DRAFT

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

REMEDIAL ACTION UNIT 3

CAMP BONNEVILLE

VANCOUVER, WASHINGTON

U.S. Army Corps of Engineers
Seattle District
And
Huntsville Center

Contract No. DACA87-00-D-0038
Delivery Order 0017

November 29, 2004

Prepared by

PARSONS

EXECUTIVE SUMMARY

ES.1 The Camp Bonneville Military Reservation (Camp Bonneville) was used by the Department of Defense from 1910 to 1995 for troop training. Training exercises conducted at Camp Bonneville included weapons training using small arms, assault weapons, and field and air defense artillery. Camp Bonneville consists of approximately 3,840 acres and is located wholly in Clark County, Washington. The U.S. Congress approved the closure of Camp Bonneville under the 1995 Base Realignment and Closure (BRAC) Commission.

ES.2 Camp Bonneville is proposed for transfer to Clark County. This property transfer will provide significant recreational, educational, and environmental opportunities for the local community and will be managed as a regional park by Clark County. The regional park includes designated areas for classrooms, amphitheater, RV and tent camping, and environmental study areas. The remainder of Camp Bonneville is designated as a wildlife management area and will be utilized for wildlife habitat, forestry, hiking and equestrian trails.

ES.3 Consistent with BRAC policy, cleanup at Camp Bonneville is being conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP). Parsons Infrastructure & Technology Group (Parsons) prepared this Remedial Investigation / Feasibility Study (RI/FS) Report consistent with CERCLA and the Washington State Model Toxics Control Act (MTCA). This Remedial Action Unit (RAU) 3 RI/FS Report deals exclusively with explosives safety of munitions and explosives of concern (MEC) resulting from prior actions at Camp Bonneville (potential impacts to soil and groundwater associated with constituent migration from munitions is not addressed herein).

ES.4 The Camp Bonneville RAU 3 site characterization has been conducted in multiple phases of work, with each subsequent phase building upon the findings and conclusions of the prior investigations. The site characterization efforts have included the following:

- United States Army Corps of Engineers (USACE)-St. Louis conducted a historical records search and prepared an Archives Search Report in 1997 which details findings on Camp Bonneville.

- United States Army Engineering and Support Center - Huntsville (USAESCH) conducted a statistical MEC sampling site characterization effort at Camp Bonneville in 1998.

- USACE Topographic Engineering Center performed a historical aerial photo-analysis of Camp Bonneville in 2000 to identify areas of potential concern.

- USAESCH conducted an instrument-aided field reconnaissance to evaluate and document MEC-related characteristics of areas of concern and areas of potential concern (AOCs/AOPCs) in 2001.

- A comprehensive Conceptual Site Model (CSM) for MEC activities was collaboratively developed by representatives of Washington State Department of Ecology, Clark County, U.S. Environmental Protection Agency and the U.S. Army in 2002.

- USAESCH conducted a second round of instrument-aided reconnaissance in 2002 to evaluate MEC-related characteristics in the proposed future regional park lands, including the roads and trails, and to confirm or refute the CSM.

ES.5 Camp Bonneville has been thoroughly characterized for the presence, location, and density of munitoins that are artifacts of past troop training activities. A total of 207 MEC sampling grids, totaling approximately 40 acres, were geophysically mapped and intrusively sampled. A total of 16,004 discrete reconnaissance data waypoints have been collected, analyzed, and mapped using digital technology and geographic information system (GIS) geo-spatial analysis. Over 2,400 acres of the 3,840 acre site has been characterized for the presence of potential MEC-related activities. The 2,400 acres of site characterization includes all of the known and suspected MEC source sites; all of the proposed future regional park re-use sites; all of the existing trails and roads; and the entire 1,200 acre area of the proposed future regional park. The Camp Bonneville RAU 3 site characterization also included the performance of two interim removal actions. These two time-critical removal actions (TCRAs) were conducted to address risks associated with the discovery of unexploded ordnance (UXO) at the M203 Ranges and Demolition Area 1 sites.

ES.6 A qualitative risk assessment to evaluate MEC hazards was performed to aid in evaluating cleanup alternatives and to establish acceptable remediation levels for use during the feasibility study. The MEC risk assessment approach developed for Camp Bonneville is a two-step process. The initial evaluation addresses the munition source characteristics and the type of explosive safety hazards that are likely to be encountered. The second evaluation addresses the likelihood for interaction between the MEC source and the human receptor and is based on the future land reuse and accessibility of an area. The Target Areas, Firing Points and open burn / open demolition (OB/OD) Areas were determined to pose the greatest explosive safety exposure hazard; while the remaining site types pose a negligible explosive safety exposure hazard.

ES.7 In addition, each of the planned reuse areas listed below was selected for risk analysis to evaluate if these sites require a specific risk management strategy:

- Roads and Trails;

- High Intensity Reuse Areas;

- High – Accessible Medium Intensity Reuse Areas;
- Remaining Medium Intensity Reuse Areas; and
- Wildlife Management Area.

ES.8 None of the planned reuse areas were determined to pose an appreciable explosive exposure hazard based on an evaluation of the MEC source and receptor interaction.

ES.9 MTCA does not identify a cleanup level for MEC; nor does it identify exposure factors for MEC that could be used to develop a site-specific cleanup level. The MTCA methods that were developed for chemical contaminants are not applicable for establishing cleanup levels for MEC. Consistent with MTCA Washington Administrative Code (WAC 173-340) remediation levels and points of compliance were identified to ensure protection of the public consistent with the planned land use. The remediation level is based on the site characterization data and the MEC risk assessment. The proposed remediation level for Camp Bonneville is the condition where the likelihood for MEC source and receptor interaction is negligible. The points of compliance will be based on those areas (measured in both horizontal and vertical dimensions) where the MEC source and receptor interactions are likely to occur.

