Port Angeles Combat Range, Washington

Formerly Used Defense Sites
Remedial Investigation Work Plan

FUDS Property No. F10WA0033
Contract No. W9128F-10-D-0058
Delivery Order 0006

Draft Final
Military Munitions Response Program

August 2013

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Draft
Military Munitions Response Program

Prepared and Presented by:

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List of Acronyms and Abbreviations

°F	degree Fahrenheit
AHA	Activity Hazard Analysis
AP	Armor Piercing
APA	Anomaly per Acre
APP	Accident Prevention Plan
AR	Administrative Record
ASR	Archive Search Report
AT	Anti-Tank
AUF	Area use factor
AVS	Assisted Visual Survey
BATFE	U.S. Bureau of Alcohol, Tobacco, Firearms, and Explosives
BCFp	Bioconcentration Factor for Plant (plant uptake factor)
BERA	Baseline Ecological Risk Assessment
bgs	Below Ground Surface
BIP	Blown-In-Place
BLM	Bureau of Land Management
BTAG	Biological Technical Assistance Group
btoc	Below Top of Casing
BW	Body Weight
CAIS	Chemical Agent Identification Set
CASRN	Chemical Abstracts Service Registry Number
CDI	Chronic Daily Intake
CDL	Commercial Drivers License
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
CO	Colorado
COPC	Contaminant of Potential Concern
COPEC	Contaminant of Potential Ecological Concern
COR	Contracting Officer’s Representative
CQAM	Corporate Quality Assurance Manager
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
Ctg	Cartridge
CWM	Chemical Warfare Materiel
DAS	Data Acquisition System
DDESB	Department of Defense Explosives Safety Board
DERP	Defense Environmental Restoration Program
DF	Detection Frequency
DFW	Definable Feature of Work
DGM	Digital Geophysical Mapping
DID	Data Item Description
DIR	Dietary Ingestion Rate

List of Acronyms and Abbreviations (cont.)

DMM	Discarded Military Munitions
DO	Delivery Order
DoD	Department of Defense
DODIC	Department of Defense Identification Code
DQCR	Daily Quality Control Report
DQO	Data Quality Objective
ELAP	Environmental Laboratory Program
EM	Electromagnetic
EMP	Explosive Management Plan
EOD	Explosive Ordnance Disposal
EPC_s	Exposure Point Concentration for Soil
ERA	Ecological Risk Assessment
ESA	Endangered Species Act
ESL	Ecological Screening Level
ESP	Explosives Site Plan
ESTCP	Environmental Security Technology Certification Program
EZ	Exclusion Zone
FCR	Field Change Request
FS	Feasibility Study
ft	foot or feet
FUDS	Formerly Used Defense Site
GIP	Geophysical Investigation Plan
GIS	Geographic Information System
GIabs	Gastrointestinal Absorption Factor
GPS	Global Positioning System
GSV	Geophysical Systems Verification
H&S	Health and Safety
HA	Hazard Assessment
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
HSD	Health and Safety Director
HSS	Health and Safety Specialist
HTRW	Hazardous, Toxic, and Radioactive Waste
Hz	hertz
IAW	In Accordance With
IEP	Important Ecological Place
IEUBK	Integrated Exposure Uptake Biokinetic Model
INPR	Inventory Project Report
IR	Information Repository
IRIS	Integrated Risk Information System
ISO	Industry Standard Object
ITRC	Interstate Technology and Regulatory Council

List of Acronyms and Abbreviations (cont.)

IVP	Instrument Validation Plan
IVS	Instrument Verification Strip
KDE	Kernel Density Estimation
Kow	Octanol-water partition coefficient
lb	pound
LiDAR	Light Detection and Ranging
LOAEL	Lowest Observable Adverse Effect Level
LUC	Land Use Control
m	meter
m/s	meter per second
MC	Munitions Constituents
MD	Munitions Debris
MDAS	Material Documented As Safe
MDC	Maximum Detected Concentration
MDL	Method of Detection Limit
MEC	Munitions and Explosives of Concern
MFD	Maximum Fragment Distance
mg/kg	milligram per kilogram
MGFD	Munition with the Greatest Fragmentation Distance
mm	millimeter
MMDC	Military Munitions Design Center
MMRP	Military Munitions Response Program
MPPEH	Material Potentially Presenting an Explosive Hazard
MRA	Munitions Response Area
MRS	Munitions Response Site
MRSPP	Munitions Response Site Prioritization Protocol
MSD	Minimum Separation Distance
NA	Not Applicable
NAD	North American Datum
NCP	National Contingency Plan
NDAI	No Department of Defense Action Indicated
NE	Not Evaluated
NEODFC	Naval Explosive Ordnance Disposal Facility Center
NEW	Net Explosive Weight
NFS	Network File System
No.	Number
NOAEL	No Observable Adverse Effect Level
NOEC	No Observed Effect Concentration
NPS	National Park Service
NRL	Naval Research Laboratory
NWK	USACE Kansas City District
NWO	USACE Omaha District
NWS	USACE Seattle District

List of Acronyms and Abbreviations (cont.)

OESS	Ordnance and Explosives Safety Specialist
ONP	Olympic National Park
PACR	Port Angeles Combat Range
PFD	Plant Fraction in Diet
PM	Project Manager
POC	Point of Contact
PPE	Provisional Peer Reviewed Toxicity Value
PSLC	Puget Sound LiDAR Consortium
PUD	Public Utility District
QA	Quality Assurance
QC	Quality Control
QCP	Quality Control Plan
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
Rfd	Reference Dose
RI	Remedial Investigation
RIWP	Remedial Investigation Work Plan
RL	Reporting Limit
RME	Reasonable Maximum Exposure
ROC	Receptor of Concern
ROE	Right of Entry
RRD	Range Related Debris
RSL	Regional Screening Level
RTS	Robotic Total Station
SI	Site Inspection
SIR	Soil Ingestion Rate
SLERA	Screening-Level Ecological Risk Assessment
SLERAP	Screening-Level Ecological Risk Assessment Protocol for Combustion Facilities
SMC	Smallest Munition of Concern
SOP	Standard Operating Procedure
SOW	Statement of Work
SSB	Soil Screening Benchmark
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SUXOS	Senior Unexploded Ordnance Supervisor
T&E	Threatened and Endangered
TBC	To Be Considered
TBV	Toxicity Benchmark Value
TCRA	Time Critical Removal Action
TL	Team Leader
TPP	Technical Project Planning
TRV	Toxicity Reference Value

List of Acronyms and Abbreviations (cont.)

U.S.C.	United States Code
UFP	Uniform Federal Policy
UFP-QAPP	Uniform Federal Policy-Quality Assurance Protection Plan
US	United States
USACE	United States Army Corps of Engineers
USAPHC	United States Army Public Health Command
USDI	United State Department of Interior
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USNPS	United States National Park Service
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
VSP	Visual Sampling Plan
WA	Washington
WAC	Washington Administrative Code
WBS	Work Breakdown Structure
WDAHP	Washington Department of Archaeology & Historic Preservation
WDFW	Washington Department of Fish & Wildlife
WDNR	Washington State Department of Natural Resources
WDOE	Washington Department of Ecology
WNHP	Washington Department of Natural Resource Natural Heritage Program
WOE	Weight of Evidence
WP	Work Plan
WWII	World War II
XRF	X-ray Fluorescence
µg/m3	microgram per cubic meter

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1.0 Introduction

This Remedial Investigation (RI) Work Plan (WP) describes the activities, associated components and procedures that will be completed to perform an RI at the Formerly Used Defense Site (FUDS) Port Angeles Combat Range (PACR) Munitions Response Site (MRS), FUDS Property Number (No.) F10WA0033 being investigated under FUDS Project No. F10WA003301.

The PACR munitions response site (MRS) is located approximately 7 miles south east of the City of Port Angeles, Washington (WA) in Clallam County. For the purposes of this RIWP and associated project plans, the commonly used nomenclature of PACR will be used to identify the FUDS property to be investigated. The entire PACR MRS is approximately 2,629 acres; however, a portion of this acreage is within the boundary of the Olympic National Park (ONP). Because the United States (US) National Park Service (NPS) does not have a programmatic agreement with the Department of Defense (DoD), the DoD does not have authorization to access the ONP. During the site inspection completed by the United States Army Corps of Engineers (USACE) in 2009 (Shaw, 2009), ONP personnel were notified regarding the project and the potential for the presence of munitions, at that point the ONP personnel elected to not participate. Therefore, the portion of the MRS within the ONP will not be investigated under this project scope. The portion of the PACR that will be investigated under this MMRP RI is approximately 1,629 acres (**Figure 1-1**).

This RIWP was prepared under contract to the USACE, Omaha District, and is being completed in accordance with Contract No. W9128F-10-D-0058, under Delivery Order No: 0006. This RIWP has been developed to provide a description of the necessary tasks to complete this RI, and to ensure it will be performed in conformance with the USACE, Omaha District project Scope of Work (SOW), dated June 2012. This RIWP incorporates the findings of the Conceptual Site Model (CSM), and the resolutions and ideas generated during the first Technical Project Planning (TPP) meeting conducted on December 13, 2012. The memorandum from the first TPP meeting is included in **Appendix I** (USACE, 2012).

This RIWP will be used with the understanding that unanticipated conditions may dictate a change in the plan as written. Any necessary deviations from the plan will be brought to the attention of the USACE as soon as possible and a written request for variance will be submitted via a field change request (FCR) form to document the decision made.

1.1 Project Authorization

The DoD has established the Military Munitions Response Program (MMRP) as part of the Defense Environmental Restoration Program (DERP) to address DoD sites suspected of containing munitions and explosives of concern (MEC) or munitions constituents (MC). Under the MMRP, USACE is conducting environmental response activities at FUDS for the U.S. Army, DoD's Executive Agent for the FUDS program.

Pursuant to the *Management Guidance for the Defense Environmental Restoration Program* (Office of the Deputy Under Secretary of Defense [Installations and Environment], September, 2001), (DoD, 2001) the USACE is conducting FUDS response activities in accordance with DERP statute (10 United States Code [USC] 2701 et seq.), the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 USC §9601) (USEPA, 2003) Executive Orders 12580 and 13016, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300) (USEPA, 2011). While not all MEC/MC constitute CERCLA hazardous substances, pollutants or contaminants, the DERP statute provides the DoD the authority to respond to releases of MEC/MC, and DoD policy states that such responses shall be conducted in accordance with CERCLA and the NCP.

1.2 Purpose and Scope

The overall objective of this project is to conduct a RI for PACR and to characterize the nature and extent of MEC and the potential resulting MC contamination at the designated MRS. The purpose of the RI is to determine whether this property warrants further response action pursuant to CERCLA and the NCP. The RI will accomplish the following objectives:

- Determine the nature and extent of MEC
- If new data become available indicating potential MC contamination at the PACR, determine the nature and extent of this MC contamination
- Determine the risk posed to human health and the environment by MEC and MC contamination if new data become available indicating potential MC contamination
- Collect or develop additional data for a Feasibility Study (FS), as appropriate, to determine remediation alternatives for mitigation, including No DoD Action Indicated (NDAI)

1.3 Work Plan Organization

The contents and order of presentation of this RIWP are based on the requirements of Data Item Description (DID) MMRP-09-001 (USACE, 2009). Specifically, this RIWP includes the following sections, as appropriate:

- **Section 1.0** – Introduction
- **Section 2.0** – Technical Management Plan
- **Section 3.0** – Field Investigation Plan
- **Section 4.0** – Quality Control Plan
- **Section 5.0** – Explosives Management Plan
- **Section 6.0** – Environmental Protection Plan
- **Section 7.0** – Property Management Plan
- **Section 8.0** – Interim Holding Facility Siting Plan for Recovered Chemical Warfare Materiel Projects (not applicable to this project)
- **Section 9.0** – References (guidance, regulations, and other policies)

- **Associated Figures and Tables**
- **Appendices A through M** include the Task Order Scope of Work, site maps, points of contact, the Accident Prevention Plan (APP)/Site Safety and Health Plan (SSHP), the Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP), appropriate contractor forms, ordnance technical data sheets, personnel certifications, the TPP Memorandum, applicable standard operating procedures (SOPs), and Washington State Threatened and Endangered (T&E) Species, Species of Concern, and Monitor Species, and ESTCP Report.

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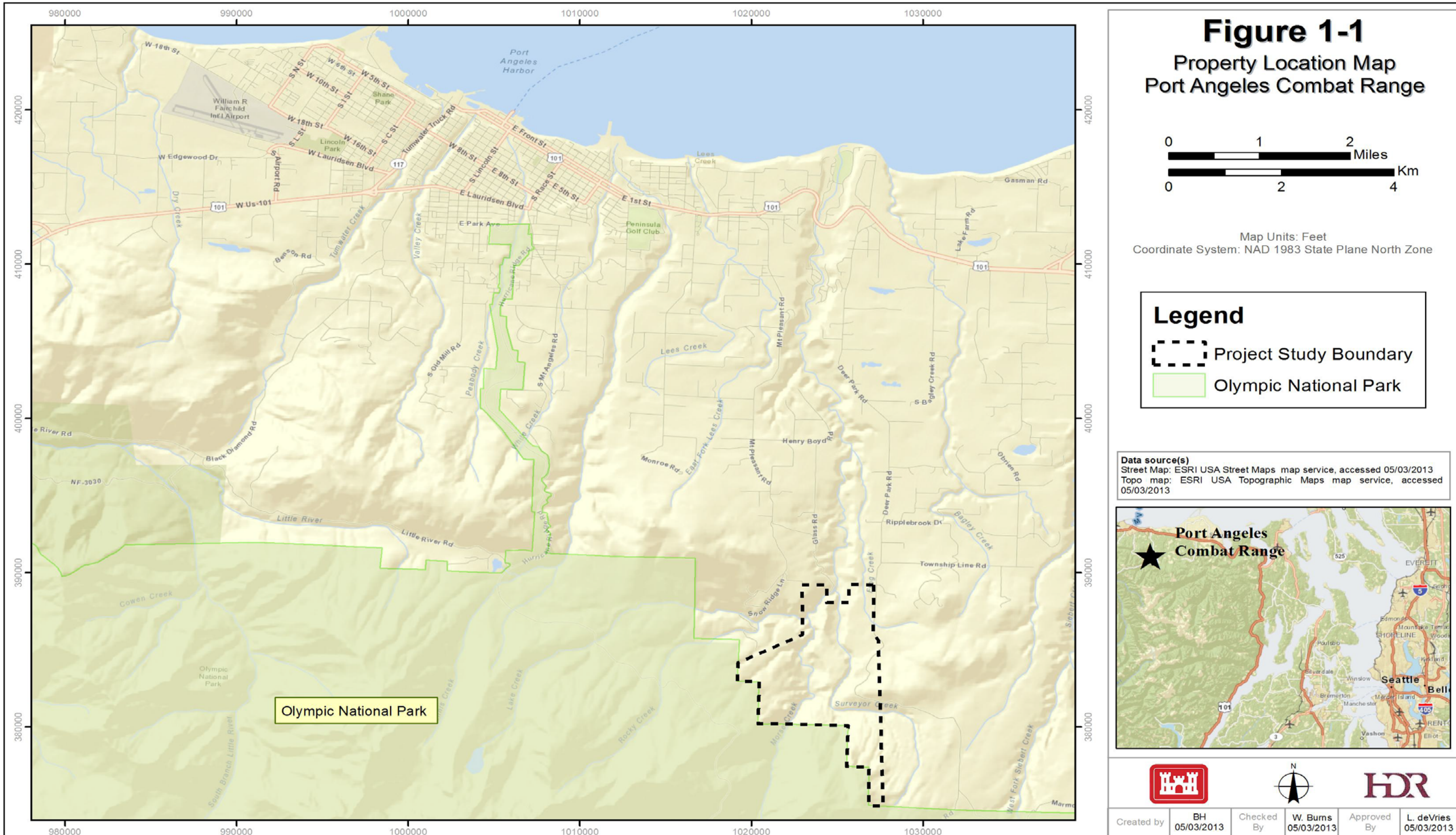

Figure 1-1
Property Location Map
Port Angeles Combat Range

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1.4 Property Location and Description

The PACR FUDS property No.: F10WA0033 is located approximately 7 miles southeast of the City of Port Angeles, in Clallam County, Washington. The PACR is partially located in Township 29 North, Range 5 West – Sections 5, 8, and 17 of the Willamette Meridian (**Figure 1-1**). The PACR is included in the MMRP Inventory in the Defense Environmental Programs Annual Report to Congress Fiscal Year 2011 (DoD, 2011) under Federal Facility Identification number WA09799F318400 with range information as identified in **Table 1-1** below (DENIX, 2009).

Table 1-1 Military Munitions Response Program Munitions Response Site Inventory – Port Angeles Combat Range

Site ID	MRSPP Score	Nearest City	Landowner Name	Ownership Interest	Range Total Acreage	Land Use Restrictions	Land Use Access Controls
01OEW	3 *	Port Angeles	Other Federal Government	No Data Available	2,629	No Data Available	No Data Available

Note:
*Indicates a "*Recommended Score*"; Approved Score pending U.S. Army QA Panel review.
MRSPP = Munitions Response Site Prioritization Protocol

The acreage of the PACR has been recorded in the Archives Search Report (ASR) as having acreage of approximately 1,600 acres (USACE, 1996) (**Figure 1-2**). The PACR MRS boundary extends beyond the FUDS property boundary. However, due to the NPS and the DoD not having a programmatic agreement to address MMRP sites the acreage within the ONP will not be investigated. The acreage and coordinates for the MRS and sub-ranges are listed in the ASR Supplement (USACE, 2004) identified in **Table 1-2** below as:

Table 1-2 Ranges and Sub Ranges – Port Angeles Combat Range

Range/Sub-range Name	Range Identification	Approximate Acreage	UTM Coordinates (meters)
Range Complex No. 1	F10WA003301R01	2,629	N 5318355 E 473503
Sub – Range Identification			
Direct Fire Impact Area	F10WA003301R01-SR01	119	N 5319614 E 474222
Direct Fire and Combat Training Area	F10WA003301R01-SR02	37	N 5245500 E 474341
Indirect Fire Impact Area	F10WA003301R01-SR03	483	N 5319084 E 473895
Buffer Zone	F10WA003301R01-SR04	856	N 5317495 E 473788
Buffer Zone and Combat Training Area	F10WA003301R01-SR05	23	N 5319758 E 474317
Combat Training Area	F10WA003301R01-SR06	41	N 5320231 E 474337
Impact/Buffer Area	F10WA003301R01-SR07	960	N 5318355 E 473503

Notes:
Coordinates for the ranges are in Universal Transverse Mercator (UTM), Zone 10N, North American Datum (NAD) 83.

The reported total area of Range Complex No.1 MRS (2,629 acres) exceeds the total area of the seven sub-ranges combined (2,519 acres). This discrepancy is due to the area of the Impact/Buffer Area extending beyond the FUDS property boundary in the northern portion of the PACR MRS.

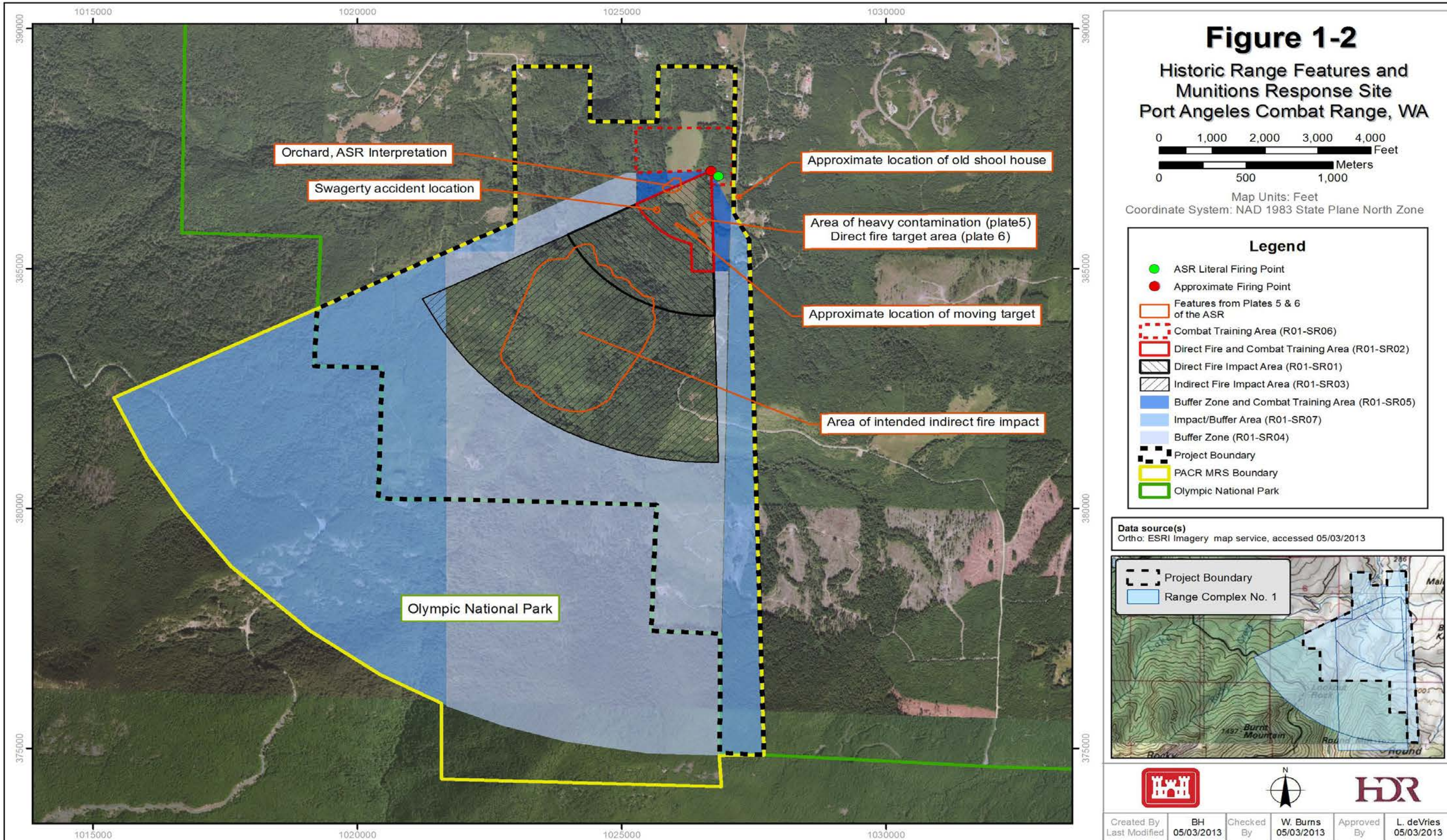
Figure 1-2
Historic Range Features and Munitions Response Site
Port Angeles Combat Range, WA
0 1,000 2,000 3,000 4,000 Feet
0 500 1,000 Meters
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
ASR Literal Firing Point
Approximate Firing Point
Features from Plates 5 & 6 of the ASR
Combat Training Area (R01-SR06)
Direct Fire and Combat Training Area (R01-SR02)
Direct Fire Impact Area (R01-SR01)
Indirect Fire Impact Area (R01-SR03)
Buffer Zone and Combat Training Area (R01-SR05)
Impact/Buffer Area (R01-SR07)
Buffer Zone (R01-SR04)
Project Boundary
PACR MRS Boundary
Olympic National Park
Data source(s)
Ortho: ESRI Imagery map service, accessed 05/03/2013
Project Boundary
Range Complex No. 1
Created By Last Modified BH 05/03/2013
Checked By W. Burns 05/03/2013
Approved By L. deVries 05/03/2013
Orchard, ASR Interpretation
Swagerty accident location
Approximate location of old shool house
Area of heavy contamination (plate5)
Direct fire target area (plate 6)
Approximate location of moving target
Area of intended indirect fire impact
Olympic National Park
1015000
1020000
1025000
1030000
390000
385000
380000
375000

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1.5 Ownership History

Approximately 1,600 acres of the PACR were obtained from within Sections 5, 8, and 17 of Township 29 North, Range 5 West of the Willamette Meridian for military use through leases and use permits. In April and May 1944, the range was declared excess and all leases and permits were canceled by the War Department/DoD. All acreage and facilities were sold and leases relinquished in 1945. An accident involving unexploded ordnance (UXO) at the PACR killed two youths in 1948. In 1963, the U.S. Army repurchased 652 acres of "*potentially contaminated*" land to restrict access where the UXO accident occurred. The 652 acres were retained by the U.S. Army until 1967, when they were transferred to the City of Port Angeles and to Mr. Raymond Diehl. A "*surface use only*" and indemnity clause was included in the quitclaim deed records as identified in the ASR (USACE, 1996). The southern and southwestern portion of the PACR is now part of the ONP. A portion of the PACR property is currently maintained as a protected watershed for the City of Port Angeles (USACE, 1996). **Figure 1-3** presents current tax lot parcels and identifies parcels that will require Right of Entry (ROE) permits.

1.6 Site Description

The following five subsections describe the topography and vegetation, T&E species, climate, area water supply, and the geologic and hydrogeologic setting of the PACR.

1.6.1 Topography and Vegetation

The PACR is part of the Olympic Peninsula in the State of Washington. The land is hilly to semi-mountainous. The northern portion of the PACR contains areas of meadowland/grassland, but other areas are densely forested. The minimum and maximum elevations of the PACR are approximately 700 feet (ft.) in the north and 3,541 ft. in the south at Round Mountain. Deep erosion features associated with Morse and Surveyor Creeks are present at the PACR and likely follow the same channels present during historical U.S. Army training activities.

Vegetation on the PACR property consists of primarily second growth fir and alder with some cedar trees. In forested areas, the PACR property has very dense undergrowth that makes access difficult. Recently logged areas have very dense growth of small trees and shrubs that makes these areas nearly inaccessible. Topography, including surface elevations and prominent features, is provided on (**Figure 1-4**).

Review of historical aerial photographs indicates that the areas of meadowland/grassland have been present since at least 1939. This open meadowland/grassland was used as a firing point. The southern portion of the PACR is located within the ONP. The buffer zone extends into the ONP (**Figure 1-4**).

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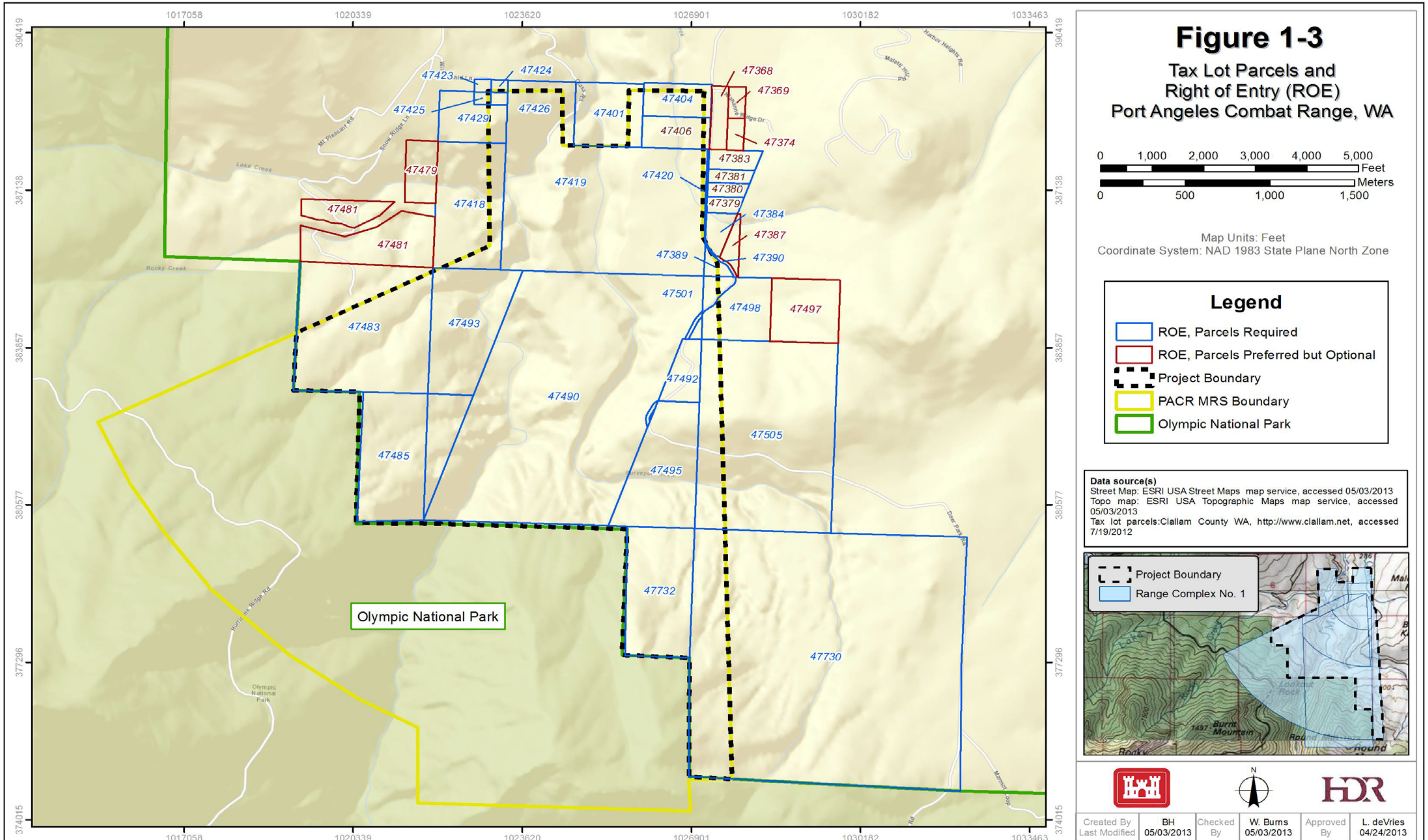

Figure 1-3
Tax Lot Parcels and Right of Entry (ROE)
Port Angeles Combat Range, WA
0 1,000 2,000 3,000 4,000 5,000 Feet
0 500 1,000 1,500 Meters
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
ROE, Parcels Required
ROE, Parcels Preferred but Optional
Project Boundary
PACR MRS Boundary
Olympic National Park
Data source(s)
Street Map: ESRI USA Street Maps map service, accessed 05/03/2013
Topo map: ESRI USA Topographic Maps map service, accessed 05/03/2013
Tax lot parcels:Clallam County WA, http://www.clallam.net, accessed 7/19/2012
Project Boundary
Range Complex No. 1
Created By Last Modified
BH 05/03/2013
Checked By
W. Burns 05/03/2013
Approved By
L. deVries 04/24/2013
HDR
Olympic National Park
1017058
1020339
1023620
1026901
1030182
1033463
390419
387138
383857
380577
377296
374015
47423
47424
47425
47429
47426
47401
47404
47406
47368
47369
47374
47383
47381
47380
47379
47384
47387
47390
47389
47420
47419
47418
47479
47481
47481
47483
47493
47501
47498
47497
47492
47490
47485
47495
47505
47732
47730
Lake Creek
Rocky Creek

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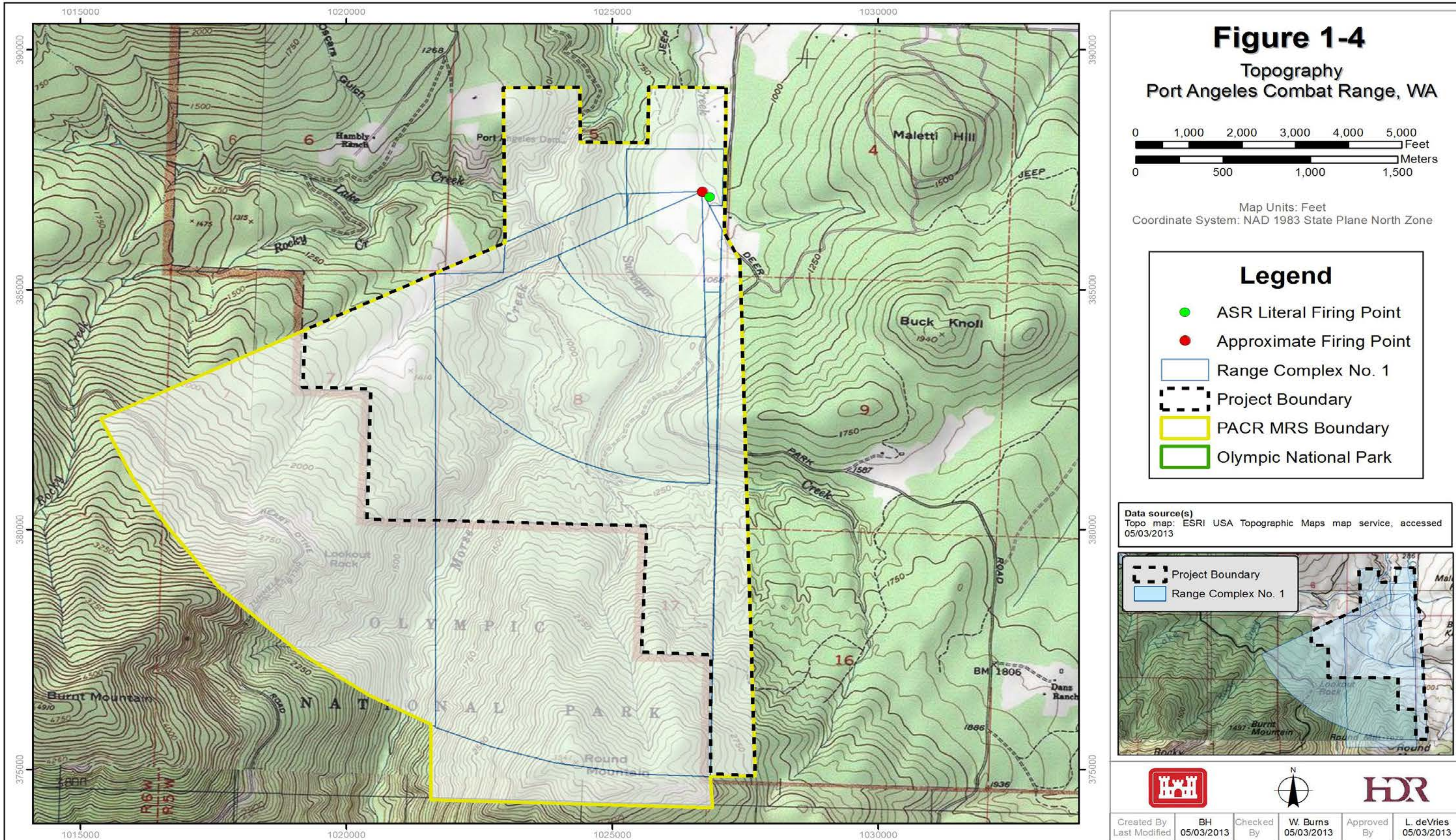
Figure 1-4
Topography
Port Angeles Combat Range, WA
0 1,000 2,000 3,000 4,000 5,000 Feet
0 500 1,000 1,500 Meters
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
ASR Literal Firing Point
Approximate Firing Point
Range Complex No. 1
Project Boundary
PACR MRS Boundary
Olympic National Park
Data source(s)
Topo map: ESRI USA Topographic Maps map service, accessed 05/03/2013
Project Boundary
Range Complex No. 1
Created By Last Modified BH 05/03/2013
Checked By W. Burns 05/03/2013
Approved By L. deVries 05/03/2013
Maletti Hill
Buck Knoll
Burnt Mountain
Round Mountain
Lookout Rock
Hambly Ranch
OLYMPIC NATIONAL PARK
1015000
1020000
1025000
1030000
390000
385000
380000
375000

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1.6.2 Climate

The PACR area climate is tempered by winds from the Pacific Ocean. Summers are warm but hot days are rare. In winter, temperatures are cool; however, freezing temperatures and snow are infrequent except in the mountains (USACE, 1996). The average maximum high temperature within the City of Port Angeles occurs in July and August at 68.4 degrees Fahrenheit (°F) and the minimum average low temperature occurs in January at 34.0°F. The average annual precipitation is 25.6 inches which occurs primarily between October and April. Average total snowfall is 3.8 inches (WRCC, 2013). See **Table 1-3** for monthly averages.

Table 1-3 Climate Table – Port Angeles Combat Range

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F°)	44.9	47.4	50.2	54.9	60.3	64.2	68	67.9	65.0	57.1	49.6	45.9	56.3
Average Min. Temperature (F°)	34.1	35.4	36.9	40.3	44.9	49.1	51.7	52	48.7	43.4	38.2	35.5	42.5
Average Total Precipitation (inches)	3.9	2.7	2.1	1.3	1.3	0.9	0.5	0.8	1.1	2.5	4.0	4.3	25.0
Average Total Snow Fall (in.)	1.7	0.9	0.4	0	0	0	0	0	0	0	0.3	0.8	4.1
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
F° = degrees Fahrenheit
in. = inches

1.6.3 Hydrology

Three creeks transect the PACR flowing from south to north; Surveyor Creek, Frog Creek, and Morse Creek (**Figure 1-5**). These creeks flow north toward the City of Port Angeles. Property associated with the PACR serves as a watershed for the City of Port Angeles. A surface water intake is located at the location labeled as "*Port Angeles Dam*" on **Figure 1-5** and the second intake is located approximately 1,200 ft. downstream of the dam. The intake at "*Port Angeles Dam*" is within the PACR boundary.

The USFWS National Wetlands Inventory indicates a 0.43 acre wetland in the southern portion of the large open meadow area of the PACR. The wetland is classified as freshwater emergent. It is specifically described as a palustrine, emergent, persistent, seasonally flooded wetland. Wetlands of this type are dominated by trees, shrubs, emergents, mosses or lichens. Surface water is present for extended periods, especially early in the growing season (USFWS, 2013a).

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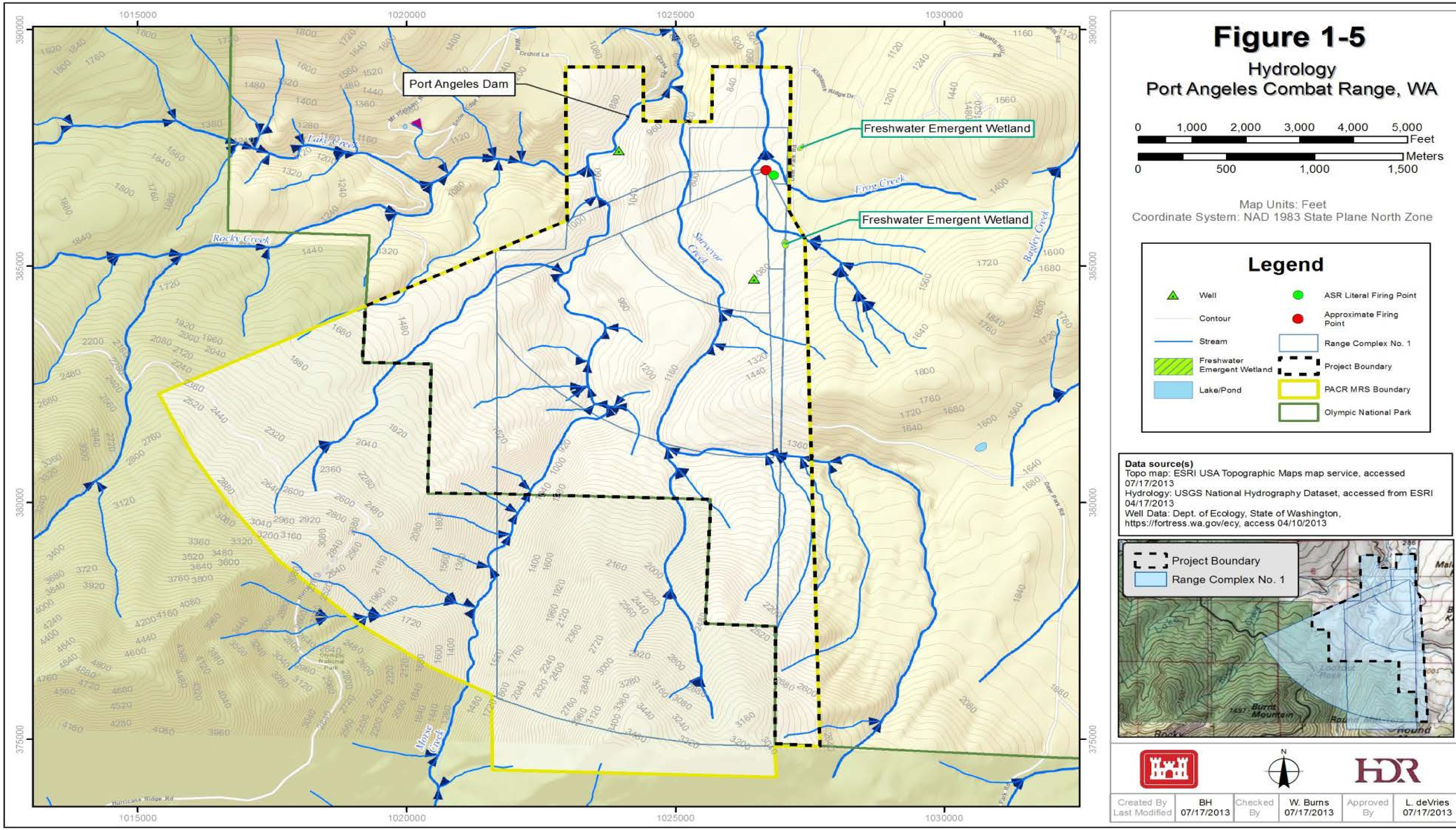
Figure 1-5
Hydrology
Port Angeles Combat Range, WA
0 1,000 2,000 3,000 4,000 5,000 Feet
0 500 1,000 1,500 Meters
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
Well
Contour
Stream
Freshwater Emergent Wetland
Lake/Pond
ASR Literal Firing Point
Approximate Firing Point
Range Complex No. 1
Project Boundary
PACR MRS Boundary
Olympic National Park
Data source(s)
Topo map: ESRI USA Topographic Maps map service, accessed 07/17/2013
Hydrology: USGS National Hydrography Dataset, accessed from ESRI 04/17/2013
Well Data: Dept. of Ecology, State of Washington, https://fortress.wa.gov/ecy, access 04/10/2013
Project Boundary
Range Complex No. 1
Port Angeles Dam
Freshwater Emergent Wetland
Freshwater Emergent Wetland
Lake Creek
Rocky Creek
Frog Creek
Surveyor Creek
Bagley Creek
Morse Creek
1015000
1020000
1025000
1030000
390000
385000
380000
375000
Created By Last Modified
BH 07/17/2013
Checked By
W. Burns 07/17/2013
Approved By
L. deVries 07/17/2013

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1.6.4 Geologic and Hydrogeologic Setting

Geology of the area is controlled by the converging of two tectonic plates (Juan de Fuca and North American plates). Underlying the PACR are accreted Tertiary sediments and pillow basalt rocks that were once on the floor of the Pacific Ocean. During the Pleistocene Epoch, colder climates brought about glaciations over much of the Olympic Peninsula and Puget Lowland, leaving thick glacial outwash deposits over older rocks (Orr and Orr, 2002). North of the PACR, these glacial outwash deposits pinch out and bedrock is covered by deposits of rocky alluvium on hillsides and by sands and gravels with silt in areas of low relief (Shaw, 2009).

Soils present at the PACR are Elwha gravelly sandy loam, Neilton very gravelly sandy loam, Puget silt loam, and Terbies very gravelly sandy loam (NRCS, 2007) (**Figure 1-6**). During the 2008 Site Inspection (SI) sampling, the surface soils were described as consisting of silty sand (Shaw, 2009).

Shallow groundwater in the region occurs in gravelly units within the glacial outwash deposits. In the PACR vicinity, groundwater occurs within sand and gravel units that overlie the bedrock. Based on well logs, groundwater occurs in these units at a depth ranging from 50 to 120 ft. Regional groundwater flow is to the north from the highlands to the Strait of Juan de Fuca. A site resident indicated that depth to groundwater at his domestic well was approximately 18 ft. bgs. No well log is available to determine the well depth or geology. Because of the surface streams in the area, shallow groundwater flow within the PACR is likely toward nearby streams where it is assumed to discharge. Surface water flows to the north to the Strait of Juan de Fuca (Shaw, 2009).

Drinking water in the area is obtained from Clallam County Public Utility District (PUD) No. 1 and private water supply wells. Clallam County PUD No. 1 obtains water from Morse Creek at two water intake structures.

There are two private domestic wells located in the northern portion of the PACR (Shaw, 2009).The total depth of the Mortensen well is 285 ft. below ground surface (bgs) and the Whitcomb well is 116 ft. bgs. Static water levels were recorded as 0 ft. and 30 ft. below top of casing (btoc) respectively. Both wells were installed by Louie’s Well Drilling Inc. (WDOE, 2013).

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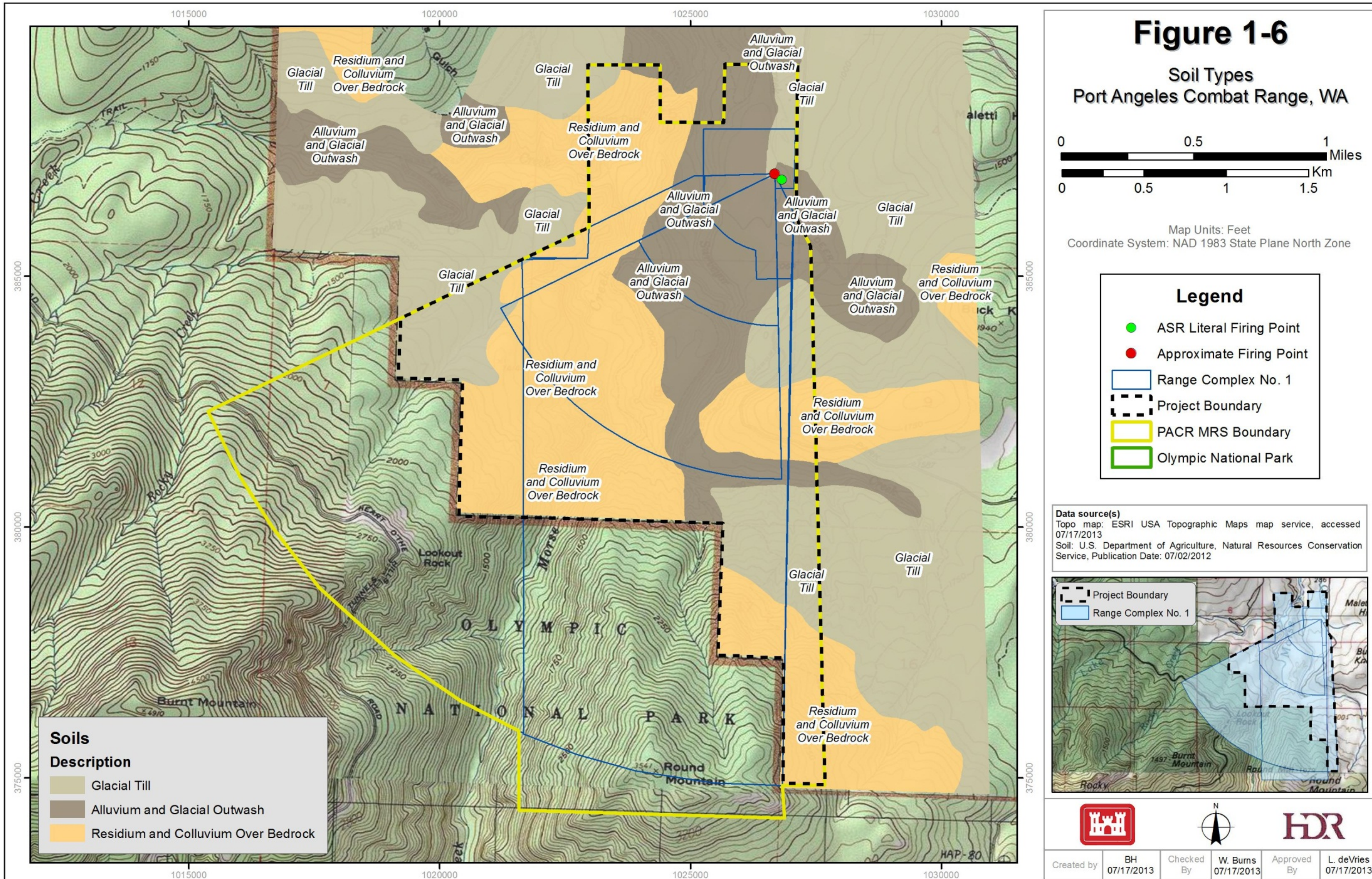
Figure 1-6
Soil Types
Port Angeles Combat Range, WA
0 0.5 1 Miles
0 0.5 1 1.5 Km
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
ASR Literal Firing Point
Approximate Firing Point
Range Complex No. 1
Project Boundary
PACR MRS Boundary
Olympic National Park
Data source(s)
Topo map: ESRI USA Topographic Maps map service, accessed 07/17/2013
Soil: U.S. Department of Agriculture, Natural Resources Conservation Service, Publication Date: 07/02/2012
Project Boundary
Range Complex No. 1
Soils
Description
Glacial Till
Alluvium and Glacial Outwash
Residium and Colluvium Over Bedrock
Glacial Till
Alluvium and Glacial Outwash
Residium and Colluvium Over Bedrock
OLYMPIC NATIONAL PARK
Lookout Rock
Burnt Mountain
Round Mountain
1015000
1020000
1025000
1030000
385000
380000
375000
Created by BH 07/17/2013
Checked By W. Burns 07/17/2013
Approved By L. deVries 07/17/2013

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1.6.5 Threatened and Endangered Species

Washington State has many species protected under both Federal and State laws. The U.S. Fish and Wildlife Service (USFWS) establishes and maintains the list of Federal T&E animal and plant species under the Endangered Species Act (ESA) of 1973 (16 U.S.C. §1531-1544 et seq.). The State of Washington adopts Federal listings and designates additional T&E species and species of concern for the state. Both the State and Federal programs designate critical habitat that supports species recovery with the goal of eventual delisting.

The ESA defines endangered and threatened species as the following: "*The term 'endangered species' means any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this chapter would present an overwhelming and overriding risk to man." "The term 'threatened species' means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range*."

"*Species of Concern*" is an informal term. It is not defined in the Federal ESA. The term commonly refers to species that are declining or appear to be in need of conservation. Many agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts.

The USFWS listing (USFWS, 2013) identifies the following T& E species that may be present or near the PACR at some of all life stages:

- Bull trout (*Salvelinus confluentus*) – Coastal Puget Sound distinct population segment (DPS) - Threatened;
- Marbled Murrelet (*Brachyramphus marmoratus*) – Threatened;
- Northern spotted owl (*Strix occidentalis caurina*) – Threatened; and
- Short-tailed albatross (*Phoebastria albatrus*) [outer coast] – Endangered.

There is federally designated critical habitat for the following T & E species in Clallam County:

1. Bull trout
2. Marbled Murrelet
3. Northern spotted owl

While there is federally designated critical habitat located within one (1) mile of the PACR (**Figure 1-7**), there are no known habitats with the PACR based on the information available at the time of this RIWP.

Recovery Plans have been published by the USFWS for the Marbled Murrelet and the Northern spotted owl (*http://ecos.fws.gov/tess_public/pub/speciesRecovery.jsp?sort=1*).

The USFWS also maintains species which are candidate species and proposed species for listing (USFWS, 2013). The species that are proposed for listing in Washington and possibly present in Clallam County include:

- White Bluffs bladderpod (*Physaria douglasii* ssp. *tuplashensis*) – Proposed Threatened;
- Umtanum Desert buckwheat (*Eriogonum codium*) – Proposed Threatened;
- Taylor's Checkerspot (Euphydryas editha taylori) – Proposed Endangered;
- Streaked Horned lark (*Eremophila alpestris strigata*) – Proposed Threatened;
- Olympia pocket gopher (*Thomomys mazama pugetensis*) – Proposed Threatened;
- Roy Prairie pocket gopher (*Thomomys mazama glacialis*) – Proposed Threatened;
- Tenino pocket gopher (*Thomomys mazama* ssp. *tumuli*) – Proposed Threatened;
- Yelm pocket gopher (*Thomomys mazama* ssp. *yelmensis*) – Proposed Threatened;
- North American wolverine (*Gulo gulo luscus*) – Proposed Threatened; and
- Dolly Varden (*Salvelinus malma*) - Proposed Similarity of Appearance (Threatened).

Species identified as *candidates* for Federal listing (USFWS, 2013) which are known or believed to occur in Washington and possibly in Clallam County include:

- Yellow-Billed Cuckoo (*Coccyzus americanus*),
- Oregon Spotted frog (*Rana pretiosa*),
- Canada Lynx (*Lynx canadensis*),
- Whitebark pine (*Pinus albicaulis*),
- Brush Prairie Pocket gopher (*Thomomys mazama* ssp. *douglasii*),
- Olympic pocket gopher (*Thomomys mazama* ssp. *melanops*),
- Shelton pocket gopher (*Thomomys mazama* ssp. *couchi*),
- Tacoma Western pocket gopher (*Thomomys mazama tacomensis*) (Pacific Region),
- Greater sage-grouse (*Centrocercus urophasianus*),
- Washington ground squirrel (*Urocitellus washingtoni*), and
- Northern Wormwood (*Artemisia borealis var. wormskioldii*).

Appendix K provides a complete Federal listing of all species that occur or have the potential to be in the State of Washington.

Information pertaining to T&E species was sought as part of the planning process. According to the ASR, "*Earlier conversations with the Clallam County Extension Office and the USNPS environmental personnel, along with review of Environmental Impact Statements and reports from the Natural Heritage Program, indicated there was no confirmed existence of any endangered plant or animal species within the project site. However, it was noted that complete surveys of the area were not done, and it was likely that at least some of the state threatened or endangered wildlife species would occur in a transient mode*" (USACE, 1996).

Priority areas for the Marbled Murrelet in Clallam County are near the PACR (WDFW, 2008). Priority areas for anadromous and resident fish are also nearby (Shaw, 2009). WDFW defines priority areas as follows: *"Species are often considered a priority only within known limiting habitats (e.g., breeding areas) or within areas that support a relatively high number of individuals (e.g., regular concentrations)"* (WDFW, 2008). The Washington Department of Natural Resources (WDNR) indicated that there were no records for rare plants or high quality native ecosystems near the PACR (WDNR, 2008).

USFWS Pacific Region 1 Washington Office, the WDNR, and the Washington Department of Fish and Wildlife Conservation Division are jointly tasked with enforcing Federal statutes with respect to the ESA. In addition, these agencies designate species within the State of Washington that may need specific and additional protection and habitat conservation.

The Washington Department of Fish and Wildlife Conservation Division provided a comprehensive Federal and State summary of T&E and candidate species for listing and species of concern at their website (*http://wdfw.wa.gov/conservation/endangered/*). (**Appendix K**). In addition, **Appendix K** provides a list of State monitor species.

The Washington State Department of Natural Resource Natural Heritage Program (WNHP) and the Spokane District of the US Department of the Interior (USDI) Bureau of Land Management (BLM) compiled a list of plants for a field guide containing fact sheets for 40 rare species of vascular plants. This guide was expanded to include 370 vascular plants, 11 mosses, and one lichen (*http://www1.dnr.wa.gov/nhp/refdesk/fguide/htm/fgmain.htm*, Access date: 8/16/12).

