DRAFT-FINAL

REMEDIAL INVESTIGATION REPORT

PALI TRAINING CAMP
OAHU, HAWAII

FUDS Project Number H09HI027701
Contract: W912DY-10-D-0053
Task Order: 0003

Prepared for:

United States Army Corps of Engineering, Honolulu District

and

United States Army Engineering and Support Center, Huntsville

by:
Huikala, LLC
3375 Koapaka St., STE F200
Honolulu, HI 96819

June 2014
Revision 2

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Reviewed by:

Richard E. Whipple
2014.06.23 13:58:27 -10'00'

Richard Whipple, Corporate and Program Quality Control Manager

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Acronyms and Abbreviations

ags	above ground surface
AMP	Archaeological Monitoring Plan
AP	armor piercing
APCT	armor piercing capped tracer
APT	armor piercing tracer
ARAR	applicable or relevant and appropriate requirements
bgs	below ground surface
BTV	background threshold value
CEPOH	United States Army Corps of Engineers, Honolulu District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	contaminant of potential concern
CSM	conceptual site model
DA	Department of Army
DD	Decision Document
DDESB	Department of Defense Explosives Safety Board
DERP	Defense Environmental Restoration Program
DGM	digital geophysical mapping
DID	data item description
DLNR	State of Hawaii Department of Land and Natural Resources
DMM	discarded military munitions
DNB	dinitrobenzene
DNT	dinitrotoluene
DoD	Department of Defense, United States
DQO	data quality objective
DU	decision units
EAL	environmental action level
edd	electronic data deliverable
EE/CA	engineering evaluation/cost analysis
EP	Engineer Pamphlet
EPA	Environmental Protection Agency, United States
ESP	Explosives Siting Plan
ESQD	explosive safety quantity distance

Acronyms and Abbreviations (continued)

°F	degrees Fahrenheit
FCR	field change request
FS	feasibility study
FUDS	Formerly Used Defense Sites
FUDSMIS	Formerly Used Defense Sites Management Information Systems
GIS	geographic information system
GPS	global positioning system
HA	hazard assessment
HARC	Hawaii Agricultural Research Center
HBMP	Hawaii Biodiversity & Mapping Program
HDOH	State of Hawaii Department of Health
HE	high explosives
HEAT	high explosive anti-tank
HEER	Hazard Evaluation and Emergency Response
HMX	cyclotetramethylenetetranitramine
IAW	in accordance with
IC	institutional controls
ID	identification
INPR	Inventory Project Report
ISM	incremental sample methodology
ISO	industry standard objects
IVS	instrument verification strip
jpg	joint photographic experts group
kg	kilogram
LCS	laboratory control samples
MC	munitions constituent
MD	munitions debris
MDAS	material documented as safe
mdb	personal geodatabase
MDT	Maunawili Demonstration Trail
MEC	munitions and explosives of concern
MFT	Maunawili Falls Trail

Acronyms and Abbreviations (continued)

mg	milligram
mm	millimeter
MPPEH	material potentially presenting an explosive hazard
MRA	munitions response area
MRS	munitions response site
MRSPP	Munitions Response Site Prioritization Protocol
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean sea level
MTC	Maunawili Training Course
MVIA	Maunawili Valley Impact Area
MVTC	Makalii Valley Training Course
NG	nitroglycerin
NT	nitrotoluene
OESS	Ordnance and Explosives Safety Specialist
pdf	portable document format
PDSQ	Point Detonating Super Quick
PDT	project delivery team
PETN	pentaerythritol tetranitrate
PP	Proposed Plan
PRG	preliminary remediation goal
PTC	Pali Training Camp
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RDX	research development explosive (cyclotrimethylenetrinitramine)
RI	remedial investigation
ROE	right-of-entry
RPD	relative percent difference
RSD	relative standard deviation
SDG	sample delivery group
SEDD	staged electronic data deliverable

Acronyms and Abbreviations (continued)

shp	shapefiles
SI	site investigation
SU	sampling unit
SW	solid waste
T&E	threatened and endangered
TBC	to be considered
Tetryl	2,4,6-Trinitrophenylmethylnitramine
TGM	Technical Guidance Manual
TNB	trinitrobenzene
TNT	2,4,6-trinitrotoluene
TO	task order
TPP	Technical Project Planning
TSQ	Time Super Quick
UFP-QAPP	Uniform Federal Policy – Quality Assurance Project Plan
USACE	United States Army Corps of Engineers
USAESCH	United States Army Engineering and Support Center, Huntsville
USC	United States Code
UTC	Ulumawao Training Course
UTL	upper tolerance limits
UXO	unexploded ordnance
UXOQCS	UXO Quality Control Specialist
VSP	Visual Sample Plan
WERS	Worldwide Environmental Remediation Services
WP	Work Plan

1.0 Executive Summary

1.0.1 This report describes the results of a Remedial Investigation (RI) conducted by Huikala, LLC (Huikala) between July and October 2013 and February and March 2014 at the Formerly Used Defense Sites (FUDS) Property Number H09HI0277, also known as the former Pali Training Camp (PTC), Oahu, Hawaii. The former PTC was included in the Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS) based on its use as regimental combat training center between 1943 and 1945, emphasizing the use of and familiarity with modern arms and field weapons, in addition to providing rugged terrain for jungle and ranger training.

1.0.2 The FUDS property consists of four non-contiguous parcels located in portions of the Maunawili and Makalii Valleys: Maunawili Valley Impact Area (MVIA), Maunawili Training Course (MTC), Makalii Valley Training Course (MVTC), and Ulumawao Training Course (UTC). Each parcel is considered a munitions response area (MRA). Each MRA contains one munition response site (MRS). The former PTC, as currently reported in the Formerly Used Defense Sites Management Information System (FUDSMIS), consists of the four MRSs totaling 4,378 acres[1]. Refer to Appendix A, Figure A1-1 for the site location map. Field investigation was performed in the MVIA MRS only.

1.0.3 The objective of this RI is to characterize the nature and extent of munitions and explosives of concern (MEC), munitions debris (MD), and munitions constituents (MC) within each MRS and to assess the associated risks to human health and the environment.

1.0.4 This RI Report is an independent document. A follow-on Feasibility Study (FS) will be prepared to evaluate potential future courses of action for each MRS.

1.1 Maunawili Valley Impact Area MRS

1.1.1 Technical Approach

1.1.1.1 The MEC investigation technical approach was designed to collect sufficient surface and subsurface anomaly data along pre-determined transects in accessible areas (defined as less than 18 degrees slope). Visual Sample Plan (VSP) software was used to determine the number of transects and transect spacing required to characterize the nature and extent of MEC contamination (areas where MEC was found). The transect design optimized the determination of MEC density and the limits of MEC contamination to ensure a 90% confidence level of traversing and detecting a potential impact area with a 500-foot radius by collecting data along transects spaced 350 feet apart (Appendix M).

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[1] *Site acreage calculated with Geographical Information System (GIS) is 3,666 acres. The acreages reported in this document and on maps are based on GIS-calculated acreages, unless otherwise noted.*

1.1.1.2 UXO Estimator software was used to determine the minimal acreage required for investigation, outside of an impact or MEC contamination, to demonstrate with at least a 90% confidence that the concentration of unexploded ordnance (UXO) did not exceed the applicable land-use threshold. For the MVIA, the entire MRS was determined to be “low use” based on the types of activities occurring in the MRS (recreational, agricultural, undeveloped forest). As a result, UXO Estimator determined that 4.59 acres outside of the potential impact or MEC-contaminated areas required investigation to ensure that the concentration of UXO did not exceed the low-use threshold of 0.5 UXO per acre. Refer to Appendix M for the UXO Estimator report.

1.1.2 MEC Investigation and Data Analysis

1.1.2.1 Approximately 36.11 miles (14.36 acres) of parallel and meandering 1-meter wide transects and an additional 10.30 miles (8.45 acres) of public trails transects were investigated using hand-held all-metals detectors and implementing a “mag and dig” approach. The final transect map is provided in Appendix A, Figure 4-3. All anomalies were investigated. Seven MEC items were found in the western portion of the MRS. A total of 1,346 MD items were found in the western and central portions of the MRS, with the majority in the west. Additionally, seven new munition types were identified. No MEC or MD items were found in the portion of the MRS east of the Aniani Nui/Olomana ridgeline. Appendix A, Figure 5-1 illustrates the location and types of MEC and MD findings.

1.1.2.2 Using the data collected from the transects, VSP software was applied to confirm that sufficient data had been collected to demonstrate that the simulated probability of traversing and detecting a 500-foot radius circular impact area with at least a 90% confidence level had been achieved in accessible areas. The seven new munition types identified during the field investigation were similar in nature to previously identified types or have a target radius of at least 500 feet. The original VSP transect design was valid. Refer to Appendix M for the VSP coverage analysis.

1.1.2.3 VSP also analyzed the transect data to estimate anomaly density in the accessible areas within the MRS. Anomaly density is characterized as either high density or elevated density. For this project, high density is defined as MEC/MD density greater than 100 anomalies per acre total density (which is at least 50 anomalies per acre greater than the selected background density of 50 anomalies per acre). Elevated density is defined as MEC/MD density above the background density of 50 anomalies per acre. VSP identified four areas of high density in the western portion of the MRS. Eight areas of elevated density were identified in the central and western regions. MEC-contamination was present in three of the VSP high density or elevated density areas. Approximately 4.57 acres of grids were then placed in or around elevated density, high density, or MEC-contaminated areas. Grids ranged in size from 0.1 acres to 0.4 acres. The grids were used to delineate the extent of possible contamination and to define the nature of

MEC-contamination potentially at the site. The grids were investigated using the same approach as the transect investigation. No additional MEC items were found in the grids.

1.1.2.4 Using the results of the VSP density analysis, the transect/grid data, and data from previous investigations, the section of the MVIA to the west and south of Pikoaka Spring (closest stream east of the spring is unnamed) is confirmed to be an impact area. The data also indicates that there may be a smaller target area, within the impact area and near Maunawili Falls, used for 81-millimeter (mm) mortars and 37-mm projectiles.

1.1.2.5 Additionally, the investigation demonstrated, with at least a 90% confidence level, that low-use areas outside of MEC-contamination had an UXO concentration below a threshold of 0.5 UXO per acre. This was achieved by investigating over 19.50 acres of transects and 1.04 acres of grids outside of MEC-contaminated and high density areas without locating any additional MEC items, satisfying the UXO Estimator software minimum requirement of 4.59 acres.

1.1.3 MC Investigation and Data Analysis

1.1.3.1 Fourteen sample units (SU) were placed in areas with high concentrations of MEC or MD (Appendix A, Figure 4-4). Forty-two surface soil samples were collected and analyzed for MCs (metals [antimony, chromium, copper, lead, and zinc] and explosive compounds). The analytical results were compared to the State of Hawaii Department of Health (HDOH) Tier 1 environmental action levels (EALs). Four or more metals were detected in all samples though below their respective HDOH Tier 1 EALs. Explosives were also detected in surface soil but at concentrations below their respective HDOH Tier 1 EALs.

1.1.3.2 Eighteen background surface soil samples were also collected from areas in the MRS that appeared to have been minimally impacted by military use. Site-specific background threshold values (BTVs) for metals (antimony, chromium, copper, lead, and zinc) were developed. The surface soil analytical results were then compared to the BTVs. In general, the comparison indicates that the concentrations of metals do not exceed background values.

1.1.3.3 Risks to human health associated with MCs in surface soil do not exceed risk thresholds. Analytical results were below HDOH Tier 1 EALs and metals concentrations did not exceed background values.

1.1.4 Results

Based on the results of the transect/grid data analysis, site usage, historical information, and topographic and natural features, the MVIA MRS was divided into multiple sections to develop revised conceptual site models (CSM) and MEC Hazard Assessments (HA) and to evaluate remedial alternatives in the FS. The MRS is divided, along mountain ridgelines, into three sections: MVIA – West, MVIA – Central, and MVIA – East.

1.1.4.1 MVIA – West

1.1.4.1.1 Seven MEC items were found in MVIA – West during the RI and 26 MEC items were found in the same area during the 2012 Removal Action (Appendix A, Figure 5-2). Four of the MEC items found during the RI were located on or in the immediate vicinity of popular public hiking trails. Given the primary uses of MVIA – West are recreational and agricultural, there is a complete exposure pathway to human receptors through direct contact with surface and subsurface MEC. There is also a complete exposure pathway for occupational workers maintaining trails and utilities.

1.1.4.1.2 The potential explosive hazards from MEC were evaluated using the Environmental Protection Agency (EPA) MEC HA methodology (EPA, 2008c). The MEC HA performed for the MVIA – West baseline condition yielded a score of 925 which corresponds to Hazard Level 1. Hazard Level 1 sites contain the highest potential explosive hazard and there may be instances of surface MEC or intrusive activities that would encounter MEC in the subsurface.

1.1.4.2 MVIA – Central

1.1.4.2.1 Even though no MEC items were found in MVIA – Central during the RI or reported historically, the types of MD found, such as the 60-mm high explosive (HE) Mortar, M49A2, indicate that munitions with HE were used in the area and could be present in the southern portion of this section.

1.1.4.2.2 MVIA – Central is used primarily for recreational activities so there is a potentially complete exposure pathway to human receptors through direct contact with surface MEC. There is also a potentially complete exposure pathway to subsurface MEC for commercial/occupational workers maintaining recreational facilities, trails, and utilities.

1.1.4.2.3 A MEC HA was not completed for the MVIA – Central since there were no MEC items found or reported.

1.1.4.3 MVIA – East

No MEC or MD items were found in MVIA – East. There is no source of an explosive hazard and therefore, no complete exposure pathways to human receptors.

1.2 Maunawili Training Course MRS

Previous investigations resulted in identifying only small arms debris and evidence of troop maneuvering, such as foxholes and C-ration residue, in the MTC MRS. Additional field data collection was not possible during the RI because right-of-entry (ROE) privileges were not granted by the landowner. However, the southern boundary of this MRS is immediately adjacent to the northwestern boundary of the MVIA MRS (Appendix A, Figure A1-1). The northwestern area of the MVIA MRS had a high density of MD and one MEC discovery during the RI. Further evaluation of the MTC MRS is recommended if ROE can be acquired.

1.3 Makalii Valley Training Course MRS

RI field activities were not conducted in this MRS as agreed to and documented during the Technical Project Planning (TPP) process. MVTC is a suspected observation point rather than a firing point since neither MEC nor MD has been found during previous investigations. The only significant finding in this MRS was two large holes along the mountain ridge. Their locations suggest that they were used as observation points and are not impact craters, given their vantage point of viewing the MVIA. The lack of MEC and MD indicates there is no source of an explosive hazard and no complete pathways to human and ecological receptors. Therefore no known MEC hazards or MC risks are suspected.

1.4 Ulumawao Training Course MRS

RI field activities were not conducted in this MRS as agreed to and documented during the TPP process. The area is documented as an encampment or cantonment and ordnance use is not suspected based on historical records and anecdotal evidence. No MEC or MD have been observed in the MRS during previous investigations or land development activities, indicating no complete pathways to human and ecological receptors. As a result, no known MEC hazards or MC risks are suspected.

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2.0 Introduction

2.0.1 This RI report has been prepared by Huikala, LLC (herein referred to as "Huikala" or the "Contractor") for the United States Army Corps of Engineers (USACE), Honolulu District (CEPOH) and the United States Army Engineering and Support Center, Huntsville (USAESCH) under Contract No. W912DY-10-D-0053 Task Order (TO) 0003. This RI Report was developed in accordance with (IAW) Data Item Description (DID) Worldwide Environmental Remediation Services (WERS) – 010.02 and Engineer Pamphlet (EP) 1110-1-18.

2.0.2 The activities outlined herein are in support of the Military Munitions Response Program at the former PTC. The activities described were conducted IAW: (1) the performance work statement entitled "Remedial Investigation/Feasibility Study, Pali Training Camp, Property No.: H09HI0277, Koolaupoko District, Oahu, Hawaii" dated 19 October 2010; (2) the Final RI Work Plan (WP) dated July 2013; and (3) the Technical Project Planning process.

2.1 Task Order Purpose and Scope

2.1.1 The overall purpose of this TO is to achieve acceptance of a Decision Document (DD) in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Department of Defense (DoD), Department of Army (DA), and USACE regulations and guidance at the former PTC, Oahu, Hawaii FUDS Property No. H09HI0277. Remedial investigation activities were conducted from July to October 2013 and February to March 2014 in order to achieve this goal.

2.1.2 The objective of the RI is to gather sufficient data from the former PTC to adequately characterize the nature and extent of military munitions and munitions-related contamination present at the site in order to assess potential risks at the site. The data will be used during the FS to develop and evaluate effective remedial alternatives to address these risks.

2.1.3 The purpose of this RI Report is to present the results from the RI and previous investigations and to assess the potential risks to human health, safety, and the environment. Additionally, this report summarizes the cumulative characterization efforts within the MVIA, MVTC, and UTC MRSs and provides an assessment of risks associated with these MRSs. Characterization of the MTC MRS is inconclusive because no additional data could be gathered during the RI.

2.1.4 A FS and Proposed Plan (PP) will be prepared and submitted in order to support the development, evaluation, and selection of the appropriate munitions response alternative(s) to achieve acceptance of a DD.

2.2 RI Report Organization

2.2.1 This RI Report contains the requirements as specified in EP 1110-1-18 and DID WERS – 010.02 and is organized as follows:

Section 1.0 – Executive Summary
Section 2.0 – Introduction
Section 3.0 – Project Remedial Response Objectives
Section 4.0 – Characterization of MEC and MC
Section 5.0 – RI Results and Revised CSM
Section 6.0 – Contaminant Fate and Transport for MEC and MC
Section 7.0 – Hazard Assessment for MEC and Baseline Risk Assessment for MC
Section 8.0 – Summary and Conclusions
Section 9.0 – References

2.2.2 The following appendices are also provided:

Appendix A – Figures
Appendix B – Biological Monitoring Report
Appendix C – Sampling and Laboratory Data
Appendix D – Daily Field Reports
Appendix E – Field Logbooks
Appendix F – Photographic Log
Appendix G – GIS Data
Appendix H – Field Change Requests
Appendix I – MPPEH Tracking Log and DD Form 1348-1A
Appendix J – Transect and Grid Logs
Appendix K – QC Documentation
Appendix L – QA Documentation
Appendix M – Visual Sample Plan Report
Appendix N – MEC HA Worksheets

2.3 Property Description and Problem Identification

2.3.1 Project Location

2.3.1.1 The former PTC (also herein referred to as "FUDS property" or "site") is located at the base of the Koolau mountain range, near Kailua on the southeast side of the island of Oahu (Appendix A, Figure A1-1). The former PTC, as currently reported in the FUDSMIS, consists of four non-contiguous parcels, totaling 4,378 acres located in portions of the Maunawili and Makalii Valleys. Each parcel is considered a MRA containing one MRS[2].

2.3.1.2 MVIA (H09HI027701R01-1) is the largest MRS and encompasses approximately 3,432 acres in FUDSMIS (2,795 acres GIS) of Maunawili Valley and includes the Royal Hawaiian Golf Club (formerly Luana Hills Country Club) and the Maunawili Estates Subdivision. The MRS can be accessed by foot, bicycle, or horse via the Golf Club road or the Maunawili neighborhood. Vehicular traffic is controlled by the Golf Club guardhouse and a locked gate at the end of Maunawili Road. There are numerous public hiking trails throughout the site.

2.3.1.3 The MTC MRS (H09H1027702R02-2) encompasses approximately 400 acres in FUDSMIS (333 acres GIS). MTC is located on the western edge of the Maunawili Valley and south of the Pali Highway. It can be accessed through the Maunawili neighborhood or the St. Stephens Seminary property. A public hiking trail crosses the southern portion of the MRS.

2.3.1.4 The MVTC (also previously referred to as the Maunawili Stream Area) MRS (H09H1027703R03-3) is the smallest, encompassing approximately 46 acres in FUDSMIS (29 acres GIS). MVTC is located on the northern ridge of Mount Olomana. It can be accessed via a public hiking trailhead off of the Golf Club road. The trail runs up to and along a ridge that defines the MRS's eastern boundary.

2.3.1.5 The UTC MRS (H0H1027704R04-4) encompasses approximately 500 acres in FUDSMIS (509 acres GIS). UTC is located outside the Maunawili Valley, north of the Pali Highway. It can be accessed via the municipal Pali Golf Course, Hawaii Pacific University property, and the Hawaii State Veterans Cemetery.

2.3.2 Topography

These four MRSs are mostly undeveloped, rugged, and densely forested land with mixed residential, agricultural, occupational, and recreational uses. Each parcel contains shallow to deep gulches and moderate to steep slopes. The MVIA ranges in elevation from approximately 200 feet mean sea level (MSL) near the Golf Club to over 2,000 feet MSL at the Koolau range ridge line. MTC ranges in elevation from approximately 400 to 1,200 feet MSL. MVTC ranges in elevation from approximately 50 to 200 feet MSL. UTC ranges in elevation from approximately 250 to 1,000 feet MSL at Ulumawao peak (Zapata, 2008)

[2] *Site acreage calculated with GIS is 3,666 acres. The acreages reported in the document and on maps are based on GIS-calculated acreages, unless otherwise noted.*

2.3.3 Geology

2.3.3.1 The four non-contiguous MRSs include portions of Maunawili and Makalii Valleys. The rocks of the Koolau mountain range are comprised chiefly of thin basalt flows with small amounts of ash. The Koolau volcanic series is comprised of lavas and dikes lying outside Koolau caldera and are altered only rarely by hydrothermal action. These lavas were erupted from two main rift zones in Pliocene time and a third southwest rift zone passing through Diamond Head (Wil Chee, 2009).