ES.10 A Feasibility Study (FS) was conducted consistent with CERCLA and MTCA (WAC 173-340-350) requirements. The following six cleanup action alternatives were evaluated for each of the MEC source types and proposed reuse areas:

- No Further Action (NFA);
- Institutional Controls (ICs);
- Surface Clearance with ICs;
- Clearance to Frost Depth (14 inches) with ICs;
- Subsurface Clearance (to a depth based on projected end use) with ICs; and
- Excavation and Restoration (E&R).

ES.11 A disproportionate cost analysis was performed, consistent with MTCA, to evaluate whether the cleanup action uses permanent solutions to the maximum extent practicable. Although the E&R cleanup alternative is a permanent remedy, implementation of this cleanup action alternative at Camp Bonneville results in near-total ecological destruction, and as such, does not meet the MTCA minimum threshold requirements. The disproportionate cost analysis compared the costs and benefits of the cleanup action alternatives.

ES.12 The cleanup actions recommended for Camp Bonneville based on the FS include the following:

- Target Areas - Frost Depth Clearance (14-inches);
- Firing Points – Frost Depth Clearance (14-inches) ;
- OB/OD Areas - Subsurface Clearance (4 feet) in Demolition Areas and surface clearance in buffer;
- High Intensity Reuse Areas – Subsurface Clearance (4 feet) and Frost Depth Clearance (14-inches) depending on the proposed future reuse (intrusive or non-intrusive, respectively); and,
- High – Accessible Medium Intensity Reuse Areas – Frost Depth Clearance (14-inches).

ES.13 In addition to the clearance actions, site-specific ICs consisting of signage and/or fencing are recommended; as well as site-wide ICs consisting of land use controls and educational awareness program (brochures, fact sheets, outreach to schools, audio/visual presentations, etc). Additional site-wide IC components also include the establishment of an exhibit and display depicting the Camp Bonneville site history and munitions used at the site. The purpose of land use controls is to ensure that the Camp Bonneville regional park remains as a park, and the wildlife management area continues to be used only for wildlife management and forestry. The estimated cost to implement site-wide ICs is $250,000. The total estimated cost for implementation of the recommended cleanup action alternatives, including site-wide ICs is $16,774,000. Table ES.1 presents a summary of the sites, cleanup actions and associated costs.

TABLE ES.1
SUMMARY OF RECOMMENDED CLEANUP ACTIONS AND COSTS

Site Name	Recommended Cleanup Action	Cost
Target Areas	Frost Depth Clearance (14-inches) with Site-Specific ICs	$273,000
Central Impact Target Area	Site-Specific ICs	$124,000
Open Burn/Open Demolition Areas	Subsurface Clearance (4 feet) at Demolition Areas 2 and 3 in a 300-feet x 300-feet Grid and Site-Specific ICs; Clearance to Frost Depth near the Demolition Areas 1, 2, and 3 in a 500-feet x 500-feet Grid Buffer Area;	$150,000 $1,120,000
Firing Points	Frost Depth Clearance (14-inches) with Site-Specific ICs	$421,000
Training Areas (M203 Practice Range/ Mortar Practice Range)	Site-Specific ICs	$6,000
Range Safety Fans	Site-Wide ICs	N/A
Storage Magazines/Transfer Points (Building 2950)	Site-Specific ICs	$3,000
Maneuver Areas	Site-Wide ICs	N/A
Central Impact Area (Not Including Targets)	Site-Specific ICs	$573,000
Roads and Trails	Frost Depth Clearance (14-inches) and Site-Specific ICs	$2,142,000
High Intensity Reuse Areas	Subsurface Clearance (4 feet) for Reuse Areas with Future Intrusive Activities; Frost Depth Clearance (14-inches) for the Reuse Areas with No Future Intrusive Activities; and Site-specific ICs	$2,264,000 $4,805,000
High Accessible – Medium Intensity Reuse Areas	Frost Depth Clearance (14-inches) with Site-Specific ICs	$4,643,000
Remaining Medium Reuse Intensity Areas	Site-Wide ICs	N/A
Wildlife Management Area	Site-Wide ICs	N/A
Site-Wide	Site-Wide ICs	$250,000

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LIST OF ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
AOPC	Area of Potential Concern
AR	Army Regulation
ARARs	Applicable or Relevant and Appropriate Requirements
ASR	Archives Search Report
BOCC	Board of County Commissioners
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CCC	Civilian Conservation Corps
CERFA	Community Environmental Response Facilitation Act
CMTC	Citizens Military Training Camps
CSM	Conceptual Site Model
DA	Department of Army
DGM	Digital Geologic / Geophysical Mapping
DNR	Department of Natural Resources
DoD	Department of Defense
EA	Environment Assessment
E&R	Excavation and Restoration
EBS	Environment Baseline Study
EIS	Environmental Impact Statement
EE/CA	Engineering Evaluation / Cost Analysis
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
ESA	Environmental Study Area
ESH	Explosive Safety Hazard
FBI	Federal Bureau of Investigation
FS	Feasibility Study
GIS	Geographical Information System
GPS	Global Positioning System
HE	High Explosive
HEAT	High Explosive Anti-Tank
HSR	Hazard Severity Ranking
ICs	Institutional Controls
ID	Identification
LAW	Light Anti-tank Weapon
LRA	Local Redevelopment Authority
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
MRE	Meal, Ready-to-Eat
msl	mean sea level
MTCA	Model Toxics Control Act
NCP	National Contingency Plan
NFA	No Further Action