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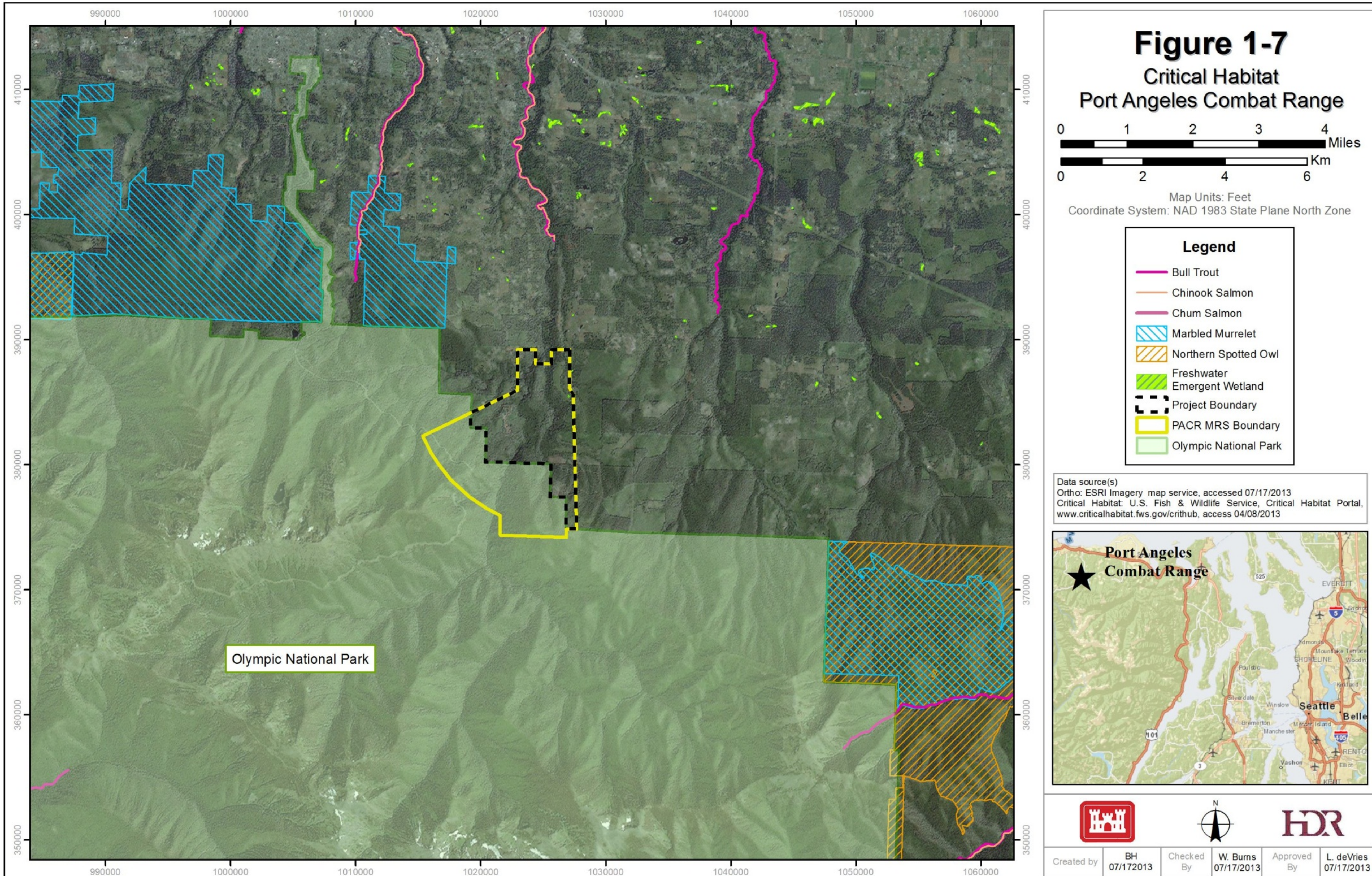
Figure 1-7
Critical Habitat
Port Angeles Combat Range
0 1 2 3 4 Miles
0 2 4 6 Km
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
Bull Trout
Chinook Salmon
Chum Salmon
Marbled Murrelet
Northern Spotted Owl
Freshwater Emergent Wetland
Project Boundary
PACR MRS Boundary
Olympic National Park
Data source(s)
Ortho: ESRI Imagery map service, accessed 07/17/2013
Critical Habitat: U.S. Fish & Wildlife Service, Critical Habitat Portal, www.criticalhabitat.fws.gov/crithub, access 04/08/2013
Port Angeles Combat Range
Seattle
Olympic National Park
Created by BH 07/172013
Checked By W. Burns 07/17/2013
Approved By L. deVries 07/17/2013

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1.7 Site History

In early 1943, the U.S. Army requested that land be leased in the area of Port Angeles, WA for use as a ground-to-ground combat range. The range was intended to be used for tactical firing problems and short-range known distance firing (200 to 300 yards). Through leases and use permits, approximately 1,600 acres were obtained within Sections 5, 8, and 17 within Township 29 North, Range 5 West of the Willamette Meridian for use as the PACR. The Inventory Project Record (INPR) (USACE, 1993) indicated the range was used for weapons practice with 37 millimeter (mm) and 75mm projectiles, 60mm and 81mm mortars, and various small arms.

The ASR also indicated that there were reports that mortars and land mines were used at the PACR. An U.S. Army investigator noted a practice land mine was found; however, there is no definitive evidence mortars were used at this FUDS. There were no buildings or improvements constructed at the PACR other than a spotting tower. Troops were encamped at the Port Angeles Fair Grounds/Conservation Corps Camp. Records indicate that the range consisted of a single firing line, with firing occurring to the south into the hilly and mountainous terrain. Interviews with former residents of the area and enlisted personnel who used the range indicated that all firing was west of Deer Park Road. Firing occurred at direct stationary and moving targets (targets and tanks pulled across the range using cables) and indirect firing using coordinates. In April and May 1944, the range was declared excess and all leases and permits were canceled.

There is no information to suggest that at the time of closing any attempt was made by the U.S. Army to perform any range clearance prior to returning the range lands to private ownership. In addition, there was no information to indicate that the U.S. Army attempted to notify land owners of the actual use of the former range in terms of potential hazards that could remain.

Two young boys were killed in August 1948, when a 37mm shell exploded while they were cutting some downed timber within the former range. The 37mm shell was embedded in a log they were sawing. Immediately after the death of the two boys, the U.S. Army initiated the de-dudding of the area expected to be impacted. On May 7, 1949, a Certificate of Clearance was issued noting that approximately 775 acres had been cleared of dangerous/explosive material. Subsequent clearances of the PACR occurred in 1952, 1955, 1956, and 1957. Copies of the Certificate of Clearances are included as Appendix E within the ASR (USACE, 1996). It should be noted that there were no SOPs identified that document the level of effort for the clearances; however, the typical procedures for clearances performed circa 1950s do not meet the quality requirements of today’s standards. In addition to the clearances being conducted, at some point in the late 1940s, signs were posted warning the public of dangers from munitions and explosive materials at the site. The information included in the ASR (e.g., Certificate of Clearances) has been analyzed and any spatial information that could be accurately extracted is displayed on **Figure 1-2**.

In 1963, 652 acres were purchased by the U.S. Army to restrict and control access to contaminated property. The 652 acres were retained until 1968 when they were transferred to the City of Port Angeles and to Mr. Raymond Diehl. Records indicated that the quitclaim deed included a "surface use only" and indemnity clause. None of the accumulated evidence summarized in the ASR indicated that chemical warfare materiel (CWM) or chemical agent identification sets (CAIS) were used at the PACR (Shaw, 2009) and based upon the documented site usage, there is no reason to suspect the presence of CWM or CAIS.

1.7.1 Range Clearance(s)

The following describes range decontamination activities at the PACR. Subsequent to the DoD transferring the land that encompassed the PACR, multiple range clearances were performed. It should be noted that range clearances performed during this time period do not meet today's quality standards. Therefore, even though previous clearances have been performed, it must be assumed that MEC still may exist within the MRS. Additionally, no thorough documentation stating the footprints cleared, procedures used, man hours per clearance, or vegetation removed has been identified. The information was summarized from the ASR and any spatial locations of the clearance efforts that could be determined are presented on **Figure 1-2** (USACE, 1996):

- Following the August 1948 accident when two boys were killed, a range clearance was conducted from October 1948 through January 1949 consisting of an inspection and "*de-dudding*" program for approximately 775 acres thought to be impacted. The work consisted of using mine detectors to sweep all open fields and known impact/target areas. Trees which were thought to contain projectiles were cut down. Heavy timber, difficult terrain, and the vastness of the area hampered clearing efforts. On May 7, 1949 a Certificate of Clearance was issued by the disposal unit that stated, "*Due to the use of high explosives, wide dispersity [sic] of fire and roughness of terrain it is recommended that these lands be restricted to surface use only*." Items recovered were identified as "*dangerous &/or explosive materials.*" The perimeter of the area was posted with signs warning of the potential danger.
- In September 1952, personnel from the bomb disposal team swept a 10-acre parcel (Peterson property) in the contaminated area that had been reportedly missed during the 1948-1949 work. No explosives were found. Despite no ordnance or scrap being found, "*surface use only*" was recommended to remain in place.
- In November 1955, a visual inspection of approximately 1,600 acres of the range was made by the bomb disposal team. A Certificate of Clearance was issued that declared the range clear of impact areas, except for one small parcel (0.71 acres). This area is identified on **Figure 1-2** as the "*Area of Heavy Contamination*". It was not reported if ordnance was found.
- A subsurface sweep (maximum 12-inch depth) of the 0.71-acre parcel was carried out by Fort Lewis personnel September 17-21, 1956. Considerable scrap metal from a target tank was collected as well as various items of expended ordnance. Items recovered included twenty-six 37mm, M51 rounds; one 37mm, M63 high explosive round; four rusted bodies, M51 fuze type; and three rusted fin fragments, 81mm mortar. A total of 96 man hours were expended utilizing one officer and two enlisted personnel.

- A final clearance certificate from March 1957 indicated that further actions toward clearing the area would not achieve a completely "*free and clear*" determination. Items recovered were identified as "*dangerous &/or explosive materials*."

1.7.2 Summary of Munitions and Explosives of Concern-Related Activities

The INPR (USACE, 1993) indicates munitions used at the range included; 37mm and 75mm projectiles, 81mm mortars, and various small arms. The ASR (USACE, 1996) and ASR Supplement (USACE, 2004) indicate that 37mm (target practice, high explosive, and armor piercing), 75mm (practice, high explosive, and white phosphorus smoke), 60mm mortar (high explosive and practice), and 81mm mortar (high explosive, practice, and white phosphorus smoke) were used at the PACR. The ASR also included unverified reports of the use of M9A1 High Explosive Anti Tank (HEAT) rifle grenades, 2.36-inch rockets (practice and HEAT), and anti-personnel and anti-tank practice mines. Other than the munitions recovered during the prior clearance efforts, there is no definitive evidence that these munitions were used at the PACR. The munitions quantities used are not known. Please refer to **Table 1-4** for a list of probable munitions used and associated munitions constituents.

Table 1-4 Composition of Munitions Potentially Used at the Port Angeles Combat Range

Size/Type Sub-Range	Nomenclature	Munitions Constituent(s)	Reference
Ctg, .30 Caliber R01-SR-01	M2/ Ball M/2 AP M1 Carbine	Lead; Propellant – single-base (nitrocellulose) or double-base (nitrocellulose and nitroglycerin); Tracer composition – strontium nitrate, polyvinyl chloride, strontium peroxide, magnesium powder.	TM 43-0001-27
Ctg, .45 Caliber R01-SR-01	M1911/ Ball with M1 Tracer	Lead; Propellant – single-base (nitrocellulose) or double-base (nitrocellulose and nitroglycerin); Tracer composition – strontium nitrate, polyvinyl chloride, strontium peroxide, magnesium powder.	TM 43-0001-27
Ctg, .50 Caliber R01-SR-01	M2/Ball M/2 AP with Tracer	Lead; Propellant – single-base (nitrocellulose) or double-base (nitrocellulose and nitroglycerin); Tracer composition – strontium nitrate, polyvinyl chloride, strontium peroxide, magnesium powder.	TM 43-0001-27
Shell, 37 mm All remaining sub-ranges	M/63 HE with fuze M58 w/ Primer w/ Propellant	M63 HE: Steel (chromium, copper, iron, nickel); Explosive – trinitrotoluene (TNT): Fuze M58 – lead azide, tetryl; Primer M23 – Black powder (sulfur, potassium nitrate, charcoal), primer mixture (mercury fulminate, potassium chlorate, antimony sulfide); Propellant – FNH powder (nitrocellulose, dibutylphthalate, dinitrotoluene, diphenylamine).	TM 43-0001-28
	M74/AP w/Tracer w/ Primer w/ Propellant	M74 AP: Steel (chromium, copper, iron, nickel); Tracer – Tracer composition (strontium nitrate, polyvinyl chloride, strontium peroxide, magnesium powder); Primer M23 – primer mixture (mercury fulminate, potassium chlorate, antimony sulfide); Propellant – FNH powder (nitrocellulose, dibutylphthalate, dinitrotoluene, diphenylamine).	

Table 1-4 Composition of Munitions Potentially Used at the Port Angeles Combat Range

Size/Type Sub-Range	Nomenclature	Munitions Constituent(s)	Reference
	M51/TP w/Primer M23 w/Propellant	M51 TP: Steel (chromium, copper, iron, nickel); Primer M23 – primer mixture (mercury fulminate, potassium chlorate, antimony sulfide); Propellant – FNH powder (nitrocellulose, dibutylphthalate, dinitrotoluene, diphenylamine).	
Mortar, 60mm All remaining sub-ranges	M49/ HE w/ primer w/ Propellant w/ Ignition ctg w/ fuze M52	M49 HE: Steel (chromium, copper, iron, nickel); Explosive – TNT; Primer M32 – Black powder (sulfur, potassium nitrate, charcoal), primer mixture (mercury fulminate, potassium chlorate, antimony sulfide); Propellant – double-base powder (nitrocellulose and nitroglycerin); Ignition cartridge – double-base powder (nitrocellulose and nitroglycerin): Fuze M52 – Mercury fulminate, lead azide, and tetryl.	TM 43-0001-28
Mortar, 60mm All remaining sub-ranges	M50/ Practice	M50 practice: Steel (chromium, copper, iron, nickel); Spotting charge – black powder (sulfur, potassium nitrate, charcoal).	TM 43-0001-28
Shell, 75mm All remaining sub-ranges	M48/ HE w/ Propellant w/ Fuze M48 or M54	M48 HE: Steel (chromium, copper, iron, nickel); Explosive – TNT; Primer M32 – Black powder (sulfur, potassium nitrate, charcoal), primer mixture (mercury fulminate, potassium chlorate, antimony sulfide); Propellant – FNH powder (nitrocellulose, dibutylphthalate, dinitrotoluene, diphenylamine); Fuze M48 – Mercury fulminate, lead azide.	TM 43-0001-28
	M64/ WP	M64 WP: White phosphorus; Steel (chromium, copper, iron, nickel); Propellant – FNH powder (nitrocellulose, dibutylphthalate, dinitrotoluene, diphenylamine).	
	M61/ AP Practice w/tracer	M61 AP (practice): Steel (chromium, copper, iron, nickel); Propellant – FNH powder (nitrocellulose, dibutylphthalate, dinitrotoluene, diphenylamine); Tracer – Tracer composition: strontium nitrate, polyvinyl chloride, strontium peroxide, magnesium powder.	
Mortar, 81mm All remaining sub-ranges	M43A1/HE Shell w/Primer M33 w/ Propellant w. Ignition Ctg w/ Fuze M52	M43A1 HE: Steel (chromium, copper, iron, nickel); Explosive – TNT; Primer M33 – Black powder (sulfur, potassium nitrate, charcoal), primer mixture (mercury fulminate, potassium chlorate, antimony sulfide); Propellant – double-base powder (nitrocellulose and nitroglycerin); Ignition cartridge – double-base powder (nitrocellulose and nitroglycerin); Fuze M52– Mercury fulminate, lead azide, and tetryl.	TM 43-0001-28
	M44/ Practice	M44 Practice: Steel (chromium, copper, iron, nickel); Spotting charge – Black powder (sulfur, potassium nitrate, charcoal).	

Table 1-4 Composition of Munitions Potentially Used at the Port Angeles Combat Range

Size/Type Sub-Range	Nomenclature	Munitions Constituent(s)	Reference
	M57/ WP Smoke	M57 WP: White phosphorus; Steel (chromium, copper, iron, nickel); Propellant – double-base powder (nitrocellulose and nitroglycerin).	
Grenade, Rifle All remaining sub-ranges	M9A1 AT (rifle)	Explosive – TNT;	Various Sources
Mines, AP All remaining sub-ranges	M8/ Practice w/ Fuze, M10A1	M8 Practice: Steel (chromium, copper, iron, nickel); Spotting charge – Black powder (sulfur, potassium nitrate, charcoal), red phosphorus.	TM 43-0001-36
Mines, AT All remaining sub-ranges	M1/ Practice w/ Fuze, M1	M1 Practice: Steel (chromium, copper, iron, nickel); Spotting charge – Black powder (sulfur, potassium nitrate, charcoal), red phosphorus.	TM 43-0001-36
Rocket, 2.36" Bazooka All remaining sub-ranges	M7/ Practice	Steel (chromium, copper, iron, nickel); spotting charge – Black powder (sulfur, potassium nitrate, charcoal),	Various Sources
	M6/ HEAT w/ Propellant	Explosive Pentolite – TNT and Pentaerythritol tetranitrate; M7 powder.	

Notes:
Ctg – cartridge
AP – Armor Piercing
AT – Anti-Tank
mm – millimeter

1.8 Current and Projected Land Use

The following three subsections detail the current land use, nearby population, and anticipated future land use of the PACR.

1.8.1 Current Land Use

The PACR is primarily maintained as a protected watershed for the City of Port Angeles, timber production, a National Park, and private residences. The site is accessible to the general public. During the SI field work in 2008, barbed wire fencing was observed along the Deer Park Road boundary in the northern portion of the PACR. The fencing was in poor condition and was propped up in places. The southern portion of the PACR is within the ONP. This portion of the PACR will not be investigated during the course of the RI because a programmatic agreement to conduct investigation and remedial actions between the NPS and the DoD does not exist. Members of the public who attended the public information meeting for the SI indicated that the area is used for hiking and hunting. A few remaining signs warning of munitions hazards are still present (Shaw, 2009).

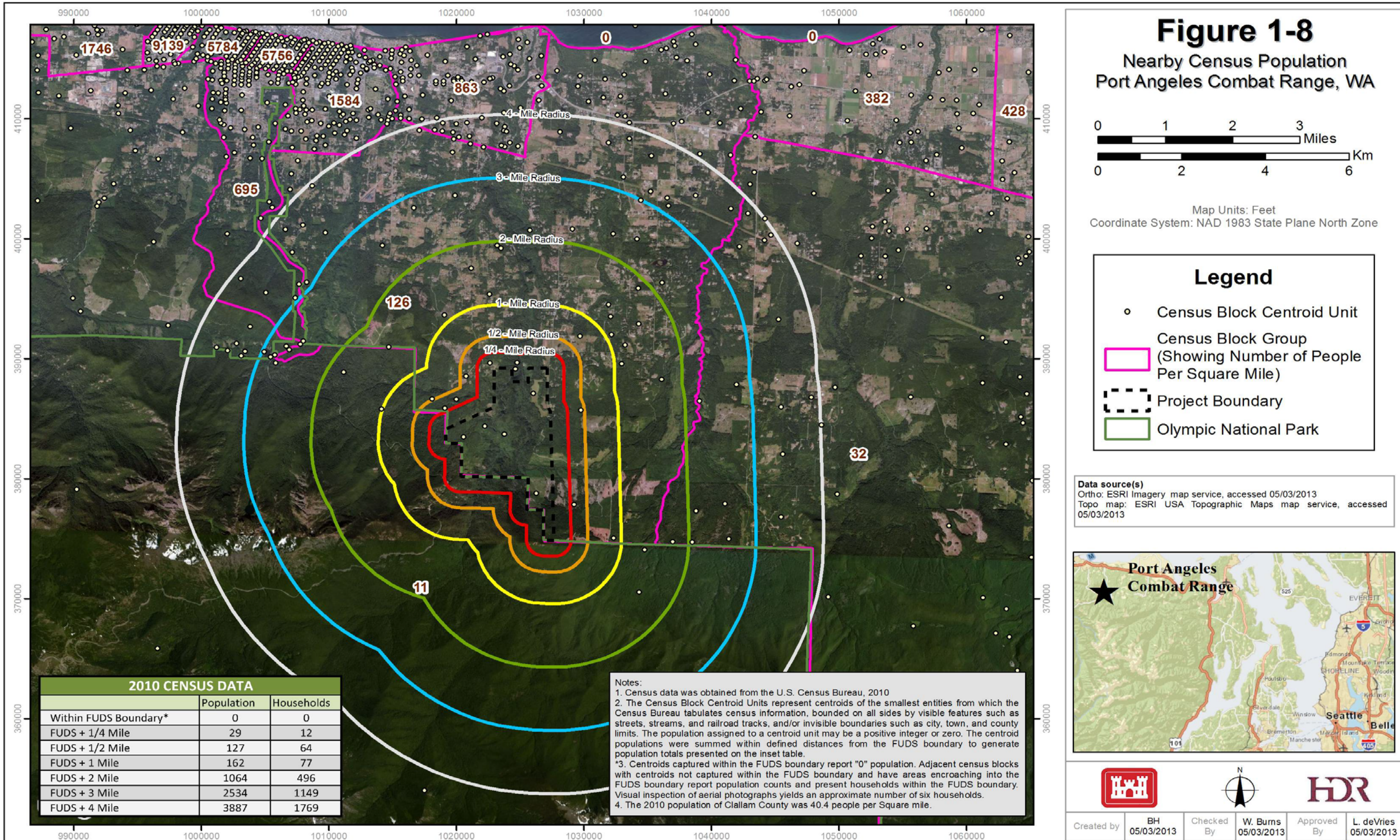
1.8.2 Nearby Population

The closest population center is the City of Port Angeles, Washington located approximately seven miles to the northwest. The 2010 census population was 19,038 persons (US Cenus Bureau [USCB], 2011). The 2010 population density for Clallam County is 40.4 persons per square mile.

Estimated populations within a 4-mile radius and 2-mile radius of the PACR property boundary are 3,887 and 1,064 respectively. The estimated numbers of households within a 4-mile radius and 2-mile radius of the PACR property boundary are 1,769 and 496, respectively (**Figure 1-8**).

1.8.3 Future Site Use

The future use of the PACR MRS is anticipated to be the same or very similar to the current use. Parts of the PACR will continue to be maintained as a protected watershed for the City of Port Angeles. Additional residential development in privately owned portions of the site should be anticipated. Future plans include the continuation of forest management, hunting, and possibly fish and wildlife conservation.



2010 CENSUS DATA

	Population	Households
Within FUDS Boundary*	0	0
FUDS + 1/4 Mile	29	12
FUDS + 1/2 Mile	127	64
FUDS + 1 Mile	162	77
FUDS + 2 Mile	1064	496
FUDS + 3 Mile	2534	1149
FUDS + 4 Mile	3887	1769

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1.9 Previous Site Investigations

Several investigations focusing on the identification of MEC have been performed at the PACR. The following sections describe the scope and major conclusions of previous work.

1.9.1 Range Clearance Technology Assessment

In 1986, a Range Clearance Technology Assessment was completed by the Naval Explosives Ordnance Disposal Facility Center (NEODFC) for the PACR. The report is limited to a one page summary and does not contain details regarding how the conclusions were derived. The report concluded that the future use of the PACR is scenic and livestock grazing; access to virtually all of the range is extremely limited due to terrain and vegetation; high explosive filled munitions have been used on the range; surface and selected subsurface clearance previously has been accomplished; and additional mechanical clearance of the range is environmentally, technically and economically unfeasible at this time or in the foreseeable future. The report recommended that the PACR not be considered for mechanical clearance in the foreseeable future; an investigation be conducted to determine the effect of natural processes on unexploded munitions; and restrictions placed on the use of the land remain in force (NEODFC, 1986).

1.9.2 Inventory Project Report

An INPR was prepared and issued in 1993 (USACE, 1993). The INPR stated, *"Based on the foregoing findings of fact, the site has been determined to be formerly used by the DoD. It is therefore eligible for the Defense Environmental Restoration Program – Formerly Used Defense Sites, established under 10 USC 2701 et seq.*" It was also proposed that further evaluation of the site be completed to better determine the hazards posed by the presence of UXO.

1.9.3 Archives Search Report

The ASR was prepared and issued in 1996 (USACE) summarizing historical information and a site visit (July 25-29, 1994) to confirm site conditions. The ASR identified six areas of interest:

- Area A – Direct Fire Impact Area,
- Area B – Indirect Fire Impact Area,
- Area C – Buffer Zone,
- Area D – Combat Training Area,
- Area E – All remaining land, and
- Area F – Impact/Buffer Area (additional acreage).

The ASR identified the likely munitions used at PACR. During the site visit, the ASR team did not observe any ordnance-related items, metal fragments, or obvious signs of ordnance usage. None of the accumulated evidence summarized in the ASR indicated that CWM or CAIS were used at the PACR (USACE, 1996).

1.9.4 Archives Search Report Supplement

The ASR Supplement identified one range and seven sub-ranges as follows (USACE, 2004):

- Range Complex No. 1:
  - Direct Fire Impact Area,
  - Direct Fire and Combat Training Area,
  - Indirect Fire Impact Area,
  - Buffer Zone,
  - Buffer Zone and Combat Training,
  - Combat Training Area, and
  - Impact/Buffer Area.

1.9.5 Site Inspection

A SI was conducted in 2008 and 2009 by the Shaw Group for USACE Northwestern Division Omaha District (NWO) Military Munitions Design Center. The technical approach was based on the Type 1 Work Plan, Site Inspections at Multiple Sites, NWO Region (Shaw, 2006) and the Formerly Used Defense Sites, Military Munitions Response Program, Site Inspections, Program Management Plan (USACE, 2005). Field activities included visual surveys and environmental media sampling (Shaw, 2009).

Visual surface reconnaissance was conducted between October 20 and October 24, 2008, along meandering path and along roadways through portions of the PACR. A two-person reconnaissance team, including a qualified UXO Technician, conducted the visual inspection.

The team documented conditions with respect to vegetative cover, evidence of military activity, unexpected debris or material, presence or absence of water or any other conditions that could potentially impact planned field activities. Particular attention was paid to identifying MEC and munitions debris (MD), potential indications of contamination such as vegetative stress and other features of interest (e.g., building foundations, permanent structures, INP etc.). Additionally, the field reconnaissance team recorded the path walked and driven within the MRS using a hand-held global positioning system (GPS) unit. Digital photographs were taken to document significant features and sample points. Representative photographs of reconnaissance and sampling activities and observations are included in the SI Final Report.

The walking visual field reconnaissance was conducted within open fields (Buffer Zone and Combat Training Area, Combat Training Area, and Direct Fire and Combat Training Area Sub-ranges) along accessible old logging roads in the sub-ranges identified above and within the Indirect Fire Impact Area Sub-range. Vehicle reconnaissance was used to supplement the walking reconnaissance and focused on observing for indications of former military operations. The walked visual reconnaissance path length was approximately 59,000 ft. The vehicle reconnaissance path length was approximately 215,000 ft. Traversing within areas where no logging roads were present was prevented due to steep slopes near creek bottoms, dense vegetation, and fallen timber that made travel unsafe. Portions of the Combat Training Area, Direct Fire and Combat Training Area, and Direct Fire Impact Area sub-ranges were comprised of open fields with thick, tall (up to knee high) grass that were used for cattle grazing. The open area can be seen on **Figure 1-2** as a lighter green with a sharp boundary within the forested areas. The tall grass restricted visual observations in the open fields. In the extreme northern portion of this open area, old farm equipment, car bodies, and miscellaneous debris were observed. No media sampling was completed in this extreme northern area.

No obvious military use features were observed in the open area or in the surrounding heavily forested areas. All other areas in the PACR were very heavily forested with thick underbrush and fallen timber. Access through some of the heavily forested areas was via old logging roads. Travel beyond these old logging roads was very limited because of the thick vegetation and fallen timber. No obvious sign of military training activities was observed during the visual reconnaissance. The area east of Surveyor Creek was inaccessible because of the terrain and vegetation hazards. Logged areas observed on aerial photographs were heavily overgrown by thick underbrush and alder trees and safe foot access was not possible.

During the SI field reconnaissance, subsurface anomaly avoidance was implemented using a magnetometer to identify subsurface anomalies. Subsurface anomalies were noted in the area described in the 1955 range clearance as an "*Area of Heavy Contamination*", which is also in the general vicinity of the 1948 accident. No MEC or MD or obvious signs of military activity were identified during SI field reconnaissance activities completed in October 2008 (Shaw, 2009).

The SI collected surface soil, sediment, surface water, and groundwater samples that were analyzed for metals of concern (chromium, copper, iron, lead, mercury, and nickel) and aluminum, magnesium, manganese, and zinc by USEPA SW-846 Methods 6020 and 7470/7471 and explosives (including nitroglycerin and PETN) by USEPA Method 8330 Modified (USEPA, 2006). Eight surface soil samples and one duplicate sample were collected.

Constituents from two of the eight surface soil samples exceeded background screening values for chromium and/or mercury. At least five percent of the uncontaminated samples were expected to exceed the background 95th upper tolerance limit (UTL). Consequently, the site data were therefore subjected to geochemical evaluation to determine if the elevated concentrations were naturally occurring or were elevated due to site operations. Geochemical evaluation indicated that the chromium and mercury concentrations in the PACR surface soil samples were most likely natural and did not reflect site-related MC. The detections of mercury and chromium were not evaluated further; therefore, the soil sample results were not compared to human health or ecological screening values. Explosives (2,4-dinitrotoluene and 1,3,5-trinitrobenzene) were detected in two surface soil samples. Sample results for the explosives did not exceed their respective human health or ecological screening values.

One sediment sample was collected. The analytical results did not exceed background screening values (using USEPA's three times background criterion for comparison of site levels to naturally occurring background levels) (Title 40 CFR Part 300, Subpart E, Appendix A, Table 2-3).

One surface water sample was collected. The analytical results did not exceed background screening values (using USEPA's three times background criterion for comparison of site levels to naturally-occurring background levels) (Title 40 CFR Part 300, Subpart E, Appendix A, Table 2-3).

One groundwater sample and one duplicate groundwater sample were collected from an on-site residential domestic water supply well. Background screening values were exceeded (using USEPA's three times background criterion for comparison of site levels to naturally occurring background levels) (USEPA, 2006a) for copper and iron. Concentrations did not exceed the human health screening values.

Because MC concentrations were below agreed upon screening values, the stakeholders agreed that MC sampling would not be required for subsequent investigations further investigation (Shaw, 2009).

Based on historical evidence of MEC, Range Complex No. 1 at the PACR FUDS was recommended for additional investigation for potential MEC hazards. Based on the SI, the location and size of the MRS at the PACR were correct as provided in the MMRP Inventory (Shaw, 2009).

1.9.6 Environmental Security Technology Certification Program Demonstration

In 2011, geophysical survey data were collected over an area at the PACR in an effort to characterize the site for future ESTCP demonstrations. Naeva Geophysics, Inc. under a subcontract to Hydro Geologic, Inc. (HGL) who was supporting the ESTCP, collected data on a parcel of approximately 31 acres using an EM61 MK-2, with a series of parallel transects spaced 30m apart. **Figure 1-9** shows the areal extent of the data coverage using the EM61-MK2 (ESTCP, 2011).

On September 29, 2011, HGL's UXO technician found a 37mm projectile at the southern extent of transect T-4 (**Figure 1-9**). The North American Datum of 1983 (NAD83) Universal Transverse Mercator (UTM) coordinates in meters of the item were 474285.654E, 5319865.518N. Following the notification protocol in the site safety and health plan, the UXO technician immediately notified the Clallam County Sheriff's office. A Washington State Police bomb technician safely disposed of the item explosively on September 29, 2011 (ESTCP, 2011).

Density analysis of the ESTCP dataset was performed by HDR using a weighted kernel density estimation (KDE) analysis utilizing the ESRI Spatial Analyst toolbox. This process is commonly used to generate a probability density function for point datasets. An initial KDE raster was generated over the entire ESTCP survey area utilizing the anomaly picks from the study. The initial KDE raster was weighted to account for coverage bias to accommodate for the approximate 3.5% coverage of the site by the DGM survey transects. Percent coverage was determined for each 1 meter kernel location in the KDE by creating a regularly spaced dense grid of points. These points were selected and retained where they intersected the actual transect swath from the survey. A KDE was then performed on the selected points and the output was normalized to values between 0 (no coverage) and 1 (100% coverage). This value was then applied to the original density calculation to provide final estimates of actual target densities throughout the ESTCP study area.

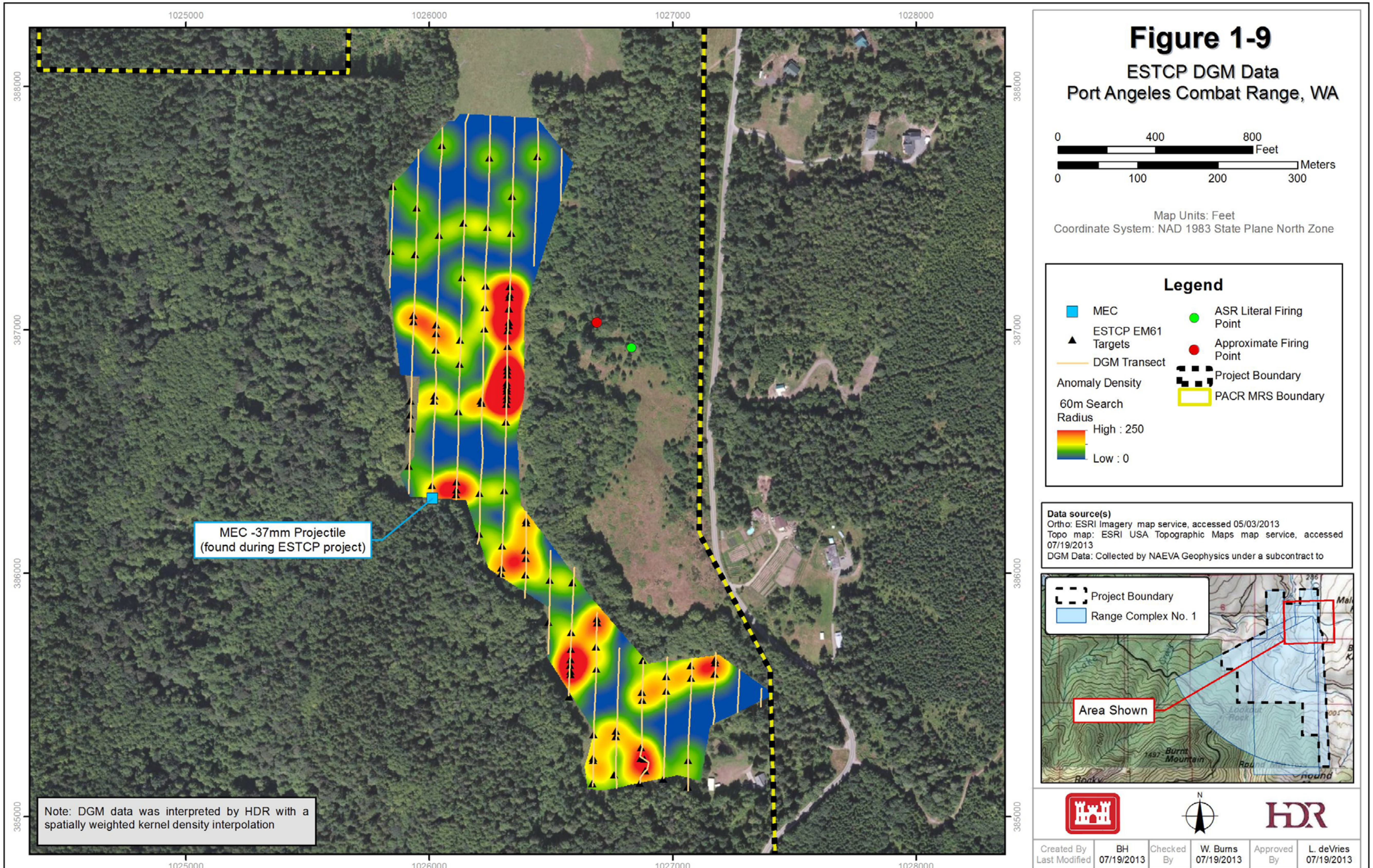

Figure 1-9
ESTCP DGM Data
Port Angeles Combat Range, WA
0 400 800 Feet
0 100 200 300 Meters
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
MEC
ESTCP EM61 Targets
DGM Transect
Anomaly Density
60m Search Radius
High : 250
Low : 0
ASR Literal Firing Point
Approximate Firing Point
Project Boundary
PACR MRS Boundary
Data source(s)
Ortho: ESRI Imagery map service, accessed 05/03/2013
Topo map: ESRI USA Topographic Maps map service, accessed 07/19/2013
DGM Data: Collected by NAEVA Geophysics under a subcontract to
Project Boundary
Range Complex No. 1
Area Shown
MEC -37mm Projectile (found during ESTCP project)
Note: DGM data was interpreted by HDR with a spatially weighted kernel density interpolation
1025000
1026000
1027000
1028000
388000
387000
386000
385000
Created By Last Modified BH 07/19/2013
Checked By W. Burns 07/19/2013
Approved By L. deVries 07/19/2013

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1.9.7 Cultural Resource Surveys

No cultural resources have been identified within the PACR. During the SI, The Washington Department of Archaeology and Historic Preservation (WDAHP) was contacted to determine if any new historical or cultural sites may have been identified within the PACR. The WDAHP recommended that consultation with nearby tribes and an archaeological survey be conducted (WDAHP, 2008). The USACE Seattle District completed an archaeological evaluation of the FUDS and noted a "*No Historic Properties Affected*" determination. This determination was forwarded to the WDAHP, who concurred with the determination. A copy of the WDAHP concurrence letter is included in the SI Report (Shaw, 2009). No further consultation with the WDAHP is planned unless the RI encounters items with potential cultural or archeological relevance.

1.10 Regulatory Activities

To date, there have been no regulatory actions with respect to MEC or MC reported for the PACR. The Washington Department of Ecology (WDOE) is the lead regulatory agency for the PACR RI. The WDOE has participated in the TPP meetings to identify the current project, determine data needs, and finalize the work plan. The WDOE will be responsible for reviewing project work plans and reports and coordinating comments from local entities. The United States Environmental Protection Agency (USEPA) will participate at their discretion.

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2.0 Technical Management Plan

The following nine subsections describe the proposed technical management plan for the PACR RI project. The project objectives are listed followed by a description of the project organization personnel. This is followed by a detail of the proposed project communications and reporting, deliverables, schedule, reports, and costing and billing. The final subsections describe the project public relations support and subcontractor and field operations management.

2.1 Project Objectives

The overall project objective is to conduct an RI for the Range Complex No. 1 MRS to determine whether the MRS recommended for RI at PACR warrants further response action pursuant to CERCLA and the NCP. The RI will accomplish the following objectives:

- Determine nature and extent of MEC;
- Determine nature and extent of MC if conditions arise requiring new sampling and analysis beyond the findings of the SI recommendation of NDAI;
- Determine the risk posed to human health and the environment by MEC and MC by conducting baseline risk assessments and a MEC Hazard Assessment (MEC HA); and
- Collect or develop additional data for the FS, as appropriate, to determine remediation alternatives for mitigation, including NDAI

The results of the RI will provide sufficient information to determine whether the PACR MRS will warrant further response action pursuant to CERCLA and the NCP.

2.2 Project Organization

Figure 2-1 presents a general project organizational chart for the PACR RI. Safety responsibilities, accountability, and lines of authority are discussed in the APP (see **Appendix D**). The contractor Project Manager (PM), Senior UXO Supervisor (SUXOS), UXO Safety Officer (UXOSO), and the Health and Safety Director (HSD) are responsible for formulating and enforcing health and safety (H&S) requirements and implementing the Site Safety and Health Plan (SSHP).

2.3 Project Personnel

The following positions are regarded as key PACR RI project personnel and identify the person:

- The MMRP Program Manager is Mr. John Steinbergs,
- The Project Manager (PM) is Mr. Larry deVries,
- The Health and Safety Director (HSD) is Ms. Sylvia Fontes,
- The Health and Safety Specialist (HSS) is Mr. Daniel Sciarro,
- The Corporate Quality Assurance Manager (CQAM) is Mr. Rich McCollum,
- The UXO Manager is Mr. Rob Irons,

- The Senior UXO Supervisor (SUXOS) is Mr. Rick. St. Armand,
- The UXO Safety Officer (UXOSO)/UXO QC Specialist (UXOQCS) is Mr. Byron Cook,
- The Site Safety and Health Officer (SSHO) designee is Mr. Byron Cook,
- The Project Geophysicist is Mr. Jon Jacobsen,
- The Geophysical Data Processor/Analyst is Mr. Stuart Bancroft,
- The Project Scientist is Ms. Nicole Luke,
- The Project Geologist is Mr. William Burns,
- The Project Chemist is Mr. Craig Walker,
- The Senior Risk Assessor is Ms. Celeste Marsh, and
- The GIS Analyst is Mr. Bryan Hosford.

The USACE PM will be notified in advance of changes in key personnel. The following subsections describe the role and responsibilities of key project personnel.

2.3.1 Program Manager

The Program Manager has overall responsibility for the activities conducted for this project. He is responsible for supporting the project with personnel and other resources, for providing performance oversight, and for QA and safety. Additional responsibilities include maintaining formal communications with the Contracting Officer and Contracting Officer's Representative (COR), contract changes, guidance on particularly difficult problems which may arise during execution; communication of program status and problems encountered to the COR and overall client satisfaction.

2.3.2 Project Manager

The PM is responsible for overall project management and is the primary point of contact (POC) to the USACE. The PM has day-to-day control and responsibility for planning, scheduling, cost control, implementation of project tasks, technical reports, and management documents. He will monitor project personnel performance, and direct technical resources. The PM has overall responsibility for safety, quality, schedule, approval of project deliverables, and, lastly, achieving the performance-based milestones.

2.3.3 Safety and Health Director

The Safety & Health Director (SHD) shall be a CIH and/or CSP and have a minimum of 3 years of experience managing safety and occupational health at hazardous waste site cleanup operations. The SHD shall enlist the support of safety and occupational health professionals with appropriate education and experience who manage and facilitate health and safety. The SHD serves as an advisor to the Health and Safety Specialist (HSS) in evaluating environmental, health, and safety concerns with respect to Hazardous, Toxic, and Radioactive Waste (HTRW) concerns and work practices. The SHD has the authority to take immediate steps to implement and correct unsafe or unhealthful conditions including the stoppage of fieldwork when deemed necessary. Refer to the APP/SHPP (**Appendix D**) for specific responsibilities of the SHD.

2.3.4 Health and Safety Specialist

With directives from the HSD, the HSS serves as an advisor to the SSHO Designee who will also function as the UXOSO with respect to overseeing current and evolving work conditions, while assuring company compliance with all applicable environmental, health and safety standards. The HSS along with the health and safety department focus on loss reduction through risk management programs and implementation. The HSS has a supporting role in the development and ongoing assessment of policies, procedures, written work practices, and health and safety program components. The HSS has the authority to take immediate steps to correct unsafe or unhealthful conditions including the stoppage of fieldwork when deemed necessary. Refer to the APP/SHPP (**Appendix D**) for specific responsibilities of the HSS.

2.3.5 Corporate Quality Assurance Manager

The Corporate Quality Assurance Manager (CQAM) will support the Program Manager with implementation of the QA program. The CQAM has the requisite authority, including stop-work authority, to ensure that all project site activities comply with applicable specifications of the Quality Control Plan (QCP) (**Section 4.0** of this Work Plan), the approved project documents, and the contract.

2.3.6 Unexploded Ordnance Quality Manager

UXO Quality Manager ensures compliance with all Federal, State, and local requirement for the procurement, transportation, storage, and use of explosive materials. Duties include; establishing and maintaining SOPs and supporting documentation, staffing projects with UXO personnel, developing test procedures to assess quality performance of new systems and processes, and review quality reports and data deliverables.

2.3.7 Senior Unexploded Ordnance Supervisor

The SUXOS shall meet the qualification in accordance with DDESB TP18 and provides oversight of all field activities for the PACR RI (DDESB, 2004). The SUXOS will provide on-site management for all on-site activities, including coordinating field team activities and meeting schedule deadlines, and will ensure that the work is being conducted in accordance with the RIWP. The SUXOS reports to the HDR PM ensuring compliance of project activities with technical, environmental, and H&S requirements. The SUXOS will coordinate the initial orientation and safety meeting prior to additional activities, as well as daily safety meetings prior to the start of each work day. The SUXOS will prepare a daily status report which will be provided to the USACE no later than 1700 PDT the following business day. Status reports may be submitted on a weekly basis at the discretion of the USACE. Weekly conference calls may also be held if requested by the USACE.

The SUXOS controls the operations of field personnel performing MEC activities and assists them in achieving maximum operational safety and efficiency. The SUXOS will implement approved plans in the field and will review and suggest any changes to the approved UXO plans to the PM. Deviations from approved plans will be reviewed with USACE before implementation. The SUXOS will have final authority in decision situations regarding all MEC issues and the performance of MEC disposal activities.

2.3.8 Unexploded Ordnance Safety Officer

The UXOSO shall meet the qualification in accordance with DDESB TP18 (DDESB, 2004). The UXOSO must be on site during all active field operations. The UXOSO is responsible for MEC related safety and will verify compliance with applicable safety and health requirements. The UXOSO reports independent of project management to the HSD. The UXOSO has the authority to temporarily stop work to correct an unsafe condition or procedure. The UXOSO will:

- Implement the PACR RI approved explosives and MEC safety program in compliance with all federal, state, and local statutes and codes; analyze MEC operational risks, hazards, and safety requirements; establish and ensure compliance with all site-specific safety requirements for MEC operations;
- Enforce personnel limits and safety exclusion zones (EZs) for MEC clearance operations, MEC transportation, storage, and destruction; and
- Conduct safety inspections to ensure compliance with explosives safety codes.

The UXOSO and the UXOQCS responsibilities will be assigned to the same person since fewer than 15 persons are working on the site. The UXOSO may also carry out the SSHO duties, as needed with direction from a qualified SSHO.

2.3.9 Unexploded Ordnance Quality Control Specialist

The UXOQCS shall meet the qualification in accordance with DDESB TP18 and reports independent of project management to the CQCSM (DDESB, 2004). The UXOQCS has the authority to temporarily stop work to correct an unsafe condition or procedure. The UXOQCS will implement MEC-related elements of the Quality Control (QC) program, conduct QC inspections of all MEC and explosives operations for compliance with established procedures, and direct and approve all corrective actions to ensure all MEC-related work complies with contractual requirements for the PACR RI project.

2.3.10 Site Safety and Health Officer

The SSHO implements all aspects of the approved project site specific APP/SSHP with direction from HSS along with approval from the HSD. The SSHO will ensure personnel have current medical clearance and up-to-date training onsite; coordinate with and identify personnel for special Personal Protective Equipment (PPE) when necessary, exposure monitoring, or work restrictions; conduct and document daily site safety inspections prior to the start of each day of field investigation; provide an ongoing review of the assigned protection level needs as project work is performed, and inform the HSD of the need to upgrade/downgrade protection levels as appropriate; ensure that field personnel follow any defined decontamination procedures; and halt site operations, if necessary, in the event of an emergency or to correct any unsafe work practices; conduct project site-specific training and daily safety briefings; assist with any investigations required for all accidents, incidents and "*near misses*"; conduct visitor orientation and maintain the onsite visitor log; review and approve the APP/SSHP by signature prior to starting any field work; and assume any other duties as directed by the HSD and HSS. The Field Lead or UXOSO may carry out the SSHO duties, as needed with direction from a qualified SSHO.

2.3.11 Unexploded Ordnance Team Leader

The UXO Team Leaders (TLs) shall meet the qualification in accordance with DDESB TP 18 and report to the SUXOS and are responsible for controlling and guiding their UXO Team so that the RI is performed in an efficient, safe, and quality manner (DDESB, 2004). The UXO TLs will be leading the UXO Teams during all intrusive investigations. The UXO TLs are responsible for understanding all of the requirements and regulations governing the RI that they are performing.

2.3.12 Unexploded Ordnance Team Composition

The UXO Team composition will be in accordance with EM385-1-97 with errata sheets (USACE, 2013). UXO Team members will report to their respective UXO TLs. Each of the UXO Team members will be responsible for understanding and complying with all requirements established in plans, procedures, and regulations and for executing their work in accordance with standard and accepted MMRP techniques and protocols. The UXO Team members will be responsible for assuring that their work is performed in an efficient, safe, and quality manner. All UXO personnel will meet the requirements of TP 18 for their respective positions (DDESB, 2004). The UXOQCS will verify all UXO personnel qualifications. Copies of the certificates will be available during field operations for inspection by the USACE, if requested.

2.3.13 Project Geophysicist

The Project Geophysicist has overall responsibility for design, implementation, and management of all geophysical investigations. The Project Geophysicist will establish and approve technical procedures, conduct technical QC on the data, communicate with the geophysical team to guide the progress of the geophysical investigation, ensure the geophysical objectives are being met, and approve the geophysical sections of the RI report.

The Project Geophysicist is initially on-site and coordinates all activities associated with the collection, processing, and analysis of geophysical data. He will review all data processing steps, including filtering, anomaly identification and data modeling.

2.3.14 Field/Geophysical Technician

The Field/Geophysical Technicians support site management personnel. Their duties may include GPS data collection tasks, natural and cultural resource support, data management record reporting, logistical support of teams, operation of geophysical and environmental sampling equipment, collection of environmental samples, and site restoration after demolition operations.

2.3.15 Geophysical Data Processor/Analyst

The Geophysical Processor/Analyst performs the initial review of the geophysical data. If problems exist, they will notify the Project Geophysicist. The Project Geophysicist will assess the problems and make adjustments to the field operations or data processing as needed to ensure quality data collection. The Geophysical Processor/Analyst checks the data for linear and non-linear drift, erratic data, dropouts/spikes, incorrect measurements, timing errors, and ensures the data collection effort meets the data quality objectives. The position applies the anomaly selection and identification criteria to choose anomalies.

The Data Processor is responsible for processing all the geophysical data using the site-specific data processing procedures and filing all the appropriate data processing paperwork. The person does not need to be on site to perform these tasks.

2.3.16 Project Scientist

The Project Scientist is the primary author of this RIWP and is also responsible for preparing the RI Report. The Project Scientist is responsible for analytical project data QC and data interpretation. The Project Scientist coordinates with all technical staff to produce quality project deliverables. The Project Scientist will also populate the FUDS MRSPP Processing Environment.

2.3.17 Project Geologist

The Project Geologist ensures all site specific geologic information included is accurate (including drill log review if necessary). The Project Geologist confirms groundwater resources and designs, implements, and manages groundwater investigations (if any) for the RI. The Project Geologist can also function in the same capacity as the Project Scientist.

2.3.18 Project Chemist

The Project Chemist ensures that the work performed will be in accordance with the Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP), this RIWP, SOPs, and other pertinent analytical procedures. The Project Chemist will be responsible for sample tracking, data management, laboratory coordination, data interpretation, and report writing. The Project Chemist will be responsible for the validation of the analytical data from the contract laboratory according to the UFP-QAPP, DoD requirements, USEPA analytical methods performed, and laboratory SOPs. The Project Chemist will also be responsible for the production of a final validation report for the project with a justification for qualifiers applied (if any), while maintaining strict adherence to project schedules. The Project Chemist will work with the field/geophysical technician responsible for collecting the environmental samples and the contract laboratory to ensure that the work performed is in accordance with the UFP-QAPP, Appendix E, and will report to the PM. The project chemist will ensure that all final data deliverables (electronic data and text) meet the criteria defined within the UFP-QAPP prior to delivery to the USACE.

2.3.19 Analytical Laboratory Project Manager

The Analytical Laboratory Project Manager is responsible for the technical quality of the laboratory, adherence to the laboratory QA Manual, laboratory personnel management, cost control, and strict adherence to project schedules concerning the analysis for the parameters of interest. The laboratory Project Manager will ensure the satisfactory analysis of all PACR RI project samples and completeness of data documentation according to the analytical statement of work and the project UFP-QAPP. The contractor will monitor the laboratory activities. The Analytical Laboratory Project Manager is responsible to the Project Chemist.

2.3.20 Senior Risk Assessor

The Senior Risk Assessor performs or directs human health and screening ecological risk assessments using the results of MC sampling, if conducted, and ensure that all risk assessment (human health and ecological) goals are attained. The risk assessments will be performed in accordance with the required regulatory guidance. A MEC hazard assessment (MEC HA) will be performed at the conclusion of the field investigation in accordance with the MEC HA guidance (USEPA, 2008). The Senior Risk Assessor or designee will prepare the MEC HA. The Senior Risk Assessor will be the principal reviewer of the required decision documents to ensure risk management decisions are fully supported.

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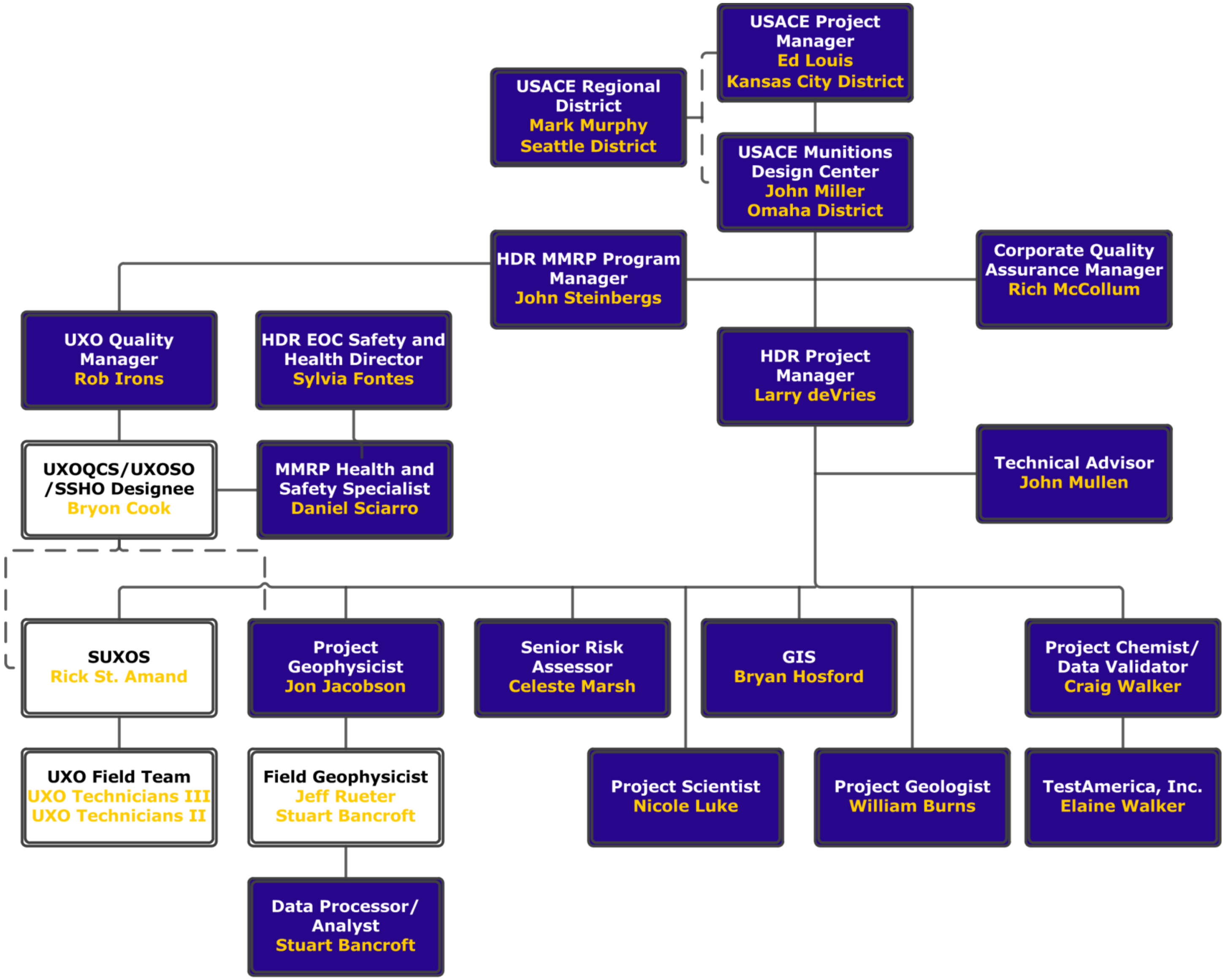
Figure 2-1 General Project Organizational Chart – Port Angeles Combat Range



Note: White boxes indicate field team members

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2.4 Project Communications and Reporting

All communication to stakeholders will be coordinated through the USACE Project Manager. The contractor will keep a record of phone conversations and written correspondence affecting decisions relating to the performance of this RI. The contractor will prepare and submit minutes of all significant meetings attended. Status reports will be submitted according to **Section 2.6**.