2.3.3.2 Soil conditions within the former PTC vary from the steep terraced areas of the Koolau mountain range, to the uniform sloping areas at the base of the mountain range. Found on the steep sloping areas (45-55% slope) are soils of both the Waikane Silty Clay and Alaeloa Silty Clay series. Soils from the Waikane Silty Clay series are found on steep terraces and alluvial fans. The surface layer is dark brown silty clay approximately 8 inches thick. The subsoil is about 52 inches thick and is dark reddish brown silty clay. Runoff is medium to rapid, and the erosion hazard is moderate to severe. These soils are commonly found in pastures. Soils from the Alaeloa Silty Clay series are found in sloping areas of 45 to 55%. The surface layer is dark reddish brown silty clay approximately 10 inches thick. The subsoil, about 48 inches thick, is dark red and red silty clay. Runoff is rapid to very rapid and the erosion hazard is severe. These soils are commonly found in pastures and wildlife habitats (Wil Chee, 2009).

2.3.3.3 Soils found in the lower lying, uniformly sloping areas of the site are predominantly of the Kaneohe Silty Clay series. These soils are reddish and dark brown soils that formed in gravelly alluvium. Permeability is moderately rapid, runoff is slow to medium, and the erosion hazard is slight. These soils are commonly found in pastures and golf courses (Wil Chee, 2009).

2.3.4 Hydrology

The project site overlies the Waimanalo aquifer system (Windward Oahu Aquifer Sector), which extends from the ridgeline of the Koolau Mountains to the northeast facing shores of Oahu, and from Makapuu Point in the southeast to Kahuku Point in the northwest. An unconfined flank aquifer overlies a basal groundwater system. Water in the upper flank aquifer is currently used, ecologically important, has low salinity (between 250 and 1,000 milligram per liter chloride ion), is replaceable, and has a high vulnerability to contamination. The basal aquifer is currently used for drinking water, has very low salinity (less than 250 milligram per liter chloride ion), is replaceable, and has a low vulnerability to contamination (Mink and Lau, 1990).

2.3.5 Climate

Due to the location of the Hawaiian Islands in the northern tropics, Oahu's climate is mild and pleasant, primarily due to the presence of cooling trade winds. Average temperatures in the lowlands are approximately 72.5 degrees Fahrenheit (°F), with decreasing temperatures in higher elevations. Temperatures are coolest in January (59°F) and warmest in August (89°F). Relative humidity on Oahu ranges from 30 to 90% per month. The main mechanism for rainfall is warm, moist ocean air rising and cooling as it passes over the mountains causing precipitation. This results in higher rainfall in the windward and mountain areas, and little in the leeward and coastal zones. The climate at the site is warm with moderate rainfall. Approximate temperatures for the project area range from 60°F to 85°F year. Approximate median annual rainfall for the area is between 24 to 47 inches per year (Wil Chee, 2009).

2.3.6 Biological and Ecological Resources

2.3.6.1 Prior to the RI, previous biological surveys in the Maunawili area were reviewed to identify any known or suspected biological resources. Most of the area is dominated by introduced plant species; however three native tree species, (ohia lehua [*Metrosideros polymorpha* var. *glaberrima*], hala [*Pandanus tectorius*], and papala kepau [*Pisonia umbellifera*], and four endemic species (koa [Acacia koa], ohia lehua [*Metrosideros polymorpha* var. *incana*], uki [*Machaerina mariscoides* ssp. *Meyenii*], and hapu`u [*Cibotium chamissoi*]) have been observed. Additionally, data results from the Hawaii Biodiversity & Mapping Program (HBMP) were reviewed for rare species observations in the general area of the FUDS property. All four MRSs were included in the HBMP data request, as well as a buffer around the MRSs. Rare elements were not located in either the UTC or MVTC MRSs. The greatest density of rare plants was located outside of the MVIA, in the mauka (upland) sections of the Koolau Mountain range (Huikala, 2013a). The steep slopes at the higher elevations of the MRSs were excluded from the field investigation due to accessibility and safety concerns

2.3.6.2 A portion of Designated Critical Habitat for Oahu, Unit 5 has boundaries within the MVIA and MTC MRSs. The portion of the critical habitat unit that falls within the project area is designated for the Oahu `Elepaio (*Chasiempis sandwichensis ibidis*). Field work was conducted outside of `Elepaio nesting period. However, vegetation was inspected for any remaining nests or adults prior to removal (Huikala, 2013a).

2.3.6.3 RI field activities were conducted only within the MVIA MRS. No threatened or endangered plant species were observed during the RI. Generally, the MRS is dominated by non-native or invasive species. The few native plant species observed were located in the higher elevations of the MRS. Native plant species observed included `ulei (*Osteomeles anthyllidifolia*), pala`a fern (*Odontosoria chinesis*), `ekaha or birds nest fern (*Asplenium nidus*), uluhe (*Dicranopteris linearis*), uluhe (*Dicranopteris linearis*), ohi`a lehua (*Metrosideros polymorpha*), hala, and tree ferns or hapu`u (*Cibotium chamissoi*), ama (*Diospyros sandwicensis),* papala kepau (*Pisonia umbellifera*), and koa (*Acacia koa*).

2.3.6.4 No threatened or endangered animal species were observed during the RI. One migratory shorebird, the Pacific Golden-Plover or Kolea (*Pluvialis fulva*) was observed in open lawns and agriculture fields. While the Kolea is not a threatened or endangered species, they are protected by Federal law under the Migratory Bird Treaty Act and by State law under Hawaii Administrative Rules Title 13 Chapter 124.

2.3.6.5 Additional information is provided in Appendix B, Biological Monitoring Report.

2.3.7 Cultural Resources

2.3.7.1 An Archaeological Monitoring Plan (AMP) was prepared prior to RI activities. The AMP identified multiple archaeological features and areas of cultural significance within the FUDS property. Field activities were planned and conducted to avoid impact to these features and areas. During the course of the RI, the CEPOH archaeologist identified an additional twenty-nine features that were not previously recorded. Activities were modified as necessary to avoid these features as well, IAW the AMP (Cultural Surveys Hawaii, 2013).

2.3.7.2 Additional information is provided in a separate report prepared by CEPOH.

2.3.8 Current and Future Land Use

2.3.8.1 Maunawili Valley Impact Area

2.3.8.1.1 The State of Hawaii owns and manages the majority of the land within the MRS boundary. The land is zoned as Preservation and is primarily undeveloped with rugged terrain. Portions of the State of Hawaii owned land are used for recreational activities such as hiking, biking, or horseback riding. There are approximately 10 miles of well-used public trails that pass through the MRS. State of Hawaii Department of Land and Natural Resources (DLNR) workers perform periodic maintenance on the various trails.

2.3.8.1.2 The Royal Hawaiian Golf Club operates on approximately 40 acres in the central portion of the MRS. Extensive agricultural activities are conducted in the western portion of the MRS by the Hawaii Agriculture Research Center (HARC) and Luluku Banana Farmers. The Golf Club, HARC, and the Luluku Banana Farmers properties all contain man-made structures.

2.3.8.1.3 Occasionally, occupational workers from public utilities require access to the MRS to perform maintenance on power line infrastructure that runs along mountain ridgelines or on irrigation water lines/ditches/tunnel that are found throughout the MRS.

2.3.8.1.4 There is currently a residential subdivision being developed near the northeastern boundary of the MRS (Appendix A, Figure A1-1). Thirteen subdivision parcels overlap or are located within the MRS boundary. Although development activities at the subdivision precluded inclusion in the RI, the private developer hired their own UXO consultants and reported finding no evidence of munitions.

2.3.8.1.5 The future use of this MRS is not expected to change.

2.3.8.2 Maunawili Training Course

MTC is owned by private landowners with a small section in the south/southwest corner owned by the State of Hawaii. One end of the Maunawili Demonstration Trail (MDT) is located in this section. Most of the MRS is undeveloped. St. Stephan's Seminary partially overlaps the boundaries of the MRS. The future use of MTC is not expected to change.

2.3.8.3 Makalii Valley Training Course

The MVTC MRS is privately owned and primarily undeveloped. The access road to the Royal Hawaiian Golf Club transects the MRS. Additionally, portions of the Olomana Trail are within the MRS boundary. The future use of this MRS is not expected to change.

2.3.8.4 Ulumawao Training Course

The UTC MRS is primarily owned by private landowners. Hawaii Pacific University and Le Jardin Academy are educational facilities located within the UTC MRS. The Hawaiian Memorial Park, Hawaii State Veterans Cemetery, and Ameron Quarry are commercial enterprises that are partially located in the MRS. The City and County of Honolulu operates the municipal Pali Golf Course in the western portion of the MRS. The future use of UTC is not expected to change.

2.3.9 Problem Identification

2.3.9.1 MEC Hazards and MC Risk

2.3.9.1.1 The former PTC was used as a regimental combat training center in the 1940s, emphasizing the use of and familiarity with modern arms and field weapons. Previous investigations have resulted in the discovery of MEC (60-mm mortar, 37-mm projectile, 75-mm shrapnel projectile, fuzes, 57-mm projectile, 2.36-inch rocket motor, 81-mm mortar), MD (75-mm shrapnel, 37-mm projectiles), and small arms (20-mm ball cartridges, other). An explosive hazard exists at the site.

2.3.9.1.2 Due to the presence of MEC and MD, MC contamination may also exist.

2.3.9.2 Potential Receptors

Based on the preliminary CSM, potential receptors that could be exposed to MEC and/or MC hazards include residents, construction/agricultural/commercial/industrial workers, visitors/recreational users, and ecological receptors (ground-dwelling animals, birds, and plants).

2.4 Historical Information

2.4.1 Historic Use

2.4.1.1 The former PTC was established in 1943 as a regimental combat training center emphasizing the use of and familiarity with modern arms and field weapons, in addition to providing rugged terrain for jungle and ranger training. Troops were housed in a sprawling tent city at the base of Nuuanu Pali capable of supporting 3,000 to 5,000 individuals. In addition to barracks, the encampments also contained latrines, showers, mess halls, administration buildings, and motor pools. Additional barracks, an ice plant, a bakery, and gun pits were situated within MVTC. A field hospital was erected where Maunawili Park now resides. Although records indicate a list of these uses/structures, their specific locations are unknown. Camp training aids consisted of 200- and 300-yard rifle ranges, a 1,000-inch range, four obstacle courses, an infiltration course, a combat in cities course, a close combat course, and a 400-yard long jungle firing course. An artillery impact area was also established in the rear of Maunawili Valley (USACE, 1994).

2.4.1.2 On 8 October 1945, G-3 Headquarters ordered the release of the PTC. The encampment was abandoned by the end of 1945. By the end of 1946, military-erected structures at PTC were subsequently sold as surplus by bid sale. Although the PTC's impact area was reportedly cleared of ordnance by the 212th ordnance disposal squad and the 18th engineer search team prior to property disposal in 1945, a warning to the public was issued in June 1948 by the Commanding Officer of Army Ordnance Services. The impact area in Maunawili Valley was one of several sites in which the public was advised to exercise caution when entering the area due to the potential presence of dud ordnance rounds (USACE, 1994).

2.4.1.3 Valley residents report that artillery rounds were fired into Maunawili Valley from firing points at the mouth of the valley or from other locations within Kailua. A ranch manager reported a "155-mm round" in the Maunawili Valley and a few claims have been made by local residents about finding duds and .30-caliber blanks. It is also reported by local residents that mortar rounds and machine gun bullets were frequently turned over in plowed fields. As of 1994, no anecdotal reports of material potentially presenting an explosive hazard (MPPEH) in Maunawili or Makalii Valleys have been substantiated (USACE, 1994). In March 2002, a worker on a movie set within the MVIA reported that a 20-mm projectile was found (Zapata, 2008).

2.4.1.4 There are anecdotal reports that sections of Makalii Valley were utilized as firing points (USACE, 1994).

2.5 Previous Investigations

2.5.1 1994 Inventory Project Report

2.5.1.1 The 1994 Inventory Project Report (INPR) established the former PTC as an eligible property under the FUDS program. The INPR also established the acreage, preliminary site boundaries, and summarized the historic military usage and investigations at the former training area.

2.5.1.2 The INPR identified munitions historically detected that included: 75-mm HE projectile; 60-mm HE mortar, a 37-mm HE projectile, 2.36- and 3.5-inch high explosive anti-tank (HEAT) rockets.

2.5.2 2008 Engineering Evaluation/Cost Analysis

2.5.2.1 During the 2008 Engineering Evaluation/Cost Analysis (EE/CA), digital geophysical mapping (DGM) was conducted within grids over six areas totaling 5.7 acres in the MVIA. A visual and surface sweep reconnaissance was conducted within the MVIA, the MTC, and the MVTC. Approximately 26.3 acres were covered during reconnaissance, which included hiking trails and meandering paths (Appendix A, Figure A2-1). Prior to conducting the DGM field work, a Geophysical Prove-out was conducted at the Luana Hills Country Club (currently known as the Royal Hawaiian Golf Club) in March 2002 to establish the methods, equipment, and procedures best suited to the site (Zapata, 2008).

2.5.2.2 No MEC items were found during the EE/CA investigation in the MVIA. However, 103 MD items were found including 75-mm HE, 75-mm shrapnel, and 37-mm projectiles. A new impact area was defined based on the results of the reconnaissance and the intrusive investigation. The majority of the MD was found in a bowl-shaped section of the Maunawili Valley that backs up to the Koolau Mountain Range on the west and is topographically exposed to the east. The northern and southern extents of the impact area are defined by finger ridges that extend eastward from the Koolau Range. Refer to Appendix A, Figure A2-2 (Zapata, 2008).

2.5.2.3 No MEC or MD items indicative of HE use were found within the MTC. However, evidence of troop maneuvering was found that included foxholes, small arms debris, and C-ration residue. Refer to Appendix A, Figure A2-3 (Zapata, 2008).

2.5.2.4 No MEC or MD items were found within the MVTC. Two large holes were discovered that may have been observation points to view impacts from firing into the MVIA. They are suspected to be observation points rather than impact craters given their location relative to the suspected firing point in the valley below and their vantage point of the MVIA. Refer to Appendix A, Figure A2-3 (Zapata, 2008).

2.5.2.5 The UTC MRS was not investigated based on historical information designating this area as an encampment or cantonment (Zapata, 2008).

2.5.3 2009 Site Investigation

2.5.3.1 The purpose of the 2009 Site Investigation (SI) was to collect and analyze sufficient soil, surface water, and sediment samples in order to complete Munitions Response Site Prioritization Protocol (MRSPP) worksheets. In November 2008, incremental soil samples were collected from six decision units (DU) within the MVIA MRS. In addition, two surface water samples and two stream bed sediment samples were collected from Maunawili Stream, the most prominent stream within the project sites. Soil, surface water, and sediment samples were analyzed for metals and explosive residues by EPA method 8330B, total metals by EPA method 6010B, and white phosphorus by EPA method 8270 (soil and sediment only). Analytical results were compared to project action levels selected for the SI.

2.5.3.2 Explosive compounds and white phosphorous were not detected at concentrations exceeding the project action level in any of the soil or sediment samples collected from the MRS.

2.5.3.3 Seven metals were detected at concentrations exceeding the respective project action levels in the multi-incremental soil samples. These compounds included aluminum, arsenic, chromium, cobalt, iron, nickel, and vanadium. A further analysis of these contaminants was conducted by screening the results against the 95th percentile estimated background concentration for major Oahu soil groups. Based on those results, five metals were identified as contaminants of potential concern (COPC) for the former PTC. These COPCs include aluminum (DU-6), arsenic (DU-2 and DU-6), chromium (DU-3), iron (DU-3), and vanadium (DU-3) (Wil Chee, 2009).

2.5.3.4 Two metals (cobalt and mercury) and one explosive compound (research development explosive [RDX]) were detected at concentrations exceeding their respective project action levels in the surface water samples collected from Maunawili Stream. Based on these results, cobalt, mercury, and RDX were identified as COPC for the Maunawili Stream. Six metals including aluminum, chromium, cobalt, iron, nickel, and vanadium were detected at concentrations exceeding their respective project action levels in both the upstream and downstream sediment samples collected from Maunawili Stream. A further analysis of these contaminants was conducted by screening the results against the 95th percentile estimated background concentrations for major Oahu soil groups. Based on those results, iron was identified as a COPC for sediment present in Maunawili Stream. Refer to Appendix A, Figure A2-4 for sample locations and results exceeding project action levels (Wil Chee, 2009).

2.5.3.5 No environmental samples were collected in the MTC, MVTC, or UTC MRSs.

2.5.4 2012 Removal Action at Maunawili Valley Impact Area

2.5.4.1 The objective of the 2012 Removal Action at MVIA was to remove and dispose of all MEC and MD on 40 acres within the MVIA (Appendix A, Figure A2-5). Approximately 1,067 pounds of MD was removed and 26 MEC items were located during fieldwork. MEC items included: 60-mm HE mortar, M49A2; 37-mm HE projectile, M63; 75-mm shrapnel projectile, MK1; fuze of a projectile Time Super Quick (TSQ); fuze of a projectile Point Detonating Super Quick (PDSQ); 57-mm Armor Piercing Tracer (APT) projectile, M70; 37-mm Armor Piercing Capped Tracer (APCT) projectile, M59; 2.36-inch rocket motor; 81-mm HE mortar, M43A1; and fuze of a projectile, M1907M (Environet, 2012).

2.5.4.2 No environmental samples were collected.

2.5.5 Quality and Utility of Existing Data

2.5.5.1 The data collected along the visual and surface sweep reconnaissance transects investigated during the 2008 EE/CA was not sufficient to completely characterize the site hazards. Data was collected at the surface only and with limited areal extent; thus, additional data was collected in the RI to determine nature and extent of MEC hazards in the reconnaissance transect area. The reconnaissance effort did identify an 81-mm HE mortar as a new munition not previously identified in the 1994 INPR.

2.5.5.2 Data collected in the 2008 EE/CA grid locations was sufficient for use in characterizing those locations because both surface and subsurface information was gathered. This data was subsequently used to determine the area to be cleared in the 2012 Removal Action.

2.5.5.3 Laboratory analytical data from the 2009 SI provided a preliminary COPC list for MCs. This list was reviewed and reduced to include only those COPCs that were directly related to munitions used at PTC, had known risk-based thresholds, and were not naturally occurring elements found in Hawaii's volcanic soil (i.e., explosives). Through this process, aluminum, arsenic, cobalt, iron, mercury, and vanadium were eliminated as potential MCs to be investigated in the RI.

2.5.5.4 The 2012 Removal Action identified new munition items including: 20-mm ball cartridge, MK1 (unfired); 20-mm ball cartridge, M55A1 (unfired); 37-mm APCT projectile, M59; fuze of a projectile TSQ; fuze of a projectile PDSQ; 57-mm APT projectile, M70; and fuze of a projectile, M1907M. This data is adequate for incorporation into the MEC HA and the MRSPP for the MVIA. The area within the 2012 Removal Action boundary was excluded from the RI MEC investigation since a removal action had been performed.

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3.0 Project Remedial Response Objectives

3.0.1 The RI was conducted IAW the objectives and goals established during the TPP process and documented in the TPP Memorandum (Huikala, 2013b) and Final RI WP (Huikala, 2013a). The objective of the RI is to characterize the nature and extent of military munitions and munitions-related contamination for the purpose of assessing risks to human health, safety, and the environment.

3.0.2 Data needs specific to the RI were determined by reviewing data from previous investigations and historical documentation and through the TPP process. The TPP team (USAESCH, CEPOH, stakeholders, regulators, and Huikala) concluded that information gathered during previous investigations and historical records research indicated no evidence of HE munitions usage at either the MVTC or UTC MRSs. Therefore, no further investigation was required at the MVTC and UTC MRSs. The TPP team agreed that additional data was necessary in the MVIA and MTC MRSs to adequately characterize the nature and extent of MEC hazards and MC risk. Data would be collected by investigating parallel transects designed by VSP. Sweep teams, utilizing standard analog (mag and dig) clearing techniques, would traverse each MRS to detect MEC and MD. Areas traversed would be limited to those with less than 18 degree slopes due to worker safety and accessibility concerns. Once the transect data was analyzed, grids would be placed and investigated to further delineate the nature and extent of MEC contamination as well as estimate anomaly density.

3.0.3 Additionally, the TPP team agreed to change the environmental sampling approach from watershed-based sampling units (SUs) to smaller SUs, more specific to the location of possible MEC contamination. Surface soil samples would be collected, per the HDOH Hazard Evaluation and Emergency Response (HEER) Technical Guidance Manual (TGM), in areas with high concentrations of MEC/MD and analyzed for MCs. Subsurface soil, sediment, and/or surface water would only be sampled if the surface soil results exceeded HDOH Tier 1 EALs. A baseline risk assessment would only be performed only if surface soil results exceeded HDOH Tier 1 EALs.

3.0.4 Subsequent to the second TPP Meeting and Memorandum, ROE was denied for the MTC MRS. No additional information was collected in the MRS.

3.1 CSM and Project Approach

3.1.1 Preliminary CSM

3.1.1.1 The preliminary CSMs were developed using historical documentation, previous investigations, and current/future land use assumptions. The preliminary CSMs for MEC and MC were refined during the TPP process and included in the Final RI WP. Table 3-1 summarizes the preliminary CSMs prior to the RI field activities.