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

N/A	Not Applicable
OB / OD	Open Burn / Open Detonation
OE	Ordnance and Explosive
PDA	Personal Digital Assistant
RAU 3	Remedial Action Unit 3
RI	Remedial Investigation
RI/FS	Remedial Investigation / Feasibility Study
ROTC	Reserve Officer Training Corps
RP	Regional Park
RPC	Reuse Planning Committee
RV	Recreational Vehicle
SOP	Standard / Standing Operating Procedure
SOW	Statement of Work
SPRT	Sequential Probability Ratio Test
TCRA	Time Critical Removal Action
TEC	Topographic Engineering Center
USACE	United States Army Corps of Engineers
USAESCH	United States Army Engineering and Support Center, Huntsville
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UXO	Unexploded Ordnance
WAC	Washington Administrative Code
WMA	Wildlife Management Area
WP	White Phosphorus

SECTION 1

INTRODUCTION

1.0 PROJECT AUTHORIZATION

1.1.1 Parsons Infrastructure & Technology Group (Parsons) was awarded Delivery Order No. 0017, Contract No. DACA87-00-D-0038 from the U.S. Army Engineering Support Center, Huntsville (USAESCH) in October 2001. The contract was awarded to conduct an Engineering Evaluation / Cost Analysis (EE/CA) at Camp Bonneville, Vancouver, Washington. Subsequently, the Army agreed to work cooperatively with the Washington Department of Ecology and perform a Remedial Investigation/Feasibility Study (RI/FS) consistent with both Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Washington State Model Toxics Control Act requirements (MTCA). This RI/FS Report was prepared consistent with the USAESCH scope of work (SOW), revised December 2002 and the Washington State MTCA Chapter 173-340 Washington Administrative Code (WAC).

1.2 PURPOSE AND SCOPE

1.2.1 The purpose of this Camp Bonneville Remedial Action Unit (RAU) 3 RI/FS Report is to document and present:

- Munitions and explosives of concern (MEC) site characterization processes and findings;
- Development of appropriate MEC risk assessment methods and results;
- Development of MEC remediation levels;
- Identification and screening of various cleanup actions; and
- Rationale for selection of proposed cleanup action(s) for the different sites located at Camp Bonneville.

1.2.2 This RAU 3 RI/FS Report deals exclusively with explosives safety of MEC resulting from prior actions at Camp Bonneville (potential impacts to soil and groundwater associated with constituent migration from munitions is not addressed herein).

1.3 REPORT ORGANIZATION

1.3.1 This Camp Bonneville RAU 3 RI/FS Report is organized to meet the format requirements of, and contain the appropriate and applicable information identified in Washington State MTCA, Chapter 173-340 WAC. Table 1.1 outlines the Sections and Appendices included in this document.

TABLE 1.1
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Section	Content
Section 1	Introduction
Section 2	Site Description
Section 3	MEC Site Characterization
Section 4	MEC Risk Assessment
Section 5	MEC Cleanup Standards
Section 6	Identification of Cleanup Action Alternatives
Section 7	Screening of Cleanup Action Alternatives
Section 8	Recommended Cleanup Actions
Section 9	References
Appendix A	Ordnance Items Descriptions
Appendix B	Institutional Controls Plan
Appendix C	Detailed Cost Estimates

SECTION 2

SITE DESCRIPTION

2.1 FACILITY INFORMATION

Project Name: Camp Bonneville Military Reservation

Project Manager: Mr. Eric Waehling, Base Environmental Coordinator
AFZH-PWE MS17, Box 339500,
Fort Lewis, WA 98433-9500
(253) 966-1732

2.2 SITE DESCRIPTION

2.2.1 Site Location

2.2.1.1 The 3,840-acre Camp Bonneville site is located northeast of Vancouver, Washington, in the southeastern region of Clark County (Figure 2.1). The property is approximately five miles from Vancouver, Washington and approximately seven miles north of the Columbia River. Camp Bonneville is located along the western foothills of the Cascade Mountain Range, with Camp Hill and Little Elkhorn Mountain to the northwest, Munsell Hill to the west, and Little Baldy Mountain to the south.

2.2.1.2 Vehicular access to Camp Bonneville is restricted to a single entrance. The entrance is located on SE 232nd Ave. and enters the site from the west at the Camp Killpack cantonment. The entrance is gated and monitored by the facilities managers.

2.2.2 Climate

2.2.2.1 The Camp Bonneville area has mild, wet winters and moderately warm, dry summers. January is the coldest month, with an average temperature of approximately 38 degrees Fahrenheit (°F). July and August are the warmest months, with an average temperature of approximately 69°F. Typically, only 26 days a year experience temperatures below freezing, and 7 days have temperatures above 90°F.

2.2.2.2 Precipitation in the area is typically caused by the passage of low-pressure zones along a path from the north Pacific Ocean eastward during the winter and spring. The rainy season usually begins in late-September to mid-October and continues through March or April. An average of 154 days a year have measurable amounts of rainfall, with an average annual precipitation of approximately 47 inches. Annual snowfall in the Vancouver area averages about 8.4 inches. The average snow depth is typically only 2 or 3 inches, with continuous snow cover lasting one to three days at a time (USACE, 1999).

Figure 2.1 Site Location Map

Based on published, conservative ("worst case") values for nearby Portland, Oregon, the depth of frost penetration for Camp Bonneville was determined to be 14-inches (USACE, 2000).