2.5 Project Deliverables

All final major submittals will be submitted in both hard copy and electronic format. At a minimum, each report will be issued in draft, draft final and final versions. The draft is typically for USACE review and comment only. Following USACE approval of the draft version, the draft final version will be submitted for regulatory review and comment. The final version will be submitted to all the stakeholders and is accessible for public viewing. All final major submittals will be submitted in both hard copy and electronic (compact disc-read only memory [CD-ROM]) format. A CD-ROM that includes the report, all data, and maps produced will be delivered with each copy of the report. An Administrative Record and Information Repository (AR/IR) will be created for the PACR project. The AR/IR will be established at the City of Port Angeles Library (USACE, 2013a).

Project deliverables specifically generated to meet CERCLA regulations include the following documents:

- Public Involvement Plan,
- RI Work Plan,
- RI Report,
- Feasibility Study,
- Proposed Plan, and
- Decision Document.

2.6 Project Schedule

An estimated schedule for the PACR RI/FS is provided below. The schedule may change based on actual field conditions; however, completion of the fieldwork is anticipated during the 2013 field season. If the investigation continues into the 2014 season, the RI/FS report will be prepared as soon as possible following completion of all RI field activities.

- RI Fieldwork: October-November 2013
- Draft Final RI/FS Report: April 2014
- Final RI/FS Report submittal: June 2014
- Proposed Plan: July 2014
- Record of Decision: September 2014

2.6.1 Periodic Reporting

Several report types and frequencies are required for the PACR RI project, and are listed and described below.

2.6.2 Daily Quality Control Reports

HDR will provide Daily Quality Control Reports (DQCRs) to the USACE PM. The daily report provide an overview of all field associated QC activities performed each day for definable features of work (DFW), including those performed for subcontractor and supplier activities. The DQCRs are generated to present an accurate and complete picture of daily QC activities. They will report both conforming and deficient conditions, and will meet the requirements to be precise, factual, legible, and objective. Copies of supporting documentation, such as checklists and surveillance reports will be attached.

2.6.3 Monthly Progress Reports

HDR will provide monthly progress reports to the USACE PM. The monthly report will provide summarized cost and performance information, including percent complete for program management purposes. Monthly reports are directly correlated with invoicing activities.

2.6.4 Field Status Reports

Field status reports will be prepared daily and provided to the USACE no later than 1700 PDT the following business day. Status reports may be submitted on a weekly instead of daily basis at the discretion of the USACE. Weekly conference calls may also be held if requested by the USACE.

2.6.5 Costing and Billing

HDR will submit monthly invoices based on percent complete or the achievement of milestones by task consistent with what is reported in monthly progress reports. Invoices will be sent to the USACE Omaha District contracting office.

2.7 Project Public Relations Support

Public relations and community participation will be managed as stated in the approved Public Involvement Plan (PIP) for the PACR RI (USACE, 2013a). Community involvement and outreach are currently being conducted to comply with the CERCLA public notification requirements consistent with the requirements of the CERCLA as amended by Superfund Amendments and Reauthorization Act of 1986 (SARA) and the NCP. An information outreach approach is in place that focuses on seeking interest from the public, establishing an AR/IR file at the City of Port Angeles Library, posting and distributing munitions safety information and information sheets to private landowners within the project area, and meeting with interested homeowner groups. If public interest is exhibited, meetings will be held to provide project updates. Information provided through these outlets is updated as appropriate, based on project status and activities.

A fact sheet was prepared for area users in the vicinity of PACR explaining the "*3 Rs*" approach followed by the DoD for sites with historical military munitions. The 3 Rs approach encourages area users to "*Recognize*" a potential munitions item, "*Retreat*" from this item, and "*Report*" details of the item such as what it looks like and its location to proper authorities. This fact sheet was made available to the public through the AR/IR at the City of Port Angeles Library.

In addition, the USACE will continually work with local communities and stakeholders to identify questions or concerns that may arise during military munitions investigations or other response activities. Open dialogue between the project team members, local communities, and stakeholders is important to ensure community understanding of the project and USACE awareness of local issues. This on-going dialogue between the project team and local and interested communities is achieved through attendance at regularly scheduled information sessions where members of the public can talk directly with project staff about any concerns or issues they have. These information sessions will be held at the discretion of the USACE and during the ROE process as a means to familiarize the public with USACE's plans for the investigation.

2.8 Subcontractor Management

Each subcontractor working on the project site will be required to adhere to the RIWP and the PACR RI APP/SSHP, and will be subject to the same training and medical surveillance requirements as prime contractor personnel depending on job activity. All activities involving the potential for exposure to hazardous materials will require medical and training certification as mandated by Title 29 CFR Sections 1910.120 and 1926.65 (OSHA, 2010) (OSHA, 2010a).

2.9 Management of Field Operations

Fieldwork will be coordinated within the contractor's Centennial, Colorado (CO) office. Field teams may be composed of staff from the Centennial, CO, Seattle, Washington (WA), or other offices. Such resources, as well as any necessary subcontractor support, will be managed by the PM and SUXOS. The PM, SUXOS and UXOSO/SSHO will be responsible for identifying appropriate field staff and will confirm that proposed project personnel have the necessary experience and required training for the project. As a quality control measure, the UXOQCS will also verify personnel qualifications.

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3.0 Field Investigation Plan

The PACR RIWP Field Investigation Plan is described in the following subsections beginning with a description of the overall approach to munitions response activities including site characterization, data quality objectives (DQOs), and how the data will be incorporated to substantiate the RI. The RIWP describes the how the PACR CSM is built and its primary components. The PACR MRS and the proposed technical approaches are described, followed by the Geophysical Investigation Plan (GIP) components, then an explanation of the proposed geospatial information collection, handling and processing, storage, and use; and associated GIS, analytical, and MRSPP electronic submittals.

The Field Investigation Plan then addresses munitions response activities including; identification, removal, storage and disposal of MEC and MD. Site control is then described along with the associated Investigation Derived Waste (IDW) Plan.

Finally, the Field Investigation Plan describes how the data collected will be used to perform a baseline Human Health Risk Assessment, exposure assessment, a toxicity assessment, a risk characterization, uncertainty analysis, an Ecological Risk Assessment, and finally a MEC HA of the PACR.

3.1 Overall Approach to Munitions Response Activities

The primary objective of the PACR RI is to collect data necessary to support decision-making regarding the potential explosive hazard posed by MEC and potential risk posed to human health and the environment by MC directly attributable to MEC. A combination of assisted visual surveys, geophysical surveys (analog and digital), intrusive investigations, and MC sampling will be performed during the RI field work. There will be three technical approaches implemented during the PACR RI:

- **Technical Approach 1** will be conducted within the Combat Training Area and buffer zones north of the Firing Point (R01-SR06).
- **Technical Approach 2** will be conducted within the Direct Impact Fire Area and adjacent buffer zones to the east and west (R01-SR01, R01-SR02, R01-SR05, a portion of R01-SR04, and a portion of R01-SR07).
- **Technical Approach 3** will be conducted within the Indirect Impact Fire Area and adjacent buffer zones to the east, west, and south (R01-SR03, a portion of R01-SR07 and a portion of R01-SR04).

A more detailed discussion of the general field methods is provided in **Section 3.1.4**. A discussion of the MC sampling requirements is provided in **Section 3.1.11** and the UFP-QAPP in **Appendix E**. DGM is addressed in the GIP (**Section 3.4**).

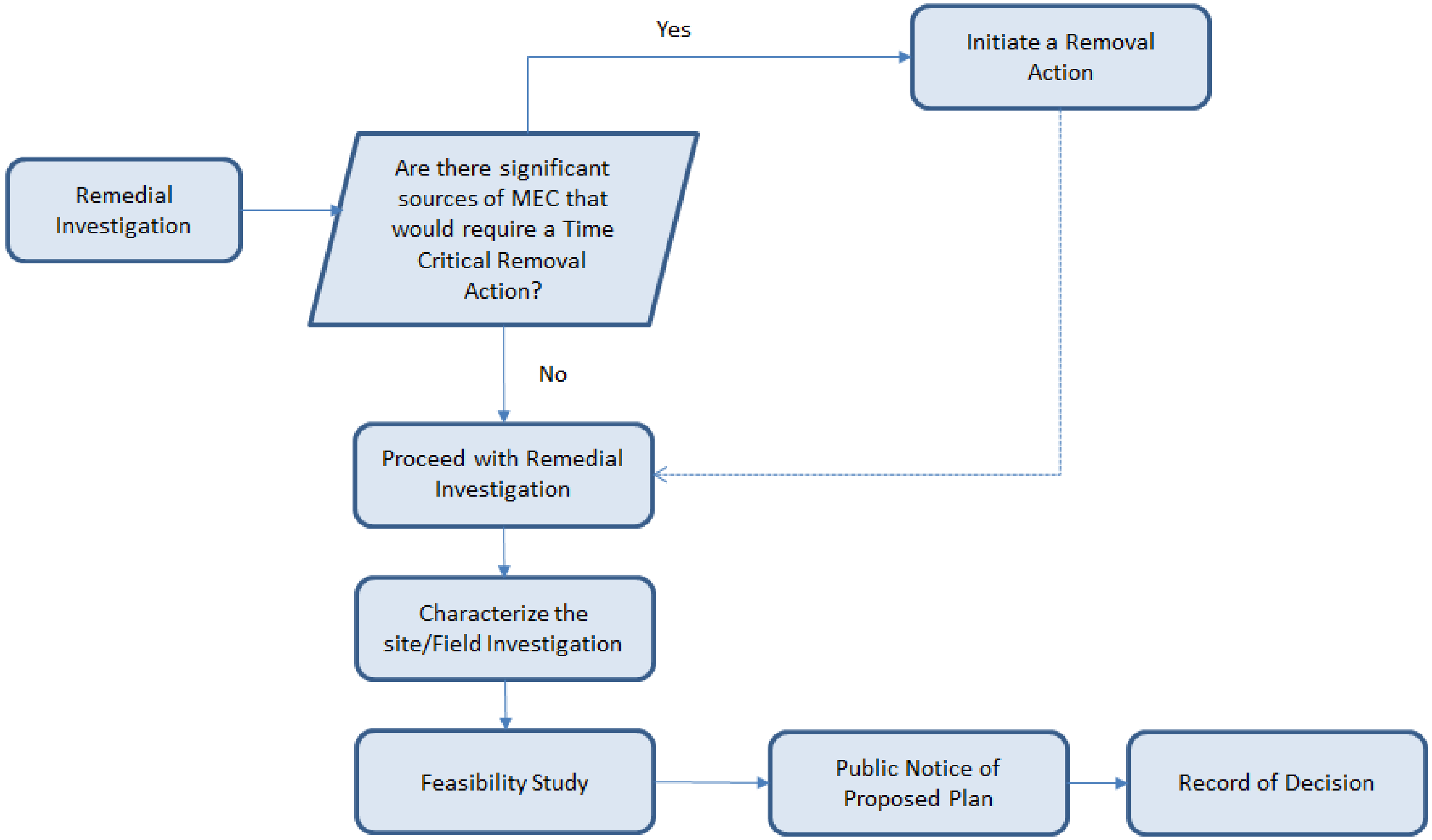
3.1.1 Site Characterization Goals and Remedial Investigation Approach

The primary site characterization goals are to collect sufficient data to determine:

- The nature and extent of MEC, including:
  - Types,
  - Location,
  - Depth, and
  - Density.
- Potentially, the nature and extent of MC, including:
  - Potential contaminants of concern related to munitions activity, and
  - Distribution and concentrations by media.
- Determine the risk posed to human health and the environment by MEC and MC.
- Collect or develop additional data for the FS, as appropriate, to support analysis of remediation alternatives, including NDAI.

The general approach for conducting the RI is shown in **Figure 3-1**.

Figure 3-1 CERCLA Remedial Investigation Approach Flowchart



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3.1.2 Preliminary Conceptual Site Models

Preliminary conceptual site models (CSMs) were developed for the PACR MRS based on the review of historical information, the ASR (USACE, 2004), and the SI (Shaw, 2009). These CSMs will be updated following completion of the RI activities.

3.1.2.1 Approach and Description

Preliminary site-specific CSMs (**Figure 3-3** through **Figure 3-5**) were developed to address the existing or potential exposure pathways for MEC and MC at the PACR MRS for both human and ecological receptors and are presented in this RIWP.

The CSM is a description of the site and its environment based on existing knowledge. It describes contamination sources and possible receptors, and the interactions that link them. It is intended to assist in planning, data interpretation, and communication. The CSM addresses both current and future land use scenarios. The CSM is developed and used as a planning tool to integrate information from a variety of resources and to evaluate the information with respect to project objectives and data needs. As such, CSM development is an iterative process based on further knowledge acquisition, field activities, and interim remedial actions. The information obtained during the RI will be used to refine the CSMs as appropriate.

3.1.2.2 Land Use Considerations

There are a number of land and leaseholders associated with the PACR and vicinity. These owners and lessees within the FUDS boundary and include the City of Port Angeles, Clallam County, Washington Department of Natural Resources and private individuals or corporations (e.g., Manke Timber Corp). A significant portion of the PACR is owned and maintained as a watershed for Port Angeles and the City permits cattle grazing in some areas. According to the ASR, no land in the PACR is owned by any DoD or other federal agency (USACE, 1996).

The site is accessible to the general public. During the SI field work in 2008, barbed wire fencing was observed along the Deer Park Road boundary in the northern portion of the PACR. The fencing was in poor condition and was in places propped up. Members of the public who attended the public information meeting indicated that the area is used for hiking and hunting. A few remaining signs warning of munitions hazards are still present.

The lands adjacent to the PACR (e.g., ONP) are also actively managed for recreation, timber harvest, and wildlife. There are several private properties with year-round residential use. Private and commercial parties manage timber harvesting. No planned changes in the existing land uses are known at this time.

The site is drained by Surveyor Creek, which flows off Morse Creek, through the central portion of the site. A small creek known as Frog Creek runs off Surveyor Creek along the northeast portion of the site. They flow in the general direction of south to north. Within the southeast corner of Section 5, there also exits an area specifically cited for hydraulic soils, with a portion actually being noted as wetlands. The natural vegetation in the area consists largely of fir, spruce, alder and hemlock trees which contribute to the logging industry of the area (USACE, 1996).

Drinking water in the area is obtained from Clallam County PUD No. 1 water systems and private water supply wells. Clallam County PUD No. 1 obtains water from Morse Creek at two water intake structures and from wells. The upstream structure is called "*Port Angeles Dam*" and the second intake is located approximately 1,200 ft. downstream of the dam. The intake at "*Port Angeles Dam*" is within the PACR FUDS boundary. Two domestic wells are located on private property within the FUDS (Shaw, 2009).

According to the SI (Shaw, 2009), there is a designated wetland (approx. 0.43 ac) within the northern portion of the FUDS (Direct Fire and Combat Training Area). This freshwater wetland is designated as freshwater emergent PEMC1 by the USFWS National Wetlands Inventory Wetlands Mapper available at: *http://www.fws.gov/wetlands/Wetlands-Mapper.html (access date 3/28/13*). The PACR does qualify as Important Ecological Place (IEP) or Sensitive Environment as defined by (USACE, 2006) and (USEPA, 1997).

Hunting is known to occur within the PACR boundary based on the presence of deer carcasses observed during a site visit in December of 2012. Hunters may include private landowners, invited guests, or trespassers.

PACR is within the Olympic Game Management Unit (GMU) 621 and licensing for hunting activities is managed by the WDFW. The 2012 hunting season in GMU 621 for Black –tailed Deer was scheduled for selected weeks in October and November (WDFW, 2013) (*http://wdfw.wa.gov/hunting/regulations/summary_hunting_dates.html* access data 5/1/13).

Zoning for the PACR is presented in **Figure 3-2**. According to Clallam County, WA, Zoning Code (*http://www.clallam.net/LandUse/zoning.html* access date 5/1/13) (Clallam County, 2013) zoning designations are as follows:

Commercial Forest (CF) - Lands predominantly associated with large private and state forest land ownerships. The intent is to protect forest lands important to the local and regional economy from encroachment of incompatible uses. Minimum parcel size is 80 acres.

Commercial Forested/Mixed Use (CFM20) - Lands characterized by private forest lands and limited low density residential. The intent is to conserve forest lands and act as a transition area to commercial forest areas. Maximum residential density (1 home per 5 to 19.6 acres) and minimum lot size (1 to 5 acres) vary depending on the specific land use designation. New land divisions must generally retain at least 70% of the site as a forest reserve.

Olympic National Park (ONP) – The Olympic National Park and Olympic Wilderness

Rural Very Low (R20) - Retain rural areas exhibiting very low residential densities and lots large enough for a mix of rural and resource land uses. Provide a transition area between rural and commercial forest land uses. Maximum residential density is 1 home per 19.6 acres, and the minimum lot size is 5 acres.

Rural Low (R5) - Allows for large residential estate lots and small-scale resource lands in a rural setting. Maximum residential density is 1 home per 5 acres, and the minimum lot size is one acre.

Rural Character Low (RCC5) - Retain larger rural lots to support a mix of rural and resource land uses. Promote conservation of natural features and open spaces which contribute greatly to rural character. Minimum lot size is either 5 or 10 acres depending on the specific land use designation. Higher densities are possible where development is appropriately sited to retain large contiguous tracts of rural resource and open space lands.

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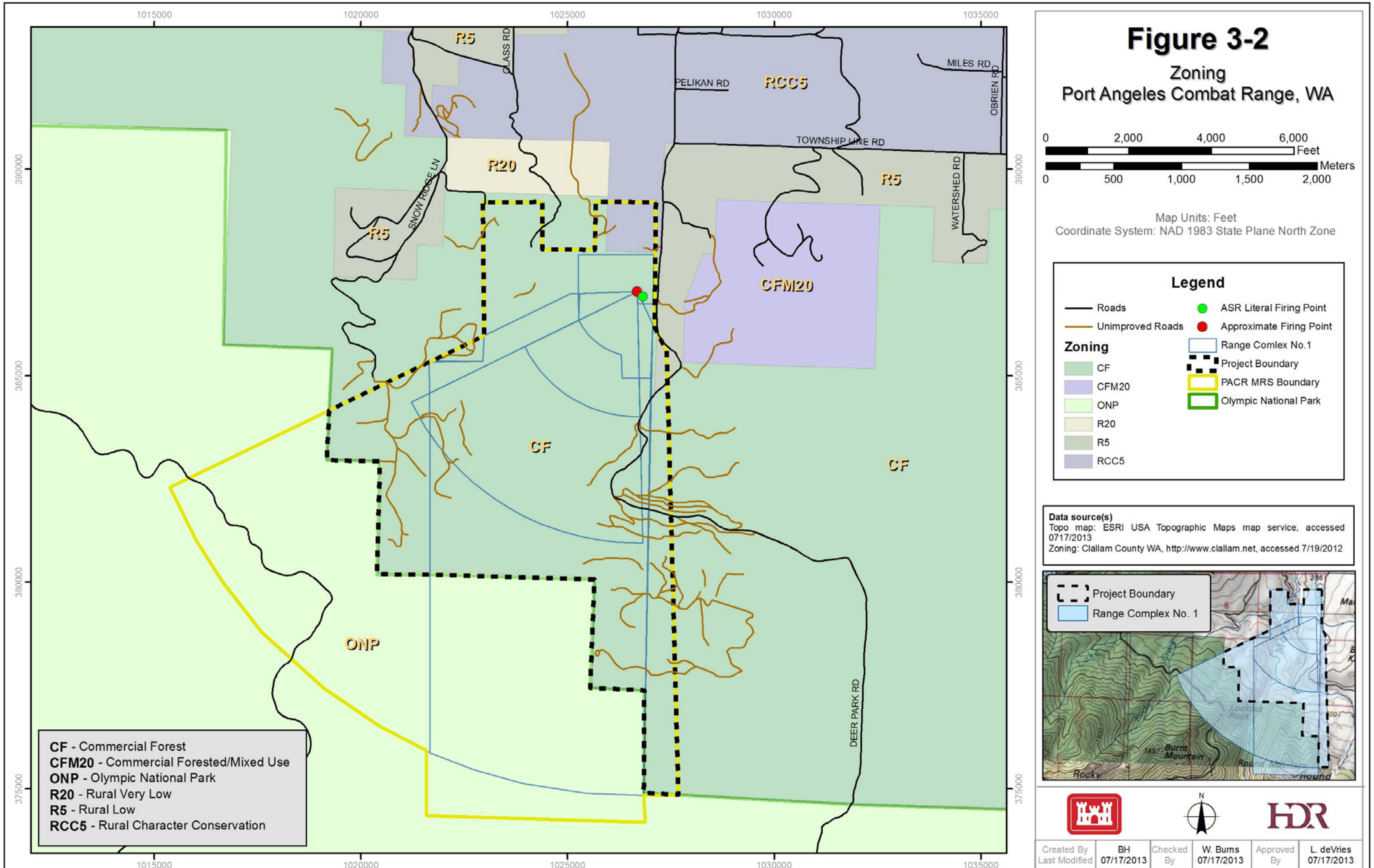

Figure 3-2
Zoning
Port Angeles Combat Range, WA
0 2,000 4,000 6,000 Feet
0 500 1,000 1,500 2,000 Meters
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
Roads
Unimproved Roads
Zoning
CF
CFM20
ONP
R20
R5
RCC5
ASR Literal Firing Point
Approximate Firing Point
Range Comlex No.1
Project Boundary
PACR MRS Boundary
Olympic National Park
Data source(s)
Topo map: ESRI USA Topographic Maps map service, accessed 07/17/2013
Zoning: Clallam County WA, http://www.clallam.net, accessed 7/19/2012
Project Boundary
Range Complex No. 1
CF - Commercial Forest
CFM20 - Commercial Forested/Mixed Use
ONP - Olympic National Park
R20 - Rural Very Low
R5 - Rural Low
RCC5 - Rural Character Conservation
PELIKAN RD
MILES RD
OBRIEN RD
TOWNSHIP LINE RD
WATERSHED RD
SNOW RIDGE LN
GLASS RD
DEER PARK RD
Created By Last Modified BH 07/17/2013
Checked By W. Burns 07/17/2013
Approved By L. deVries 07/17/2013

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Figure 3-3 Preliminary Conceptual Site Model for Access and Exposure to Munitions and Explosives of Concern - Port Angeles Combat Range

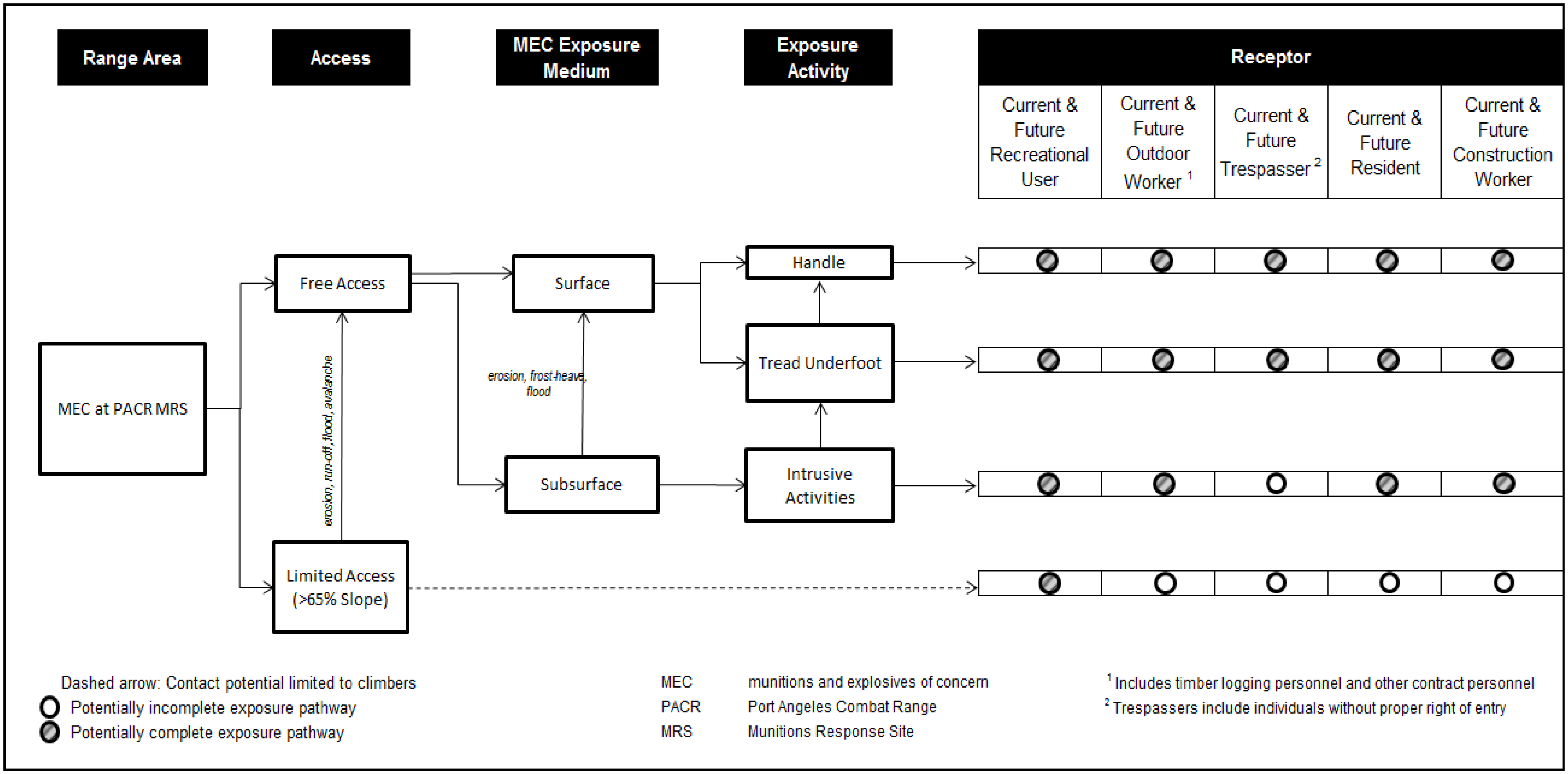

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Figure 3-4 Preliminary Conceptual Site Model for Exposure to Munitions Constituents for Human Receptors - Port Angeles Combat Range

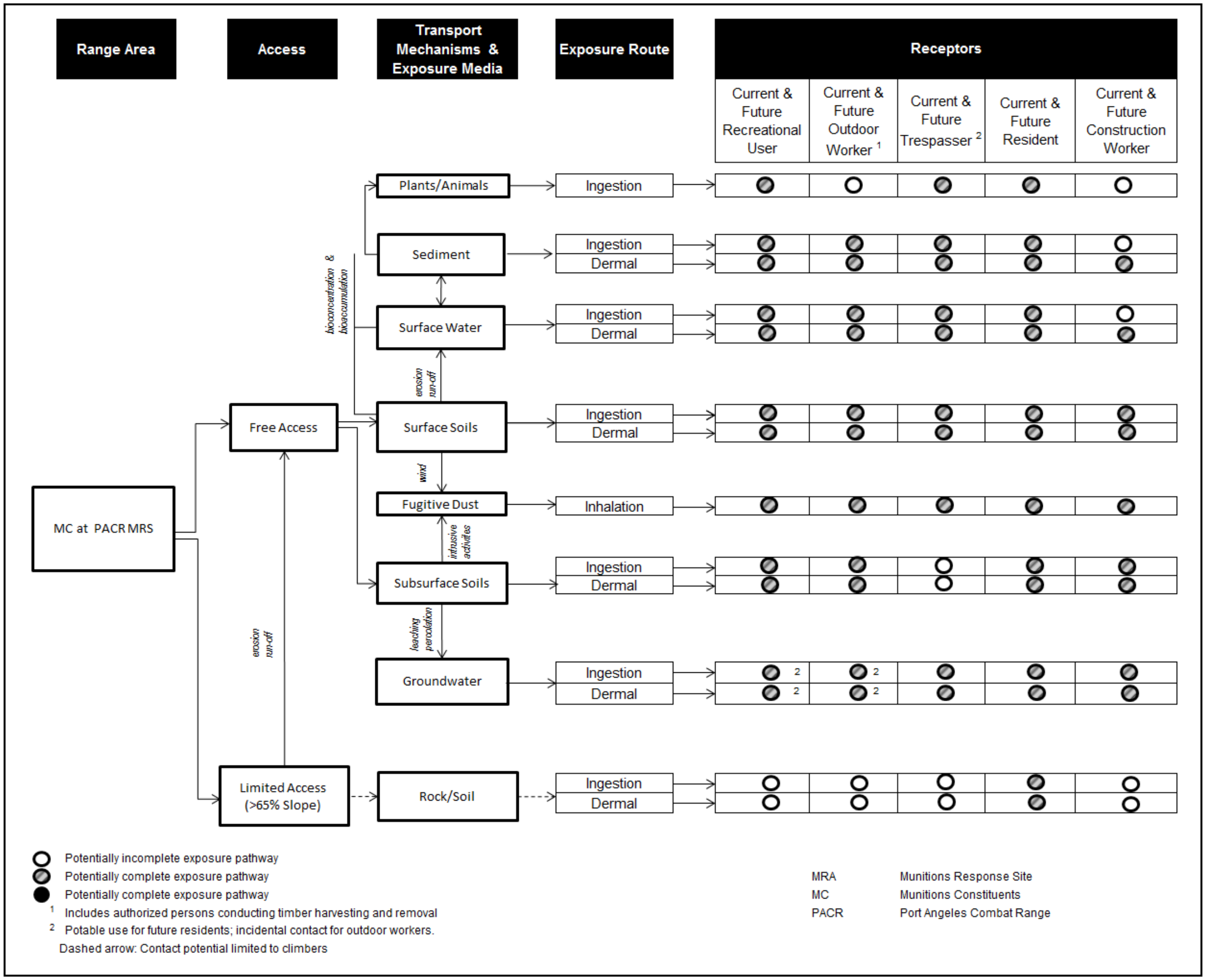

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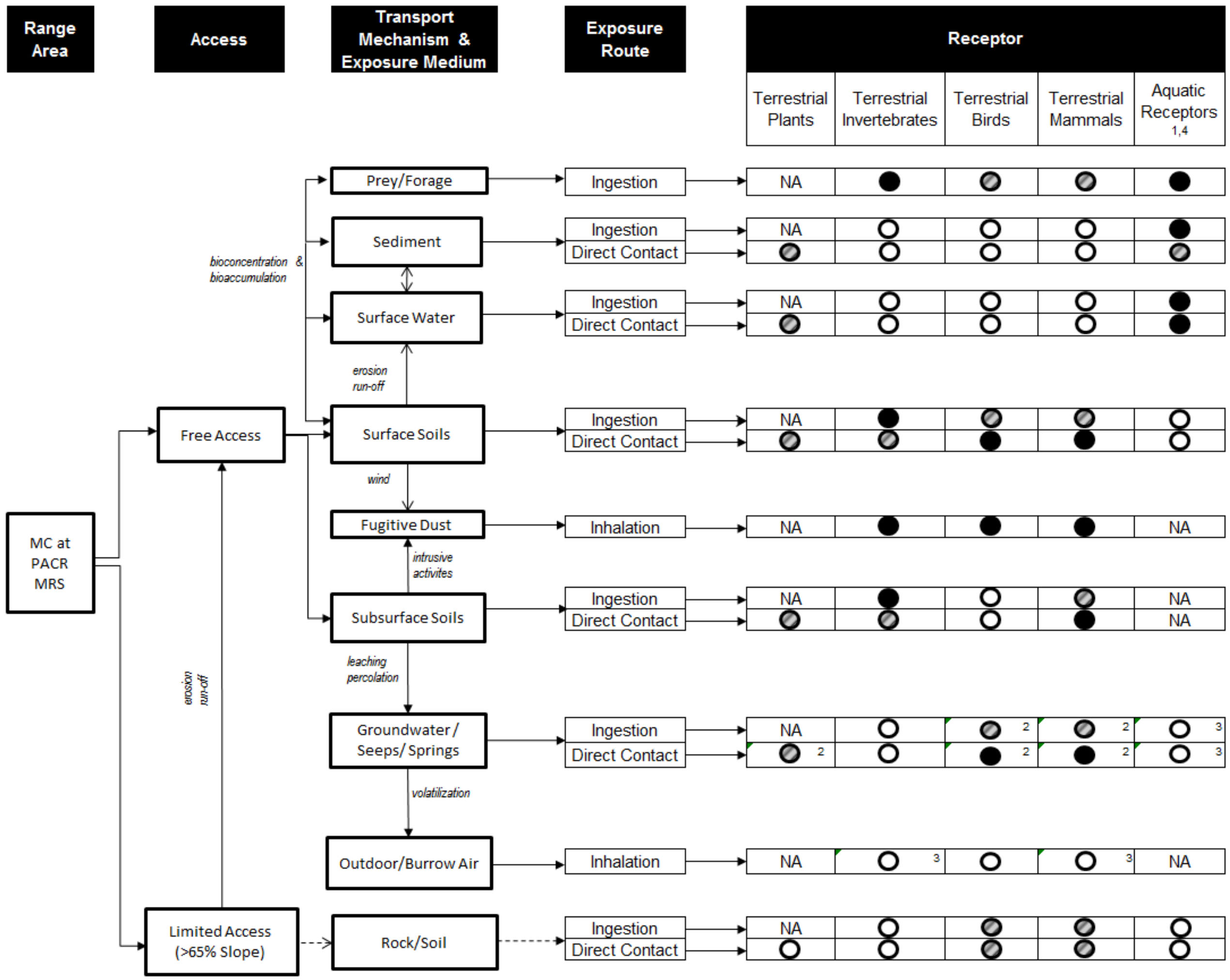
Figure 3-5 Preliminary Conceptual Site Model for Exposure to Munitions Constituents for Ecological Receptors - Port Angeles Combat Range



Dashed arrow: Contact potential limited
○ Potentially incomplete exposure pathway
◐ Potentially complete exposure pathway
● Potentially complete but likely insignificant or not typically quantified

NA = Not Applicable
MC = Munitions Constituents

1 The belted kingfisher is known to burrow in stream banks
2 Only applies if groundwater seeps/springs are present or groundwater is within 20' of the surface
3 Only applies if volatile or semi-volatile organic compounds are detected in subsurface soils or groundwater
4 Includes aquatic plants, vertebrates, invertebrates, and aquatic dependent mammals and birds

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3.1.2.3 Sources of Munitions and Explosives of Concern and Munitions Constituents

Potential sources of MEC and MC at the PACR MRS include historical munitions use described in **Table 1-4**.

If present, MEC may be lying on the surface or buried in subsurface soils (or sediments if present) at the site. If MEC has been compromised, MC may have been released to the environment. The receiving media potentially include soils, sediment, surface water, and groundwater. The presence or absence of seeps or springs will be noted during the field investigation.

MEC has been previously found within the PACR and it is known that MD is present which indicates that additional MEC may be present; therefore, the applicable exposure pathways for all receptors are considered potentially complete. CWM and CAIS is not anticipated within the PACR.

Explosive hazards due to MEC detonation are not normally addressed for ecological receptors; however, in the case of T&E or species of concern, loss of an individual species as opposed to populations, is considered. The potential presence of Federal T&E and Washington State species of concern is presented in **Section 1.6.5** and **Appendix L**.

The MC for chemical analysis includes lead and explosives if samples are collected. If isolated MEC items are encountered, they will be removed from the site, and MC soil sampling will be conducted at these locations only if there is evidence of energetic material or if the MEC item is compromised (refer also to **Section 3.1.11.1** for the six MC sampling criteria).

If isolated MEC items are encountered, they will be removed from the site and MC soil sampling will be conducted at these locations only if there is evidence of energetic material or if the MEC item is compromised (refer also to Section **3.1.11.1** for the six MC sampling criteria).

Single MEC items found in isolation are unlikely to be significant sources of MC that would result in exceedance of human health or ecological soil screening levels. All MEC items (whether intact or compromised) will be removed and disposed of properly and evaluated in accordance with the MC sampling criteria in **Section 3.1.11.1**.

3.1.2.4 Human and Ecological Receptors

Current and future human and ecological receptors that will be addressed in the RI include:

1. Current and Future Recreational Users (adult and child) — The precise nature of recreational use in the PACR MRS is unknown at this time. This receptor category may need revision following field investigations and acquisition of more current usage information.

   These receptors are primarily associated with the terrestrial environment at the PACR but some exposure to aquatic environments is addressed through consideration for anglers and waders. The following categories are meant to be inclusive of most recreational users:

    a. Hikers, climbers, mountain bikers, and off-road vehicle users (year around)

   b. Hunters—this receptor category was added as a conservative measure since hunting is known to occur based on presence of deer carcasses (typically seasonal during hunting season). Hunting occurrences may be private landowners, invited guests, or trespassers.
   c. Horseback riders—possibly year round depending on weather and precipitation. The use of horses in the PACR is also unknown but possible as is limited fishing based on the extent of the streams in the MRS.
   d. Anglers and waders - these receptors are primarily associated with the small streams in the PACR while engaged in fishing or wading and possibly year round.
   e. Domestic animals, such as pack animals and dogs, and grazing livestock (these are addressed under the human exposure pathways).
2. Current and Future Outdoor Workers (adult)
   a. Contractors (authorized) engaged in timber harvesting, processing, and removal operations on an occasional basis year round.
3. Current and Future Trespassers (adult and child) - although the PACR is posted in some places, trespassing likely occurs on a regular basis. Trespassing on private property is also likely. Trespassing may be dependent on weather and precipitation.
4. Current and Future Residents (adult and child) - there are currently residents on private in holdings and other residences may be built in the future.
5. Current and Future Construction Workers (adult) - construction workers may be engaged in laying pipelines or utility corridors, or construction or demolition of buildings or residences.
6. Biota - Terrestrial and aquatic ecological receptors such as terrestrial and aquatic vegetation, soil invertebrates, birds, mammals, reptiles, amphibians, and aquatic and benthic life (both vertebrates and invertebrates).

The receptors listed above are considered a conservative representation or the most highly exposed either by exposure frequency, duration, or contact rates. It is assumed that if these receptors are evaluated, that use and exposure for other human or ecological receptors will also be addressed. For example, uses by environmental or cultural resource study teams are expected to result in lower exposure rates than those of loggers or other long-term forest personnel who could work outdoors in this region for many years or construction workers who would be actively engaged in intrusive activities. Winter users are expected to have lower contact rates than hikers, hunters, or anglers who would be present on-site at a time when snow cover did not prevent or limit contact with MEC or MC in surface soils.

Washington Department of Fish & Wildlife lists bear, elk, deer, other small mammals, raptors, songbirds, upland birds, reptiles, amphibians, and spawning salmon as wildlife that may be present at the Morse Creek Wildlife Area approximately 5 miles north of the general PACR location (*http://wdfw.wa.gov/lands/wildlife_areas/county/Clallam/* access date: 8/17/2012) (WDFW, 2013a). American Pika (*Ochotona princeps*) and Yellow-bellied Marmot (*Marmota flaviventris*) and other rodents are terrestrial mammals that might frequent steep terrain and cliffs as the major component of their home range in the PACR and vicinity.

3.1.2.5 Exposure Pathways

The PACR can be easily accessed from Deer Park Road simply by stepping over a low barbed-wire fence. The fence is in a state of disrepair. There are some worn and faded warning signs posted to discourage entry.

MC released from MEC (if present) could be transported by surface water runoff to other areas down gradient from the source. MC could migrate to groundwater in areas where depth to groundwater is shallow. Depth to groundwater is likely variable in the region but can be as low as 18 ft. based on a private well sampled during the SI as discussed below (Shaw, 2009). Exposure to MEC or MC via frost heave is expected to be negligible; however, exposure via erosion is possible. Significant rainfall events or avalanches on steeper terrain could expose MEC.

Access to the PACR is not restricted except for areas where terrain steepness limits receptor access (e.g., > 65% slope). This applies to both human and animal receptors. Climbers may access certain steep areas such as cliffs or boulder fields, but they are not expected to remain on that terrain for long periods or at high annual frequencies.

MEC on the surface or subsurface can be potentially accessed by all mobile receptors in areas of unrestricted or unlimited access (**Figure 3-3**). If MEC are encountered, sampling for MC will be performed as described in **Section 3.1.11**. MC released to the environment become contaminants of potential concern (COPCs), and as such, can present hazards to all receptors via several exposure pathways. Ecological receptors are not evaluated for contact with MEC because this is an individual effect, and ecological receptors are typically addressed for effects on populations. The exception is evaluating potential risk to federally threatened or endangered species under the ESA. However, potential remediation for protection of human health is expected to be protective of special status species as well. MC is not expected to be an issue on steep terrain such as cliffs because contaminants are not expected to be retained by rock.

The CSMs include all potential exposure pathways associated with direct soil contact, as well as contact with surface water and sediment, and indirect exposure pathways whereby COPCs in the form of MC are absorbed from contaminated media and accumulate in plants and animals. Inhalation of potentially contaminated dust is also possible depending on the nature of the COPCs and other variables. The potentially complete exposure pathways for MC are presented in **Figure 3-4** and **Figure 3-5** discussed below:

- Surface soil incidental ingestion and direct or dermal contact – all receptors who contact surface soils are potentially exposed to MC in this medium. Typically, dermal exposure is not quantitatively addressed for vertebrate ecological receptors, but direct contact by plants and invertebrates is addressed. The terrestrial invertebrate community is addressed by evaluating direct contact as opposed to ingestion of soils.
- Subsurface soil ingestion and direct or dermal contact – all receptors who contact subsurface soils are potentially exposed to MC in this medium. This would include outdoor workers engaged in intrusive activities (e.g., contractors performing site investigations, logging contractors or other contractor personnel) or future residents who

might excavate for building construction. Burrowing mammals, invertebrates, and plants are potentially exposed to subsurface soils. The Belted Kingfisher (*Ceryle alcyon*), for example, will burrow and live in holes in stream banks. Typically, dermal exposure is not quantitatively addressed for vertebrate ecological receptors, but direct contact by plants and invertebrates is addressed. The terrestrial invertebrate community is addressed by evaluating direct contact as opposed to ingestion of soils.

- Fugitive dusts – humans and ecological receptors are potentially exposed to wind-blown fugitive dusts that may carry MCs. Fugitive dusts may be generated from surface soils or subsurface soils brought to the surface via excavation. Typically, inhalation exposure is not quantitatively addressed for ecological receptors although it is recognized as a potentially complete pathway. It will be addressed in the baseline HHRA if necessary.
- Vapor inhalation from COPCs in subsurface soil (e.g., trenches) or groundwater– vapors could possibly be generated by some semi-volatile explosive compounds (e.g., nitrobenzene) in groundwater and subsurface soils. This pathway is potentially complete though likely insignificant since there are no volatile organic compounds as MC. Inhalation exposure is not quantitatively addressed for ecological receptors although it is recognized as a potentially complete but likely insignificant pathway. It will be addressed qualitatively in the baseline HHRA and limited to discussion associated with outdoor air only.
- Ingestion or dermal contact with groundwater or groundwater discharges at seeps and springs – recreational users may drink from springs or seeps. Ecological receptors may also use seeps and springs as drinking water sources. Groundwater may be contaminated from subsurface MEC and MC leaching and percolating downward. Groundwater from private wells may be used as a potable drinking water supply by residents in the area. Outdoor workers or future construction workers engaged in excavation could encounter groundwater. Seeps or springs may be present in the PACR since a wetland area was noted in the northern portion of the site (Shaw, 2009). This water feature suggests a possible shallow depth to groundwater. The HDR Team will document any such observances of seeps or springs during field investigations.
- Incidental ingestion of sediment and dermal contact – all receptors who contact sediments are potentially exposed to MC in this medium. This includes anglers and hikers, as well as riparian plants, the benthic invertebrate community, and aquatic dependent birds and mammals. Typically, dermal exposure is not quantitatively addressed for vertebrate ecological receptors except fish, but direct contact by plants and invertebrates is addressed. The streams on the PACR are very small and shallow. Consequently, these streams are unlikely to attract most anglers.
- Surface water ingestion and dermal contact – all receptors who contact surface water are potentially exposed to MC in this medium if contamination exists. This includes incidental ingestion by residents, anglers, and hikers, as well as direct contact by the aquatic life community (i.e., aquatic plants, invertebrates, and fish), and ingestion as a source of drinking water by aquatic dependent birds and mammals. Domestic animals (e.g., sheep, cattle, horses, and dogs) may also ingest or contact surface water. Typically, dermal exposure is not quantitatively addressed for vertebrate ecological

receptors except fish, but direct contact by plants and invertebrates is addressed. If deemed necessary, dermal exposure to humans will be addressed quantitatively in the baseline HHRA.

- Uptake of COPCs by plants and animals and ingestion of food items by humans– some COPCs may bioconcentrate (be taken up from water) or bioaccumulate (taken up from solid media like soil or sediments) or biomagnify (transfer through the food chain). Plants and animals then serve as a secondary source or transport mechanism for exposure to humans and higher trophic level animals. Not all COPCs will uptake in plant and animal tissue; however, as some are not absorbed and are excreted others are absorbed and readily metabolized. Bioconcentration factors (BCFs) and bioaccumulation factors (BAFs) are used as an indicator of a compound's ability to concentrate in biota. Lead has a low potential for bioconcentration and bioaccumulation in the terrestrial environment (USEPA, 2011, available at:

  http://www.epa.gov/R5Super/ecology/toxprofiles.htm#pb; (USEPA, 2011b) access date 8/21/2012). Ingestion of lead from sediment by waterfowl and raptors is well known. WDOE does not include lead on their list of persistent, bio accumulative and toxic chemicals, but it is listed as a metal of concern (WDE, 2013). Fish, game, and vegetation (e.g., mushrooms and berries) may also be harvested by recreational users and possibly by Native American Lower Klallam tribal members.

The Final PACR SI Report stated "*shallow groundwater in the region occurs in gravelly units within the glacial outwash deposits. In the PACR vicinity, groundwater occurs within sand and gravel units that overlie the bedrock. Based on well logs, groundwater occurs in these units at a depth ranging from 50 to 120 ft. Regional groundwater flow is to the north from the highlands to the Strait of Juan de Fuca. A site resident indicated that depth to groundwater at his domestic well was approximately 18 ft. bgs. Because of the surface streams in the area, shallow groundwater flow within the PACR is likely toward nearby streams where it is assumed to discharge. Surface water flows to the north to the Strait of Juan de Fuca*" (Shaw, 2009).

Based on this information, the migration to groundwater pathway is potentially complete though likely insignificant.

The future use of the PACR by the various property owners is anticipated to be the same or very similar to the current uses. Future land use plans will likely include continued forest management, fish and wildlife conservation, recreation, and timber harvesting. Development in portions of the site is possible in areas with suitable terrain.

There are no known cultural or archeological resources present within the PACR (**Section 1.9.7**).

3.1.3 Data Quality Objectives

Data quality objectives (DQOs) were developed in accordance with the *Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4HW* (USEPA, 2000). DQOs were reviewed at the first TPP meeting with project stakeholders. DQOs steps include:

1. State the problem
2. Identify the goal of the study
3. Identify the information inputs
4. Define the study boundaries
5. Develop the analytical approach
6. Specify performance or acceptance criteria
7. Develop the plan for obtaining data

Table 3-1 identifies the DQO process for PACR that will be evaluated during the RI. The DQOs for MC sampling will be developed in accordance with the systematic planning process presented in Worksheet #11 of the project UFP-QAPP (**Appendix D**). The DQOs for the DGM are provided in the Geophysical Investigation Plan (GIP) (**Section 3.1.4**), **Table 3-6**).

Table 3-1 Data Quality Objectives Process, Port Angeles Combat Range

Step	Data Quality Objective
1. State the problem	There is the potential for surface and subsurface MEC and MC at the PACR MRS based on past military use of the area. The distribution of potential MEC/MD and MC must be established in order to assess the potential explosive hazard associated with MEC, and the potential risk posed to human health and the environment associated with MC contamination. The potential for remaining MEC and MC was identified based on the INPR, the ASR, the ASR Supplement, and SI results (**Section 1.9**). These information sources documented the U.S. Army's use of the PACR for training in tactical firing problems and short-range known-distance firing in 1943 and 1944. Munitions used at the site include 37mm and 75mm projectiles and 60mm and 81mm mortars. There are also unconfirmed reports of small arms, rifle grenade and land mine usage within the MRS.
2. Identify the goal of the study	The soil sampling conducted as part of the SI in 2009 reported no MC concentrations above the agreed upon screening levels and concluded that further MC sampling was not recommended. During the SI, subsurface soils were not addressed. This RI will collect the data necessary to support decision-making regarding the potential explosive hazard posed by MEC and potential risk posed to human health and the environment by MC directly attributable to MEC requiring further action under CERCLA. The RI will evaluate nature and extent of MEC/MD. The RI will identify and characterize any observed MEC/MD source or sources. The extent of the MEC/MD will be characterized horizontally and vertically. The RI will also evaluate the nature and extent of MC in soil from explosives and small arms sources (if warranted). Evaluating the MC extent will include comparing analytical sample results to human health screening levels of MC (**Table 3-8**). The horizontal extent and vertical depth of MC which exceed human health risk-based screening levels will be delineated.

Table 3-1 Data Quality Objectives Process, Port Angeles Combat Range

<table>
<tr><th>Step</th><th>Data Quality Objective</th></tr>
<tr><td>3. Identify the information inputs</td><td>Information inputs are needed to assess the potential hazard posed by MEC and potential risk posed to human health and/or the environment by MC at the MRS.

Information inputs in support of decision making will include the compilation of all previously gathered site information, such as the
o INPR, ASR, and SI Reports (Refer to Section 1.9)
o Preliminary Conceptual Site Model from the Site Inspection
o Data to characterize the extent of surface and/or subsurface MEC/MD from metal detector assisted visual surveys with the hand excavation of identified anomalies throughout the MRS
o DGM surveys using an EM-61 in selected areas within the MRS to determine areas of high density anomalies
    o High density anomaly areas (target features/impact areas which generally consist of areas containing 250 anomalies per acre or greater) to be investigated will be selected by the project geophysicist and approved by the USACE. UXO Teams will investigate the high density areas to evaluate the subsurface (Section 3.1.4).
    o Refer to Section 3.1.11.2 for discussion regarding sampling for lead as an indicator for small arms MC.
o Intrusive Investigations (Section 3.1.7).
    o UXO teams will investigate areas containing high anomaly densities (generally 250 anomalies per acre or greater) determined from the DGM data utilizing grid methodology.
    o Grids will be expanded as necessary to define the horizontal extents of MEC/MD.
o Analytical results of discrete samples collected for explosives and lead to determine the nature and extent of potential MC contamination based on MEC discoveries or evidence of small arms activities. MC in soil will only be sampled if the criteria presented in Section 3.1.11.1 and Figure 3-13 are met.
o Discrete MC (explosives) soil samples are proposed beneath all MEC items defined by the criteria presented in Figure 3-13 and discussed in Section 3.1.11.1.</td></tr>
<tr><td>4. Define the study boundaries</td><td>The physical boundary of the 2,629-acre PACR was defined at the conclusion of the SI, though the spatial boundary of this RI will be constrained to those areas within the 1,628- acre FUDS eligible property where ROE may be obtained and assisted visual survey, geophysical survey, intrusive investigation and MC sampling data collection may occur. Surveys are not planned in areas where an ROE cannot be obtained. Total acreage investigated will be affected by which ROEs can be obtained and unsurveyable areas (e.g. steep slopes greater than 65%).
RI activities are not planned within the Olympic National Park because an agreement is not in place between the USNPS and DoD to permit environmental investigations.

The temporal boundaries of this RI include any limitations of technology in unsurveyable areas. Data acquisition may be limited by unsurveyable areas.</td></tr>
</table>

Table 3-1 Data Quality Objectives Process, Port Angeles Combat Range

Step	Data Quality Objective
5. Develop the analytical approach	The purpose of these analyses is to delineate the area considered most likely contaminated with MC. 1. GIS Analysis (**Sections 3.1.8** through **3.1.10**) - Line-of Sight Analysis for artillery (37mm and 75mm projectiles) travel. - Trajectory and effective range for mortars (60mm and 81mm) - Historic Aerial Photography Analysis 2. Assisted Visual Surveys (**Section 3.1.5**) - UXO Teams will assess the nature and extent of any MEC/MD located on the surface. - UXO Teams will investigate subsurface anomalies indicative of munitions observed during the assisted visual surveys throughout Technical Approach Areas 1 and 3 (**Section 3.1.4**) to define the nature and extent of subsurface MEC/MD. 3. Digital Geophysical Mapping (**Section 3.4**) - DGM is proposed for the Direct Fire Impact Area to identify areas of high anomaly densities. - High density anomaly areas (target features/impact areas which generally consist of area containing 250 anomalies or greater per acre) to be investigated will be selected by the project geophysicist and approved by the USACE. - UXO Teams will reconcile the subsurface anomalies identified by the DGM as target features or as non-munitions related features starting at the high density anomaly areas (250 anomalies per acre or greater) to define the nature and extent of subsurface MEC/MD. 4. MC Sampling and Analytical Analysis (**Section 3.1.11**) - Discrete MC (explosives) soil samples are proposed beneath all MEC items defined by the criteria presented in **Figure 3-13**. o If the MRS is observed to have multiple MEC items, and sampling is warranted for these items as discussed in **Section 3.1.11.1**, samples will be collected that are geographically dispersed throughout the MRS. If 20 samples are collected and analyzed for energetics and the results indicate concentrations below the screening levels then MC sampling will no longer be required for the MRS. - Discrete MC (lead) samples will be collected at the Combat Range if evidence of small arms debris or a natural berm feature are identified that could have been used as a backstop. - If analytical soil sample results show presence of MC above the screening levels established in the RIWP, then additional surface and subsurface samples will be collected to establish the vertical and horizontal extent of soil impacted by small arms contamination. If a significant soil impact is determined *(i.e., MC are above human health screening levels)* and the nearby sediment, surface water, or groundwater pathways are potentially complete, then sampling and analysis of those media will be performed provided that the criteria for such sampling as identified in **Sections 3.1.11.3** and **3.1.11.4** are met.