Table 3-1: Summary of Preliminary CSMs

Criteria	Maunawili Valley Impact Area MRS	Maunawili Training Course MRS
Acreage	3,432 acres (FUDMIS) 2,795 acres (GIS)	400 acres (FUDMIS) 333 acres (GIS)
Past Department of Defense (DoD) Activities	Regimental combat training center emphasizing the use of and familiarity with modern arms and field weapons, in addition to providing rugged terrain for jungle and ranger training.	
MEC and MD Found Since Closure:	75-mm HE projectile, M48 75-mm shrapnel projectile, Mk I 60-mm HE mortar, M49A2 37-mm HE projectile, M63 57-mm APT projectile, M70 37-mm APCT projectile, M59 81-mm HE Mortar, M43A1 2.36- and 3.5-inch HEAT rockets 2.36-inch rocket motor 20-mm ball cartridge, MK1 (unfired) 20-mm ball cartridge, M55A1 (unfired) fuze of a projectile TSQ fuze of a projectile PDSQ fuze of a projectile, M1907M Small Arms	Small Arms, General .50-caliber
Munitions Constituents of Concern	Antimony, Chromium, Copper, Lead, Zinc, Tetryl, cyclotetramethylenetetranitramine (HMX), RDX, trinitrobenzene (TNB), dinitrobenzene (DNB), 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), nitrotoluene (NT), nitroglycerin (NG), pentaerythritol tetranitrate (PETN)	
Current and Future Land Use	Residential, agricultural, recreational, undeveloped forest	
Potential Receptors	Residents, construction/commercial/industrial workers, visitors/recreational users, ecological receptors	
Pathways for Human Exposure to MEC	Direct contact with MEC on the surface or subsurface (intrusive activities)	
Pathways for Human Exposure to MC	Dermal contact and ingestion of MC in surface soil, subsurface soil, sediment, and surface water, as well as inhalation of MC in surface and subsurface soil. Ingestion of biota.	
Geological and Environmental Features that Impact Proposed Activities	"Hot rocks" containing metallic content that trigger a magnetometer response may result in false-positive readings. Steep terrain, streams, and impassable vegetation also affect the transect placement and likelihood of detecting MEC items. Public hiking trails throughout the MRS may have more potential for MEC and MC exposure. Sensitive archaeological and biological features will be avoided.	

3.1.1.2 Revised CSMs based upon the RI findings and receptor pathway analyses are presented in Section 5.0 of this report.

3.1.2 Project Approach

The project approach identified during the TPP process and described in the Final RI WP included:

- Collecting and reviewing historical data and reports to help define the extent of contamination.
- Utilizing VSP to optimize a parallel transect design that determines MEC density and limits of contamination.
- Avoiding impacts to cultural, archaeological, and ecological resources.
- Minimizing vegetation removal.
- Performing geophysical investigations and mapping to identify lateral range boundaries and vertical extent of MEC.
- Identifying areas of high MEC/MD density (MEC/MD density of 100 anomalies per acre total density, which is equivalent to at least 50 anomalies per acre greater than the selected background density of 50 anomalies per acre).
- Managing, tracking, and disposing of MPPEH.
- Collecting and analyzing background surface soil samples for metals.
- Collecting and analyzing surface soil samples with the potential for MC as evidenced by the presence of MEC/MD.
- Comparing surface soil sample results to HDOH Tier 1 EALs and background concentrations.
- Collecting additional media samples if surface soil results exceeded HDOH Tier 1 EALs.
- Performing a screening-level risk assessment if surface soil results exceeded HDOH Tier 1 EALs.
- Compiling and analyzing data from historical documentation, previous investigations, and the RI to determine the nature and extent of MEC hazards and MC risk to human health and the environment.

3.2 Preliminary Remediation Goals

Preliminary remediation goals (PRGs) are both site- and contaminant-specific and provide the requirements necessary to be protective of human health and the environment. While PRGs are initially established within the RI, they are subject to review and refinement throughout the course of the CERCLA process, as more project-related information is obtained. The final goal of the project is to manage the MEC hazards and MC risk through a combination of institutional controls, removal/remediation, and public education to render an MRS as safe as reasonably possible to humans and the environment under the current and anticipated future land uses.

3.2.1 Assessment of Land Use and Institutional Analysis Aspects

3.2.1.1 The majority of land comprising the MVIA MRS is owned by the State of Hawaii and is primarily undeveloped forest with pockets of recreational, agricultural, and industrial use (including power lines, drainage features, and water lines). A private entity owns the Royal Hawaiian Golf Club and surrounding land parcels, currently undeveloped forest. A private landowner has initiated a residential development along the northeastern boundary of the MRS. The future use of this MRS is unlikely to change.

3.2.1.2 The MTC, MVTC, and UTC MRSs are largely owned by private landowners and are mostly undeveloped except for pockets of recreational and educational areas. The future land uses of these MRSs are not expected to change.

3.2.1.3 Institutional controls (IC) include administrative controls (permits), engineering controls (fencing, signage), public education programs, and legal mechanisms (deed notices). The overall effectiveness of ICs depends entirely on stakeholder (government agencies and private landowners) support, involvement, and willingness to enforce and maintain ICs implemented to reduce the potential for interaction with MEC/MC.

3.2.2 PRG for MEC

The PRG for MEC is to demonstrate with at least 90 percent confidence that the UXO concentration is less than 0.5 UXO per acre for low-use areas. The MVIA MRS is determined to be “low use” based on the types of activities occurring in the MRS (recreational, agricultural, and undeveloped forest).

3.2.3 PRG for MC

A PRG for MC is a concentration value for a specific COPC believed to be protective based on preliminary site information. The values established during the TPP process for the MVIA MRS were based on the HDOH Tier 1 EALs for Soil for Unrestricted Land Use at Sites where Surface Water is Located within 150 Meters of the Release Site and where the Site is Underlain by a Drinking Water Resource. Table 3-2 presents the PRGs for potential MCs.

Table 3-2: Preliminary Remediation Goals for MCs

Chemical of Potential Concern	HDOH Tier 1 EAL[1] Soil (milligram/kilogram [mg/kg])
Antimony (Sb)	24
Copper (Cu)	630
Chromium (Cr)	1,100
Lead (Pb)	200
Zinc (Zn)	1,000
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	29
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.009 / 5.5[2]
1,3,5-Trinitrobenzene (1,3,5-TNB)	8.4
1,3-Dinitrobenzene (1,3-DNB)	0.21
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	49
Nitrobenzene (NB)	0.0046 / 4.8[2]
2,4,6-Trinitrotoluene (2,4,6-TNT)	1.0
4-Amino-2,6-dinitrotoluene (4-Am-DNT)	0.7
2-Amino-4,6-dinitrotoluene (2-Am-DNT)	0.7
2,4-Dinitrotoluene (2,4-DNT)	0.021 / 1.6[2]
2,6-Dinitrotoluene (2,6-DNT)	3.6
2-Nitrotoluene (2-NT)	0.0038 / 1.9[2]
3-Nitrotoluene (3-NT)	7.3
4-Nitrotoluene (4-NT)	0.25
Nitroglycerin (NG)	0.07 / 1.2[2]
Pentaerythritol tetranitrate (PETN)	0.42

[1] Tier 1 EALs for Sites where groundwater is a source of drinking water, less than 150 meters from the nearest surface water body (HDOH, 2012; Table A-2).

[2] For these analytes, the groundwater protection EAL is followed by a direct exposure EAL, since the most stringent (i.e., groundwater protection) EAL is lower than the Limit of Detection. To allow for risk-based screening, analytical results will be compared to the direct exposure EAL.

3.3 Preliminary Identification of Applicable or Relevant and Appropriate Requirements and To Be Considered Information

3.3.0.1 CERCLA Section 121 requires that site cleanups comply with federal Applicable or Relevant and Appropriate Requirements (ARARs), or state ARARs in cases where these requirements are more stringent than federal requirements. The preliminary ARARs presented herein are a compilation of the promulgated, substantive requirements of federal and state laws or regulations that are legally applicable or are relevant and appropriate based upon the circumstances present at the site as related to the release of MEC or MC contamination to the environment. Identification and evaluation of ARARs is an iterative process that occurs throughout the life of the project. The preliminary ARARs are presented in Table 3-3. The final ARARs are selected and become enforceable when the DD for the site is signed.

3.3.0.2 Under CERCLA Section 121(d)(2), the federal ARARs for remedial action could include requirements under any of the federal environmental laws (e.g., Clean Air Act, Clean Water Act, Safe Drinking Water Act). State ARARs include promulgated requirements under state environmental or facility siting laws that are more stringent than federal ARARs and that have been identified in a timely manner, according to 40 Code of Federal Regulations (CFR) Part 300.400(g)(4). A requirement may be either "applicable," or "relevant and appropriate."

3.3.0.3 Applicable requirements are defined as those cleanup or control standards, or other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state laws.

3.3.0.4 A requirement is applicable if the specific terms (or jurisdictional prerequisites) of the statute or regulation directly address the circumstances at the site.

3.3.0.5 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 cleanup standards, or other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, that, while not necessarily applicable, address problems or situations sufficiently similar to those encountered at the CERCLA site, and whose use is well-suited to the particular site.

3.3.0.6 Determining whether a requirement is both relevant and appropriate is a two-step process. First, to determine relevance, a comparison is made between the response action, location, or chemicals covered by the requirement and related conditions at the site, release, or potential remedy. A requirement is relevant if it generally 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, the circumstances of the release, and the proposed response action. The requirement is appropriate if, based on such comparison, its use is well-suited to the particular site. USACE must comply with requirements that are determined to be both relevant and appropriate.

3.3.0.7 Federal or state agencies may develop criteria, advisories, guidance, and proposed standards that are not legally enforceable but may be helpful in carrying out, or in determining protectiveness of, selected remedies. These materials are "to be considered" (TBC) and are meant to complement the use of ARARs, not compete or replace them. TBC materials are not ARARs and their identification and use are not mandatory.

3.3.0.8 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 (e.g., worker safety) 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.
- 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).

3.3.0.9 ARARs that govern actions at CERCLA sites fall into three broad categories based upon the chemical contaminants present, site characteristics, and alternatives proposed for cleanup. These three categories (chemical-specific, location-specific, and action-specific) are described in the following subsections.

3.3.1 Chemical-Specific ARARs

3.3.1.1 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. These requirements generally set health- or risk-based concentration limits or discharge limits for specific hazardous substances by media. Chemical-specific ARARs are triggered by the specific chemical contaminants found at a particular site.

3.3.1.2 MC sampling was only conducted within the MVIA MRS. Since no MCs were detected above the HDOH Tier 1 EALs for surface soil, the potential for adverse risks to human health or ecological receptors from exposure to MCs is negligible. Therefore, there are no chemical-specific ARARs for the MVIA MRS.

3.3.1.3 There are no current chemical-specific ARARs for the MTC MRS; however this should be re-evaluated if additional investigation is performed.

3.3.1.4 Based on previous investigations and historical documentation, risks associated with MCs at the MVTC and UTC MRSs are not suspected. Therefore, there are no chemical-specific ARARs for these MRSs.

3.3.2 Location-Specific ARARs

3.3.2.1 Location-specific requirements are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations. Common examples of this type of ARAR include site proximity to wetland or floodplains, or the presence of natural or cultural resources.

3.3.2.2 The MVIA MRS and the MTC MRS are known to contain significant archaeological features and biological and ecological resources (rare, threatened, and endangered species and a critical habitat). Two location-specific ARARs have been identified, including one State of Hawaii Endangered Species requirement incorporated during the TPP process. Refer to Table 3-3.

3.3.3 Action-Specific ARARs

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. One action-specific ARAR has been identified. Refer to Table 3-3.

Table 3-3: Preliminary Identification of ARARs

Type of ARAR	Requirement	Citation	Description	Comments
Action-Specific	Resource Conservation and Recovery Act (RCRA)	40 CFR 264.601 (RCRA, Subpart X)	Requires miscellaneous units for the management of hazardous waste, such as open burning/open detonation units, to be located, designed, constructed, operated, maintained, and closed in a manner that will ensure protection of human health and the environment.	Permits are not required for on-site response actions conducted under CERCLA and only the substantive requirements of Subpart X are considered potential ARARs.
Location-Specific	Endangered Species Act	16 United States Code (USC) 1538(a)(1)(B)	Prohibits the “taking” of any federally listed threatened or endangered species of fish or wildlife. In addition, federal agencies must ensure that their actions will not jeopardize the continued existence of any listed species or result in the destruction or adverse modification of the designated critical habitat of a listed species.	Threatened and endangered (T&E) species are present on the site. Refer to Appendix B for additional information.
Location-Specific	Endangered Species	Hawaii Revised Statutes Title 12, Chapter 195D-4(e)(2) Hawaii Administrative Rules Title 13, Chapter 124-3(b)(1)	Prohibits the take of any threatened or endangered species of aquatic life, wildlife, or land plant within the State of Hawaii. In addition to species listed under the federal Endangered Species Act, the prohibition on take under the state endangered species law applies to certain other indigenous species identified under state law as endangered or threatened.	T&E species are present on the site. Refer to Appendix B for additional information.

3.4 Institutional Analysis

3.4.1 An institutional analysis is currently underway with the governmental agencies having jurisdiction over the properties within the MRS; the results of which will be presented in the FS. The institutional analysis process involves the collection of data from government agencies and landowners needed to design and support an institutional control program at the site. The objectives of the institutional analysis are to (1) illustrate the opportunities that exist to implement an institutional control program at the site, (2) identify government agencies and landowners having jurisdiction over the site, and (3) assess the appropriateness, capability, and willingness of these parties to assert their control over the site.

3.4.2 Data collection from government agencies, such as HDOH, DLNR, the State of Hawaii Land Use Commission, the City and County of Honolulu, Department of Planning and Permits, and private landowners is in progress. The types of data being gathered include:

- Jurisdiction of the Agency/Landowner
- Authority Exercised by the Agency/Landowner within its Jurisdiction
- Mission of the Agency/Landowner
- Capability of the Agency/Landowner
- Desire of the Agency/Landowner to Participate in the Institutional Control Program

3.4.3 Once this data is collected, it will be used to develop an institutional analysis as well as control strategies. Control strategies may consist of a single institutional control or a combination of strategies. The local community and stakeholders drive the development of the appropriate institutional control alternatives. The alternatives for the site will reflect the framework of the local institutions and the needs of the community. The information will be summarized and presented in a separate Institutional Analysis Report in accordance with EP 1110-1-24 and included in the FS.

3.5 Data Needs and Data Quality Objectives

3.5.0.1 Data quality objectives (DQOs) are statements defining the quality, quantity, and type of data required, and the acceptance criteria for those data, necessary to provide an adequate database to support project decisions. To generate data that will meet the project objectives, it is necessary to define the types of decisions that will be made and identify the intended use of the data in an effort to characterize the residual risk remaining at the FUDS property.

3.5.0.2 Data needs specific to this RI have been identified by evaluating existing data and through discussions of project requirements with stakeholders. The process by which data needs were developed is documented in the TPP Memorandum (Huikala, 2013b).

3.5.1 Analysis of Existing Data

3.5.1.1 Data collected from previous investigations was compiled and analyzed to determine data gaps and refine the additional data needs to meet the RI DQOs.

3.5.1.2 Previous investigations provide no evidence indicating MEC hazards or MC risks at either MVTC or UTC. MVTC was a suspected observation point and no MEC or MD items have been recovered from the MRS to date. The UTC MRS is documented as an encampment or cantonment area and no MEC were reported during development of the site, thus ordnance use is not suspected. The 2009 SI developed MRSPP ratings of “No Known or Suspected Hazards” for both of these MRSs. As a result, the TPP team concluded that additional investigation was not required in MVTC or UTC.

3.5.1.3 For the MTC and MVIA MRSs, a comprehensive list of anticipated MEC items was compiled from the 1994 INPR, 2008 EE/CA, and 2012 Removal Action. Since each progressive investigation identified new munition items, there was not sufficient data to determine the nature of MEC at the project site. Additional information needed to be collected during the RI.

3.5.1.4 The 2008 EE/CA instrument-assisted visual reconnaissance transects collected surface-only data, not subsurface (Appendix A, Figure A2-1). This was not suitable to adequately characterize the extent of MEC in the surveyed areas. After discussions with the project delivery team (PDT [USAESCH and CEPOH]), it was determined that additional data was needed along the EE/CA transect areas.

3.5.1.5 Data collected during the 2012 Removal Action was useful in developing a comprehensive list of anticipated MEC items and completing the MEC HA and MRSPP (Environet, 2012). The 40 acres covered by this project were removed from the RI MEC investigation fieldwork, however, since a removal action was performed.

3.5.1.6 The 2009 SI provided the only MC data for MVIA. All samples were collected in the western portion of the MRS. The SI COPCs were identified as five metals (aluminum, arsenic, chromium, iron, and vanadium) in surface soil, two metals (cobalt and mercury) and one explosive compound (RDX) in surface water, and six metals (aluminum, chromium, cobalt, iron, nickel, and vanadium) in sediment. While the sample results for these constituents exceeded the SI project action levels, not all were related to munitions use or have known risk-based thresholds.

3.5.1.7 The comprehensive MEC list was also used to identify additional MCs not identified during the 2009 SI.

3.5.2 Data Needs

3.5.2.1 The RI data needs for the MVIA and MTC MRSs were identified as follows:

- Additional data to determine and delineate the nature, extent, and overall hazard potential for MEC suspected or used.
- Additional data to determine the nature and extent of MC in surface soil.
- Background concentrations of naturally occurring metals in surface soil.
- Identification of sensitive habitats and/or cultural resources present within the MRSs (i.e., protected species and critical habitats, culturally significant sites, etc.)
- Sufficient data to develop and evaluate effective response alternatives given the anticipated future land use.

3.5.2.2 No additional data was required for the MVTC and UTC MRSs.

3.5.3 MEC DQOs Resulting from TPP Process

3.5.3.1 Development of the DQOs is iterative and occurs through the TPP process. Notable changes from the preliminary MEC DQOs to the final MEC DQOs were:

- Changing the definition of "accessible" from areas with less than 30 degrees to areas with less than18 degrees slope. This change was made for worker safety. Working in areas with greater than 18 degrees slopes requires greater worker protection.
- Removing the MVTC and UTC MRSs from further investigation. No evidence of military munitions has been found in these MRSs and no known MEC hazards or MC risks are suspected.

3.5.3.2 The final MEC DQOs are:

1. Delineate the nature and extent of MEC contamination in accessible areas with at least a 90% confidence level of identifying impact areas within the MVIA and MTC.
2. For areas outside of the MEC-contaminated areas, determine with 90% confidence that the concentration of UXO in residential areas are less than or equal to 0.1 UXO per acre and low-use areas are less than or equal to 0.5 UXO per acre.

3.5.3.3 Table 3-4 summarizes the data needs, quantity of data, and data collection methods required to achieve the final MEC DQOs.

Table 3-4: Final MEC DQOs

DQO Step	Description
Step 1: State the Problem	The former PTC was used as a regimental combat training center in the 1940s, emphasizing the use of and familiarity with modern arms and field weapons, in addition to providing rugged terrain for jungle and ranger training. MEC has been identified or is suspected of being present at several areas within the Site including MD from 81-mm mortars, 75-mm HE, 75-mm shrapnel, and 37-mm projectiles. Additional investigation is required to assess whether MEC and/or MC are present at the site, to evaluate risk, and to guide further management decisions. ***Delineate the nature and extent of MEC contamination within the MVIA MRS and MTC MRS***.
Step 2: Identify the Goal of the Study	***Principal Study Questions*** • Are MEC present at the site? • What types of MEC (i.e., energetic material category) are present? • Do known MEC items comprise the extent of MEC present within each MRS? • Do MEC items exist outside of the current boundaries of each MRS? • Do MEC items pose an unacceptable hazard to human receptors?

Table 3-4: Final MEC DQOs (continued)

DQO Step	Description
Step 2: Identify the Goal of the Study (continued)	***Alternative Actions*** • No further investigation is required and a No Further Action determination may be sought for the site. • Investigate additional transects/grids if MEC items exist outside the known boundaries of the MRS in order to identify the lateral extents of MEC. • Institute Institutional Controls or perform a removal action to reduce the MEC hazard to an acceptable level • Collect incremental surface soil samples in areas identified as having MEC or MD contamination. ***Based on the principal study questions and the alternative actions that may result in response to these questions, the following decision statements have been generated:*** • Determine the type and spatial extent of MEC and the exposure pathways for humans. If MEC is present, does the risk posed to humans require additional investigation, implementation of institutional controls, and implementation of remedial or removal actions.
Step 3: Identify Information Inputs	Historical Data and Previous Investigations: Historical information, investigation results, and analytical data from previous reports, including: • INPR (CEPOH, 1994) • EE/CA (Zapata, 2008) • SI Report (WCP, September 2009) • Site Specific Final Report (Environet, 2012) Current RI: • Analog geophysical data. • Results of visual and instrument investigations along transects and in grids. • Results of intrusive investigation of identified anomalies. • Evaluation of the conceptual site model and site receptors.

Table 3-4: Final MEC DQOs (continued)

DQO Step	Description
Step 4: Define the Boundaries of the Study	***Lateral and Vertical Boundaries*** • Only areas with less than 18 degrees slope will be investigated. • Instrument investigation is bound by 1-meter wide transects. • Transects will be spaced approximately 350 feet apart for MVIA and 350 feet apart for MTC. • Transect spacing is designed to allow at least a 90% probability of traversing and detecting any 1,000-foot diameter (500-foot radius) circular target area. • Perpendicular transects will be used to refine potential target areas. Perpendicular transects are terminated at the intersection of the parallel transect bounding the target area. • Analog grid investigation may be used to define and bound target areas. • Grid locations will be determined based on results of transect investigations. • Vertical boundary will consist of the depth to which the metal detection device can detect metal in the subsurface. ***Constraints*** Rights-of-Entry, environmental setting, weather, current land use activities, e.g., agricultural, recreational.
Step 5: Develop the Analytical Approach	***IF MEC:*** a) are identified, THEN determine the lateral and vertical extents and distribution of the MEC. b) are not identified, THEN collect sufficient data to assess potential hazards and develop and evaluate effective remedial alternatives. ***IF the MEC investigation:*** a) does indicate areas of high density, THEN investigate additional transects/grids to determine lateral and vertical extent of MEC to an accuracy of +/- 100 feet horizontal and +/- 0.5 feet vertical. b) does not indicate areas of high density, THEN collect sufficient data to assess risk and develop and evaluate effective remedial alternatives. ***IF the results of the MEC investigation:*** a) do not indicate the presence of MEC within the MRS, THEN the MRS (or portions of the MRS) will be considered for unrestricted use in the FS. b) do indicate the presence of MEC/MD at the MRS, THEN incremental sampling of surface soil will be conducted and the results analyzed for MC associated with MEC/MD item identified.

