5	221051.23	32.95	Reacquired		
62	1772136.1	221082.66	33.47	Reacquired		
585	1772075.5	221074.27	34.39	Reacquired		
68	1772129.7	221089.97	34.52	No contact		
82	1772087.9	221148.33	34.98	No contact-berm		
173	1772039.2	221187.1	35.24	Reacquired		
103	1772028.5	221127.54	35.54	No contact		
81	1772105.6	221150.04	36.33	No contact		

99	1772140	221127.23	37.09	Reacquired-18" NE
59	1772040.6	221057.14	41.36	Reacquired
6	1772068	221045.59	58.4	Reacquired
549	1772169.6	221183.74	58.71	Reacquired
550	1772172.9	221186.31	59.7	Reacquired
660	1772135.6	221013.06	65.2	Reacquired
563	1771996.9	221168.54	81.95	Reacquired
644	1772172.6	221211.89	93	No contact
179	1772137.7	221192.88	149.37	Reacquired
656	1772038.4	221048.58	183.9	No contact

Grid 5

ID	EASTING	NORTHING	mV	Comment	% No contac	47.9%
495	1771895.3	221396.29	10.05	Reacquired		
378	1771768.5	221467.97	11.59	Reacquired	% Reacquire	52.1%
311	1771756.8	221384.15	11.63	Reacquired		
343	1771774.7	221402.91	11.63	No contact		
278	1771762.5	221329.59	13.08	No contact		
266	1771870.3	221343.12	13.36	Reacquired		
491	1771909.9	221407.88	13.72	No contact		
607	1771706.6	221501.35	13.73	Reacquired		
387	1771737.9	221483.51	14.28	No contact		
610	1771767.7	221506.36	14.4	Reacquired		
295	1771761.7	221361.11	14.41	Reacquired		
264	1771864.4	221343.86	14.42	Reacquired		
397	1771843.1	221502.32	14.43	Reacquired		
373	1771710.7	221461.6	14.52	Reacquired		
263	1771809.5	221355.16	14.59	No contact		
305	1771748.4	221394.11	14.6	No contact		
520	1771753.9	221322.93	14.74	No contact-berm		
623	1771786.5	221403.12	14.86	Reacquired		
292	1771753.7	221355.97	14.87	No contact		
411	1771788.1	221507.06	14.88	Reacquired		
279	1771799.9	221330.36	15.06	No contact		
364	1771846.7	221432.71	15.58	No contact		
258	1771818.4	221337.97	15.63	No contact		
226	1771759.7	221319.13	15.96	No contact		
435	1771860.1	221496.17	15.98	Reacquired		
253	1771831	221343.69	16.37	Reacquired		
294	1771792.5	221359.34	16.4	No contact		
202	1771819	221288.74	16.44	No contact-berm		
440	1771722.5	221506.7	17.07	Reacquired		
320	1771762.8	221390.62	17.13	Reacquired-25" SW		
669	1771861.9	221355.46	17.17	Reacquired-20" SE		
249	1771842.6	221329.74	17.89	No contact		
408	1771761.8	221504.82	17.95	No contact		
679	1771842.7	221343.28	18.34	No contact		
332	1771777.5	221409.44	18.38	No contact		
210	1771756.9	221300.8	18.59	No contact		
319	1771773.8	221380.62	18.68	No contact-berm		
222	1771767.7	221322.3	18.84	No contact		
425	1771905.3	221490.92	19.09	Reacquired		
450	1771714.3	221490.09	19.1	No contact		
390	1771716.9	221484.47	19.4	No contact		
243	1771818.7	221358.31	19.45	No contact		
438	1771898.3	221511.36	19.53	Reacquired		
331	1771769	221410.87	19.55	No contact		
394	1771826.7	221501.25	19.86	Reacquired		
277	1771750.2	221339.62	19.93	No contact		
293	1771791.9	221365.26	19.94	Reacquired		
207	1771792.2	221296.35	20.67	No contact		
241	1771812	221351.84	21.65	No contact		

240	1771871.7	221350.97	22.05	No contact
621	1771900.8	221503.11	22.3	Reacquired
407	1771765	221500.83	23.11	Reacquired
381	1771904.3	221470.59	23.26	Reacquired
330	1771774.9	221413.41	25.64	Reacquired
234	1771821.2	221352.36	29.79	No contact-berm
509	1771900.4	221383.76	31.01	No contact
329	1771791.8	221403.98	31.21	No contact-berm
433	1771858.9	221503.4	32.74	Reacquired
233	1771829.8	221351.58	33.31	No contact-berm
406	1771797.9	221504.95	34.07	Reacquired
372	1771713.4	221468.77	38.23	No contact
393	1771840.3	221487.93	40.19	Reacquired
449	1771712.4	221492.08	40.23	Reacquired
220	1771808.2	221315.8	49.77	Reacquired
230	1771793.9	221323.89	60.53	Reacquired
368	1771837.7	221445.31	73.96	Reacquired
465	1771849.2	221471.07	121.49	Reacquired
375	1771780.2	221462.55	261.76	Reacquired
392	1771750.4	221487.27	376.11	Reacquired
463	1771862.4	221480.72	380.38	Reacquired
462	1771908	221505.63	996.24	Reacquired

Grid 6

ID	EASTING	NORTHING	mV	Comment		
33	221514.71	1771689.04	11.88	No contact	% No contact	9.8%
35	221524.17	1771625.43	13.38	No contact	% Reacquired	90.2%
36	221524.34	1771613.6	15.45	No contact		
52	221573.9	1771680.7	19.62	Reacquired		
55	221584.99	1771640.12	17.57	Reacquired		
59	221601.82	1771610.79	15.88	No contact		
88	221635.01	1771663.61	20.1	Reacquired		
72	221628.22	1771690.7	20.52	Reacquired		
7	221476.6	1771692.43	20.8	Reacquired		
56	221590.76	1771694.09	21.07	Reacquired-E edge, concrete block		
16	221491.7	1771601.95	21.21	Reacquired		
18	221492.42	1771642.71	21.42	Reacquired-2.1' SE		
81	221656.52	1771685.19	22.94	Reacquired		
87	221607.11	1771642.87	23.62	Reacquired		
25	221500.58	1771623.11	24.32	Reacquired		
6	221476.32	1771666.14	24.95	Reacquired		
26	221503.35	1771657.99	25.12	Reacquired		
15	221494.24	1771607.9	25.57	Reacquired		
63	221611.32	1771679.28	25.83	Reacquired-East edge of grid 6		
64	221617.04	1771692.5	26.08	Reacquired-East edge of grid 6		
70	221620.63	1771670.87	31.75	Reacquired		
85	221576.36	1771592.58	31.8	Reacquired		
86	221538.92	1771596.62	33.3	Reacquired		
89	221639.61	1771663.02	34.2	Reacquired		
90	221520.63	1771681.62	38.3	Reacquired		
69	221618.92	1771653.1	42.86	Reacquired		
60	221603.25	1771692.96	46.35	Reacquired-E edge		
29	221506.4	1771673.8	47.86	Reacquired		
9	221482.64	1771637.97	49.67	? mV value- not a good response with fisher		
66	221624.96	1771643.99	50.02	Reacquired		
65	221619.14	1771637.99	56.11	Reacquired		
75	221646.03	1771594.34	56.68	Reacquired		
43	221551.55	1771637.66	59.47	Reacquired		
73	221632.31	1771590.2	76.68	Reacquired		
41	221537.14	1771636.13	112.17	Reacquired		
68	221626.84	1771650.58	127.68	Reacquired		
30	221512.06	1771645.63	128.65	Reacquired		
83	221673.73	1771630.24	138.56	Reacquired-outside grid ~15' N		
37	221527.87	1771596.56	144.24	Reacquired		
2	221466.78	1771600.28	2232.63	Reacquired		
78	221656.75	1771669.42	3421.63	Reacquired		

Grid 7

ID	EASTING	NORTHING	mV	Comment	% No contac	10.6%
143	1771843.31	221608.92	11.13	Reacquired		
68	1771805.82	221558.92	15.33	No contact	% Reacquire	89.4%
40	1771889.46	221532.1	15.43	Reacquired		
139	1771775.7	221609.91	15.76	Reacquired		
13	1771816.83	221503.62	16.46	No contact		
127	1772018.59	221609	19.45	Reacquired		
100	1771858.72	221585.07	20.37	Reacquired		
54	1771696.63	221544.76	26.18	Reacquired		
133	1771916.25	221613.77	27.84	Reacquired		
251	1772022.07	221518.9	28.1	Reacquired		
215	1772021.21	221653.6	30.48	Reacquired		
97	1771955.09	221575.79	37.64	Reacquired		
71	1771964.06	221561.21	37.78	Reacquired		
150	1771987.77	221611.42	38.42	Reacquired		
29	1771788.19	221520.45	41.99	Reacquired		
239	1771915.53	221633.91	44.95	Reacquired		
53	1771989.97	221537.2	44.99	Reacquired		
104	1771693.54	221602.57	45.91	Reacquired-duplicate 160-grid 6		
62	1771700.09	221556.53	46.3	Reacquired		
180	1771823.97	221633.5	46.69	Reacquired		
41	1772028.7	221536.64	52.63	Reacquired		
242	1771732.48	221584.11	52.7	Reacquired		
250	1772016.91	221524.87	53.35	Reacquired		
5	1771917.24	221501.5	53.4	Reacquired		
193	1771987.54	221640.3	55.32	Reacquired		
67	1771805.29	221568.12	57.15	No contact-N-S farrow		
220	1772006.25	221663.01	58.43	Reacquired		
52	1771848.93	221543.85	58.57	Reacquired		
110	1771829.92	221591.4	59.1	Reacquired		
2	1771938.3	221505.13	60.76	Reacquired		
15	1771888.44	221507.17	66.36	Reacquired		
176	1772020.87	221629.97	69.43	Reacquired		
36	1771789.58	221525.68	69.69	No contact		
50	1771804.24	221540.57	70.03	Reacquired		
157	1771769.26	221618.54	70.58	Reacquired		
60	1771797.24	221555.77	74.02	No contact		
245	1771809.23	221585.61	80.8	No contact		
163	1771999.03	221617.82	82.16	Reacquired		
241	1771727.32	221590.09	83.05	Reacquired		
65	1771885.25	221559.08	85.53	Reacquired		
132	1771928.73	221614.24	86.16	Reacquired		
167	1771794.39	221630.64	100.97	Reacquired		
209	1771988.36	221651.45	106.87	Reacquired		
214	1772029.13	221656.11	123.74	Reacquired		
146	1771861.96	221627.69	134.38	Reacquired		
164	1772018.77	221621.47	158	Reacquired		
43	1771997.76	221531.18	164.48	Reacquired		
169	1771886.38	221636.52	166.86	No contact		
98	1772007.6	221575.68	176.06	Reacquired-bomb surface		

8	1771795.28	221511.81	178.58	Reacquired
189	1772013.17	221642.55	181.54	Reacquired
184	1771761.66	221637.03	182.41	Reacquired
82	1771907.51	221599.46	205.52	Reacquired
55	1771908.66	221543.64	222.86	Reacquired
64	1771755.27	221559	232	Reacquired
16	1771929.86	221511.82	362.87	Reacquired
185	1771736.9	221649.86	455.95	Reacquired
231	1771727.35	221670.35	648.91	Reacquired
204	1771914.17	221651.22	797.06	Reacquired
120	1771708.68	221605.63	848.8	Reacquired
116	1771966.69	221606.47	899.86	Reacquired
81	1771904.7	221587.02	1086.87	Reacquired
168	1771880.6	221645.14	1228.59	Reacquired
46	1771866.04	221546.89	1267.15	Reacquired
23	1771939.83	221520.21	1432.21	Reacquired
7	1771906.79	221504.94	1482.19	Reacquired

Grid 8

ID	EASTING	NORTHING	mV	Comment	% No conta	30.8%
112	1771921.1	221408.48	20.08	Reacquired		
62	1772019.9	221479.38	21.22	Reacquired	% Reacquir	69.2%
66	1772029.7	221479.24	21.45	Reacquired		
91	1771923.9	221466.81	22.19	No contact		
60	1771937.9	221479.26	23.19	Reacquired		
77	1771960.4	221494.69	23.45	No contact		
40	1772039	221439.71	23.85	Reacquired		
117	1771928.5	221419.52	24.02	Reacquired		
9	1771966.1	221390.87	24.43	No contact		
93	1771901.7	221471.72	25.01	Reacquired-repeat g-4 381		
72	1772000.3	221486.89	25.23	Reacquired		
94	1771903.6	221468.41	25.3	No contact		
55	1772004.1	221476.33	27.2	No contact-N side of ridge		
68	1771909.1	221485.59	28.5	Reacquired		
85	1771902	221493.36	28.77	No contact-furrow		
13	1771906	221404.22	29.42	No contact		
87	1771934.2	221498.79	30.08	Reacquired		
109	1772032.4	221487.52	31.07	Reacquired		
90	1771941.4	221496.72	31.61	Reacquired		
97	1771949.3	221497.26	32.9	Reacquired		
22	1772024	221401.84	44.98	Reacquired-repeat g-2 73		
98	1771952.5	221493.94	46.14	Reacquired		
8	1771961.5	221389.62	49.33	No contact		
86	1771915.9	221499.06	50.24	Reacquired-duplicate g-7 5		
108	1772034.5	221494.71	114.47	Reacquired-repeat g-2 171		
116	1771928.5	221423.45	286.75	Reacquired		

Grid 9

ID	EASTING	NORTHING	mV	Comment	% No conta	8.5%
383	1772325.7	221348.95	22.17	Reacquired		
55	1772127.3	221240.15	23.29	No contact	% Reacquir	91.5%
235	1772154	221314.66	24.5	Reacquired		
447	1772156.1	221365.22	25.28	Reacquired		
101	1772273.3	221266.27	25.52	No contact		
400	1772145.6	221368	26.22	Reacquired		
190	1772216.8	221303.89	26.81	Reacquired		
176	1772135.4	221296.53	26.89	Reacquired		
37	1772134.4	221231.5	27.03	Reacquired		
95	1772152.7	221268.03	27.6	Reacquired		
141	1772318.2	221285.33	27.73	Reacquired		
26	1772291.7	221219.36	27.74	Reacquired		
36	1772135.7	221228.2	27.96	Reacquired		
33	1772166	221234.33	28.15	Reacquired		
356	1772180.7	221347.12	28.2	Reacquired		
129	1772184.3	221276.11	28.33	Reacquired		
201	1772172.2	221305.19	28.41	Reacquired		
297	1772066	221352.73	28.82	Reacquired		
137	1772123.5	221290.79	29.19	No contact		
404	1772115.4	221367.12	29.65	No contact-furrow		
157	1772253.3	221287.59	30.06	Reacquired		
443	1772246.5	221362.59	30.33	Reacquired		
32	1772164	221231.73	32.15	Reacquired		
185	1772119.8	221308.59	32.27	Reacquired		
427	1772104.3	221370.57	32.27	Reacquired		
328	1772204.2	221339.55	32.35	Reacquired		
51	1772207.4	221239.64	33.44	No contact		
319	1772033.7	221340.06	34.2	Reacquired		
19	1772213.1	221225.1	34.71	Reacquired		
200	1772174.2	221307.79	34.82	Reacquired		
306	1772162.2	221334.25	34.96	Reacquired		
365	1772304.1	221348.61	35.76	Reacquired		
329	1772323.6	221337.81	36.29	Reacquired-repeat g-3 60		
134	1772177.1	221279.5	37	Reacquired		
348	1772071.2	221346.74	38.67	Reacquired		
50	1772202.9	221245.62	38.82	Reacquired		
258	1772112.3	221331.03	38.92	Reacquired		
278	1772144.6	221343.7	40.08	Reacquired		
507	1772192.7	221314.39	40.38	Reacquired		
112	1772137.6	221265.62	41.58	Reacquired		
187	1772186	221304.99	41.66	Reacquired		
113	1772197.2	221264.1	41.85	Reacquired		
277	1772146.3	221327.25	43.93	No contact-furrow		
225	1771995.3	221314.34	44.04	Reacquired		
175	1772132.1	221298.55	45.36	Reacquired		
424	1772170.5	221368.29	48.13	Reacquired		
433	1772122.7	221370.96	48.59	Reacquired		
423	1772175.1	221368.88	50.07	Reacquired		
149	1772155.6	221290.98	51.18	No contact		