2.2.3 Physiography

2.2.3.1 The majority of the Camp Bonneville property consists of moderately steep, heavily vegetated foothill slopes of the Cascade Ranges. The Lacamas Creek valley floor is a relatively narrow floodplain, and ranges in elevation from approximately 360 feet above mean sea level (msl) in the central portion of the site to approximately 290 feet msl on the southwestern end of the property. The adjacent slopes rise to elevations of between 1,000 and 1,500 feet within the Camp Bonneville boundaries.

2.2.3.2 Lacamas Creek flows southwestward from the confluence of North Fork Creek and East Fork Creek in the north-central part of Camp Bonneville, to the southwestern corner of the property. It is fed by David Creek and Buck Creek, which drain the southeastern part of the property. From the southwestern property boundary, Lacamas Creek flows southwestward toward the town of Proebstel, where it turns toward the southeast and continues to its confluence with the Columbia River at the town of Camas.

2.2.3.3 The two cantonments, Camp Killpack and Camp Bonneville, are located on the Lacamas Creek valley floor. The cantonment areas are accessible by a paved roadway through the entrance of Camp Bonneville. Access within the camp is limited to a few all-season gravel roads, most of which are on the valley floor, and dirt roads leading into perimeter areas in the northern, southern, and eastern portions of the facility. Access to the camp is currently restricted to law enforcement, military personnel, and others on official business.

2.2.4 Regional Geology

2.2.4.1 Camp Bonneville is situated along the structural and physiographic boundary between the western flank of the southern Cascade Mountains and the Portland-Vancouver Basin. Four distinctive geologic units underlie Camp Bonneville:

- Quaternary floodplain and stream channel alluvium and lacustrine deposits, which mantle the Lacamas Creek valley floor;
- A Quaternary landslide deposit formed in bedrock on the steep slope along David Creek;
- A thick sequence of Quaternary to Pliocene-age gravel, fine-grained sand, and cobbly and bouldery sand known as the Troutdale Formation, which underlies areas to the west of the Bonneville cantonment; and,
- Oligocene-age volcanic bedrock, which is exposed at the surface in the eastern part of the Camp.

2.2.4.2 The alluvium underlying the Lacamas Creek valley floor was deposited as stream channel, floodplain, and alluvial fan sediments. This type of deposit typically varies significantly in grain size, both laterally and vertically, depending on localized depositional environments.

2.2.4.3 A large landslide deposit has been mapped on the steep northwest-facing slope of Lacamas Creek above the Camp Bonneville cantonment (Phillips, 1987). The age of the landslide is not known, although its topographic expression suggests that it is ancient. The slide involved displacement of surface soils and bedrock over approximately 100 acres of land adjoining David Creek. The landslide deposits extended from an elevation of about 1,000 feet at the headwall of the slide to an elevation of about 500 feet at its toe along David Creek.

2.2.4.4 The Troutdale Formation, which underlies a portion of the western part of the camp, ranges from a poorly consolidated sand and gravel to a cemented conglomerate in its upper part. There is considerable variation in the lithology and thickness of the Troutdale Formation. In general, the formation thins eastward against the underlying bedrock, and the lower part of the formation reportedly is typically coarser grained toward the east (Mundorff, 1964).

2.2.4.5 Bedrock is exposed at the surface in the eastern part of the Camp. The bedrock is composed of Oligocene-age volcanic rocks, including andesite and basaltic flows, minor flow breccias, pyroclastics, and tuffs, with some interbedded sedimentary rocks. Andesite is the most common volcanic rock in the area. It generally ranges from medium to very fine grained, is commonly porphyritic, and is medium to brownish gray. This volcanic bedrock unit underlies the Lacamas Creek valley floor alluvial/lacustrine deposits, and the Troutdale Formation, where it is present.

2.2.5 Soils

2.2.5.1 The major soil type at Camp Bonneville is located on the slopes of the foothills. The slope of this surface is very steep and the surface layer is stony. The well drained and slowly permeable soil has a high available water capacity. The upland soils in this area are shallow, stony, and poorly consolidated. The lowland soils surrounding Lacamas Creek tend to have higher clay content. Surface runoff is rapid and the potential hazard of erosion is great on bare surfaces.

2.2.5.2 In a typical soil profile from surface to depth, Camp Bonneville soils consist of: thin, friable, dark reddish-brown clayey sandy silt; firm, reddish-brown heavy clayey sandy silt; and a very firm, dark-brown gravely clayey-sandy-silt. The majority of soil at the site is a stony, dark reddish-brown clayey-sandy-silt. The bedrock is composed of basalt, and the depth to basalt bedrock differs as the topography changes. Generally, as the slope increases, the bedrock depth becomes shallower.

2.2.6 Hydrology

2.2.6.1 The existing water supply wells in the Camp Bonneville area appear to draw groundwater from volcanic rock. The volcanic rock typically is a poor aquifer. At places

the rock is weathered to depths of several tens of feet, and a considerable volume of water may be stored in the saturated subsoil. Wells drilled into the unweathered volcanic rock typically yield only enough water for limited domestic use. In some cases, groundwater may be obtained from the vesicular, broken, and brecciated upper part of an individual lava flow, immediately beneath the base of the overlying flow.

2.2.6.2 Shallow groundwater appears to generally conform to site topography. The water table is typically within a few feet of the surface in the Lacamas Creek valley area. Iron staining observed in the soil profile above the water table provides an indication that the groundwater beneath the valley floor is very near the ground surface during the rainy season. The water table aquifer appears to fluctuate only a few feet in depth, rising in the fall through spring during the rainy season, and falling during the drier summer months.