Table 3-4: Final MEC DQOs (continued)

DQO Step	Description
Step 6: Specify Performance or Acceptance Criteria	• Repeatability (Instrument Functionality) - All items in test strip detected. • Dynamic Repeatability (transects) - Repeat a segment of transect and show extra flags/digs with not greater than the greater of 20% or 8 flags. • Coverage (grids) - Blind coverage seeds and blind detection seeds recovered 75% if MEC 90% if no MEC. • Detection and Recovery (grids) - Blind detection seeds recovered 80% if MEC, 100% if no MEC. • Anomaly Resolution - QC checks open holes to determine if MEC: 70% confidence <10% anomalies unresolved, and a 90% confidence <5% unresolved if no MEC is found. • Identification of MEC-contaminated areas (areas with elevated anomaly densities relative to background density of 50 anomalies per acre) with at least a 90% statistical confidence. • Analog grids demonstrate that areas surrounding MEC-contaminated areas do not exceed 0.1 UXO per acre for residential areas and 0.5 UXO per acre for low use areas.
Step 7: Develop the Detailed Plan for Obtaining Data	• Design transect plan to allow at least a 90% probability of identifying impact areas (areas with elevated anomaly densities relative to background density of 50 anomalies per acre). • Conduct visual and instrument investigation on transects. • Collect data 32.05 miles/11.6556 acres of transects in MVIA and 6.21 miles/2.2598 acres of transects in MTC. • If impact areas are identified, investigate perpendicular transects to bound impact area. • After the potential target areas are defined through VSP and intrusive investigation, apply UXO Estimator to the surrounding area. Through the use of GIS, the surrounding area will be divided into different land uses: residential and low use (such as, agricultural, golf course) areas. UXO Estimator will then be applied for the land uses that apply for both 0.1 and 0.5 UXO per acre. • Conduct intrusive investigation of anomalies identified during transect and grid sweeps. • Perform a MEC Hazard Assessment using investigation data to determine the overall hazard potential.

3.5.4 MC DQOs Resulting from TPP Process

3.5.4.1 During the TPP process, stakeholders expressed concern about using a sampling approach based on watershed-size SUs. Collecting one incremental sample per watershed is not representative of the nature and extent of MC contamination due to the size of the watersheds surrounding the MRSs. The TPP team agreed that a better approach is to use a 5,000 square foot SU centered on potential impact areas or in areas with high MD concentrations. Background SUs would also be 5,000 square feet and located in upgradient areas with the least probability of military activity. The 5,000 square feet SU size is based on HDOH guidance for typical residential areas in Hawaii.

3.5.4.2 Additionally, the stakeholders requested that the number of sub-samples included in one (1) incremental soil sample be increased from 30 to 50.

3.5.4.3 The TPP team also reviewed the list of MCs that were developed using the 2009 SI data and the list of MEC potentially used at the site. The team eliminated several metals identified during the 2009 SI from further consideration since the metals were not associated with the munitions suspected at the site. Metals that have no risk-based threshold or were below the 2009 SI project action levels were also eliminated from consideration. The final MC list included antimony, chromium, copper, lead, zinc, Tetryl, HMX, TNB, DNB, TNT, DNT, NT, NG, PETN, and RDX.

3.5.4.4 The stakeholders also requested a phased sampling approach. Surface soil would be collected and analyzed first. If MC concentrations in surface soil exceeded the HDOH Tier 1 EALs, then subsurface soil, sediment, and surface water would be collected and analyzed.

3.5.4.5 The final MC DQOs are:

1. Within MEC-contaminated areas or potential target areas, determine the nature and extent of MC concentrations in surface soil by collecting incremental surface soil samples IAW the HDOH HEER TGM (HDOH, 2009), analyzing samples using EPA approved methods and following general DoD guidelines (DoD, 2010).

2. Determine if MC concentrations in surface soil are above acceptable risk thresholds by comparing concentrations against HDOH Tier 1 EALs and, if necessary, performing a Tier 2 site-specific baseline risk assessment.

3. If MC concentrations are above acceptable risk thresholds in surface soil, delineate the nature and extent of MC contamination in subsurface soil as well as sediment and surface water. Incremental subsurface soil samples will be collected at the same locations as the surface soil samples but in the 6 to 12 inches below ground surface (bgs) interval. Discrete sediment and surface water samples will be collected downgradient from MC contamination in surface soil. Analysis will be conducted using EPA approved methods

following general DoD guidelines (DoD, 2010). Surface water will only be sampled if sediment concentrations are above HDOH EALs.

4. Determine background concentrations of metals in surface soil through collection of eight incremental background soil samples from areas with the least probability of DoD activity and where no MEC was found; analyze samples using EPA approved methods following general DoD guidelines (DoD, 2010).

5. If sediment and surface water samples are collected, determine background concentrations of metals in sediment and surface water by collecting eight discrete sediment samples and one surface water sample upgradient of MC contamination and where no MEC was found; analyze samples using EPA approved methods following general DoD guidelines (DoD, 2010).

3.5.4.6 Table 3-5 summarizes the final MC DQOs developed during the TPP process.

Table 3-5: Final MC DQOs

DQO Step	Description
Step 1 State the Problem	MEC has been identified or is suspected of being present at several areas within the Site including MD from 81-mm mortars, 75-mm high explosive, 75-mm shrapnel, and 37-mm projectiles. Additional investigation is required to assess whether MEC and/or MC are present at the site, to evaluate risk, and to guide further management decisions.
Step 2 Identify the Goal of the Study	**The principal study questions for this project are:** ▪ Are MEC present at the site? ▪ What types of MEC (i.e., energetic material category) are present? ▪ If MEC or MD is present at the site, is MC present in surface soil at concentrations exceeding the Tier 1 screening level risk assessment Environmental Action Levels (EALs) and/or Tier 2 site-specific screening levels? ▪ If MEC or MD is present at the site, are metals present in surface soil at concentrations exceeding background metal concentrations? ▪ What risk of injury or death is posed by MEC/MC identified at the site? **The alternative actions for this project are:** ▪ No further investigation is required and a No Further Action determination may be sought for the site. ▪ Perform a MEC Hazard Assessment to assess whether on-site MEC present an unacceptable level of risk to human health and/or the environment and requires the performance of additional site work. ▪ If MEC or MD is found in surface soil, determine target area and conduct increment sampling of surface soil for MC associated with each specific type of MEC or MD item identified. Compare MC concentrations to human health and ecological screening values, as presented in the HDOH's Tier 1 EALs as presented in Worksheet #15.

Table 3-5: Final MC DQOs (continued)

DQO Step	Description
Step 2 Identify the Goal of the Study (continued)	▪ If MC concentrations exceed Tier 1 EALs, perform a Tier 2 Site-Specific Screening-Level Evaluation in accordance with the HDOH Technical Guidance Manual (TGM) (HDOH, 2009) to determine whether MC associated with MEC present an unacceptable level of risk to human health and/or the environment and requires the performance of additional site work. ▪ If the Tier 2 Site-Specific Screening-Level Evaluation indicates a risk to human health and ecology, then collect subsurface soil, sediment and surface water samples as detailed in Worksheet #17; and perform a Baseline Risk Assessment as detailed in Worksheet #14, Section 14.4. **Based on the principal study questions and the alternative actions that may result in response to these questions, the following decision statements have been generated:** If MEC and/or MC are present, evaluate whether the risk posed to human health and/or the environment requires additional site investigation activities, implementation of land use controls (LUCs), and/or implementation of remedial or removal actions.
Step 3 Identify Information Inputs	The inputs to the project decision include information from the following: **Historical Data and Previous Investigations:** Historical information, investigation results, and analytical data from previous reports, including: ▪ INPR (CEPOH, 1994) ▪ EE/CA (Zapata, 2008) ▪ SI Report (WCP, September 2009) ▪ Site Specific Final Report (Environet, 2012) **Current RI:** The MEC/MC investigation technical approach is comprised of the following: ▪ Cultural and biological monitoring to avoid sensitive resources ▪ Identification of Sampling Units with potential MC in available media as evidenced by the presence of MEC or MD. ▪ Use of increment sampling (IS) and discrete sampling techniques to determine concentrations of MC ▪ Use of HDOH EALs to evaluate COPC metals (antimony, chromium, copper, lead, zinc) and explosives (Tetryl, HMX, RDX, TNB, DNB, TNT, DNT, NT, PETN, and NG). ▪ Use of background soil samples from areas with the least probability of military activity to evaluate background concentrations of COPC metals (antimony, chromium, copper, lead, and zinc). ▪ Perform laboratory analysis of metals and explosives in soil using methods 3050A/6020A and 8330B, respectively.

Table 3-5: Final MC DQOs (continued)

DQO Step	Description
Step 4 Define the Boundaries of the Study	**The lateral boundaries of the study area are as follows:** The lateral boundaries are confined to accessible areas (areas of less than 18 degrees slope) within two non-contiguous parcels within the Maunawili Valley near Kailua, Oahu. These two parcels are: ▪ Maunawili Valley Impact Area ▪ Maunawili Site For investigation of MEC the lateral boundaries will consist of the outer edges (3 feet width) of transects shown on Figure E4. For the investigation of MC, the lateral boundaries will consist of 5,000-square foot sampling units centered on locations where potential target areas were identified during the MEC investigation, or in locations biased where MD was found on soil. For the investigation of background metal concentrations, the lateral boundaries will be confined to locations where no MEC or MD is found and with the least probability of military activity. **The vertical boundaries of the study area are as follows:** ▪ The vertical boundary for MEC investigation will consist of the depth to which the metal detection device can detect metal in the subsurface. ▪ For MC, the initial sampling conducted in the Phase One of the MC investigation will be a vertical depth of 6 inches. If concentrations exceed Tier 2 Site-specific Screening Levels, additional samples will be collected below 6 inches. ▪ For background metal concentrations in surface soil, the vertical boundary will be a vertical depth of 6 inches. If surface soil sample concentrations exceed Tier 2 Site-Specific Screening Levels, the vertical boundary of background metal concentrations in subsurface soil will below 6 inches. **The temporal boundaries of the study area are as follows:** For all fieldwork, the temporal boundary is limited to the time required to complete these activities. The concentration and location of MC in subsurface soil, if any, are not anticipated to change over time.
Step 5 Define the Decision Rules	**1. IF** the results of the initial MEC investigation: a. **do not indicate** the presence of MEC-contaminated/potential target areas at the Site, **THEN** the site or portions of the site will be considered for unrestricted use in the FS. b. **do indicate** the presence of MEC-contaminated/potential target areas, **THEN** increment sampling of surface soil will be conducted and the results analyzed for MC associated with each specific MEC item identified. The MC COPCs are listed in Worksheet #15. c. **do not indicate** the presence of MEC but MD indicating the presence of potential target areas was found at the site, **THEN** increment sampling of surface soil will be conducted and the results analyzed for MC associated with each specific item identified. The MC COPCs are listed in Worksheet #15.

Table 3-5: Final MC DQOs (continued)

DQO Step	Description
Step 5 Define the Decision Rules (continued)	**2. IF** MC concentrations in surface soil samples: a. **are less than** the Tier 1 EALs for that constituent, THEN no further sampling will be conducted. b. **are greater than** the Tier 1 EAL for a specific COPC, THEN the MC results will be used to conduct a detailed Tier 2 Site-Specific Screening-Level Evaluation. c. **are greater than** the Tier 1 EAL for a specific COPC, and are located within 100 feet upgradient from a surface water body; THEN sediment and surface water samples will be collected from the surface water body; and all the MC results will be used to conduct a detailed Tier 2 Site-Specific Screening-Level Evaluation. **3. IF** the results of the Tier 2 Site-Specific Screening-Level Evaluation indicate a: a. **minimal** risk posed to human health and/or the environment by MC, **THEN** no further sampling will be conducted. **b.** **unacceptable** risk posed to human health and/or the environment by MC, THEN additional sampling of surface water, sediment, and subsurface soil will be conducted, and the results will be used to prepare a Tier 3 Baseline Risk Assessment. The Tier 3 Baseline Risk Assessment will provide a detailed exposure and toxicity assessment which will be used to evaluate whether remedial actions will be required to protect human health and/or the environment.
Step 6 Specify Acceptance Criteria	**1. Presence of MD/MEC** The stated baseline condition (null hypothesis) is that the site does not contain MEC. This assumption will be maintained unless there is convincing evidence to the contrary. The alternative condition to the baseline condition is that the site contains MEC. The statistical hypotheses for this study are as follows: ▪ **H_0** = Site does not contain MEC ▪ **H_a** = Site contains MEC A decision error occurs when the decision-maker rejects the null hypothesis when it is true, or fails to reject the null hypothesis when it is false. For the purposes of this project, the possible decision errors are as follows: ▪ **False Rejection Error (α)**: H_0 is correct. The true condition is that the site does not contain MEC, yet the data show that the site does contain MEC. The consequence of a false rejection error at this site may result in the implementation of unnecessary remedial alternatives and/or LUCs and the expenditure of associated and unnecessary funds. To make the determination that MEC are not present and that the site can be made available for unrestricted use, an intrusive investigation of anomalies detected along transects spaced in parallel with sufficient density will be performed. The spacing of the transects will allow at least a 90% probability of identifying potential target areas given the munitions of concern with the smallest expected fragmentation dispersion pattern. The false rejection decision error limit shall be 0.05, and the false acceptance decision error limit shall be 0.20.

Table 3-5: Final MC DQOs (continued)

DQO Step	Description
Step 6 Specify Acceptance Criteria (continued)	**2. Presence of MD/MEC** The stated baseline condition (null hypothesis) is that the site does not contain MEC. This assumption will be maintained unless there is convincing evidence to the contrary. The alternative condition to the baseline condition is that the site contains MEC. The statistical hypotheses for this study are as follows: ▪ $\mathbf{H_0}$ = Site does not contain MEC ▪ $\mathbf{H_a}$ = Site contains MEC A decision error occurs when the decision-maker rejects the null hypothesis when it is true, or fails to reject the null hypothesis when it is false. For the purposes of this project, the possible decision errors are as follows: ▪ **False Rejection Error (α)**: H_0 is correct. The true condition is that the site does not contain MEC, yet the data show that the site does contain MEC. The consequence of a false rejection error at this site may result in the implementation of unnecessary remedial alternatives and/or LUCs and the expenditure of associated and unnecessary funds. ▪ **False Acceptance Error (β):** H_0 is false. The true condition is that the site contains MEC, yet the data show that the site does not contain MEC. The consequence of a false acceptance error at this site could result in injury or death due to an adverse human or ecological resources encounter with MEC. To make the determination that MEC are not present and that the site can be made available for unrestricted use, an intrusive investigation of anomalies detected along transects spaced in parallel with sufficient density will be performed. The spacing of the transects will allow at least a 90% probability of identifying potential target areas given the munitions of concern with the smallest expected fragmentation dispersion pattern. The false rejection decision error limit shall be 0.05, and the false acceptance decision error limit shall be 0.20. **3. Presence of MC above Tier 1 and Tier 2 Screening Levels** In the event that MEC or MD is identified as present at the site, the stated baseline condition (null hypothesis) is that the site does not contain MC at concentrations above the EALs. This assumption will be maintained unless there is convincing evidence to the contrary. The alternative condition to the baseline condition is that the site contains MC at concentrations above the EALs. The statistical hypotheses for this hypothesis are as follows: ▪ $\mathbf{H_0}$ = Site does not contain MC at concentrations above the EALs ▪ $\mathbf{H_a}$ = Site contains MC at concentrations above the EALs A decision error occurs when the decision-maker rejects the null hypothesis when it is true, or fails to reject the null hypothesis when it is false. For the purposes of this hypothesis, the possible decision errors are as follows: ▪ **False Rejection Error (α)**: H_0 is correct. The true condition is that the site does not contain MC at concentrations above the EALs, yet the data show that the site does contain MC at concentrations above the EALs. The consequence of a false rejection error at this site may result in the implementation of unnecessary remedial alternatives and/or LUCs and the expenditure of associated and unnecessary funds.

Table 3-5: Final MC DQOs (continued)

DQO Step	Description
Step 6 Specify Acceptance Criteria (continued)	▪ **False Acceptance Error (β):** H_0 is false. The true condition is that the site contains MC at concentrations above the EALs, yet the data show that the site does not contain MC at concentrations above the EALs. The consequence of a false acceptance error at this site could result in illness due to an adverse human or ecological resources encounter with MC. To make the determination that MC are not present and that the Site can be made available for unrestricted use, IS samples will be collected and analyzed for the constituent(s) of the munitions at each potential target area identified during the MEC investigation or in areas where higher concentrations of MD was found. **4. Presence of MC above Background** In the event that MEC or MD is identified as present at the site, the stated baseline condition (null hypothesis) is that the Site does not contain MC concentrations at concentrations above background metals concentrations; explosive compounds are not naturally occurring and will not be included in background sample analyses. The assumption that the Site does not contain MC concentrations at concentrations above background metals concentrations will be maintained unless there is convincing evidence to the contrary. The alternative condition to the baseline condition is that the site contains MC at concentrations above background concentrations. The statistical hypotheses for this hypothesis are as follows: ▪ $\mathbf{H_0}$ = Site does not contain MC at concentrations above the background concentrations ▪ $\mathbf{H_a}$ = Site contains MC at concentrations above the background concentrations A decision error occurs when the decision-maker rejects the null hypothesis when it is true, or fails to reject the null hypothesis when it is false. For the purposes of this hypothesis, the possible decision errors are as follows: ▪ **False Rejection Error (α)**: H_0 is correct. The true condition is that the site does not contain MC at concentrations above the background concentrations, yet the data show that the site does contain MC at concentrations above the background concentrations. The consequence of a false rejection error at this site may result in the implementation of unnecessary remedial alternatives and/or LUCs and the expenditure of associated and unnecessary funds. ▪ **False Acceptance Error (β):** H_0 is false. The true condition is that the site contains MC at concentrations above the background concentrations, yet the data show that the site does not contain MC at concentrations above the background concentrations. The consequence of a false acceptance error at this site could result in illness due to an adverse human or ecological resources encounter with MC. To make the determination that MC are not present and that the site can be made available for unrestricted use, increment soil samples (IS) will be collected and analyzed for the constituent(s) of the munitions at each potential target area identified during the MEC investigation or in areas where higher concentrations of MD was found. The false rejection decision error limit shall be 0.05, and the false acceptance decision error limit shall be 0.20.

Table 3-5: Final MC DQOs (continued)

DQO Step	Description
Step 6 Specify Acceptance Criteria (continued)	**5. Risk Assessment** In the event that a Tier 2 Site-Specific Screening-Level Evaluation is prepared for the site, the stated baseline condition (null hypothesis) is that MC present at the site does not present an unacceptable risk to human health. This assumption will be maintained unless there is convincing evidence to the contrary. The alternative condition to the baseline condition is that MC at the site does present a risk to human health and/or the environment. The statistical hypotheses for this hypothesis are as follows: ▪ $\mathbf{H_0}$ = Site does not present an unacceptable risk to human health and/or the environment ▪ $\mathbf{H_a}$ = Site does present an unacceptable risk to human health and/or the environment A decision error occurs when the decision-maker rejects the null hypothesis when it is true, or fails to reject the null hypothesis when it is false. For the purposes of this hypothesis, the possible decision errors are as follows: ▪ **False Rejection Error (α)**: H_0 is correct. The true condition is that the site does not present an unacceptable risk to human health and/or the environment, yet the data show that the site does present an unacceptable risk to human health and/or the environment. The consequence of a false rejection error at this site may result in the implementation of unnecessary remedial alternatives and/or LUCs and the expenditure of associated and unnecessary funds. ▪ **False Acceptance Error (β):** H_0 is false. The true condition is that the site does present an unacceptable risk to human health and/or the environment, yet the data show that the site does not present an unacceptable risk to human health and/or the environment. The consequence of a false acceptance error at this site could result in preventable illness due to an adverse human or ecological resources encounter with MC. For the purpose of determining that MC concentrations at the site do not present a risk to human health and/or the environment, and that the Site can be made available for unrestricted use, a Tier 2 Site-Specific Screening-Level Evaluation will be prepared using data collected during the increment surface soil sampling event. The false rejection decision error limit shall be 0.05, and the false acceptance decision error limit shall be 0.20.
Step 7 Describe the Plan for Obtaining Data	The investigation design and rationale were developed using the Conceptual Site Model presented in Appendix B of the Work Plan, and are described in Worksheet #17. In general, the investigation design includes the following elements: A MEC survey designed to collect sufficient surface and subsurface anomaly data along pre-determined transects using a MINELAB SE or equivalent all-metals detector will be performed to determine if MD/MEC are present at the site. MC sampling will be performed in a phased approach following identification of MEC-contaminated, potential target areas, or areas with higher concentrations of MD. MC increment sampling of surface soil will be conducted within these areas. If concentrations of MC in soil samples exceed the Tier I EALs for leaching to groundwater, a Tier 2 Site-Specific Screening-Level Tier 2 Site-Specific Screening-Level Evaluation will be conducted to evaluate the risk posed to human health and/or the environment by MC at the site. If the Tier 2 Site-Specific Screening-Level Evaluation concludes that an unacceptable level of risk due to MC is present at the site, additional sampling of surface water, sediment, and subsurface soil will be conducted, and the results used to prepare a Tier 3 Baseline Risk Assessment.