18	1772218.2	221219.77	52.41	Reacquired
390	1772195.4	221364.64	53.56	Reacquired
107	1772167.9	221280.29	55.66	Reacquired
211	1772184.2	221317.5	55.76	Reacquired
413	1772272.1	221361.56	55.95	Reacquired
515	1772196.3	221292.7	56.17	Reacquired
432	1772131.8	221364.26	57.59	Reacquired
457	1772323.4	221371.32	57.95	Reacquired-repeat g3 103
239	1772202.1	221331.7	58.07	Reacquired
412	1772270.9	221370.11	60.05	Reacquired
460	1772074.2	221374.95	61.29	Reacquired
256	1772124	221326.26	64.59	Reacquired
60	1772046.1	221245.93	65.01	Reacquired
411	1772259	221365.03	67.38	Reacquired
388	1772196.8	221368.57	70.16	Reacquired
275	1772142.4	221324.68	71.13	Reacquired
410	1772257.6	221359.14	73.75	Reacquired
431	1772129.2	221367.58	75.9	Reacquired
321	1771911.8	221345.12	78.43	Reacquired
38	1772200	221227.92	81.02	Reacquired
71	1772235.1	221251.72	81.64	Reacquired
123	1772150.1	221273.98	82.52	Reacquired
106	1772173.1	221272.99	83.19	No contact
282	1772014.5	221327.86	83.69	Reacquired
425	1772225.6	221362.89	84.12	Reacquired
350	1772284.4	221347.58	88.28	Reacquired
105	1772169	221264.51	91.77	Reacquired
399	1772145.5	221358.14	96.96	Reacquired
330	1772123.7	221346.64	99.98	Reacquired
104	1772167.8	221267.81	107.77	Reacquired
440	1772244.1	221373.79	114.49	Reacquired
480	1772151	221377.77	120.26	Reacquired
274	1772151	221334.41	124.27	Reacquired
304	1772223.8	221329.41	132.66	Reacquired
387	1772201.2	221356.68	139.28	Reacquired
409	1772263.7	221366.94	142.75	Reacquired
94	1772148	221262.18	144.13	Reacquired
495	1771914.2	221374.19	156.95	Reacquired
28	1772285.2	221222.08	169.99	Reacquired
496	1771914.8	221371.56	174.6	Reacquired
136	1772126.7	221286.15	205.16	Reacquired-20" S
340	1772089.5	221345.82	256.75	Reacquired
273	1772143.8	221331.23	289.76	Reacquired
463	1772208.1	221380.88	289.89	Reacquired
49	1772211.4	221249.43	306.34	Reacquired

Transect 1

ID	EASTING	NORTHING	mV	Comment	% No contacts	0.0%
14	1772033.5	221701.57	35.21	Reacquired		
13	1772035.25	221731.71	37.19	Reacquired-repeat G-1 395	% Reacquired	100.0%
21	1772028.9	221655.73	51.8	Reacquired-repeat G-7 214		

Transect 2

ID	EASTING	NORTHING	mV	Comment	% No contacts	0.0%
73	1772122.81	221491.2	32.55	Reacquired		
72	1772130.7	221493.05	37.91	Reacquired	% Reacquired	100.0%
48	1772209.33	221577.82	42.2	Reacquired		
36	1772239.21	221602.97	46.23	Reacquired		
46	1772211.92	221575.82	49.46	Reacquired		
35	1772235.88	221599.73	54.6	Reacquired		
55	1772187.37	221555.84	59.55	Reacquired		
69	1772165.34	221529.28	63.61	Reacquired		
34	1772244.53	221608.13	65.54	Reacquired		
77	1772108.17	221476.99	67.22	Reacquired		
58	1772183.38	221552.62	82.78	Reacquired		
61	1772173.4	221542.93	109.55	Reacquired		
76	1772116.82	221485.39	120.45	Reacquired-repeat G-2 273		

Transect 3

ID	EASTING	NORTHING	mV	Comment	% No contacts	0.0%
40	1772182.62	221372.25	31.32	Reacquired		
47	1772187.25	221374.81	34.5	Reacquired	% Reacquired	100.0%
28	1772075.77	221375.77	39.22	Reacquired-repeat G-9 460		
7	1772384.42	221369.98	39.41	Reacquired-repeat G-3 108		
6	1772368.61	221366.28	47.92	Reacquired		
50	1772234.47	221374.77	48.88	Reacquired		
56	1772322.29	221370.22	50.84	Reacquired-repeat G-9 457		
38	1772145.32	221377.38	51.08	Reacquired		
51	1772243.63	221373.33	137.9	Reacquired-repeat G-9 440		
1	1772271.45	221367.69	199.24	Reacquired-repeat G-9 412		

Transect 5

ID	EASTING	NORTHING	mV	Comment		
49	1771678.52	220634.28	30	Reacquired		
103	1771632.83	220526.48	30.04	Reacquired	% Reacquired	100.0%
170	1771398.41	220011.78	30.39	Reacquired		
50	1771736.7	220754.15	44.56	Reacquired		
14	1771512.26	220256.18	46.2	Reacquired		
124	1771600.96	220454.8	46.36	Reacquired		
36	1771617.39	220491.49	52.38	Reacquired		
33	1771603.26	220467.42	60.74	Reacquired		
115	1771620.05	220504.37	70.86	Reacquired		

Transect 6

ID	EASTING	NORTHING	mV	Comment		
113	1771309.59	220722.18	36.53	Reacquired		
53	1771872.72	221246.52	50.33	Reacquired	% Reacquired	100.0%

Transect 8

ID	EASTING	NORTHING	mV	Comment		
35	1771487.42	221591.61	31.54	Reacquired		
33	1771431.32	221612.76	33.59	Reacquired	% Reacquired	100.0%
22	1771106	221742.56	44.01	Reacquired		
49	1771751.54	221488.73	187.21	Reacquired-repeat G-4 392		

Transect 9

ID	EASTING	NORTHING	mV	Comment		
50	1771785.92	221692.52	53.13	Reacquired		
22	1771695.96	221812.15	168.41	Prove out-300' line	% Reacquired	100.0%
56	1771884.33	221559.92	286.11	Reacquired-repeat G-7 65		

Transect 10

ID	EASTING	NORTHING	mV	Comment		
46	1772086.85	221345.44	52.1	Reacquired-repeat g-9 340		
51	1772123.95	221325.88	55.93	Reacquired-repeat g-9 256	% Reacquired	100.0%

Transect 11

ID	EASTING	NORTHING	mV	Comment		
1	1772036.06	221350.93	38.7	Reacquired		
2	1772042.54	221345.59	106.2	No contact	% Reacquired	50.0%

Transect 12

ID	EASTING	NORTHING	mV	Comment		
7	1771996.01	220994.22	41.15	Reacquired		
11	1771989.98	220895.27	50.57	Reacquired-24" W	% Reacquired	100.0%

Transect 13

ID	EASTING	NORTHING	mV	Comment		
29	1771409.71	221297.96	38	No contact		
63	1771341.43	221293.05	44.3	Reacquired	% Reacquired	50.0%

Transect 15

ID	EASTING	NORTHING	mV	Comment		
20	1771417.69	221759.97	37	Reacquired		
23	1771482	221717.06	38.3	Reacquired	% Reacquired	100.0%
18	1771353.34	221799.6	43.2	Reacquired		
26	1771515.16	221697.55	43.95	Reacquired		

Transect 16

ID	EASTING	NORTHING	mV	Comment		
1	1771339.17	222004.05	31.4	No contact-outside transect		
32	1771634.29	221732.82	38.4	Reacquired	% Reacquired	75.0%
33	1771644.03	221726.12	58.9	Reacquired		
23	1771588.35	221776.12	103.4	Reacquired		

Makawao

Grid 1

ID	EASTING	NORTHING	mV	Comment	% No contacts	60.9%
39	1777663.82	209753.63	15.6	No contact		
58	1777668.36	209794.95	15.79	No contact	% Reacquired	39.1%
64	1777628.48	209807.36	15.92	Reacquired		
41	1777680.92	209756.01	16.18	No contact		
8	1777607.66	209684.82	16.84	No contact-rocks 3' away		
72	1777602.51	209827.45	17.56	Reacquired		
70	1777660.1	209814.13	17.84	No contact		
62	1777655.27	209797.77	19.57	No contact-rocks		
9	1777660.88	209687.33	19.89	Reacquired		
83	1777731.84	209870.89	20.39	Reacquired		
40	1777651.38	209756.44	21.26	No contact		
1	1777640.1	209658.07	22.02	No contact		
21	1777639.07	209722.46	24.28	No contact		
32	1777606.65	209750.52	25	No contact		
31	1777604.64	209747.93	25.19	No contact		
13	1777642.65	209698.1	32.29	No contact		
43	1777676.36	209758.05	48.85	No contact		
2	1777628.42	209667.44	116.02	Reacquired		
22	1777652.25	209726.21	167.59	No contact		
45	1777629.19	209765.31	245.05	Reacquired		
52	1777655.73	209784.63	503.18	Reacquired		
51	1777655.78	209787.91	520.57	Reacquired-iron rail nearby		
71	1777653.08	209828.02	649.09	Reacquired		

Grid 3

ID	EASTING	NORTHING	mV	Comment	% No contacts	2.6%
169	1778966.96	208905.14	11.06	Reacquired		
172	1779088.62	208972.89	13.33	No contact	% Reacquired	97.4%
23	1779036.69	208872.13	13.46	Reacquired		
37	1778949.92	208904.9	13.88	Reacquired		
7	1779063.79	208840.88	15.53	Reacquired		
10	1778955.66	208848.36	16.15	Reacquired		
55	1778974.64	208935.39	16.92	Reacquired		
25	1779076.16	208879.43	17.02	Reacquired		
94	1779123.39	209014.63	17.14	Reacquired		
136	1779162.6	209009.19	18.11	Reacquired		
158	1779083.07	208951.98	20.38	Reacquired		
109	1779010.04	209024.16	23.9	Reacquired		
111	1779019.23	209024.68	25.2	Reacquired		
150	1779023.98	208992.19	25.23	Reacquired		
62	1779116.19	208970.75	25.55	Reacquired		
113	1779172.16	209029.68	25.75	Reacquired		
148	1778954	209005.67	25.98	Soda can		
41	1779088.4	208908.79	26.16	Reacquired - nearby dig		
73	1779119.64	208982.52	27.83	Reacquired		
59	1779115.89	208949.75	28.54	Reacquired		
40	1779079.27	208912.86	28.59	Reacquired		
165	1779017.75	208834.88	29.77	Reacquired		
151	1779023.9	208986.94	30.05	Reacquired		
92	1779006.49	209005.17	38.54	Reacquired		
102	1779027.65	209017.34	42.77	Reacquired		
39	1779090.99	208906.78	44.49	Reacquired - nearby dig		
74	1779160.33	208983.24	45.37	Reacquired		
141	1779067.62	208926.63	77.63	Reacquired-small fisher response		
101	1779031.07	209026.48	88.79	Reacquired-small fisher response		
139	1779065.04	208929.94	96.92	Reacquired-small fisher response		
100	1779026.9	209010.78	125.67	Reacquired		
98	1779063.6	209008.28	220.08	Reacquired		
2	1779077.28	208820.99	241.66	Reacquired-station 20 pipe		
89	1778978.94	209005.57	337.97	Reacquired		
99	1779033.62	209021.84	342.83	Reacquired		
147	1778954.08	209011.57	351.9	Trash pit with soda can		
72	1778991.04	208980.45	449.94	Reacquired		
117	1778994.52	209039.48	742.54	Reacquired		

Grid 4

ID	EASTING	NORTHING	mV	Comment		
141	1778654.72	208910.07	10.29	Reacquired		
24	1778590.95	208987.98	11.61	Reacquired	% Reacquired	94.4%
137	1778577.64	208976.12	11.67	Reacquired		
97	1778679.71	209093.12	12.24	Reacquired		
27	1778646.92	209002.94	13.58	No contact		
35	1778733.93	209032.55	13.75	Reacquired		
15	1778742.03	208958.19	14.3	Reacquired		
66	1778724.37	209051.74	14.31	Reacquired		
8	1778708.88	208933.71	15.77	Reacquired-1.7ft. SE		
3	1778684.34	208915.02	15.95	Reacquired		
34	1778656.36	209020.54	18.35	Reacquired-1.3ft. SW		
109	1778681.16	209104.47	18.59	Reacquired		
158	1778672.89	209077.05	25.91	Reacquired-1.6ft. W		
37	1778617.79	209029.64	27.19	Reacquired		
110	1778703.21	209087.75	27.83	Reacquired		
33	1778649.19	209023.92	28.73	Reacquired		
52	1778596.9	209081.84	32.24	Reacquired		
75	1778619.89	209084.13	33.55	Reacquired		

Grid 5

ID	EASTING	NORTHING	mV	Comment
34	1778837.1	202813.65	10.3	No contact
11	1778809.81	202787.13	11.47	No contact
35	1778813.04	202828.45	12.14	No contact
4	1778835.57	202753.27	12.37	No contact
10	1778795.84	202774.2	12.43	No contact
18	1778694.2	202778.96	12.57	No contact
50	1778868.69	202865.07	12.75	No contact
62	1778716.72	202883.69	13.77	No contact
73	1778826.65	202907.04	15.11	No contact
15	1778728.3	202777.15	15.17	No contact
32	1778758.95	202809.54	15.19	No contact
45	1778691.3	202850.57	15.24	No contact
55	1778760.13	202890.28	15.26	No contact
52	1778693.03	202878.78	15.29	No contact
1	1778764.47	202737.89	15.94	No contact
54	1778765.36	202888.89	16.35	No contact
76	1778750.81	202926.53	16.55	No contact
8	1778803.8	202779.99	16.79	No contact
63	1778740.43	202889.25	17.41	No contact
37	1778723.36	202844.2	19.16	No contact
82	1778710.26	202935.66	19.45	No contact
71	1778868.6	202903.81	21.94	No contact