2.2.7 Surrounding Land Use and Populations

2.2.7.1 Surrounding Land Use

2.2.7.1.1 Camp Bonneville is located entirely within Clark County, which is one of the fastest growing counties in the state of Washington. The land uses surrounding Camp Bonneville are predominantly agricultural, residential, and forestry. The current zoning around Camp Bonneville is FR-80 (forest zoning with an 80-acre minimum lot size). Neighboring properties are zoned FR-80, FR-40, R-10 (rural estate zoning with minimum 10 acre lots), and R-5. As Clark County has grown, so has the expansion of residential development near Camp Bonneville. Although current zoning permits nothing smaller than a five-acre lot size, many residents own smaller lots. These residents obtained their property prior to the adoption of the current standards.

2.2.7.1.2 The northeastern boundary of the camp borders with the Yacolt Burn State forest, which is managed by the Washington State Department of Natural Resources (DNR). The Livingston Quarry is a gravel mining operation that also exists as an adjacent land use activity along the southern boundary. Livingston Cemetery (two acres) is just south of the camp's access road and outside of the main gate along the western property boundary.

2.2.7.2 Population

2.2.7.2.1 Clark County, Washington had a population of 345,238 based on the 2000 U.S. Census Bureau Report. The Washington State Office of Financial Management estimates the Clark County 2004 population to be 383,300. The population growth rate of Clark County has it ranked as one of the fastest growing counties in Washington State. This growth rate is anticipated to continue in the future as the adjacent Portland, Oregon metropolitan area has "Urban Growth Boundaries" with restrictive zoning and land use controls. Clark County is subjected to less restrictive land development / growth management systems since it is located in Washington State and is not subject to the jurisdiction of Portland, Oregon. As such, Clark County is an outlet for population growth and development in the metro Portland, Oregon area. Clark County has a land area of 628 square miles, resulting in a population density of approximately 610 people per square mile, based on the 2004 population estimates.

2.2.8 Archeological and Historical Resources

2.2.8.1 Numerous surveys of local historic records and available studies in the general area have been conducted; however, no references were identified that included any activity or structure of historical or archeological significance (Parsons, 1998; Dalan, et al., 1981; Dornbos 1986a,b; Heritage Research Associates, 1986; Larson, 1980; U.S. Army Corps of Engineers, Seattle District, 1986; Washington Department of Natural Resources, Office of Archeology, 1994).

2.2.8.2 Woodward and Clyde (1996) conducted a review of the listings for National Historic Landmarks, the National Register of Historic Places, the State Register of Historic Places, and properties removed from the listings as of January 1993. This review did not reveal any listed resources on Camp Bonneville. The State Historic Preservation Officer determined that the Killpack cantonment was ineligible for inclusion on the National Register of Historic Places.

2.2.9 Ecosystems

2.2.9.1 Camp Bonneville is located at the tip of a portion of prairie habitat that extends into the foothills of the Cascade Mountains (Clark County, 1998). The Washington Cooperative Fish and Wildlife Research Unit of the University of Washington (Seattle) have mapped the area of Camp Bonneville. The majority of the site is in the "Westside western hemlock" vegetation zone (University of Washington, 1998). Forested areas on the installation occur on the higher elevations. These areas are densely wooded and provide an excellent habitat for existing wildlife. The aged stands on the installation contain Douglas fir that are generally less than 50 years old. Scattered stands of western red cedar and hemlocks that are remnants of the original plant community are located at Camp Bonneville. Other plant species include: vine maple (Acer circinatum), salmonberry (Rubus spectabilis), elderberry (Sambucus canadensis), hazelnut (Corylus sp.), salal (Gaultheria shallon), and sword fern. The Lacamas Creek valley floor is occupied by generally level to sloping lands; and consists of open fields, light to densely vegetated areas, and wetlands associated with small drainages and depressions in the floodplain of Lacamas Creek. The remnant stands of the valley floor habitat contain Garry oak (Quercus garryana), a dominant tree in former forests that once occupied the area. The valley floor of Camp Bonneville also includes trees such as the red alder (Alnus sp.), Oregon ash (Fraxinus sp.), Douglas fir (Pseudotsuga menziensii), big leaf maple (Acer macrophyllum), Garry oak, cottonwood (Populus deltoides), crabapple (Malus sp.), and willow (Salix sp.). Common understory species associated with this valley floor habitat include vine maple, salmonberry, Indian plum (Oemleria cerasiformis), snowberry (Symphoricarpos albus), and lady fern (Pentec 1995a in Clark County, 1998). Native grasses and small shrubs dominate the open fields at Camp Bonneville.

2.2.9.2 Camp Bonneville has been designated by Clark County as a "Forest Tier 1 Area". A Forest Tier 1 area is defined as an area that is potentially capable of sustaining "long-term production of commercially significant forest products" (Clark County, 1998). The U.S. Army has managed the forests and other vegetation on Camp Bonneville since 1957. Vegetation has been controlled by scarification and replanting

after fires that occurred in 1902, 1938, and 1951 (Hunter 1991 in Clark County, 1998). Timber has not been actively managed since 1981, however, a timber valuation report has been published for the area by Clark County (Forest Resource Management, Inc., November 12, 1997, in Clark County, 1998). Selective thinning has been recommended to utilize the forest resources on the site in order to help fund the reuse plan, optimize tree growth, simulate succession of the original Douglas fir community, maximize forest health, and minimize fire hazards. The Clark County forester conducted a detailed evaluation of the site in January 1999 in order to identify forest parcels that are essential to complete the reuse plan successfully. The county forester prioritized the site into five phases of activities. The first two phases identify areas along the western half of Camp Bonneville for thinning. Phase three identifies an area along the northern boundary east of the demolition area for selective thinning to promote future yields. Phases four and five were identified for thinning west of Lacamas Creek in the southwest portion of the site.