3.5.5 MRSPP DQO

The MRSPP DQO is to determine the MRS Priority score for each MRS by collecting MRS-specific data from historical documentation and the RI field work. The Explosive Hazard Evaluation, Chemical Warfare Materiel Hazard Evaluation, and Health Hazard Evaluation modules from the MRSPP Scoring Tables will be updated using all data. The MRSPP Scoring Tables will be submitted independently of this RI Report.

3.5.6 MEC Data Obtained During RI

3.5.6.1 Visual and analog investigation was conducted along 46.42 miles (22.81 acres) of transects within the MVIA MRS to evaluate the nature and extent of MEC. The transect data was analyzed to identify MEC-contaminated areas and potential impact areas. Using RI and historical data, 5.60 acres of grids were placed to either define the nature and extent of MEC-contamination or to demonstrate that areas outside of MEC-contaminated areas were below the respective land-use UXO threshold of 0.5 UXO per acre. The MEC data was sufficient for meeting the MEC DQOs, as detailed in Section 5.1.

3.5.6.2 No additional MEC data was obtained for the MTC MRS due to ROE refusal.

3.5.7 MC Data Obtained During RI

3.5.7.1 Forty-two surface soil samples (14 primary and 28 duplicates/triplicates) were collected in areas with the highest concentration of MEC/MD, including the 2012 Removal Action area, and in areas where MEC items were demolished. The MC data was sufficient for meeting the MC DQOs, as detailed in Section 5.3.

3.5.7.2 Eighteen background surface soil samples (6 primary and 12 duplicates/triplicates) were collected in areas that appeared to be un-impacted by military use. The background MC data was sufficient for meeting the MC DQOs.

3.5.7.3 No subsurface soil, sediment, or surface water samples were collected in the MVIA MRS.

3.5.7.4 No additional MC data was obtained for the MTC MRS, including collection of background surface soil samples (2 primary, 4 duplicates/triplicates), due to ROE refusal.

3.5.8 Evaluation of MC Methodology

3.5.8.1 Evaluation of Chemical-Specific DQOs

3.5.8.1.1 One of the primary goals of the RI were to determine if MC were present in surface soil at concentrations exceeding the HDOH Tier 1 EALs and if so, to evaluate the potential risk the MC pose to humans and the environment. The following principal study questions were developed for the RI:

- If MEC or MD is present at the site, is MC present in surface soil at concentrations exceeding the HDOH Tier 1 EALs?
- If MEC or MD is present at the site, are metals present in surface soil at concentrations exceeding background concentrations?
- What is the risk of injury or death posed by MC at the site?

3.5.8.1.2 The DQOs listed in Section 3.5.4 were developed to address these questions.

3.5.8.2 MC Data Collection Methods

3.5.8.2.1 Soil samples were collected IAW the HDOH HEER TGM (HDOH, 2009) guidance on incremental sampling methodology (ISM). Each ISM sample was comprised of 50 incremental subsamples. Within each SU a primary, duplicate, and triplicate ISM sample was collected. Transects were laid out across each SU at fixed intervals and increment locations were selected based on a systematic-random sampling scheme. Increments were collected at evenly spaced intervals along each transect line beginning at the randomly selected starting locations. Each increment consisted of an approximately 45-gram soil sample collected from the 0 to 6 inches bgs interval with a disposable hand trowel. The soil increments were then composited in a zip-top bag. The duplicate and triplicate ISM samples were collected in the same manner as the primary ISM sample, but from a different starting point that was offset to the left or right along each transect.

3.5.8.2.2 Based on the use of disposable sampling equipment, equipment decontamination was not required or performed. Waste generated during sampling included used personal protective equipment (i.e., nitrile gloves) and municipal debris (e.g., plastic bottles, food waste, etc.). Nitrile gloves contained minimal adherence of site soil and were therefore containerized along with municipal debris in trash bags and disposed of off-site in municipal trash bins.

3.5.8.2.3 Following compositing, each sample bag was re-bagged in a new, clean zip-top bag. Zip-top bags were labeled with identifying information, including the sample identification (ID), sample collection date and time, the initials of the sampler, the client’s name, and the analyses to be performed. Sample IDs indicated the SU (i.e., MVIA-# or BKG-#) and whether the sample was the primary (i.e., -A), duplicate (i.e., -D1), or triplicate (-D2) ISM. Soil samples were stored in a sample cooler packed with ice while on-site. At the completion of each day’s sampling activities, the samples were transported by motor vehicle under chain-of-custody protocols to TestAmerica in Honolulu, Hawaii for shipment to TestAmerica in West Sacramento, California. Sample records were maintained during field activities, and chain-of-custody forms were prepared and maintained with the samples at all times. Appendix C includes copies of the soil sample records and chain-of-custody forms.

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4.0 Characterization of MEC and MC

The goal of the RI field work was to gather sufficient data on the former PTC to characterize the nature and extent of MEC and MC and assess the potential threat posed by MEC and MC to human health, safety, and the environment. This section describes the procedures used to collect the data necessary for characterization and assessment of the site. The detailed technical approach for the MEC field investigation is described in the Final RI WP (Huikala, 2013a). Deviations from the Final RI WP are described in the following sections.

4.1 Data Management

4.1.1 Hard Copy Data

During fieldwork, a written record of data, notes, and observations was maintained in a field logbook and on field forms and drawings. In addition, production reports, health and safety briefings, and contractor quality control (QC) reports were prepared for each day of fieldwork. Appendices D and E contains copies of these reports and forms.

4.1.2 Electronic Data

Electronic data collected during the RI included digital photographs and laboratory analytical results. Appendix C contains the laboratory results. Digital photographs were captured in Joint Photographic Experts Group format (.jpg). Appendix F contains the representative digital photographs taken during this RI.

4.1.3 Geographic Information System Data

Global positioning system (GPS) data was collected in the field using Universal Transverse Mercator Zone 4 North, WGS84 format. Data was then projected into NAD 1983 HARN and converted to into ArcGIS shapefiles (.shp) or personal geodatabase (.mdb). The GIS coordinate system is in meters. Satellite imagery used in maps was acquired from United States Geological Survey high resolution orthoimages and Bing Maps aerial imagery GIS service. Final GIS data is provided in Appendix G.

4.2 MEC Characterization

4.2.0.1 Primary MEC investigation activities were conducted from July 2013 thru October 2013 in the MVIA MRS. After a preliminary review of the data, the PDT and Huikala determined that additional investigation along public trails would be appropriate to address finding a 105-mm HE projectile on the Maunawili Demonstration Trail (MDT) and a 37-mm HE M63 on the Maunawili Falls Trail (MFT). Additional investigation activities along public trails were performed from February to March 2014.

4.2.0.2 No investigation activities were performed in the MTC MRS because the landowners did not provide ROE.

4.2.1 Technical Approach

4.2.1.1 The MEC investigation technical approach was designed to collect sufficient surface and subsurface anomaly data along pre-determined transects using a hand-held all-metals detector. The transect design optimized the determination of MEC density and the limits of MEC contamination, to ensure a 90% confidence level of identifying potential impact areas (e.g., areas with elevated anomaly densities relative to background) given the munitions of concern with the smallest expected fragmentation dispersion pattern. VSP software was used to calculate the probability of traversing and detecting a target area using 1-meter wide transects with a parallel transect pattern. A background anomaly density of 50 anomalies per acre was selected for the MVIA.

4.2.1.2 The target radius for MVIA was determined to be 500 feet based on discussions with the PDT. Once potential impact or high MEC/MD density areas were identified, the field team would subsequently collect additional anomaly data by placing and investigating grids to estimate the anomaly density and determine nature and extent of MEC. UXO Estimator would then be used to calculate the acreage requiring investigation to determine if areas outside of MEC-contaminated areas were below the low-use threshold of 0.5 UXO per acre.

4.2.1.3 The approach was comprised of the following steps:

- Archaeological, Cultural, and Biological Resource Avoidance
- Limited Vegetation Removal
- MEC Investigation
- MEC Disposal
- Disposal/Disposition of MPPEH
- Quality Control

4.2.2 Field Change Requests

4.2.2.1 Field change request (FCR) 001 was submitted and approved to incorporate the use of meandering transects in the investigation. Steep topography impaired and limited the application of the parallel transects in the central and western areas of the MRS.

4.2.2.2 FCR 0003 was submitted and approved to modify the transect width from the 1-meter wide standard to the actual width of the trail. This modification was specifically for the public trails investigation. FCR 002 was relevant to MC sampling and is described in Section 4.3.2.

4.2.2.3 FCRs are provided in Appendix H.

4.2.3 Geophysical Prove Out

4.2.3.1 An instrument verification strip (IVS) was installed at the laydown yard as described in the Final RI WP (Appendix A, Figure A4-1). Industry standard objects (ISOs) were used as the seed items and buried at varying depths and orientations. Initially, the three ISO sizes listed in Table 4-1 were used as seed items.

Table 4-1: IVS Construction

Item	Nominal Pipe Size	Outside Diameter	Length	Depth	Orientation
Small ISO	1-inch	1.315-inch (33-mm)	4.000-inch (102-mm)	3 inches	Vertical
				7 inches	Horizontal
Medium ISO	2-inch	2.375-inch (60-mm)	8.000-inch (204-mm)	6 inches	Horizontal
				14 inches	Vertical
Large ISO	4-inch	4.500-inch (115-mm)	12.000-inch (306-mm)	20 inches	Vertical
				28 inches	Horizontal

4.2.3.2 The UXO Quality Control Specialist (UXOQCS) determined that there was an issue detecting the large ISOs in the IVS during the operator/equipment QC check. The all-metals detector could not detect the large ISOs when the instrument was held 6 inches above ground surface (ags). The large ISOs were installed at depths of 28 inches (in a horizontal orientation) and 20 inches (in a vertical orientation) bgs. The equipment was detecting the ISO at the 20-inch depth more often than the ISO at the 28-inch depth, but not with sufficient confidence. The PDT and the Huikala project team agreed that the largest munition expected was an 81-mm mortar which was closer in size to a medium ISO and would likely be found at a depth shallower than 28 inches bgs. As a result, the large ISOs were replaced by medium ISOs and buried deeper than 12 inches bgs in a horizontal orientation.

4.2.3.3 A new IVS was established for the public trails investigation in February 2014 (Appendix A, Figure A4-2). The new IVS was constructed as described in the Final RI WP using ISOs placed at the depths/orientations shown in Table 4-1, with the exception of the large ISO. During the July – October 2013 investigation, a 105-mm HE projectile was found along the MDT. The 105-mm projectile replaced the 81-mm mortar as the largest munition expected and the large ISO was appropriate to use in the IVS. However, as described in the previous paragraph, the all-metals detectors were not detecting the large ISO at a 28-inch depth (in a horizontal orientation) with sufficient confidence. The PDT and the Huikala project team agreed to install a large ISO at a 20-inch depth in both the vertical and horizontal orientation.

4.2.4 Archaeological, Cultural, and Ecological Resource Avoidance

Trained archaeological and ecological monitors accompanied the UXO teams to identify existing or new resources within the areas of investigation. If resources were identified, the UXO teams adjusted the path of the transect or location of the grid to avoid any impact to the resource.

4.2.5 Limited Vegetation Removal

Vegetation removal was conducted only to allow access for investigation or sampling activities. Grass, vines, shrubs, and small trees less than 4-inches in diameter were cleared to 6 inches ags using manual methods such as machetes, brush cutters, and chain saws. Vegetation cuttings were left on-site to naturally decay. No threatened or endangered species were impacted.

4.2.6 MEC Investigation

Investigation activities were performed by qualified UXO personnel meeting the standards of Department of Defense Explosives Safety Board Technical Paper 18 (DDESB, 2004) and the requirements outlined in the Final RI WP (Huikala, 2013a). Transects and grids were navigated and recorded by using a hand-held TRIMBLE GeoExplorer (XH) 6000 GPS unit with a pole-mounted external antenna.

4.2.6.1 Transect and Grid Investigation

4.2.6.1.1 Refer to Appendix A, Figure A4-3 for final transect and grid locations and Appendix J for transect and grid logs.

4.2.6.1.2 UXO teams, using a MINELAB Explorer SE, swept 1-meter wide transects and identified surface and subsurface anomalies in accessible areas (less than 18 degrees slope) during the primary investigation activities in 2013. In the eastern portion of MVIA, transects were placed in a parallel pattern spaced approximately 350 feet apart, as designed. As the UXO team moved westward, the terrain became steeper and more rugged and evenly spaced parallel transects were not feasible. Meandering transects, following terrain and topography, were implemented IAW FCR 001 (Appendix H). A total of 86 transects of varying orientation and length were investigated.

4.2.6.1.3 Once the transect data was analyzed, 19 grids ranging in size from 0.1 acres to 0.4 acres were placed in areas of high density, elevated density, or where MEC was found to better define the nature of potential MEC contamination. Three grids were placed in areas with low MD density and without MEC to determine if areas outside of the MEC-contaminated areas were less than the low-use threshold of 0.5 UXO per acre, as referenced in Section 4.2.1.2. No grids were placed in the eastern portion of the MVIA due to the lack of MEC/MD finds during transect investigation.

4.2.6.1.4 During the additional investigation activities in 2014, 24 transects were placed and swept on the MDT and the MFT. The entire lengths of the MDT and MFT within the MVIA boundary were investigated. The width of the transects varied to match the actual width of the trail, as delineated by vegetation growth and professional judgment of the UXO sweep team IAW FCR 0003 (Appendix H). No additional grids were installed.

4.2.6.1.5 Each subsurface anomaly location was excavated until the anomaly was located and the excavation was confirmed to be clear. Excavations were then backfilled. Seven MEC items, including two discarded military munitions (DMM) items, and 1,346 MD items were found. Table 4-2 lists the types of items discovered. Seven items were found that had not been identified during previous investigations. The discovery of the 105-mm HE projectile resulted in an amendment to the Explosives Siting Plan (ESP). The 105-mm HE projectile replaced the 81-mm HE mortar, M43A1 as the munition with the greatest fragmentation distance. The minimum separation distance was increased from 1,579 feet to 2,111 feet for intentional detonations. Additionally, the seven new munition types identified during the field investigation were similar in nature to previously identified types or have a target radius of at least 500 feet. The original VSP transect design was valid.

Table 4-2: MEC and MD Items

Item Description	Quantity
MD, 2.36-in Rocket, M7A1 Practice*	3
MD, 37-mm armor piercing (AP) M74	4
MD, 37-mm, APCT, M51*	1
MD, 37-mm, APCT M59	8
MD, 57-mm Projectile, APT M70	1
MD, 60-mm Mortar, M49A2	4
MD, 60-mm Mortar, M50A2, Practice *	1
MD, 60-mm Mortar, Tail Boom	10
MD, 75-mm Projectile, Shrapnel MK1	2
MD, 81-mm Mortar	9
MD, 81-mm Mortar, White Phosphorus, M57 *	1
MD, 81-mm Mortar, Tail Boom	40
MD, Frag Unknown	1,070
MD, Fuze Component	88
MD, Fuze, PD M48 *	47
MD, Fuze, PTT M1907	2
MD, Fuze, PTT TSQ M54	6
MD, Large Frag Unknown*	4
MEC, 105-mm HE Projectile *	1
MEC, 37-mm, HE M63 with BD M58 Fuze	3
MEC, 75-mm Shrapnel, Mk1	1
MEC, 81-mm HE Mortar, M43A1 (DMM)	2
Small Arms	45
Total	**1,353**

*New item (not identified during previous investigations)

4.2.6.1.6 Data (location, coordinates, depth, fuzing type, and condition) for each MEC/MD anomaly was recorded as described in the Final RI WP (Huikala, 2013a) and is available in Appendix I. Digital photographs were taken of each MEC item and MD item type and are provided in Appendix F.

4.2.6.1.7 Additional transect and grid information is provided in Appendix J. Results of the investigation are presented in Section 5.0.

4.2.7 MEC Disposal

Seven MEC items were found during the transect and trail investigation. No MEC items were found in grids. MEC disposal was performed IAW the procedures outlined in the Final RI WP (Huikala, 2013a) and ESP. Four items were determined to be acceptable-to-move and were relocated to a consolidated demolition area for disposal. Three items, the 37-mm HE projectiles, though deemed acceptable-to-move, were blown-in-place due to logistical challenges of moving them over rugged terrain to reach a consolidated demolition area. The project biologist and CEPOH archaeologist surveyed the demolition areas and verified they were void of sensitive resources prior to demolition.

4.2.8 Disposal/Disposition of MPPEH

All MD/MPPEH were stored on-site in a locked container IAW the Final RI WP (Huikala, 2013a). The items were inspected and determined to be material documented as safe (MDAS). The MDAS was packaged, sealed in a labeled container, and shipped off-island for destruction and final disposition. The signed DD Form 1348-1A and the MEC-MD-MPPEH Log are presented in Appendix I. Final destruction forms will be submitted upon receipt from the destruction facility.

4.2.9 Quality Control

4.2.9.1 QC inspection and/or surveillance points and sampling frequency for each selected definable feature of work were in accordance with the Final RI WP (Huikala, 2013a). Inspection frequencies were at a normal state but could have been tightened or relaxed based on a variety of factors such as team performance, project duration, geophysical, and intrusive investigative results, etc. Daily QC reports are provided in Appendix D. Additional QC documentation is provided in Appendix K.

4.2.9.2 During the transect investigation, the UXOQCS or QC assistant followed the sweep teams to perform 100% transect and 100% anomaly verification checks. The QC assistant was designated by the UXOQCS to verify that the appropriate QC measures were being followed during the data collection process. Specifically, the QC assistant was tasked with following the investigation team and sweeping 100% of the transects and 100% of the anomalies and ensuring that the QC process was correctly documented. The UXOQCS then conducted spot checks at

60-meter intervals with the QC assistant. Once a transect “lot” was verified by the UXOQCS, the dynamic repeatability and anomaly resolution results were recorded on QC inspection forms and submitted to the Ordnance and Explosives Safety Specialist (OESS). A transect “lot” is defined as either 4 transects or approximately 2,000 meters.

4.2.9.3 During grid investigation, team leaders conducted 100% verification of blind seed recovery. The UXOQCS conducted 20% verification along a meandering path. Recovered seeds were recorded on grid data sheets. Coverage seeds, placed and recovered, were reported on the QC inspection forms on a per lot basis. A grid “lot” is defined as less than one-acre.

4.2.9.4 The UXOQCS notified the OESS when a transect or grid lot was completed to allow the OESS to conduct their quality assurance (QA) check. QA documentation is provided in Appendix L.

4.2.9.5 Functional checks of the MINELAB Explorer SE were performed at the IVS. Instruments that did not function properly during the functional test, or at any time during the investigation, were replaced and not used during field activities until they were repaired and passed the function test.

4.2.9.6 GPS equipment was tested on a known control point prior to the start of each day of use. The tolerance for testing the GPS equipment functionality was established at 1-foot checked against a known benchmark. If the test failed, the equipment was re-tested, repaired, or replaced.

4.2.9.7 Additionally the UXOQCS conducted QC checks and surveillance of the procedures used for processing and certifying metal scrap throughout the duration of field operations. The UXOQCS performed visual inspections on every container of scrap or waste generated, to ensure no items of a dangerous or explosive nature were identified as MDAS. All certified-MDAS material was segregated to prevent co-mingling and to maintain an intact chain-of-custody, and secured in storage containers while awaiting final destruction and disposition.

4.3 MC Characterization

4.3.0.1 Data were collected during the RI to determine if MC (i.e., metals [antimony, chromium, copper, lead, and zinc] and explosives), associated with identified MEC, are present at the site and to provide sufficient information to conduct a human health baseline risk assessment and a screening level ecological risk assessment if MC are identified at concentrations exceeding the HDOH Tier 1 EALs (i.e., potentially impacted groundwater is a current or potential drinking water resource; surface water body is located within 150 meters) (HDOH, 2012). Data were also collected to evaluate site-specific background metals concentrations in soil in order to verify the assumption that the site does not contain metals concentrations above background.

4.3.0.2 Soil sampling activities were conducted between October 16 and October 22, 2013. This section summarizes the soil sampling activities, the handling and shipping of samples, data quality and usability, and describes the procedures for managing data. Appendix D contains copies of field notes and forms. Appendix F provides photographs of the field activities. Laboratory results and validation reports are discussed in Section 5.0 and provided in Appendix C.

4.3.1 Technical Approach

4.3.1.1 Sampling was to be performed in a phased approach following identification of MEC-contaminated areas. If MEC-contaminated areas were identified during the MEC investigation, MC incremental sampling of surface soil would be conducted within the MEC-contaminated area, as well as areas with high MD density. The results of the MC sampling would be compared against HDOH Tier 1 EALs and background soil concentrations. If MC concentrations exceeded either threshold, a more detailed risk assessment would then be performed. If the next tier risk assessment indicated that a risk exists above acceptable risks to human health and the environment, subsurface soil, sediment, and surface water bodies that may be impacted by the MC-contaminated soil would also be subsequently sampled and a baseline risk assessment conducted. The approach was comprised of the following steps:

- Archaeological, Cultural, and Biological Resource Avoidance
- Identification of SUs with potential MC in available media as evidenced by the presence of MEC or MD
- Identification of SUs in background locations where environmental impacts from military munitions is unlikely
- Collection of surface soil samples using increment sampling techniques (50 increments per sampling unit)
- Calculation of the 95^{th} percentile upper tolerance limit background concentrations
- Comparison of soil sample results to HDOH Tier 1 EALs and background concentrations
- Collection of additional surface soil, subsurface soil, sediment, or surface water samples, if necessary

4.3.2 Field Change Requests

FCR 002 was submitted and approved to revise sampling protocols (disposable sampling equipment), reduce the number of background samples, and laboratory procedures and reporting limits (Limits of Detection and Limits of Quantitation). FCR 002 is provided in Appendix H.