Table 3-1 Data Quality Objectives Process, Port Angeles Combat Range

Step	Data Quality Objective
	- In-situ XRF screening for lead in soils – For field information only and to help assist the field teams where to collect samples for laboratory analysis - Analytical data will be collected as necessary for all decision-making purposes - Refer to **Section 3.1.11.1** for discussion regarding sampling for lead as an indicator for small arms MC. - Discrete MC (explosives) soil samples are proposed beneath all MEC items defined by the criteria presented in **Figure 3-13** and discussed in **Section 3.1.11.1**. 5. If MC samples are collected, analytical results will be used to perform a Baseline Human Health Risk Assessment (HHRA) (**Section 3.10.2**) and a Baseline Ecological Risk Assessment (BERA) (**Section 3.11.3**). 6. MEC HA using the USEPA MEC HA Methodology (Interim) (USEPA, 2008) will be performed whether or not MEC is found (**Section 3.12**) When assisted visual surveys, DGM, intrusive investigations, and MC sampling are performed in accordance with the SOPs, DQOs specified in the GIP, and the UFP-QAPP, then adequate data to perform a MEC HA and MC risk assessment for the PACR will have been collected. The RI will have provided sufficient data necessary to support decision-making regarding the progression of the PACR through the CERCLA process.
6. Specify performance or acceptance criteria	Data collected will be of the quantity and quality necessary to provide technically sound and defensible assessment of potential risks to human health and the environment and will support the determination of potential explosive hazard. Assisted visual surveys, geophysical surveys, intrusive investigations, and MC sample collections are proposed to occur in accordance with the USACE Three Phase Inspection Process, as presented in **Section 4.0** of the RIWP, and will meet or exceed the level of QA/QC established for this project (Refer to **Section 4.0**). Analytical data will meet the UFP-QAPP requirements for data quality and usability as presented in **Appendix D**.
7. .Develop the plan for obtaining data	The plan for obtaining data was developed through the TPP and presented within the work plan. Information inputs gathered during the RI will be used to develop a determination of potential hazards associated with MEC, and of potential risks posed by MC directly attributable to munitions contamination within the spatial confines of this RI. If unacceptable explosives hazards and MC risks are determined to exist, an FS will be performed to develop and screen remedial response alternatives.

Notes: to **Table 3-1**
ASR – Archive Search Report
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
DGM – Digital Geophysical Mapping
DoD – Department of Defense
DQO – Data Quality Objective
GIS – Geographic Information System

Table 3-1 Data Quality Objectives Process Port Angeles Combat Range (cont.)

Notes: to **Table 3-1 (cont.)**
HA – Hazard Assessment
INPR – Inventory Project Report
MC – Munitions Constituents
MD – Munitions Debris
MEC – Munitions and Explosives of Concern
Mm – millimeter
MRS – Munitions Response Site
NDAI – No Department of Defense Action Indicated
PACR – Port Angeles Combat Range
RI – Remedial Investigation
ROE – Right of Entry
SI – Site Investigation
SOP – Standard Operating Procedure
TPP – Technical Project Planning
UFP – QAPP - Uniform Federal Policy-Quality Assurance Protection Plan
USACE – United States Army Corps of Engineers
USEPA – United States Environmental Protection Agency
USNPS – United States National Park Service
UXO – Unexploded ordnance
WDOE – Washington Department of Ecology

3.1.4 Investigative Strategy

This RI will collect the data necessary to support decision-making regarding the potential explosive hazard posed by MEC and potential risk posed to human health and the environment by MC directly attributable to MEC. A combination of investigation methods will be used to optimize data collection. Unsurveyable areas will consist of slopes greater than 65%, heavy vegetation that can not be cleared with hand tools, water bodies that can not be traversed by foot, and any other field condition that presents an unacceptable safety risk to the field investigation team.

The project area has been delineated into three separate technical approach areas based on the types of munitions used, how the munitions were fired, the types of investigation methods required to delineate nature and extent and the ability to implement the technology available at the time of the RI based on site specific limitations such as topography and vegetation. The three different technical approach areas are presented below.

Technical Approach 1 will be conducted within the **Combat Training Area** and **buffer zones north of the Firing Point** (R01-SR06). The technical approach within this area is driven by the potential use of small arms and practice land mines.

- Assisted Visual Surveys (AVS) with limited real time excavations by hand will be performed by a UXO Technician and a Geophysical/Field Technician (**Section 3.1.5**) to characterize the nature and extent of MEC and small arms (i.e. visual evidence of military small arms such as brass casings or lead projectiles). All field teams will be assembled in accordance with EM-385-1-97 (USACE, 2013).
    - o If real time digs are performed, the Geophysical/Field Technician will be temporarily replaced with a UXO Technician

  - o Initial AVS transects will be spaced 150 ft. apart
  - o If munitions evidence is observed the 150-ft. spacing of AVS transects may be changed to 75-ft. spacing to assist in delineating the extents of the area impacted by munitions.
- In-situ XRF screening will be conducted to analyze for lead in soils if natural features (e.g., natural berm feature) or small arms debris is identified (**Section 3.1.11.2**)
  - o XFR screening will be utilized for information only and to assist the field investigation team to determine sampling locations for subsequent laboratory analysis

  Sampling for laboratory analysis will be conducted if there is evidence of small arms use and elevated lead levels (above WDOE soil clean-up level of 250 milligrams per kilogram (mg/kg) are detected by the XRF analyzer (**Section 3.1.11.2**)
  - o Environmental media samples for laboratory analysis will be collected as necessary for all decision-making purposes. Refer to **Section 3.1.11.2** regarding sampling for lead as an indicator for small arms MC.

<u>Technical Approach 1</u> will be implemented in the area shown in **Figure 3-6**.

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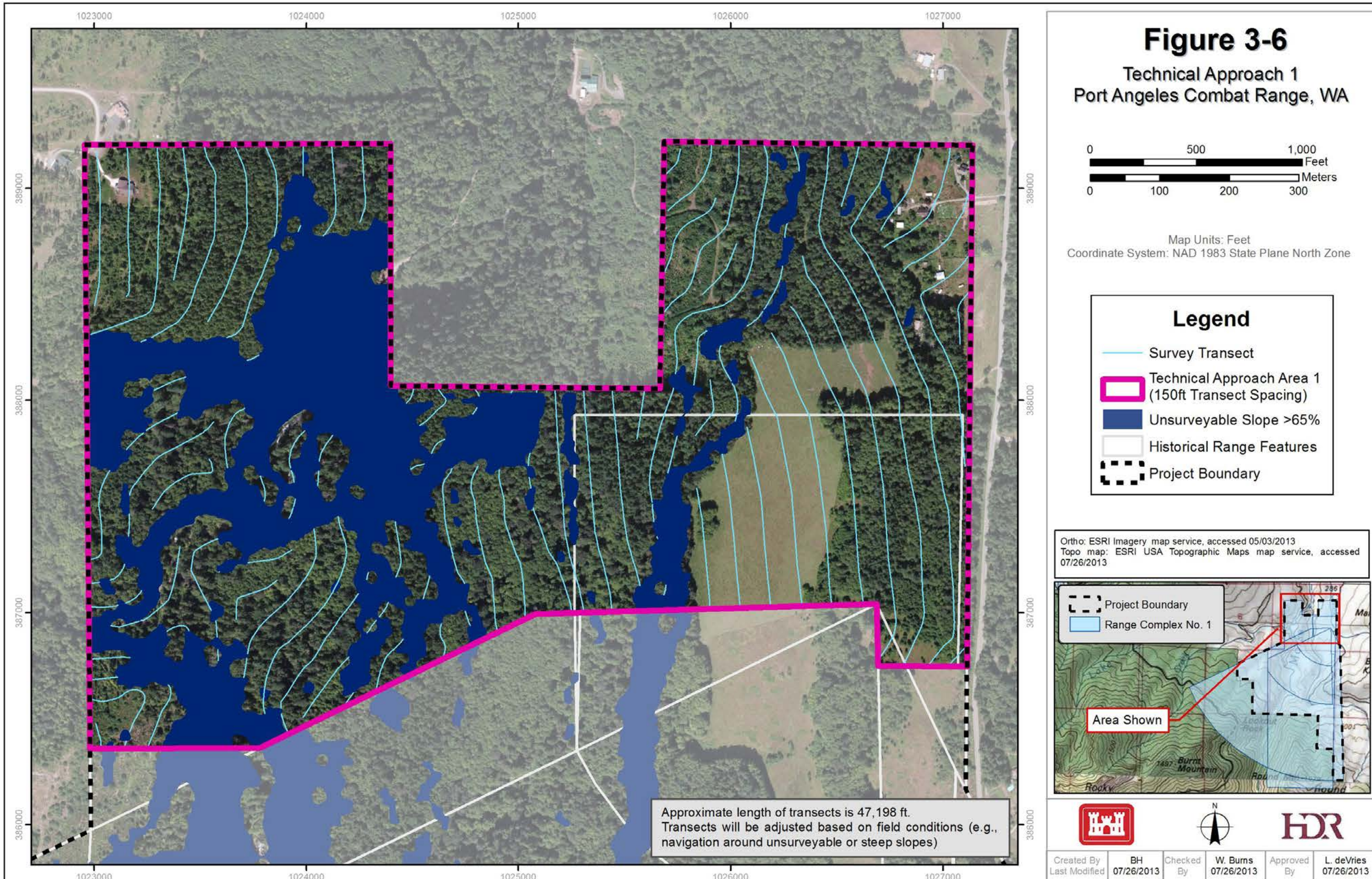
Figure 3-6
Technical Approach 1
Port Angeles Combat Range, WA
0 500 1,000 Feet
0 100 200 300 Meters
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
Survey Transect
Technical Approach Area 1 (150ft Transect Spacing)
Unsurveyable Slope >65%
Historical Range Features
Project Boundary
Ortho: ESRI Imagery map service, accessed 05/03/2013
Topo map: ESRI USA Topographic Maps map service, accessed 07/26/2013
Project Boundary
Range Complex No. 1
Area Shown
Approximate length of transects is 47,198 ft.
Transects will be adjusted based on field conditions (e.g., navigation around unsurveyable or steep slopes)
Created By Last Modified BH 07/26/2013
Checked By W. Burns 07/26/2013
Approved By L. deVries 07/26/2013
1023000
1024000
1025000
1026000
1027000
389000
388000
387000
386000

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Technical Approach 2 will be conducted within the **Direct Impact Fire Area** and **adjacent buffer zones to the east and west** (R01-SR01, R01-SR02, R01-SR05, a portion of R01-SR04, and a portion of R01-SR07). The technical approach within this area is driven by the use of 37mm and 75mm artillery fired and fixed and towed ground based targets within a discrete area.

- AVS will be performed by a UXO Technician and a Geophysical/Field Technician (**Section 3.1.5**). All field teams will be assembled in accordance with EM-385-1-97 (USACE, 2013).
  - Initial AVS transects will be spaced 75 ft. apart.

Non-munitions related features (e.g., fencing, utilities) that can interfere with DGM will be recorded

- DGM surveys will be conducted to determine areas with high subsurface metallic anomaly densities(**Sections 3.1.6** and **3.4**)
  - DGM transects will be spaced 75 ft. apart.
  - 200 ft. x 200 ft. subsurface investigation grids will be positioned over areas identified as containing high anomaly densities determined by the DGM.
  - A minimum of 10 percent (%) of each grid (i.e., a 200 ft. x 200 ft. grid with 5 ft. lanes at the 0 ft., 50 ft., 100 ft., 150 ft. and 200 ft. intervals).
  - Contiguous subsurface investigation grids stepping out from the high anomaly density areas (i.e., 250 anomalies per acre or greater) will be established if munitions are observed and until the extent of the munitions have been determined.
- Analytical sampling for explosives will be conducted, if required (**Section 3.1.11.1**).

<u>Technical Approach 2</u> will be implemented in the area shown in **Figure 3-7**.

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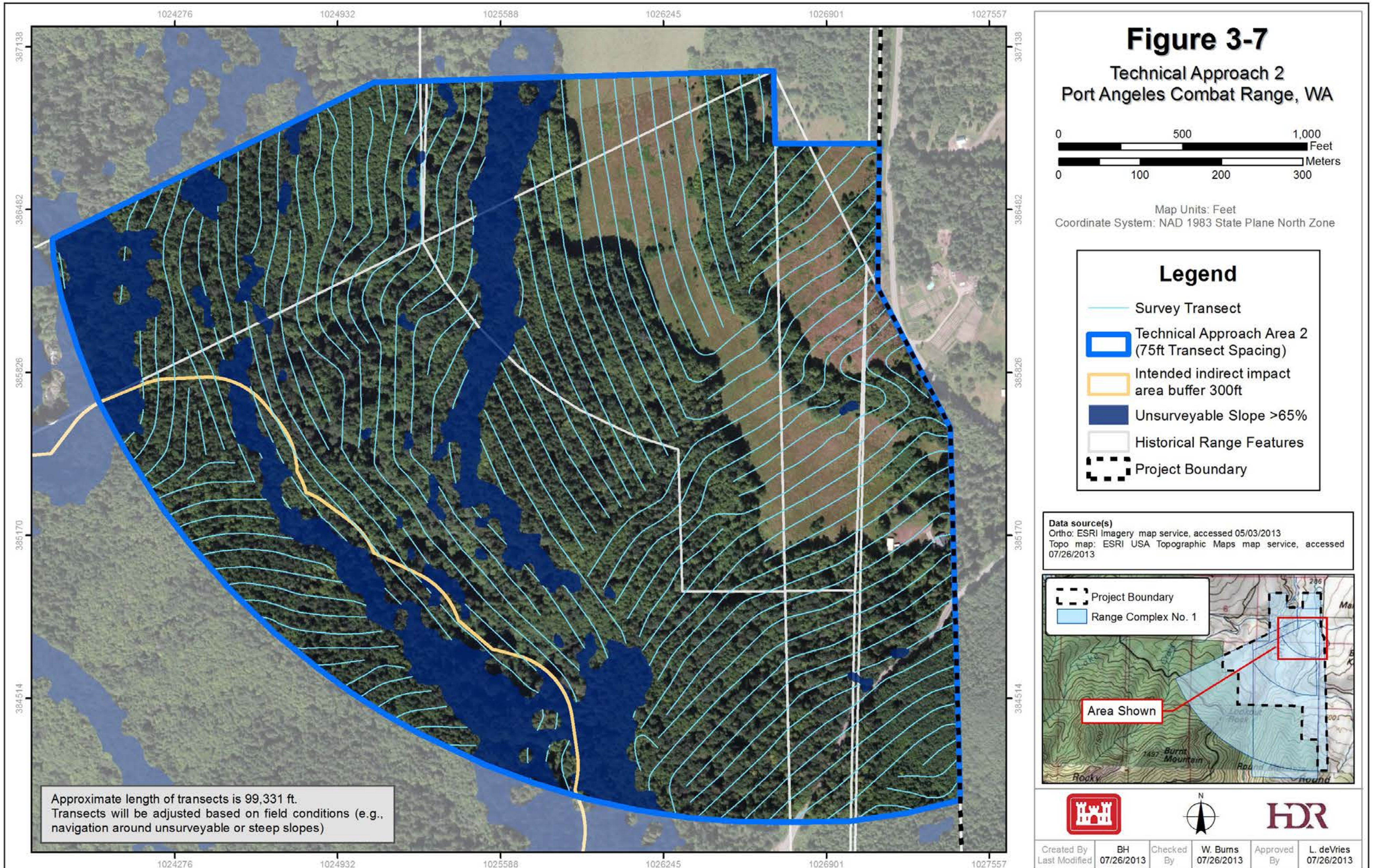
Technical Approach 2
Port Angeles Combat Range, WA
0 500 1,000 Feet
0 100 200 300 Meters
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
Survey Transect
Technical Approach Area 2 (75ft Transect Spacing)
Intended indirect impact area buffer 300ft
Unsurveyable Slope >65%
Historical Range Features
Project Boundary
Data source(s)
Ortho: ESRI Imagery map service, accessed 05/03/2013
Topo map: ESRI USA Topographic Maps map service, accessed 07/26/2013
Project Boundary
Range Complex No. 1
Area Shown
Approximate length of transects is 99,331 ft.
Transects will be adjusted based on field conditions (e.g., navigation around unsurveyable or steep slopes)
1024276
1024932
1025588
1026245
1026901
1027557
387138
386482
385826
385170
384514
Created By Last Modified
BH 07/26/2013
Checked By
W. Burns 07/26/2013
Approved By
L. deVries 07/26/2013

Figure 3-7

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Technical Approach 3 will be conducted within the **Indirect Impact Fire Area** and **adjacent buffer zones to the east, west, and south** (R01-SR03, a portion of R01-SR07, and a portion of R01-SR04). The technical approach within this area is driven by the trajectory, distance, and impact of 60mm and 81mm mortars, and the areas identified during the ASR. Some 37mm and 75mm artillery are also anticipated based on the line of sight analysis presented in **Section 3.1.9**. Artillery may have been fired over the intended target within the area presented for Technical Approach 2 and deposited within the area defined by Technical Approach 3. The topography and vegetation is rugged throughout the area limiting the effective use of DGM and subsurface investigation grids.

- AVS with real time excavations by hand will be performed by two UXO Technicians (**Section 3.1.5**) to characterize the nature and extent of MEC. All field teams will be assembled in accordance with EM-385-1-97 (USACE, 2013).
  - AVS transects will be spaced will be 75 ft. apart within the intended impact area per the ASR and the immediately adjacent 300 ft. buffer area.
  - AVS transects will be spaced 150 ft. apart outside the 300 ft. buffer area.
- Analytical sampling for explosives, if required (**Section 3.1.11.1**).

<u>Technical Approach 3</u> will be implemented in the area shown in **Figure 3-8**.

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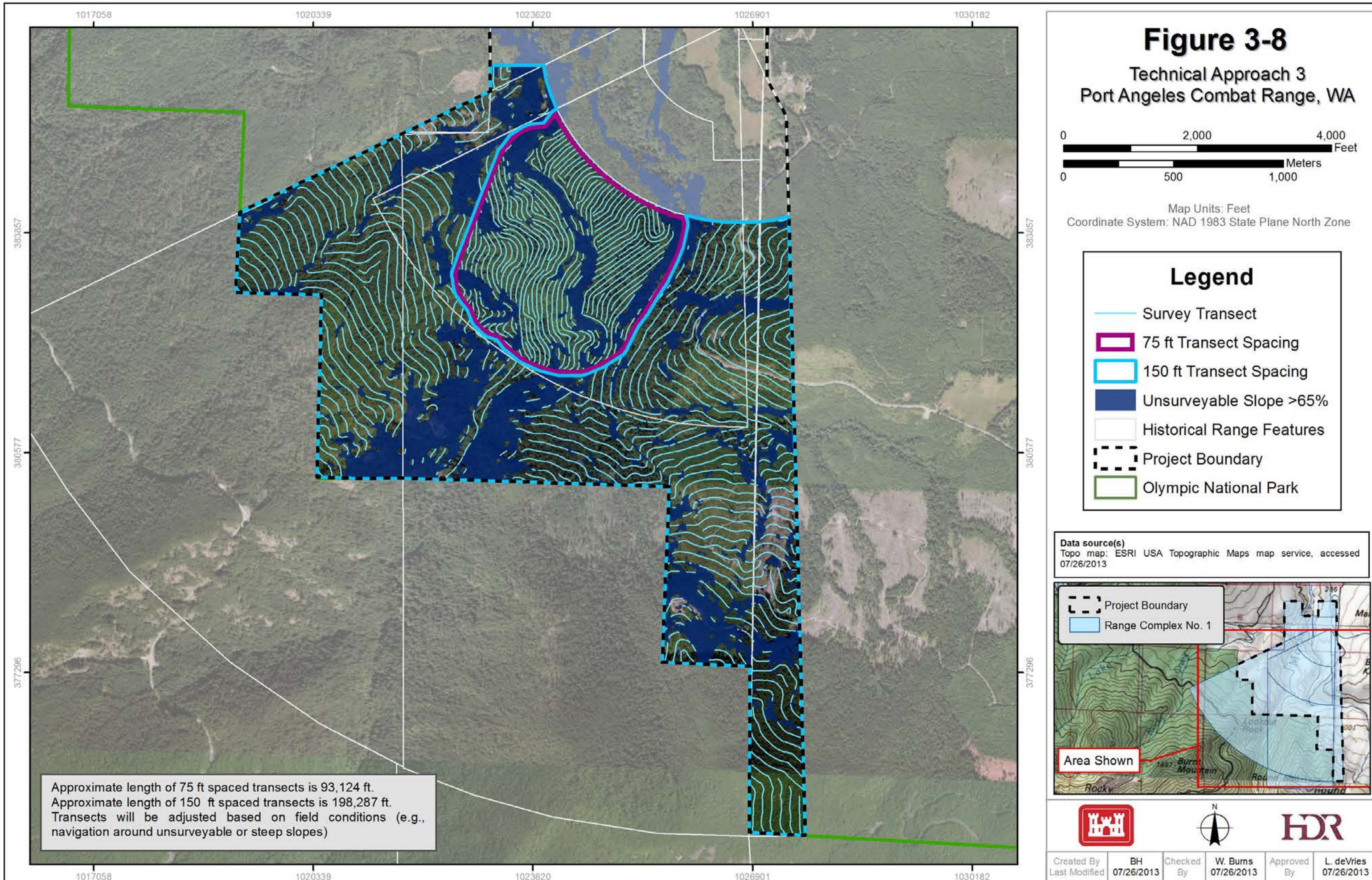

Figure 3-8
Technical Approach 3
Port Angeles Combat Range, WA

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3.1.5 Assisted Visual Surveys with Limited Real Time Excavations by Hand

Assisted visual surveys will be the primary investigation tool used during the RI at PACR. These assisted visual surveys will include observations of surface and subsurface MEC/MD, evidence of small arms activity (if warranted), as well as any other features relevant to the CSM such as water features, nearby receptors etc. The AVS team will be conducting real-time intrusive investigations on subsurface anomalies in areas where the use of DGM is not practical. DGM is not practical in areas with limited access, heavy vegetation, and steep topography. The intrusive investigation does not serve as a removal action but rather to meet the goal of determining the nature and extent of the munitions. Not every anomaly identified during the assisted visual survey will need to be recovered, only the amount necessary to meet the objective of determining the nature and extent of munitions. As an example, if an area containing munitions is identified (e.g. the center of an impact area) not all anomalies will need to be investigated to determine there are munitions present. In areas where munitions are not identified, all anomalies along the transect will be investigated.

An AVS Team will be comprised of personnel as directed by EM-385-1-97 (USACE, 2013). Because it is not feasible to survey every square foot of the property, a representative number of transects will be performed to characterize the MRS and support decision-making. The survey areas and transect spacing were developed based on the types of ranges, impact areas and munitions that are anticipated within the MRS. Transects will be walked by the AVS Team at either a 75 ft. or 150 ft. spacing.

A UXO Technician III will function as the TL and will use either a Schonstedt magnetometer or Whites All Metals detector to locate surface and sub-surface anomalies. Vegetation will be cleared by hand or with hand tools, if warranted, to navigate the transect. A UXO Technician II will operate a Trimble GeoXH GPS unit to navigate, record the path of travel and to record any findings (including photographs). Within areas requiring DGM or environmental sampling the UXO Technician II may be replaced by a Field/Geophysical Technician. Field/Geophysical Technicians will not be present during any subsurface investigations. A minimum of one UXO Technician III and one UXO Technician II will perform the subsurface investigations during the AVS. To the maximum extent practical the AVS Team will walk transects along terrain contours and perpendicular to the firing line. Transects will be used as a general guide for the field teams during the AVS. For areas where physical barriers or manmade features are present (e.g., structures, equipment, land features) the teams will divert around the barrier and reacquire the transect pathway once the barrier is bypassed.

The planned transects will be uploaded to the Trimble GeoXH GPS unit and the AVS Team will navigate along each planned transect using the GPS. The GPS system will be configured to record position data at maximum intervals of one minute or no more than 50 ft. along each transect to create a permanent record of where each team actually walked. If MEC or MD are identified along the transect path, the location will be stored in the GPS along with a brief description of the findings. The GPS track path and findings along each transect will be uploaded to the project GIS in order to create a permanent record of the actual path followed. The spatial distribution of MEC, MD, small arms or evidence of historical munitions use will be analyzed and used to refine the extents of the MRS, as applicable.

For safety purposes, UXO personnel conducting subsurface clearances will use a Schonstedt magnetometer or Whites all metals detector to locate and investigate subsurface anomalies. When an anomaly is investigated (only by UXO personnel), a Schonstedt magnetometer, or Whites all metals detector will be used to locate and otherwise aid in investigating the anomaly. The metal detector will also be used to confirm that an excavation is free of subsurface anomalies. The depth of detection is limited by the size and orientation of the target and by soil characteristics. The instrument is not capable of classifying anomalies; it will only indicate the presence or absence of a subsurface anomaly.

The following analog performance metrics will be used for the detector assisted visual survey transects:

Repeatability - Instrument functionality will be sufficient to detect 100% of the items in the analog test strip. On a daily basis, each instrument operator will be required to sweep the test strip using the sweep techniques and instrument settings proposed for the project, and detect 100% of the items. Please refer to **Section 3.4.6.4** for details regarding the proper functioning of analog instruments.

Dynamic Repeatability - Instrument operators will consistently recover all anomalies of interest on the surface. The second member of the field team will walk approximately 20 to 2 ft. behind the instrument operator and visually inspect the surface to verify that no additional items of a similar size/mass to the items of concern are found. If such an item is found during the check by the second field team member, the entire transect will be reworked.

When an anomaly indicative of a munition is identified, a UXO Technician will unearth the item using hand tools under the supervision of a UXO TL. As the excavation progresses toward the anomaly source, the UXO technician will continue to use the metal detector to determine item location both horizontally and vertically.

Once the UXO Team member uncovers an item, the item will be assessed to determine if it is munitions related or other metallic material. If the item is determined to be MEC, the TL will determine its type and condition, and report all findings to the SUXOS and UXOSO. If MEC is identified, the item will be marked with crossing red pin-flags indicating required follow-up treatment. Details regarding the reporting and disposition of munitions related items and their management are provided in **Sections 3.6 and 5.0**.

If the item is to be put in the category of Material Documented as Safe (MDAS), the weight and other identifying characteristics of the item will be recorded with the GPS and entered in the project GIS. Only UXO qualified personnel will perform these inspections and characterizations. All munitions related metallic debris will be removed and managed as described in **Section 3.7**. Debris not related to munitions, including Range Related Debris (RRD) will be left in place.

If cultural artifacts (e.g. burial grounds) are encountered during the RI the USACE will be notified. The USACE will then notify the WDHAP.

Figure 3-9 summarizes the transect spacing fro the FUDS eligible portion of the PACR MRS.

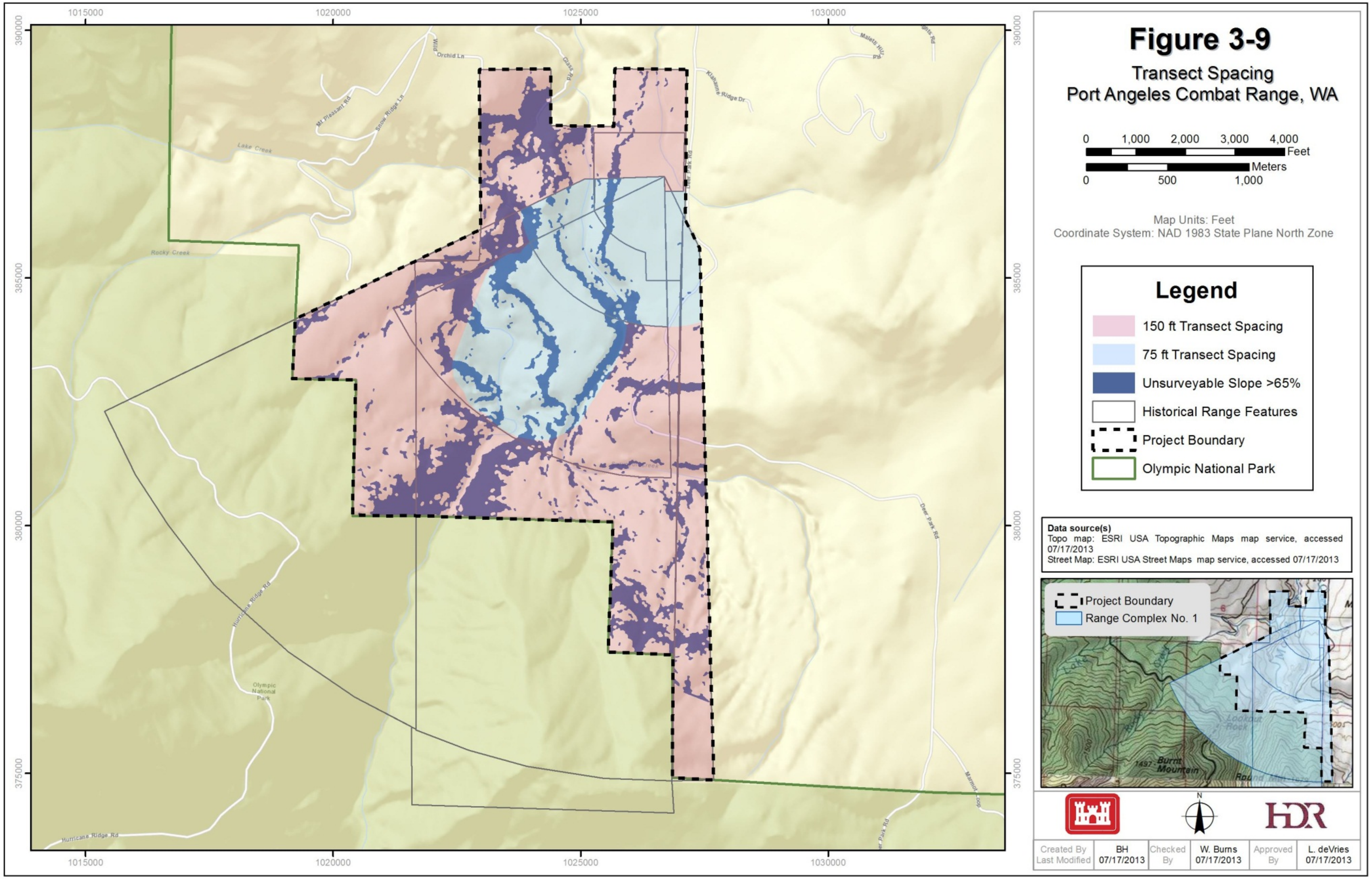
Figure 3-9
Transect Spacing
Port Angeles Combat Range, WA
0 1,000 2,000 3,000 4,000 Feet
Meters 0 500 1,000
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
150 ft Transect Spacing
75 ft Transect Spacing
Unsurveyable Slope >65%
Historical Range Features
Project Boundary
Olympic National Park
Data source(s)
Topo map: ESRI USA Topographic Maps map service, accessed 07/17/2013
Street Map: ESRI USA Street Maps map service, accessed 07/17/2013
Project Boundary
Range Complex No. 1
Created By Last Modified BH 07/17/2013
Checked By W. Burns 07/17/2013
Approved By L. deVries 07/17/2013
1015000
1020000
1025000
1030000
390000
385000
380000
375000
Lake Creek
Rocky Creek
Hurricane Ridge Rd
Olympic National Park

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3.1.6 Digital Geophysical Mapping

Digital geophysical mapping will also be implemented during the RI at PACR. The DGM process is described in detail in the Geophysical Investigation Plan (**Section 3.4**). DGM will be used to identify areas exhibiting high anomaly densities indicative of munitions within the area assigned to Technical Approach 2. DGM transects will be walked at a spacing of 75 ft. using a EM61 MKII sensor mounted on a man portable non-metallic litter. Any additional suspected munitions related features outside the pre-determined 75 ft. transect spacing within areas assigned to Technical Approach 2 will also be captured. It is noted that the EM61 cannot be operated reliably on slopes greater than 65%.

Figure 3-10 Digital Geophysical Mapping Litter

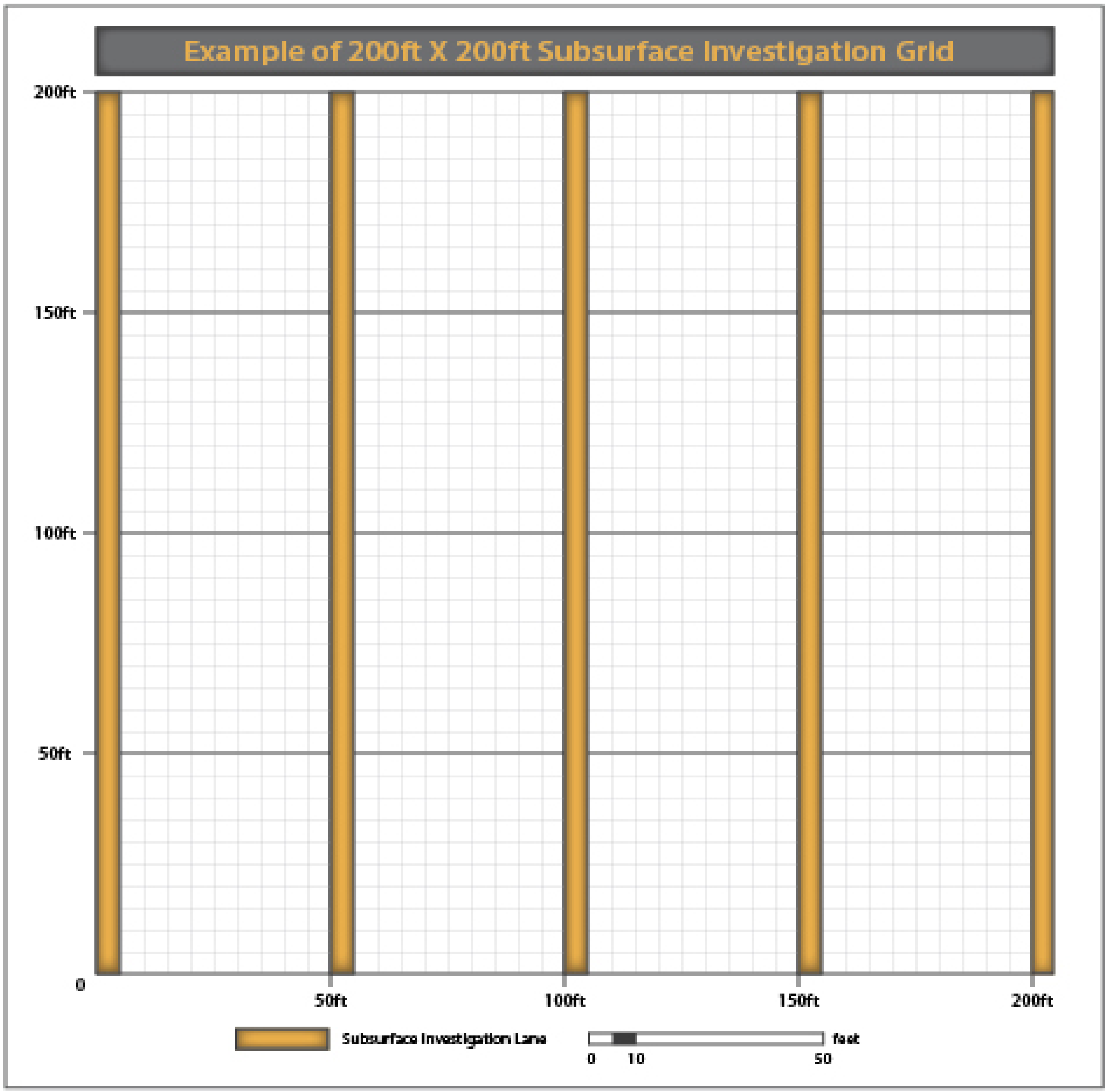
3.1.7 Intrusive Investigation

Once the DGM has been completed, and areas with high anomaly densities (i.e., 250 anomalies per acre or greater) have been identified, subsurface investigations will be conducted to define the nature and extent of MEC/MD. 200 ft. x 200 ft. grids will be laid out on each high anomaly density area. Subsurface investigations will be performed on a minimum of 10% of each grid. **Figure 3-11** illustrates an example 200 ft. x 200 ft. grid with 5 ft. sweep lanes at the 0 ft., 50 ft., 100 ft., 150 ft., and 200 ft. intervals. At every 50 ft. of the grid a 5 ft. lane will have subsurface anomalies investigated. Contiguous subsurface investigation grids stepping out from high anomaly density areas will be established if munitions are observed and until the extent of the munitions have been determined. The intrusive investigation will not serve as a removal action but rather to define the nature and extent of MEC/MD.

The composition of the Intrusive Investigation Team will be in accordance with EM385-1-97 (USACE, 2013) who will investigate anomalies via hand excavation, and manage all munitions related items discovered. The SUXOS and UXOSO/UXOQCS will not participate in the physical excavation activities but rather serve as management and oversight.

When an anomaly is identified, a minimum qualified UXO Technician II will follow the same protocols as described above in **Section 3.1.5**.

Figure 3-11 Example of 200 ft. X 200 ft. Grid Subsurface Investigation Grid



3.1.8 Visual Sampling Plan

The Visual Sample Plan (VSP) software developed by Pacific Northwest National Laboratories was utilized for spatial modeling to determine transect spacing required during the RI. The VSP model is supported by the Interstate Technology Regulatory Council (ITRC) as an accepted method for developing an investigation plan (ITRC, 2008). Site data from a previous investigation conducted by the ESTCP program in September of 2011 (**Appendix M**) was utilized as an input for the VSP analysis. The investigation utilized transects covering approximately 3.5% of a 31 acre area at PACR that was documented as an area of high historical training activity. The survey resulted in selection of 106 anomalies above the threshold value of 4mV. It should be noted that the 4mV value is also approximately the noise threshold for the EM61-MK2. The Naval Research Laboratory's EM61-MK2 Response Calculator was used to determine the appropriate threshold value based on a 37mm projectile (ESTCP, 2011). Anomaly density analysis was utilized to delineate high density areas from background areas. The result of this analysis in conjunction with the 0.71 acre target area previously identified as containing MEC in the ASR (USACE, 1996) supported the VSP decision unit.

Both the traversal and detection of a target using VSP was used to determine that a 75 ft. transect spacing would intersect both elliptical and circular 0.71 acre target area 100% of the time. This was achieved through Monte Carlo simulations of potential target locations that utilized 10,000 random tests for both location and orientation of theoretical target areas. Because the firing location and direction of fire is known, HDR expects elliptical target areas oriented in a northeast/southwest direction and where site conditions allow transects will be oriented perpendicular to the direction of fire.

Table 3-2 Visual Sampling Plan Input Data Table

Transect Spacing Needed to Traverse and Detect Target Areas		
VSP Input	**Value**	**Comment**
Transect Width	1 m	Cart or litter sensor swath
Transect orientation	130°	Perpendicular to direction of fire
Target Area Size	0.71 acre	Based on previous Removal Action
Ellipse Shape	0.2	Expect targets to elongate along direction of fire
Ellipse Orientation to transect line	45°	Expect targets to elongate along direction of fire
Background Density	20 ApA	ApA near 60 from ESTCP survey adjusted to account for increased anomaly picking threshold based on size smallest expected munition; and anticipation of lower densities outside the known target area.
Expected Target Density Above Background	380 ApA	The objective is to identify areas with metallic debris targets. Initial survey results may lead to adjustments to transect design and resulting VSP reanalysis
Transect Spacing	75 ft.	100% probability of detection of Mag and Dig of over .71 acres

Note: ApA = Anomalies per Acre
Note: Transect spacing determined by VSP probability statistics; a transect spacing of 75 feet provides a 100% probability of detecting a target size of 0.71 acres.

3.1.9 Line of Sight Analysis Results

To support advanced spatial modeling and analysis of the PACR site, publically available LiDAR data was utilized. LiDAR data provides a terrain model that supports highly detailed terrain modeling. LiDAR data was collected by others in 2005 and was obtained through the Puget Sound LiDAR Consortium (PSLC) and covers parts of Clallam County, WA and most of the PACR site. Line of Site and Slope analysis was performed utilizing this data.

The line of sight analysis represents what terrain would be visible during munitions training activities from the firing point. The areas identified during the line of sight analysis indicate terrain that may be impacted by artillery, either as a target area or as an area containing munitions that missed the intended target. The line of sight model was considered when developing the transect spacing. The line of sight model is an indicator where munitions may be present. However, based on the arched trajectory of mortars and the potential for munitions to migrate to other areas by erosion, the line of sight model was not solely relied upon. Areas outside the line of sight model were also considered. The line of sight analysis is presented in **Figure 3-12**.

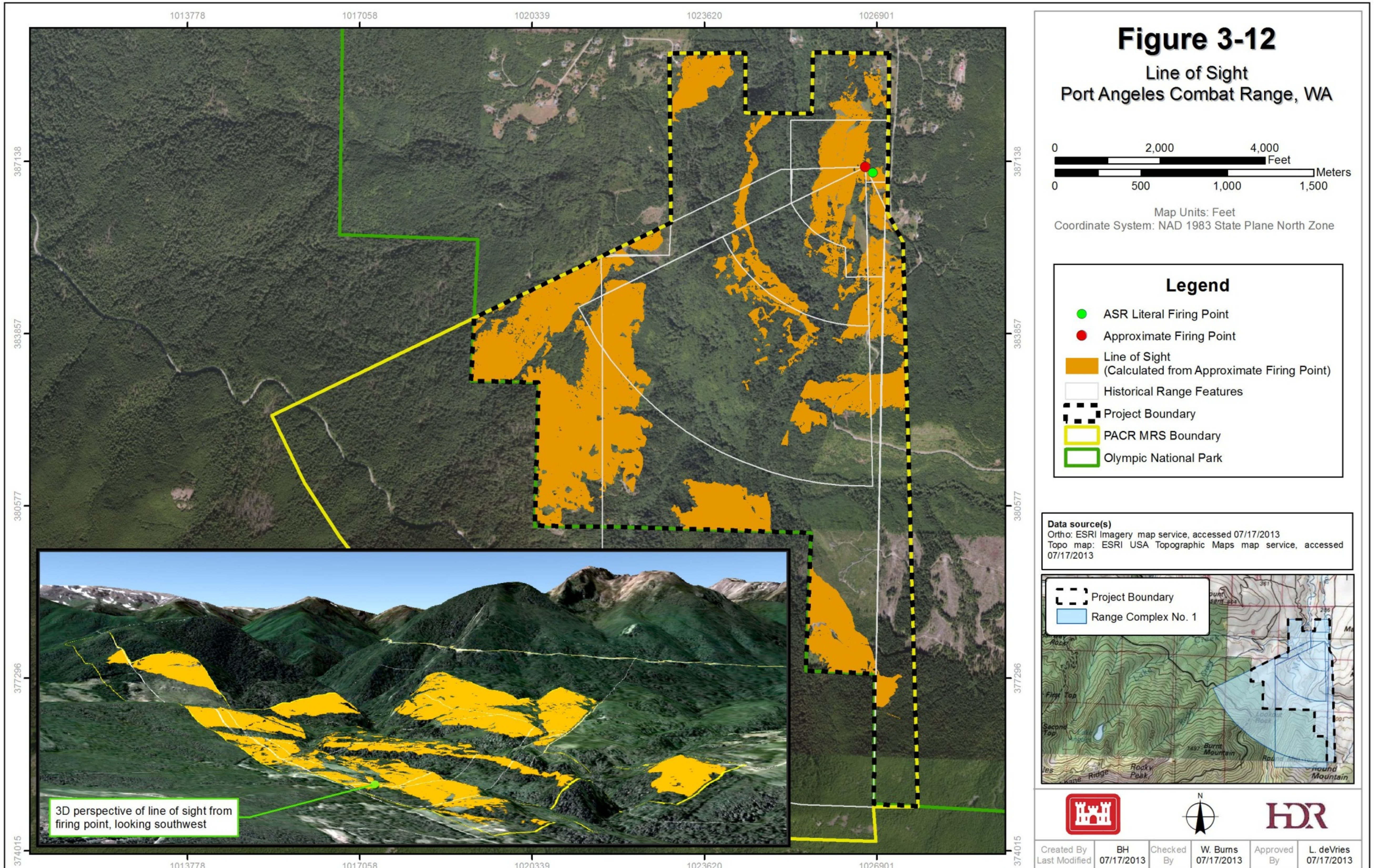


Figure 3-12
Line of Sight
Port Angeles Combat Range, WA
0 2,000 4,000 Feet
0 500 1,000 1,500 Meters
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
ASR Literal Firing Point
Approximate Firing Point
Line of Sight (Calculated from Approximate Firing Point)
Historical Range Features
Project Boundary
PACR MRS Boundary
Olympic National Park
Data source(s)
Ortho: ESRI Imagery map service, accessed 07/17/2013
Topo map: ESRI USA Topographic Maps map service, accessed 07/17/2013
Project Boundary
Range Complex No. 1
3D perspective of line of sight from firing point, looking southwest
1013778
1017058
1020339
1023620
1026901
387138
383857
380577
377296
374015
Created By Last Modified
BH 07/17/2013
Checked By
W. Burns 07/17/2013
Approved By
L. deVries 07/17/2013

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3.1.10 Terrain Slope Analysis

A terrain slope analysis was conducted using LiDAR data obtained for Clallam County, WA and made available through the Puget Sound LiDAR Consortium. Based on experience in the mountains, HDR knows that it is possible to perform visual surveys and EM61 mapping on slopes of up to 65%. Steeper areas are not accessible for evaluation, but are also not likely to be areas that the public can access so safety risks are minimal in these areas. Terrain slopes greater than 65% are depicted on **Figure 3-6** through **Figure 3-8**.

3.1.11 Munitions Constituents Sampling

Media sampling and analysis may be performed during the RI activities to determine levels of MC contamination. The analytes to be evaluated will be based on the MC sources (refer to **Table 3-3**), as supported by historical records of MEC use, evidence of MEC or small arms debris/activity observed at the MRS during the assisted visual surveys and intrusive investigation. Investigated media will primarily be soil, but sediment, surface water, and groundwater sampling also may be performed. Media sampling and analysis will be performed as described in detail in the UFP-QAPP provided in **Appendix D**.

The types of media to be sampled, locations and number of samples, methods of sampling, and analyses to be performed will be determined based on historical data, the results of the visual survey, and intrusive investigation. The analytical methods selected to address munitions-related chemical contaminants will be based on the types of items known or suspected to exist at the MRS and the associated MC (see **Table 1-4**). All media sampling and analysis follows the Project DQOs as outlined in **Section 3.1.3**.

3.1.11.1 Munitions Constituents Energetics Sampling - Soil

If concentrations of MEC are sufficient to possibly cause a release at the MRS, discrete grab samples may be taken and sent to an off-site laboratory for analysis. If there is no significant source (MEC) observed within the MRS, no sampling will be conducted. There are six general situations that may be encountered during field operations that will be evaluated to determine if MC sampling for energetics will be required if a MEC item is found:

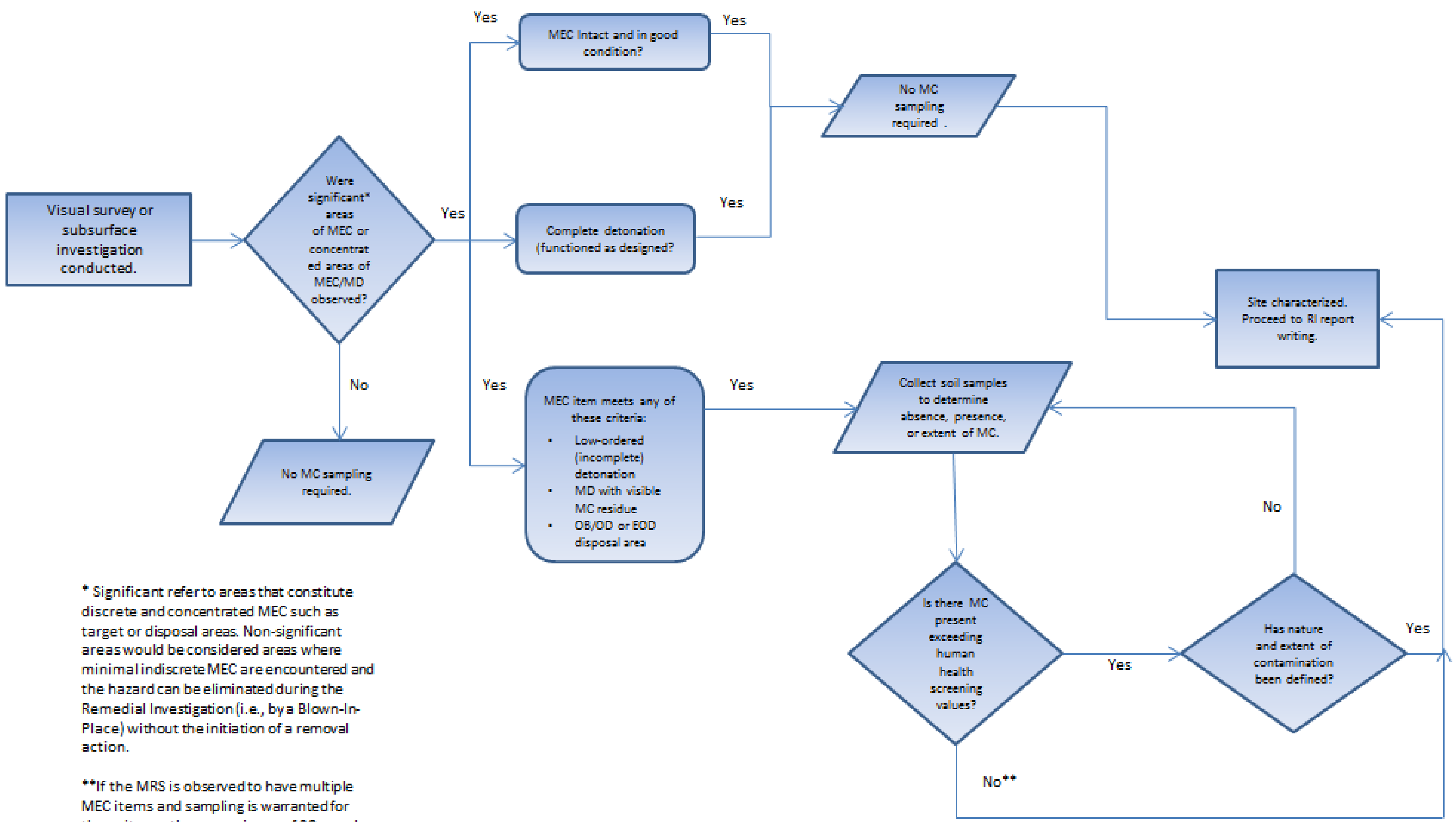
1. An intact, in good condition, MEC item has been found – MC sampling would not be performed because a release would not have occurred. The item will be disposed of by the UXO Team.
2. An intact, in poor condition, MEC item has been found – MC sampling would be performed if an immediate explosive hazard was not present. If an immediate explosive hazard exists, the item will be disposed of by the UXO Team. MC sampling would occur after the disposal operations.
3. A low-ordered (incomplete detonation) MEC item has been found – MC sampling would be performed if an immediate explosive hazard was not present. If an immediate explosive hazard exists, the item will be disposed of by the UXO Team. MC sampling would occur after the disposal operations.

4. Munitions debris with visible MC residue has been found – MC sampling would be performed if an immediate explosive hazard was not present. If an immediate explosive hazard exists, the item will be disposed of by the UXO Team. MC sampling would occur after the disposal operations.
5. Munitions that have functioned as designed (complete detonation) have been found- MC sampling would not occur because all explosives associated with the munitions would have been consumed during detonation.
6. Open Burn/Open Detonation – MC sampling would be performed if an immediate explosive hazard was not present.

The soil sampling conducted as part of the SI in 2009 reported no MC concentrations above the agreed upon screening levels and concluded that further MC sampling is not recommended. If the MRS is observed to have multiple MEC items, and sampling is warranted for these items, as discussed above, then samples will be collected that will be geographically dispersed throughout the MRS. If 20 samples are analyzed for energetics and the results indicate concentrations below the screening levels then MC sampling will no longer be required for the MRS.

Figure 3-13 presents the decision logic for conducting MC sampling at PACR.

Figure 3-13 Decision Logic for Munitions Constituent Sampling for Explosives



* Significant refer to areas that constitute discrete and concentrated MEC such as target or disposal areas. Non-significant areas would be considered areas where minimal indiscrete MEC are encountered and the hazard can be eliminated during the Remedial Investigation (i.e., by a Blown-In-Place) without the initiation of a removal action.

If the MRS is observed to have multiple MEC items and sampling is warranted for these items, then a maximum of 20 samples will be collected that are geographically dispersed throughout the MRS. Once analyzed for energetics and the results indicate concentrations below the screening levels, then MC sampling will no longer be required for the MRS (Refer to **Section 3.10.1.3.2 for 20-sample basis).

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3.1.11.2 Munitions Constituents Lead Sampling - Soil

MC sampling for small arms will be conducted based on the Interstate Technology and Regulatory Council (ITRC) guidance. Lead in a small arms projectile makes up more than 85% of its total weight, and is the indicator for all other small arms projectile constituents. Since lead constitutes the greatest environmental concern as documented impacts to human health indicate, and since it is known that lead projectile fragments create dust upon impact at the berm and vapor upon heat of ignition at the firing line, lead in soil will be utilized to delineate MRS for all other constituents (ITRC, 2003).

Discrete soil sampling for lead will be conducted in areas that are observed to have small arms debris or suspicion of natural features that could have historical small arms activity *(e.g.,* natural berm-like feature). Handheld XRF instruments will be utilized as an in-situ screening tool and will analyze the soil as it is observed at the time of analysis (e.g., samples will not be prepared or air dried). Since there may be a matrix interference due to the soil moisture content potentially being greater than 20%, per USEPA Method 6200, a conservative in-situ XRF screening level of 125 mg/kg (compared to the State of Washington soil cleanup level of 250 mg/kg) will be utilized. Any in-situ XRF samples that exceed the 125 mg/kg screening level will be sent to an off-site laboratory for analysis. XRF will assist the field team to determine soil sampling locations within the PACR that have evidence of small arms use. XRF measurements will be recorded and geo-referenced only to provide information to the field investigation team to collect samples for laboratory analysis. The locations will also be utilized to document the absence of lead in natural berm like features if there is no evidence of small arms use.

Below are four general situations that are encountered during field operations that would be evaluated to determine if lead sampling and laboratory analysis is required:

1. Small arms debris (casings, projectiles) observed in an area
2. Berm or targets indicating an impact zone of a potential small arms range
3. Firing platforms indicating a firing point of a potential small arms range
4. Ground scarring and/or debris (exploded casings, projectiles) indicating the potential of a small arms burn pile- soil sampling would be conducted for lead.