% No contacts	100.0%
% Reacquired	0.0%

Grid 6

ID	Easting	Northing	mV	Comment
90	1778036.31	208922.94	10.06	Reacquired
128	1777963.07	208847.27	10.32	Reacquired
92	1778045.35	208912.97	11.32	Reacquired
51	1777918	208858.57	12.89	Reacquired
4	1777910.92	208777.27	13.09	Reacquired
127	1778007.04	208849.26	13.15	Reacquired
53	1777960.04	208861.89	13.44	Reacquired
8	1778045.53	208786.47	13.71	Reacquired
6	1778082.87	208783.3	14.87	Reacquired
88	1778021.08	208912.67	15.07	Reacquired
23	1777986.45	208828.69	15.25	Reacquired
30	1778008.54	208859.22	15.56	Reacquired
105	1777999.66	208838.21	15.96	No contact
78	1777963.3	208951.12	17.09	Reacquired
104	1778002.89	208834.23	17.9	Reacquired
102	1778079.62	208834.43	19.43	Reacquired
106	1778004.82	208832.24	19.68	Reacquired
112	1777942.67	208932.83	21.85	Reacquired
85	1778006.88	208838.11	22.52	Reacquired
24	1778005.95	208861.88	29.71	Reacquired
19	1778029.66	208822.81	31.82	No contact
101	1778074.37	208834.5	33.1	Reacquired
58	1778060.72	208884.06	34.44	Reacquired
62	1778095.67	208896.03	49.84	Reacquired
64	1778112.85	208904.97	50.24	Reacquired
109	1777940.37	208819.4	56.79	Reacquired
76	1778039.87	208938.85	62.07	Reacquired
1	1777917.97	208766	83.48	Reacquired
61	1778070.75	208897.04	201.33	Reacquired

% No contacts	6.9%
% Reacquired	93.1%
	6.9%
	93.1%

Grid 7

ID	EASTING	NORTHING	mV	Comment
39	1780894.7	209950.81	10	Reacquired
10	1780864.78	209833.77	10.07	Reacquired
9	1780820.16	209833.11	10.58	Reacquired
34	1780834.48	209915.59	10.7	Reacquired
42	1780827.93	209960.97	11.3	Reacquired
5	1780919.17	209783.76	11.44	Reacquired
45	1780843.16	209970.59	12.49	Reacquired
7	1780773.55	209831.16	15.07	Reacquired
26	1780793.13	209868.94	15.11	Reacquired
48	1780784.24	209979.33	15.16	Reacquired
25	1780783.85	209862.52	15.32	Reacquired
24	1780776.6	209860.65	15.34	Reacquired
23	1780749.1	209864.33	15.52	Reacquired
36	1780787.5	209933.34	15.6	Reacquired
35	1780782.9	209932.75	15.64	Reacquired
52	1780776	209999.79	16.66	Reacquired
55	1780949.92	210003.82	16.96	No Contact
57	1780782.7	210008.88	17.02	No Contact
3	1780764.42	209789.95	17.61	Reacquired
2	1780766.97	209784.66	17.7	Reacquired
22	1780787.22	209869.03	22.54	Reacquired
21	1780779.29	209865.21	24.56	Reacquired
46	1780776.38	209980.75	26.08	Reacquired
20	1780769.88	209849.59	26.98	Reacquired
19	1780773.25	209855.45	28.25	Reacquired
18	1780789.91	209873.58	28.4	Reacquired
41	1780779.43	209964.96	28.63	Reacquired
40	1780784.63	209961.6	28.96	Reacquired
17	1780793.22	209875.5	32.2	Reacquired
16	1780751.6	209855.77	36.89	Reacquired
15	1780779.14	209854.71	39.86	Reacquired
14	1780763.4	209854.94	53.48	Reacquired
13	1780776.45	209850.15	55.54	Reacquired
12	1780757.52	209856.99	56.69	Reacquired
11	1780760.84	209859.57	65.11	Reacquired

% No contacts	5.7%
% Reacquired	94.3%

Grid 8

ID	EASTING	NORTHING	mV	Comment	% No contacts	3.0%
39	1780853.48	208029.07	11.1	No contact		
112	1780823.15	207932.76	11.2	Reacquired	% Reacquired	97.0%
22	1780940.17	207989.71	13.85	Reacquired		
23	1780829.35	207993.95	14.21	Reacquired		
55	1780766.11	208111.8	15.13	Reacquired		
54	1780916.17	208099.1	15.58	Reacquired		
34	1780833.43	208003.74	16.01	Reacquired		
63	1780898.83	208131.03	16.16	Reacquired		
36	1780745.11	208021.45	16.91	Reacquired		
56	1780951.76	208109.75	16.95	Reacquired		
46	1780855.92	208061.22	17.26	Reacquired		
57	1780733.42	208120.15	18.17	Reacquired		
12	1780937.62	207949.67	18.48	Reacquired		
27	1780922.57	207997.85	22.62	Reacquired		
25	1780849.71	207995.62	22.64	Reacquired		
5	1780874.03	207908.56	23.2	Reacquired		
45	1780859.82	208059.19	25.69	Reacquired		
74	1780890.82	207986.21	37.9	Reacquired		
24	1780850.5	208004.81	38.31	Reacquired		
21	1780894.96	207993.65	38.66	Reacquired		
38	1780778.06	208031.48	39.04	Reacquired		
37	1780780.71	208033.41	39.82	Reacquired		
17	1780853.22	207966.01	54.31	Reacquired		
20	1780886.24	207980.64	54.61	Reacquired-60mm parts ~3lbs.		
72	1780840.44	207904.31	62.83	Reacquired		
26	1780919.26	207995.27	63.06	Reacquired		
32	1780872.1	208001.21	68.23	Reaquired-barrage rocket		
16	1780856.53	207967.93	79.67	Reacquired		
11	1780948.14	207950.83	82.52	Reacquired		
65	1780729.18	208010.2	102.98	Reacquired		
64	1780951.53	208056.81	110.26	Reacquired		
13	1780738.88	207953.88	117.36	Reacquired		
73	1780887.51	207984.29	133.7	Reacquired		

Grid 9

ID	EASTING	NORTHING	mV	Comment		
100	1780138.38	205697.29	23.43	No contact	% No contacts	100.0%
15	1780124.45	205643.05	23.46	No contact	% Reacquired	0.0%
55	1780126.13	205667.95	24.58	No contact		
159	1780172.48	205738.12	26.6	No contact		
91	1780096.2	205688.07	32.52	No contact		
30	1780147.72	205661.73	34.89	No contact		
44	1780170.66	205658.12	43.54	No contact		
86	1780161.83	205683.18	48.61	No contact		
16	1780091.61	205643.53	49.35	No contact-road berm		

Grid 10

ID	EASTING	NORTHING	mV	Comment
66	1780640.4	203700.23	10.38	No contact
124	1780559.08	203745.36	10.76	No contact
88	1780692.55	203723.74	11.18	No contact
128	1780734.9	203749.36	13.43	Reacquired
75	1780561.9	203713.84	13.54	Reacquired
126	1780736.94	203754.58	15.11	Reacquired
132	1780692.89	203747.35	15.14	Reacquired-3' E
145	1780516.14	203769.6	15.48	No contact
139	1780673.3	203752.88	15.84	No contact
119	1780688.13	203735.61	16.73	No contact
123	1780663.33	203743.85	17.35	Reacquired-2.4 NE
82	1780485.94	203722.16	18.64	Reacquired
149	1780741.05	203766.33	19.44	No contact
143	1780763.3	203763.38	22.34	No contact
118	1780484.24	203740.55	22.84	No contact
130	1780504.74	203752.05	23.07	No contact
101	1780546	203748.17	25.09	Reacquired
80	1780737.03	203715.88	25.72	Reacquired
125	1780731	203752.04	25.81	Reacquired
93	1780592.32	203731.1	26.2	No contact
98	1780551.51	203766.46	27.68	No contact
70	1780463.48	203710.68	29.89	Reacquired
61	1780631.64	203729.22	31.99	No contact
60	1780637.42	203720.61	33.41	No contact
97	1780550.73	203757.94	39.13	Reacquired
96	1780541.37	203745.62	39.26	Reacquired-2.3' N
92	1780594.98	203733.69	41.26	Reacquired
95	1780551.59	203771.71	44.69	Reacquired
136	1780586.05	203751.53	57.16	No contact
129	1780612.26	203749.84	75.66	Reacquired-2.9' SW

% No contacts	50.0%
% Reacquired	50.0%

Grid 12

ID	EASTING	NORTHING	mV	Comment
62	1780973.79	204381.97	18.14	Reacquired
27	1780872.04	204344.09	18.15	No contact
4	1780895.49	204329.32	18.18	No contact
262	1780824.2	204533.69	19.09	No contact
178	1780946.08	204464.36	19.61	No contact
132	1780859.55	204434.13	19.62	No contact
136	1780943.11	204440.79	19.86	No contact
59	1780829.71	204370.29	20.09	No contact
72	1780829.96	204387.34	22.51	No contact
66	1780886.35	204379.3	22.81	No contact
34	1781002.19	204346.13	23.4	No contact
302	1781005.26	204557.29	24.16	No contact
244	1781009.98	204520.49	24.23	No contact
129	1781015.86	204427.93	24.52	Reacquired
298	1780848.76	204550.39	24.6	No contact
276	1780928.76	204538.73	24.82	No contact
229	1780961.68	204498.24	24.83	Reacquired-Rock
300	1780957.82	204548.8	25.58	No contact
275	1780922.15	204536.2	25.69	No contact
79	1781022.52	204388.47	26.19	Reacquired-Rock
301	1781007.11	204549.4	26.27	No contact
144	1780901.15	204447.96	26.79	No contact
153	1780925.5	204450.23	27.87	No contact
139	1780961.52	204441.83	28.01	No contact
305	1780944.08	204552.94	28.11	Reacquired-Rock
89	1780838.07	204402.96	29.41	No contact
185	1781016.46	204469.24	29.47	No contact
112	1780982.18	204416.61	31.13	No contact
274	1780926.4	204557.13	31.92	No contact
152	1780918.87	204446.39	32.92	Reacquired
78	1781021.92	204392.42	33.31	Reacquired
109	1780987.47	204418.5	35.27	Reacquired
70	1781004.07	204385.46	37.65	Reacquired
313	1780998.05	204558.71	37.96	Reacquired-Rock
210	1780930.78	204496.72	38.73	Reacquired
123	1781004.05	204428.75	44.23	Reacquired-Rock
32	1781012.85	204356.47	51.4	Reacquired-Rock
74	1780994.87	204384.94	55.17	Reacquired-Rock

% No contacts	63.2%
% Reacquired	36.8%

Grid 13

ID	EASTING	NORTHING	mV	Comment	% No contacts	35.7%
15	1780022.38	204042.15	15.44	No contact		
26	1780046.51	204076.56	15.92	No contact	% Reacquired	64.3%
24	1780064.67	204061.21	16.06	No contact		
14	1780011.18	204039.03	17.12	No contact		
41	1779982.33	204176.54	22.51	Reacquired		
54	1780053.04	203995.12	26.68	Reacquired		
39	1779930.78	204152.37	27.58	No contact		
9	1780031.59	203998.07	27.59	Reacquired		
31	1779966.03	204094.13	35.78	Reacquired		
55	1780056.27	203991.14	38.31	Reacquired		
8	1780036.2	203999.31	39.67	Reacquired		
7	1780040.08	203995.32	40.13	Reacquired		
6	1780032.99	204004.61	41.71	Reacquired		
5	1780035.49	203996.04	42.78	Reacquired		

Grid 15

ID	EASTING	NORTHING	mV	Comment	% No contacts	58.3%
99	1780180.75	208041.16	16.8	Reacquired		
94	1780272.59	208030.62	17.21	No Contact	% Reacquired	41.7%
75	1780128.3	208003.82	17.69	No Contact		
159	1780201.15	208088.15	18.24	Reacquired		
120	1780314.31	208053.01	18.52	Reacquired		
177	1780183.63	208103.51	18.53	Reacquired		
22	1780141.94	207947.8	18.56	No Contact		
49	1780186.85	207963.57	18.62	No Contact		
152	1780308.74	208076.73	19.24	No Contact		
77	1780215.74	208007.15	19.42	No Contact		
131	1780165.97	208063.7	19.72	Reacquired - 2' W		
82	1780228.28	208010.91	19.85	No Contact		
174	1780125.12	208101.73	20.29	Reacquired		
80	1780198.07	208012	20.8	No Contact		
160	1780178.18	208090.45	21.45	No Contact		
21	1780141.35	207952.41	21.98	No Contact		
115	1780166.4	208048.59	22.19	No Contact		
33	1780258.28	207950.7	23.01	Reacquired		
45	1780248.61	207963.32	23.22	Reacquired		
11	1780261.93	207930.29	23.71	No Contact		
20	1780138.02	207949.17	28.66	No Contact		
164	1780162.5	208096.59	30.77	No Contact		
135	1780210.05	208067.66	36.9	Reacquired		
60	1780159.6	207987.61	73.26	Reacquired		

Grid 16

ID	EASTING	NORTHING	mV	Comment	% No contacts	23.7%
102	1780652.65	208920.1	13.47	No contact		
90	1780708.67	208892.35	13.81	Reacquired	% Reacquired	76.3%
93	1780717.89	208894.85	13.82	Reacquired		
86	1780609.52	208886.57	15.58	No contact		
26	1780698.98	208857.68	16.34	Reacquired-small arms casing		
87	1780681.69	208886.83	17.86	No contact		
148	1780596.58	208989.22	20.24	No contact		
28	1780681.38	208865.82	21.77	Reacquired		
121	1780731.92	208957.7	21.86	Reacquired		
13	1780617.49	208848.36	22.99	No contact		
109	1780684.47	208942.62	25.13	Reacquired		
179	1780603.04	209027.23	25.15	No contact		
30	1780618.4	208865.42	25.41	No contact		
55	1780770.68	208871.09	28.11	Reacquired		
16	1780722.47	208848.8	28.66	Reacquired		
54	1780739.77	208910.95	29.08	Reacquired		
53	1780773.31	208871.05	30.45	Reacquired		
52	1780742.5	208918.13	31.79	Reacquired		
27	1780567.84	208862.87	31.83	Reacquired-1' S		
51	1780753.97	208939.64	35.05	Reacquired		
50	1780744.4	208913.51	36.33	Reacquired		
48	1780748.33	208958.12	38.95	Reacquired		
47	1780746.78	208896.4	42.73	Reacquired		
46	1780745.83	208966.69	43.08	Reacquired		
45	1780745.66	208954.87	43.7	Reacquired		
44	1780729.24	208999.12	46.25	Reacquired		
42	1780744.48	208964.08	47.87	Reacquired		
147	1780579.52	208988.82	54.67	Reacquired		
39	1780744.67	208931.9	54.76	No contact		
183	1780721.15	209028.79	66.73	No contact		
35	1780761.82	208893.55	66.92	Reacquired		
153	1780662.94	208996.14	67.26	Reacquired		
34	1780761.09	208888.31	68.37	Reacquired		
33	1780752.9	208911.41	79.53	Reacquired		
32	1780756.13	208908.08	80.99	Reacquired		
31	1780748.87	208904.9	88.77	Reacquired		
15	1780568.98	208851.03	102.24	Reacquired		
92	1780702.18	208897.7	113.54	Reacquired		

Grid 19

ID	Easting	Northing	mV	Comment	% No contacts	60.0%
12	1778846.39	205447.13	10.22	No contact		
4	1778865.21	205433.08	11.25	No contact	% Reacquired	40.0%
5	1778857.5	205444.35	11.61	No contact		
26	1778884.92	205525.29	11.78	Reacquired		
23	1778877.54	205514.24	12.44	No contact		
3	1778877.97	205407.97	12.95	No contact		
15	1778834.51	205487.97	13.13	No contact		
22	1778850.61	205512.01	13.99	No contact		
24	1778845.46	205518.64	14.93	Reacquired		
33	1778876.62	205498.47	17.34	No contact		
28	1778864.83	205499.3	17.8	Reacquired		
38	1778838.09	205464.93	18.01	No contact		
34	1778843.23	205457.64	18.44	No contact		
37	1778837.35	205459.03	19.08	No contact		
25	1778859.34	205525.66	19.1	Reacquired		
32	1778885.77	205496.37	24.11	Reacquired		
21	1778842.01	205506.89	35.7	Reacquired		
27	1778826.06	205493.96	39.1	Reacquired		
39	1778826.42	205486.02	53.19	No contact		
30	1778819.61	205456.67	107.3	Reacquired		