4.3.3 Archaeological and Ecological Resource Avoidance

Trained archaeological and ecological monitors accompanied the sampling team to identify resources within the SUs. If resources were identified, the sampling team adjusted the location or orientation of the SU to avoid any impact to the resource.

4.3.4 MC Investigation

4.3.4.1 Identification and Location of Sampling Units

4.3.4.1.1 Surface soil samples were collected at twenty SUs at the MVIA MRS (Appendix A, Figure A4-4). Each SU was approximately 5,000 square feet in size, and was sampled using an ISM. Six SUs (BKG-01 through BKG-06) were located in areas identified during the MEC investigation as un-impacted by MEC and/or MD. Fourteen of the SUs were located in areas where MEC and/or MD was discovered as follows:

- Ten SUs (MVIA-01, -02, -05 through -07, and -09 through -13) were located within characterization grids or along transects where all MEC and MD were removed during the RI. The 10 areas selected for sampling were those where the highest concentrations of MEC and MD were found.
- Two SUs (MVIA-03 and MVIA-08) were located in portions of the 2012 Removal Action Area where high concentrations of MEC were previously identified.
- One SU (MVIA-04) was centered on the consolidated demolition area where MEC identified during the RI, and deemed “acceptable-to-move” were relocated for demolition.
- One SU (MVIA-14) was centered on the area where the 37-mm HE projectile was blown-in-place during the primary RI activities.

4.3.4.1.2 SU boundaries were recorded using a TRIMBLE GeoXH hand-held GPS device.

4.3.4.2 Surface Soil Sampling

4.3.4.2.1 Soil samples were collected in accordance with the HDOH HEER TGM guidance on ISM (HDOH, 2009). Each ISM sample was comprised of 50 incremental subsamples. Within each SU a primary, duplicate, and triplicate ISM sample was collected. Transects were laid out across each SU at fixed intervals and increment locations were selected based on a systematic-random sampling scheme. Increments were collected at evenly spaced intervals along each transect line beginning at the randomly selected starting locations. Each increment consisted of an approximately 45-gram soil sample collected from the 0 to 6 inches bgs interval with a disposable hand trowel. The soil increments were then composited in a zip-top bag. The duplicate and triplicate ISM samples were collected in the same manner as the primary ISM sample, but from a different starting point that was offset to the left or right along each transect.

4.3.4.2.2 Equipment decontamination was not required or performed because disposable sampling equipment was used. Waste generated during sampling included used personal protective equipment (i.e., nitrile gloves) and municipal debris (e.g., plastic bottles, food waste, etc.). Nitrile gloves contained minimal adherence of site soil and were therefore containerized along with municipal debris in trash bags and disposed of off-site in municipal trash bins.

4.3.4.3 Analytical Services

4.3.4.3.1 A total of 60 soil samples were analyzed by TestAmerica in West Sacramento, California. The laboratory is accredited by the United States DoD Environmental Laboratory Accreditation Program. Samples were received between October 18, 2013 and October 24, 2013 and assigned in the following sample delivery groups (SDGs) for metals: 320-1614, 320-4621, 320-4644, 320-4654, 320-4686. All samples were analyzed for the following:

- Selected Metals (i.e., antimony, chromium, copper, lead, and zinc) by the EPA Solid Waste (SW)-846 Method 6020 (EPA, 2008a)
- Explosives (also known as Nitroaromatics, Nitramines, and Nitrate Esters) by EPA SW-846 Method 8330B (EPA, 2008a)

4.3.4.3.2 ISM preparation and subsampling was performed by the lab IAW the approved Uniform Federal Policy – Quality Assurance Project Plan (UFP-QAPP) (Huikala, 2013a). In accordance with HDOH guidance, a 10-gram unground aliquot was analyzed for metals.

4.3.4.3.3 Although not required, the background surface soil samples were analyzed for explosives. This was a deviation from the Final UFP-QAPP submitted as part of the Final RI WP (Huikala, 2013a). Additional information is provided in Section 5.3.

4.3.4.4 Data Management

The laboratory provided analytical results as data files in Adobe portable document format (.pdf). The analytical data are provided in five analytical reports, organized by SDG. Appendix C contains the laboratory analytical reports. The third-party data validator provided a single data validation report that included all five SDGs in .pdf format, which is also presented in Appendix C. In addition, the third-party data validator provided the validated laboratory data in a staged electronic data deliverable (SEDD) format (.edd) compatible with EPA SEDD specifications. The SEDD files were provided to USACE on compact disc and are not included in this RI Report.

4.3.5 Quality Control Procedures

4.3.5.1 Data Validation

A third-party validation was performed by Laboratory Data Consultants. Samples were validated at the frequency of 90% Level III (standard validation) and 10% Level IV (full validation). The following six samples underwent full validation: PTC-SOIL-1-MVIA-11-A, PTC-SOIL-1-MVIA-11-D1, PTC-SOIL-1-MVIA-11-D2, PTC-SOIL-1-MVIA-13-A, PTC-

SOIL-1-MVIA-13-D1, and PTC-SOIL-1-MVIA-13-D2. The analyses were validated using the following documents, as applicable to each method:

- Approved UFP-QAPP (Huikala, 2013a)
- DoD Quality Systems Manual for Environmental Laboratories (DoD, 2010)
- Test Methods for Evaluating Solid Waste, Physical/Chemical methods (EPA, 2008a).

4.3.5.2 Data Validation Summary and Conclusions

4.3.5.2.1 Review of the data shows that the data are usable and of acceptable quality. Qualifiers applied to the dataset are U (non-detected), J (estimated), UJ (non-detected and estimated), and NJ (presumptive evidence of presence of the compound at an estimated quality).

4.3.5.2.2 Non-detected Data: Two RDX results were qualified as not detected because the analyte was detected in laboratory blank.

4.3.5.2.3 Estimated Data: Portions of the metal, nitroaromatics and nitroamines were qualified as estimated because of matrix spike/matrix spike duplicate (MS/MSD) recoveries, relative standard deviations (RSD) and relative percent differences (RPD) of field triplicate, laboratory blanks, and laboratory control samples (LCS) not meeting laboratory QC limits.

4.3.5.2.4 Data Completeness Assessment: A total of 1,260 data records were reviewed during the data validation and data quality review. No data were rejected and 100% of the data are considered valid.

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5.0 RI Results and Revised CSM

5.0.1 This section summarizes the RI results for MEC and MC at the MVIA MRS. RI field activities were not performed at the MTC, MVTC, and UTC MRSs.

5.0.2 Figures, daily field reports, field logbooks, photographic logs, transect and grid logs, the MEC/MD/MPPEH log, and VSP analysis are included in the Appendices.

5.1 RI Results (MEC)

5.1.0.1 A total of 86 1-meter wide parallel and meandering transects and 24 trail transects were investigated in the MVIA. A total length of 46.42 miles (22.81 acres) was swept for the presence of MEC and MD within the 2,795-acre (GIS) MRS. An additional 5.60 acres of grids were also investigated. Areas with a slope greater than 18 degrees were not investigated due to worker safety concerns. Refer to Appendix A, Figure A4-3 for final transect and grid locations.

5.1.0.2 Overall, the MEC and MD finds were concentrated in the western portion of MVIA. MD was well distributed in the south-central region. No MEC or MD items were found in the north-central or eastern portions of the MRS. Refer to Appendix A, Figure A5-1 for MEC and MD locations. In total, 7 MEC items and 1,346 MD items were found, as listed in Table 5-1.

Table 5-1: Summary of RI Findings

Anomalies	MEC Items	MD		Non-MD (pounds)
		Items	Weight (pounds)	
5,649	7	1,346	476	646

5.1.0.3 Seven new types of munitions were identified during the RI (Table 4-2). The findings were generally consistent with previous investigations with respect to the type and locations of MEC/MD, with the exception of the 105-mm HE projectile and the large MD fragments. The munition type that generated the large fragments is unknown, though it is estimated to be larger than the 105-mm HE projectile. Additionally, the seven new munition types did not impact the VSP transect design.

5.1.1 Visual Sample Plan Analysis

5.1.1.1 Following the completion of the transect investigation, transect data and the locations of MEC and MD were input into VSP. The data were then used to generate (1) a report demonstrating that the simulated probability of traversing and detecting a 500-foot radius circular target area with at least a 90% confidence had been achieved and (2) a density analysis identifying locations of elevated and high anomaly density (Appendix M). Areas of elevated density were defined as areas where MEC/MD density is greater than background density of 50 anomalies per acre. VSP identified eight small areas of elevated density, three in the western half and five in the central section of the MRS. Additionally, VSP identified four areas of high density in the western portion of the MVIA. Areas of high density were defined as locations where MEC/MD density is greater than 100 anomalies per acre total density, which is at least 50 anomalies per acre greater than background density. Areas of elevated density and high density correspond to areas where higher concentrations of MD were located (Appendix A, Figure A5-1).

5.1.1.2 Seventeen grids (Grids 02, 03, 05 through 16, 18, 20, and 21) were placed in areas with high MD density or near locations where MEC items were found during the transect investigation in order to determine nature and extent. Two grids (Grid 04 and 17) were placed at MEC locations. Three grids (Grids 01, 19, and 22) were located outside of MEC-contaminated areas. Grid locations are depicted in Appendix A, Figure A4-4. No additional MEC items were found in the grids. One new MD item, an 81-mm Mortar, White Phosphorus, M57 was identified in Grid 02; however, there were no other instances of this item in surrounding grids or transects.

5.1.1.3 As shown on Appendix A, Figure A5-1, there were no MEC items found in the central region of the MRS and only limited MD findings during both the transect and grid investigation. This is consistent with previous investigations. Based on this data, the elevated density areas identified by VSP in the central region are not MEC-contaminated and do not appear to be target areas.

5.1.1.4 In the western region of the MRS, VSP identified four large areas of high MEC/MD density and three smaller areas of elevated MEC/MD density (Appendix M). The VSP density analysis is consistent with the 1994 INPR and 2008 EE/CA which outlined the area west and south of Pikoakea Spring (closest stream east of the spring is unnamed) as an impact area. A removal action was conducted in this area based on these previous findings. One small elevated density area was also identified in the western portion of MVIA and is MEC-contaminated because two 81-mm mortars were found during the investigation. However, the area is not a target since the items found were DMM and intentionally buried rather than fired at that location.

5.1.1.5 Two large high density and two small elevated density areas are located in the southwestern bowl-shaped valley surrounding the 40-acre area cleared during the 2012 Removal Action. These areas likely represent an extension of the impact area that was previously addressed during the 2012 Removal Action. No MEC items were found, although a substantial quantity of MD, categorized as munitions fragments of unknown type were found within these four areas during the RI. The RI data in conjunction with the previous investigations and removal action, confirm that this is an impact area. There were no areas in the “bowl” with a high concentration of any specific munition type. There was also no evidence of physical targets, such as bunkers or a tank. It is likely that the “bowl” was a “general use” impact area.

5.1.1.6 The large high density area near the Maunawili Falls is MEC-contaminated. Three MEC items, all 37-mm HE projectiles, were found on or adjacent to the MFT. There was also a concentration of 81-mm mortar MD in the same area. This may have been a target area for these munitions types.

5.1.1.7 . One MEC item, a 75-mm projectile, was found in the large high density area located in the northwest valley of the MRS, separated from the "bowl" by the MFT/O`mao Stream. This area is MEC-contaminated. Similar to the "bowl," there were no areas with high concentrations of specific munition types. The types of MD found during both the RI and previous investigation were also categorized as munitions fragments of unknown type or high explosives fragments. It is likely this valley was also a "general use" impact area.

5.1.1.8 Based on the combined data from the 2008 EE/CA, the 2012 Removal Action, and the RI, the impact areas in the MVIA MRS have been identified with at least a 90% confidence level the nature and extent of MEC-contamination has been delineated within these impact areas. Appendix A, Figure A5-2 depicts the combined MEC and MD finds. The MEC DQO 1 was achieved (refer to Section 3.5.3).

5.1.2 UXO Estimator

5.1.2.1 UXO Estimator software was utilized to determine the acreage required for investigation in order to demonstrate that areas outside of potential MEC contamination were less than a specific land use UXO density threshold. The MVIA MRS has a land use classification of "low-use" and the corresponding threshold is 0.5 UXO per acre. "Low-use" typically indicates that there is minimal intrusive activity occurring. UXO Estimator acreage can be achieved by either investigating transects, grids, or both.

5.1.2.2 UXO Estimator determined that a minimum of 4.59 acres, outside of MEC-contaminated areas, required investigation to achieve a 90% confidence that low-use areas were below the 0.5 UXO per acre threshold. Approximately 19.50 acres of transects and 1.04 acres of grids (Grids 01, 19, and 22), outside of MEC-contaminated areas, were investigated with no MEC items found. The MEC DQO 2 was achieved (refer to Section 3.5.3).

5.1.3 Results of RI Compared to Previous Studies

5.1.3.1 The RI findings were relatively consistent with findings from previous investigations with regards to the nature of MEC potentially within the MVIA MRS. Seven new types of potential munitions were identified: 2.36-inch rocket, M7A1, Practice; 37-mm APCT, projectile, M51; 60-mm mortar, M50A2, Practice; 81-mm mortar, white phosphorous, M57; 105-mm HE projectile; fuze of a projectile, PD, M48; and unknown large fragments. With the exception of the 105-mm HE projectile and the unknown large fragments, the other five types of munitions were variations of munition types previously identified.

5.1.3.2 The extent of MEC/MD found within the MVIA was also relatively consistent with previous investigations, particularly in the western portion of the MRS. The combined data supported the conclusion to define this area as an impact area.

5.1.3.3 The extent of MEC/MD found in the central portion of the MRS was not consistent with previous investigations. Ninety-four MD items were found in the central portion during the RI, whereas no MEC or MD were found during the 2008 EE/CA. This inconsistency may be attributed to less transect coverage during the EE/CA as well as performing visual/surface sweeps only.

5.2 Revised CSM (MEC)

5.2.0.1 The locations and densities of the MEC and MD were assessed in relation to the topography of the MRS, the suspected military activities that may have occurred within the MRS, current/future land use scenarios, and possible receptors. As a result, the MVIA MRS was divided into three sections: MVIA – West, MVIA – Central, and MVIA – East. Refer to Appendix A, Figure A5-2. Dividing the MRS into sections will assist in analyzing different remedial alternatives during the FS.

5.2.0.2 The CSM for MEC was updated using the RI results and is included in Appendix A, Figure A5-3. A CSM was developed for each of the MVIA subdivisions. There were no changes to the MTC CSM for MEC.

5.2.1 MVIA – West

5.2.1.1 MVIA – West is naturally bound by the Koolau mountain range to the south and ridgelines to the east and west. It is approximately 1,000 acres. MVIA – West is primarily undeveloped forest with steep, rugged terrain. However, there are public hiking trails, an agricultural research center, farmland, water tunnels, and power lines within the boundary (Appendix A, Figure A1-1). Receptors in the section include recreational users, agricultural workers, and occupational workers maintaining trails or utility infrastructure.

5.2.1.2 Seven MEC items and 1,252 MD items were found in the 22.40 miles (11.05 acres) of meandering transects and 4.86 acres of grids investigated. The density of the MEC and MD in MVIA – West indicates that this section was used as an impact area. This is consistent with previous investigations. The types and quantities of MEC and MD items are provided in Table 5-2.

Table 5-2: MEC and MD in MVIA – West

Item Description	Quantity
MD, 2.36-in Rocket, M7A1 Practice*	3
MD, 37-mm AP, M74	1
MD, 37-mm, APCT, M51*	1
MD, 37-mm, APCT M59	8
MD, 57-mm Projectile, APT M70	1
MD, 60-mm Mortar, M49A2	3
MD, 60-mm Mortar, M50A2, Practice *	1
MD, 60-mm Mortar, Tail Boom	10
MD, 75-mm Projectile, Shrapnel MK1	2
MD, 81-mm Mortar	9
MD, 81-mm Mortar, Tail Boom	34
MD, Frag Unknown	999
MD, Fuze Component	83
MD, Fuze, PD M48 *	45
MD, Fuze, PTT M1907	2
MD, Fuze, PTT TSQ M54	5
MD, Large Frag Unknown*	4
MEC, 105-mm HE Projectile *	1
MEC, 37-mm, HE M63 with BD M58 Fuze	3
MEC, 75-mm Shrapnel, Mk1	1
MEC, 81-mm HE Mortar, M43A1 (DMM)	2
Small Arms	41
Total	**1,259**

*New item (not identified during previous investigations)

5.2.1.3 MEC items have been found in MVIA – West, both on the surface and subsurface. Therefore the exposure pathway from MEC to human receptors is complete.

5.2.2 MVIA – Central

5.2.2.1 MVIA – Central is naturally segregated to the east and west by topographical features and is approximately 867 acres. The Aniani Nui/Olomana ridgeline extends from the Koolau mountain range on the east and the `Ainoni ridgeline extends from the Koolau to the west. Portions of the Royal Hawaiian Golf Club and the MDT as well as power and water utilities are within the boundary. However, MVIA – Central is primarily undeveloped forest with steep, rugged terrain (Appendix A, Figure A1-1). Receptors in this section include recreational users, golf club employees, and occupational workers maintaining trails or utility infrastructure.

5.2.2.2 Ninety-four MD items were found in the 16.40 miles (8.09 acres) of parallel and meandering transects and 0.74 acres of grids investigated. No MEC items were found in accessible areas (less than 18 degrees slope) The majority of the MD was located southern half of the MVIA – Central, with a small clustering of fragmentation and 81-mm mortar tail booms in the northwestern corner along the `Ainoni ridgeline. There were no MD findings in the Golf Club property.

5.2.2.3 The lack of large areas with high anomaly density suggests that this section was more likely used as a maneuver area rather than an impact/target area. The types and quantities of MD items are provided in Table 5-3.

Table 5-3: MD in MVIA – Central

Item Description	Quantity
MD, 37-mm AP, M74	3
MD, 60-mm Mortar, M49A2	1
MD, 81-mm Mortar, Tail Boom	6
MD, 81-mm Mortar, White Phosphorus, M57 *	1
MD, Frag Unknown	71
MD, Fuze Component	5
MD, Fuze, PD M48 *	2
MD, Fuze, PTT TSQ M54	1
Small Arms	4
Total	**94**

*New item (not identified during previous investigations)

5.2.2.4 Even though no MEC items were found in the MVIA – Central accessible areas (less than 18 degrees slope), the types of MD found during the RI suggest that a potential explosive hazard exists. The exposure pathway from MEC to human receptors potentially complete through direct exposure to MEC located on the surface and subsurface.

5.2.3 MVIA – East

5.2.3.1 MVIA – East is approximately 612 acres, topographically segregated from the rest of the MRS. The Aniani Nui/Olomana ridgeline extends from the Koolau mountain range to the northeast MRS border. A new residential community being constructed overlaps with the eastern border (Appendix A, Figure A1-1). The developer is providing their own UXO response contractor to manage any items found during construction. To the south of the new development, is an area owned by the State of Hawaii and leased to a community organization. ROE was not granted for this area. Therefore, neither area was included in the investigation

5.2.3.2 No MEC or MD items were found in the 7.61 miles (3.67 acres) of parallel transects investigated. However, there were multiple areas littered with non-MD items.

5.2.3.3 No MEC or MD were found during the RI or during previous investigations. There is no evidence to suggest an explosive hazard at MVIA – East. Consequently, the exposure pathway between MEC and human receptors is incomplete.

5.3 RI Results (MC)

5.3.1 MC Presence, Nature, and Extent

Soil results were compared to the HDOH Tier 1 EALs (i.e., potentially impacted groundwater is a current or potential drinking water resource; surface water body is located within 150 meters). Metals results were also compared to site-specific background values. Tables 5-4 and 5-5 summarize the soil sampling results and the HDOH Tier 1 EALs. Tables 5-6 and 5-7 present the site-specific background values for metals and summary statistics for the background soil data. Surface soil samples were collected in MVIA MRS only.

5.3.1.1 Soil Sample Results

5.3.1.1.1 In total, 42 soil samples (i.e., 14 primary and 28 replicate) were collected in SUs associated with MEC and/or MD. Metals and explosive concentrations in all samples were below the HDOH Tier I EALs (HDOH, 2012) (Tables 5-4 and 5-5).

5.3.1.1.2 Four or more metals were detected in all samples at concentrations one to two orders of magnitude below their respective HDOH Tier 1 EALs. Additionally, the soil metals concentrations results were generally below, or within one standard deviation of, the maximum detected background concentration. One or more of the following explosives were detected in one or more of the samples at concentrations one to three orders of magnitude below their respective HDOH Tier 1 EALs: 2,4,6-Trinitrotoluene; 2,4-Dinitrotoluene; 2-Amino-4,6-dinitrotoluene; 2-Nitrotoluene; 4-Amino-2,6-dinitrotoluene; 4-Nitrotoluene; HMX; Nitrobenzene; RDX; and Tetryl.

5.3.1.2 Site-Specific Background Evaluation

5.3.1.2.1 Site data were compared to the site-specific background values in order to verify the assumption that the site does not contain metals concentrations above background values and, if this assumption proved incorrect, to enable the risk assessments to focus on MC related to site-specific activities and to eliminate metals that are present at natural or anthropogenic background concentrations. Background is defined as either naturally occurring (i.e., the concentration is not due to a release of chemicals from human activities) or anthropogenic (i.e., the concentration is due to human activities but is not the result of site-specific use or a chemical release).