After the decision that sampling is necessary or warranted, discrete surface and subsurface soil samples will be collected and sent to an analytical laboratory for analysis. Soil sampling will follow the procedures as outlined in HDR MMRP SOP-300 (**Appendix K**). Sample collection will continue horizontally and vertically until the analytical results are below the WDOE soil cleanup level for Washington Model Toxics Act Soil Cleanup Level under Method A for unrestricted future land use at 250 mg/kg (**Table 3-8**). Lab analysis for lead will be expedited and results reviewed before the field team demobilizes from the site. The results from the laboratory are considered to be definitive and will be used in future decision making for the site.

3.1.11.3 Environmental Media Sampling - Surface Water and Sediment

Surface water in the form of precipitation runoff may serve as a transport mechanism for MC bound to soil particles and be transported to areas of standing water. MEC or small arms debris could also be found in areas of standing or flowing water and MC could be bound to the sediments at the specific MEC or small arms debris location. The decision to collect sediment and surface water samples will be the same as that for soil sampling and is based on the presence of compromised MEC or observed small arms debris. Sediment sample will be discrete samples directly below the MEC item or small arms debris items. Surface water samples will be co-located with the item and co-located with the sediment sample.

Sediment sampling, if warranted, will be conducted following HDR MMRP SOP-1000 (**Appendix K**). All surface water sampling, if conducted, will be performed in strict adherence to the HDR MMRP SOP-800 (**Appendix K**). All surface water samples handling for laboratory analysis will follow the guidelines for sample handling and preservation techniques as defined in the USEPA SW-846 methods (USEPA, 2008a).

3.1.11.4 Environmental Media Sampling - Groundwater

If MEC is present, there is the potential for MC to be present; thus, a possible migration to groundwater pathway may exist depending on soil permeability and depth to groundwater at that location. No groundwater sampling is anticipated at the PACR based on the groundwater sampling conducted as part of the SI in 2009 (Shaw, 2009). All MC concentrations were reported as non-detects. During the field efforts, field teams will note evidence of seeps, springs, or surface to groundwater communication (i.e., hydrogeological connections). Groundwater will be sampled if there are at least 10 clustered and breached MEC items per acre that meet any of the soil criteria defined in **Section 3.1.11.1**, *and if* there is highly permeable soil and shallow groundwater (e.g. less than 12 ft. below grade) in close proximity. If deemed necessary, focused but limited groundwater sampling will be conducted as discussed below.

All groundwater sampling, if conducted, will be performed in strict adherence to the HDR MMRP SOP-900 (**Appendix K**). All groundwater sampling, if any, for laboratory analysis will follow the guidelines for sample handling and preservation techniques as defined in the USEPA SW-846 methods (USEPA, 2008a).

3.1.11.5 Decontamination Requirements

Decontamination will be performed on reusable sampling and non-sampling equipment to prevent cross-contamination between sampling locations. Disposable equipment will be used whenever possible and will not require decontamination. It is anticipated that minimal decontamination (if any) will be required. If decontamination is required, procedures are outlined in *HDR MMRP SOP-500 Equipment and Personnel Decontamination.*

3.1.11.6 Quality Control Sampling

Appendix D presents the UFP-QAPP for the RI field activities, including a description of the types and frequency requirements of samples collected for QC purposes. These will include field duplicate samples and matrix spike/matrix spike duplicate (MS/MSD) samples. Equipment rinsate blanks will only be required if non-disposable sampling equipment is used to collect samples.

3.1.11.7 Analytical Program

The potential MC at the PACR includes energetics (nitroaromatics, nitramines, and nitrate esters) and lead. Energetics will be analyzed following USEPA SW-846 Method 8330B (mod), and lead following USEPA SW-846 Method 6010C. Method 8330B is referred to as modified because, although all of the laboratory requirements for implementing SW-846 Method 8330B will be conducted (e.g., air drying, sub-sampling, etc.), multi-increment sampling in the field will not be conducted. The specific chemicals of concern are list below in **Table 3-2**.

Table 3-3 Analyte List

Analyte List
Lead – USEPA SW-846 Method 6010C
Lead
Explosives – USEPA SW-846 Method 8330B (modified)
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
1,3,5-Trinitrobenzene (1,3,5-TNB)
1,3-Dinitrobenzene (1,3-DNB)
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)
Nitrobenzene (NB)
3,5-Dinitroaniline
2,4,6-Trinitrotoluene (2,4,6-TNT)
4-Amino-2,6-dinitrotoluene (4-Am-DNT)
2-Amino-4,6-dinitrotoluene (2-Am-DNT)
2,4-Dinitrotoluene (2,4-DNT)
2,6-Dinitrotoluene (2,6-DNT)
2-Nitrotoluene (2-NT)
3-Nitrotoluene (3-NT)
4-Nitrotoluene (4-NT)
Pentaerythritol tetranitrate (PETN)
Nitroglycerin

Refer to **Section 3.1.11.2** for discussion regarding sampling for lead as an indicator for small arms MC

Sample identification number consists of an alphanumeric designation related to the event, screening sample (as appropriate), location, media type, and QC sample (as appropriate), according to the following convention:

Event:	**RI** = Remedial Investigation
Installation:	**PA** = Port Angeles
Sample:	**LS** = Laboratory Sample
Location:	**01** = Combat Range / Range Complex 01
Media Type:	**SSS** = Surface Soil Sample (0-6 inches)
	SB1 = Subsurface Soil (6-12 inches)
	SB2 = Subsurface Soil (12-18 inches), SB3, SB4 = Continue pattern
	SES = Sediment sample
	SWS = Surface Water sample
	GWS = Ground Water Sample
Sample Number:	Sample day #1 = 0101, 0102, 0103, etc…
	Sample day #2 = 0201, 0202, 0203, etc…
Duplicate Samples:	Insert the number 9 and add the reverse sample number

Examples:

RI-PA-LS-01-SSS-0201 = First surface soil sample, of day two, at combat range, for laboratory analysis, for the RI project at Port Angeles Combat Range.

Duplicate of example = **RI-PA-LS-01-SSS-90201**

QC Sample: **MS/MSD** = Matrix Spike/Matrix Spike Duplicate samples are identified on the chain of custody (COC) form under comments and are not used in the sample identification.

3.1.12 Data Incorporation into the RI

Whenever possible, existing data will be incorporated into the RI. The following is a summary of existing data and how it will be used:

Archives Search Data – The ASR (USACE, 1996) and the ASR Supplement (USACE, 2004) provide historical documentation regarding the site and identifies the types of activities conducted, the types of munitions used, and historical finds and incidents. This data was used to identify the expected baseline conditions, to assess risk, and to identify the Munitions with the Greatest Fragmentation Distance (MGFD) and other hazards that may be present.

SI Data – The SI conducted at PACR provided visual survey data (Shaw, 2009). The visual survey data was used in conjunction with historical aerial photography data to preliminarily delineate areas of military munitions activities. During the SI, limited soil, surface water, sediment, and groundwater samples were also collected and analyzed for select metals and explosives to assess MC. This data set has been reviewed and considered during the technical approach for the RI.

In addition, 10 background surface soil samples were collected at locations outside the range impact area boundaries that were not known to be impacted by military activities and analyzed for potential MC (chromium, copper, iron, lead, mercury, and nickel) and aluminum, magnesium, manganese, and zinc for geochemical analysis (Shaw, 2009). These results will be evaluated as naturally occurring background in the RI report (**Figure 3-14**).

<u>ESTCP Data</u> – Following planning the SI, geophysical surveys were completed in selected portions of PACR to determine if evidence of subsurface anomalies are present. This data set has been reviewed and considered during the technical approach for the RI. The data will also be considered during the DGM data collection planning for the RI and used in the nature and extent evaluations and MEC risk assessment.

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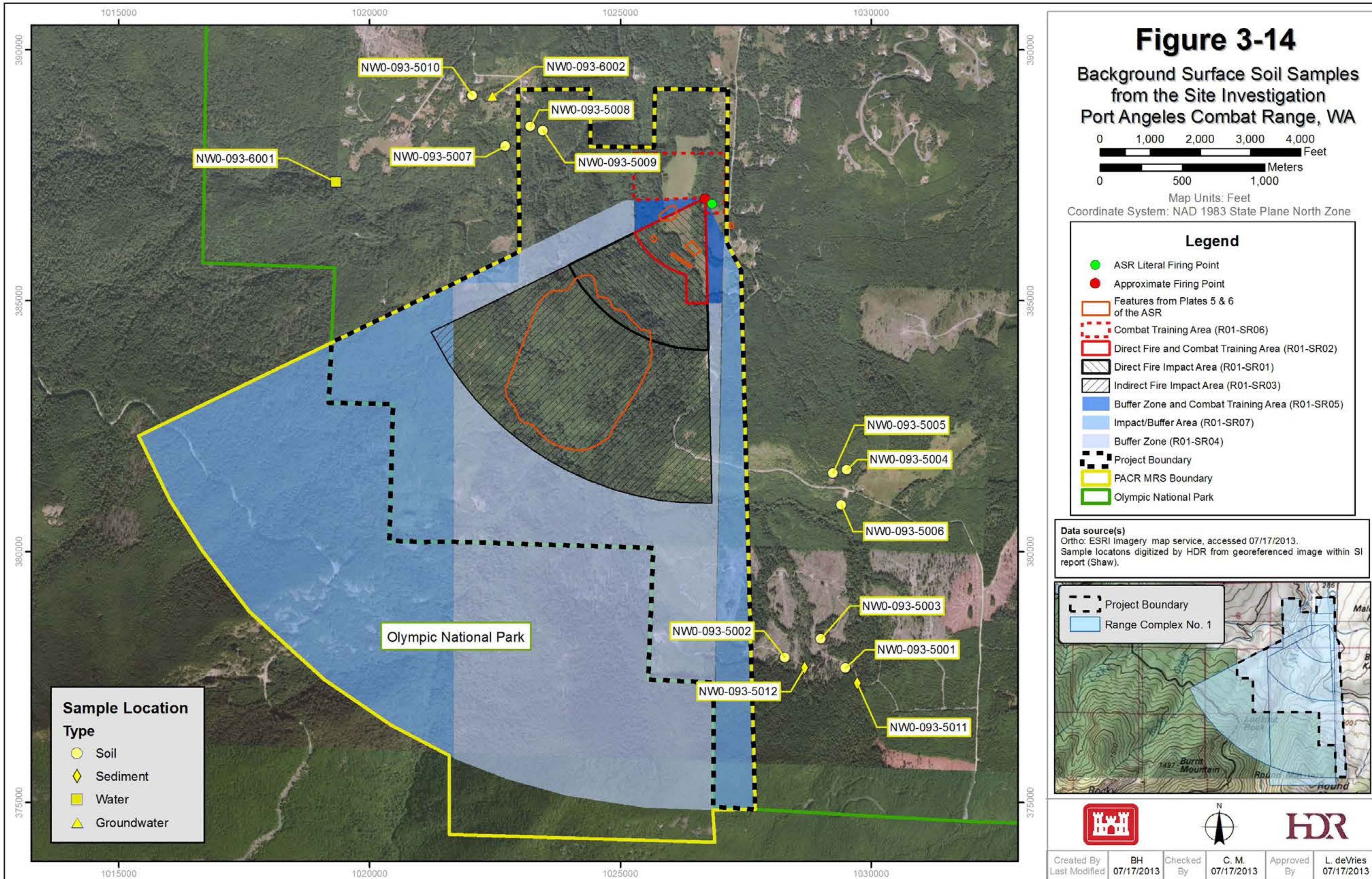
Figure 3-14
Background Surface Soil Samples from the Site Investigation
Port Angeles Combat Range, WA
0 1,000 2,000 3,000 4,000 Feet
0 500 1,000 Meters
Map Units: Feet
Coordinate System: NAD 1983 State Plane North Zone
Legend
ASR Literal Firing Point
Approximate Firing Point
Features from Plates 5 & 6 of the ASR
Combat Training Area (R01-SR06)
Direct Fire and Combat Training Area (R01-SR02)
Direct Fire Impact Area (R01-SR01)
Indirect Fire Impact Area (R01-SR03)
Buffer Zone and Combat Training Area (R01-SR05)
Impact/Buffer Area (R01-SR07)
Buffer Zone (R01-SR04)
Project Boundary
PACR MRS Boundary
Olympic National Park
Data source(s)
Ortho: ESRI Imagery map service, accessed 07/17/2013.
Sample locatons digitized by HDR from georeferenced image within SI report (Shaw).
Project Boundary
Range Complex No. 1
Sample Location Type
Soil
Sediment
Water
Groundwater
Olympic National Park
NW0-093-5010
NW0-093-6002
NW0-093-5008
NW0-093-5009
NW0-093-5007
NW0-093-6001
NW0-093-5005
NW0-093-5004
NW0-093-5006
NW0-093-5003
NW0-093-5002
NW0-093-5001
NW0-093-5012
NW0-093-5011
1015000
1020000
1025000
1030000
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385000
380000
375000
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Checked By C. M. 07/17/2013
Approved By L. deVries 07/17/2013

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3.2 Use of Time Critical Removal Actions

Use of Time Critical Removal Actions (TCRAs) is not anticipated during the RI. If there is a need for a removal action, the requirements noted in Section 4-5 of ER 200-3-1 (USACE, 2004a) and in the NCP will be followed. The selection of the appropriate type of removal action is based on the evaluation of the following site-specific features:

- The nature of the MEC or the presence of MC contamination,
- The urgency/threat of release or potential release of MEC or MC contamination, and
- The time frame required for initiating a removal action.

Based on the evaluation of these features, an emergency, time critical, or non-time critical removal action could be selected.

3.3 Follow-On Activities

Once all RI data is collected, an RI Report will be prepared identifying the nature and extent of contamination and the hazard associated with MEC will be analyzed as well as potential risk to human health and the environment. The USEPA Munitions and Explosives of Concern Hazard Assessment Methodology (MEC HA) (USEPA, 2008) will be used to assess potential explosive hazards associated with recovered MEC, if any. An FS will then be produced to develop and evaluate potential remedial actions. The proposed action will then be presented to the public in a Proposed Plan. After public comments are received, the selected remedy will be documented in a Decision Document. A Remedial Design will be developed and a Remedial Action will be performed, which may consist of institutional controls and/or any other appropriate response action. The remedial action will be performed under a separate task order at a later date to be determined.

3.4 Geophysical Investigation Plan

This section was developed in accordance with the DID MMRP-09-004, Geophysics (USACE, 2009a), Engineering Manual (EM) 1110-1-4009 (USACE, 2007), Digital Geophysical Mapping Guidance Operational Procedures and Quality Control Manual (DGM QC Guidance) (USACE, 2003), and Geophysical System Verification (GSV): A Physics-Based Alternative to Geophysical Prove-Outs for Munitions Response (Environmental Security Technology Certification Program (ESTCP, 2009). It is anticipated that during completion of the RI at the Direct Fire Impact Area, EM61 MK2 geophysical sensors will be used in conjunction with a real-time kinematic (RTK) GPS and/or robotic total station (RTS) positioning system for the DGM survey, resulting in one dimensional (1D) transects. The proposed DGM surveys for the Direct Fire Impact Area will be detailed in **Section 3.4.6.2**. A summary of the general procedures that apply to the DGM surveys and the general guidelines for the GSV process at the Direct Fire Impact Area are presented in this subsection.

3.4.1 Instrument Validation Plan and Report

The objective of the instrument validation plan (IVP) is to ensure proper functioning of the geophysical instruments. The instruments will be tested at an instrument verification strip (IVS). The IVS will be constructed in an area free of geophysical noise near the Direct Fire Impact Area. Each day, prior to and after surveying, the survey platform will survey the IVS. The IVS consists of two lines placed outside the survey area and in an area with very little to no response from the survey sensor. The first line contains predetermined metal pipes, known as industry standard objects (ISO), placed either on the surface or buried at depth to allow for a consist response from the survey sensor. The second line is a noise line. The noise line will represent the survey background level. The IVS is not intended to set anomaly selection thresholds but to test the consistency of the sensor response two or more times per day. The DGM DQOs are data quality metrics (such as data density, sensor response and positional accuracy) that must be met to ensure the data sensors are performing correctly. The DGM DQOs for the project and IVS are presented in **Table 3-5** and **Table 3-6** of this RIWP.

The results of the IVS will be submitted in a letter report for review and approval and will include, at a minimum, the following information:

- As-built map of the test strip;
- Digital photographs of the ISO seed items as used and in the open hole;
- Graphical plots of the EM61 MK2 DGM system responses for the ISOs superimposed on the Naval Research Laboratory (NRL) standardized curves;
- Color-coded maps of the geophysical data with track path superimposed;
- Geophysical interpretation, including initial anomaly selection criteria;
- Proposed geophysical equipment, techniques, and methodologies; and
- Recommended QC performance metrics.

All instrument functional and quality tests will be digitally documented and stored in the project database for review by the stakeholders.

In accordance with the GSV, HDR will construct an IVS utilizing ISOs buried at varying depths and orientations in the calibration area. ISOs have been defined by NRLs, and positioned in the most and least favorable orientations for detection by sensor system. The IVS will consist of six ISOs buried approximately 10 to 16 ft. (3 to 5 meters [m]) apart at various depths and orientations on a test strip line in a "*background*" area (i.e., area void of subsurface metal and electromagnetic interference), and the positions will be recorded by a Washington Registered Land Surveyor to an accuracy of 1.2 inches (3 centimeters [cm]). The ISOs may consist of 1 inch by 4-inch (small), 2-inch by-8 inch (medium), and/or 4-inch by 12 -inch (large) pipe nipples made from Schedule 40 black carbon steel from McMaster Carr Hardware (or equivalent) as shown in **Table 3-4**. The sizes of ISOs utilized, burial depth, and orientation will be verified on a later date based on the site specific characteristics and anticipated munitions at each site. A "*noise strip*" (transect void of anomalies) will also be surveyed in conjunction with the IVS to record background noise at the site in order to determine the site-specific "*noise*," which is an important component in determining the anomaly selection criteria. The test strip construction will follow the guidelines described in Geophysical System Verification (GSV): A Physics-Based Alternative to Geophysical Prove-Outs for Munitions Response (ESTCP, 2009).

Table 3-4 Sample Test Strip Design

Item	Burial Depth (feet)	Orientation	Number of Items	Easting (feet)	Northing (feet)
Small ISO	0.5	H	1	TBD	TBD
Medium ISO	1.5	H	1	TBD	TBD
Large ISO	2.5	H	1	TBD	TBD
Small ISO	1.25	V	1	TBD	TBD
Medium ISO	2.25	V	1	TBD	TBD
Large ISO	3.5	V	1	TBD	TBD

Notes:
H = horizontal
ISO = industry standard object
TBD = to be determined
V = vertical

The ISOs will be used to confirm the sensitivity of the geophysical instrumentation and adequacy of the data acquisition parameters (line spacing, sampling frequency, and positioning system accuracy and precision, and sensor height above the ground surface) by comparing the sensor responses from the ISOs to standardized, physics-based models of the ISOs created specifically for munitions response projects by the NRL. Since geophysical measurements of the ISOs in the field will likely vary from the physics-based models, each IVS lane will be surveyed multiple times with at least two separate EM61 MK2 systems to establish an average electromagnetic (EM) response for each item. This average response will then be used to determine whether the sensors are functioning properly throughout the duration of DGM activities. If above ground power line interference is present near any of the geophysical survey areas, static geophysical sensor data will be acquired prior to the initiation of survey activities so that the information can be incorporated into the anomaly selection criteria.

In addition to the daily IVS surveys the following standardization tests are conducted and results are documented in the Equipment Standardization Report.

At a minimum, the IVS data will be collected twice daily and after any equipment changes. The DQO **Table 3-6** contains the limits for the test, and the Daily Summary Report documents the results of the test.

Most geophysical instrument readings drift for a couple of minutes after start-up. All sensors are warmed up for at least 15 minutes (may be longer for colder temperatures) prior to testing or data collection. Each time the instrument starts (e.g., at the start of the day, after breaks, battery changes, etc.), this procedure is followed.

At the beginning of the survey, and thereafter at any changes in form factor, or when a sensor is reattached to a pole or cart, the relative positions of the geophysical sensors with respect to the positioning system antenna or prism will be measured (tolerance ± 1 inch) and documented, as will the platform or sensor height above the ground surface.

The Static Background and Spike Test checks the instruments' background reading and drift, identifies potential interference, checks the instrument's response against a known standard test item (spike), and checks to make sure the instruments' readings returned to background levels after a spike. The standard test item typically used is a 2-inch steel ball. HDR field crews perform this test at the start and end of each survey day. However, if the Project Geophysicist terminated field operations early because of weather conditions, the end of day test is not required to be performed.

With the sensor held in a stationary position, the HDR Data Acquisition System (DAS) records static background data for three minutes. Then, the standard test item is placed in a jig that holds the test item above the center of the coil for one minute. After the coil has been spike tested, the standardization item is removed, and the system records background static data for a minimum of one minute. The DQO Table (**Table 3-6**) contains the limits for the test and the Daily Summary Report documents the results of the test.

The Personnel Test checks the operators for potential sources of noise, only when a man-portable platform is used for data collection. HDR field team members remove any metal or electronic contents from their person prior to survey activities. Each person walks by the sensor and another team member observes the response of the sensor in the DAS. If the level exceeds the values defined in the previous section, the team member will check his possessions, remove any possible sources of noise, and perform the test again. HDR field team members will perform this test prior to data collection. The DQO Table (**Table 3-6**) contains the limits for the test and the Daily Summary Report documents the results of the test.

Loose cabling is a preventable source of noise. The test measures any anomalous readings caused by cable movement, short circuits, or bad connectors. HDR field crews perform a cable shake test prior to data collection. If values measured by the test exceed the limits defined in the Static Test section, a HDR team member cleans, secures, or replaces the cable. This process continues until the noise is eliminated. The DQO Table (**Table 3-6**) contains the limits for the test and the Daily Summary Report documents the results of the test.

The Point Position Test checks the function and accuracy of the positioning system. The GPS antenna is positioned over a known, surveyed point and the observed location is compared to the known location. HDR field crews perform this test at the start of each survey day. The DQO Table (**Table 3-6**) contains the limits for the test and the Daily Summary Report documents the results of the test.

3.4.2 Personnel

All project personnel will, at a minimum, meet the requirements outlined in USACE Data Item Description OE-005-05. Refer to **Section 2.3** for descriptions of project personnel.

3.4.3 Production Rates

DGM production rates are highly variable and depend on several factors including topography, vegetation, and site access, proximity of survey area to the mobilization area, weather conditions, and platforms used. When utilizing the man portable push-cart or litter, it is anticipated that 1 to 3 miles of transect data acquisition will occur per day.

3.4.4 Site Conditions

Bedrock geology of the area is controlled by the converging of two tectonic plates (Juan de Fuca and North American plates). Underlying the PACR are accreted Tertiary sediments and pillow basalt rocks that were once on the floor of the Pacific Ocean. During the Pleistocene Epoch, colder climates brought about glaciations over much of the Olympic Peninsula and Puget Lowland, leaving thick glacial outwash deposits over older rocks (Orr and Orr, 2002). North of the PACR, these glacial outwash deposits pinch out and bedrock is covered by deposits of rocky alluvium on hillsides and by sands and gravels with silt in areas of low relief (Shaw, 2009).

Overburden soils present at the PACR are Elwha gravelly sandy loam, Neilton very gravelly sandy loam, Puget silt loam, and Terbies very gravelly sandy loam (NRCS, 2007). During the 2008 SI sampling, the surface soils were described as consisting of silty sand (Shaw, 2009).

The PACR is located on the Olympic Peninsula of Washington. The land is hilly and semi-mountainous. The northern portion of the FUDS contains areas of meadowland/grassland, but other areas are densely forested. Review of historical aerial photographs indicates that the areas of meadowland/grassland have been present since at least 1939. This portion was the area used for actual firing. The southern portion of the property is located within the Olympic National Park and is contained in the Buffer Zone. The minimum and maximum elevations of the PACR are approximately 700 ft. in the north and 3,541 ft. in the south at Round Mountain. Deep ravines associated with Morse and Surveyor Creeks are present at the site. The FUDS consists of primarily second growth fir and alder with some cedar trees. Where forested, the site has very heavy undergrowth that makes travel difficult. Areas that have been recently logged have very dense growth of small trees and shrubs that makes the areas impassible.

Man-made features can negatively affect geophysical investigations. Fences, roads, power lines, and buried pipelines are examples of typical man-made features. Using proper survey and data processing techniques, the effect of such features can be mitigated. Surveying parallel to the feature reduces the gradient produced by the feature. During processing, a trend removal filter is used to shift the background response level towards 0 millivolts (mV) thus removing long wavelength trends in the data. It must be noted that in some situations, survey and data processing techniques cannot overcome the effects of cultural interference (ex. close proximity to a fence line or power lines). In areas where these techniques do not work, the Project Geophysicist will deliver a map to the client detailing the cause for the non-surveyable area. Areas that could not be geophysically mapped, due to natural or man-made obstacles, will be documented and included in the project GIS.

The Direct Impact Fire Area, where geophysics will be performed, is located within an undeveloped area and contains no major buildings and roads. Man-made features existing within or in close proximity to the DGM survey areas have the potential to negatively impact geophysical investigations. Anomalies associated with or in close proximity to man-made features will be masked and excluded from target selection. These features include, but are not limited to:

- Utility corridors;
- Former railroad beds and rail lines;
- Buried pipes, cables, and radio transmitters;
- Above and below ground power lines;
- Fences;
- Trash dumpsters;
- Monitoring wells;
- Benches;
- Metal signs;
- Buildings;
- Vehicles;
- Firing targets;
- Bunkers; and
- Berms.

All of these features may introduce noise in the DGM data; therefore, the position of these features will be accurately documented with the proposed positioning system(s) so that they can be accounted for during the interpretation.

In areas where power lines or radio transmitters are present, static noise tests may be performed prior to large-scale mapping efforts in order to assess the impact of these features on the DGM data. Modifications to the existing DGM system (e.g., data acquisition platform, data processing parameters, and interpretation criteria) may be performed in areas where the source of the noise can be mitigated by changes to existing protocol. Any changes to the DGM system during the project will be documented in the digital project files (e.g., Oasis Montaj processing log).

Dynamic events (rain, lightning, solar flares, etc.) may temporarily impact geophysical data collection and/or data quality. Procedures for these anticipated events are as follows:

- **Rain**: Rain is a hazard to crew and equipment. During periods of rain, the team members will assess the intensity and its effect to the equipment and crew safety (slip-trip-fall). They will determine when or how to proceed with survey operations. When surveying stops, the field activity log will reflect the conditions and reasons for the stoppage. Once the rain ends, the survey will resume, if time permits.

- **<u>Lightning</u>**: Lightning is a severe hazard to the health and well-being of field crews. Site personnel and equipment will take shelter in a safe area. Geophysical team members will make the determination that lightning is present, annotate the survey activities log, and shut down field operations until the threat has passed.
- **<u>High Winds</u>**: High winds present a safety hazard to field crews. Either the site safety officer or the TL will determine if hazardous wind conditions exist and will terminate field activities if they do. Upon a return to safe conditions, work will resume.

All site personnel will adhere to the practices, procedures, and training and monitoring requirements mandated by the APP/SSHP. Because of the potential UXO hazard a UXO technician will accompany the DGM teams and provide real-time escort if the location of transects is uncertain. Additional biological and survey operations hazards will be addressed in the APP/SSHP.

Electronic fuzing is not expected at the MRS. If the possibility of electronic fuzes is discovered, geophysical procedures for that MRS will be re-evaluated. The possibility exists where pulsed electromagnetic instruments can activate electronic fuzes. In order to minimize the risk of this safety hazard, USACE Interim Safety Alert of January 20, 1999 recommends that no geophysical equipment, its electronics, data logger or battery pack be placed on the ground in areas where electronic fuzing may be present.

Site conditions pose challenges in terms of MRS accessibility. The following general site conditions and remedies are expected at the MRS:

- **<u>Remote Access</u>**: The majority of the Direct Fire Impact Area is covered by forest or tree dominated vegetation. The site will be accessed daily by vehicles that will stay on hardened roads, trails, or former railroad beds where possible, but off road driving may be required to access remote areas.
- **<u>Poisonous Plants</u>**: To the maximum extent possible, these plants will be avoided during the surveys. If possible, they will be removed prior to surveying by brush cutting.
- **<u>Sensitive Habitats</u>**: HDR will coordinate with the WDOE prior to conducting activities that may impact sensitive habitats (i.e., forested areas, wetlands, streams, ponds, grasslands, areas with threatened and/or endangered species, etc.).
- **<u>Thick Vegetation</u>**: The removal of any thick vegetation from forested areas or grasses is not anticipated. However minor vegetation clearance (e.g. removal of underbrush with hand tools to allow passage during visual survey and DGM transects) will be coordinated with land owners during the ROE process.
- **<u>Wooded Areas</u>**: Investigative activities may occur in forested areas. No forested areas will be disturbed (i.e., removal of trees larger than a 3-inch diameter) without the approval of the landowners.
- **<u>Surface Water Features (i.e., ponds, wetlands, and streams)</u>**: Surface water features such as ponds, wetlands, and streams may cause access issues within MRS. Access to surface water features will be limited and mainly include transient access. No vehicles or heavy equipment will access surface water features.

3.4.5 Survey Control

A licensed Washington surveyor will establish 3 control points of third order horizontal accuracy (residual error less than or equal to 1 part in 10,000 relative to the NAD83, 2011 realization datum) that will be used to provide position information for the DGM survey. If additional control points are generated during the DGM activity, they will be validated by occupying at least one other independent control point.

A system of 1D transects will be generated over the survey areas prior to DGM activities. The location of each transect endpoint will be pre-defined using the project GIS, and the coordinate data will be uploaded to a GPS unit for the field crew to use for navigation purposes.

All survey control will be developed in UTM meters, UTM Zone 10 NAD83. Geospatial data will also be provided in the Washington State Plane North Coordinate System, U.S. Survey Feet.

3.4.6 Geophysical Survey Modes

A transect-based approach will be employed for site-characterization.

3.4.6.1 Transect Surveys

The transect survey method quickly covers an area and is typically used in site characterization activities. Survey lanes typically follow long straight paths and with spacing designed to verify proper clearance of a site. In the Direct Fire Impact Area, the transect length will be 75 ft. (23 m).The transect spacing will be determined using the VSP. VSP is a software program developed by Pacific Northwest National Laboratory under funding from the Strategic Environmental Research and Development Program (http://vsp.pnl.gov). It utilizes statistical sampling theory and statistical analysis of sample results to provide a defensible sampling plan. Typically, 1% - 20% of an area is mapped during such a sampling activity. Loading the GIS-created transect file into the DAS guides the operator to the beginning and end of each lane.

Quality Assurance for Transect Surveys

A blind seeding program will be incorporated at the Direct Fire Impact Area as a quality assurance (QA) measure (**Table 3-6**). In a transect survey, seeded items are placed within a transect line between two flags that are 33 ft (10 m) apart. Equipment operators then walk the seeded transect and the embedded item is recorded by the DAS and mapped by data processors.

3.4.6.2 Digital Geophysical Mapping System

The DGM mapping mode proposed for the Direct Fire Impact Area is a transect survey. This survey will use a Geonics EM61-MK2 (EM61-MK2) metal detector deployed using a man-portable platform. Time-domain electromagnetic metal detectors detect shallow metallic objects with good spatial resolution and with minimal interference from adjacent metallic features. The EM61-MK2 is the industry standard metal detector. The instrument generates a transient primary magnetic field, which induces eddy currents in nearby metallic objects. As the eddy currents decay, the instrument measures the secondary magnetic field over four geometrically spaced time windows. The first measurement occurs a relatively long time after the primary pulse. This allows current induced in the ground to dissipate, leaving only the magnetic field produced by nearby metallic objects. The secondary magnetic field induces a current in the coils, which the instrument electronics convert the current to a voltage. The DAS timestamps and records the voltage. The instrument collects data at 12 Hertz (Hz) or samples per second. The EM61 MK2 was designed to detect individual small items at shallow depths and relatively larger items (e.g., 155 mm projectile) at depths approaching 5 to 7 ft. (1.5 to 2.1m). The resulting data can be used to differentiate, in simplistic fashion, the relative size and distance (or depth) of metal items when the anomaly density is relatively low. In cluttered areas where the anomaly density is relatively high (e.g., burial pits, trenches, etc.) and the anomaly signatures overlap, the determination of size and depth is much more difficult. In addition to the metal detector, a Trimble RTK global GPS is used to accurately record the position of the metal detector relative to the Earth. The data streams from these sensors are collect using a DAS and stored on a computer hard drive. After data collection, the data are downloaded, processed, and analyzed, resulting in an anomaly list. These anomalies are then visited with the same geophysical and positioning sensor. Once the anomaly is verified, a non-metallic flag annotated with the anomaly number is placed next to spot so they can be investigated by a UXO qualified dig team.

3.4.6.3 EM61-MK2 Litter

Due to thick vegetation and rough terrain in the Direct Fire Impact Area, the man-portable litter platform will used to collect DGM data. A single EM61-MK2 coil is attached to a fiberglass frame that allows two geophysical team members to hold the coil, suspended above the ground, while maintaining a distance away from the coil large enough to prevent personnel interference. The coils height above the ground surface is 9 inches (23 cm). An RTK GPS antenna is positioned directly above the center of the coil. Both the GPS antenna and the EM61-MK2 coil are powered by portable batteries located inside of the GPS antenna and backpack worn by the geophysical team member supporting the rear end of the litter. This backpack also contains the EM61 control box. The AVS Team member supporting the front end of the litter platform wears a harness with a laptop computer attached and is responsible for navigating to the survey lines and controlling the DAS. The AVS Team members also wear a waist strap with loops that attach to the litter platform handles to help maintain a fixed coil height and to allow occasional hands free operation when the front end team member is operating the computer. The litter is not able to survey in areas too difficult to walk through or areas with widespread vegetation that would prevent the coil from maintaining a specified height. Litter platform standardization tests will meet the DGM DQOs outlined in **Table 3-6**.

3.4.6.4 Analog Detectors

In areas that are inaccessible to any EM61 platform or where anomalies are saturated, mag and dig operations may take place. Qualified UXO Dig Teams will perform any mag and dig operation that is required. Each UXO Technician will be equipped with a GA-52Cx Schonstedt magnetometer or other handheld electromagnetic detectors that compensate for magnetic soils will be used (e.g., Vallon VMH3, Minelab Explorer). To ensure instrument functionality, each instrument operator will be required to sweep the test strip using the sweep techniques and instrument settings proposed for the project, and detect 100% of the items at least once a day. There are no data generated during the verification of analog detectors. The results of the test will result in a "*go*" or "*no-go*" decision. These results will be documented on the DQCR by the UXOQCS.

3.4.7 Real-Time Kinematic Global Positioning Systems

Real-time kinematic global positioning systems to be utilized at the PACR include the Trimble RTK-GPS. As an alternative if GPS lock cannot be obtained a Leica Robotic Total Station (RTS) may be used.

3.4.7.1 Trimble RTK-GPS

HDR will use a GLONASS enabled Trimble RTK-GPS as the position measurement technology. GPS technology uses the broadcasts from a minimum of four Earth orbiting satellites to triangulate the antenna's 3D location. A local GPS base station provides differential corrections via a radio link to correct for systematic errors, such as atmospheric distortions. The rover should be within 6 to 10 miles of the base station and have line of sight for optimum operation. Due to dense vegetation and tree canopy at the Direct Fire Impact Area, a characterization accuracy of +/- 3 ft. (1 m) will be utilized. If additional survey coverage is required in areas where vegetation interferes with RTK GPS reception, an RTS sensor may be used to provide positioning data for the geophysical measurements. GPS data are collected with the DAS and used in post surveying processing procedures to calculate sensor positions.

To use GPS on site, HDR will employ following actions:

- Use a semi-permanent GPS base station to provide differential corrections
- Use radio repeaters to extend the transmission range of the real-time corrections provided by the local GPS base station
- Establish temporary control points to perform positional accuracy tests as part of data quality checks

In addition to mapping geophysical data, HDR field crews shall use GPS for other related tasks, including:

- Feature Identification: GPS will augment geophysical data and improve effectiveness of geophysical mapping by capturing culture features not noted in the GIS (e.g., surface metal)
- Mapping points for quality control purposes

3.4.7.2 Leica Robotic Total Station

The Leica TPS1200 (or similar) is a motorized RTS that uses automatic target recognition to track the location of the prism and has a highly accurate distance/azimuth measurement system to produce ± 2mm accuracy. Use of the RTS in the Direct Fire Impact Area is unlikely as the RTK GPS will provide the +/- 1 m accuracy necessary for characterization activities. The RTS system hardware consists of three integrated components:

1) The Leica TPS1200 dual-laser RTS
2) The RTS rover remote link control panel
3) A survey prism that is tracked by the RTS base station

The position data are recorded onto a data storage card on the RTS. The data storage card can be used to transfer position data between the RTS and field computers. For DGM, RTS navigation data can also be output as a real-time data stream via a serial adapter from the remote link to the geophysical sensor's data logger.

The determination of the specific positioning method used in areas of canopy will be addressed during reconnaissance activities during the initial stages of the field program. In addition to providing position data for the geophysical sensor measurements, the RTS or GPS will be used for other location tasks including:

Feature Identification: The RTS or GPS will be used to augment geophysical data and improve geophysical mapping through capture of visual observations made during MRS walk-overs. During this process, RTS or GPS will be used to record the positions of cultural features (e.g., fences, vehicles, wells, structures, manhole covers, above-ground utilities, sign posts) so that these features can be accounted for during the interpretation of the geophysical data.

Position data for the project will be reported in UTM meters, NAD83 Datum in order to be compatible with existing MRS information and data. Position data will also be provided in the Washington State Plane North Coordinate System, U.S. survey feet.

3.4.8 Data Processing

HDR uses a several pieces of software to process and analyze data. HDR has a proprietary software package that is used to merge the geophysical and positioning sensor data recorded by the DAS. Geosoft Oasis Montaj is a commercially available data processing and visualization software package. HDR uses the UX-Process package within Oasis Montaj as part of the standardized workflow for processing EM61 data. The following sections describe the processing steps used for data processing, correction, and analysis.

Before the field data is sent to the data processor, the geophysical team member will download the sensor data from the DAS and verify for completeness. The review consists of a field notes review, which looks for the correct input of the survey parameters and site-specific information. The data will then be electronically transferred to the Data Processor for further processing.

The Data Processor performs the initial review of the geophysical data within 24 hours of collection. If problems exist, they will notify the Project Geophysicist. The Project Geophysicist will assess the problems and make adjustments to the field operations or data processing as needed to ensure quality data collection. The sections below detail the review of each kind of data.

The initial review checks the data for linear and non-linear drift, erratic data, dropouts/spikes, incorrect measurements, and timing errors. A qualified Data Processor visually inspects the data. The Daily Summary Report documents any discrepancies.

The initial review of positional data involves checking line profiles for position dropouts/spikes, survey lane straightness and proper spatial registration. In general, GPS data points with position dilution of precision (PDOP) values higher than 4 and RTK fix solution other than 3 will be removed. Some GPS data may require post-processing with GPS base station data to correct errors. At the discretion of the data processor, PDOP values up to 6 may be used when positions appear valid and bounded by low PDOP values. The UX-Process module in Oasis Montaj performs the review and provides a summary of the mean distance between points as well as the percentage of the data spacing which exceeds the DQO metric. The Daily Summary Report documents any discrepancies.

3.4.8.1 Data Density

The along-track data spacing is the distance between data points. The data processor monitors the data densities and flags any areas for recollection that do not meet the DQOs stated in **Section 3.4.14.** Any failures in the quality objective will trigger a recollection of data over the affected area.

After the initial data review, the data follows a site-specific processing procedure that includes baseline, background, sensor drift, latency, and heading corrections.

Each sensor platform has a fixed geometry that requires correcting to accurately position geophysical sensor data. This processing step uses the configuration geometry to project the positional data to that sensor.

Each site has conditions that affect the geophysical instruments and the effect is seen as a constant offset. To correct for this site specific bias, filtering techniques remove the bias and bring the data to a common background.

Geophysical instruments, such as the EM61, drift over the course of the day. This drift is a function of temperature and battery voltage supplied to the instrument's electronics. HDR will evaluate the data and apply drift correcting filtering to level data to a zero background.

When data spikes are numerous, this indicates a problem with the instrument. Sporadic data spikes are typical and usually happen infrequently. Running a spike rejection function removes data points that resemble spikes.

Occasionally, survey lines overlap. Typically, this is not a big problem, but when performing advanced target analysis data overlapping data could become problematic. Any overlapping data creating problems with the analysis will be removed.

The Remove Backtracks processing steps removes any data that has a retrograde motion. When the platform stops moving, small errors in positioning are magnified by the configuration lever arms, which leads to noisy data. These data will be manually removed from the data.

There exist inherent timing issues when collecting asynchronous data streams from various unrelated instruments. Latency corrections prevent misshaped anomalies. To resolve these timing problems, the issue will be evaluated and corrected on a case by case basis using the lag correction tool within Oasis Montaj.

The Data Processor will identify geophysical data noise and apply appropriate filtering techniques available in Oasis Montaj to remove the noise. These techniques use special algorithms implementing temporal and/or spatial channels to strip noise from the data. Noise sources include geology, excessive sensor motion, temporal effects caused by drifting power, and high gradient areas. If data filtering is not successful, the data processor will mark the area for recollection. All filtering will be described and documented in the Daily Summary Report.

To convert the data into an image map, an interpolation algorithm will convert the XYZ data into an evenly spaced grid image. The interpolation algorithm will be Oasis Montaj minimum curvature. The data processor will review the grids to determine the completeness and accuracy of prior data manipulation steps.

The Project Geophysicist will select color distribution levels (thresholds, min/max) that accentuate the anomalies of interest.

3.4.9 Advanced Data Processing and Enhancement

Geophysical data sets may require additional processing to extract the maximum amount of information about subsurface targets. Oasis Montaj has a series of filters and tools that may be used to enhance the data or aid in anomaly selection. These tools include non-linear filtering, decay rate, signal size/strength and noise computations. HDR may employ these techniques to remove noise caused by clutter. A trained operator uses the processing software to identify the more subtle anomalies. All data filtering and processing will be described in the Data Processing Log.

3.4.10 Anomaly Selection and Decision Criteria

The Project Geophysicist will assess each of the following factors prior to generating an anomaly list:

- Geophysical response (magnitude and area) of the Smallest Munitions of Concern (SMC) and anomalies detected above noise levels. The SMC for PACR is a 37mm projectile.
- The local background conditions, such as magnetic gradients, geology
- Data completeness, quality, and accuracy
- Field notes and observations
- Proximity of utilities and/or other cultural features
- The specific MEC item(s) for a given area and their geophysical response as modeled using the NRL EM61-MK2 Response Calculator.

For the Direct Fire Impact Area, the expected ordnance types and their burial depths are unknown. Therefore the data will be analyzed to the noise level. The noise level is determined by computing the mean and standard deviation for the data, and applying the following formula: Noise threshold = mean + 3 × standard deviation, for example if the noise = 1 mV and the standard deviation is 2 mV the noise threshold is 7 mV. All anomalies that meet this threshold will be selected. The noise levels are computed from statistics of a subsection of the transect line. This subsection is chosen at the discretion of the data processor and multiple subsections may be used depending on the localized geophysical response. Anomaly selection will use a summation of the 4 time channels from the EM61-MK2.

Additional anomaly characteristics may be calculated for each anomaly. Additional anomaly discrimination criteria may include:

- Decay Curve – The rate of signal decay between the time channels;
- Signal-to-Noise Ratio – How strong the signal is relative to the noise;
- Signal Strength – The value of the summation of the signal above the threshold within a defined polygon; and
- Spatial Extent – The area of the response above the threshold.

During the QC process, anomalies may be deleted for various reasons. Anomaly locations outside of the site boundaries or sources due to known cultural features are a few reasons for removing anomalies from further investigation. Based upon the anomaly's profile and gridded image, targets that look like noise spikes may be removed. In some cases, anomalies that are less than 2.5 ft. (0.75 m) apart may be merged and presented as a single anomaly.

The Data Processor will perform an automatic anomaly selection using the 1-D profile data. Anomaly threshold values are determined by the site-specific MEC and modeling using the NRL EM61 response calculator. Anomalies selected by this process are quality controlled by the Data Processor. A review of time decay profiles, raw data, and 1-D data profiles will augment the selection of suspect and/or low amplitude anomalies. During inspection of the data in profile form, the Data Processor looks at the decay response exhibited by each anomaly. The response exhibited by a valid anomaly normally has its highest response at the earliest time in the measurement period (Channel 1) and decays to its weakest response at the latest time (Channel 4).

3.4.11 Anomaly Detection

The quality objective regarding anomaly detection is to minimize the number of costly false alarms and dangerous false negatives. After the data processor selects anomalies, using an automated process and/or manual picking, the QC geophysicist checks the anomaly list for completeness and accuracy. QC will add any anomalies missed during the initial picking phase or remove anomalies from the target list because they do not meet the target criteria or are the product of some cultural feature. After finalizing the list, the QC geophysicist initials and dates the list. The Project Geophysicist reviews the target lists prior to delivery for completeness and accuracy.

3.4.12 False Alarms

A false alarm occurs when an identified anomaly is incorrectly selected as a possible target when no object is present. In essence, a false alarm is an empty hole. False alarms result from geologic conditions, low signal to noise ratio (SNR), platform motion, personnel error, and/or data processing. False alarms can also result from faulty positioning equipment. HDR minimizes false alarms by the use of the best available geophysical practices executed by qualified geophysical staff.

3.4.13 False Negatives

A false negative occurs when a target is not detected. This may result from either a failure of the geophysical instrument to detect a response or a response was not identified during data processing. Additional causes for false negatives include operator error, instrument error, or positioning inaccuracy. Data processing QC procedures mitigate false negatives resulting from processing, while the equipment tests described earlier in this document minimize the chance of undetected instrument problems.

3.4.14 Digital Geophysical Mapping Data Quality Objectives

Table 3-5 outlines the RI data collection specifications. **Table 3-6** lists the DGM DQOs for geophysical surveys conducted by HDR.

Table 3-5 Data Collection Specifications

Metric	Push-Cart or Litter Platform
Survey Speed	3.2 ± 0.6 ft./s (1.0 ± 0.2 m/s)
Down Lane Spacing	0.26 ± 0.06 ft./s (0.08 ± 0.02m)
Across Lane Spacing	75 ft. (20 m) +/- 10 ft. (3m)*
Background Noise	Less than 2.5 mV peak to peak on each channel
Signal-to-Noise Variance	4 mV
Spatial Accuracy	RTS: < 3.3 ft. (1.0m) GPS: < 3.3 ft. (1.0m) Fiducials: < 2.3 ft. (0.7m)

Notes:
m/s = meters per second
ft. = feet
m = meters
*The PACR site contains significant vegetation and terrain obstacles. There may be areas that contain unsurveyable features or obstacles that must be navigated around. The metrics presented will be applied to areas where access is possible.

The table below outlines the DQOs for the geophysical surveys.

Table 3-6 Digital Geophysical Data Quality Objectives

Data Quality Objective	Test Method	Measurement Performance Criteria
Equipment warm-up (minimum 15 minutes)	A power on, conduct real time monitoring of EM61-MK2 instrument readings. Data is not recorded; this will be a visual check by the field team prior to starting calibration tests.	Drift of less than 3 mV over 3 minutes
Repeatable static data are being obtained from the DGM system	At the beginning and end of day, conduct a static background and spike test for each coil. Data will be collected for at least 60	Less than 2.5 mV peak to peak for static background, spike ±10% of standard item response after background corrections

Table 3-6 Digital Geophysical Data Quality Objectives

Data Quality Objective	Test Method	Measurement Performance Criteria
	seconds for each test.	
Prevent noise related to loose pins or cable connectors	At the beginning of the day, conduct a cable shake test. Each cable will be tested for at least 5 seconds while monitored by the sensor operator.	Less than 2.5 mV peak to peak
Ensure instrument operators are not carrying any metallic objects that can interfere with the EM61-MK2 readings	At the beginning of the day, conduct a personnel test (applicable to single coil cart systems only).	Less than 2.5 mV peak to peak
Position of GPS is accurate	At the beginning of the day, the GPS unit's position will be compared with a known point during a point position test. Positions will be recorded for at least 60 seconds.	Within 10 cm of known values for point position test. Only positions with a PDOP below 4 and RTK fix value of 3 will be accepted for DGM. Brief spikes of PDOP below 6 may be accepted in limited cases
Repeatable dynamic data are being obtained from the DGM system	At the beginning and end of the day, the geophysical instruments will collect data over an IVS. The IVS will contain enough ISOs such that each sensor will see a spike individually.	± 25% of prior response; position of anomalies repeatable within 10 cm
Positioning of detected anomalies is accurate	Anomalies selected will be compared with known seed item locations to ensure compliance.	100% of all anomaly locations lie within a 3-6 ft. (1-2m) radius of a point on the ground surface directly above the source of the anomaly. For seeds outside of the 3-6 ft. (1-2m) radius, a corrective action will be conducted to determine the appropriate amount of failed data.
Density of down-line density is sufficient to detect MEC items	Results of DGM surveys will be evaluated to ensure compliance.	100% of the data will not exceed 0.5 ft. (0.15m) except for areas that are unsurveyable because of cultural features. Lot size is the survey file.
Survey coverage is sufficient to meet project objectives	Results of DGM surveys will be evaluated to ensure compliance.	Transect line gaps will not exceed 10 ft. (3 m) for distances > 13 ft. (4 m). Lot size is the survey file.
Consistent detection of blind seed items during dynamic survey	Transects with fixed RTK GPS coverage will be seeded with ISOs and surveyed by geophysical personnel.	95% of the ISOs will be detected. Any misses will results in a root cause analysis and may result in a resurvey of all or a portion of the transect.

Notes:
PDOP = position dilution of precision
GPS = global positioning system
DGM = digital geophysical mapping
ISO = industry standard object
IVS = instrument verification strip
The PACR site contains significant vegetation and terrain obstacles. There may be areas that contain unsurveyable features or obstacles that must be navigated around. The metrics presented will be applied to areas where access is possible.

3.4.15 Corrective Measures

Specific corrective measures are dependent on the type of geophysical equipment used during an operation and will be developed on a site-specific basis. However, the following are the basic corrective measures HDR employs for digital geophysical mapping:

- Replacement of geophysical or positioning sensors or components if they fail to meet calibration requirements;
- Resurvey areas when data quality specifications are not achieved;
- If the QC process identifies an excessive number of missed anomalies, data spikes or other processing errors, the whole survey day's data shall be returned to the processing geophysicist to be re-processed; and
- Basic corrective measures will be implemented as part of day-to-day activities (i.e., replacing faulty equipment).

If unusual or serious problems occur that cannot be addressed using the steps outlined above, HDR will immediately notify USACE personnel so that issues can be resolve quickly and do a formal root cause analysis, if necessary. Determination of an appropriate remedy will be carried out in coordination with the appropriate USACE personnel. Any data negatively impacted will be recollected by HDR at no cost to the client.

3.4.16 Geophysical Data Management

The geophysical data collected is processed, analyzed and stored using Geosoft Oasis Montaj, which interfaces with the existing installation GIS. Geosoft databases will be located on a network storage device that will be backed up as part of the corporate disaster recovery plan.

The surveys conducted at the site will contribute to a clear, complete, and defensible site report. The report shall contain all geophysical data (raw and processed), description of processing procedures, maps, reports, field sheets, databases, and all other ancillary data used to develop the geophysical results.

Finalized DGM data will be transmitted to the USACE as an internal QC check 30 days after completion of survey activities, along with a letter of transmittal conveying explanations and pertinent information. The data submittal will include maps, QC reports, summaries, and supporting data.

The data will be presented in delineated fields as X, Y, Z1, Z2, Z3…, where X and Y are UTM Zone 10N coordinates and Z1, Z2, Z3… are the instrument readings. Data deliverables and figures will also be provided is in the Washington State Plane, North Zone Coordinate System, U.S. survey feet, NAD83 Datum. Each of the fields will be separated by a space or comma. A "*read me*" file will accompany the transmittal that specifies the data channels and measurement units. Final versions of DGM-related field logs and the digital documentation for the QC tests and data processing logs for each data acquisition session will also be provided.

Data delivered to the client during the DGM field program will adhere to the formats and timelines specified in Sections 4.0 and 5.0 in DID MMRP-009-04 (USACE, 2009a). Digital maps of the DGM data collected for the project will be prepared as part of the final deliverable. These maps will reflect the current MRS conditions when the DGM survey was performed. Geosoft Oasis Montaj or ArcView format GIS maps will be provided including the locations of all anomalies and any sampling results superimposed on a color-coded image of the DGM data.

3.4.17 Deliverables

Raw geophysical data will be available from an ftp site within 36 hours of data collection. All geophysical data will be available from an ftp site for independent review one week after collection. Data files will contain raw and processed data results. The data will be translated into the project coordinate system if the system differs from the default coordinate system. A header is included with each file that defines the contents of each data field.

The XYZ file format is an ASCII file with space delineated fields of T, X, Y, Z, V1, V2, … where X and Y are in project coordinates for easting and northing and elevation is the instrument elevation, T is the time of the reading and V1, V2, … are the geophysical readings. Each grid of data follows a naming scheme so that the file name correlates with the grid name used by other project personnel.

A digital map of each MEC removal grid is available one week after data collection (including rework fill in). These PDF maps generated by ArcGIS or Oasis Montaj will include the locations of all targets and excavation results. Geophysical image maps will provide the geophysical data for each grid displayed in color with overlaid target data.

Field notes, and geophysical reports will be available for client review one week after data collection (including rework fill in) depending on the report and the availability of data. A Readme file will be included with the deliverables.

At the conclusion of the project, a report will detail all steps of the activities conducted on site and contain maps and target lists in a tabular format. A data CD or DVD containing all the project data (dig lists, field reports, and survey data) and digital copies of all the maps will accompany the report. The report will be in Microsoft Word format and tabular data will be in Microsoft Excel format.

3.5 Geospatial Information and Electronic Submittals

The Geospatial Information and Electronic Submittals plan is used to describe the methods, equipment, and accuracy for conducting location surveys and mapping during the PACR RI, and the subsequent development of the project GIS databases to support the mapping and document production process. This section was drafted using the general instructions outlined in *DID MMRP-09-007.01, Geospatial Information and Electronic Submittals* (USACE, 2009b).

DGM activities will be performed as part of the PACR RI. All geospatial data generated during the course of this project will be incorporated into the project GIS.

3.5.1 Munitions and Explosives of Concern Tracking

Personal data assistants or other electronic data interface instruments will be used to record and track MEC, MD, and other metallic items as warranted that are identified during the course of the RI activities. The instruments will be populated with the DGM anomalies selected for reacquisition. UXO Teams will be able to link the DGM anomaly with the dig results electronically, in real-time, while in the removal grid. In addition, the instruments have the capability of recording the type, weight, size, and other characteristics of MEC, MD, and other metallic items observed. The northing and easting locations of all evidence of MEC will be recorded and tracked.

3.5.2 Accuracy

Semi-permanent and permanent control monuments established by a licensed Washington State surveyor will be of Class I, Third Order accuracy relative to the NAD 83, 2011 realization datum.