Grid 20

ID	Easting	Northing	mV	Comment	% No contacts	73.9%
33	1778768.19	207772.35	10.02	No contact		
39	1778750.99	207717.51	10.02	No contact	% Reacquired	26.1%
34	1778843.4	207803.39	10.54	No contact		
35	1778864.02	207778.17	10.59	No contact		
20	1778942.42	207825.15	11.4	Reacquired		
16	1778906.72	207808.6	12	No contact		
38	1778827.8	207722.29	12.08	No contact		
9	1778764.33	207682.02	12.09	No contact		
43	1778920.17	207625.2	12.59	No contact		
4	1778808.94	207633.45	12.7	No contact		
19	1778822.91	207826.23	12.72	No contact		
22	1778924.87	207837.22	13.23	No contact		
25	1778910.57	207847.93	13.34	No contact		
23	1778951.83	207839.45	13.5	No contact		
26	1778865.92	207848.58	13.91	No contact		
27	1778795.03	207850.92	14.34	No contact		
32	1778824.47	207854.16	14.36	No contact		
8	1778901.63	207639.32	20.53	Reacquired		
46	1778940.51	207851.17	20.89	Reacquired		
14	1778939.83	207782.52	21.72	Reacquired		
40	1778745.69	207623.15	22.9	No contact		
17	1778807.59	207811.36	26.84	Reacquired		
24	1778771.96	207845.35	183.35	Reacquired		

Grid 21

ID	Easting	Northing	mV	Comment
1	1778700.2	208030.48	15.25	No contact
2	1778745.13	208048.21	13.38	Reacquired
3	1778834.56	208054.78	25.31	Reacquired
4	1778816.92	208060.95	19.54	Reacquired
5	1778660.05	208069.79	12.23	Reacquired
8	1778660.26	208084.23	10.85	Reacquired
9	1778619.59	208088.76	11.36	No contact
10	1778760.9	208093.93	12.51	No contact
11	1778831.18	208092.91	16.94	Reacquired
12	1778843.68	208094.04	12.45	Reacquired
13	1778839.78	208097.38	10.53	No contact
14	1778639.54	208105.54	13.6	No contact
15	1778838.73	208115.12	13.18	Reacquired
20	1778661.75	208141.98	14.78	No contact
21	1778841.11	208143.31	17.21	Reacquired
26	1778615.09	208185.33	15.73	No contact
27	1778621.63	208183.92	13.86	Reacquired
28	1778838.44	208186.02	11.72	No contact
29	1778843.79	208192.51	14.03	No contact
32	1778618.82	208216.13	12.55	No contact
33	1778632.8	208229.05	13.3	No contact
34	1778617.81	208201.49	24.25	No contact
35	1778614.5	208199.57	12.43	No contact
36	1778844.62	208149.01	27.68	Reacquired

% No contacts	54.2%
% Reacquired	45.8%

Transect 1-West

ID	EASTING	NORTHING	mV	Comment
282	1777570.27	209783.17	14.78	Reacquired
290	1777921.93	209071.03	16.68	No contact
126	1778813.1	204865.33	19.98	Reacquired
144	1778783.38	205527.51	20.23	Reacquired
24	1778601.5	202761.21	20.37	No contact
188	1778685.81	206845.84	25.55	Reacquired
317	1778779.9	205562.96	25.84	Reacquired
162	1778804.23	206194.84	29.03	No contact
307	1778688.96	206841.18	34.89	Reacquired
124	1778817.53	204854.12	36.25	Reacquired
161	1778801.01	206198.82	36.71	Reacquired
316	1778771.5	205571.6	39.81	Reacquired
284	1777607.63	209375.97	39.82	Reacquired
43	1778629.24	203360.9	42.89	Reacquired
101	1778433.1	204351.44	44.06	Reacquired
28	1778635.32	202876.8	45.1	No contact
140	1778797.65	205471.55	46.21	Reacquired
142	1778783.5	205536.03	46.31	Reacquired
33	1778657.53	203051.59	47.5	Reacquired
96	1778422.38	204245.35	56.42	Reacquired
275	1777752.53	209282.08	58.68	Reacquired
302	1778317.01	207871.66	59.89	No contact
320	1778793.55	205464.38	64.11	Reacquired
318	1778790.5	205525.42	66.91	Reacquired
341	1778581.48	203463.24	75.84	Reacquired
123	1778818.07	204846.24	104.91	Reacquired
122	1778818	204841	122.71	Reacquired
328	1778425.89	204083.95	129.14	Reacquired
304	1778473.44	207534.91	136.7	Reacquired
54	1778517.08	203496.32	144.19	Reacquired
121	1778812.83	204846.32	145.88	Reacquired
120	1778813.65	204858.11	150.7	Reacquired
138	1778799.41	205457.1	177.3	Reacquired

% No contacts	15.2%
% Reacquired	84.8%

Transect 1-East

ID	EASTING	NORTHING	mV	Comment	% No contacts	55.6%
248	1780888.37	207860.16	24.72	No contact		
69	1780305.23	205198.02	24.88	No contact	% Reacquired	44.4%
243	1780878.77	207831.45	27.25	Reacquired		
258	1781038.33	208113.76	29.98	No contact		
167	1780255.95	206951.17	31.11	No contact		
162	1780182.49	206906.33	31.76	No contact		
37	1780361.6	204518.4	32.11	No contact		
268	1781110.16	208542.3	33.64	Reacquired		
75	1780277.69	205333.53	36.72	No contact		
20	1780275.5	204145.16	44.84	No contact		
100	1780173.18	205499.01	47.85	No contact		
296	1781682.27	210445.78	64.15	Reacquired		
217	1780765.25	207557.64	76.22	Reacquired		
216	1780761.35	207560.32	78.78	Reacquired		
1	1780436.61	203857.52	88.2	Reacquired-surveyor's nail		
229	1780850.76	207754.46	199.92	Reacquired-3' NW		
273	1781124.48	208940.85	222.72	Reacquired		
272	1781129.01	208936.85	224.8	Reacquired-guardrail pile		
33	1778657.53	203051.59	47.5	Reacquired		
96	1778422.38	204245.35	56.42	Reacquired		
275	1777752.53	209282.08	58.68	Reacquired		
302	1778317.01	207871.66	59.89	No contact		
320	1778793.55	205464.38	64.11	Reacquired		
318	1778790.5	205525.42	66.91	Reacquired		
341	1778581.48	203463.24	75.84	Reacquired		
123	1778818.07	204846.24	104.91	Reacquired		
122	1778818	204841	122.71	Reacquired		
328	1778425.89	204083.95	129.14	Reacquired		
304	1778473.44	207534.91	136.7	Reacquired		
54	1778517.08	203496.32	144.19	Reacquired		
121	1778812.83	204846.32	145.88	Reacquired		
120	1778813.65	204858.11	150.7	Reacquired		
138	1778799.41	205457.1	177.3	Reacquired		

Transect A1

ID	EASTING	NORTHING	mV	Comment		
44	1778387.27	202397.06	14.61	Reacquired-2.1' E		
42	1778401.37	202418.51	15.88	No contact	% Reacquire	39.1%
4	1778472	202308.55	16.37	No contact		
60	1778402.81	202342.96	20	Reacquired		
13	1778429.06	202335.42	20.91	Reacquired		
26	1778424.86	202363.04	21.31	No contact		
63	1778431.59	202337.95	22.17	No contact		
58	1778370.16	202397.87	23.85	No contact		
25	1778416.94	202360.53	24.14	Reacquired		
64	1778433.48	202332.68	24.98	Reacquired		
38	1778384.09	202404.32	25.8	No contact		
37	1778391.97	202404.21	26.98	No contact		
31	1778413.98	202382.23	27.87	No contact		
36	1778394.67	202409.42	28.03	No contact		
19	1778406.82	202341.65	28.28	Reacquired		
35	1778392.66	202406.17	28.37	No contact		
67	1778372.04	202391.94	29.2	No contact		
65	1778472.61	202317.68	29.64	No contact		
33	1778390.05	202407.52	31.21	No contact		
32	1778386.11	202407.57	31.58	No contact		
18	1778404.96	202348.9	74.84	Reacquired		
10	1778440.12	202328.7	132.38	Survey point		
24	1778421.64	202367.68	373.78	Reacquired		

Transect A2

ID	EASTING	NORTHING	mV	Comment		
40	1778570.51	202582.57	11.21	No contact		
50	1778616.3	202661.99	13.67	No contact	% Reacquired	9.5%
67	1778646.88	202700.52	13.87	No contact		
36	1778554.55	202523.06	14.63	No contact		
66	1778649.61	202707.69	14.77	No contact		
74	1778597.42	202455.95	14.79	No contact		
73	1778535.7	202496.2	15.08	No contact		
48	1778602.25	202643.81	15.19	No contact		
13	1778504.66	202387.25	15.53	No contact		
80	1778494.44	202319.72	15.74	No contact		
33	1778585.24	202512.11	15.8	Reacquired		
12	1778508.53	202382.6	15.94	No contact		
63	1778632.83	202715.57	16.13	No contact		
41	1778579.79	202589	16.35	No contact		
47	1778642.83	202636	17.12	No contact		
68	1778660.54	202693.1	19.34	No contact		
51	1778664.56	202686.23	20.32	No contact		
53	1778655.56	202698.83	20.79	No contact-rock		
82	1778535.22	202327.66	21.53	No contact		
70	1778627.14	202650.96	26.32	No contact		
20	1778518.55	202439.56	51.77	Reacquired		

Transect Path B

ID	EASTING	NORTHING	mV	Comment	% No contacts	100.0%
163	1778671.57	203405.89	42.5	No contact		
112	1778682.79	203407.29	52.93	No contact	% Reacquired	0.0%
142	1778782.35	203402.31	90.75	No contact		
72	1778873.97	203376.28	108.29	No contact		
61	1778815.55	203375.16	120.99	No contact		
167	1778815.49	203381.5	139.65	No contact		
131	1778660.16	203430.6	141.55	No contact		
130	1778658.96	203437.84	151.04	No contact		
143	1778831.2	203379.3	176.4	No contact		

Transect Path C

ID	EASTING	NORTHING	mV	Comment	% No contacts	62.5%
50	1778642.79	206045.41	16.95	No contact		
3	1778623.89	206040.64	25.91	No contact-near #2	% Reacquired	37.5%
36	1778771.4	206066.09	27.27	No contact		
35	1778768.17	206070.08	29.09	No contact		
34	1778772.78	206070.67	30.08	Reacquired		
22	1778659.5	206049.98	32.31	No contact		
33	1778779.91	206064	44.16	Reacquired		
2	1778622.53	206037.37	831.71	Reacquired		

Transect Path D

ID	EASTING	NORTHING	mV	Comment		
94	1778240.11	208263.95	25.67	No contact		
98	1778276.89	208264.72	28.98	No contact	% Reacquired	20.0%
118	1778179.9	208276.63	32.8	No contact		
52	1778367.43	208215.52	36.79	No contact		
64	1778360.49	208235.3	45.68	No contact		
190	1778004.21	208339.53	48.85	No contact		
88	1778232.92	208266.02	49.62	No contact		
79	1778341.14	208259.2	51.86	Reacquired		
162	1778030.91	208324.71	54.95	No contact		
69	1778332.6	208258.67	94.21	Reacquired		

Transect Path E

ID	EASTING	NORTHING	mV	Comment		
144	1777510.36	209364.68	34.33	Reacquired		
180	1777562.82	209497.78	35.47	No contact-edge effect	% Reacquired	70.0%
179	1777561.57	209502.39	40.66	Reacquired		
178	1777558.29	209502.44	42.7	Reacquired		
36	1777681.53	209179.11	43.71	Reacquired		
188	1777590.89	209533.46	47.01	Reacquired		
91	1777575.59	209248.24	54.84	No contact		
50	1777726.3	209188.96	64.52	Reacquired-2.9' SE		
19	1777763.39	209168.07	89.27	No contact		
235	1777601.45	209226.15	202.2	Reacquired		

Transect Path F

ID	EASTING	NORTHING	mV	Comment	% No contacts	76.5%
148	1780546.14	203833.15	16.12	No contact		
78	1780484.27	203593.35	17.14	No contact	% Reacquired	23.5%
275	1780990.98	204062.8	17.61	No contact		
43	1780564.52	203562.67	26.22	No contact		
334	1780688.7	203853.34	27.6	Reacquired-rock		
259	1781177.55	204035.82	31.2	No contact		
269	1781079.5	204060.2	31.95	No contact		
305	1781178.35	204136.16	37.14	No contact		
330	1780471.32	203832.89	40.4	No contact		
238	1781107.83	204023.72	47.6	Reacquired		
109	1780644.94	203815.32	49.88	No contact		
166	1780680.97	203856.77	53.99	No contact		
63	1780458.61	203587.82	65.73	No contact-edge effect		
22	1780811.99	203393.14	68.22	No contact		
67	1780671.82	203588.66	104.63	Reacquired		
31	1780792.68	203463.6	211.86	No contact		
233	1781145.09	204014.65	238.64	Reacquired		

Transect Path G

ID	EASTING	NORTHING	mV	Comment	% No contacts	75.0%
34	1780238.46	204679.62	15.12	No contact		
29	1779976.77	204362.72	15.8	No contact	% Reacquired	25.0%
38	1780334.71	204758.89	17.31	No contact		
14	1780114.04	204587.7	17.73	No contact		
16	1780193.15	204655.42	24.62	Reaquired		
19	1780260.73	204697.73	30.35	No contact		
33	1780056.49	204522.9	32.41	No contact		
36	1780246.47	204689.34	58.4	Reaquired-4.2' SE		

Transect Path H

ID	EASTING	NORTHING	mV	Comment		
75	1780061.66	206240.52	28.87	No contact	% No contacts	100.0%
15	1780289.34	206155.84	38.01	No contact	% Reacquired	0.0%
3	1780325.16	206138.26	40.95	No contact		
57	1780154.39	206212.26	44.13	No contact		
92	1780295.28	206160.31	73.82	No contact		
66	1780108.71	206228.02	124.88	No contact		
65	1780105.39	206225.44	147.95	No contact		
64	1780103.47	206228.75	170.54	No contact		
63	1780104.2	206233.99	331.13	No contact		

Transect Path I

ID	EASTING	NORTHING	mV	Comment		
32	1781255.36	208844.27	15.3	Reacquired		
18	1781209.78	208821.39	15.58	No contact	% Reacquired	42.9%
22	1781248.84	208846.41	16.51	No contact		
38	1781217.34	208845.48	17.5	Reacquired		
21	1781246.79	208840.53	23.62	No contact		
23	1781224.51	208842.17	28.91	No contact		
17	1781198.03	208824.84	51.61	Reacquired		
38	1780334.71	204758.89	17.31	No contact		
14	1780114.04	204587.7	17.73	No contact		
16	1780193.15	204655.42	24.62	Reaquired		
19	1780260.73	204697.73	30.35	No contact		
33	1780056.49	204522.9	32.41	No contact		
36	1780246.47	204689.34	58.4	Reaquired-4.2' SE		