2.2.10 Wildlife

2.2.10.1 The majority of Camp Bonneville is forested area, interspersed with streams and open fields. This provides an excellent habitat for all forms of wildlife, including mammals, birds, reptiles, amphibians, and aquatic life. Detailed studies of wildlife of Camp Bonneville have not been published. The following information is based on a review of available literature and information provided in the Reuse Plan (Clark County, 1998).

2.2.10.2 A partial baseline survey of nesting raptors at Camp Bonneville was conducted by Stalmaster and Associates (1994). Thirty-three raptors were sighted, including red-tailed hawks, Northern harriers, great horned owls, turkey vultures, and a raven. A single osprey was observed, and was described as a probable migrant. Due to limitations on field research time and poor road conditions, complete coverage of Camp Bonneville was not possible (Stalmaster and Associates 1994).

2.2.10.3 Aquatic habitats in the site are associated with Lacamas, Main Stem, North and East Forks, Buck, and David Creeks. These creeks are expected to provide good quality aquatic habitats that support diverse fish and invertebrate populations based on the condition of the overall area.

2.2.11 Threatened and Endangered Species

2.2.11.1 An endangered species survey was performed in 1995 by Pentec Environmental, Inc. (Pentec) (1995a,b) (In Woodward and Clyde 1996). Field surveys were conducted by Pentec for amphibians, reptiles, mammals, songbirds, marsh birds, game birds waterfowl and water birds, raptors, fish, and rare plants. None of these surveyed species were defined as being federal- or state-listed as threatened or endangered. This species investigation has been updated in the USACE St. Louis District Final Archives Search Report (ASR) (1997). The St. Louis District conducted correspondence with the United States Fish and Wildlife Service (USFWS) and the Washington State Department of Fish and Wildlife regarding the occurrence of

threatened and endangered species on Camp Bonneville (USACE, 1997). Table 2.1 summarizes this information, as well as information on likely habitats for each species.

TABLE 2.1
LIST OF STATE AND FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES LIKELY TO OCCUR ON THE CAMP BONNEVILLE SITE*

Name	Status	Likely Habitat and Occurrence
Bald Eagle (Haliaeetus leucocephalus)	Federal Threatened Species	Occasional visitor through area
Northern Spotted Owl (Strix occidentalis)	Federal Endangered; State Endangered	Throughout site

*Based on Summary of Agency Correspondence provided in USACE Final Archives Search Report, 1997

2.2.11.2 Table 2.2 includes Federal Species of Concern, Federal Candidate Species, and Washington State Monitored Species. A Federal Species of Concern includes those species that were formerly classified as candidate species by the USFWS prior to 1997. A large number of candidate species were delisted in 1997 and reclassified as Species of Concern. Species of Concern are not formally "listed" species. However, these species are considered to be rare and are an important indicator of overall habitat quality of a particular area. The greater the number and diversity of these Federal Species of Concern, as well as their respective populations, reflects positively on the quality and viability of the habitat.

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2.3 PROPOSED FUTURE LAND USE

2.3.1 The Camp Bonneville closure presents Clark County with the opportunity to transform property allocated as surplus by the BRAC process into publicly available lands that will provide the community with significant educational, environmental, and recreational benefits.

TABLE 2.2
FEDERAL AND STATE SPECIES OF CONCERN LIKELY TO OCCUR ON THE CAMP BONNEVILLE SITE*

Name	Status	Likely Habitat and Occurrence
Bull Trout (Salvelinus confluents)	Federal Candidate Species	Lacamas Creek and tributaries (Buck Creek, David Creek)
Northwestern Pond Turtle (Clemmys marmorata marmorata)	Federal Species of Concern	Riparian areas along Lacamas Creek; Lacamas Creek
Larch Mountain Salamander (Plethodon larselli)	Federal Species of Concern	Wooded areas; Lacamas Creek
Cascades Frog (Rana cascadae)	Federal Species of Concern	Lacamas Creek and tributaries (Buck Creek, David Creek)
Spotted Frog (Rana pretiosa)	Federal Candidate Species	Lacamas Creek and tributaries (Buck Creek, David Creek)
Pacific Western Big-Eared Bat (Corynorhinus (Plecotus) townsendii townsendii)	Federal Species of Concern	Riparian areas; wooded areas
Long-eared myotis (Myotis evotis)	Federal Species of Concern	Riparian areas; wooded areas
Long-legged myotis (Myotis volans)	Federal Species of Concern	Riparian areas; wooded areas
Northern Goshwak (Accipter gentilis)	Federal Species of Concern	Throughout site
Olive-sided flycatcher (Contopus borealis)	Federal Species of Concern	Throughout site; riparian areas
Clackamas corydalis (Corydalis aquae-gelidae)	Federal Species of Concern	Riparian areas along creeks
Tailed frog (Ascaphus truei)	Federal Species of Concern, State Monitored Species	Moist habitats, wetlands, riparian areas, creeks
Cope's Giant Salamander (Dicamptodon copei)	State Monitored Species	Moist habitats; wetlands, riparian areas, creeks
Cascade Torrent Salamander (Rhyacotriton cascadae)	State Monitored Species	Moist habitats; wetlands, riparian areas, creeks