3.5.3 Geographic Information System Incorporation

Geo-referenced information generated during the course of the project will be incorporated into the project GIS. The project GIS will be used for map development and progress tracking. The project GIS will be used to quickly plot MEC locations and determine the most appropriate minimum separation distances (MSDs) for demolition activities.

3.5.4 Mapping

Data will be collected in UTM Zone 10 meters. Data deliverables and figures will be provided is in the Washington State Plane, North Zone Coordinate System, U.S. survey feet, NAD83, 2011 Realization Datum.

3.5.5 Computer Files and Digital Data Sets

All GIS files will be compatible with ArcGIS. Data will be available electronically on CD or DVD upon request and submitted with the Final RI/FS Report.

3.5.6 Accountability and Records Management

HDR will maintain a detailed accounting of all MEC items encountered. Data from the assisted visual surveys and intrusive investigations will be entered in the GIS database and included in the RI Report. The database will track all anomalies investigated and all surface and subsurface MEC recovered.

Data collected regarding MEC found will include the standard official nomenclature (defined by U.S. Army Technical Manuals), condition of the item, depth located, the orientation of item, location coordinates, and final disposition. A digital photograph of each type of MEC item and significant/unusual items recovered during the intrusive investigation will be taken and entered into the GIS database.

MD will be tracked in the database as well as the number and type of intact, inert munitions if any are discovered. The items shall be documented from the munitions and range debris turn-in procedure and documented in the final report.

3.6 Management of Material Potentially Presenting an Explosive Hazard

All items discovered are initially considered material potentially presenting an explosive hazard (MPPEH). After inspections by qualified UXO personnel, MPPEH items will be further segregated into the follow categories:

- **MEC** - Munition items determined to contain an explosive hazard and require disposal by detonation. Disposal can be accomplished by blow in place (BIP) or consolidated shots. Refer to **Section 3.6.2** for specific disposal procedures.
- **MD** - Munition items determined to be free from explosive hazards. Upon re-inspections, MD items will be certified as MDAS and secured for final disposition and demil.
- **RRD** - Munitions packing material, target debris. Items identified as RRD will not be managed during this investigation.
- **MDAS** - The management and disposition of MDAS will be performed in accordance with DoD Instruction (DODI) 4140.62 (DODI, 2004). The closed circuit process discussed in this section that maintains a chain of custody from collection through release from the DoD as MDAS will be used. Because MDAS will ultimately be disposed of off-site, it is imperative that MDAS be segregated and secured in a manner which prevents tampering or comingling with no certified MDAS items. This approach is designed to ensure that all MDAS is 100 % independently inspected and then 100 % re-inspected as part of the certification and verification process.
- **Debris** - Non-munitions related debris will not be managed during this investigation.

3.6.1 Munitions and Explosives of Concern Storage

There will be no anticipated MEC storage on site. All MEC items found will be disposed of in consolidated shots or BIP if items are unacceptable to move. Any items that cannot be disposed of on the day it was found will be safe guarded until disposal can be accomplished. No MEC will be left unattended. Further, all MPPEH identified during the course of the project will be guarded until proper disposal is accomplished.

3.6.2 Munitions and Explosives of Concern Disposal

The contractor will be responsible for destroying MEC or MPPEH encountered during the investigation. The following details how MEC disposal will be accomplished:

- **BIP -** Blow in place demolition procedures will be used when MEC items are deemed unsafe to move by the SUXOS and UXOSO.

- **<u>Consolidated Demolition Shots</u>** - Consolidated shots will only be used during disposal operations that do not require engineering controls and items have been verified as safe to move by the SUXOS and UXOSO. There are no planned or established demolition areas at the site. Donor explosives to be used for MEC demolition will be delivered to the demolition location from the on site explosive storage magazine.
- **<u>Engineering Controls</u>** - If employed, single item intentional detonations that require engineering controls to mitigate the effects of blast and fragmentation will be conducted in accordance with HNC-ED-CS-S-98-7, "*Use of Sandbags for Mitigation of Fragmentation and Blast Effects Due to Intentional Detonation of Munitions*" dated August 1998 (USACE 1998a), USACE safety advisory dated July 12, 2010 (USACE 2010), DDESB Memorandum "*Clarifications Regarding Use of Sandbags for Mitigation of Fragmentation and Blast Effects Due to Intentional Detonation of Munitions*" dated November 29, 2010 (DDESB 2010), or DDESB TP-16 Chapter 6, Buried Explosion Module (BEM) Procedures (DDESB, 2010), as applicable, to reduce MSDs for intentional detonations. Copies of these documents will be available on site.

3.6.3 Venting

Venting of MPPEH items will be performed to expose the inner filler, verify the filler is inert, and open any portions of an item that cannot be fully probed or visually inspected. MDAS items that have a ballistic shape will also be vented mechanically or explosively to ensure the item is unrecognizable as a munition prior to final disposition.

3.6.4 Munitions with Greatest Fragmentation Distance and Minimum Separation Distances

Table 3-9 provides the MGFD and the calculated fragmentation distances for the MGFD expected at the PACR. The fragmentation distances are specified in the Explosive Site Plan.

<u>Unintentional Detonations</u>

The MSD for unintentional detonations is the distance non-project personnel must maintain from intrusive operations. The MSD will be the hazard fragment distance (HFD) for the MGFD. All UXO Teams will be separated by the K40 distance of the MGFD indicated in **Table 3-7**.

<u>Intentional Detonations</u>

The MSD for intentional detonations is the distance all personnel must maintain from the BIP detonation or consolidated detonation site, and will be based on the greatest of the fragmentation and blast overpressure distances as follows:

The maximum fragmentation is distance of the specific munitions being detonated.

The blast overpressure distance of the munitions according to the following formula:

K (NEW) 1/3
Where:
K = the K-factor (328 for intentional detonations).
NEW = the net explosive weight in pounds (including the donor charge).
200- ft. minimum (per DoD 6055.09-M, paragraph V5.E3.2.2.1).

The MSD for intentional detonations when conducting munitions disposal operations is identified in **Table 3-9**.

Table 3-7 Munition with Greatest Fragmentation Distance

MEC	MSD (ft.)			
	For Unintentional Detonations		For Intentional Detonations	
	HFD	K40	Without Engineering Controls	Using Sandbag Mitigation
81mm Mortar M43A1	209	43	1579	200

Notes:
ft. = feet
MEC = munitions and explosives of concern
MSD = minimum separation distance
HFD = Hazard Fragmentation Distance

3.6.5 Demolition Procedures

MEC disposal activities will be supervised by the SUXOS, and conducted using qualified UXO personnel who meet the requirements of TP-18 (DDESB, 2004). All explosive operations will follow the procedures outlined in USACE Engineer Manual, USACE EM 385-1-97 (USACE, 2013) (and Technical Manual (TM) 60A-1-1-31 (DoD, 2008).

Detonations will be scheduled by the SUXOS, in consultation with the USACE Ordnance and Explosives Safety Specialist (OESS) if on site, based on weather and logistical considerations. If an OESS is not available on site the Lead OESS at the USACE Omaha Military Munitions Design Center will be consulted. Detonations will occur only after all personnel have left the area (based on the MSD for intentional detonation) and road guards have been posted as instructed by the SUXOS. During hook-up procedures, a designated project vehicle will remain in the area to provide emergency egress for the demolition team.

The SUXOS (or his designated assistant) shall make notification of detonations (provided in **Appendix D**). The composition of the demolition team will be determined by the SUXOS. The team will be composed of only UXO technicians under the direct supervision of the SUXOS or a designated UXO TL. Other personnel will provide perimeter security.

Only the demolition team, SUXOS, UXOSO, UXOQCS, and the on-site USACE OESS (if available) will be permitted in the area where charges are being assembled and demolition operations are being conducted.

All consumed demolition materials will be accounted for using an explosives consumption report. This report is generated and signed by the SUXOS. Only the estimated amount needed to complete the day's demolition operations will be withdrawn from the magazine and transported to the demolition site (Refer to **Section 5.0**).

Demolition of all MEC items will be photographed with a digital camera prior to and after firing of the shot, and the photograph(s) will be saved electronically for the Report. After each detonation, the detonation points and general demolition site will be inspected by the SUXOS with a safety observer to ensure that a misfire, low order, or kick out has not occurred. The area where demolition operations are being conducted will remain guarded until the SUXOS gives the "*all clear*". Any craters caused by disposal shots will be restored using displaced soil as backfill. These disturbed locations will also be restored using a native seed mixture (refer to **Section 6.3.7**).

3.6.6 Material Potentially Presenting an Explosive Hazard

Material Potentially Presenting an Explosive Hazard inspection procedures will ensure that the items collected will be properly inspected and classified. The method includes three distinct inspections, which will be performed by persons of increasing levels of responsibility. The UXO Technician will perform the first inspection at the operating grid; the UXO Technician III responsible for the operating grid or transect will perform the second; and the final inspection/certification will be performed by the SUXOS and the process verified by the OESS (if on site). The certification and verification process will be documented utilizing DoD Form 1348-1A. In the absence of an OESS, the UXOQCS may be utilized to verify the inspection. The process is shown in **Figure 3-15** and includes:

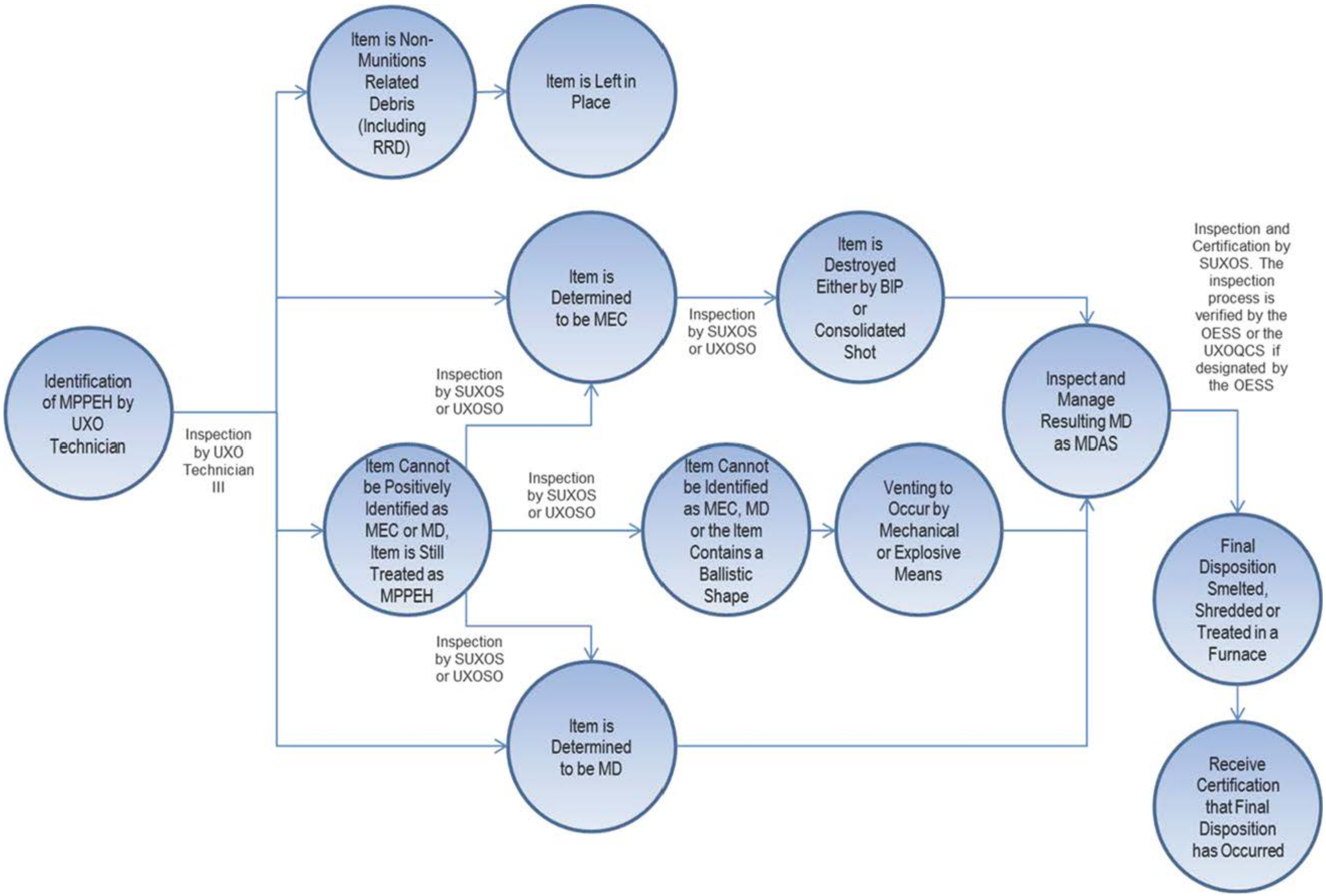
- The UXO Technician II or higher will perform a 100 % inspection of any MPPEH and determine if the item is a MEC or MDAS (i.e., DMM, MD range related debris or cultural artifact).
- The UXO TL will perform a 100 % independent inspection (re-inspection) of any MPPEH to determine if free of explosives hazards or other dangerous fillers.
- All items identified as MDAS will be segregated and securely stored in lockable containers until it can be shipped to a scrap yard for disposition and demil. All MDAS will be collected in a centralized, secured area pending re-inspection and will be segregated from other metallic debris.
- MPPEH identified as MEC will be managed in accordance with **Section 3.6.2** for MEC Disposal.
- The UXOQCS will conduct daily audits of the procedures performed by UXO teams.
- The UXOSO will ensure the specific procedures are being performed safely and consistent with applicable regulations.
- The demilitarized and inspected MDAS will be placed into a sealed container with completed DoD Form (DD Form) 1348-IA, Issue Release/Receipt Document or equivalent, attached. The following statement will be included on the form:

"This certifies and verifies that the material listed has been 100% inspected and to the best of our knowledge and belief, are inert and/or free from explosives or related materials."

- The SUXOS will sign the form as the certifier and the UXOQCS will sign as the verifier.
- This DD Form 1348-IA will be maintained as a chain of custody until the MD reaches final disposition. The DD Form 1348-IA will be signed by the recycling vendor upon receiving the MDAS. The recycling vendor will provide documentation on company letterhead stating that the contents of these sealed containers will not be sold, traded, or otherwise given to another party until the contents have been smelted, shredded, or treated in a furnace and are only identifiable by their basic content. Once the munitions related scrap is smelted, shredded, or treated in a furnace, the recycling vendor is required to send follow-on documentation indicating the material is now only identifiable by their basic content.

At the end of each day, the UXO TL will submit daily reports that quantify the materials encountered throughout the day. This information will be included in the SUXOS' Weekly Report and tracked for disposal estimating and demolition planning purposes. MPPEH will be tracked from cradle-to-grave, whether final disposal is by demolition or if certified as MDAS after inspection procedures have been performed.

Figure 3-15 Material Potentially Presenting an Explosive Hazard - Inspection Process



3.7 Investigative Derived Waste Plan

The section describes the handling of investigative-derived waste (IDW) that is expected to be generated during the RI activities planned at the PACR FUDS MRS. The handling of IDW will follow the methods outlined in DID MR-005-13, IDW Plan (USACE, 2003e). Minimal to no hazardous waste is anticipated for this project. Environmental media and solid waste will be contained separately. For the environmental media, unsaturated soils will be segregated from saturated soils. For solid waste, decontamination fluids will be containerized separately from expendable solid waste debris. Non-munitions related scrap could be generated during intrusive investigations. Characterization and classification of the different types of IDW will be based on the specific protocols described below:

- **Soils and Dry Sediment**: Excess surface soils and dry sediment with expected contamination from MC (i.e., any soil that remains from a sample collected for MC analysis) will be placed in 55-gallon steel drums, plastic lined and sealed with gasket ring-topped lids. Disposition of the drummed soil will be based on analytical results from the environmental samples or from direct results of composite IDW samples. The volume of material collected is expected to be low.
- **Groundwater Purge Fluids:** Groundwater sampling is not currently anticipated. However, in the event that any samples are required the purge water will be collected and disposed in compliance with the IDW Plan. Any required analysis, disposal permits, and documentation will be completed.
- **Decontamination Fluids: Decontamination fluids** will be placed in steel or polyethylene drums. Disposition of decontamination liquid will be based on the analytical results of composite grab samples from the containers.
- **Expendable Waste Debris**: Expendable waste debris, including non-ordnance related scrap metal, will be segregated as non-contaminated and potentially contaminated material based on visual inspection, use of the waste material and field screening using field screening instruments. Scrap metal will be placed in secure storage container for off-site recycling or disposal. Expendable waste debris considered to be non-contaminated (PPE, disposable sampling equipment, and miscellaneous trash) will be placed in trash bags and stored in sanitary waste containers whereas potentially contaminated expendable waste will be containerized in 55-gallon steel drums, plastic lined and sealed with gasket ring-topped lids. Disposition of expendable waste debris will be based on correlative results of the environmental samples submitted for laboratory analyses.

All containerized environmental media and solid waste will be labeled. Label information on each container will be written in indelible ink and will include at a minimum: container number, contents, source of the waste, source location, project name, and MRS identification, physical characteristics of the waste, and generation dates. Each label will be placed on the side of each container at a location that will be protected from damage or degradation.

3.7.1 Investigative Derived Waste Field Staging

Minimal to no hazardous waste is anticipated for this project. Central field staging areas (FSAs) will be coordinated with the applicable stakeholders prior to generating waste. All waste shall remain on the FSAs until it has been characterized for disposal. The FSAs will be visibly identified with signage and the drums/containers will be covered with poly sheeting or tarps if the FSAs are in an open location.

Decontamination fluids (if warranted) will also be staged at the identification location within secondary containment structures. To avoid potential drum rupture due to freezing conditions, drums containing liquid IDW will be filled only to 75% capacity.

3.7.2 Investigative Derived Waste Disposal

All waste determined to be 'non-hazardous, contaminated' or 'hazardous, contaminated' will be disposed off-site at a permitted waste facility. Non-contaminated expendable waste debris will be disposed as sanitary trash. Potentially contaminated expendable waste debris will be disposed similar to the associated waste under which it was generated.

If generated waste (soils, groundwater, and/or dry sediments) are identified with concentrations below the human health and ecological screening criteria presented in the UFP-QAPP in **Appendix E** and background concentrations, they may be placed back at the site at which they were generated following approval from the USACE, landowner and applicable stakeholders. If soil or dry sediment is placed back at a site, it will be graded and stabilized with a native grass seed mix prior to completion of the project. Refer to **Section 6.2.7** for native seed mixture specifics.

All MPPEH will be managed as described in **Section 3.6.2**.

3.8 Vegetation Clearing

Widespread vegetation removal is not anticipated for the RI. Areas where DGM activities may be conducted may be overgrown with high grasses, thick vegetation, debris, and low tree limbs (less than 6 ft. above the ground). Depending on the time of year, minimal clearing/trimming of this vegetation may be required to allow for the performance of the geophysical survey and sampling activities. Any vegetation clearing/trimming activities at these locations will be minimized to the extent possible to allow for the execution of work. Coordination with the USACE and landowners will occur prior to performing work and any vegetation disturbance during the ROE process. Ground level vegetation may be mowed as necessary so personnel and equipment can safely access the designated sampling locations. Only vegetation that impedes or interferes with the safe and effective implementation of the project will be cleared.

3.9 Site Control

Prior to initiating any intrusive activity to investigate a detected anomaly, an exclusion zone (EZ) will be established which encompasses the excavation. The EZ radius will be effective at the point of the intrusive activity based on its location and will move accordingly as the operation progresses.

Only personnel directly involved with the subsurface investigation operations will be authorized unescorted access in the EZ. All excavation activities will cease immediately if unauthorized personnel enter the EZ. Access control is maintained by placement of security personnel around the work site as it moves.

The following safety precautions are applicable to all MEC that may be encountered during field activities described in Section 1.2, Scope of Work and follow guidelines established in *EM 385-1-97, Explosives Safety and Health Requirements Manual* (USACE, 2013).

Consider MEC items, which may have been exposed to fire and detonation, as extremely hazardous. Chemical and physical changes may have occurred to the contents, which might render it more sensitive than its original state:

- Do not rely on the color coding of MEC for positive identification.
- Suspend all operations immediately upon approach of an electrical storm.
- Observe the hazards of electromagnetic radiation precautions and grounding procedures when working with, or on, electronically initiated or susceptible MEC.
- Do not dismantle, strip, or handle any MEC unnecessarily.
- Avoid inhalation and skin contact with smoke, fumes, dust, and vapors of detonations.
- Do not attempt to extinguish burning explosives or any fire that might involve explosive materials.
- Do not manipulate external features of ordnance items.
- Ensure appropriate procedures and personnel protective measures are implemented during MEC operations.
- Do not subject MEC to rough handling or transportation.
- Avoid approaching the forward area of an UXO item until it can be determined whether or not the item contains a shaped charge.
- Assume that practice munitions contain a live charge until it can be determined otherwise.
- Avoid unnecessary movement of armed or damaged MEC.
- Avoid the forward portions of munitions employing proximity fuzing.
- Assume unknown fuzes contain cocked strikers or anti-disturbance features;
- Non-UXO personnel will not perform any activities without a UXO qualified individual with them.
- MEC survey and handling operations will only be performed during daylight.

While on-site, the UXO Technician III will have a cell or satellite phone capable of communicating emergency notifications if applicable. All UXO Technicians will maintain line-of-sight contact with each other at all times and with other field workers during MEC operations.

3.10 Human Health Risk Assessment

A baseline human health risk assessment (HHRA) will be performed if environmental data are collected for MC analysis during the RI. It is unlikely that MC samples will be collected, thus negating the need for screening or quantitative risk assessments, in which case, a qualitative discussion will be provided. The purpose of the HHRA is to determine if contamination in environmental media pose unacceptable risks to human receptors.

The baseline HHRA consists of an initial COPC screening (**Section 3.10.1.3**) and if the screening indicates it is necessary, a quantitative HHRA (**Section 3.10.2**). The purpose of this initial COPC screening is to identify COPCs that might be associated with MEC and MC during the RI effort. Munitions constituents will be evaluated for their potential to cause unacceptable risks to human receptors if a potential source item consistent with **Section 3.1.11.1** is located.

3.10.1 Screening-Level Human Health Risk Assessment

A screening-level HHRA will be performed if environmental sample data are collected during the RI as a result of MEC or small arms being located during the field investigation and if there is an identified MC source.

The HHRA for the PACR MRS will be conducted in accordance with USEPA's Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989) and Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, 2002).

A screening-level HHRA typically consists of evaluation of COPCs in media to which human receptors may be exposed. Maximum detected concentrations (MDCs) of chemicals are compared to risk-based screening levels by medium (**Section 3.10.1.3**). In addition, analytical laboratory reporting limits (RLs) and method detection limits (MDLs) for chemicals are also compared to screening levels to ensure that contaminants are not underestimated when not detected.

3.10.1.1 Data Evaluation and Usability

A 100 % data review will be conducted on all laboratory data for compliance with QA/QC requirements contained in the UFP-QAPP (**Appendix E**). In addition, at least 10 % of the laboratory data will be fully validated to Level IV. Reporting limits and method detection limits (MDLs) will be compared to HHRA screening values to ensure they do not exceed the screening values. If a screening value is less than the MDL or RL for an analyte, each such occurrence will be addressed as a source of uncertainty. Those chemicals will be retained for further evaluation. Soil data will be segregated by surface (0-6" bgs) and subsurface (> 6" bgs) intervals for risk assessment purposes. No "*R*" (rejected) data will be used in the risk assessment.

3.10.1.2 Summary Statistics for Environmental Data

Summary statistics will be generated by medium for the PACR MRS (i.e., number of samples, detection frequency (DF), minimum and maximum detected values, and minimum and maximum RLs) for all chemical data to be evaluated in the risk assessment.

3.10.1.3 Initial Screening for Contaminants of Potential Concern

A screening-level HHRA consists of an initial screening for COPCs where screening hazard quotients (HQs) are calculated (**Section 3.10.2.3**). The need for calculations of intakes and hazard quotients (HQs) and hazard indices (HIs) for each pathway and receptor is determined following the initial screening for COPCs.

USEPA has developed risk-based Regional Screening Levels (RSLs) for residential and industrial scenarios to differentiate areas that do not require further evaluation from contaminated sites that require further evaluation and a complete baseline risk assessment. The most recent RSLs (May 2013) are included in USEPA's website "*Regional Screening Levels for Chemical Contaminants at Superfund Sites*", available at: http://www.epa.gov/region9/superfund/prg/ (USEPA, 2013). As a conservative measure, initial COPC screening will be conducted with residential soil RSLs. Screening hazard quotients (HQs) will be provided which represent the MDC divided by the RSL. To address multiple COPCs at a location, the RSLs for residential soil will be divided by 10 and COPC screening will also be conducted using the $1/10^{th}$ residential soil RSLs.

The potential for MC migration to groundwater will be assessed during the field investigation. If groundwater samples are collected, the RSLs for migration to groundwater will be used for comparison to soil concentrations where depth to groundwater is likely shallow (<20 ft bgs). The minimum value based on the Migration-to-Groundwater RSL will be used to screen soil data where depth to groundwater is likely shallow (<20 ft bgs). At other soil locations, the residential soil RSL and the Residential Soil RSL (1/10th) will be used for COPC screening.

3.10.1.3.1 Evaluation of Essential Nutrients and Common Laboratory Contaminants

This evaluation is not applicable since neither lead nor explosives are considered essential nutrients nor are any of the MC considered common laboratory contaminants.

3.10.1.3.2 Evaluation of Detection Frequency

USEPA RAGS Part A, Volume I (USEPA, 1989) suggests an evaluation of DF when at least 20 samples for a specific medium are available. Chemicals with a detection frequency (DF) of 5% or more are retained as COPCs or proceed into COPC screening.

COPCs which exceed a conservative RSL or other HHRA screening level and are detected at less than 5% DF will be screened from further evaluation in the HHRA provided there are at least 20 samples while considering other criteria as shown in **Figure 3-16**.

MDCs will be identified for each chemical by location, medium, and depth. MDCs will then be compared to residential soil RSLs or other HHRA screening values (e.g., surface water or soil migration to groundwater). If the MDC does not exceed the HHRA screening value, then the chemical will be eliminated as a COPC[1]. Chemicals that exceed the RSL or $1/10^{th}$ the RSL for

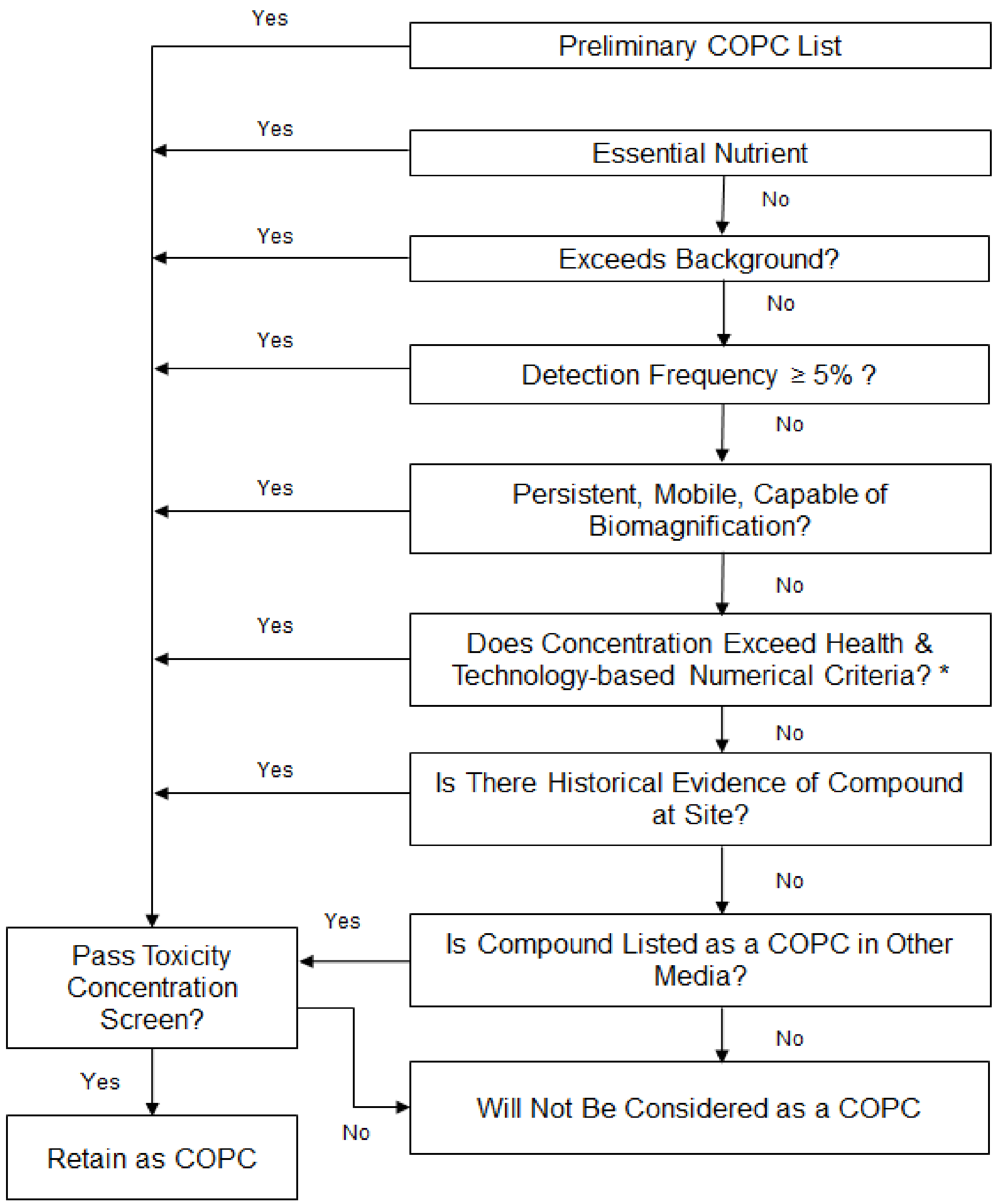
[1] If the maximum concentration does not exceed the HHRA screening value, it is not necessary to also compare a UCL95 to the screening value. The reasons for this are (1) when the maximum concentration does not exceed the screening value and the UCL95 value is LOWER than the maximum detected value, then the UCL95 will also not exceed the screening value, and (2) when the maximum concentration does not exceed the screening value and the UCL95 is HIGHER than the maximum detected value, then the maximum detected value, rather than the UCL95, will be used for comparison to the HHRA screening value.

residential soil will be retained for further evaluation in the quantitative HHRA (**Section 3.10.2**). RLs and MDLs will be compared to the screening values in order to reduce the potential for Type II errors (i.e., false negatives). Analytes with elevated RLs or MDLs will be retained for further evaluation.

No Washington State human health screening values for environmental media were located.

Table 3-8 provides the proposed screening values for the HHRA.

Figure 3-16 Preliminary Screening for Contaminants of Concern



Source: RAGS, Part A, Volume 1 (USEPA, 1989) and USEPA Region 8 Superfund Technical Guidance, RA-03, Contaminants of Concern (USEPA, 1994)

* ARARs or other health-based promulgated criteria

ARAR – Applicable, Relevant, or Appropriate Requirement
COPC – Contaminant of Potential Concern

3.10.1.3.3 Comparison of Site Lead Data to Background Lead Data

Unless more recent lead background data for Washington State are located, regional background lead data (WDOE, 1994) will be used for comparison to site data. Initially, MDCs for lead by exposure area will be compared to the 90^{th} percentile State-wide lead value of 17 mg/kg. If a quantitative HHRA is required, EPCs for each exposure area will be compared to this same value. Lead will be removed as a COPC if the MDC for an exposure area is less than 17 mg/kg.

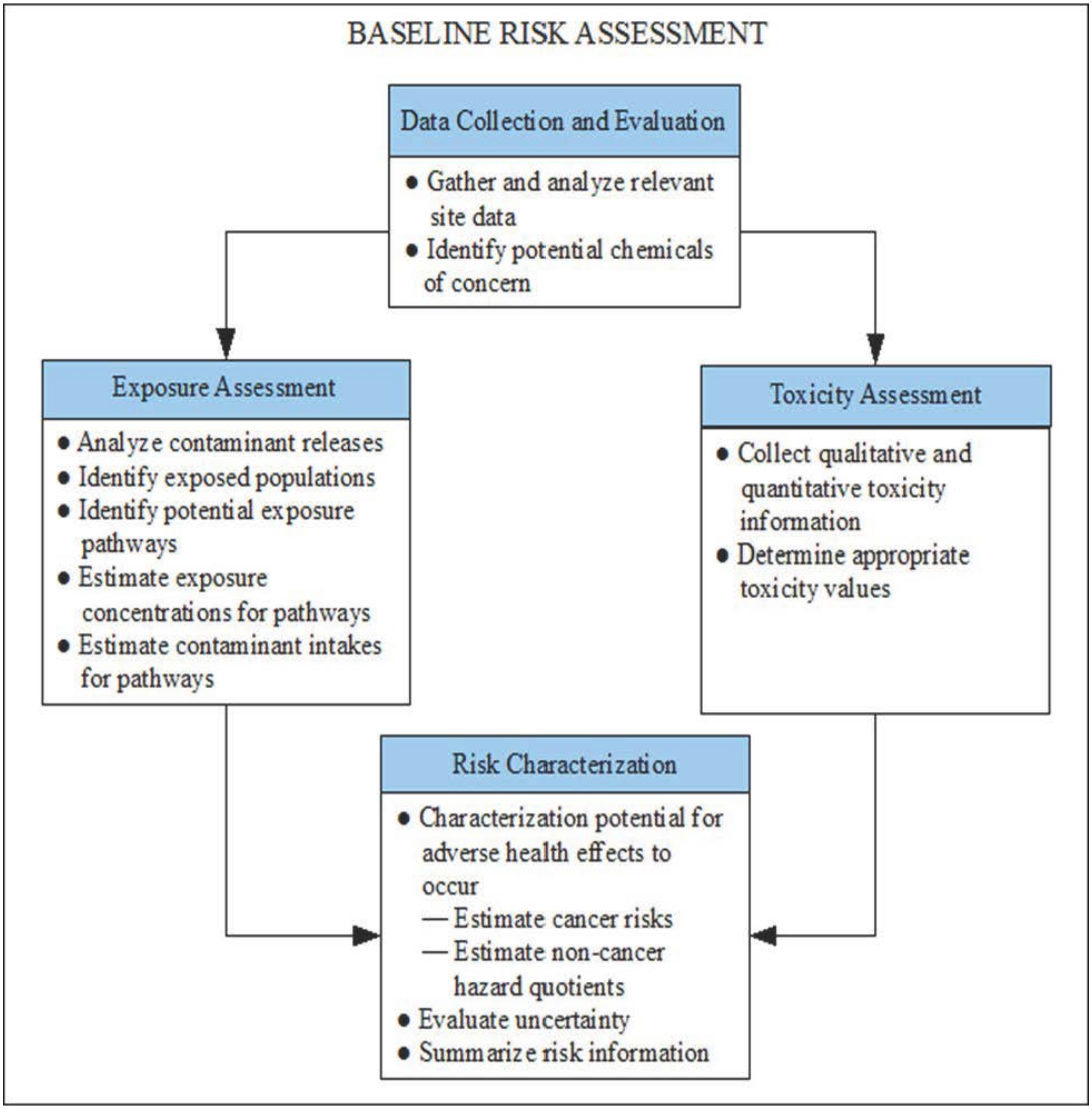
3.10.2 Baseline Human Health Risk Assessment

Should the MDCS for any COPC exceed human health screening values, a quantitative baseline HHRA will be performed. **Figure 3-17** presents the general approach and components of a baseline HHRA (USEPA, 1989).

A quantitative baseline HHRA will consist of the following:

1. Exposure Assessment
    a. Calculation of intakes by exposure pathway for each receptor.
2. Toxicity Assessment
3. Risk Characterization
    a. Risk Estimation
        i. Estimation of noncancer hazard quotients (HQs) and hazard indices (HIs)
        ii. Estimation of cancer risks
    b. Risk Description
        i. Discussion of the potential for any contaminants of concern (COCs) to pose health risks due to cancer noncancerous toxicity.
4. Uncertainty Analysis

Figure 3-17 Baseline Human Health Risk Assessment Process



Source: RAGS Part A, Volume I, Exhibit 1-2 (USEPA, 1989)

Table 3-8 Proposed Soil and Surface Water Screening Values for the Human Health Risk Assessment – Port Angeles Combat Range

Chemical	USEPA Human Health Regional Screening Level [1]		USEPA Human Health Regional Screening Level [1]	USEPA Human Health Regional Screening Level [1]	USEPA Human Health Regional Screening Level [1]	Proposed HHRA Soil Screening Level	USEPA NRWQC for Human Consumption [2]	USEPA NRWQC for Human Consumption [2]
	Residential Soil (mg/kg)	Key	Residential Soil (1/10th) (mg/kg)	Migration to Groundwater-Risk-based SSL (mg/kg)	Migration to Groundwater-MCL based (mg/kg)	Minimum Value (mg/kg)	Water + Organism (mg/L)	Organism Only (mg/L)
Metals by SW-846 3010A/3050B/6010B								
Lead	*250*	†	400	--	14 †	14 †	--	--
Explosives by SW-846 Method 8330B (Modified)								
1,3,5-Trinitrobenzene	2200	n	220	1.7	--	1.7	--	--
1,3-Dinitrobenzene	6.1	n	0.61	0.0014	--	0.0014	--	--
3,5-Dinitroaniline	--	--	--	--	--	--	--	--
2,4,6-Trinitrotoluene	19	c**	3.6	0.013	--	0.013	--	--
2,4-Dinitrotoluene	0.72	c	0.72	1.30E-04	--	1.30E-04	**1.10E-04**	3.40E-03
2,6-Dinitrotoluene	0.72	c	0.72	1.30E-04	--	1.30E-04	--	--
2-Amino-4,6-dinitrotoluene	150	n	15	0.023	--	0.023	--	--
4-Amino-2,6-dinitrotoluene	150	n	15	0.023	--	0.023	--	--
2-Nitrotoluene	2.9	c*	2.9	2.5E-04	--	2.5E-04	--	--
3-Nitrotoluene	6.1	n	0.61	0.0012	--	0.0012	--	--
4-Nitrotoluene	30	c**	24	0.0034	--	0.0034	--	--
HMX	3800	n	380	0.99	--	0.99	--	--
Nitrobenzene	4.8	c*	4.8	7.9E-05	--	7.9E-05	**0.017**	0.69
RDX	5.6	c	5.6	2.3E-04	--	2.3E-04	--	--
Tetryl	240	n	24	0.58	--	0.58	--	--
PETN	120	c**	12	0.024	--	0.024	--	--
Nitroglycerin	6.1	n	0.61	6.6E-04	--	6.6E-04	--	--

[1] USEPA Region 9, May 2013 Regional Screening Levels (RSLs) (Formerly PRGs); http://www.epa.gov/region9/superfund/prg/
[2] USEPA National Recommended Water Quality Criteria available at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm
USEPA – U.S. Environmental Protection Agency
mg/kg – milligram per kilogram
mg/L – milligram per liter
MCL – maximum contaminant level
SSL – soil screening level
HHRA – human health risk assessment
c – carcinogen
n – not a carcinogen
** where non carcinogen screening level is < 100x carcinogen screening level
** where non carcinogen screening level is < 10 x carcinogen screening level
SW-846 – USEPA's analytical methods for solid waste available at: http://www.epa.gov/osw/hazard/testmethods/sw846/online/
† - The Washington Department of Ecology (WDE) Method A soil cleanup level (SCL) for unrestricted land use is 250 mg/kg. There were no SCLs for explosives.
Bold text indicates proposed screening value for freshwater.
As a conservative measure, all values for 2,4-dinitrotoluene and 2,6-dinitrotoluene are based on the 2,4/2,6-dinitrotoluene mixture values
The minimum value based on the Migration-to-Groundwater RSL will be used to screen soil data where depth to groundwater is likely shallow (<20 ft bgs). At other soil locations, the residential soil RSL and the Residential Soil RSL (1/10th) will be used for COPC screening.

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3.10.2.1 Exposure Assessment

The purpose of the exposure assessment is to evaluate how exposure to site chemicals could occur, and to estimate the extent of exposure. In addition, the exposure assessment identifies the exposure pathways and EPCs that will be combined with toxicity data and exposure parameters to estimate potential risk.

Four steps will be included in the exposure assessment:

1. Characterization of exposure setting, receptors, and further definition of the CSM,
2. Identification of exposure pathways and exposure areas,
3. Estimation of EPCs, and
4. Quantitation of exposure.

These steps are discussed in the following subsections.

3.10.2.1.1 Characterization of Exposure Setting

Detailed site descriptions will be provided and land use (both current and future) will be evaluated as part of the HHRA.

3.10.2.1.2 Receptors

Receptors for risk evaluation are provided in the preliminary CSMs. Both current and future receptors will be evaluated.

Receptors to be included in the quantitative HHRA (if deemed necessary) will be the following:

1. Current and Future Resident (Adult and Child)
2. Current and Future Outdoor Worker (Adult)
3. Current and Future Recreational User (Adult and Child)

A separate trespasser scenario is not proposed as this receptor is addressed under the recreational user. Exposure parameters proposed for these receptor categories are presented in **Section 3.10.2.1.8**, **Table 3-13**, below.

3.10.2.1.3 Conceptual Site Model

The preliminary CSMs for potential human exposure to MEC and MC at the PACR MRS were discussed in **Section 3.1.2** (**Figure 3-3** and **Figure 3-4**). A CSM is a schematic representation of the chemical source areas, chemical release mechanisms, environmental transport media, potential exposure routes, and potential receptors. The purpose of the CSM is (1) to represent chemical sources and exposure pathways that may result in human health risks; (2) to aid in developing a sampling plan to address significant chemical release and migration pathways; and (3) to aid in identifying effective remediation alternatives, if necessary, that are targeted at significant contaminant sources and exposure pathways.

Only complete exposure pathways will be evaluated in the HHRA. A complete exposure pathway includes all of the following elements:

- A source and mechanism of contaminant release,
- A transport or contact medium (e.g., soil, surface water, groundwater, or sediment),
- An exposure point where humans can contact the environmental medium, and
- An exposure (intake) route (such as ingestion, dermal contact, or inhalation).

The absence of any one of these elements results in an incomplete exposure pathway. Where there is no potential for exposure, there is no potential for risk. The preliminary CSM for potential MC exposure identifies the likely (1) incomplete pathways – no evaluation necessary; (2) pathways that are potentially complete, but for which risk is likely low and only qualitative evaluation is needed; and (3) pathways that are complete and may be significant in which case quantitative evaluation will be performed. The preliminary CSMs will be reassessed and revised as necessary based on the RI field results.

3.10.2.1.4 Source and Transport Mechanisms

Should MC sources be identified, these sources and corresponding transport mechanisms will be updated as necessary from those presented in the preliminary CSMs based on the results of the RI field activities.

3.10.2.1.5 Exposure Pathways

Potentially complete pathways by which current and future human receptors could be exposed to chemicals in environmental media will be described in the RI report. These primary pathways include:

1. Incidental surface and subsurface soil ingestion,
2. Inhalation of fugitive dust from surface and subsurface soil, and
3. Dermal contact with surface and subsurface soil.

Incidental ingestion of, and dermal contact with, surface water and sediment will be evaluated if MEC is discovered and MC samples for these media are collected.

3.10.2.1.6 Exposure Areas

Chemical data will be evaluated separately in the risk assessment. Surface (0-6 inches) and subsurface soil (>6 inches) will be segregated for the purposes of risk calculations. Following the RI fieldwork, sample locations may be associated with smaller areas and specific types and/or severity of exposure within the PACR MRS. In such cases, smaller exposure units and potential hot spots will be assessed as appropriate.

3.10.2.1.7 Estimation of Exposure Point Concentrations

If an MDC exceeds a residential soil RSL, or 1/10th an RSL if multiple chemicals are detected, the DF and number of samples will be evaluated. If the number of detections is greater than 5 percent, a UCL95 will be estimated using ProUCL Version 4.1 (USEPA, 2010) where applicable. The lower of the MDC or UCL95 will be used to represent the exposure point concentration (EPC) in the quantitative risk assessment (**Section 3.10.2**). In calculating the UCL95, no substitution of ½ the RL or MDL will be used as proxy values for nondetects (NDs) in accordance with the ProUCL V.4.1 guidance (USEPA, 2010).

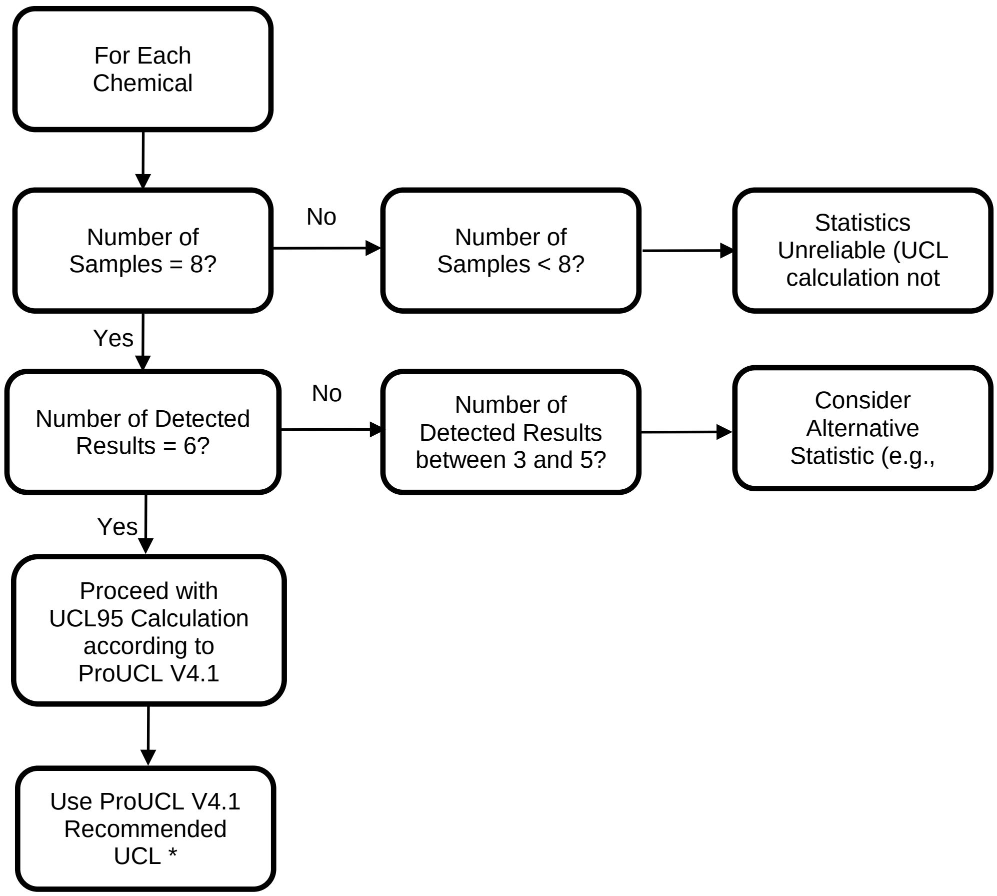
The EPC is the arithmetic average concentration that is contacted by the receptor over the exposure period and exposure area. The UCL95 on the arithmetic mean will be used to represent the EPC because it provides a conservative estimate of the average concentration (USEPA, 1994). In some cases, variability in measured concentrations and small sample sizes may produce UCL95 concentration that exceeds the MDC. In these cases, the MDC will be used to represent the EPC. The UCL95s will be calculated in accordance with ProUCL V4.1 guidance (USEPA, 2010).

For each COPC addressed in the baseline HHRA, the EPC will be the lower of the MDC or the UCL95 for a given analyte where data are sufficient to estimate the UCL95 statistic (USEPA, 2002a). A sufficient data set is considered a sample size of at least eight with at least six detected values; this is consistent with USEPA guidance (USEPA, 2010). If data are insufficient to estimate a UCL95, the median of the detected data may be applied if there are at least three detected values. If there are fewer than three detected values, the MDC will be used.

If there are no detected values, and the analyte is carried forward from the screening-level HHRA because of elevated RLs or MDLs, a value of ½ the maximum reporting limit (RL) will be used to represent the EPC for the baseline exposure assessment. This decision logic is presented in **Figure 3-18**. The baseline HHRA will avoid basing risk calculations on non-detected data where possible because of the uncertainty inherent in the non-detected values.

Figure 3-18 Decision Diagram for Selecting the Exposure Point Concentration

Calculation of an Upper Confidence Limit Using USEPA's ProUCL Version 4.1



* ProUCL V4.1 usually suggests a UCL; however, if there is more than one UCL provided, use of the maximum value (if also statistically relevant) is a conservative approach; consultation with a statistician may be considered.

3.10.2.1.8 Exposure Parameters

Exposure parameters (e.g., ingestion rates, exposure frequency and duration, surface area, body weight) will be used to estimate chemical intakes by exposure pathway for each receptor identified in the CSM. Exposure factors proposed for the various human receptors were selected from the USEPA Exposure Factors Handbook (USEPA, 2011c) (**Table 3-9**) and defaults from the USEPA RSL On-line Calculator (http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) (USEPA, 2013a).

Professional judgment and site-specific exposure information will be used where published guidance is unavailable. The assumptions used in selecting the exposure factors for the human receptors will be summarized in the RI report. The reasonable maximum exposure (RME) scenario will be assessed; a central tendency exposure (CTE) scenario may be performed based on the results of the RME evaluation.

Table 3-9 Proposed Reasonable Maximum Exposure Parameters for the Human Health Risk Assessment – Port Angeles Combat Range

Exposure Parameter		Units	Current and Future Resident			Current and Future Outdoor Site Worker		Current and Future Recreational Visitor		
			Child	Adult	*	Adult	*	Child	Adult	*
Adherence Factor	(AF_i)	mg/cm^2-event	0.2	0.07	a	0.2	a,c	0.2	0.2	a,f
Averaging Time - Cancer	(ATc)	d	25,550	25,550	a	25,550	a	25,550	25,550	a
Averaging Time - Noncancer	(ATnc)	d	2,190	8,760	a	9,125	a	2,190	8,760	e
Body Weight	(BW_i)	kg	15	70	a	70	a	15	70	e
Conversion Factor, mass	(CFm)	kg/mg	1E-06	1E-06	a	1E-06		1E-06	1E-06	--
Exposure Time - Air	(ETs)	hr/d	24	24	a	8	a	2	2	e
Exposure Duration	(ED_i)	yr	6	24	a	25	a	6	24	e
Exposure Frequency, Soil	(EFs)	d/yr	200	200	e	180	b	50	50	e
Events per Day	(EV)	event/d	1	1	a	1	a	1	1	a
Soil Ingestion Rate	(IRS_i)	mg/d	200	100	a	100	a	200	100	e
Soil Ingestion Rate (Age Adjusted)	(IRSadj)	mg-y/kg-d	114	NA	a	NA	--	114	NA	--
Surface Area - Soil Contact	(SAS_i)	cm^2	2,800	5700	a	3,300	a,e	2,800	3,300	e
Surface Area - Soil Contact (Age Adjusted)	(SASadj)	mg-y/kg-d	361	NA	a	NA	--	450	NA	--
Particulate Emission Factor	PEF	m^3/kg	5.71E+09	5.71E+09	g	5.71E+09	g	5.71E+09	5.71E+09	g

a – Region 9 Regional Screening Levels (RSLs) tables - Equations and User's Guide (USEPA, 2013) available at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm; default exposure parameters for resident
b - EF based on snow-free assumption of June to October
c - Exposure Factors Handbook. Final, (USEPA, 2011c)
d - RAGS, Part A, Volume 1, (USEPA, 1989)
e - Site-specific based on professional judgment
f - RAGS E, Exhibit 3-2, 3-3, & C-1, (USEPA, 1989)
g - Value is for Seattle, WA from the USEPA On-Line RSL calculator available at: http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search

Table 3-9 Proposed Reasonable Maximum Exposure Parameters for the Human Health Risk Assessment – Port Angeles Combat Range (cont.)

Abbreviations:
RME – reasonable maximum exposure
HHRA – Human Health Risk Assessment
mg – milligram
cm^2 – square centimeter
kg – kilogram
kg/mg – kilogram per milligram (1/x conversion factor)
d - day
s - second
y – year
i – refers to a parameter that differs by age where a = adult, c = child
RME = reasonable maximum exposure

3.10.2.1.9 Estimation of Intakes

The estimates of chemical intake will be combined with toxicity information to yield estimates of potential health risk. Chemical intake is expressed in terms of milligrams of chemical per kilogram of body weight per day (mg/kg-day). The general equation for calculating chemical intake (or dose) in terms of mg/kg-day is:

Equation 3-1 Estimation of Intakes

$$Intake = \frac{EPC \times IR \times EF \times ED}{BW \times AT}$$

Where

EPC	=	exposure point concentration, mg/kg
IR	=	ingestion rate, mg/day
EF	=	exposure frequency, day/year
ED	=	exposure duration, year
BW	=	body weight, kilogram
AT	=	averaging time, day

Omitting the chemical concentration from the intake equation yields a pathway-specific intake factor. The intake factor (kilogram [kg] soil/kg body weight-day or liter [L)] surface water/kg-day) can then be multiplied by the EPC of each chemical in soil to obtain the pathway-specific intake for that chemical.

Intakes will be estimated for the RME for the most sensitive receptor and age group (i.e., typically the child resident) and age-adjusted accordingly. The RME is estimated by selecting values for exposure parameters (variables) so that the combination of all variables results in the maximum exposure that can reasonably be expected to occur at the site.

Intakes will be calculated for 1) incidental soil ingestion, 2) inhalation of fugitive dust, and 3) dermal contact with soil for each COPC and receptor.

Appendix J presents the receptor-specific intake equations for the HHRA.

3.10.2.2 Toxicity Assessment

Toxicity values specific to the oral and inhalation pathways will be obtained from the sources listed below in the following hierarchy (USEPA, 2003a):

1. Integrated Risk Information System (IRIS) on-line database (USEPA, 2013b)
2. USEPA's Provisional Peer Reviewed Toxicity Reference Values (PPTRVs) – The Office of Research and Development/National Center for Environmental
3. Assessment/Superfund Health Risk Technical Support Center (STSC) develops PPRTVs on a chemical specific basis when requested by USEPA's Superfund program.

4. Other Toxicity Values – additional USEPA and non-USEPA sources of toxicity information. Priority should be given to those sources of information that are the most current, the basis for which is transparent and publicly available, and which have been peer reviewed.
    a. Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997a).

Route-to-route extrapolation from oral value to inhalation (or vice versa) will not be undertaken. For example, if there is an oral reference dose (RfDo) for a chemical, but no inhalation IUR, then only the oral route will be evaluated in the risk assessment. Toxicity values based on route-to-route extrapolation will be used in the risk assessment if provided in IRIS.

For evaluating hazard/risk for dermal routes of exposure, oral toxicity values will be used in the absence of specific information concerning gastrointestinal absorption (GI_{abs}) values as recommended in the Supplemental Guidance for *Dermal Risk Assessment* (USEPA, 2004).

The USEPA provides an inhalation unit risk (IUR) value for many chemicals by which inhalation exposure may be assessed (USEPA, 2013). The HHRA will evaluate inhalation of fugitive dust for outdoor exposures in accordance with existing USEPA guidance documents.