Transect Path J

ID	EASTING	NORTHING	mV	Comment
40	1781165.33	209801.94	15.23	No contact
18	1781296.94	209553.39	15.5	No contact
27	1781250.74	209626.22	15.59	No contact
32	1781213.11	209702.2	15.63	No contact
23	1781270.7	209599.69	16.37	No contact
22	1781285.52	209580.45	16.57	No contact
39	1781183.74	209759.04	17.77	No contact
38	1781188.31	209757.01	18.2	No contact
6	1781332.97	209503.02	19.5	No contact
7	1781333.75	209511.53	19.65	No contact
46	1781341.37	209466.79	19.71	No contact
14	1781312.95	209525.61	19.95	No contact
25	1781260.48	209618.86	21.23	No contact
30	1781231.83	209680.28	24.91	No contact
45	1781342.67	209466.11	28.07	No contact
26	1781262.54	209625.39	29.33	No contact

% No contacts 100.0%

% Reacquired 0.0%

Transect Road Data

ID	EASTING	NORTHING	mV	Comment
102	1777810.36	209951.86	20.03	Reacquired
95	1777836.1	209915.4	20.31	No contact
73	1777912.25	209689.26	20.79	No contact
94	1777838.01	209911.44	22.4	No contact
70	1777907.79	209653.9	27.85	No contact
101	1777815.45	209940.63	28.13	No contact
43	1777905.13	209470.89	39.12	Reacquired
42	1777904.55	209476.14	39.63	Reacquired
106	1777797.99	209958.6	60.32	Reacquired

% No contacts 55.6%

% Reacquired 44.4%

APPENDIX G
OPANA POINT
GEOPHYSICAL ANOMALY MAPS
(unavailable)

APPENDIX H
MAKAWAO GUNNERY RANGE GEOPHYSICAL ANOMALY MAPS
(unavailable)

APPENDIX C
OE INVESTIGATION RESULTS

Makawao Dig Sheets

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item Found	UXO	OE Scrap	Depth to top of Item in inches
East Road	216						Barbed Wire			10
East Road	217						Barbed Wire			10
East Road	243						Hole Clear			6
East Road	248						Hole Clear			6
East Road	258						45 Cal. Slug		✔	8
East Road	268						False Positive Depth 18" Neg. Find Hole Clear.			0
East Road	268						Nothing Found, Hole Clear			10
G-1	70						4' long fence post			1
G-1	1						Hole clear.			6
G-1	13						Hole clear. Nothing found.			12
G-1	2						Hole clear.			0
G-1	21						Hot rocks.			9
G-1	22						Hole clear.			10
G-1	31						Hot rock.			4
G-1	32						Hole clear.			6
G-1	39						Hot rocks.			6
G-1	40						Hot Rock			0
G-1	41						Hole clear.			18
G-1	43						Hot rocks and a 9"x1" Fence post			18
G-1	45						Hole clear, 2' iron bar.			6
G-1	51						Hot rock & a 2' Iron Bar.			4
G-1	52						2' Metal Bar.			0
G-1	72						Iron Bar			3
G-1	8						Hot rock.			4
G-1	81						Non OE Scrap			6
G-1	9						Hot rock.			0
G-10	101						Hole not cleared.			48
G-10	118						Hole clear, nothing found.			10
G-10	119						Hole clear, nothing found.			14
G-10	126						Hole cleared, nothing found.			16
G-10	128						Hole cleared, small hot rocks			14
G-10	129						Large hot rock on surface. Hole cleared.			0
G-10	130						Hole cleared, nothing found.			8
G-10	132						Hole clear, hot rocks.			24
G-10	136						Hole clear, nothing found.			18
G-10	139						Hole clear, nothing found.			4
G-10	143						Hole clear, nothing found.			10
G-10	145						Hole clear, nothing found.			0
G-10	149						Hot rock 30/40 lbs., hole cleared.			10
G-10	60						Hole Clear. Hot Rocks.			10
G-10	61						Hole Cleared, Nothing Found.			12
G-10	66						Hole cleared, hot rocks.			16
G-10	70						Hole clear, nothing found.			12

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item Found	UXO	OE Scrap	Depth to top of Item in inches
G-10	75						Very large hot rock too large to move.			2
G-10	80						Hole cleared, hot rocks.			18
G-10	82						Hole cleared. Piece of a horse shoe.			5
G-10	88						Hole clear, hot rock & gravel.			24
G-10	92						Hot rock, hole clear.			12
G-10	93						Hot rock. Hole clear.			12
G-10	98						Hole cleared, nothing found.			10
G-12	109						Large hot rock surface.			0
G-12	112						Hot rock. Hole clear.			12
G-12	123						Hot rock, very large.			2
G-12	129						Large hot rock.			0
G-12	139						Hole cleared. Hot rock.			8
G-12	144						Hole cleared. Hot rock.			12
G-12	152						Hot rock. Hole clear.			6
G-12	153						Hole cleared. Two hot rocks.			12
G-12	185						Hot rock. Hole clear.			8
G-12	244						Hole clear. Hot rock.			8
G-12	274						Hole cleared. Nothing found.			18
G-12	275						Nothing Found			6
G-12	276						Hole cleared. Large field stone (hot rock).			6
G-12	298						Hole cleared. Hot pebbles,			12
G-12	300						Large field stone (hot rock), on surface. Hole clear.			0
G-12	301						Hole cleared. Nothing found.			24
G-12	302						Hole cleared. Nothing found.			24
G-12	305						Large field stone on surface. Hole cleared. (Hot rock).			0
G-12	313						Hole cleared. Nothing found.			24
G-12	32						Two hot rocks. Hole cleared.			4
G-12	32						Hole cleared, Nothing found			8
G-12	62						Numerous hot rocks. Hole clear.			12
G-12	74						Large hot rock.			0
G-12	78						Numerous hot rocks. Hole cleared.			8
G-12	79						Numerous hot rocks. Hole cleared.			8
G-13	14						Hole clear, nothing found.			10
G-13	15						Hole clear. Nothing found.			8
G-13	24						Moving hit, very faint.			18
G-13	26						Hole cleared, nothing found.			16
G-13	29						No reading.			12
G-13	31						Barbed wire. Hole clear.			4
G-13	39						Nothing found, moving signal.			24
G-13	41						Rust fragments. Hole clear.			8
G-13	5						Hole clear. Nothing found.			18
G-13	54						Hole clear, nothing found.			6

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item Found	UXO	OE Scrap	Depth to top of Item in inches
G-13	55						Hole clear, hot rock.			8
G-13	6						Hole cleared, nothing found.			16
G-13	7						Hole clear. Nothing found.			8
G-13	8						Hole clear. Nothing found.			12
G-13	9						Hole cleared. Hot rock.			2
G-15	11						Rust.			8
G-15	115						Hole cleared. Nothing found.			6
G-15	120						Hole cleared. Bits of rust.			8
G-15	131						None.			12
G-15	135		✔				81mm Tail Boom.		✔	6
G-15	152						Hole cleared. Bits of rust.			12
G-15	159						Scattered rust. Hole cleared.			6
G-15	160						Hole cleared. Nothing found.			8
G-15	164						None.			6
G-15	177						Small pieces of rusted metal. Hole cleared.			12
G-15	20						Depth 10". Hole clear, nothing found.			10
G-15	21						Rust NOES.			12
G-15	22						Depth 8". Nothing found but rust.			8
G-15	33		✔				Four pieces of 81mm mortar OES.		✔	13
G-15	45						306 Rol.		✔	4
G-15	49						Nothing Found			2
G-15	60	✔					HE, 60mm	✔		2
G-15	75						Hole cleared. Nothing found.			18
G-15	77						Bits of rust. Hole cleared.			8
G-15	80						Bits of rust.			12
G-15	82						Hole cleared. Hot soil.			8
G-15	94						Hole clear.			18
G-15	99						Hot rocks. Hole clear.			12
G-16	147						Non OE Scrap			4
G-16	15	✔					UXO	✔		4
G-16	153						Non OE Scrap			6
G-16	16	✔					60 mm OE Scrap		✔	4
G-16	26						Small Arms Casing.		✔	4
G-16	34						Non OE Scrap			3
G-16	50						Very Small Metallic Object.			4
G-16	52						Very Small Metallic Object.			4
G-16	54						Very Small Metallic Object.			3
G-19	12						Hole clear, nothing found.			18
G-19	15						Hole clear.			10
G-19	21						Hole clear.			18
G-19	22						Hole clear, nothing found.			8
G-19	23						Hole clear.			8

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item Found	UXO	OE Scrap	Depth to top of Item in inches
G-19	24						Hole clear, rust.			20
G-19	25						Hole clear, hot rock.			6
G-19	26						Hole clear.			12
G-19	27						Hole clear.			10
G-19	28						Hole clear, hot rock.			8
G-19	3						Hole clear.			8
G-19	30						Hole clear. Hot rocks.			16
G-19	32						Hole clear.			8
G-19	34						Hole clear, nothing found.			18
G-19	37						Hole clear, nothing found.			18
G-19	38						Hole clear, nothing found.			18
G-19	39						Hole clear, nothing found.			18
G-19	4						Hole clear, hot rock.			12
G-19	5						Hole clear, nothing found.			10
G-21	1						Hot rock.			3
G-21	10						No signal			0
G-21	11						Aluminum can.			0
G-21	12						Wire.			2
G-21	13						No signal.			0
G-21	15						Barbed wire.			1
G-21	2						Nothing Found			0
G-21	20						No signal.			0
G-21	21						None.			4
G-21	26						No signal.			0
G-21	27						Nothing Found			3
G-21	28						Nothing Found			4
G-21	3						Wire.			1
G-21	35						No signal.			0
G-21	36						Wire on surface.			0
G-21	4						Wire.			4
G-21	5						Aluminum can.			0
G-3	10						Rusted Frag		✔	4
G-3	100						Tent Poles & Beer Can & Lawn Chairs.			6
G-3	101						2 Tent Poles & 1 Tent Spike.			6
G-3	102						Tent Stake.			6
G-3	109						Metal Tube.			3
G-3	111						Metal tube.			4
G-3	113						Rusted Frag		✔	8
G-3	117						Cooking Pan.			0
G-3	136						Brick.			6
G-3	141						Hot Dirt, also flaged as #39.			0
G-3	147						TRASH Pit (Buried) for Camping Area. Also Marked with Flag #148.			12
G-3	148						Buried trash pit. Also Marked with Flag #147.			12

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item Found	UXO	OE Scrap	Depth to top of Item in inches
G-3	150						Aluminum Can & Spoon.			4
G-3	151						2 Metal Tubes.			6
G-3	158						Hot Rock Also @ 1'			10
G-3	165						Hot Rocks (x4)@4"			
G-3	169						Hot Dirt.			6
G-3	172						No reaquisition, dug hole to 12".			0
G-3	2						Marking Dgps Survey Pipe.			0
G-3	23						Soda Can Pull Tab.			4
G-3	25						Rusted Frag		✔	2
G-3	37						30-06 Shell Casing.		✔	0
G-3	39						Hot Dirt, also marked with flag #141			0
G-3	39						Hot Dirt.			1
G-3	4						Appears to Be a Mark For DGPS Antenna.			0
G-3	40						Hot Dirt.			4
G-3	41						Hot Dirt.			6
G-3	55						Rusted Frag		✔	6
G-3	59						Rusted			4
G-3	62						Hot Rock.			12
G-3	72						Cooking Pan.			6
G-3	73						Aluminum Can.			4
G-3	74						Aluminun Can.			6
G-3	89						Cooking Pan.			6
G-3	92						Tubing & Wire.			6
G-3	94						Red Rock at 6 inches			6
G-3	98						Aluminum Dish.			6
G-3	99						Aluminum Tent Poles and Tent Stake (buried),			4
G-4	109						Hot dirt.			1
G-4	110						None.			3
G-4	137						Hot rock.			4
G-4	141						OE Scrap		✔	0
G-4	15						Hot rock. Hole clear.			13
G-4	24						Hot rock.			6
G-4	27						Hot rock.			6
G-4	3						Hole clear.			1
G-4	33						Hot dirt.			6
G-4	34						Hot rock.			6
G-4	34						Hot dirt.			4
G-4	35						Hot dirt.			6
G-4	37						Hot rock.			4
G-4	52						Hot rock.			0
G-4	66						OE Scrap		✔	6
G-4	75						Red brick.			6
G-4	8						Hole clear, hot rock.			4
G-4	97						Hot rock.			2

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item Found	UXO	OE Scrap	Depth to top of Item in inches
G-5	10						Hole clear, nothing found.			18
G-5	15						Hole clear, nothing found.			18
G-5	32						Hole clear, nothing found.			18
G-5	50						Hole clear, nothing found.			18
G-5	50						Hole clear, nothing found.			18
G-5	62						Hole clear, nothing found.			18
G-5	63						Hole clear, nothing found.			18
G-7	10						Non OE Scrap			12
G-7	11						Red Brick & Soil, Depth 4'.			0
G-7	12						Hot Brick & Soil.			0
G-7	123						Rusted Spray Can.			0
G-7	13						4' Depth Hot bricks.			0
G-7	14						4' Depth - Nothing Found.			0
G-7	15						Depth 4' - Nothing Found.			0
G-7	16						Depth 4' - Nothing Found.			0
G-7	17						Depth 3' Hole Cleared, Nothing Found.			0
G-7	18						Depth 3', Hole Cleared, Nothing Found.			0
G-7	21						Depth 4' Hole, Not Cleared, Reach Required Depth.			0
G-7	24						Depth 4", Hole not cleared.			0
G-7	25						Depth 18", Nothing Found.			0
G-7	26						Depth 18" Hole Cleared, Nothing Found.			0
G-7	34						Non OE Scrap			6
G-7	34						Depth 18", Hole Clear, Nothing Found.			0
G-7	39						Depth 18", Hole Clear, Nothing Found.			0
G-7	40						Depth 4", Hole Not Cleared.			0
G-7	41						Depth 4', Nothing Found, Hole Not Clear.			0
G-7	42						False Positive - 18" Nothing Found.			0
G-7	45						Non OE Scrap			4
G-7	45						Depth 18" - Nothing Found - Hole Cleared.			0
G-7	46						Depth 30" to Clear Hole - Nothing Found.			0
G-7	52						Depth 18" - Hole Cleared, Nothing Found.			0
G-7	52						Also Marked with Flag #38 Pipe.			4
G-7	55						Non OE Scrap			9
G-7	55						False positive depth 18", Nothing Found hole clear.			0
G-7	57						Depth 18", Hole cleared, Nothing found.			0
G-7	9						Hot Dirt.			18
G-8	11						Hot Rock.			1
G-8	112						Insignificant Metallic Object.			2
G-8	12						Hot Rock.			1
G-8	13						Rusted Non OE Scrap			6
G-8	20	✔					60 mm Illumination Mortar with Unfunctioned Burster.			6

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item Found	UXO	OE Scrap	Depth to top of Item in inches
G-8	21						Pipe.			4
G-8	22						OE Scrap			3
G-8	23						Rusted Non OE Scrap			2
G-8	24						Hot rock.			2
G-8	25	✔					Tail fin only		✔	3
G-8	26						Pipe.			4
G-8	27						Pipe.			4
G-8	32						4.5 Barrage Rocket	✔		24
G-8	34						Rusted Non OE Scrap			4
G-8	36						OE Scrap		✔	12
G-8	38						Also Marked with flag #37 Pipe.			4
G-8	39						Hot Rock.			6
G-8	45						Also marked with flad #46			6
G-8	46						Also Marked with Flag #45.			6
G-8	5						Insignificant Metallic Object.			4
G-8	54						No I.D./Frag.			3
G-8	55						Non OE Scrap			6
G-8	56						Hot Rock/Dirt.			2
G-8	57						Aluminum Can.			4
G-8	63						Rusted Non OE Scrap			6
G-8	64						Pipe.			3
G-8	65						OE Scrap		✔	3
G-8	72						OE Scrap		✔	4
G-8	73						Pipe, Also Marked with Flag #74.			6
G-8	74						Pipe, Also Marked with Flag #73.			6
G-9	100						Hole cleared, nothing found.			8
G-9	15						Hole cleared, nothing found.			18
G-9	159						Nothing found, hole clear.			8
G-9	30						Hole cleared, nothing found.			10
G-9	44						Hole clear, nothing found.			10
G-9	55						Hole cleared, nothing found.			12
G-9	86						Hole clear, nothing found.			14
Path C	2						3'x2" Pipe			6
Path C	22						Nothing Found, Hole Clear			6
Path C	33						Hole Cleared, Nothing Found			8
Path C	35						Hole Clear, Nothing Found			8
Path D	118						Nothing Found			8
Path D	162						Hole Clear, Nothing Found			10
Path D	190						Hole Clear, Nothing Found			6
Path D	64						Hole Clear, Nothing Found			8
Path D	69						Hole Clear, Nothing Found			8
Path D	79						Nothing Found, Hole Clear			12
Path D	88						Nothing Found, Hole Clear			18