5.3.1.2.2 Background concentrations were calculated using EPA's Statistical Software ProUCL Version 5.0 (EPA, 2013) and the analytical results from the 18 background soil samples collected during the RI (Table 5-6). Background concentrations were calculated in accordance with the following guidance:

- "Use of Statistics for Determining Soil/Groundwater Cleanup Levels under the Risk Reduction Rules" (EPA, 1998)

- Memorandum Regarding "Role of Background in the CERCLA Cleanup Program, OSWER 9285.6-07P" (EPA, 2002)

- USEPA Region 10 Superfund Regional, Sediment Evaluation Team, Dredged Material Management Program (DMMP) Dioxin Workgroup. "Statistical Experts' Workshop, Workshop Report" (EPA, 2008b)

5.3.1.2.3 The background threshold value (BTV) was defined in this assessment as the 95% upper tolerance limits (UTLs) for the background dataset. ProUCL 5.0 computes UTLs which adjust for data skewness. ProUCL 5.0 computes upper limits using estimates based on normal, lognormal, gamma, or nonparametric distributions. Table 5-6 presents the calculated BTVs for each metal by distribution and identifies the recommended BTV based on the most appropriate distribution for each dataset. The BTV selected was based on the ProUCL recommended distribution. When data appeared to follow more than one distribution, the BTV was selected assuming the dataset was normally distributed. Appendix C presents the complete ProUCL background statistics for each metal.

5.3.1.2.4 All five metals were detected in one or more background samples (Table 5-4). Table 5-7 presents the summary statistics for the background samples including minimum detection concentration, maximum detection concentration, average concentration, standard deviation, and the selected BTV. A comparison of the site data to the BTVs identified the following:

- Antimony was not detected in any of the background soil samples; therefore, no BTV was calculated. Antimony was detected in four soil samples, from two locations, (i.e., PTC-SOIL-I-MVIA-9-A, PTC-SOIL-I-MVIA-9-D1, PTC-SOIL-I-MVIA-9-D2, and PTC-SOIL-I-MVIA-10-D2) at concentrations ranging from 1.3 mg/kg to 1.7 mg/kg.

- Chromium was detected in three samples, all from a single location, (i.e., PTC-SOIL-I-MVIA-14-A, PTC-SOIL-I-MVIA-14-D1, PTC-SOIL-I-MVIA-14-D2) at concentrations greater than the BTV (i.e., 500 mg/kg, 510 mg/kg, 570 mg/kg versus 490 mg/kg).

- Copper was detected in a single sample (i.e., PTC-SOIL-I-MVIA-04-D1) at a concentration greater than BTV (i.e., 130 mg/kg versus 104 mg/kg). Copper concentrations in the corresponding primary and triplicate sample were below the BTV.

- Lead was detected in a single sample (i.e., PTC-SOIL-I-MVIA-14-D2) at a concentration slightly greater than BTV (i.e., 19 mg/kg versus 17 mg/kg). Lead concentrations in the corresponding primary and duplicate sample were below the BTV.

- Zinc concentrations were below the BTV in all samples.

5.3.1.2.5 In general, results of the comparison of site data to the background data suggest that metals concentrations at the site do not exceed background values. A limited number of detections at concentrations slightly above the BTVs likely reflect uncertainty in the BTV values as a result of the limited sample size and variability in soil composition at the site.

5.3.1.2.6 Though not required in the UFP-QAPP, background samples were also analyzed for explosives to further confirm that selected background locations were not impacted by MEC and/or MD. There were insufficient detections for calculations of BTVs, as was done for metals; therefore, results are discussed solely by sample. Explosives concentrations were not detected in any soil samples except for RDX in PTC-SOIL-I-BKG-04, both of its replicates, and in the primary sample for PTC-SOIL-I-BKG-05-A. RDX was not detected in the replicate samples for PTC-SOIL-I-BKG-05-A. According to the requirements of EPA SW-846 Method 8330 (EPA, 2008a), detections of explosives must be confirmed by second column analysis to be considered a valid result. In all four cases, RDX was only detected by first column analysis and was not detected by the second column. Further, the four first column detections were between the laboratory limit of quantitation and the limit of detection and are considered estimated values. Based on the lack of second column detection, the estimated nature of the first column detections, and the fact that no other explosives were detected in the samples, the four RDX detections most likely represent interference and not actual presence of RDX in the samples.

Table 5-4: Summary of Soil Analytical Results - Metals

Sample ID	Date Collected	Depth (inches bgs)	Antimony	Chromium	Copper	Lead	Zinc
		HDOH Tier I EAL[1]	2.4	1,100	630	200	1,000
		Background Threshold Value (95% UTL)	NA	490	104	17	120
PTC-SOIL-I-BKG-01-A	10/16/2013	0—6	<1 J	**140 J**	**74 J**	**3.4**	**80 J**
PTC-SOIL-I-BKG-01-D1	10/16/2013	0—6	<0.97 J	**160**	**73**	**2.6**	**75**
PTC-SOIL-I-BKG-01-D2	10/16/2013	0—6	<1 J	**150**	**74**	**2.5**	**73**
PTC-SOIL-I-BKG-02-A	10/16/2013	0—6	<1	**180**	**44**	**6.5**	**74**
PTC-SOIL-I-BKG-02-D1	10/16/2013	0—6	<1	**180**	**44**	**7**	**73**
PTC-SOIL-I-BKG-02-D2	10/16/2013	0—6	<0.99	**190**	**47**	**7.1**	**75**
PTC-SOIL-I-03-A	10/16/2013	0—6	<0.96	**210**	**62**	**4.6**	**110**
PTC-SOIL-I-03-D1	10/16/2013	0—6	<1	**210**	**63**	**4.6**	**110**
PTC-SOIL-I-03-D2	10/16/2013	0—6	<0.98	**210**	**63**	**4.6**	**110**
PTC-SOIL-I-BKG-04-A	10/17/2013	0—6	<1 J	**220 J**	**98**	**6.9 J**	**92 J**
PTC-SOIL-I-BKG-04-D1	10/17/2013	0—6	<1 J	**230**	**78**	**6.6**	**76**
PTC-SOIL-I-BKG-04-D2	10/17/2013	0—6	<1 J	**230**	**77**	**6.2**	**76**
PTC-SOIL-I-BKG-05-A	10/17/2013	0—6	<1	**470**	**35**	**14**	**80**
PTC-SOIL-I-BKG-05-D1	10/17/2013	0—6	<0.99	**480**	**37**	**15**	**82**
PTC-SOIL-I-BKG-05-D2	10/17/2013	0—6	<1	**490**	**37**	**15**	**85**
PTC-SOIL-I-BKG-06-A	10/17/2013	0—6	<1	**170**	**38**	**8.6**	**61**
PTC-SOIL-I-BKG-06-D1	10/17/2013	0—6	<0.97	**160**	**39**	**9**	**63**
PTC-SOIL-I-BKG-06-D2	10/17/2013	0—6	<1	**150**	**35**	**7.8**	**57**
PTC-SOIL-I-MVIA-01-A	10/17/2013	0—6	<1	**180**	**59**	**6.5**	**100**
PTC-SOIL-I-MVIA-01-D1	10/17/2013	0—6	<0.97	**170**	**55**	**6.6**	**95**
PTC-SOIL-I-MVIA-01-D2	10/17/2013	0—6	<0.99	**160**	**53**	**6.2**	**91**
PTC-SOIL-I-MVIA-02-A	10/18/2013	0—6	<1 J	**170 J**	**78 J**	**2.8 J**	**87 J**

Table 5-4: Summary of Soil Analytical Results – Metals (continued)

Sample ID	Date Collected	Depth (inches bgs)	Antimony	Chromium	Copper	Lead	Zinc
		HDOH Tier I EAL[1]	2.4	1,100	630	200	1,000
		Background Threshold Value (95% UTL)	NA	490	104	17	120
PTC-SOIL-I-MVIA-02-D1	10/18/2013	0—6	<1 J	**150**	**69**	**2.6**	**77**
PTC-SOIL-I-MVIA-02-D2	10/18/2013	0—6	<0.99 J	**160**	**71**	**2.7**	**80**
PTC-SOIL-I-MVIA-03-A	10/18/2013	0—6	<0.97	**220**	**69**	**4**	**57**
PTC-SOIL-I-MVIA-03-D1	10/18/2013	0—6	<0.97	**220**	**72**	**5.2**	**62**
PTC-SOIL-I-MVIA-03-D2	10/18/2013	0—6	<0.97	**260**	**78**	**5.1**	**73**
PTC-SOIL-I-MVIA-04-A	10/18/2013	0—6	<1.1	**240**	**93**	**7.7 J**	**66**
PTC-SOIL-I-MVIA-04-D1	10/18/2013	0—6	<1	**290**	**130**	**14 J**	**69**
PTC-SOIL-I-MVIA-04-D2	10/18/2013	0—6	<1	**290**	**95**	**5.2 J**	**71**
PTC-SOIL-I-MVIA-05-A	10/18/2013	0—6	<1	**250**	**91**	**4.7**	**96**
PTC-SOIL-I-MVIA-05-D1	10/18/2013	0—6	<0.99	**260**	**95**	**5**	**98**
PTC-SOIL-I-MVIA-05-D2	10/18/2013	0—6	<0.99	**270**	**92**	**4.5**	**92**
PTC-SOIL-I-MVIA-06-A	10/21/2013	0—6	<0.98	**180**	**73**	**2.8**	**79**
PTC-SOIL-I-MVIA-06-D1	10/21/2013	0—6	<0.98	**170**	**70**	**3.1**	**78**
PTC-SOIL-I-MVIA-06-D2	10/21/2013	0—6	<1	**120**	**52**	**2**	**57**
PTC-SOIL-I-MVIA-07-A	10/21/2013	0—6	<0.99	**150**	**58**	**2.9**	**71**
PTC-SOIL-I-MVIA-07-D1	10/21/2013	0—6	<1	**190**	**70**	**4**	**85**
PTC-SOIL-I-MVIA-07-D2	10/21/2013	0—6	<1	**180**	**67**	**3.5**	**85**
PTC-SOIL-I-MVIA-08-A	10/21/2013	0—6	<1	**360**	**42**	**10**	**48**
PTC-SOIL-I-MVIA-08-D1	10/21/2013	0—6	<0.98	**330**	**35**	**11**	**45**
PTC-SOIL-I-MVIA-08-D2	10/21/2013	0—6	<0.96	**350**	**36**	**11**	**45**
PTC-SOIL-I-MVIA-09-A	10/21/2013	0—6	**1.7**	**300**	**72**	**7**	**82**
PTC-SOIL-I-MVIA-09-D1	10/21/2013	0—6	**1.8**	**220**	**58**	**4.9**	**65**
PTC-SOIL-I-MVIA-09-D2	10/21/2013	0—6	**1.3 J**	**260**	**69**	**6**	**75**
PTC-SOIL-I-MVIA-10-A	10/21/2013	0—6	<1 J	**300**	**69**	**6.3**	**73**
PTC-SOIL-I-MVIA-10-D1	10/21/2013	0—6	<1 J	**290**	**67**	**6.1**	**72**
PTC-SOIL-I-MVIA-10-D2	10/21/2013	0—6	**1.4 J**	**310**	**72**	**6.9**	**73**
PTC-SOIL-I-MVIA-11-A	10/22/2013	0—6	<1 J	**210 J**	**89**	**5.3**	**110**
PTC-SOIL-I-MVIA-11-D1	10/22/2013	0—6	<1 J	**200**	**85**	**5.3**	**100**
PTC-SOIL-I-MVIA-11-D2	10/22/2013	0—6	<1 J	**190**	**80**	**5.1**	**99**
PTC-SOIL-I-MVIA-12-A	10/22/2013	0—6	<1	**250**	**72**	**7**	**82**
PTC-SOIL-I-MVIA-12-D1	10/22/2013	0—6	<0.99	**240**	**73**	**7**	**82**
PTC-SOIL-I-MVIA-12-D2	10/22/2013	0—6	<1	**250**	**71**	**7.4**	**80**
PTC-SOIL-I-MVIA-13-A	10/22/2013	0—6	<1	**270**	**75**	**7.1**	**77**
PTC-SOIL-I-MVI-13-D1	10/22/2013	0—6	<1	**250**	**72**	**6.8**	**74**
PTC-SOIL-I-MVIA-13-D2	10/22/2013	0—6	<1	**240**	**70**	**6.8**	**74**
PTC-SOIL-I-MVIA-14-A	10/22/2013	0—6	<1	**500**	**43**	**16**	**53**
PTC-SOIL-I-MVIA-14-D1	10/22/2013	0—6	<1	**510**	**43**	**15**	**54**
PTC-SOIL-I-MVIA-14-D2	10/22/2013	0—6	<0.96	**570**	**50**	**19**	**58**

Notes:
All results are provided in milligrams per kilogram
All samples analyzed by EPA Method 6020
1 = HDOH, 2012. "Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Appendix 1, Table A-2, Soil Action Levels (Potentially impacted groundwater IS a current or potential drinking water resource; surface water body IS located within 150m)." Office of Hazard Evaluation and Emergency Response. January.

Bold = analyte detected at concentration shown
< Sample was not detected above the indicated laboratory limit of detection
bgs = below ground surface
EAL = environmental action levels
EPA = U.S. Environmental Protection Agency
HDOH = Hawaii Department of Health
J = Estimated value. Analyte was detected at a concentration between the laboratory limit of detection and the limit of quantitation.
UTL = upper tolerance limit

Table 5-5: Summary of Soil Analytical Results - Explosives

Sample ID	1,3,5-Trinitrobenzene	1,3-Dinitrobenzene	2,4,6-Trinitrotoluene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Amino-4,6-dinitrotoluene	2-Nitrotoluene	3-Nitrotoluene	4-Amino-2,6-dinitrotoluene	4-Nitrotoluene	HMX	Nitrobenzene	Nitroglycerin	PETN	RDX	Tetryl
HDOH Tier I EAL[1]	8.4	0.21	1.0	1.6[2]	3.6	0.7	1.9[2]	7.3	0.7	0.25	29	4.8[2]	1.2[2]	0.42	5.5[2]	49
PTC-SOIL-I-MVIA-01-A	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.25	<0.25	<0.051 J	<0.051
PTC-SOIL-I-MVIA-01-D1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.05 J	<0.05 J
PTC-SOIL-I-MVIA-01-D2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.05 J	<0.05 J
PTC-SOIL-I-MVIA-02-A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.05 J	<0.05 J
PTC-SOIL-I-MVIA-02-D1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.05 J	<0.05 J
PTC-SOIL-I-MVIA-02-D2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.05 J	<0.05 J
PTC-SOIL-I-MVIA-03-A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.05 J	<0.05
PTC-SOIL-I-MVIA-03-D1	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.25	<0.25	<0.049 J	<0.049
PTC-SOIL-I-MVIA-03-D2	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.25	<0.25	<0.049 J	<0.049
PTC-SOIL-I-MVIA-04-A	<0.05	<0.05	**0.13 J**	<0.05	<0.05	**0.076 J**	<0.05	<0.05	**0.072 J**	<0.05	<0.05	<0.05	<0.25	<0.25	<0.05 J	<0.05 J
PTC-SOIL-I-MVIA-04-D1	<0.051 J	<0.051 J	**0.25 J**	<0.051 J	<0.051 J	**0.093 J**	<0.051 J	<0.051 J	**0.089 J**	<0.051 J	<0.051 J	<0.051 J	<0.25 J	<0.25 J	<0.051 J	<0.051 J
PTC-SOIL-I-MVIA-04-D2	<0.049 J	<0.049 J	**0.054 J**	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.25 J	<0.25 J	<0.049 J	<0.049 J
PTC-SOIL-I-MVIA-05-A	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.25 J	<0.25 J	<0.061 J	<0.049 J
PTC-SOIL-I-MVIA-05-D1	<0.05 J	<0.05 J	<0.05 J	<0.05 J	<0.05 J	<0.05 J	<0.05 J	<0.05 J	<0.05 J	<0.05 J	<0.05 J	<0.05 J	<0.25 J	<0.25 J	<0.053 J	<0.05 J
PTC-SOIL-I-MVIA-05-D2	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.049 J	<0.25 J	<0.25 J	<0.049 J	<0.049 J
PTC-SOIL-I-MVIA-06-A	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.25	<0.25	<0.051 J	<0.051
PTC-SOIL-I-MVIA-06-D1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	**0.066 NJ**	<0.05
PTC-SOIL-I-MVIA-06-D2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	**0.093 NJ**	<0.05
PTC-SOIL-I-MVIA-07-A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	**0.14 NJ**	<0.05
PTC-SOIL-I-MVIA-07-D1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.05 J	<0.05
PTC-SOIL-I-MVIA-07-D2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.05	<0.05
PTC-SOIL-I-MVIA-08-A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.059 J**	<0.05	<0.25	<0.25	**0.4 NJ**	<0.05
PTC-SOIL-I-MVIA-08-D1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	**0.27 NJ**	<0.05
PTC-SOIL-I-MVIA-08-D2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	**0.33 NJ**	<0.05
PTC-SOIL-I-MVIA-09-A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.11 J**	<0.05	<0.25	<0.25	**0.094 NJ**	<0.05
PTC-SOIL-I-MVIA-09-D1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	**0.1 NJ**	<0.05
PTC-SOIL-I-MVIA-09-D2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.065 J**	<0.05	<0.25	<0.25	**0.093 NJ**	<0.05
PTC-SOIL-I-MVIA-10-A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	**0.081 NJ**	<0.05
PTC-SOIL-I-MVIA-10-D1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05 J	<0.05	<0.25	<0.25	**0.063 NJ**	<0.05 J

Table 5-5: Summary of Soil Analytical Results – Explosives (continued)

Sample ID	1,3,5-Trinitrobenzene	1,3-Dinitrobenzene	2,4,6-Trinitrotoluene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Amino-4,6-dinitrotoluene	2-Nitrotoluene	3-Nitrotoluene	4-Amino-2,6-dinitrotoluene	4-Nitrotoluene	HMX	Nitrobenzene	Nitroglycerin	PETN	RDX	Tetryl
HDOH Tier I EAL[1]	8.4	0.21	1.0	1.6[2]	3.6	0.7	1.9[2]	7.3	0.7	0.25	29	4.8[2]	1.2[2]	0.42	5.5[2]	49
PTC-SOIL-I-MVIA-10-D2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.055 J**	<0.05	<0.25	<0.25	**0.077 NJ**	<0.05 J
PTC-SOIL-I-MVIA-11-A	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.051	<0.25	<0.25	**0.054 NJ**	<0.051
PTC-SOIL-I-MVIA-11-D1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	**0.052 NJ**	<0.05
PTC-SOIL-I-MVIA-11-D2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	**0.06 NJ**	<0.05
PTC-SOIL-I-MVIA-12-A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.05 J	<0.05
PTC-SOIL-I-MVIA-12-D1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	**0.054 NJ**	<0.05
PTC-SOIL-I-MVIA-12-D2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	**0.064 NJ**	<0.05
PTC-SOIL-I-MVIA-13-A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.067 NJ**	<0.05	<0.05	<0.25	<0.25	**0.15 NJ**	<0.05
PTC-SOIL-I-MVI-13-D1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.053 J**	<0.05	<0.25	<0.25	**0.86 NJ**	<0.05
PTC-SOIL-I-MVIA-13-D2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.077 NJ**	**0.052 J**	<0.05	<0.25	<0.25	**0.29 NJ**	<0.05
PTC-SOIL-I-MVIA-14-A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.05 J**	**0.12 J**	<0.05	<0.25	<0.25	**0.43 NJ**	<0.05
PTC-SOIL-I-MVIA-14-D1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.087 J**	<0.05	<0.25	<0.25	**0.41 NJ**	<0.05
PTC-SOIL-I-MVIA-14-D2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.076 J**	<0.05	<0.25	<0.25	**0.34 NJ**	<0.05

Notes:
All results are provided in milligrams per kilogram
All samples analyzed by EPA Method 8330B
1 = HDOH, 2012. "Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Appendix 1, Table A-2, Soil Action Levels (Potentially impacted groundwater IS a current or potential drinking water resource; surface water body IS located within 150m)." Office of Hazard Evaluation and Emergency Response. January.
< Sample was not detected above the laboratory limit of detection

Bold = analyte detected at concentration shown

bgs = below ground surface
EAL = environmental action levels
HDOH = Hawaii Department of Health
J = Estimated value. Analyte was detected at a concentration between the laboratory limit of detection and the limit of quantitation.
NJ = Presumptive evident of presence of the compound at an estimated quantity. The compound was detected on the first column but not detected on the second column.

Table 5-6: Site-Specific Background Values for Metals

Metal	Frequency of Detection	Approximate Distribution	Background Threshold Values 95% UTL with 95% Coverage			
			Assuming Normal Distribution	Assuming Gamma Distribution	Assuming Lognormal Distribution	Non-parametric Upper Limits
Antimony	0/18	NA	NA	NA	NA	NA
Chromium	18/18	Data do not follow a Discernible Distribution	520	547	572.6	**490**
Copper	18/18	Data appear Approximate Normal at 5% Significance Level	**103.9**	114.2	123.3	98
Lead	18/18	Data appear Approximate Normal at 5% Significance Level	**16.8**	19.7	23.6	15
Zinc	18/18	Data appear Approximate Normal at 5% Significance Level	**119.5**	123.3	126.1	110

Notes:
Background Threshold Values calculated by ProUCL version 5.0
Bold and shaded = ProUCL BTV based on recommended distribution. When data appeared to follow more than one distribution, the BTV based on an assumed normal distribution was selected.