*Based on Summary of Agency Correspondence provided in USACE Final Archives Search Report, 1997

2.3.1 Camp Bonneville Local Redevelopment Authority

2.3.1.1 The Local Redevelopment Authority (LRA) is responsible for determining cost-effectiveness and feasibility of the land reuse plans for Camp Bonneville. In 1995, the Clark County Board of County Commissioners (BOCC), as a board of the LRA, appointed a five member Reuse Planning Committee (RPC) to oversee the reuse planning

process. RPC members include the County Parks Commission Chair, the County Planning Commission Chair, the Commissioner from the Camp Bonneville district, and two appointees from the Governor. After conducting public hearings, the RPC appointed representatives from the various reuse interest groups to six subcommittees to research the proposed reuse ideas and make recommendations to the RPC. Representatives from each of these subcommittees met as a steering committee.

2.3.1.2 The LRA subcommittees met regularly from February to June 1996, and in April 1997 they received approval for a land reuse planning grant from the Office of Economic Adjustment. From April 1997 through March 1998, the LRA subcommittees held meetings regarding the land reuse plan. After this process, the steering committees submitted a reuse plan to the RPC. After public hearings regarding the reuse scenario, modifications were made and the plan was submitted to the BOCC. After additional public hearings, a draft Camp Bonneville Land Reuse Plan (1998) was published.

2.3.2 Camp Bonneville Land Reuse Plan

2.3.2.1 Clark County has published an updated Preliminary Site Plan, Camp Bonneville Reuse Plan that identifies specific areas of Camp Bonneville for specific future uses (January 2003). This updated Land Reuse Site Plan graphic is shown on Figure 2.2. The central focus of the Draft Camp Bonneville Land Reuse Plan consists of approximately 1,200 acres along the western portion of the Camp and within the floodplain of the Lacamas Creek Valley. Other portions of the Camp radiating from the 1,200 acre park area will be utilized by the reuse plan for hiking and equestrian trails, wildlife habitat areas, and education study areas. The park area is designed to provide recreational opportunities for the local community and will be managed by Clark County. The recreational activities proposed in the reuse plan include, but are not limited to, the following:

- Recreational trails (hiking and equestrian use);
- Group picnic areas and picnic shelters;
- Amphitheater and stage (for outdoor school and small local events);
- Meadow area for group picnicking and recreational sports activities;
- Restroom facilities;
- Clark College/Law Enforcement Classrooms;
- Tent camping facilities;
- Recreational vehicle camping facilities;
- FBI, Law Enforcement, and Public firing range;
- Archery range;

Figure 2.2 Camp Bonneville Reuse Plan

- Park directors' residences;
- Vehicular access roads;
- Parking areas;
- Native American cultural center at the Bonneville cantonment area; and
- Environmental study area.

2.3.2.2 The primary economic resource at Camp Bonneville is its timber resources. The revenue from timber management may be used to fund site infrastructure costs for roads and utilities and could offset other costs associated with the development of the regional park. Camp Bonneville's significant forested areas provide a valuable wildlife habitat. In order to keep this habitat healthy, timber thinning is recommended. Timber thinning will maintain the health of the forest and reduce potential fire hazards, while providing revenue for the park operations.

2.3.2.3 Approximately 25 miles of trails, as well as approximately 2,700 acres of wildlife management areas will be maintained in the portion of the Camp Bonneville property located east of the Lacamas Creek valley. Access to these trails will be limited to hiking and equestrian use. The majority of these trails will consist of pre-existing four-wheel drive roads, but as additional funding becomes available, more trails may be added. The wildlife management area will be left in its current state.

2.4 SITE BACKGROUND

2.4.1 General

2.4.1.1 Camp Bonneville was utilized by the Department of Defense (DoD) for troop training from 1910 until 1995. The National Guard, Reserves, and the U.S. Air Force, as well as federal, state, and local law enforcement agencies, have trained personnel at the camp. Training exercises conducted at Camp Bonneville included weapons training using small arms, assault weapons, and field and air defense artillery. Camp Bonneville's location within the Northern Cascade Mountains provided a unique training area as the plateau was protected from wind by the surrounding Cascade foothills. The site geography is the reason this area was selected as a training area by the Department of the Army in the early 1900's.

2.4.1.2 The historical information regarding training operations and locations and previous MEC discoveries at Camp Bonneville was compiled from the Final Archives Search Report (USACE, 1997). The following sections provide a summary discussion of the past uses of Camp Bonneville.

2.4.2 Historical Summary

2.4.2.1 General

2.4.2.1.1 In 1910, the federal government entered into a lease with a purchase option on approximately 3,000 acres of land near Proebstel, Washington, which later became Camp Bonneville. The federal government's lease on the land expired in 1915, and the War Department acquired the land in 1918 by purchase and condemnation. The site was briefly declared surplus in the mid-1940s, but in May 1947, Camp Bonneville was removed from surplus status. In the early 1950's, the Defense Department leased an additional 840 acres from the State of Washington, and in 1957 the federal government returned 20 acres of the overall property to the State of Washington. From 1957 until placement on the Base Realignment and Closure (BRAC) list in 1995, the remaining 3,839 acres have remained under the military's jurisdiction.