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item Found	UXO	OE Scrap	Depth to top of Item in inches
Path D	98						Hole Clear, Nothing Found			6
Path E	144						Hot Rock, Hole Clear			8
Path E	178						Hole Clear, Nothing Found			6
Path E	179						Hot Rock, Hole Clear			4
Path E	180						Hole Clear, Hot Rock			4
Path E	188						metal knife			6
Path E	19						Hole Clear, Nothing Found			18
Path E	235						Non OE Scrap			8
Path E	36						Hole clear, Nothing Found			8
Path E	50						Nothing Found, Hole Clear			8
Path E	91						Hot Rock			8
Path H	3						Hole clear, nothing found.			18
Path H	63						Depth 4, Hole Not Cleared.			6
Path H	63						Hole clear, nothing found.			6
Path H	64						Hot rock.			12
Path H	65						Small piece of wire.			4
Path H	66						Hole clear.			8
Path H	75						Hole cleared, nothing found.			6
Path I	17						Metal Wrench			0
Path I	21						Hole Clear, Nothing Found			18
Path I	22						Hole Clear, Nothing Foud			18
Path I	23						Hole Clear, Hot Dirt			24
Path J	22						Nothing Found, Hole Clear			18
Path J	23						Hole Clear, Nothing Found			18
Path J	26						Hole Clear, Nothing Found			18
Path J	32						Hole Clear, Nothing Found			18
Path J	38						Hole Clear, Nothing Found			18
Path J	39						Hole Clear, Nothing Found			18
Path J	40						Hole Clear			12
Path J	45						Hole Clear, Nothing Found			18
Path J	7						Hole Clear, Nothing Found			18
RDW 161	161						Hot Rock			10
Road	101						Hole Clear, Nothing Found			8
Road	106						Hole Clear, Nothing Found			6
Road	42						Knife Blade			8
Road	70						Hole Clear, Nothing Found			6
Road	94						Nothing Found			0
T-A	19						Can.			6
T-A	24						Can.			3
T-A	60						Can.			3
T-F	149						Hot rock, hole clear.			3
T-F	22						Hole clear, nothing found.			6
T-F	31						Hole clear, nothing found.			8
T-F	330						Hole clear, nothing found.			6
T-F	43						Nothing found, hole clear.			4
T-F	67						Hole clear, nothing found.			6
TS1 West	275						Hot Dirt			8
TS1 West	284						Non OE Scrap			1
TS1 West	302						Hot Dirt, Hole Clear			6
TS1 West	304						Hot Dirt, Hole Clear			6

Opana Point Dig Sheets

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item found	OE Category	UXO	OE Scrap	Depth to top o item in inches
5	14						Hot Rock				
G-1	299				✔		OE Scrap	Practice		✔	6
G-1	300				✔		OE	Practice		✔	4
G-1	302						OE Scrap			✔	10
G-1	306				✔		OE Scrap	Practice		✔	2
G-1	308				✔		OE Scrap	Practice		✔	6
G-1	310				✔		OE Scrap	Practice		✔	6
G-1	312						Nothing found				
G-1	324						Dirt/Rock				
G-1	332						Dirt/Rock				
G-1	336						Rock				36
G-1	337						Dirt/Rock				
G-1	349						Dirt/Rock				
G-1	360						Dirt/Rock				
G-1	361						Soda can				1
G-1	362						1" pipe on surface				
G-1	364						Rock				12
G-1	396						OE Scrap			✔	
G-1	403						1" pipe on surface				
G-1	404						OE Scrap			✔	0
G-1	405						OE Scrap			✔	3
G-1	406						Dirt/Rock				
G-1	407				✔		OE Scrap	Practice		✔	0
G-1	408				✔		OE Scrap	Practice		✔	7
G-1	410					✔	OE Scrap	Practice		✔	12
G-1	414						tail boom			✔	
G-1	415				✔		OE Scrap	Practice		✔	10
G-1	416						nothing found				
G-1	417						Survey Monument				
G-1	427						Rock				
G-1	433				✔		OE Scrap	Practice		✔	8
G-1	437						pipe				
G-1	438						slag				6
G-1	447						nothing found				
G-1	451		✔				OE Scrap			✔	6
G-1	453				✔		OE Scrap	Practice		✔	5
G-1	458				✔		OE Scrap	Practice		✔	0
G-1	469						Nothing Found				
G-1	487						rock				0
G-1	500						Rock				
G-1	504						Nothing Found				
G-1	512						.22 cal cart			✔	
G-1	513						Nothing Found				

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item found	OE Category	UXO	OE Scrap	Depth to top o item in inches
G-1	515				✔		UXO	Practice with spotting charge	✔		6
G-1	518						Nothing Found				
G-1	519						Rock				6
G-1	528						Dirt/Rock				
G-1	541	✔					UXO	He	✔		2
G-1	542						Nothing Found				
G-1	547						OE Scrap			✔	0
G-1	555						Nothing Found				
G-1	557						Nothing found				
G-1	558						nothing found				
G-1	560						rock				18
G-1	562						Nothing Found				
G-1	580						Slag				4
G-1	617						Nothing Found				
G-1	641				✔		OE Scrap	Practice		✔	6
G-1	656						Nothing Found				
G-1	665						Nothing Found				
G-1	673						Nothing Found				
G-1	687						Nothing Found				
G-1	693						rock				0
G-1	706						OE Scrap			✔	
G-1	713					✔	OE Scrap	Practice		✔	6
G-1	715						Slag				12
G-1	721						hot rock				
G-1	740				✔		OE Scrap	Practice		✔	3
G-1	757				✔		OE Scrap	Practice		✔	2
G-1	771						nothing found				
G-1	772						OE Scrap				2
G-1	775						1" pipe on surface				
G-1	779				✔		OE Scrap	Practice		✔	6
G-1	782						OE Scrap			✔	0
G-1	783						rock				1
G-1	786						Dirt/Rock				
G-2	102						Nothing Found				
G-2	110						metal				0
G-2	114				✔		OE Scrap	Practice		✔	18
G-2	116					✔	OE Scrap	Practice		✔	3
G-2	117					✔	OE Scrap	Practice		✔	10
G-2	118					✔	OE Scrap	Practice		✔	0
G-2	118						metal				
G-2	122					✔	OE Scrap	Practice		✔	4
G-2	126				✔		OE Scrap	Practice		✔	12

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item found	OE Category	UXO	OE Scrap	Depth to top o item in inches
G-2	131				✔		OE Scrap	Practice		✔	18
G-2	136					✔	OE Scrap	Practice		✔	8
G-2	162						OE Scrap			✔	8
G-2	165						OE Scrap			✔	0
G-2	170				✔		OE Scrap	Practice		✔	5
G-2	171						RR Track				0
G-2	190				✔		OE Scrap	Practice		✔	6
G-2	194					✔	OE Scrap	Practice		✔	4
G-2	2						Nothing found				
G-2	20					✔	OE Scrap	Practice		✔	6
G-2	208					✔	OE Scrap	Practice		✔	0
G-2	217				✔		OE Scrap	Practice		✔	6
G-2	220					✔	OE Scrap	Practice		✔	3
G-2	2238						Nothing Found				
G-2	225					✔	OE Scrap	Practice		✔	4
G-2	226						dirt				
G-2	238						Nothing Found				
G-2	247						metal				10
G-2	27					✔	OE Scrap	Practice		✔	8
G-2	274				✔		OE Scrap	Practice		✔	6
G-2	275						metal				6
G-2	276					✔	OE Scrap	Practice		✔	6
G-2	282					✔	OE Scrap	Practice		✔	6
G-2	290						metal				0
G-2	310					✔	OE Scrap	Practice		✔	0
G-2	317						Also marked with Flag G-7 #250				4
G-2	322				✔		OE Scrap	Practice		✔	4
G-2	332					✔	OE Scrap	Practice		✔	8
G-2	347						metal				8
G-2	351				✔		OE Scrap	Practice		✔	3
G-2	365						OE Scrap			✔	6
G-2	368					✔	OE Scrap	Practice		✔	8
G-2	372						Nothing found				
G-2	375						RR Spike				
G-2	408						metal			✔	12
G-2	410				✔		OE Scrap	Practice		✔	4
G-2	418				✔		OE Scrap	Practice		✔	6
G-2	43					✔	OE Scrap	Practice		✔	0
G-2	435						metal				0
G-2	454				✔		OE Scrap	Practice		✔	2
G-2	462						OE Scrap			✔	10
G-2	463					✔	OE Scrap	Practice		✔	3
G-2	526						RR Track				0
G-2	581						Nothing found				

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item found	OE Category	UXO	OE Scrap	Depth to top o item in inches
G-2	589						rock				
G-2	73						metal				
G-2	77				✔		OE Scrap	Practice		✔	8
G-2	83						metal				8
G-2	84				✔		OE Scrap	Practice		✔	0
G-2	88						Nothing Found				
G-2	90						metal				2
G-3	124						Non-OES				
G-3	134					✔	OE	Practice		✔	0
G-3	135				✔		OE	Practice		✔	2
G-3	136					✔	OE	Practice		✔	6
G-3	146				✔		OE	Practice		✔	3
G-3	147				✔		OE	Practice		✔	4
G-3	148					✔	OE	Practice		✔	4
G-3	149					✔	OE	Practice		✔	0
G-3	150					✔	OE	Practice		✔	0
G-3	151						non oes				
G-3	152						clump of steel				
G-3	153				✔		OE	Practice		✔	4
G-3	154				✔		OE	Practice		✔	4
G-3	155				✔		OE	Practice		✔	8
G-3	157				✔		OE	Practice		✔	4
G-3	159					✔	OE	Practice		✔	4
G-3	160					✔	OE	Practice		✔	8
G-3	177						nothing found				
G-3	182						OE Scrap			✔	
G-3	183				✔		OE	Practice		✔	0
G-3	187					✔	OE	Practice		✔	4
G-3	202				✔		OE	Practice		✔	0
G-3	211						nothing found				
G-3	212				✔		OE	Practice		✔	6
G-3	213					✔	OE	Practice		✔	6
G-3	78				✔		OE	Practice		✔	0
G-4	123						Hot Rock				
G-4	129						hot rock				
G-4	135					✔	OE	Practice		✔	6
G-4	136						Hot Rock				
G-4	148						hot rock				
G-4	158					✔	OE	Practice		✔	5
G-4	160						nothing found				
G-4	162						nothing found				
G-4	173				✔		OE	Practice		✔	6
G-4	174						OE Scrap			✔	0
G-4	179				✔		OE	Practice		✔	4

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item found	OE Category	UXO	OE Scrap	Depth to top o item in inches
G-4	193						nothing found				
G-4	195						nothing found				
G-4	198						hot rock				
G-4	226						rock				6
G-4	425						Dirt/Rock				
G-4	438						rock				
G-4	543						nothing found				
G-4	544						hot rock				
G-4	549				✔		OE	Practice		✔	6
G-4	550				✔		OE	Practice		✔	6
G-4	557					✔	OE	Practice		✔	4
G-4	563				✔		OE	Practice		✔	6
G-4	621						soda can				4
G-4	634					✔	OE	Practice		✔	0
G-4	643						hot rock				
G-4	644					✔	OE	Practice		✔	6
G-5	202						rock				0
G-5	207						rock				0
G-5	210						rock				4
G-5	222						rock				0
G-5	277						rock				4
G-5	278						rock				3
G-5	292						rock				0
G-5	295						rock				0
G-5	305						rock				4
G-5	311						rock				0
G-5	319						rock				0
G-5	320						Bottle Cap				1
G-5	329						rock				0
G-5	330						metal plate				3
G-5	331						rock				3
G-5	332						rock				0
G-5	343						rock				2
G-5	364						rock				3
G-5	368						Steel Bar				6
G-5	372						large rock				
G-5	373						soda can				0
G-5	375						steel				0
G-5	378						rock				0
G-5	387						rocks				
G-5	390						rock				0
G-5	440						rock				0
G-5	450						Nothing Found. Schonstedt used in conjunction with the fisher located an anomaly 2 feet away.				

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item found	OE Category	UXO	OE Scrap	Depth to top o item in inches
G-5	465						steel cable				4
G-5	520						rock				5
G-5	606						rock				5
G-5	623						rock				2
G-6	15						Nothing Found				
G-6	16						sheet metal				
G-6	2						metal				0
G-6	25						metal				12
G-6	26						rock				
G-6	29						metal				6
G-6	30				✔		UXO	Practice	✔		4
G-6	33						Nothing Found				
G-6	35						rock				
G-6	36						rock				
G-6	37				✔		UXO	Practice	✔		10
G-6	41						metal				6
G-6	52						rock				
G-6	56						Rock				
G-6	59						rock				
G-6	64				✔		OE Scrap	Practice		✔	6
G-6	70					✔	UXO	Practice	✔		6
G-6	72				✔		OE Scrap	Practice		✔	2
G-6	73				✔		UXO		✔		2
G-6	75				✔		UXO	Practice	✔		4
G-6	78						RR Track				0
G-6	85						metal				12
G-6	86						metal				6
G-7	116						OE Scrap			✔	0
G-7	127						Rusted OE Scrap			✔	8
G-7	132				✔		OE Scrap	Practice		✔	2
G-7	133				✔		OE Scrap	Practice		✔	6
G-7	15				✔		OE Scrap	Practice		✔	4
G-7	150						Hot Rock				8
G-7	16						OE Scrap			✔	
G-7	164				✔		OE Scrap	Practice		✔	24
G-7	176					✔	OE	Practice		✔	0
G-7	189		✔				OE Scrap	He		✔	4
G-7	193				✔		OE Scrap	Practice		✔	0
G-7	2						Rusted OE Scrap			✔	
G-7	204						3 Pieces of Rebar				0
G-7	209				✔		OE Scrap	Practice		✔	8
G-7	214				✔		OE Scrap	Practice		✔	4
G-7	215						Nothing Found				
G-7	220				✔		OE Scrap	Practice		✔	1