3.10.2.2.1 Toxicity Values for Carcinogens

Most USEPA cancer slope factors (CSFs) are upper 95th percentile confidence limits of the probability of response per unit intake of a chemical (by oral or inhalation routes) over a lifetime. CSFs are based on mathematical extrapolation from experimental animal data and epidemiological studies, when available. CSFs are expressed in units of risk per milligram of chemical intake per kg body weight per day $(mg/kg\text{-}day)^{-1}$. Because CSFs are upper bound estimates and because most chemicals are not known human carcinogens, actual cancer potency of chemicals may be lower than estimated and may even be zero. Carcinogens are also given USEPA weight-of-evidence (WOE) classifications (listed below) whereby potential carcinogens are grouped according to the likelihood that the chemical is a human carcinogen, depending on the quality and quantity of carcinogenic potency data for a given chemical.

- Group A - Human Carcinogen (sufficient evidence of carcinogenicity in humans)
- Group B - Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
- Group C - Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data)
- Group D - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)
- Group E - Evidence of No carcinogenicity for Humans (no evidence of carcinogenicity in adequate studies)

In March 2005, the USEPA published the Supplemental Guidance for Assessing Susceptibility from Early-Life Exposures to Carcinogens ("*Supplemental Guidance*") (USEPA, 2005) to provide additional focus on childhood exposures to carcinogens, as recommended in the Guidelines for Carcinogen Risk Assessment (USEPA, 2005a). The Supplemental Guidance document addresses cancer risks from early-life exposure and compares them to cancer risks associated with exposures occurring later in life. The Supplemental Guidance recommends that in some cases, when carcinogens have a mutagenic mode of action (MMOA), it may be appropriate to apply a default safety factor called an age-dependent adjustment factor (ADAF) to risk calculations when evaluating cancer risk associated with exposure for children ages 0 to 16 years. Cancer slope factors to be used in the HHRA are presented in **Table 3-10**. None of the MC listed in **Table 3-8** (lead and explosives) have been identified as known mutagens.

3.10.2.2.2 Toxicity Values for Noncarcinogens

The reference dose (RfD) is a pathway-specific (e.g., oral or inhalation) estimate of a daily chemical intake per unit body weight that is likely to be without deleterious effects during a lifetime (USEPA, 1989). The USEPA has developed chronic RfDs to evaluate long-term exposures (seven [7] years to a lifetime), and subchronic RfDs to evaluate exposures of shorter duration (two [2] weeks to seven [7] years). However, as a conservative measure, where possible, only chronic RfDs will be used for human receptors in the risk assessment. Noncancer RfDs for use in the HHRA are presented in **Table 3-10**.

3.10.2.2.3 Evaluation of Lead

There is no RfD for lead associated with noncancer risk. Risk due to lead exposure is not evaluated with the exposure assessment process described in **Section 3.10.2.1.9**. Instead, lead risks are determined by comparing site-specific EPCs for lead in soil to acceptable soil concentrations developed with the USEPA Integrated Exposure Uptake Biokinetic (IEUBK) model for the child (USEPA, 2010a) and the Adult Lead Model (ALM) for adult receptors (USEPA, 2009). These models then predict blood lead concentrations associated with environmental exposures. The level of concern for lead in blood is 10 micrograms per deciliter (µg/dL) (USEPA, 1998).

The IEUBK and ALM will be run for the quantitative risk assessment if lead is retained as a COPC from the initial screening.

3.10.2.2.4 Chemicals Lacking Toxicity Values

Chemicals lacking toxicity values will be addressed qualitatively in the risk characterization and uncertainty analysis sections of the RI report. This could be important as toxicity values have not been developed for some of the MC COPCs.

Table 3-10 Summary of Toxicity Information for the Human Health Risk Assessment - Port Angeles Combat Range

Analyte	CASRN	CSFo (mg/kg-day)$^{-1}$	Key	IUR (µg/m^3)$^{-1}$	Key	RfDo (mg/kg-day)	Key	VOC	GIabs	ABS
1,2-Dinitrobenzene	528290					1.0E-04	P		1	0.1
1,3-Dinitrobenzene	99650					1.0E-04	I		1	0.1
1,4-Dinitrobenzene	100254					1.0E-04	P		1	0.1
2,4/2,6-Dinitrotoluene Mixture	25321146	6.8E-01	I						1	0.1
2,4-Dinitrotoluene	121142	3.1E-01	C	8.9E-05	C	2.0E-03	I		1	0.102
2,6-Dinitrotoluene	606202					1.0E-03	P		1	0.099
2-Amino-4,6-Dinitrotoluene	35572782					2.0E-03	S		1	0.006
4-Amino-2,6-Dinitrotoluene	19406510					2.0E-03	S		1	0.009
RDX	121824	1.1E-01	I			3.0E-03	I		1	0.015
Nitrobenzene	98953			4.0E-05	I	2.0E-03	I	V	1	
Nitroglycerin	55630	1.7E-02	P			1.0E-04	P		1	0.1
3-Nitrotoluene	99081					1.0E-04	X		1	0.1
2-Nitrotoluene	88722	2.2E-01	P			9.0E-04	P	V	1	
4-Nitrotoluene	99990	1.6E-02	P			4.0E-03	P		1	0.1
HMX	2691410					5.0E-02	I		1	0.006
PETN	78115	4.0E-03	X			2.0E-03	P		1	0.1
Tetryl	479458					4.0E-03	P		1	0.1
1,3,5-Trinitrobenzene	99354					3.0E-02	I		1	0.019
2,4,6-Trinitrotoluene	118967	3.0E-02	I			5.0E-04	I		1	0.032

Source: USEPA Regional Screening Levels, available at: http://www.epa.gov/region9/superfund/prg/ May 2013
CASRN Chemical Abstracts Service Registry Number
CSFo Oral Cancer Slope Factor
IUR Inhalation Unit Risk
RfDo Oral Noncancer Reference Dose
ABS Absorbance Factor
GIabs Gastrointestinal Absorbance Factor
I Integrated Risk Information System (IRIS) available at:
C California Environmental Protection Agency (Cal-EPA)
P Provisional Peer Reviewed Toxicity Values (PPRTVs)
derived by USEPA's Superfund Health Risk Technical Support Center for Superfund
S see user guide Section 5 available at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
X PPRTV Appendix
V volatile
Note-. None of the chemicals on this table are known mutagens
mg/kg-day milligram per kilogram of body weight per day
µg/m3 microgram per cubic meter
HHRA Human Health Risk Assessment

3.10.2.3 Risk Characterization

In the risk characterization, the toxicity values (RfDs, IURs, and CSFs) will be applied in conjunction with chemical concentrations of COPCs and intake assumptions to estimate noncarcinogenic and carcinogenic health risks. Both hazard quotients (HQs) and hazard indices (HIs) will be calculated. Cancer risks will also be calculated. Chemicals will be evaluated for mutagenicity where applicable in accordance with USEPA guidance (USEPA, 2005a) above.

3.10.2.3.1 Estimation of Noncancer Hazard Quotients

The potential for noncarcinogenic effects will be characterized by comparing estimated chemical intakes with chemical-specific RfDs. The resulting ratio is the HQ. Noncancer HQ equations are provided in **Appendix J**.

For each COPC, an HQ of <1 indicates that no unacceptable health risk is expected from the exposure conditions evaluated. An HQ above 1 does not indicate an actual health threat exists, but there may be cause for concern for potential adverse health effects.

To assess multiple exposures to multiple chemicals, the HQs for each chemical will be summed to yield a HI. If a receptor is exposed to multiple pathways, then HIs from all relevant pathways will be summed to obtain the total HI for that receptor.

Equation 3-2 Estimation of Noncancer Hazard Quotient

$$Noncancer\ Hazard\ Quotient = \frac{Chemical\ Intake\left(\frac{mg}{kg-day}\right)}{RfD\left(\frac{mg}{kg-day}\right)}$$

Where
mg = milligram
kg-day = kilogram-day
RfD = reference dose (or reference concentration for inhalation)

3.10.2.3.2 Estimation of Cancer Risks

Potential carcinogenic effects will be characterized in terms of the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen, for chronic exposure scenarios. Excess lifetime cancer risk will be calculated by multiplying the estimated chemical intake by the cancer CSF. Cancer risk equations are provided in **Appendix J**.

USEPA's target acceptable lifetime incremental cancer risk range is $1E^{-04}$ to $1E^{-06}$ (1 in 10,000 to 1 in 1,000,000).

The risks resulting from exposure to multiple carcinogens will be assumed to be additive. The total cancer risk will be estimated by summing the risks estimated for each COC and for each pathway.

Equation 3-3 Estimation of Cancer Risk

$$\text{Cancer Risk} = \text{Cancer Intake (mg/kg-d)} \times \text{CSF (mg/kg-d)}^{-1} \text{ or the IUR } (\mu g/m^3)^{-1}$$

Where

mg/kg-day	= milligram per kilogram-day
CSF	= cancer slope factor
IUR	= inhalation unit risk
$\mu g/m^3$	= microgram per cubic meter

Appendix J presents the receptor-specific risk equations for the HHRA.

3.10.2.4 Uncertainty Analysis

Sources of uncertainty related to the HHRA, will be assessed.

The large number of assumptions made in an HHRA introduces uncertainty in the risk characterization results.

Sources of uncertainty include, but are not limited to:

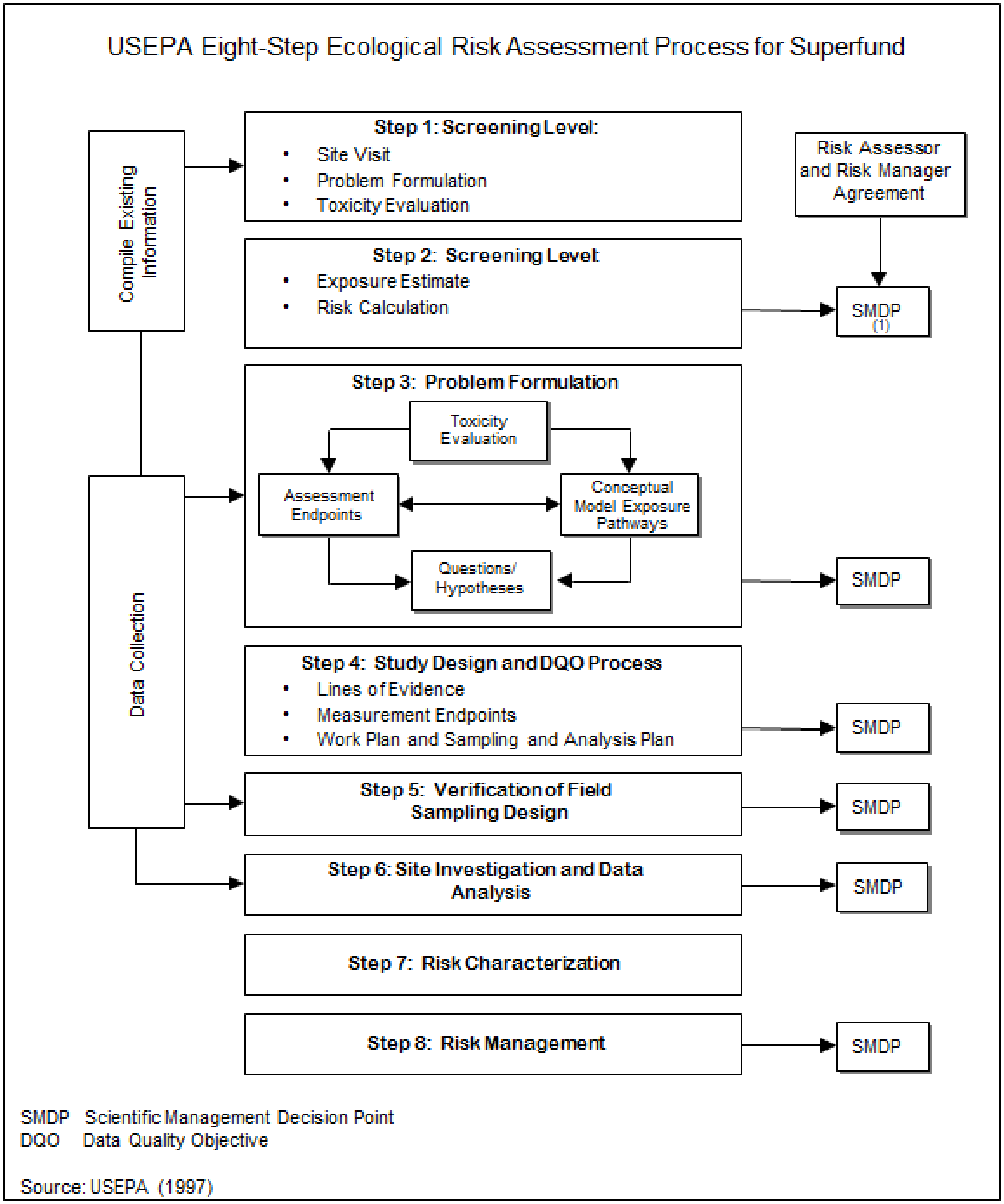
- Variation in the sampling and analysis and resulting data,
- Calculation of EPCs,
- Uncertainty in the exposure parameters,
- Selection of exposed receptors,
- Initial media screening values, and
- Toxicity values.

3.11 Ecological Risk Assessment

An ecological risk assessment (ERA) will be performed for the PACR MRS where environmental data are available. It is unlikely that MC samples will be collected, thus negating the need for screening or quantitative risk assessments, in which case, a qualitative discussion will be provided. The initial stage of this evaluation includes a screening-level assessment to identify contaminants of potential ecological concern (COPECs) that might be associated with MEC and MC. Munitions constituents will be evaluated for their potential to cause unacceptable risks to ecological receptors if a potential source item consistent with **Section 3.1.11.1** is located.

The 8-step ecological risk assessment (ERA) process begins with a screening-level ERA (SLERA), which consists of Steps 1 and 2 as shown in **Figure 3-19**. The need for further evaluation in a baseline ERA (BERA) is determined following the screening for contaminants of potential ecological concern (COPECs). For ecological receptors, the chemicals reported at concentrations that exceed screening levels would be included in a BERA. Alternatively, they may be addressed in a qualitative manner depending on nature, and extent of contamination, habitat size, environmental degradation, frequency of detection, environmental toxicity, among other considerations.

Figure 3-19 USEPA Eight-Step Ecological Risk Assessment Process



3.11.1.1 General Approach

Environmental media to be investigated during the PACR RI may include soil, surface water, and sediment following discovery of a source requiring sampling in accordance with **Section 3.1.11.1.**

The SLERA, and if deemed necessary, a BERA will be conducted in accordance with the following guidance documents:

- Washington Department of Ecology (Ecology) *Terrestrial Ecological Evaluation* (TEE) process described on Ecology's website: http://www.ecy.wa.gov/programs/tcp/policies/terrestrial/TEEHome.htm (WDEC, 2012);
- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997);
- *Guidelines for Ecological Risk Assessment* (USEPA, 1998a);
- *Tri-Service Procedural Guidelines for Ecological Risk Assessment [U.S. Army Environmental Center* (USAEC, 2000)];
- *Screening-Level Ecological Risk Assessments for FUDS MMRP Site Investigations, USACE HTRW CX, August 2006* (USACE, 2006)*;*
- *A Guide to Screening Level Ecological Risk Assessment, Tri-Service Ecological Risk Assessment Working Group, TG-090801, September, 2008* (TSERAWG, 2008); and
- *Risk Assessment Handbook, Volume II: Environmental Evaluation* (USACE, 2010).

The SLERA will address the potential for ecological risks from exposure to contaminants detected at locations sampled during the RI if samples are collected.

The results of the SLERA will provide sufficient information for risk managers to make a decision of (1) negligible ecological risk at the MRS (no further ERA is necessary), (2) more study is needed to reach a SLERA conclusion, such as filling of data gaps, or (3), continue to BERA.

The SLERA will address the following components as necessary based on scope and COPEC screening:

- Description of the environmental setting at the site;
- Discussion of the constituents detected on-site, ecological screening values, and selection of COPECs by medium;
- Discussion of the constituent's fate and transport;
- Discussion of the potential ecological receptors at the site, such as state species of concern, threatened and/or endangered species, and nongame species;
- Description of the complete exposure pathways at the site; and
- Presentation of SLERA hazard quotients (HQs) expressed as the ratio of the MDC divided by the ecological screening level.

3.11.2 Screening for Contaminants of Potential Ecological Concern

The SLERA, Steps 1 and 2 in the overall ERA process includes a preliminary ecological effects evaluation and the determination contaminant exposure levels that represent conservative thresholds for adverse ecological effects. Those conservative thresholds are ecological screening levels (ESLs).

If environmental media are sampled in the RI, MDCs for each sample record will be compared to available ESLs by chemical. ESLs for explosives/energetics are limited come from several sources. The minimum ESL from each source will be selected as appropriate while incorporating best professional judgment. The hierarchy selected for soil screening values with few exceptions is as follows:

1. USEPA, Ecological Soil Screening Levels (Eco-SSLs) (only value available is for lead in soil).
2. LANL Eco-Risk Database, Release 3.1 and/or the ORNL Risk Assessment Information System (RAIS).
3. Talmage et al., 1999.

Table 3-11 presents the proposed screening levels for lead and explosives in soil.

Few ESLs are available for explosives in sediment and surface water. There are no USEPA National Recommended Water Quality Criteria (NRWQC) for any explosive chemical.

Surface water and sediment screening values (freshwater) were taken from 2 primary sources:

1. LANL Eco-Risk Database, Release 3.1, available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php, accessed 3/1/13
2. Oak Ridge National Laboratory Risk Assessment Information System (RAIS) On-Line, available at: http://rais.ornl.gov/, accessed 3/20/2013

Table 3-12 presents the proposed screening levels for lead and explosives in sediment and surface water.

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Table 3-11 Proposed Soil Screening Values for the Ecological Risk Assessment – Port Angeles Combat Range

Chemical	CASRN	USEPA Eco-SSL[1]	LANL EcoRisk Database ESL (Release 3.1)[5]	LANL, 2012	ORNL RAIS 2013 Ecological Benchmark[6]	ORNL, 2013	Talmage et al., Screening Benchmark[7]	Talmage et al., 1999	Recommended Ecological *Soil* Screening Value
		(mg/kg)	(mg/kg)	Comment	(mg/kg)	Notes	(mg/kg)	Notes	(mg/kg)
Lead (total)	744066	**11**, 50[2], 500[3], 118[4]	14	American robin (Avian insectivore)	0.0537	USEPA R5 ESL SSB	--	--	**11**
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	2691410	--	27	Deer mouse (Mammalian omnivore)	--	--	**5.6**	Diet of shorttail shrew	**5.6**
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121824	--	**7.5**	Earthworm (Soil-dwelling invertebrate)	--	--	15	Diet of shorttail shrew and cottontail rabbit	**7.5**
1,3,5-Trinitrobenzene	99354	--	6.6	Deer mouse (Mammalian omnivore)	0.376	USEPA R5 ESL SSB	1.4	Diet of shorttail shrew and cottontail rabbit	**0.376**
1,3-Dinitrobenzene	99650	--	**0.073**	Deer mouse (Mammalian omnivore)	0.655	USEPA R5 ESL SSB	0.41	Diet of shorttail shrew	**0.073**
Methyl-2,4,6-trinitrophenylnitramine	479-45-8	--	**0.99**	Deer mouse (Mammalian omnivore)	NA	NA	4.4	Diet of shorttail shrew	**0.99**
Nitrobenzene	98953	--, 40[3]	2.2	Earthworm (Soil-dwelling invertebrate)	**1.31**	USEPA R5 ESL SSB	--	--	**1.31**
3,5-Dinitroaniline	618871	--	--	--	--	--	--	--	--
2,4,6-Trinitrotoluene	118967	--	6.4	American robin (Avian herbivore)	--	--	**0.56**	Diet of shorttail shrew	**0.56**
4-Amino-2,6-dinitrotoluene	19406-51-0	--	**3.6**	Deer mouse (Mammalian omnivore)	--	--	--	--	**3.6**
2-Amino-4,6-dinitrotoluene	35572782	--	**10**	Deer mouse (Mammalian omnivore)	--	--	80	Plants, soil	**10**
2,4-Dinitrotoluene	121142	--	2.5	Deer mouse (Mammalian omnivore)	**1.28**	USEPA R5 ESL SSB	--	--	**1.28**
2,6-Dinitrotoluene	606202	--	1.8	Deer mouse (Mammalian omnivore)	**0.0328**	USEPA R5 ESL SSB	--	--	**0.0328**
2-Nitrotoluene	88-72-2	--	**9.9**	Deer mouse (Mammalian omnivore)	--	--	--	--	**9.9**
3-Nitrotoluene	99-08-1	--	**12**	Deer mouse (Mammalian omnivore)	--	--	--	--	**12**
4-Nitrotoluene	99-99-0	--	**22**	Deer mouse (Mammalian omnivore)	--	--	--	--	**22**
Pentaerythritol tetranitrate	78115	--	**100**	Deer mouse (Mammalian omnivore)	--	--	--	--	**100**
Nitroglycerin	55630	--	**71**	Deer mouse (Mammalian omnivore)	--	--	--	--	**71**

Notes-.
1 USEPA, Eco-SSL
2 Washington Department of Ecology (WDOE), screening value for plants
3 WDOE - screening value for soil biota
4WDOE - screening value for wildlife
5 LANL EcoRisk Database, Release 3.1, (LANL, 2012) October 2012; available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php
6 ORNL RAIS Ecological Benchmark
7 Talmage et al., 1999, Screening Benchmark
ERA - Ecological Risk Assessment
Eco-SSL - Ecological Soil Screening Level, (USEPA, 2005b); available at: http://www.epa.gov/ecotox/ecossl/
ESL - ecological screening level
ORNL RAIS - Oak Ridge National Laboratory Risk Assessment Information System, 2013; available at: http://rais.ornl.gov/tools/eco_search.php
SSB - soil screening benchmark
mg/kg - milligram/kilogram
USEPA - United States Environmental Protection Agency
CASRN - Chemical Abstracts Service Registry Number
-- - no value available
For detail on individual screening value notes, see original sources at links provided.

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Table 3-12 Proposed Sediment and Surface Water Screening Values for the Ecological Risk Assessment – Port Angeles Combat Range

Chemical	CASRN	LANL *Sediment* Screening Value (freshwater) [1]	LANL, 2012	USEPA Region III BTAG *Sediment* Screening Benchmark (SSB) (freshwater) [2]	USEPA R3 SSB BTAG	USEPA Region V BTAG *Sediment* Screening Benchmark (SSB) (freshwater) [3]	USEPA Region V BTAG SSB (freshwater)	LANL, *Surface Water* Screening Value (freshwater) [4]	LANL, 2012	ORNL RAIS Surface Water ESL (freshwater) [5]	ORNL RAIS
		(mg/kg)	Notes	(mg/kg)	Notes	(mg/kg)	Notes	(mg/L)	Notes	(mg/L)	Notes
Lead (total)	744066	**27**	Violet-green Swallow (Avian aerial insectivore)	35.8	h 6	35.8	u	0.001	Aquatic community organisms - water	**0.0025**	12, D,E
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691410	--	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	--	--	330	Montane shrew (water)	**0.15**	USEPA R3 BTAG
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	45	Violet-green Swallow (Avian aerial insectivore)	**0.013**	e	--	--	44	Montane shrew (water)	**0.19**	Tier 2 SCV
1,3,5-Trinitrobenzene	99354	**1,300**	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	--	--	60	Montane shrew (water)	**0.014**	Tier 2 SCV
1,3-Dinitrobenzene	99650	1.2	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	**0.00861**	--	**0.016**	Aquatic community organisms - water	--	--
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	479-45-8	**100**	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	--	--	**5.8**	Montane shrew (water)	--	--
Nitrobenzene	98953	27	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	**0.145**	z	0.55	Aquatic community organisms - water	**0.22**	USEPA R5
3,5-Dinitroaniline	618871	--	--	--	--	--	--	**0.03**	L	--	--
2,4,6-Trinitrotoluene	118967	420	Violet-green Swallow (Avian aerial insectivore)	**0.092**	e	--	--	40	Violet-green Swallow (water)	**0.1**	USEPA R3 BTAG
4-Amino-2,6-dinitrotoluene	19406-51-0	**9.5**	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	--	--	**43**	Montane shrew (water)	--	--
2-Amino-4,6-dinitrotoluene	35572782	**34**	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	--	--	62	Montane shrew (water)	**0.02**	Tier 2 SCV
2,4-Dinitrotoluene	121142	0.29	Aquatic community organisms - sediment	**0.0416**	a,b 1	0.0144	z	0.065	Aquatic community organisms - water	**0.044**	USEPA R3 BTAG & R5
2,6-Dinitrotoluene	606202	9.7	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	**0.0398**	--	0.23	Aquatic community organisms - water	**0.081**	USEPA R3 BTAG & R5
2-Nitrotoluene	88-72-2	**28**	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	--	--	39	Montane shrew (water)	**0.75**	USEPA R3 BTAG
3-Nitrotoluene	99-08-1	**24**	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	--	--	47	Montane shrew (water)	**0.88**	USEPA R3 BTAG
4-Nitrotoluene	99-99-0	52	Occult little brown myotis bat (Mammalian aerial insectivore)	**4.06**	a,b 1	--	--	87	Montane shrew (water)	**1.9**	USEPA R3 BTAG
Pentaerythritol tetranitrate (PETN)	78115	**1400**	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	--	--	310	Montane shrew (water)	**85**	USEPA R3 BTAG

Table 3-12 Proposed Sediment and Surface Water Screening Values for the Ecological Risk Assessment – Port Angeles Combat Range

Chemical	CASRN	LANL *Sediment* Screening Value (freshwater) [1]	LANL, 2012	USEPA Region III BTAG *Sediment* Screening Benchmark (SSB) (freshwater) [2]	USEPA R3 SSB BTAG	USEPA Region V BTAG *Sediment* Screening Benchmark (SSB) (freshwater) [3]	USEPA Region V BTAG SSB (freshwater)	LANL, *Surface Water* Screening Value (freshwater) [4]	LANL, 2012	ORNL RAIS Surface Water ESL (freshwater) [5]	ORNL RAIS
		(mg/kg)	Notes	(mg/kg)	Notes	(mg/kg)	Notes	(mg/L)	Notes	(mg/L)	Notes
Nitroglycerin	55630	**1,700**	Occult little brown myotis bat (Mammalian aerial insectivore)	--	--	--	--	430	Montane shrew (water)	**0.138**	USEPA R3 BTAG

Notes-.
1 - Los Alamos National Laboratory (LANL) Sediment Screening Value (freshwater) available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php
2 - USEPA Region III (R3) BTAG Sediment Screening Benchmark (SSB) (freshwater) available through ORNL RAIS at: http://rais.ornl.gov/tools/eco_search.php
3 - USEPA Region V (R5) BTAG Sediment Screening Benchmark (SSB) (freshwater) available through ORNL RAIS at: http://rais.ornl.gov/tools/eco_search.php
4 - LANL, Surface Water Screening Value (freshwater) available at: http://www.lanl.gov/community-environment/environmental-stewardship/protection/eco-risk-assessment.php
5 - ORNL RAIS - Oak Ridge National Laboratory Risk Assessment Information System, 2013; available at: http://rais.ornl.gov/tools/eco_search.php
NRWQC - National Recommended Water Quality Criteria (NRWQC), **C**hronic **C**ontinuous **C**riterion, (USEPA, 2013c), available at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm
D - Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column.
E - The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 100 mg/L. Criteria values for other hardness may be calculated per the equation presented in the criteria document.
BTAG - Biological Technical Assistance Group
ESL - Ecological screening level
mg/L = milligram/liter
USEPA - United States Environmental Protection Agency
CASRN - Chemical Abstracts Service Registry Number
-- -- no value available
Tier 2 SCV - These are secondary chronic values derived using USEPA's Tier II methodology.
For detail on individual screening value notes, see original sources at links provided.
ERA – Ecological Risk Assessment
Bolded Values - recommended screening value

3.11.3 Baseline Ecological Risk Assessment

Following the SLERA, COPECs which exceed the ecological screening values will be assessed in the BERA as shown in **Figure 3-19**. Steps three through eight include:

3. Problem Formulation (**Section 3.11.3.3**)
    a. Toxicity Evaluation
    b. Assessment Endpoints
    c. Conceptual Model Exposure Pathways
    d. Questions/Hypotheses
4. Study Design & DQO Process (addressed in **Section 3.1.3**)
5. Verification of Field Sampling Design (addressed in **Section 3.1.11**)
6. Site Investigation and Data Analysis (addressed in **Section 3.0** and herein)
7. Risk Characterization
8. Risk Management

3.11.3.1 General Approach

Specific tasks that will be completed for the BERA consist of the following:

- Data Evaluation
- Problem Formulation
    - Selection of Assessment Endpoints
    - Identification of Measurement Endpoints
    - Toxicity Evaluation for COPECs from SLERA
    - Questions/Hypotheses as necessary
- Calculation of EPCs for COPECs from the SLERA for each environmental media at the PACR MRS. The approach used will be essentially the same as that presented in the HHRA (**Section 3.10.2.1.7**)
- Calculation of no observable adverse effect level (NOAEL) HQs for each COPEC in environmental medial for the selected wildlife receptors
- Identification of final COECs in soil or other environmental media if sampled.
- Consideration of additional lines of evidence that may be important in the evaluation of the HQ estimates, such as more realistic estimates of chemical bioaccumulation, bioavailability, exposure, and/or toxicity
- Uncertainty analysis
- BERA summary and conclusions

3.11.3.2 Data Evaluation and Usability

Laboratory reporting limits will be evaluated to determine if they exceed screening levels for protection of ecological receptors for non-detected values (NDs). All laboratory data will be validated to Level II, and 10% will be validated to Level IV in accordance with the UFP-QAPP (HDR, 2013). No "*R-flagged*" (i.e., rejected) data will be used in BERA. Additional discussion regarding data evaluation is provided in the HHRA (**Section 3.10.1.1**).

3.11.3.3 Problem Formulation

The problem formulation step (USEPA, 1997) as summarized in **Figure 3-19** includes:

- Toxicity Evaluation,
- Assessment Endpoints,
- Conceptual Site Model and Exposure Pathways, and
- Questions/Hypotheses.

3.11.3.3.1 Toxicity Evaluation

While there is considerable ecological toxicity information pertaining to lead, toxicity data for explosives are limited, especially for effects on avian species. The Eco-SSL for lead provides toxicity reference values (TRVs) which will be evaluated for use in the BERA. The U.S. Army Public Health Command (USAPHC) has published wildlife toxicity assessments for some explosives which will be reviewed for applicability. Other sources such as the ORNL RAIS and literature articles will be evaluated for obtaining no observable adverse effect level (NOAEL)-based TRVs. Extrapolation of TRVs by application of uncertainty factors is not proposed for this BERA as this would likely increase the uncertainty in the risk assessment.

3.11.3.3.2 Assessment and Measurement Endpoints

Assessment endpoints are expressions of the ecological resources that should be protected (USEPA, 1997). An assessment endpoint consists of an ecological entity and a characteristic of the entity that is important to protect. Measurements (or measurement endpoints) used to evaluate risks to the assessment endpoints are termed "*measures*" and may include measures of effect, measures of exposure, and/or measures of ecosystem or receptor characteristics (USEPA, 1997). Based on the site ecology, COPECs, and CSM, the ecological resources potentially at risk at the PACR site include terrestrial vegetation and invertebrates, mammals, birds, and aquatic biota (fish, amphibians, benthos, and other aquatic organisms).

At this time, the following assessment endpoints are proposed:

- The protection of long-term survival and reproductive capabilities for populations of terrestrial and aquatic herbivorous, invertivorous, omnivorous, and/or carnivorous mammals and birds.
- The corresponding null hypothesis (H_o) for the first assessment endpoint is stated as "*the presence of site contaminants within soil, vegetation, and prey will have no adverse*

effect on the survival or reproductive capabilities of populations of herbivorous, invertivorous, omnivorous, and/or carnivorous mammals and birds."

- The protection of long-term survival and reproductive capabilities for populations of terrestrial and aquatic plants and invertebrates.
  - The corresponding null hypothesis (H_o) for the second assessment endpoint is stated as "*the presence of site contaminants within surface water, sediment, soil, vegetation, and prey will have no adverse effect on the survival or reproductive capabilities of populations of aquatic and terrestrial plants and invertebrates*."

Measurement endpoints will include the evaluation of the environmental media concentrations, HQs, and HIs for each receptor, COPEC, and exposure pathway.

3.11.3.3.3 Receptors of Concern

Many species of birds, mammals, reptiles, amphibians, and invertebrates may be present at the PACR (**Appendix L**) but not all can be assessed in an ERA. In addition, there are fish and other aquatic species in the shallow streams that are present in some areas on the MRS. The evaluation of species for the BERA will be limited due to the nature of MEC and MC and the low likelihood of dispersal of MC from the impact areas. Energetics are designed to oxidize during detonation and the older explosive chemicals for the most part biodegrade or photochemically degrade in soil (Sunahara, 2009). There may be low concentrations of metals associated with some MC but energetics comprise the majority of the explosive charges that could be present.

Quantitative estimates of risk expressed as HQs are proposed for the following terrestrial receptors of concern (ROCs):

1. Mourning dove (*Zenaida macroura*)
2. Deer mouse (*Peromyscus maniculatus*)
3. Plants
4. Soil invertebrates

Evaluation of these receptors should be protective of higher trophic level receptors as these receptors spend most of their life associated with soil. The need to evaluate aquatic-dependent receptors (e.g., ducks and benthos) will be considered during the RI fieldwork.

3.11.3.3.4 Exposure Pathways

The following exposure pathways will be assessed if soil samples are collected:

1. Soil ingestion
2. Dietary ingestion of food items based on life history of the avian and mammalian ROCs.
3. Direct soil contact (plants and soil invertebrates only)

Inhalation of fugitive dust and dermal soil contact cannot be assessed quantitatively due to a lack of receptor-specific exposure parameters.

Deer Mouse – will be modeled as strictly an herbivore, ingesting surface soil and plant material.

Mourning Dove – will be modeled strictly as an avian herbivore, ingesting surface soil only and plant material.

Both exposure scenarios are conservative since both species are in high contact with soil and ingest seeds which are in contact with soil. The deer mouse would have the highest degree of site-specific exposure since it feeds exclusively on the ground and has a smaller home range.

The CSM developed in **Section 3.1.2** and shown in **Figure 3-5** will be further evaluated and revised as necessary during the BERA.

3.11.3.3.5 Exposure Parameters

Exposure parameters to be used in estimating chemical intakes are summarized in **Table 3-13**, below.

Table 3-13 Proposed Reasonable Maximum Exposure Parameters for the Port Angeles Combat Range Baseline Ecological Risk Assessment

RME Parameter		Units	Mourning Dove	Deer Mouse
Dietary Ingestion Rate	(DIR)	kg/kg-day	0.094	0.340
Water Ingestion Rate	(WIR)	kg/kg-day	NE	NE
Adjusted Dietary Ingestion Rate	(DIR adj)	kg/kg-day	0.085	0.333
Soil Fraction in Diet	(SFD)	unitless	0.139†	0.02
Invert Fraction in Diet	(IFD)	unitless	NA	NA
Fish Fraction in Diet	(FFD)	unitless	NA	NA
Amphibian Fraction	(AFD)	unitless	NA	NA
Mammal Fraction in Diet	(MFD)	unitless	NA	NA
Bird Fraction in Diet	(BFD)	unitless	NA	NA
Plant Fraction in Diet	(PFD)	unitless	1	1
Body Weight	(BW)	g	108	14
Body Weight	(BW)	kg	0.108	0.014
Home Range/Territory Size	(HR)	hectares	100	1.85E-02

Notes:
For deer mouse, body weight (mean values from all Appendix A entries) and home range are minima; DIR is 95th percentile (Wildlife Exposures Handbook, Appendix A, USEPA, 1993)
For mourning dove - Birds of North America – On-Line available at http://bna.birds.cornell.edu/bna/species/117doi:10.2173/bna.117; access date: 3/29/13
RME – reasonable maximum exposure
NE – not evaluated
NA – not applicable
DIR adj = DIR – (DIR * SFD) to account for soil in diet and avoid double counting when calculating intakes
SFD for deer mouse is from Beyer et al, 1993 for the white-footed mouse.
All units are on a dry weight basis
† Eco-SSL for lead, Table 5.2 for avian herbivore (dove) (USEPA, 2005b)
PACR – Port Angeles Combat Range
BERA – Baseline Ecological Risk Assessment

3.11.3.3.6 Estimation of Intakes

The estimation of intakes (dose) for vertebrate ecological receptors is performed for each exposure pathway for which soil, surface water, or sediment data are available. The general intake equations are provided below. Dietary ingestion rates for a limited number of vertebrate species are provided in Appendix A of the Wildlife Exposures Handbook (USEPA, 1993).

3.11.3.3.6.1 Soil-to-Plant Bioconcentration Factors

Soil to plant uptake factors (BCFp) are used to convert chemical concentrations in soil to concentrations in plant biomass resulting from plant root uptake. This factor is used to estimate the concentration of a COPEC that bioaccumulates in plants grown in contaminated soil during one growing season. This factor is also used to model concentrations of COPECs through plants to herbivores. Use of these factors assumes that plant root uptake for a specific chemical is equal for all plants.

BCFp values for organic COPECs were obtained from the literature or derived from a chemical-specific octanol-water partition coefficient (Kow) by the method of (Travis and Arms, 1988) **Table 3-14**. Some degree of uncertainty is associated with the use of the Kow and BCFp, especially for perennial plants. For the most part, however, animals feed on portions of the plants that are renewed annually (i.e., foliage, seeds, and fruit).

Equation 3-4 Model for Estimating Plant Uptake of COPECs from Soil

$$C_p = C_s \times BCF_p$$

Where:

C_p	=	COPEC concentration in plant (mg/kg)
C_s	=	COPEC concentration in surface soil (mg/kg)
BCF_p	=	soil-to-plant bioconcentration factor, unitless

Assumptions:

BCF_p is a chemical-specific factor relating soil concentration to plant tissue equilibrium concentration on a dry-weight basis.

Table 3-14 Draft Soil to Plant Uptake Factors for the Baseline Ecological Risk Assessment

Chemical	Plant BCFp	Kow	Kow Source
2-Amino-4,6-dinitrotoluene	2.9	89	Ecotoxicology of Explosives, Sunahara et al., 2009
4-Amino-2,6-dinitrotoluene	3.1	79	Ecotoxicology of Explosives, Sunahara et al., 2009
3,5-Dinitroaniline	7	1.29	EpiSuite V 4.1, Kow WIN value
1,3-Dinitrobenzene	5.3	31	USEPA, 1999 (SLERAP, Appendix C)
2,4-Dinitrotoluene	2.8	1.98	(USEPA, 2011a)
2,6-Dinitrotoluene	3.2	73	USEPA, 1999 (SLERAP, Appendix C)
HMX	31	1.5	(USEPA, 2011a)
Nitrobenzene	3.1	79.4	SCDM **Invalid source specified.**
Nitroglycerin	4.5	41.7	(USEPA, 2011a)
2-Nitrotoluene (ortho)	1.8	200	Hazardous Substances Database, HSDB at: http://toxnet.nlm.nih.gov, April 2013
3-Nitrotoluene (meta)	1.5	281.8	Spectrum Laboratories chemical fact sheet**Invalid source specified.**
4-Nitrotoluene (para)	1.7	234.4	Hazardous Substances Database, HSDB at: http://toxnet.nlm.nih.gov, April 2013
PETN	0.3	5129	(USEPA, 2011a)
RDX	12.2	7.4	(Meylan et al., 2005)
Tetryl	4.4	43.7	HSDB at: http://toxnet.nlm.nih.gov, April 2013
1,3,5-Trinitrobenzene	8.1	15.1	Hazardous Substances Database, HSDB at: http://toxnet.nlm.nih.gov, April 2013
2,4,6-Trinitrotoluene	4.6	40	http://www.epa.gov/fedfac/pdf/technical_fact_sheet_tnt.pdf and Sunahara et al., 2009

Note:
Kow – octanol-water partition coefficient
SLERAP – Screening Level Ecological Risk Assessment Protocol for Combustion Facilities (USEPA, 1999)
Equation used to derive BCFp values above: log BCF = 1.588 - 0.578 log Kow (SLERAP, Equation C-1-2) (USEPA, 1999)

3.11.3.3.6.2 Derivation of Area Use Factors

This factor permits consideration of less than full-time exposure for animals with foraging areas exceeding the area of contamination. When the foraging area of the receptor is less than the size of the site, it is assumed that the animal occupies the site 100% of the time, and the foraging factor is equal to 1. It is assumed that these receptors are continuously exposed to site contaminants. Species with small foraging areas or home ranges are likely to be affected by contamination at a site more than species with large foraging areas because a higher percentage of foraging may occur in contaminated areas.

In the SLERA, the AUF is conservatively assumed to be 1 for all receptors in calculating SLERA HQs. In the BERA, an AUF is calculated for the mourning dove and deer mouse at each exposure area.

Equation 3-5 Estimation of the Area Use Factor

$$AUF = \frac{Area\ of\ Surface\ Soil\ Contamination}{Foraging\ Area\ of\ Animal}$$

Both the numerator and denominator are in the same units, usually hectares. Thus, the AUF is unitless. Foraging areas for the mourning dove and deer mouse are provided in **Table 3-13**.

Equation 3-6 Model for Estimating Animal Intake of COPECs from Ingestion of Plants

$$CDI\ (mg/kg\text{-}day) = \frac{EPC_s \times BCF_p \times CF \times DIRadj \times PFD \times AUF}{BW}$$

Where:

CDI = chronic daily intake (mg/kg-day)
EPC_s = soil exposure point concentration (mg/kg)
BCF_p = soil-to-plant bioconcentration factor (unitless)
CF = conversion factor (10^{-6} kg/mg) as necessary
DIRadj = dietary ingestion rate (kg/kg-day)
= DIR – (DIR *SFD)
PFD = plant fraction in diet (unitless)
AUF = area use factor (unitless)
BW = body weight (kg)

Assumptions:

AUF is calculated as the ratio of the area of suitable habitat available at each site to the animal foraging area. Thus, the AUF is both species- and site-specific.

The soil ingestion rate, SIR, is derived from the dietary ingestion rate [in kg/kg-day (USEPA, 1993)] as follows:

Equation 3-7 Soil Ingestion Rate

Soil Ingestion Rate (SIR) (kg/kg-d) = *DIR * SFD*

Where:

SFD = soil fraction in diet, unitless
DIR = dietary ingestion rate, kg/kg-d

Equation 3-8 Model for Estimating Animal Intake of COPECs from Ingestion of Soil

$$CDI\ (mg/kg-day) = \frac{EPCs \times DIRadj \times SFD \times CF \times AUF}{BW}$$

Where:

CDI = chronic daily intake (mg/kg-day)
EPC_s = EPC for COPEC in soil (mg/kg)
DIRadj = dietary ingestion rate adjusted for soil (mg/day)
= DIR – (DIR *SFD)
SFD = soil ingestion expressed as fraction of total food intake (unitless)
CF = conversion factor (10^{-6} kg/mg) as necessary
AUF = area use factor (unitless)
BW = body weight (kg)

Assumptions:

- Exposure parameters are presented in **Table 3-13**.
- AUF is calculated as the ratio of the area of suitable habitat available at each site to the animal foraging area. Thus, the AUF is both species- and site-specific. The maximum value for an AUF is 1.

Dermal or direct contact with soil or dust inhalation cannot be addressed quantitatively due to the lack of exposure parameters.

3.11.3.3.7 Toxicity Assessment

Some chemicals have the potential to bioaccumulate in the terrestrial environment. Other COPECs are likely to be toxic primarily due to direct contact or ingestion.

Toxicity reference values (TRVs) are lacking for many ecological receptors especially for explosives. Where possible, no observable adverse effect level (NOAEL)-based TRVs will be used.

The literature sources for the mammalian and avian TRVs proposed for the PACR BERA are provided in **Table 3-15**.

Plant and soil invertebrate toxicity benchmark values (TBVs) are used in lieu of TRVs for assessing risks to these receptors. The literature sources for the proposed TBVs are in **Table 3-16**.

Several sources will be evaluated for bird and mammal TRVs. The lowest value will be applied for the BERA where appropriate. No allometric scaling of doses or application of uncertainty factors are proposed for this BERA as this will likely increase the uncertainty in the TRVs. Efforts will be made to obtain additional TRVs for the remaining explosives listed in **Table 3-17**.

The avian and mammalian TRVs and TBVs for soil invertebrates and terrestrial plants are presented in **Table 3-17**.

Table 3-15 Draft Summary of TRV Sources Reviewed for the Port Angeles Combat Range Baseline Ecological Risk Assessment

Chemical	TRV-NOAEL (mg/kg bw/d) *	TRV-LOAEL (mg/kg bw/d)	Species	Study Description	Reference	Comment
2-Amino-4,6-dinitrotoluene	9	provided but not evaluated	Class: Mammalia	see reference	Wildlife Toxicity Assessment for 2-Amino-4,6-Dinitrotoluene and 4-Amino-2,6-Dinitrotoluene, USACHPPM, Health Effects Research Program Environmental Risk Assessment Program, USACHPPM, Dec. 2005	Low confidence
2-Amino-4,6-dinitrotoluene	3	provided but not evaluated	Bobwhite quail (*Colinus virginianus*)	Subacute and chronic oral gavage	Acute, subacute, and subchronic exposure to 2A-DNT (2-amino-4,6-dinitrotoluene) in the northern bobwhite (Colinus virginianus); Quinn et al, 2010, Ecotoxicology, V19: pp945-952	Based on median LD50=1167 mg/kg
4-Amino-2,6-dinitrotoluene	9	provided but not evaluated	Class: Mammalia	see reference	Wildlife Toxicity Assessment for 2-Amino-4,6-Dinitrotoluene and 4-Amino-2,6-Dinitrotoluene, USACHPPM, Health Effects Research Program Environmental Risk Assessment Program, USACHPPM, Dec. 2005	Low confidence
4-Amino-2,6-dinitrotoluene	3	provided but not evaluated	Bobwhite quail (*Colinus virginianus*)	see reference	Acute, subacute, and subchronic exposure to 2A-DNT (2-amino-4,6-dinitrotoluene) in the northern bobwhite (Colinus virginianus); Quinn et al, 2010, Ecotoxicology, V19: pp945-952	Used 2A-4DNT study as surrogate chemical
1,3-Dinitrobenzene	0.04	provided but not evaluated	Class: Mammalia	see reference	Wildlife Toxicity Assessment for 1,3-Dinitrobenzene (m-DNB), USACHPPM, Final, December, 2001	Moderate confidence
2,4-Dinitrotoluene	0.7	1.4	Class: Mammalia	see reference	Wildlife Toxicity Assessment for 2,4, 2,6-DNT USACHPPM, 2012	LED10 value; high confidence
2,4-Dinitrotoluene	0.01	0.13	Class: Aves	NA	Wildlife Toxicity Assessment for 2,4, 2,6-DNT USACHPPM, 2012	NOAEL-based; low confidence
2,6-Dinitrotoluene	0.7	provided but not evaluated	Class: Mammalia	see reference	U.S. Army Public Health Command, Wildlife Toxicity Assessment for 2,4 & 2,6-Dinitrotoluene, May 2012	Ingestion TRV; moderate confidence
2,6-Dinitrotoluene	0.1	provided but not evaluated	Class: Aves	see reference	U.S. Army Public Health Command, Wildlife Toxicity Assessment for 2,4 & 2,6-Dinitrotoluene, May 2012	Ingestion TRV; low confidence
HMX	2.6	NA	Class: Mammalia	see reference	Talmage et al., 1999 for meadow vole	UFs applied and other extrapolations from NOAEL
Nitroglycerin	3	32	Class: Mammalia		Wildlife Toxicity Assessment for Nitroglycerin, USACHPPM, November, 2001	Recommended value, medium confidence
RDX	6.7	NA	Class: Mammalia	see reference	Talmage et al., 1999 for meadow vole (Talmage, Opresko, Maxwell, & al., 1999)	UFs applied and other extrapolations from NOAEL
RDX	8.7	11	Class: Aves	14 day oral	Wildlife Toxicity Assessment for RDX, USACHPPM, July, 2002, final.	Decreased egg production, Northern bobwhite (Colinus virginianus); Gogal et al, 2001
Tetryl	0.1	1.72	Class: Mammalia	see reference	Wildlife Toxicity Assessment for Tetryl, USACHPPM, 2010 update	medium confidence; reduced female body weight, Reddy et al, 1994, 1999
1,3,5-Trinitrobenzene	2.68	13.31	Class: Mammalia	see reference	Wildlife Toxicity Assessment for Trinitrobenzene, USACHPPM, November, 2001, final.	Medium confidence
2,4,6-Trinitrotoluene	0.2	provided but not evaluated	Class: Mammalia	see reference	Wildlife Toxicity Assessment for 2,4,6-Trinitrotoluene, USACHPPM, November, 2001, final.	High confidence
2,4,6-Trinitrotoluene	0.07	provided but not evaluated	Class: Aves	see reference	Wildlife Toxicity Assessment for 2,4,6-Trinitrotoluene, USACHPPM, November, 2001, final.	Low confidence

NA – not available
TRV - Toxicity Reference Values
NOAEL - no observable adverse effect level
LOAEL – low observable adverse effect level
mg/kg-bw/day or mg/kg-day – milligram per kilogram of body weight per day
LD_{50} – lethal dose to 50% of test population
UF – uncertainty factor
No values for 3,4-dinitroaniline

Table 3-16 Summary of Literature Reviewed for Plant and Soil Invertebrate Toxicity Benchmark Values

Chemical	TBV-Low (mg/kg)	Species	Reference	Comment
2-Amino-4,6-dinitrotoluene	14	Terrestrial Plants	Sunahara, 2012. Development of Toxicity Benchmarks and Bioaccumulation Data of N-based Organic Explosives for Terrestrial Plants and Soil Invertebrates, SERDP Project ER-1416, November (Sunahara, 2012)	Draft Eco-SSL, aged soil
2-Amino-4,6-dinitrotoluene	43	Soil Invertebrates	Sunahara, 2012. Development of Toxicity Benchmarks and Bioaccumulation Data of N-based Organic Explosives for Terrestrial Plants and Soil Invertebrates, SERDP Project ER-1416, November (Sunahara, 2012)	Draft Eco-SSL, aged soil
4-Amino-2,6-dinitrotoluene	33	Terrestrial Plants	Sunahara, 2012. Development of Toxicity Benchmarks and Bioaccumulation Data of N-based Organic Explosives for Terrestrial Plants and Soil Invertebrates, SERDP Project ER-1416, November (Sunahara, 2012)	Draft Eco-SSL, aged soil
4-Amino-2,6-dinitrotoluene	18	Soil Invertebrates	Sunahara, 2012. Development of Toxicity Benchmarks and Bioaccumulation Data of N-based Organic Explosives for Terrestrial Plants and Soil Invertebrates, SERDP Project ER-1416, November (Sunahara, 2012)	Draft Eco-SSL, aged soil
2,4-Dinitrotoluene	6	Terrestrial Plants	Sunahara, 2012. Development of Toxicity Benchmarks and Bioaccumulation Data of N-based Organic Explosives for Terrestrial Plants and Soil Invertebrates, SERDP Project ER-1416, November (Sunahara, 2012)	Draft Eco-SSL, aged soil
2,4-Dinitrotoluene	18	Soil Invertebrates	Sunahara, 2012. Development of Toxicity Benchmarks and Bioaccumulation Data of N-based Organic Explosives for Terrestrial Plants and Soil Invertebrates, SERDP Project ER-1416, November (Sunahara, 2012)	Draft Eco-SSL, aged soil
2,6-Dinitrotoluene	4.5	Terrestrial Plants	Development of Ecological Toxicity and Biomagnification Data for Explosives Contaminants in Soil, Final Technical Report, Project CU-1221, prepared by R. Kuperman (U.S. Army Edgewood Chemical Biological Center, 2003)	Draft Eco-SSL, not published
2,6-Dinitrotoluene	6.9	Soil Invertebrates	Development of Ecological Toxicity and Biomagnification Data for Explosives Contaminants in Soil, Final Technical Report, Project CU-1221, prepared by R. Kuperman, (U.S. Army Edgewood Chemical Biological Center, 2003)	Draft Eco-SSL, not published
HMX	16	Soil Invertebrates	Sunahara, 2012. Development of Toxicity Benchmarks and Bioaccumulation Data of N-based Organic Explosives for Terrestrial Plants and Soil Invertebrates, SERDP Project ER-1416, November (Sunahara, 2012)	Draft Eco-SSL - aged soil
Nitrobenzene	2.2	Soil Invertebrates	LANL EcoRisk Database Release 3.1	
RDX	98.6	Soil Invertebrates	Development of Ecological Toxicity and Biomagnification Data for Explosives Contaminants in Soil, Final Technical Report, Project CU-1221, prepared by R. Kuperman, (U.S. Army Edgewood Chemical Biological Center, 2003)	Draft Eco-SSL
1,3,5-Trinitrobenzene	8.6	Terrestrial Plants	Development of Ecological Toxicity and Biomagnification Data for Explosives Contaminants in Soil, Final Technical Report, Project CU-1221, prepared by R. Kuperman, (U.S. Army Edgewood Chemical Biological Center, 2003)	Draft Eco-SSL
1,3,5-Trinitrobenzene	18.1	Soil Invertebrates	Development of Ecological Toxicity and Biomagnification Data for Explosives Contaminants in Soil, Final Technical Report, Project CU-1221, prepared by R. Kuperman, (U.S. Army Edgewood Chemical Biological Center, 2003)	Draft Eco-SSL
2,4,6-Trinitrotoluene	62	Terrestrial Plants	LANL EcoRisk Database Release 3.1 (LANL, 2012)	Generic plant (terrestrial autotroph - producer)
2,4,6-Trinitrotoluene	32	Soil Invertebrates	LANL EcoRisk Database Release 3.1 (LANL, 2012)	Earthworm (soil-dwelling invertebrate)

TBV-Low – toxicity benchmark value used for no observed effect concentration (NOEC) in **Table 3-17**, below.
LANL – Los Alamos National Laboratory (LANL, 2012)
Eco-SSL – ecological soil screening level
No values for 3,4-dinitroaniline

Table 3-17 Draft Toxicity Reference Values for the Baseline Ecological Risk Assessment

Chemical	Mourning Dove NOAEL	Deer Mouse NOAEL	Plant - NOEC	Soil Fauna - NOEC
Lead	1.63	4.70	120	1,700
2-Amino-4,6-dinitrotoluene	3	9	14	43
4-Amino-2,6-dinitrotoluene	3	9	33	18
1,3-Dinitrobenzene	NA	0.04	2.2	2,260
2,4-Dinitrotoluene	0.01	0.67	6	18
2,6-Dinitrotoluene	0.1	0.7	4.5	6.9
HMX	NA	2.6	NA	16
Nitrobenzene	NA	NA	2.2	2,260
Nitroglycerin	NA	3	NA	NA
2-Nitrotoluene (ortho)	NA	NA	NA	NA
3-Nitrotoluene (meta)	NA	NA	NA	NA
4-Nitrotoluene (para)	NA	NA	NA	NA
PETN	NA	NA	NA	NA
RDX	8.7	6.7	NA	98.6
Tetryl	NA	0.1	NA	NA
1,3,5-Trinitrobenzene	NA	2.68	8.6	18.1
2,4,6-Trinitrotoluene	0.07	0.2	62	32

Note: Table is incomplete but will be completed if quantitative estimates of risk are necessary
NOAEL TRVs are in units of mg/kg body weight/day (mg/kg-d)
NOAEL – no observable adverse effect level
NOEC – no observable effect concentration in mg/kg
mg/kg – milligram per kilogram
Lead values are from the Eco-SSL for lead (USEPA, 2005c)
1,3-dinitrobenzene values from Screening Level Risk Assessment Protocol for Combustion Facilities (SLERAP), (USEPA, 1999), Appendix E. Used same value as a surrogate for nitrobenzene
Used nitrobenzene value plant NOEC for 1,3-dinitrobenzene plant NOEC
No values for 3,4-dinitroaniline

3.11.3.4 Risk Estimation

The integration of toxicity and exposure information is used to predict possible adverse effects to ecological receptors. The HQ method is used to screen sites when potential adverse effects to ecological receptors occur. It provides an evaluation of the potential environmental effect of a given COPEC. The method compares estimates of animal intake values to the TRV; this comparison is expressed as the quotient (i.e., the HQ value) of the ratio of uptake or intake divided by the TRV. If the HQ is greater than 1, a receptor has a potential for adverse effects because of exposure to a contaminant via a specific exposure pathway.