NNA = Not applicable
UTL = Upper Tolerance Limit

Table 5-7: Summary Statistics for Background Soil Data

Sample ID	Date Collected	Depth (inches bgs)	Antimony	Chromium	Copper	Lead	Zinc
PTC-SOIL-I-BKG-01-A	10/16/2013	0—6	<1 J	**140** **J**	**74** **J**	**3.4**	**80** **J**
PTC-SOIL-I-BKG-01-D1	10/16/2013	0—6	<0.97 J	**160**	**73**	**2.6**	**75**
PTC-SOIL-I-BKG-01-D2	10/16/2013	0—6	<1 J	**150**	**74**	**2.5**	**73**
PTC-SOIL-I-BKG-02-A	10/16/2013	0—6	<1	**180**	**44**	**6.5**	**74**
PTC-SOIL-I-BKG-02-D1	10/16/2013	0—6	<1	**180**	**44**	**7**	**73**
PTC-SOIL-I-BKG-02-D2	10/16/2013	0—6	<0.99	**190**	**47**	**7.1**	**75**
PTC-SOIL-I-03-A	10/16/2013	0—6	<0.96	**210**	**62**	**4.6**	**110**
PTC-SOIL-I-03-D1	10/16/2013	0—6	<1	**210**	**63**	**4.6**	**110**
PTC-SOIL-I-03-D2	10/16/2013	0—6	<0.98	**210**	**63**	**4.6**	**110**
PTC-SOIL-I-BKG-04-A	10/17/2013	0—6	<1 J	**220** **J**	**98**	**6.9** **J**	**92** **J**
PTC-SOIL-I-BKG-04-D1	10/17/2013	0—6	<1 J	**230**	**78**	**6.6**	**76**
PTC-SOIL-I-BKG-04-D2	10/17/2013	0—6	<1 J	**230**	**77**	**6.2**	**76**
PTC-SOIL-I-BKG-05-A	10/17/2013	0—6	<1	**470**	**35**	**14**	**80**
PTC-SOIL-I-BKG-05-D1	10/17/2013	0—6	<0.99	**480**	**37**	**15**	**82**
PTC-SOIL-I-BKG-05-D2	10/17/2013	0—6	<1	**490**	**37**	**15**	**85**
PTC-SOIL-I-BKG-06-A	10/17/2013	0—6	<1	**170**	**38**	**8.6**	**61**
PTC-SOIL-I-BKG-06-D1	10/17/2013	0—6	<0.97	**160**	**39**	**9**	**63**
PTC-SOIL-I-BKG-06-D2	10/17/2013	0—6	<1	**150**	**35**	**7.8**	**57**
Minimum Detection			*NA*	*140*	*35*	*2.5*	*57*
Maximum Detection			*NA*	*490*	*98*	*15*	*110*
Average			*NA*	*235*	*57*	*7*	*81*
Standard Deviation			*NA*	*116*	*19*	*4*	*16*
Background Threshold Value (95% UTL)			*NA*	*490*	*104*	*17*	*120*

Notes:
All results are provided in milligrams per kilogram
All samples analyzed by EPA Method 6020

Bold = analyte detected at concentration shown
< Sample was not detected above the laboratory limit of detection
bgs = below ground surface
EAL = environmental action levels
EPA = U.S. Environmental Protection Agency
HDOH = Hawaii Department of Health
J = Estimated value. Analyte was detected at a concentration between the laboratory limit of detection and the limit of quantitation.
NA = not applicable, all results are non-detect
UTL = upper tolerance limit

5.4 Revised CSM (MC)

Separate CSMs were developed and updated for the MVIA and MTC MRSs and are presented in Appendix A, Figures A5-4 and A5-5.

5.4.1 Maunawili Valley Impact Training Area

Risks above acceptable thresholds that are attributed to MC in soil is unlikely given the surface soil analytical results were below HDOH Tier 1 EALs and metals concentrations were generally below background values. As a result, the transport mechanisms and exposure routes to potential human and ecological receptors are considered incomplete.

5.4.2 Maunawili Training Course

No surface soil samples were collected during the RI. The pathways from MCs in surface soil to potential human and ecological receptors are incomplete or have not been quantitatively assessed.

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6.0 Contaminant Fate and Transport for MEC and MC

6.1 MEC

6.1.1 Potential Sources of Contamination

6.1.1.1 The former PTC was used as a regimental combat training center in the 1940s emphasizing the use of and familiarity with modern arms and field weapons, in addition to providing rugged terrain for jungle and ranger training. The former PTC is divided into four MRSs: MVIA, MTC, MVTC, and UTC.

6.1.1.2 Data collected during the RI and previous investigations indicate that the MVIA MRS was used as an impact area and a maneuver area as evidenced by the type and density of MEC and MD found. Sections 5.1 and 5.2 describe the types and quantities of MEC and MD located throughout the MRS and Appendix A, Figure A5-2 shows the locations of these items. It is a source of contamination.

6.1.1.3 The MTC MRS may be a potential source of contamination; however, additional data needs to be obtained.

6.1.1.4 Historical documentation and previous investigations were used to determine that the MVTC and UTC MRSs are unlikely sources of contamination.

6.1.2 Contaminant Persistence

MEC may remain intact for long periods of time. MEC was found during the 2012 Removal Action and the 2013 Remedial Investigation, more than 65 years after the abandonment of the former PTC.

6.1.3 Contaminant Migration

It is possible that MEC within the MVIA MRS will migrate from its original site of deposition (i.e., target areas) due to naturally occurring events (storm water runoff, landslides) and the steep terrain. It is also possible that MEC could be disturbed by human activity. Recreational users and occupational workers using paths and trails could possibly disturb MEC or collect MEC as a souvenir. Most of the munition items found are relatively lightweight and could be hand-carried without much difficulty. The heaviest item found, the 105-mm HE projectile, weighs approximately 40 pounds and is less likely to be moved.

6.1.4 Potential Human Receptors and Exposure Pathways

Current and future human receptors at the MVIA MRS consist of recreational users (visitors, hikers, golfers), agricultural workers, and occupational workers (utility and trail maintenance). The potential exposure pathway to MEC is through direct contact with MEC present on the surface. Contact with subsurface MEC is possible for agricultural workers while excavating plots and for occupational workers performing subsurface infrastructure maintenance.

6.2 MC

MCs were not identified at concentrations exceeding the HDOH Tier 1 EALs. Per the HDOH, concentrations of chemicals below the HDOH Tier 1 EALs are not considered to pose a risk to human health or the environment and no response action is required to address these contaminants. Therefore, evaluation of the fate and transport of MC at the site are not discussed in this RI.

7.0 Hazard Assessment for MEC and Baseline Risk Assessment for MC

7.0.1 The purpose of the MEC HA and Baseline Risk Assessment is to assist in the evaluation and selection of removal and remedial alternatives, including the implementation of land use controls, during the RI/FS stage of remedial actions.

7.1 MEC HA

7.1.0.1 The MEC HA addresses the National Contingency Plan direction to conduct site-specific risk assessments for threats to human health and the environment. For the purpose of this RI, the MEC HA methodology presented in the document titled, "Munitions and Explosives of Concern Methodology (Interim)" prepared by the Technical Working Group for HA was used to evaluate the hazards (EPA, 2008c). The MEC HA was designed to be used as the CERCLA HA methodology for a MRS where there is an explosive hazard from the known or suspected presence of MEC. An explosive hazard exists at a site if there is a potentially complete MEC exposure pathway. A potentially complete MEC exposure pathway is present any time a receptor can come into contact with MEC and interact with the item in a manner that might result in its detonation. There are three elements of a potentially complete MEC exposure pathway: (1) a source of MEC, (2) a receptor, and (3) the potential for interaction between the MEC source and the receptor. All three of these elements must be present for a potentially complete MEC exposure pathway to exist.

7.1.0.2 The MEC HA is structured around three components of a potential explosive hazard incident:

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

7.1.0.3 Each of these components is assessed in the MEC HA using nine numerically weighted input factors. The sum of the input factor scores falls within one of four defined ranges, called hazard levels. Each of the four levels reflects site attributes that describe groups of site and site conditions ranging from highest to lowest hazards. The MEC HA hazard levels are:

- Hazard Level 1 (Score 840-1000): Sites with the highest potential explosive hazard conditions. There may be instances where there is an imminent threat to human health from MEC.

- Hazard Level 2 (Score 725-835): Sites with high potential explosive hazard conditions. There may be instances of surface MEC or intrusive activities that would encounter MEC in the subsurface. Sites have moderate or greater accessibility by the public.
- Hazard Level 3 (Score 530-720): Sites with moderate potential explosive hazard conditions. Site may have gone through a surface cleanup or has moderate or limited accessibility and low number of contact hours.
- Hazard Level 4 (Score 125-525): Sites with low potential explosive hazard conditions. Site may have undergone a cleanup and MEC is only located subsurface, below the depth of receptor intrusive activities. Accessibility is limited or very limited.

7.1.0.4 The MEC HA may be conducted several times to analyze different remedial alternative scenarios as well as evaluate the current/future human activities or land use and types and densities of MEC items in the MRS. Each scenario will be assigned a Hazard Level.

7.1.0.5 The following sections describe the ratings assigned to the nine input factors for each MRS or MRS subdivision. The MEC HA worksheets are provided in Appendix N.

7.1.1 Maunawili Valley Impact Area – West

7.1.1.1 Energetic Material Type

The MEC items known or suspected to be present at the MVIA – West include projectiles (105-mm HE; 75-mm shrapnel; 57-mm APT; 37-mm HE, AP, APCT), mortars (81-mm HE; 60-mm HE, practice), 2.36-inch rockets, and fuzes. MD, such as small arms and 20-mm ball cartridges, are also known and suspected. Based on these findings, the energetic material type selected for the site is determined to be "High Explosive and Low Explosive Filler in Fragmenting Rounds" which is the most potentially hazardous of the available selections.

7.1.1.2 Location of Additional Human Receptors

Within the MVIA – West, there are multiple public hiking trails, access roadways, an agricultural research center, agricultural fields, an irrigation waterline, and utilities. Additionally, there is a residential area and a water tower outside of the MRS boundary but within the 2,111-foot Explosive Safety Quantity Distance (ESQD) arc. This input factor is rated "Inside the MRS or inside the ESQD arc."

7.1.1.3 Site Accessibility

MVIA – West contains multiple public hiking trails that are easily accessible by receptors. Additionally, portions of the area are actively used as an agricultural research center and for farming. Occupational workers occasionally access the area to maintain hiking trails and public utilities. As a result, this input factor category is "Moderate Accessibility."

7.1.1.4 Potential Contact Hours

The Potential Contact Hours factor is evaluated by estimating both the number of users per year and the number of hours that each user engages in activities that may result in encounters with MEC. The MVIA – West is accessed daily by residents and visitors using the Maunawili Demonstration Trail and the Maunawili Falls Trail, by workers at an agricultural research center and by farmers. Occupational workers maintaining trails or infrastructure also access the area on a less frequent basis. The Potential Contact Hours input factor was assessed as "100,000 to 999,999 receptor-hours/year."

7.1.1.5 Amount of MEC

The potential MEC presence within MVIA – West is likely given the MEC items located during the RI, previous investigations, and the historic use of the site as an impact area. For this reason, a classification of "Target Area" is considered most appropriate for the site for purposes of the MEC HA.

7.1.1.6 Minimum MEC Depth Relative To The Maximum Receptor Intrusive Depth

The MEC and MD found were located on the ground surface and subsurface. The maximum receptor intrusive depth at the site is anticipated to be two feet, in agricultural fields and infrastructure repair areas. Based on this information, the minimum MEC depth relative to the maximum receptor intrusive depth is assessed to be "Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC."

7.1.1.7 Migration Potential

Migration Potential has been rated as "Possible" because migration can occur via natural forces such as erosion caused by overland water flow or landslides along steep slopes.

7.1.1.8 MEC Classification

The MVIA – West was used as an impact area, where MEC, including projectiles, mortars, and fuzes, have been detected. The MEC HA guidance suggests that assessment teams should assume UXO is present in former target areas (EPA, 2008c). The MEC Classification input factor for this site is assessed as "UXO Special Case."

7.1.1.9 MEC Size

The items known or suspected to be present within the MVIA – West vary in size from fuzes up to 105-mm projectiles. A potential receptor is more likely to pick up or interact with a smaller item, such as fuzes than a heavy bomb. The MEC Size classification for this site is conservatively assessed as "Small" because of the detection of both small arms and large MEC at the site.

7.1.1.10 MEC Score

Table 7-1 contains the MEC HA scores calculated for the baseline analysis. The total MEC HA score is 925 and associated MEC HA Hazard Level of 1 for the baseline assessment. The MEC HA worksheets are provided in Appendix N.

Table 7-1: Summary of MEC HA Score for MVIA – West Baseline

Explosive Hazard Component	Input Factors	Category Selected for MRS/Area	Baseline Score (Max. Score)
Severity	Explosive Material Type	High Explosive and Low Explosive Filler in Fragmenting Rounds	100 (*100*)
	Location of Additional Human Receptors	Inside the MRS or inside the ESQD arc	30 (*30*)
Accessibility	Site Accessibility	Moderate Accessibility	55 (*80*)
	Total Contact Hours	100,000 to 999,999 receptor hours/year	70 (*120*)
	Amount of MEC	Target Area	180 (*180*)
	Minimum MEC Depth vs. Maximum Intrusive Depth	Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240 (*240*)
	Migration Potential	Possible	30 (*30*)
Sensitivity	MEC Classification	UXO Special Case	180 (*180*)
	MEC Size	Small	40 (*40*)
Total MEC HA Score			925
MEC HA Hazard Level			1

7.1.2 Maunawili Valley Impact Area – Central

No MEC and only limited MD were found during the RI or previous investigations. There is no evidence to indicate that this portion of the MVIA MRS poses MEC hazards to human receptors. Laterally, the ESQD arc extends from the MVIA – West. However, there are a mountain ridges that physically separate the MVIA – Central from the rest of the MRS. It is unlikely that unintentional detonation in MVIA – West would impact human receptors in MVIA – Central. Therefore, a MEC HA was not performed.

7.1.3 Maunawili Valley Impact Area – East

Neither MEC nor MD were found during the RI or previous investigations. There is no evidence that this portion of the MVIA MRS poses MEC hazards to human receptors. Laterally, the

ESQD arc extends from the MVIA – Central. As discussed in the previous section, however, there is no MEC hazard in the MVIA – Central. Additionally, there is a mountain ridge that physically separates the MVIA – East from the rest of the MRS. It is unlikely that unintentional detonation in MVIA – Central or MVIA – West would impact human receptors in MVIA – East. Therefore, a MEC HA was not performed.

7.1.4 Maunawili Training Course

There is insufficient data to prepare a MEC HA. RI field activities were not conducted in MTC. Although, no MEC or MD, indicative of HE use, were found in during the 2008 EE/CA, small arms casings were found. Given the close proximity of the southwestern border of the MRS to the northwestern portion of the MVIA – West, where a high density of MD and one MEC item (Mk1 75-mm) were found during the RI, additional data collection efforts is recommended.

7.1.5 Makalii Valley Training Course

RI field activities were not conducted in this MRS. MVTC was a suspected observation point, and no MEC or MD have been found to date. The lack of MEC and MD indicates an incomplete pathway to human and ecological receptors, and therefore no known MEC hazards are suspected.

7.1.6 Ulumawao Training Course

The area is documented as an encampment or cantonment and ordnance use is not suspected based on historical records anecdotal evidence. No MEC or MD have been observed in the MRS during previous investigations or during land development, indicating no and incomplete pathway to human and ecological receptors. As a result, no known MEC hazards are suspected.

7.2 Baseline Risk Assessment for MC

7.2.1 Maunawili Valley Impact Area

MCs were not identified in surface soil at concentrations exceeding the HDOH risk-based EALs. Per the HDOH, concentrations of chemicals below the HDOH Tier 1 EALs are not considered to pose a risk to human health or the environment and no response action is required to address these contaminants. Therefore, no further evaluation of risk is necessary.

7.2.2 Maunawili Training Course

RI field activities were not conducted at MTC. There is not sufficient data to evaluate risk associated with MCs at this MRS.

7.2.3 Makalii Valley Training Course

No MEC or MD items have been found at this MRS. Therefore, there is no evidence of MC risk.

7.2.4 Ulumawao Training Course

UTC is documented as an encampment or cantonment and neither MEC nor MD have been found at this MRS. Therefore, there is no evidence of MC risk.

8.0 Summary and Conclusions

8.0.1 A RI was conducted at the former PTC between July and October 2013 and February and March 2014. The PTC consists of four non-contiguous parcels: MVIA, MTC, MVTC, and UTC. Each parcel is referred to as an MRS. The objective of the RI is to characterize the nature and extent of MEC, MD and MC within each MRS and to assess the associated risks to human health and the environment.

8.0.2 Previous investigations in the MVIA MRS have found numerous MEC and MD items including projectiles, mortars, fuzes, rockets, ball cartridges, and small arms. Additional data was gathered during the RI to further delineate and determine the nature and extent of MEC contamination in accessible areas and to demonstrate that areas outside of MEC-contamination were less than an appropriate UXO per acre threshold. A total of 46.42 miles (22.81 acres) of transects and 5.60 acres of grids were investigated in order to achieve (1) at least a 90% probability of traversing and detecting a 500-foot radius circular impact area and (2) a 90% confidence level that areas outside of MEC-contamination were below a low-use threshold of 0.5 UXO per acre. Both of these goals were achieved.

8.0.3 Seven MEC items and 1,346 MD items were found the in the MVIA. All MEC items were found in the western portion of the MRS. No MEC or MD items were found in the east of the Aniani Nui/Olomana ridgeline. Refer to Appendix A, Figure A5-1.

8.0.4 Seven new munition types identified during the field investigation were similar in nature to previously identified types or have a target radius of at least 500 feet. The original VSP transect design was valid. VSP identified eight areas of elevated density (MEC/MD density is above the selected background density of 50 anomalies per acre) and four areas of high density (MEC/MD density is at least 100 anomalies per acre total density) in the MVIA MRS based on the spatial distribution of MEC and MD found during the RI. Three elevated and four high density areas were located in the western portion of MVIA and five elevated density areas were located in the central portion. Refer to Appendix M. Three of the areas in the west contained MEC.

8.0.5 Grids were placed at or near elevated density, high density, or MEC-contaminated areas to gather additional data to determine nature and extent (Appendix A, Figure A4-3). No additional MEC items were found. One MD item found in Grid 02, an 81-mm mortar, white phosphorus, M57, was identified as a new munitions type. No other instances of this item were found in the surrounding transects or grids, however. Nature and extent of MEC contamination has been delineated.

8.0.6 The results of both the transect and grid findings during the RI were relatively consistent with previous investigations with respect to the type and locations of the MEC/MD. The collective data confirms that there is an impact area to the west and south of Pikoakea Spring.

The types of MEC and MD found are widely dispersed in the impact area, with the exception of the area near Maunawili Falls. There is a concentration of 37-mm projectiles (MEC) and 81-mm mortar tail booms (MD) in this area, suggesting that it may be a target area, within the impact area, for these particular munitions types.

8.0.7 The elevated density areas in the central region of the MRS are not impact areas and likely associated with maneuver activities.

8.0.8 In addition to identifying impact areas and delineating nature and extent of MEC contamination, the investigation also determined that the area outside of the MEC-contamination were below the low-use land threshold of 0.5 UXO per acre. Approximately 19.50 acres of transects and 1.04 acres of grids, outside of MEC-contamination and high-density areas, were investigated. No MEC items were found.

8.0.9 The RI findings and previous investigation data were evaluated with respect to the MVIA historical usage, topographical features, current/future land use scenarios, and potential receptors of MRS. As a result, the MVIA MRS was divided into three sections: MVIA – West, MVIA - Central, and MVIA – East. Dividing the MRS into sections will assist in analyzing different remedial alternatives during the FS.

8.0.10 The cumulative types and quantity of MEC and MD found in MVIA – West indicates that an explosive hazard exists in this section of the MRS. MVIA – West is primarily used for recreational and agricultural purposes, with limited industrial-type use. There are complete exposure pathways to human receptors through direct contact with surface and subsurface MEC. The MEC HA performed for the MVIA – West baseline condition yielded a score of 925 which corresponds to Hazard Level 1. Hazard Level 1 sites contain the highest potential explosive hazard and there may be instances of surface MEC or intrusive activities that would encounter MEC in the subsurface.

8.0.11 Although no MEC items have been found in MVIA – Central during the RI or previous investigations, the types of MD found during the RI indicate that MEC with HE could be present in this section. There are recreational activities that occur in the MVIA – Central so a potentially complete exposure pathway to human receptors through direct contact with surface MEC exists. Occupational workers maintaining recreational facilities or utilities may also have a complete exposure pathway through direct contact with subsurface MEC. A MEC HA was not conducted for MVIA – Central since there have been no MEC finds.

8.0.12 There is no evidence that an explosive hazard exists in MVIA – East. There are no complete exposure pathways to human receptors.

8.0.13 Surface soil samples were collected in the MVIA MRS in areas with high concentrations of MEC or MD and analyzed for MCs (metals [antimony, chromium, copper, lead, zinc] and explosive compounds). Background samples were also collected from non-impacted areas to calculate the site-specific BTVs. The analytical results were compared to the HDOH Tier 1 EALs and the BTVs. Although metals and explosives were detected in surface soil samples, the concentrations were below their respective EALs and within the range of BTVs. Risks to human health associated with MCs in surface soil are less than acceptable risk thresholds.

8.0.14 Small arms have been found in the MTC MRS during previous investigations. However, the landowner did not provide ROE to conduct RI activities. As a result, the characterization of this MRS is inconclusive because no additional data could be gathered. Further evaluation is recommended given the close proximity of the southwestern border to the MVIA MRS, where a high density of MD and one MEC item were found during the RI.

8.0.15 Neither MEC nor MD have been found in MVTC or UTC; therefore, these MRSs have no explosive hazards. No further investigation was conducted in these MRSs.

8.0.16 A follow-on FS will evaluate the potential future courses of action for the former PTC FUDS property.

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Appendices

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