Grid ID	Anomaly ID	60mm	81mm	105mm	AN MK23	MK5	Description of item found	OE Category	UXO	OE Scrap	Depth to top o item in inches
G-7	23						OE Scrap			✔	12
G-7	239				✔		OE Scrap	Practice		✔	6
G-7	250						Also marked with Flag G-2 #317				4
G-7	251						OE Scrap				
G-7	40						Rock				2
G-7	43					✔	OE	Practice		✔	6
G-7	44					✔	OE Scrap	Practice		✔	1
G-7	462						RR Track				0
G-7	53						Non-OES				4
G-7	55						RR Track				0
G-7	65				✔		OE Scrap	Practice		✔	6
G-7	71				✔		OE Scrap	Practice		✔	8
G-7	82						RR Track				2
G-7	90				✔		OE Scrap	Practice		✔	0
G-7	97						OE Scrap				
G-8	108						RR Track				0
G-8	62						metal				
G-8	72						Nothing found				
G-8	85						Nothing found				
G-8	86						Dirt				
G-8	93						Rebar				4
G-8	94						Nothing found				
T-1	395						OE Scrap			✔	0
T-1	73						metal				0
T-12	11						Scrap Metal				
T-12	63						nothing found				
T-12	7				✔		OE	Practice		✔	6
T-13	29						nothing found				
T-15	18						nothing found				
T-15	20					✔	OE	Practice		✔	6
T-15	23					✔	OE	Practice		✔	4
T-15	26					✔	OE	Practice		✔	6
T-16	1						Nothing Found				
T-16	23						sheet metal				
T-16	32						nothing found				
T-16	33						nothing found				
T-2	46				✔		OE Scrap	Practice		✔	8
T-2	48						metal				0
T-2	55				✔		OE Scrap	Practice		✔	4
T-2	58				✔		OE Scrap	Practice		✔	2
T-2	61				✔		OE Scrap	Practice		✔	8
T-2	69				✔		OE Scrap	Practice		✔	6
T-2	72				✔		OE Scrap	Practice		✔	0
T-2	76				✔		OE Scrap	Practice		✔	2
T-5	103						Hot Rock				
T-5	115						Hot Rock				
T-5	124						Hot Rock				
T-5	170						Hot Rock				
T-5	33						Hot Rock				
T-5	36						Hot Rock				
T-5	49						nothing found				
T-6	113						OE HE	He			6
T-6	53						Hot Rock				
T-8	22						nothing found				
T-8	33						Scrap Metal				
T-8	35						OE	Practice		✔	2
T-8	49						Nothing Found				
T-9	22						metal pipe				
T-9	50						OE Scrap	Practice		✔	5
T-9	50						OE	Practice		✔	0
T-9	56				✔		OE	Practice		✔	0
									8	❐ ◂ ▸▸	

APPENDIX D

COST ANALYSIS SUMMARY

COST ANALYSIS SUMMARY

1.0 INTRODUCTION

1.1 This cost-analysis summary presents costing assumptions and rough-order-of-magnitude (ROM) estimates for the OE response-action alternatives using best professional judgment based on information collected during the OE investigation conducted August through October 2002, and relevant experience with similar projects. The ROM cost estimates for clearance alternatives have been developed using proven technologies, current USACE procedures and methodologies, and site-specific information gathered during the EE/CA investigation.

1.2 The ROM estimates are only intended for comparing costs associated with the proposed risk-reduction alternatives and are not intended to represent actual costs to implement. These costs are used in Chapter 8.0 solely for comparative purposes to evaluate the three OE response-action alternatives. Some general assumptions made for cost comparison purposes are as follows:

- Costs have been estimated for three of the four alternatives evaluated in this report. No cost is associated with the NDAI alternative. Therefore, it is not discussed for either site.
- The Makawao site is approximately 1,002 acres. For the both Surface Clearance and Clearance to Depth alternatives, ZAPATAENGINEERING estimates 10%, or 100 acres of the area will be cleared.
- For both Surface Clearance and Clearance to Depth alternatives at the Opana Point site, ZAPATAENGINEERING estimates that approximately 90 acres (approximate area of planned development) will be cleared.
- Data collected during the EE/CA were analyzed and used to evaluate the potential number of targets and for cost-calculation purposes, ZAPATAENGINEERING assumes:
  - That 2,200[1] targets meeting selection criteria used during the EE/CA are present within the 100[1]-acre Makawao Gunnery Site area for clearance, of which approximately 274[1] are suspected to be OE items. 484 (22%) of the anomalies are assumed to be on the surface. These assumptions are based on anomaly and OE densities within the 100[1]-acre area, not the densities calculated from the overall site.
  - That 4,438[1] targets meeting selection criteria used during the EE/CA are present within the Opana Point area (90[1] acres), of which approximately 2,012[1] are suspected to be OE items. 1,065 (24%) of items that meet the target selection criteria are assumed to be on the surface. These assumptions are based on the number of target anomalies relocated (498) and OE recovered from intrusive investigations.

[1] Calculation Sheet for these estimates is provided at the end of this appendix.

2.0 MAKAWAO GUNNERY SITE NDAI - ALTERNATIVE 1

NDAI is not an acceptable alternative based on the High OERIA Risk Level. Additionally, there is no action and therefore no cost associated with implementation of this alternative.

3.0 MAKAWAO GUNNERY SITE INSTITUTIONAL CONTROLS - ALTERNATIVE 2

3.1 The estimated cost to implement Alternative 2 is $8,501. The project is estimated to last approximately three weeks. Institutional-Control (IC) cost estimates include publication of an informational fact sheet for distribution to the employees at the East Maui Irrigation Company and local residents, and one public-information meeting. The cost estimate is based on the following assumptions:

- The project design will be conducted by a Task Manager and is estimated to take approximately 40 man-hours (24 for development of educational materials and 16 for meeting support).
- The project implementation will be conducted by a Task Manager and is estimated to take approximately 40 man-hours (conducting public-information meeting and publication of educational material).
- A Project Manager will provide approximately eight man-hours of project oversight.
- A Contracts Manager will use approximately four man-hours to generate any necessary contractual agreements.
- Mobilization, demobilization and subsistence costs include;
    - Public Meeting – One airfare, three days of a rental vehicle with fuel, two nights at a hotel for one person and an estimated 2.5 per diem allowances (two 75% travel days and one full day) for the Task Manager.
- Estimated annual cost for reprinting of 500 copies of educational material for distribution is $1000.

TABLE 1 MAKAWAO GUNNERY SITE INSTITUTIONAL CONTROLS - ALTERNATIVE 2

Item	Unit	Rate	Quantity	Cost
Project Design (Task Manager)	Man-hours	$55.40	40	$2,216
Project Implementation (Task Manager)*	Man-hours	$55.40	40	$2,216
Project Oversight (Project Manger)	Man-hours	$81.10	8	$ 649
Contracts Manager	Man-hours	$76.57	4	$ 306
Airfare	Round trip	$1,200.00	1	$1,200
Rental Vehicle*	Day	$69.25	3	$ 208
Hotel Stay*	Day	$159.00	2	$ 318
Per Diem*	Day	$89.00	2.5	$ 223
Production of Informational Brochures*	Each	$2.00	500	$1,000
Hawaii Excise Tax		4.166%	$3,965	$ 165
TOTAL				$8,501

* Subject to Hawaii Excise Tax

4.0 MAKAWAO GUNNERY SITE SURFACE CLEARANCE IN 100 ACRES - ALTERNATIVE 3

4.1 The estimated capital cost to implement Alternative 3 is $223,576. The project is estimated to last approximately two and one-half weeks including mobilization, setup, and demobilization, based on an average of 12.5 acres per day, four 10-hour days a week. Institutional-control cost estimates include production of educational materials, and a public-information meeting, as detailed above. A Senior UXO Supervisor will supervise a five-man UXO team during the surface clearance activities. The cost estimate is based on the following assumptions.

- Institutional control costs (Alternative 2) are included in this alternative.
- The project design will be conducted by a Task Manager and is estimated to take approximately 60 man-hours.
- The project implementation will be conducted by a Task Manager and is estimated to take approximately 40 man-hours.
- A Project Manager will provide approximately 16 man-hours of project oversight.
- A Contracts Manager will use approximately 12 man-hours to generate any necessary contractual agreements.
- A UXO Safety Officer will support site work using an estimated 116 man-hours, which includes two 8-hour travel days and approximately ten 10-hour workdays.
- A Senior UXO Supervisor will supervise a five-man UXO team (one UXO Supervisor and four UXO Technician II) while conducting the surface clearance. Each person is estimated at 116 man-hours, which includes two 8-hour travel days and approximately ten 10-hour workdays.
- For estimation purposes, a local explosives distributor will make two once-per-week explosives-deliveries to the site so that any UXO items discovered during the surface clearance can be destroyed at the end of each week.
- Mobilization, demobilization and subsistence costs include;
    - Initial Site Visit – two airfares, three days of a rental vehicle with fuel, two nights at a hotel for two people and an estimated five per diem allowances (two 75% travel days and one full day) for the Task Manager and the UXO Safety Officer.
    - Fieldwork – seven airfares, 34 days of a rental vehicle with fuel (two SUVs for 17 days), 119 nights at a hotel (17 nights for seven men) and an estimated 129.5 per diem allowances (two 75% travel days and 17 full days for the UXO Safety Officer and the six-member UXO project team).
- Field equipment includes a digital camera ($400), three hand-held EM metal detectors (at a cost of $10 each week for two weeks), three hand-held radios (at $200 each) and miscellaneous hand tools ($150).
- Brush clearing/thinning and grass mowing over approximately 50% (50 acres) will be required.

- A Task Manager will require approximately 40 hours to generate a project report at the conclusion of the site work.
- A Project Manager will require approximately 4 hours to review the project report.

TABLE 2 MAKAWAO GUNNERY SITE SURFACE CLEARANCE IN 100 ACRES - ALTERNATIVE 3

Item	Unit	Rate	Quantity	Cost
Institutional Controls	Lump sum	$8501.00	1	$8,501
Project Design (Task Manager)	Man-hours	$55.40	60	$3,324
Project Implementation (Task Manager)*	Man-hours	$55.40	40	$2,216
Project Oversight (Project Manager)	Man-hours	$81.10	16	$1,298
Contracts Manager	Man-hours	$76.57	12	$ 919
UXO Safety Officer	Man-hours	$43.77	16	$ 700
UXO Safety Officer (4% differential)*	Man-hours	$45.52	100	$4,552
Senior UXO Supervisor	Man-hours	$46.24	16	$ 740
Senior UXO Supervisor (8% Differential)*	Man-hours	$49.94	100	$4,994
UXO Supervisor	Man-hours	$41.18	16	$ 659
UXO Supervisor (8% Differential)*	Man-hours	$44.47	100	$4,447
4 - UXO Technician II	Man-hours	$36.12	64	$2,312
4 - UXO Technician II (8% Differential)*	Man-hours	$39.01	400	$15,604
Brush Clearing*	Per acre	$2,300	50	$115,000
Airfare	Round trip	$1,200.00	9	$10,800
Rental Vehicles*	Day	$69.25	37	$2,562
Hotel Stay*	Day	$159.00	123	$19,557
Per Diem*	Day	$89.00	134.5	$11,971
Explosives Delivery*	Each	$1,000.00	2	$2,000
Equipment and Supplies*	Lump sum	$1,210.00	1	$1,210
Project Report (Task Manager)	Man-hours	$55.40	40	$2,216
Project Report (Project Manager)	Man-hours	$81.10	4	$ 324
Hawaii Excise Tax		4.166%	$184,113	$7,670
TOTAL				$223,576

* Subject to Hawaii Excise Tax

5.0 MAKAWAO GUNNERY SITE CLEARANCE TO DEPTH IN 100 ACRES - ALTERNATIVE 4

5.1 The estimated capital cost to implement the clearance to depth alternative is $878,992. The project is estimated to last approximately 28 weeks, based on geophysical mapping and removing 2,200 estimated targets in the approximately 100 acres within the 700 and 800 foot elevation area. A Senior UXO Supervisor will supervise a five-man UXO team during the clearance to depth activities. The cost estimate is based on the following assumptions.

- Institutional Control costs (Alternative 2) are included in this alternative.

- The project design will be conducted by a Task Manager and is estimated to take approximately 80 man-hours.
- The project implementation will be conducted by a Task Manager and is estimated to take approximately 80 man-hours.
- A Project Manager will provide approximately 40 man-hours of project oversight.
- A Contracts Manager will use approximately 8 man-hours to generate any necessary contractual agreements.
- Brush clearing and localized grass mowing will be necessary for approximately 50 acres or 50% of the area. This will be completed by two 5-man teams at a rate of 5 acres per day for 12 days. Unit cost is based on similarly scoped projects in Hawaii.
- Three two-man geophysical teams will mobilize all geophysical equipment to the site, including EM-61s, all-terrain vehicles (ATV), Trimble Real-Time Kinematic GPS systems and necessary support equipment.
- Three two-man geophysical teams will collect data over the area using grid methodology at a rate of 6 acres a day for 17 10-hour days. Unit cost is based on a similarly scoped project on the Island of Oahu. Rate includes per diem and travel expenses.
- Geophysical data will be processed and interpreted offsite by a Project Geophysicist and a geophysical team at a rate of 10 acres per day for ten 10-hour days. Unit cost is based on a similarly scoped project on the Island of Oahu.
- An estimated 2,200 anomalies will be reacquired using GPS by the three two-man geophysical teams at a rate of 100 anomalies per day per team for eight 10-hour days. Unit cost is based on a similarly scoped project on the Island of Oahu.
- A UXO Safety Officer will support site work using an estimated 1006 man-hours, which includes two 8-hour travel days, approximately 32 10-hour workdays (geophysical survey and relocation), and approximately 67 10-hour workdays (4,675 anomalies at a rate of 70 anomalies a day).
- A Senior UXO Supervisor will supervise a five-man UXO team (one UXO Supervisor and four UXO Technician II) while conducting the subsurface clearance. Each person is estimated at 686 man-hours, which includes two 8-hour travel days and 67 10-hour workdays (4,675 anomalies at a rate of 70 anomalies per day).
- A local explosives distributor will make 16 once-a-week explosives deliveries to the site so that any UXO items discovered during the surface clearance can be destroyed.
- Mobilization, demobilization and subsistence costs include;
    - Initial Site Visit – two airfares, three days of rental vehicle and fuel, two nights hotel for two people and five per diem allowances (two 75% travel days and one full day) for the Task Manager and the SUXOS.

  - Fieldwork – seven airfares, 134 days of a rental vehicle with fuel (two SUVs for 67 days), 469 nights at a hotel (67 nights for seven men) and an estimated 479.5 per diem allowances (two 75% travel days and 67 full days for the UXO Safety Officer and the six-member UXO project team).
  - Site Meetings – one airfare, three days of rental vehicle and fuel, two nights hotel for one person and five per diem allowances (two 75% and one full day) for the Task Manager for each of two meetings.
- Field equipment includes a digital camera ($400), three Schonstedt Magnetometers (at $10 each per week for 17 weeks), three hand-held radios (at $200 each) and other small miscellaneous hand tools and equipment ($150).
- A Task Manager will require approximately 80 hours to generate a project report and the Project Manager will require approximately 8 hours to review.