Based on the availability of site data, exposure parameters, and toxicity information, HQs can be determined for each COPEC and exposure pathway affecting the selected receptors at each site. The HQ is calculated using the following expression:

Equation 3-9 Estimation of Hazard Quotient

$$HQ = \frac{Intake\ of\ COPEC\ by\ Animal\ Receptor}{TRV\ for\ COPEC\ for\ Animal\ Receptor}$$

Where

HQ = hazard quotient calculated for a given exposure pathway

A total risk expressed as a hazard index (HI) for each COPEC due to all pathway exposures at the site is usually calculated for each receptor as shown.

Equation 3-10 Estimation of Hazard Index

$$HI = \sum_{j}^{m} HQ$$

Where HI = hazard index which is the sum of all HQs for a receptor at a site, for pathway *j* through the m^{th} pathway

m = Number of pathways assessed for the receptor at a site

HIs exceeding 1 indicate that the receptor being assessed has a potential for adverse effects resulting from exposure to a COPEC via a variety of pathways at a given site. It should be noted that a single chemical or pathway may be the driving force for an HI for a representative species at a site.

Hazard indices exceeding 1 indicate potential risk because the exposure level exceeds the identified effects level. Such values do not necessarily indicate that an effect will occur, only that a lower threshold has been exceeded based on the exposure assumptions used in the model. Since the HI is the sum of HQ values that are themselves conservative, the HIs are also considered conservative.

Note that the HI, as an evaluation of a measurement endpoint, provides some insight into general effects on individual plant and animal reproduction and/or survival in the local population. It is assumed that if effects are judged insignificant for the average individual receptor, they will be considered insignificant at the population level. However, if risks are present at the individual receptor level, risks may or may not be important at the population level.

HQs for plants and soil invertebrates are estimated by dividing the EPC by the no observed effect concentration (NOEC) or other toxicological benchmark**.**

3.11.3.5 Risk Description

The HQs and HIs will serve as measurement endpoints. The degree of the HQs and HIs are discussed relative to the assessment endpoints and potential for unacceptable ecological risks for each receptor by exposure pathway and location.

Hazard indices exceeding 1 indicate that the receptor being assessed has a potential for adverse effects resulting from exposure to a COPEC via a variety of pathways at a given site. It should be noted that a single chemical or pathway may be the driving force for an HI for a representative species at a site.

Note that the HI, as an evaluation of a measurement endpoint, provides some insight into general effects on individual plant and animal reproduction and/or survival in the local population. It is assumed that if effects are judged insignificant for the average individual receptor, they will be considered insignificant at the population level.

3.11.3.6 Uncertainty Analysis

Ecological risk assessment results depend primarily on the weight of evidence supporting particular conclusions, and each line of evidence is subject to varying degrees of uncertainty. Because of the complexity of ecosystems and the associated mechanisms that cause ecological stress, uncertainty in environmental risk characterization is inevitable. Uncertainty stems from a number of sources, including but not limited to the following:

1. Sampling and statistical variability
2. Limitations of toxicity testing
3. Difficulty of extrapolating from laboratory data to field data
4. Problems in evaluating environmental responses to mixtures of contaminants
5. Assumptions underlying the use of fate and transport models
6. Range of conditions for which models, ESLs, TBVs, or TRVs are applicable

Other uncertainty sources include unexpected weather conditions or sources of contamination. A detailed discussion of all sources of uncertainty in the BERA will be provided in the RI Report.

3.12 Munitions and Explosives of Concern Hazard Assessment

The MEC HA allows a project team to evaluate the potential explosive hazard associated with an MRS, given current or reasonably anticipated future conditions, and under various cleanup and land use activities. A MEC HA will be conducted in conjunction with the RI risk assessment to evaluate baseline hazards associated with each MRS. The *USEPA Munitions and Explosives of Concern Hazard Assessment Methodology (MEC HA)* (USEPA, 2008) will be used to assess potential explosive hazards associated with recovered MEC, if any. The MEC HA will then be completed as part of the RI report for the MRS where evaluation of the effectiveness of remedial alternatives is required and to aid in decision-making. This will not preclude an evaluation of each alternative against the nine CERCLA criteria if the MRS proceeds to a FS. Rather, it will be utilized in the evaluation as part of the long-term effectiveness discussion.

The MEC HA will be conducted following the USEPA guidance. If the potential for an encounter with MEC exists, the potential that the encounter will result in death or injury also exists. Consequently, if MEC is known or suspected to be present, a munitions response will be required. That may include further investigation, cleanup of MEC through a removal or remedial action, including land use controls (LUCs), or land use controls alone. Where a cleanup action for MEC has occurred, some level of LUCs will often be required to address the uncertainty that all MEC items have been found and removed from the site. These may range from educational programs to restrictions on land use activities. The utilization of LUCs will be evaluated during the Feasibility Study, if necessary. The MEC HA addresses human health and safety concerns associated with potential exposure to MEC at land based sites. It does not address underwater sites, nor does it address explosive or other hazards associated with stockpile or non-stockpile chemical warfare material. It does not directly address environmental or ecological concerns that might be associated with MEC.

The MEC HA is structured around three components of potential explosive hazard incidents:

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

Each of these components is assessed in the MEC HA by input factors. Each input factor has two or more categories. Each input factor category is associated with a numeric score that reflects the relative contributions of the different input factors to the MEC hazard assessment. The MEC HA scores should not be interpreted as quantitative measures of explosive hazard. The sum of the input factor scores falls within one of four defined ranges, called hazard levels. Each of the four levels reflects site attributes that describe groups of sites and site conditions ranging from the highest to lowest hazards.

The MEC HA allows a project team to assess sites on the most appropriate scale by dividing an MRS into subunits, if necessary. The MEC HA can be used to score a site several times to assess current site conditions, as well as conditions after completion of different levels of proposed cleanup, to assess different types of determined or reasonably anticipated future land use activities.

4.0 Quality Control Plan

This PACR RI Quality Control Plan (QCP) identifies the approach and operational procedures to be employed to perform QC during activities associated with the project. This QCP was developed in accordance with *DID MR-005-11.01* (USACE, 2003a) and the specifications of this RI WP.

The objectives of this QCP are to address the specific operating needs of the project and to establish the necessary levels of management and control to ensure all work performed meets the technical requirements of the applicable project plans and conforms to the requirements of the contract and applicable regulations. Specifically, this QCP addresses the following:

- Document quality including all associated required planning and reporting documents for the PACR RI,
- Daily Quality Control Reports (DQCRs); and weekly and monthly summary reports,
- Health and Safety Inspections,
- QC Inspection Process,
- QC Audits,
- Corrective/Preventive Action Procedures,
- Lessons Learned,
- Submittal Review and Document Change Procedures,
- Qualifications and Training, and
- Chemical Data Quality Management.

4.1 Document Quality

The contractor has in place policies for the generation of quality documents associated with the PACR RI project. These standards ensure that each document generated for the project, primarily plans and reports are subjected to a three-phase quality review process. Once a primary author has generated a completed document, the preparatory phase of review, (peer-review), is performed by another project scientist or manager to ensure that all facts and data presented are accurate and comprehensive. The document is returned to the author for incorporation of corrections or suggested changes, and back checked with the peer reviewer. A complete, accurate, and clear document is then submitted to the PM for a quality review, as the initial phase of document control where the PM verifies the report correctly represents the work to be completed or completed with a full understanding of all stakeholders and the client needs, and especially with the contract requirements and all appropriate CERCLA RI requirements (Management Quality Review). The document is returned to the author for incorporation of corrections or suggested changes, and back checked with the PM. Before the document is produced in quantity either electronically and/or as hard copies, the follow-up phase of inspection is completed where one printed copy of each document is inspected for its completeness in that all text, figures, charts, tables, appendices, etc. are present and complete, accurately listed, and that the document has a professional structure and appearance (Final QC Inspection). If the document has any components missing, or misnamed, or is not professional in appearance, it is corrected by the document author or production team, and verified that the corrections have been made by the person completing the Final QC Inspection.

4.2 Daily Quality Control Reports

For all field work days, the UXOQCS is responsible for preparing and submitting the DQCR to the USACE PM/OESS and posting it to the PACR RI project file. A DQCR is generated to provide an overview of all field associated QC activities performed each day for definable features of work (DFW), including those performed for subcontractor and supplier activities. If media sampling is completed as part of a day's activities, the project Field/Geophysical Technician will assist the UXOQCS with the generation of the DQCR, documenting all sampling activities for that day. The QC reports are generated to present an accurate and complete picture of daily QC activities. They will report both conforming and deficient conditions, and will meet the requirements to be precise, factual, legible, and objective. Copies of supporting documentation, such as checklists and surveillance reports will be attached.

Each DQCR is to be assigned and tracked by a unique number comprised of the Delivery Order number followed by the date expressed as DDMMYY. Copies of DQCRs with attachments are to be maintained in the project file. An example DQCR is provided in **Appendix F**.

4.3 Site Health and Safety Inspections

The SSHO will conduct daily health and safety inspections. As stated in **Section 2.3.10**, the SSHO will coordinate with the SUXOS and UXOSO to identify and conduct appropriate field inspections of project activities and associated field equipment. Activity Hazard Analysis (AHA) are prepared and documented for each of the phases of work. AHAs define the activities being performed and identify the sequences, task specific hazards, daily site conditions, equipment, materials, and all control measures used to eliminate or reduce each hazard to an acceptable level of risk. Work will not begin until the AHA for each activity has been reviewed and accepted by all employees involved. The SSHO shall periodically inspect the field activities for concurrence of the approved AHA’s and that work is completed safely. In addition, the SSHO shall ensure all personnel onsite have current medical clearances and up-to-date H&S training. The SSHO will provide an ongoing review of all protection levels and designated PPE per AHA as project work is performed, and will inform the SUXOS of the need to upgrade/downgrade protection levels as appropriate under the direction of the HSS and/ or the HSD.

Safety inspections will be conducted by the following individuals at the specified frequency:

- SSHO will conduct health and safety inspections on a daily basis.
- SUXOS will conduct health and safety inspections regularly, no less than once each week.

Any deficiencies will be documented in the DQCR and the HDR Safety and Occupational Health Tracking System. This tracking system lists and monitors the status of safety and health deficiencies in chronological order. The list shall be posted on the project safety bulletin board or at a minimum held responsible to the SSHO and on-site. All deficiencies are tracked in order to ensure proper follow-up and corrective action. The project safety bulletin board or binder will provide the following information:

- Date the deficiency was identified,
- Description of deficiency,
- Name of person responsible for correcting the deficiency,
- Projected resolution date, and
- Date resolved.

The HSS will conduct an accident review after each incident to determine the root cause of the incident, identify required corrective measures, assign a responsible person, and evaluate any needed changes to the APP/SSHP. After the deficiency is resolved, the DQCR and HDR tracking system will be updated. Lessons learned will be shared in safety meetings for continuous safety improvement.

Outside organizations or regulatory agencies may perform inspections or audits of HDR's health and safety policies and procedures on the PACR job site at any given time. The HDR PM, HSD, SSHO, UXOSO, SUXOS, and the on-site client representatives shall be immediately notified if a regulatory agency requests access to the PACR for a compliance inspection. The inspection will be allowed to proceed even if contact cannot be made with the individuals listed.

4.4 Quality Control Inspections

The QC staff will be responsible for assisting the HDR PM in maintaining compliance with this PACR RI project QCP through the implementation of a three-phase inspection process for DFWs and other associated project activities. This section specifies the minimum requirements that must be met and to what extent QC monitoring must be conducted by the QC staff. The inspection system is based on the three-phase system of control to cover the PACR RIWP project activities. The three-phase inspection system consists of preparatory, initial, and follow-up inspections for applicable DFWs and other associated project activities. The three-phase inspection system will be performed on all proposed work sequences. HDR has in place three-phases of control procedures for the production of project documents and deliverables, especially plans and reports. These procedures will be utilized throughout the project to ensure the quality of these documents.

A DFW is defined as a major work element that must be performed to execute and complete the project. It consists of an activity or task that is separate and distinct from other activities and requires separate control. The DFWs that have been identified for this project are as follows:

- Writing and Obtaining Approval through Various Phases of Project RI Planning Documents

- Coordinating On-Site Field Work Activities
- Field Work, Primarily Consisting of the following seven DFWs:
  - Assisted Visual Surveys
  - Digital Geophysical Mapping
  - Subsurface Investigations
  - MEC Disposal by Detonation
  - MD Handling, Storage, and Demilitarization
  - Environmental Media Sampling and Analysis
  - IDW Handling and Disposal
- Writing and Obtaining Approval through Various Phases of Project RI Reporting Documents

The primary field work DFWs are summarized in **Table 4-1** along with reference to the pertinent RIWP section. Inspection criteria for these DFWs will depend on the work tasks being performed. Procedures for conducting these DFWs are provided in this RIWP, which may include specific QC procedures and tests that are integral to the work, such as equipment calibration and testing. This QCP does not attempt to reiterate these procedures. The QC staff will refer to the applicable portion of this RIWP for specific QC requirements to be checked during QC inspections. Similarly, associated H&S inspections will be performed using the project APP/SSHP.

Table 4-1 Field Work Definable Features of Work- Port Angeles Combat Range

Feature No.	Definable Feature Of Work	Work Document Reference
1	Assisted Visual Surveys	RI Work Plan, Section 3.1.4
2	Digital Geophysical Mapping	RI Work Plan, Section 3.1.5
3	Subsurface Investigations	RI Work Plan, Section 3.1.6
4	MEC Disposal by Detonation	RI Work Plan, Section 3.7
5	MD Handling, Storage, and Demilitarization	RI Work Plan, Section 3.7 and 5.0
6	Environmental Media Sampling	RI Work Plan, Section 3.1.7 and UFP-QAPP
7	IDW Handling and Disposal	RI Work Plan, Section 3.8

4.4.1 Preparatory Phase Inspection

A preparatory phase inspection will be performed prior to beginning each field work primary DFW. The purposes are to review applicable work plans, processes, SOPs and specifications and verify that the necessary resources, conditions, and controls are in place and compliant before the start of field work activities. The UXOQCS will verify that lessons learned during similar previous projects work have been incorporated as appropriate into the PACR project procedures to prevent recurrence of past problems. The UXOQCS shall generate and use a Preparatory Phase Quality Control Inspection Report template for each DFW inspected. A general checklist is provided in **Appendix F**, and will be customized to address the specific DFW, work scope, and site conditions encountered. The PACR RIWP and SOPs will be reviewed by the UXOQCS to ensure that prequalifying requirements or conditions, equipment and materials, appropriate work sequences, methodology, hold/witness points, and QC provisions are adequately described for the PACR project. The UXOQCS will verify, as applicable, the following:

- The required PACR RIWP SOPs have been prepared and approved, are appropriate for the PACR project and are available to the field staff;
- Field equipment and materials meet required specifications;
- Field equipment is appropriate for its intended use, and is available, functional, and calibrated;
- Work responsibilities have been assigned and communicated;
- Field staff possess the necessary qualifications, knowledge, expertise, and information to perform their jobs;
- Arrangements for support services (such as on-site testing and off-site test laboratories) have been made; and
- Prerequisite site work has been completed.

Discrepancies between existing conditions and approved plans/procedures will be resolved. Corrective actions for unsatisfactory and nonconforming conditions identified during a preparatory inspection will be verified by the QC staff prior to granting approval to begin work.

The USACE will be notified at least 48 hours prior to conducting the preparatory phase inspections. Results will be documented in a Preparatory Phase Quality Control Report and summarized in the DQCR (see **Appendix F**).

4.4.2 Initial Phase Inspection

An initial phase inspection will be performed, as applicable, the first time each DFW is performed. The purposes of this inspection will be to check preliminary work for compliance with procedures and specifications, to establish the acceptable level of workmanship, and to check for omissions and resolve differences of interpretation. The UXOQCS will generate and use an initial inspection checklist. The Initial Phase Quality Control Report form provided in **Appendix F** may be customized to address the specific work scope and site conditions. The UXOQCS will be responsible to ensure that discrepancies between site practices and approved specifications are identified and resolved. The UXOQCS will oversee, observe, and inspect all applicable DFWs at the project site and ensure that off-site activities, such as analytical testing, are properly controlled. Discrepancies between site practices and approved plans/procedures are to be resolved and corrective actions for unsatisfactory and nonconforming conditions or practices are to be verified by the CQCSM or designee before granting approval to proceed. Client notification for initial inspections will be required at least 48 hours in advance. Results of initial inspections are to be documented in the Initial Phase Quality Control Report and summarized in the DQCR.

4.4.3 Follow-On Phase Inspection

Follow-on phase inspections will be performed periodically while the DFW is performed in order to ensure continuous compliance and level of workmanship. The UXOQCS will be responsible to monitor on-site practices and operations taking place, and to verify continued compliance of the specifications and requirements within the contract, site work scope, and applicable approved project plans and procedures. Discrepancies between site practices and approved plans/procedures will be documented, resolved, and corrective actions for unsatisfactory and nonconforming conditions or practices will be verified by the UXOQCS prior to granting approval to continue work. Results of Follow-on inspection will be documented in the Follow-on Phase Quality Control Report and summarized in the DQCR (**Appendix F**).

Periodic checks of procedures and/or documentation will be made for completeness, accuracy, and consistency. Follow-on inspections of field activities will typically include a review of field data and any calibration logs for all instruments in use.

Additional inspections may be performed on the same DFW at the discretion of the USACE or the UXOQCS with approval by the USACE. Completion and acceptance inspections will also be performed to verify that project requirements relevant to the DFW are satisfied.

4.5 Corrective/Preventive Action Procedures

Regular inspections are completed to prevent deviations from the work plans and methods being used to perform quality work. However, this is not always the case. When unplanned deviations are detected that may affect the quality of the work performed, a nonconformance will be reported. If a change is discovered prior to beginning work on the PACR project, it will be documented as a variance.

4.5.1 Nonconformance Documentation

Complex field investigation, sampling, and analysis tasks, such as those scheduled to be performed routinely as part of the PACR RI, are sometimes subject to non-conformances. A nonconformance is defined as an unplanned deviation that occurs during the implementation of a task that cannot usually be corrected until after it has occurred. Non-conformances may include using unapproved methods, not following procedures, or substituting unapproved materials or equipment to perform an activity. All non-conformances must go through a cycle of being identified, documented, assessed, corrected, and reported. Each of these steps is critical in handling non-conformances as they are encountered.

The identification of a nonconformance is the responsibility of every person assigned to support the project. This responsibility is incorporated into each person's understanding of the tasks assigned by the supervisor or task leader and the individual's function on the project. As personnel perform their duties on the project, they must constantly be aware of the scope of the activity and recognize when a deviation from the planned activity has occurred or is occurring. After recognizing deviations, they must take action by informing their supervisors or site leaders and documenting in writing the specifics of what occurred using a nonconformance report. An example Nonconformance Report form is included in **Appendix F**. When completed, the Nonconformance Report will be reviewed by a peer or supervisor and presented to the HDR PM. The HDR PM will assign a lead individual who will work with the person who identified the nonconformance (and other team members as needed) to assess its impact on the project and develop a corrective action plan.

As warranted by the nonconformance, the USACE PM and/or appropriate technical support person will be contacted by the HDR PM and asked to provide input into the assessment and corrective action process. In all cases, the HDR PM will be consulted and the corrective action will be decided upon and recorded on the nonconformance report. Once the corrective action is implemented, the contractor PM will assign a person to verify that the corrective action is successful in preventing future occurrences of the nonconformance. When this has been verified, the nonconformance report will be completed, and copies will be distributed to all individuals who participated in the identification, assessment, and resolution of the nonconformance. The completed report will be included as a permanent part of the project file. In addition, full documentation will be provided to USACE detailing what failed the QC process, why it failed, and how the problem was corrected.

Before the next periodic revision of the QCP, documented non-conformances will be reviewed and appropriate resolutions incorporated into the revised document. Non-conformances will also be used by project auditors to help focus audits on the historical project deviations. The auditors will review the corrective action procedures established from the resolution of the nonconformance and determine whether the original nonconformance issues have been permanently resolved. Modified corrective actions may be indicated by the findings of the audit.

4.5.2 Continual Improvement

The PACR project staff at all levels are encouraged to provide recommendations for improvements in established work processes and techniques. The intent is to identify activities that are compliant but can be performed in a more efficient or cost-effective manner.

Typical quality improvement recommendations include the identification of an existing practice that should be improved (e.g., a bottleneck in production) and/or recommendations for an alternative practice that provides a benefit without compromising prescribed standards of quality. Project staff members are to bring their recommendations to the attention of project management or QC staff through verbal or written means.

Deviations from established protocols are not to be implemented without prior written approval of the PM and concurrence of the CQCSM. Staff-initiated recommendations resulting in tangible benefits to the project should be formally acknowledged by project management personnel.

4.6 Client Quality Assurance

Audits of various project functions will be performed by the USACE. These functions include, but are not limited to, explosive inventory, site documentation, scheduled reports, MEC/MD accountability, MPPEH inspection, assisted visual surveys, MC sampling and analysis, and administrative support activities. All required records will be maintained on-site for audit purposes. DQCRs will be maintained by the UXOQCS to document details of the field investigation.

The USACE OESS will be on-site and conduct quality assurance inspections as described in *DDESB Technical Paper 27 Explosive Safety Training* (DDESB, 2013).

The USACE geophysicists will independently seed ISO items as a DGM quality assurance measure as described in **Section 3.4.10** of the GIP.

4.7 Lessons Learned

Lessons learned on the project will be captured and reported on QC documentation forms described in this work plan. Significant lessons learned will be highlighted, as applicable, in the monthly status reports.

4.8 Submittal Management

The HDR PM will be responsible for overall management and control of project submittals, including submittal scheduling and tracking. The CQCSM will be responsible for ensuring, through detailed review, that submittals, as well as the materials and work these represent, are in full compliance with applicable contract specifications. The CQCSM will also be responsible for ensuring that a project file is established and maintained and that accurate project documents are retained and controlled as prescribed herein.

4.8.1 Submittal Reviews

Prior to client delivery or use, project submittals are to be reviewed and approved by the HDR PM. Knowledgeable members of the project staff and the PM or designated representative will conduct technical reviews for the project planning documents and report(s). Multiple reviewers will be used to evaluate different components of the documents (i.e., technical, editorial, and QC reviews). The reviewers will ensure that the planning documents and report(s) meet the following requirements:

- The documents satisfy the requirements of the SOW, requirements and DQOs identified, client requirements (including applicable DIDs), and applicable regulatory requirements;
- Report assumptions are clearly stated, justified, and documented;
- The reports clearly and accurately present the site investigation results;
- The basis for the recommendations and conclusions presented in the reports are clearly documented;
- The tables and figures are prepared and checked according to contractor requirements; and
- The documents have been proofread (i.e., punctuation, grammar, and spelling are correct).

Submitted documents may also contain signature locations for HDR PM approval. External reviewer comments, and comment resolution records will be retained in the project file, traceable to the deliverable, for recordkeeping purposes and future reference.

4.8.2 Work Plan Changes

The distribution of this PACR RIWP will be controlled by the HDR PM in order to ensure that the most recent, accepted version is available at all locations where investigative activities covered by this RIWP are performed. Revisions to this RIWP will require the same level of approval, control, and distribution as the original. Revisions will be documented in the footer of each page and personnel will be informed of changes.

This RIWP will be used with the understanding that unanticipated conditions may dictate a change in the plan as written. Any necessary deviations from the plan will be brought to the attention of the USACE as soon as possible and a written request for variance will be submitted via a field change request (FCR) form to document the decision made (**Appendix F**).

4.9 Qualifications and Training

Project staff will be qualified to perform their assigned tasks in accordance with terms outlined by the contract. UXO personnel will meet the minimum qualification standards commensurate with their duties, in accordance with *DDESB TP 18* (DDESB, 2004). The UXOQCS will conduct and document all site-specific training and maintain records documenting the required qualifications and training for each site worker. All personnel who enter a hazardous site must recognize and understand the potential safety and health hazards. It is the intent of this training to provide every person a level of safety and health training consistent with his or her job function and responsibility. Site-specific safety discussions will be held daily at the beginning of each workday. The UXOSO/SSHO will monitor expiration dates of health and safety qualifications in order to advise employees of the need for refresher training and will maintain training records for personnel and visitors, as required by this RIWP.

4.10 Uniform Federal Policy – Quality Assurance Plan

The UFP-QAPP is provided in **Appendix E** of this RIWP. The UFP-QAPP was developed in accordance with the *Uniform Federal Policy for Quality Assurance Project Plans* to provide assurance that the monitoring of quality-related events has occurred, and that the data gathered in support of the project are complete, accurate, and precise (USEPA, 2005d). Implementation of this UFP-QAPP will help ensure the validity of the data collected and will establish a firm foundation for decisions regarding the RI.

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5.0 Explosives Management Plan

This Explosives Management Plan (EMP) provides details for the management of explosives during the PACR RI. The EMP details the explosives safety items required to implement the PACR RIWP including:

- Explosives acquisition and use source, quantity, and licenses/permits;
- Explosives management, storage, security, and transportation procedures and requirements; and
- Explosives receipt, inventory, authorized use, return to the magazine and magazine inspection, or lost, stolen, or unauthorized use, and the disposal of any remaining explosives.

5.1 Licenses/Permits

The RI at the PACR are subject to the explosives regulations and requirements established by; the State of Washington, Department of Defense (DoD 6055.09-M, 29) (DoD, 2010), the DOT, the US Bureau of Alcohol Tobacco, Firearms, and Explosives ([BATFE] Publication 5400.7) (BATFE, 2007), and the USACE (Explosives Safety and Health Requirements Manual, EM 385-1-97) (USACE, 2013).

HDR will acquire and maintain all licenses and permits required to purchase, store, transport, and use explosives in the State of Washington. Current copies of licenses/permits for explosives purchase, storage, and transportation will be available at the site for inspection by any regulating agencies. Specific permits/licenses in place are as follows:

- US Department of Treasury, Bureau of Alcohol, Tobacco, Firearms, and Explosives - License/Permit, 33-User of High Explosives (granted to HDR);
- Washington State – Individual Blasters License;
- Washington State – Explosives Storage License;
- Washington State – Explosives Purchaser's License;
- Department of Transportation issued Commercial Drivers License (CDL); and
- Department of Transportation Hazardous Materials endorsement (granted to individual HDR employees holding CDLs).

5.2 Acquisition

HDR and its UXO qualified personnel are licensed under BATFE and permitted by the State of Washington to purchase, possess, store, transport, and use explosives for UXO disposal (including demilitarization of military munitions). HDR will supply commercial demolition materials for munitions management operations at the PACR. Accountability and use of the HDR purchased explosives will remain with HDR.

5.2.1 Estimated Quantity and Type of Explosives

HDR plans to acquire boosters, perforators, detonating cord, detonators, and trunk line for the PACR project. Total net explosives weight (NEW) of donor explosives is presented in the approved DDESB Explosives Site Plan (ESP) available at the discretion of the USACE.

5.2.2 Acquisition Source

HDR will purchase the explosives required for the project through local licensed and permitted commercial vendors or manufacturers.

5.3 Initial Receipt of Explosives

Upon initial receipt of explosives shipments, each shipping container will be inspected and inventoried, and the contents verified to be the quantity and type of material ordered and shipped by the vendor or manufacturer, as indicated on the invoice, shipping documents, or bills of lading. At a minimum, an inventory will be conducted jointly by the SUXOS or designated alternate, Magazine Custodian, and the UXOQCS. Only countable units shall be ordered.

All documentation associated with the order, shipment, receipt, inspections, inventories, accountability, and use of explosives will be maintained at the PACR field office throughout the period of the active fieldwork after which they shall be retained by HDR in its home office. The UXOQCS will periodically confirm that documentation is occurring relative to the accounting, transportation, and storage of explosives.

5.3.1 Procedure of Reconciling Discrepancies

In the event that discrepancies are identified during initial receipt of explosives, the supplier/shipper will be immediately notified of the discrepancy. HDR is responsible for full documentation of the event and immediate resolution of the discrepancy, including the possibility of returning all items. HDR will not accept custody of products if there is a question of quality or quantity of explosive materials. The HDR PM, SUXOS or UXOQCS and the on-site USACE OESS will be immediately notified of the situation.

5.4 Storage

HDR shall use a Type II magazine to store explosives. Please refer to the approved DDESB ESP available at the discretion of the USACE. The explosives magazine location is pending. The magazine will be inspected and approved prior to storing explosives. The explosives approved in the ESP for use at this site are Class 1.1 or Class 1.4, and the maximum combined NEW for the Type II magazine will be 50 lbs.

Based on DoD Ammunition and Explosives Safety Standards (DoD 6055.09-M) Volume 3, Enclosure 3 (DoD, 2010), the required safe distance from the Type II magazines to the nearest inhabited building for this NEW is 388 ft. The required safe separation distance from public traffic routes is 233 ft. The following distances are in reference to the magazine:

- Type II portable magazine - Nearest inhabited buildings is a domicile at ~3900 ft. to the north
- Type II portable magazine - Nearest public traffic route is Deer Park Road at 730 ft. to the north

The surrounding area must be kept clear of rubbish, brush, dry grass or trees (less than 10 ft. tall for no less than a 25 ft. radius. Volatile material must be kept at least 50 ft. away from outdoor magazines.

5.4.1 Physical Security of Explosives Storage Facilities

The magazine will be located within a parcel to be determined. Magazine construction will be in accordance with US Bureau of Alcohol Tobacco, Firearms, and Explosives ([BATFE] P 5400.17) (BATFE, 2007). The magazine doors will be equipped with two key-operated, high-security, 5-pin pad locks. These locks will be covered by a tamper proof hood. The anticipated vendor for both the rental of the explosives storage magazine and purchase of the donor explosives is Austin Powder Co Inc. located at 2852 Centralia Alpha Rd, Onalaska, WA 98570.

5.5 Transportation

This section presents the vehicle requirements and on-site transportation procedures for explosives during the PACR RI activities.

5.5.1 Explosives Transportation to Disposal Locations Procedures

On-site transportation of explosives from the magazine to the demolition location(s) will be in a designated vehicle. If the demolition location is inaccessible by vehicle, donor explosives will be hand carried to the demolition site under the supervision of the SUXOS. Locked day boxes will be secured to the vehicle bed to prevent the release of materials in the event of poor road conditions or a vehicular accident. Other materials or supplies will not be placed on or in the cargo space of the demolition truck containing explosives with the exception of items required for the operation, and properly secured non-sparking equipment used expressly in the handling of explosives. Explosives and initiators will be transported in separate containers in the same vehicle.

Prior to moving donor explosives, a individual with a CDL with hazardous materials endorsement will visually inspect the transport vehicle to ensure that it is equipped to safely transport explosives. These materials will be loaded, placarded, and transported in accordance with local, state, and federal regulations.

Donor explosives will be transported on routes predetermined for each operation by the SUXOS and CDL holder. Explosives and detonators will be transported promptly and without delays in transit and will be transported at times and over routes that expose a minimum number of persons. Vehicles transporting explosives will not exceed the posted speed limits. When transporting donor explosives or MEC off paved roads, vehicles will not exceed 25 miles per hour. If MEC has been determined safe to transport, it will be placed in appropriate containers with packing material to prevent migration of the hazardous fillers. Padding will be added to protect the exposed filler from heat, shock, and friction.

5.5.2 Vehicle Requirements

Explosives transport vehicles will have a substantially constructed body and will be equipped with suitable sides and tailgates. Vehicles containing explosives or detonators will be maintained in good condition, will be operated at safe speeds, in accordance with all safe operating procedures as outlined in the APP/SSHP, and will be posted with proper warning signs. Additionally, prior to explosives transportation the CDL driver will insure the vehicle meets requirements in DD Form 626 Motor Vehicle Inspection (Transporting Hazardous Materials). Vehicle placards will be posted IAW the US Department of Transportation.

5.6 Receipt Procedures

Upon receipt of explosives and after validation as described in **Section 5.3**, a Magazine Data Card (**Appendix F**) will be completed for each lot number of explosives stored at the project site. The card is self-explanatory; items on the card that do not apply to commercial explosives (such as DoD Identification Code [DoDICs] or federal stock numbers) will not be completed. Whenever explosives stocks are supplied, inventoried, or issued, the action will be noted in the appropriate block(s) of the card. Whenever a card is completely filled in, a new card will be started and the old one retained as part of the official record and submitted with the final report. The UXOQCS will periodically confirm that entries are properly made on the Magazine Data Cards.

5.6.1 Authorized Individuals

The SUXOS or designee (only another Washington State Blasters License holder) will be responsible for the receipt, issuance, and use of all explosives that are used for venting of MPPEH and disposal of MEC. A Blasters License holder will draw the necessary explosives and accompany the explosives to the venting and/or disposal location. Once at the detonation location, the Blaster-in-Charge will be responsible for the venting and/or disposal operation and will ensure the explosives are used for the intended purpose for which they were issued. The SUXOS and UXOSO or UXOQCS will observe all venting and demolition setups and shots to verify that the explosives that were issued were used for their intended purpose or returned to the magazines. An "*Explosives Consumption Report*" (detailed in **Appendix F**) will be issued by the SUXOS or designee and included in the weekly report. The UXOQCS will periodically confirm the accuracy of written entries.

5.7 Inventories

Inventories shall be made monthly and not in conjunction with the issue or return of explosives for a disposal operation. A visual inspection of the magazine will also be completed at least once a week. A Washington State Blasters License holder will conduct the inventory. The SUXOS and/or UXOQCS will oversee the inventory and verify the accuracy of the count and the entries on the Magazine Data Card. If a discrepancy is found no adjustments will be made to the Magazine Data Cards as a result of the inventory until after a thorough investigation has occurred and the SUXOS have approved the adjustment. The SUXOS will indicate in the daily journal the fact that an inventory was conducted that day.

5.8 Inspection of Magazines

Visual inspections of the storage magazines shall be conducted every seven days. This inspection will not serve as an inventory but will be sufficient to determine whether there has been unauthorized entry into the magazines, or unauthorized removal of the contents of the magazine.

5.8.1 Lost, Stolen, or Unauthorized Use of Explosives

Loss or theft of explosives will be reported as required in 27 CFR Part 55, Sub Part C paragraph 55 .30. (BATFE, 2010) BATFE Form 5400.5 will be completed by the SUXOS or designee within 24 hours and forwarded to the BATFE, with a copy to the on-site USACE OESS, the USACE PM, and the HDR's PM. The following persons or entities will be notified immediately:

- On-site USACE OESS,
- USACE PM (who will notify the Contracting Officer, if necessary),
- HDR PM,
- BATFE at 1-800-800-3855,
- Washington State Department of Labor and Industries, and
- Port Angeles Police Department.

5.9 Procedure for the Return of Unused Explosives to Magazine

A Washington State Blasters License holder and a CDL holder will return unused "*daily use*" explosives to the magazines. Explosives will be returned to their original containers. The returned quantities will be indicated on the Magazine Data Card. The UXOQCS will periodically confirm the accuracy of written entries.

5.9.1 Disposal of Remaining Explosives

If, during the execution or at the end of the project, it is determined that the explosives are to be disposed of by detonation, an inventory of all material will be made by the SUXOS, a Magazine Custodian, and a UXOQCS. The above people will witness the destruction of the explosives and sign the Explosives Consumption Report documenting the inventory and destruction of the explosive. This document will become part of the official site record and will be included in the final report.

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6.0 Environmental Protection Plan

The purpose of this Environmental Protection Plan (EPP) is to describe the approach, methods, and procedures to be employed by HDR and its subcontractors to protect the natural and cultural environments during performance of tasks associated with the PACR RI. Specifically, this EPP describes the procedures and methods that will be implemented during RI activities to minimize pollution, protect and conserve natural resources, restore damaged areas, and control noise and dust within reasonable limits. This EPP was prepared in accordance with *DID MR-005-12, Environmental Protection Plan* (USACE, 2003b).

6.1 Identification of Environmental Resources

Portions of the PACR are designated as a commercial forest (**Figure 3-2**). The majority of the PACR is owned by the City of Port Angeles and the land is managed as a protected watershed for the City of Port Angeles. PACR site is accessible to the general public.

6.1.1 Rare, Threatened, and Endangered Species

The USFWS listing (USFWS, 2013) identifies the following species that may be present or near the PACR at some of all life stages:

- Bull trout (*Salvelinus confluentus*) – Coastal Puget Sound distinct population segment (DPS) - Threatened
- Marbled Murrelet (*Brachyramphus marmoratus*) - Threatened
- Northern spotted owl (*Strix occidentalis caurina*) - Threatened
- Short-tailed albatross (*Phoebastria albatrus*) [outer coast] - Endangered

There is federally designated critical habitat for the following species in Clallam County:

1. Bull trout
2. Marbled Murrelet
3. Northern spotted owl

While there is federally designated critical habitat located within one (1) mile of PACR (**Figure 1-7**), there are no known habitats with the PACR based on the information available at the drafting of this RIWP.

Information pertaining to T&E species was sought as part of the planning process. According to the ASR, *“Earlier conversations with the Clallam County Extension Office and the USNPS environmental personnel, along with review of Environmental Impact Statements and reports from the Natural Heritage Program, indicated there was no confirmed existence of any endangered plant or animal species within the project site. However, it was noted that complete surveys of the area were not done, and it was likely that at least some of the state threatened or endangered wildlife species would occur in a transient mode”* (USACE, 1996).

Recovery Plans have been published by the USFWS for the Marbled Murrelet and the Northern spotted owl (*http://ecos.fws.gov/tess_public/pub/speciesRecovery.jsp?sort=1*).

The USFWS also maintains species which are candidate species and proposed species for listing (USFWS, 2013). The species that are proposed for listing in Washington and possibly present in Clallam County include:

- White Bluffs bladderpod (*Physaria douglasii ssp. tuplashensis*) – Proposed Threatened
- Umtanum Desert buckwheat (*Eriogonum codium*) – Proposed Threatened
- Taylor's Checkerspot (*Euphydryas editha taylori*) – Proposed Endangered
- Streaked Horned lark (*Eremophila alpestris strigata*) – Proposed Threatened
- Olympia pocket gopher (*Thomomys mazama pugetensis*) – Proposed Threatened
- Roy Prairie pocket gopher (*Thomomys mazama glacialis*) – Proposed Threatened
- Tenino pocket gopher *(Thomomys mazama ssp. tumuli*) – Proposed Threatened
- Yelm pocket gopher (*Thomomys mazama ssp. yelmensis*) – Proposed Threatened
- North American wolverine (*Gulo gulo luscus*) – Proposed Threatened
- Dolly Varden (*Salvelinus malma*)- Proposed Similarity of Appearance (Threatened)

Species identified as candidates for Federal listing (USFWS, 2013) which are known or believed to occur in Washington and possibly in Clallam County include:

- Yellow-Billed Cuckoo (*Coccyzus americanus*)
- Oregon Spotted frog (*Rana pretiosa*)
- Canada Lynx *(Lynx canadensis)*
- Whitebark pine *(Pinus albicaulis)*
- Brush Prairie Pocket gopher (Thomomys mazama ssp. douglasii)
- Olympic pocket gopher *(Thomomys mazama ssp. melanops)*
- Shelton pocket gopher (*Thomomys mazama ssp. couchi)*
- Tacoma Western pocket gopher (*Thomomys mazama tacomensis*) (Pacific Region)
- Greater sage-grouse *(Centrocercus urophasianus*)
- Washington ground squirrel *(Urocitellus washingtoni)*
- Northern Wormwood (*Artemisia borealis var. wormskioldii)*

Priority areas for the Marbled Murrelet in Clallam County are near the PACR (WDFW, 2008). Priority anadromous and resident fish are also nearby (Shaw, 2009). WDFW defines priority areas as follows: "*Species are often considered a priority only within known limiting habitats (e.g., breeding areas) or within areas that support a relatively high number of individuals (e.g., regular concentrations)*" (WDFW, 2008). The Washington Department of Natural Resources (WDNR) indicated that there were no records for rare plants or high quality native ecosystems near the PACR (WDNR, 2008).

USFWS Pacific Region 1 Washington Office, the Washington State Department of Natural Resources, and the Washington Department of Fish and Wildlife Conservation Division are jointly tasked with enforcing Federal statutes with respect to the ESA. In addition, these agencies designate species within the state of Washington that may need specific and additional protection and habitat conservation.

The Washington Department of Fish and Wildlife Conservation Division provided a comprehensive Federal and State summary of T&E and candidate species for listing and species of concern at their website (http://wdfw.wa.gov/conservation/endangered/) (**Appendix L**). In addition, **Appendix L** provides a list of State monitor species.

The Washington State Department of Natural Resource Natural Heritage Program (WNHP) and the Spokane District of the U.S. Department of the Interior (USDI) Bureau of Land Management (BLM) compiled a list of plants for a field guide a field guide containing fact sheets for 40 rare species of vascular plants. This guide was expanded to include 370 vascular plants, 11 mosses and one lichen (*http://www1.dnr.wa.gov/nhp/refdesk/fguide/htm/fgmain.htm, Access date: 8/16/12*).

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Table 6-1 Designation of Important Ecological Places

	Important Ecological Place Category [a]	Yes / No	Comments
1	Locally important ecological place identified by the Integrated Natural Resource Management Plan, BRAC Cleanup Plan or Redevelopment Plan, or other official land management plans.	☐ / ☒	
2	Critical habitat for Federal designated endangered or threatened species.	☐ / ☒	Source: http://criticalhabitat.fws.gov/crithab/ (Access date 4/4/2013)
3	Marine Sanctuary.	☐ / ☒	
4	National Park.	☒ / ☐	The Olympic National Park is located to the south of the MRS R01. No investigation will take place with the National Park Boundary.
5	Designated Federal Wilderness Area.	☐ / ☒	
6	Areas identified under the Coastal Zone Management Act.	☐ / ☒	
7	Sensitive Areas identified under the National Estuary Program or Near Coastal Waters Program.	☐ / ☒	
8	Critical areas identified under the Clean Lakes Program.	☐ / ☒	
9	National Monument.	☐ / ☒	
10	National Seashore Recreational Area.	☐ / ☒	
11	National Lakeshore Recreational Area.	☐ / ☒	
12	Habitat known to be used by Federal designated or proposed endangered or threatened species.	☒ / ☐	Occasional transient use by the Northern spotted owl (threatened) and the Marbled Murrelet (threatened) possible. Bull trout (threatened) habitat located within 2 miles of the PACR MRS.
13	National preserve.	☐ / ☒	
14	National or State Wildlife Refuge.	☐ / ☒	
15	Unit of Coastal Barrier Resources System.	☐ / ☒	
16	Coastal Barrier (undeveloped).	☐ / ☒	
17	Federal land designated for protection of natural ecosystems.	☐ / ☒	MRSPP scoring for PACR (Range Complex No. 1) MRS will be handled as an ecologically-sensitive area.
18	Administratively Proposed Federal Wilderness Area.	☐ / ☒	

Table 6-1 Designation of Important Ecological Places

	Important Ecological Place Category [a]	Yes / No	Comments
19	Spawning areas critical for the maintenance of fish/shellfish species within river, lake, or coastal tidal waters.	☐ / ☒	
20	Migratory pathways and feeding areas critical for maintenance of anadromous fish species within river reaches or areas in lakes or coastal tidal waters in which fish spend extended periods of time.	☐ / ☒	
	Important Ecological Place Category [a]	**Yes / No**	**Comments**
21	Terrestrial areas utilized for breeding by large or dense aggregations of animals.	☒ / ☐	Area used by recreational hunters, therefore wildlife breeding populations assumed present.
22	National river reach designated as Recreational.	☐ / ☒	
23	Habitat known to be used by state designated endangered or threatened species.	☒ / ☐	Occasional transient use by Northern spotted owl (endangered) and/or Marbled Murrelet (threatened) possible.
24	Habitat known to be used by species under review as to its Federal endangered or threatened status.	☐ / ☒	
25	Coastal Barrier (partially developed).	☐ / ☒	
26	Federally designated Scenic or Wild River.	☐ / ☒	
27	State land designated for wildlife or game management.	☐ / ☒	
28	State-designated Scenic or Wild River.	☐ / ☒	
29	State-designated Natural Areas.	☐ / ☒	
30	Particular areas, relatively small in size, important to maintenance of unique biotic communities.	☐ / ☒	
31	State-designated areas for protection or maintenance of aquatic life.	☐ / ☒	
32	Wetlands.	☒ / ☐	0.43 designated acres of freshwater emergent wetland in northern portion of the PACR.
33	Fragile landscapes, land sensitive to degradation if vegetative habitat or cover diminishes.	☒ / ☐	Property associated with the PACR serves as a protected watershed for the City of Port Angeles.

6.1.2 Watersheds and Wetlands

Three creeks transect the PACR flowing from south to north; Surveyor Creek, Frog Creek, and Morse Creek (**Figure 1-5**). These creeks flow north toward the City of Port Angeles. Property associated with the PACR serves as a protected watershed for the City of Port Angeles. A surface water intake is located at the location labeled as "*Port Angeles Dam*" on **Figure 1-5**, and the second intake is located approximately 1,200 ft. downstream of the dam. The intake at "*Port Angeles Dam*" is within the PACR boundary.

Drinking water in the area is obtained from Clallam County PUD No. 1 water systems and private water supply wells. Clallam County PUD No. 1 obtains water from Morse Creek at two water intake structures and from wells (Shaw, 2009).

The USFWS National Wetlands Inventory indicates a 0.43 acre wetland in the southern portion of the large open meadow area of the PACR. The wetland is classified as freshwater emergent. It is specifically described as a palustrine, emergent, persistent, seasonally flooded wetland. Wetlands of this type are dominated by trees, shrubs, emergents, mosses or lichens. Surface water is present for extended periods, especially early in the growing season (USFWS, 2013a) .

There are two private domestic wells located in the northern portion of the PACR. The total depth of the Mortensen well is 285 ft. bgs and the Whitcomb well is 116 ft. bgs. Static water levels were recorded as 0 ft. and 30 ft. btoc, respectively. Both wells were installed by Louie's Well Drilling Inc. (WDOE, 2013).

6.1.3 Timber Resources

The natural vegetation in the area consists largely of fir, spruce, alder and hemlock trees. (USACE, 1996). Manke Timber Company and Green Crow Timber Company own a number of parcels located within the PACR.

6.1.4 Wilderness Areas

The PACR is not located within a designated Wilderness Area.

6.2 Proposed Mitigation Measures

The following sections detail proposed environmental protection mitigation measures to be implemented during the PACR RI. As this project is a RI no removal actions are anticipated.

6.2.1 Manifesting, Transportation, and Waste Disposal

Production of hazardous wastes is not anticipated. MEC items that require destruction or venting will be destroyed in demolition operations, followed by recovery and off-site disposal of the nonhazardous fragments. When detonation of MEC is determined appropriate, explosives will be brought to the location and will then be utilized in consolidated shots or BIP.

Appropriate on-site housekeeping practices (e.g. rubbish and brush removal) and will be maintained during the course of the project. All RI project or MRS-generated wastes will be collected and disposed properly off-site.

6.2.2 Burning Activities

No burning will take place at the PACR as part of the RI activities. Any activities that could potentially cause a spark (such as during demolition operations) will be carefully monitored. Fire extinguishers will be present during demolition operations, and an assessment of vegetation conditions will be made prior to each detonation. If the vegetation is dry and may pose a wildfire hazard, precautionary measures will be taken. This will include spraying water on the area or other measures. Fire prevention measures and emergency response plans for fire control are discussed in the APP/SSHP (**Appendix D**).

6.2.3 Dust and Emission Control

Field operations are not anticipated to generate an amount of dust that would require dust control measures. However, if required, any dust suppression will consist of water application to exposed surface soils from an approved water source. Water will be applied so as to prevent soil migration to nearby drainage pathways. Additional information on dust monitoring and controls is presented in the APP/SSHP (**Appendix D**).

6.2.4 Spill Control and Prevention

Use of powered equipment at the PACR will be limited. Refueling of vehicles and equipment will be conducted off-site.

6.2.5 Storage Areas and Temporary Facilities

Temporary facilities, such as an explosives storage magazine and temporary waste staging areas, if required, will be staged so as to minimize disturbance of native vegetation or interference with investigation areas. HDR will coordinate the locations of these temporary facilities with USACE, the City of Port Angeles, and commercial land owners prior to mobilizing them to the field. All temporary storage and facilities will be removed upon completion of the RI activities.

6.2.6 Access Routes

It is not expected that field operations will require the construction of new access roads. However, in the event that additional access or modification to existing roads is required, the contractor will coordinate these activities with USACE and property owners prior to initiating vegetation and/or soil disturbance.

6.2.7 Protection and Restoration of Vegetation

Widespread vegetation removal is not anticipated for the RI. Some minor vegetation disturbance (brush cutting, grass mowing and removal of low hanging limbs) may be required to facilitate the DGM surveys or assisted visual surveys, but large-scale vegetation removal, clearing, or other activities that would disturb vegetation and create erosion conditions are not anticipated. Some vegetation disturbance may occur near temporary facilities. Clearing activities at the PACR will be minimized to the extent possible to allow for the execution of work. To further minimize environmental impacts, the following special protection measures will be implemented:

- Any vegetation disturbance will be coordinated with the appropriate landowners.
- HDR will consult with the USACE and appropriate landowners prior to commencing fieldwork that will disturb any ecological or cultural resources or vegetation clearing.
- Locations of temporary facilities will be approved and coordinated with the USACE and the property owner.
- Strict fire control measures will be implemented during MEC disposal operations as described in **Section 6.3** and the APP/SHPP (**Appendix D**).
- Minimal vegetation clearance will be performed to reduce the possibility of the influx of nonnative, noxious weeds. Although minimal vegetation clearance is anticipated, it will be conducted following approval of the landowners.
- Clothing, equipment, tools, and other items brought to the MRS will be inspected for presence of foreign items that could impact the MRS (e.g., exotic slugs/snails, plants, and seeds). Equipment and tools will be cleaned prior to being introduced to the MRS.

All disturbed or impacted areas will be restored to their original condition. All disturbed impacted areas where vegetation was removed will be seeded with a native seed mix within seven (7) days of disturbance. Restoration activities will be coordinated with the appropriate landowners.

Inside Passage Seed and Native Plant Services (http://www.insidepassageseeds.com/) has been consulted regarding suitable native plants for PACR. The native seed mixture presented below is an example of a mixture that may be utilized for restoration efforts:

6%	*Achillea millefolium* Yarrow
10%	*Agrostis exarata,* Pacific bentgrass
12%	*Danthonia californica,* California oatgrass
18%	*Deschampsia caespitosa,* **Tufted Hair-grass** or **Tussock grass**
12%	*Elymus glaucus*, Wild rye
20%	*Festuca rubra*, **red fescue** or **creeping red fescue**
8%	*Hordeum brachyantherum*, Meadow barley
10%	*Lupinus spp.*, Lupine
4%	*Prunella vulgaris*, common self-heal or heal-all
100%	

6.2.8 Soil Stabilization Requirements

Surface vegetation clearance will be limited and no significant excavation is anticipated. Excavation of buried MEC/MD may be required based on the past historical uses of the site and the results of the geophysical investigation activities to be performed as discussed in **Section 3.4**. Because of the investigative nature of the proposed activities, the exact location(s) where excavations by hand may be conducted is not known at this time.

Disturbed portions of each work area where the subsurface investigation activities have permanently ceased will be stabilized with permanent native seeding as presented in **Table 6-2**.

Table 6-2 Permanent Stabilization Requirements

Area Requiring Permanent Stabilization	Time Frame to Apply Erosion Controls
Any area that will lie dormant for one year or more	Within 7 days of the most recent disturbance
Any areas within 50 ft. of a stream and at final grade	Within 2 days of reaching final grade
Any other areas at final grade	Within 7 days of reaching final grade within that area

All permanent vegetative cover will be placed in consideration of landowner requirements, adaptability to site conditions, aesthetics and natural resource values and maintenance requirements.

6.2.9 Decontamination and Disposal of Equipment

Waste may be generated as a result of decontamination and disposal of equipment or other materiel; however, hazardous waste is not anticipated for this project. Any used equipment or components (such as batteries or used PPE) that must be disposed will be placed in a suitable storage area pending accumulation of suitable quantities and will be disposed of as municipal waste in an appropriate manner (also refer to **Section 3.7.2**).

6.2.10 Minimization of Disturbed Area

To minimize the impacts of vehicles and other equipment within the PACR, vehicles will remain on existing roads to the extent practicable.

6.3 Post-Activity Cleanup

Following completion of fieldwork activities, investigation related debris created during the project will be removed. If deemed appropriate by stakeholders, the MRS will be restored to the original topography and the surface will be re-vegetated. Temporary facilities, such as storage magazine, dumpsters, portable toilets, and similar facilities will be removed. Any MD generated during demolition procedures will be transported off-site (refer to **Section 5.5**).

7.0 Property Management Plan

This PACR Property Management Plan describes how government property will be managed for this project.

7.1 Government Property

Property used on the PACR RI project can include both government property and contractor property. Government property can include:

- Government Furnished Property – Property directly acquired and furnished to the project by the government.
- Contractor-Acquired Property – Property directly purchased by the contractor for the project using government funds.

There are no plans to obtain or use government property for this PACR RI project. However, if government property is received or purchased by the contractor, it will be managed according to the following guidelines.

7.2 Purchase Requisition Procedures

Acquisitions will be carefully managed in accordance with Federal Acquisition Regulations.

7.3 Storage

Government property will be stored in an organized manner so that inventory of the material can easily be performed on a regular basis.

7.4 Property Tracking

All government property will be tracked to ensure all items are maintained in accordance with the procedures outlined in this Property Management Plan. All property will be classified into two main categories:

- Expendable Property - Supplies and materials that are consumed or expended routinely and lose their identity under contract performance. Expendable property includes small tools with a unit value of not more than $250.
- Non-Expendable Property - Property that is durable with an expected useful life of one or more years, is complete in itself, and does not lose its identity or become a component part of another item.

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8.0 Interim Holding Facility Siting Plan for Recovered Chemical Warfare Materiel Projects

An Interim Holding Facility Siting Plan for Recovered Chemical Warfare Materiel is not applicable to the PACR RI project.

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