TABLE 3 MAKAWAO GUNNERY SITE CLEARANCE TO DEPTH IN 100 ACRES - ALTERNATIVE 4

Item	Unit	Rate	Quantity	Cost
Institutional Controls	Lump sum	$8501.00	1	$8,501
Project Design (Task Manager)*	Man-hours	$55.40	80	$4,432
Project Implementation (Task Manager)	Man-hours	$55.40	80	$4,432
Project Oversight (Project Manager)	Man-hours	$81.10	40	$3,244
Contracts Manager	Man-hours	$76.57	8	$ 613
Brush Clearing Crew*	Per Acre	$3500	50	$175,000
Geophysical Mobilization/Demobilization	Lump sum	$12,060	1	$12,060
Geophysical Data Collection (EM-61)*	Weeks	$26,475.00	5	$132,375
Geophysical Data Interpretation	Weeks	$12,675.00	3.5	$44,363
Anomaly Reacquisition*	Weeks	$26,475.00	3	$79,425
UXO Safety Officer	Man-hours	43.77	16	$ 700
UXO Safety Officer (4% differential)*	Man-hours	$45.52	990	$45,065
Senior UXO Supervisor	Man-hours	$46.24	16	$ 740
Senior UXO Supervisor (8% differential)*	Man-hours	$49.94	670	$33,460
UXO Supervisor	Man-hours	$41.52	16	$ 664
UXO Supervisor (8% differential)*	Man-hours	$44.84	670	$30,043
4 - UXO Technician II	Man-hours	$36.12	64	$2,312
4 - UXO Technician II (8% differential)*	Man-hours	$39.01	2,680	$104,547
Airfare	Round trip	$1,200.00	11	$13,200
Rental Vehicles*	Day	$69.25	143	$9,903
Hotel Stay*	Day	$159.00	477	$75,843
Per Diem*	Day	$89.00	494.5	$44,011
Explosives Delivery*	Each	$1,000.00	16	$16,000
Equipment and Supplies*	Lump sum	$1,660.00	1	$1,660
Project Report (Task Manager)	Man-hours	$55.40	80	$4,432
Project Report Review (Project Manager)	Man-hours	$81.10	8	$ 649
Hawaii Excise Tax		4.166%	$751,764	$31,318
TOTAL				$878,992

* Subiect to Hawaii Excise Tax

6.0 OPANA POINT NDAI- ALTERNATIVE 1

NDAI is not an acceptable alternative based on the High OERIA Risk Level. Additionally, there is no action and therefore no cost associated with implementation of this alternative.

7.0 OPANA POINT INSTITUTIONAL CONTROLS (IC) - ALTERNATIVE 2

The estimated cost to implement Alternative 2 is $8,501. The project is estimated to last approximately three weeks. Institutional-Control (IC) cost estimates include development, publication of informational fact sheet for distribution to local residents, and one public information meeting. The cost estimate is based on the following assumptions.

- The project design will be conducted by a Task Manager and is estimated to take approximately 40 man-hours (24 for development of educational materials and 16 for meeting support).
- The project implementation will be conducted by a Task Manager and is estimated to take approximately 40 man-hours for publication of educational material and conducting a public meeting.
- A Project Manager will provide approximately eight man-hours of project oversight.
- Mobilization, demobilization and subsistence costs include;
    - Public Meeting – One airfare, three days of a rental vehicle with fuel, two nights at a hotel for one person and an estimated 2.5 per diem allowances (two 75% travel days and one full day) for the Task Manager.
- Estimated annual cost for reprinting of 500 copies of educational material for distribution is $1,000.

TABLE 4 OPANA POINT INSTITUTIONAL CONTROLS - ALTERNATIVE 2

Item	Unit	Rate	Quantity	Cost
Project Design (Task Manager)	Man-hours	$55.40	40	$2,216
Project Implementation (Task Manager)*	Man-hours	$55.40	40	$2,216
Project Oversight (Project Manager)	Man-hours	$81.10	8	$ 649
Contract Manager	Man-hours	$76.57	4	$ 306
Airfare	Round trip	$1,200.00	1	$1,200
Rental Vehicle*	Day	$69.25	3	$ 208
Hotel Stay*	Day	$159.00	2	$ 318
Per Diem*	Day	$89.00	2.5	$ 223
Production of Informational Brochures*	Each	$2.00	500	$1,000
Hawaii Excise Tax		4.166%	$3,965	$ 165
TOTAL				$8,501

* Subject to Hawaii Excise Tax

8.0 OPANA POINT SURFACE CLEARANCE IN 90 ACRES - ALTERNATIVE 3

8.1 The estimated capital cost to implement Alternative 3 is $222,248. The project is estimated to last approximately two weeks, based on an average of 9 acres per day, four 10-hour days a week. Institutional-control cost estimates include production of educational materials and a public meeting, as detailed above. A Senior UXO Supervisor will supervise a five-man UXO team during the surface clearance activities. The cost estimate is based on the following assumptions.

- Institutional control costs (Alternative 2) are included in this alternative.
- The project design will be conducted by a Task Manager and is estimated to take approximately 60 man-hours.
- The project implementation will be conducted by a Task Manager and is estimated to take approximately 40 man-hours.
- A Project Manager will provide approximately 16 man-hours of project oversight.
- A Contracts Manager will use approximately 12 man-hours to generate any necessary contractual agreements.
- A UXO Safety Officer will support site work using an estimated 96 man-hours, which includes two 8-hour travel days and approximately eight 10-hour workdays.
- A Senior UXO Supervisor will supervise a five-man UXO team (one UXO Supervisor and four UXO Tech II) while conducting the surface clearance. Each person is estimated at 96 hours including two 8-hour travel days and eight 10-hour workdays.
- For estimation purposes, a local explosives distributor will make a one-time explosives-delivery so that UXO items discovered during the clearance can be destroyed.
- Mobilization, demobilization and subsistence costs include;
    - Initial Site Visit – two airfares, three days of a rental vehicle with fuel, two nights at a hotel for two people and an estimated five per diem allowances (two 75% travel days and one full day) for the Task Manager and the UXO Safety Officer.
    - Fieldwork – seven airfares, 22 days of a rental vehicle with fuel (two SUVs for 11 days), 84 nights at a hotel (12 nights for seven men) and an estimated 80.5 per diem allowances (two 75% travel days and 10 full days for the UXO Safety Officer and the six-member UXO project team).
- Field equipment includes a digital camera ($400), three hand-held EM metal detectors (at a cost of $10 each week for two weeks), three hand-held radios (at $200 each) and miscellaneous hand tools ($150).
- Brush clearing/thinning and grass mowing over approximately 90 acres will be required.
- A Task Manager will require approximately 40 hours to generate a project report at the conclusion of the site work and the Project Manger will require four hours for review.

TABLE 5 SURFACE CLEARANCE IN 90 ACRES - ALTERNATIVE 3

Item	Unit	Rate	Quantity	Cost
Institutional Controls	Lump sum	$8,501.00	1	$8,501
Project Design (Task Manager)	Man-hours	$55.40	60	$3,324
Project Implementation (Task Manager)*	Man-hours	$55.40	40	$2,216
Project Oversight (Project Manager)	Man-hours	$81.10	16	$1,298
Contracts Manager	Man-hours	$76.57	12	$ 919
UXO Safety Officer	Man-hours	$43.77	16	$ 700
UXO Safety Officer (4% differential)*	Man-hours	$45.52	80	$3,642
Senior UXO Supervisor	Man-hours	$46.24	16	$ 740
Senior UXO Supervisor (8% Differential)*	Man-hours	$49.94	80	$3,995
UXO Supervisor	Man-hours	$41.18	16	$ 659
UXO Supervisor (8% Differential)*	Man-hours	$44.47	80	$3,558
4 - UXO Technician II	Man-hours	$36.12	64	$2,312
4 - UXO Technician II (8% Differential)*	Man-hours	$39.01	320	$12,483
Brush Clearing*	Per acre	$1,500.00	90	$135,000
Airfare	Round trip	$1,200.00	9	$10,800
Rental Vehicles*	Day	$69.25	25	$1,731
Hotel Stay*	Day	$159.00	88	$13,992
Per Diem*	Day	$89.00	85.5	$7,610
One-time Explosives Delivery*	Each	$1,000.00	1	$1,000
Equipment and Supplies*	Lump sum	$1,210.00	1	$1,210
Project Report (Task Manager)	Man-hours	$55.40	40	$2,216
Project Report Review (Project Manager)	Man-hours	$81.10	4	$ 324
Hawaii Excise Tax		4.166%	$186,437	$7,767
TOTAL				$222,248

* Subject to Hawaii Excise Tax

9.0 CLEARANCE TO DEPTH IN 90 ACRES - ALTERNATIVE 4

9.1 The estimated capital cost to implement the clearance to depth alternative is $551,294. The project is estimated to last approximately 12.5 weeks consisting of four 10-hour days a week, based on geophysical mapping and removing an estimated 4,438 targets. A Senior UXO Supervisor will supervise two five-man UXO teams during the clearance-to-depth activities. The cost estimate is based on the following assumptions.

- The project design will be conducted by a Task Manager and is estimated to take approximately 80 man-hours.
- The project implementation will be conducted by a Task Manager and is estimated to take approximately 80 man-hours.

- A Project Manager will provide approximately 40 man-hours of project oversight.
- A Contracts Manager will use approximately 8 man-hours to generate any necessary contractual agreements.
- Three two-man geophysical teams will mobilize all geophysical equipment to the site, including EM-61s, all-terrain vehicles (ATV), Trimble Real-Time Kinematic GPS systems and necessary support equipment.
- Three two-man geophysical teams will collect data over the entire 90-acre area using grid methodology at a rate of 12 acres a day for 8 10-hour days. Unit cost is based on a similarly scoped project on the Island of Oahu. Rate includes per diem and travel expenses.
- Geophysical data will be processed and interpreted offsite by a Project Geophysicist and a geophysical team at a rate of 15 acres a day for six 10-hour days. Unit cost is based on a similarly scoped project on the Island of Oahu.
- An estimated 4,438 targets will be reacquired using GPS equipment by the three two-man geophysical teams at a rate of 150 anomalies per day per two-man team for ten 10-hour days. Unit cost is based on a similarly scoped project on the Island of Oahu.
- A UXO Safety Officer will support site work using an estimated 496 man-hours, which includes two 8-hour travel days, approximately 18 10-hour workdays (geophysical data collection and anomaly reacquisition), and approximately 30 10-hour workdays for removal activities.
- A Senior UXO Supervisor will supervise two five-man UXO teams (one UXO Supervisor and four UXO Technician II) while conducting the subsurface clearance. Each person is estimated at 316 man-hours, which includes two 8-hour travel days and approximately 30 10-hour workdays (4,438 targets at a rate of 150 per day).
- A local explosives distributor will make eight weekly explosives-deliveries to the site so that any UXO items discovered during the surface clearance can be destroyed.
- Mobilization, demobilization and subsistence costs include;
    - Initial Site Visit – two airfares, three days of a rental vehicle with fuel, two nights at a hotel for two people and an estimated five per diem allowances (two 75% travel days and one full day) for the Task Manager and the SUXOS.
    - Fieldwork – twelve airfares, 120 days of a rental vehicle with fuel (four SUVs for 30 days), 360 nights at a hotel (30 nights for twelve men) and an estimated 378 per diem allowances (two 75% travel days and 30 full days for the UXO Safety Officer, SUXOS, and the two five-member UXO teams).
    - Site Meetings – one airfare, three days of a rental vehicle with fuel, two nights at a hotel for one person and an estimated five per diem allowances (two 75% travel days and one full day per trip) for the Task Manager for each of two meetings.

- Field equipment includes a digital camera ($400), three hand-held metal detectors (at $10/each per week for nine weeks), three hand-held radios (at $200 each) and other small miscellaneous hand tools and equipment ($150).
- Brush clearing/thinning and grass mowing over approximately 90 acres will be required.
- A Task Manager will require approximately 80 hours to generate a project report at the conclusion of the site work and the Project Manager will require approximately eight hours for review of the project report.

TABLE 6 CLEARANCE TO DEPTH IN 90 ACRES - ALTERNATIVE 4

Item	Unit	Rate	Quantity	Cost
Project Design (Task Manager)	Man-hours	$55.40	80	$4,432
Project Implementation (Task Manager)*	Man-hours	$55.40	80	$4,432
Project Oversight (Project Manager)	Man-hours	$81.10	40	$3,244
Contracts Manager	Man-hours	$76.57	8	$ 613
Geophysical Mobilization/Demobilization	Lump sum	$12,060	1	$12,060
Geophysical Data Collection (EM-61)*	Weeks	$26,475.00	2	$52,950
Geophysical Data Interpretation	Weeks	$12,675.00	1.5	$19,013
Anomaly Reacquisition*	Weeks	$26,475.00	2.5	$66,188
UXO Safety Officer	Man-hours	43.77	16	$ 700
UXO Safety Officer (4% differential)*	Man-hours	$45.52	480	$21,850
Senior UXO Supervisor	Man-hours	$46.24	16	$ 740
Senior UXO Supervisor (8% differential)*	Man-hours	$49.94	300	$14,982
UXO Supervisor	Man-hours	$41.52	16	$ 664
UXO Supervisor (8% differential)*	Man-hours	$44.84	300	$13,452
4 - UXO Technician II	Man-hours	$36.12	64	$2,312
4 - UXO Technician II (8% differential)*	Man-hours	$39.01	1,200	$46,812
Brush Clearing*	Per acre	$1,500	90	$135,000
Airfare	Round trip	$1,200.00	16	$19,200
Rental Vehicles*	Day	$69.25	129	$8,933
Hotel Stay*	Day	$159.00	368	$58,512
Per Diem*	Day	$89.00	393	$34,977
Explosives Delivery*	Each	$1,000.00	8	$8,000
Equipment and Supplies*	Lump sum	$1,420.00	1	$1,420
Project Report (Task Manager)	Man-hours	$55.40	80	$4,432
Project Report Review (Project Manager)	Man-hours	$81.10	8	$ 649
Hawaii Excise Tax		4.166%	$467,508	$19,476
TOTAL				$551,294

* Subject to Hawaii Excise Tax

Makawao 100-acre Density calculations for Costs Analysis

Targets per Acre

relocated targets fell within the boundary of the 100-acre area from 8.22 acres sampled during the EE/CA.

183 / 8.22 = 22 targets per acre

22 * 100 = **2,200** targets per 100 acres

OE per Acre

24 OE items were recovered from intrusive investigations within the 100-acre area (paragraphs 4.5.3.1 and 4.5.3.1.4 of the EE/CA)

24 / 193 = 0.1244

0.1244 * 2,200 = **274** OE per 100 acres

Opana Point Density calculations for Costs Analysis (90 acres)

Targets per Acre

498 located targets from 10.1 acres sampled during the EE/CA.

498 / 10.1= 49.3 targets per acre

49.3 * 90 = **4,438** targets per 90-acre

OE per Acre

146 OE items were recovered from 322 intrusive investigations (paragraph 4.5.4.1.4 of the EE/CA)

146 / 322 = 0.4534

0.4534 * 4,438 = **2,012** OE over 90 acres

APPENDIX E

SUMMARY OF INTERVIEWS CONDUCTED IN SUPPORT OF THE INSTITUTIONAL ANALYSIS

(will be included at a later time)

APPENDIX F

OE SCRAP TURN-IN DOCUMENTATION
AND
SUMMARY OF DEMOLITION MATERIALS UTILIZED ON-SITE

Summary of Demolition Materials Utilized On-site
Makawao Gunnery Site
And
Opana Point Bombing Range

1.0 Week ending 9/20/02

Demolition operations conducted on Tuesday, consumed 3 boosters, 25 ft. Det cord, 4 electric caps. Disposed of one 60mm mortar, excess explosives were on hand for MK23 and MK5 practice bombs which might be live after checking all 23 none were live.

Awaiting decision on going to Makawao on continuing at Opana Point.

2.0 Week ending 9/27/02

Explosives expended this week are: 8 1lbs. Boosters, 8 electric blasting caps, and 401 ft. of detonating cord. Two personnel departed site this loss will reduce the work force.

3.0 Week ending 10/10/02

Demolition operations were carried out on the 9th, disposing of the 60mm HE mortar. All scrap OES was inspected and certified. The scrap was turned over to Maui Scrap Metal Co. Explosives consumed were, 2 1lbs. Boosters, 4 Electric Blasting Caps, and 10 ft. of Detonating Cord.

APPENDIX G

RESPONSIVENESS SUMMARY

(comments will be included at a later time)