2.4.2.2 Pre-World War II Era

2.4.2.2.1 Troops from Vancouver Barracks began to use land near Proebstel, Washington, for a target range in 1910 due to the near-level range floor that was protected from wind by the foothills of the Cascade Mountains. The plateau-valley (350 yards wide and 2,000 yards long) contained the Army's fourteen short-range and seven long-range small arms ranges. The federal government did not own the land at this time, but had an option on the property that it did not utilize for many years. In 1912, the government obtained another option, but after it expired in 1915, the army began conducting its target practice at an Oregon National Guard range near Clackamas, Oregon. The acquisition of the original reservation, consisting of approximately 3,000 acres, occurred in 1918 by purchase and condemnation. When the Army resumed activities at Camp Bonneville in 1918, the valley contained twenty-four targets. The installation was officially named Camp Bonneville in 1926. The records indicate that at some point prior to 1929, a machine gun range was also added to the training facilities at Camp Bonneville.

2.4.2.2.2 Camp Bonneville contains two separate cantonment areas. The Camp Bonneville cantonment area appears to have been built in the late 1920's, and in 1935 the Civilian Conservation Corps (CCC) built and occupied the Camp Killpack cantonment area. These facilities included barracks, kitchens and mess halls, an infirmary, latrines, administration and recreation buildings, and a library. Several organizations other than the garrison at Vancouver Barracks used the facilities at Camp Bonneville. Citizens Military Training Camps (CMTC) and the Reserve Officer Training Corps (ROTC) used the camp. The ROTC program prepared college students for a commission in the army and CMTC exposed high-school-aged males to military discipline and training.

2.4.2.3 World War II Era

2.4.2.3.1 Camp Bonneville continued to be used as a training area for the Vancouver Barracks during the Second World War. The camp reportedly housed Italian prisoners-of-war during this period. In 1946, the War Department declared the property excess. In May 1947 the military withdrew the camp from surplus citing a continuing need for its

training facilities. The ranges activated during the World War II era were 0.22-caliber, 0.30- caliber, and 0.45-caliber small arms ranges.

2.4.2.4 Post-World War II (1950s Era)

2.4.2.4.1 The Army refurbished many of the buildings and systems at the cantonment areas along with the ranges on the installation in 1950. This project was performed in preparation for training by the U.S. Army Reserve units in southern Washington and northern Oregon. During this time, the National Guard and the Marine Corps also expressed an interest in training at Camp Bonneville.

2.4.2.4.2 In the early 1950's, the Defense Department arranged to lease an additional 840 acres from the State of Washington DNR to expand the training facilities at Camp Bonneville. The Army returned twenty acres of the leased land to the DNR in 1957. This transfer marked the last significant real estate action at Camp Bonneville. In 1959, Vancouver Barracks became a sub-installation of U.S. Army, Fort Lewis (Tacoma, Washington). As a result, Fort Lewis assumed responsibility for Camp Bonneville.

2.4.2.4.3 By 1959, the property inventory included a known distance range, a pistol range (20 targets), a submachine gun range (21 targets), a live hand grenade range, and a mortar training range. Targets and target storage buildings for machine gun and anti-aircraft ranges were inventoried; however, the actual ranges could not be located. Two demolition areas of unknown chronology are also mentioned (USACE, 1997). They were approximately located in the southwest quadrant of the site along Lacamas Creek and in the northwest quadrant of the site near Little Elkhorn Mountain. These demolition areas had been used for destruction of unserviceable munitions since the late 1950's. Since 1993, the destruction of unserviceable munitions by any method (burning or detonation) has not been permitted.

2.4.2.5 Late 1960 through 1995

2.4.2.5.1 Camp Bonneville provided training areas for a variety of military units as well as federal, state, and local law enforcement agencies until selection for closure under the BRAC process in 1995. From 1969 to 1985, artillery units had conducted live firing exercises about twice a year with each training session resulting in the firing of approximately 50 rounds.

2.4.2.5.2 During the 1970's, the military switched to sub-caliber rounds for training purposes. Additional training in maneuvers, bivouacking, and tactics were practiced on the many preexisting training areas at Camp Bonneville, and occasionally vehicles would support this training with the use of smoke or riot control agents. These training areas utilized land from previously established ranges. The literature does not indicate the installation of any new ranges during this period. After receiving its BRAC designation in 1995, all active training ceased at the site with the exception of the continued use of the FBI small arms range by local, State and Federal Law enforcement personnel.

2.4.2.6 1987 through 1991

2.4.2.6.1 During the period from 1987 to 1991, three new ranges were introduced at Camp Bonneville. The ranges included an M16 rifle range and two M203 ranges. The M203 ranges were used for troop training in the use of 40mm rifle grenades. One range was reportedly used solely for inert, practice 40mm training, while the second range was used for high explosive (HE) 40mm training.

2.4.2.7 Chemical Agent Training

2.4.2.7.1 Several documents from the 1930's are discussed in the ASR concerning the expenditure of two gas identification sets from Vancouver Barracks Supply (Assistant Adjutant General 1935; Office of the Chief of Chemical Warfare Service 1936; Chemical Warfare Service 1937; Headquarters, Ninth Corps Area, 1937). These documents refer to the use of one set per instance, but they do not specify the location or extent of the training involved. Camp Bonneville had two gas training facilities. One of these facilities was located adjacent to the Camp Bonneville cantonment area and the other was located to the southeast in former Training Area #15. Camp Bonneville also reportedly had a 100x100 yard mustard training area which may have been in the vicinity of the "old gas chamber" identified by the Environmental Baseline Survey (EBS) (Woodward-Clyde, 1996), but the exact location of the mustard training area is unknown. This "old gas chamber" was destroyed by fire in the 1970's. There is no direct evidence that chemical agent training activities were conducted at Camp Bonneville. The available information indicates that only tear gas was used in the two former gas training facilities and the mustard training area at Camp Bonneville.

2.4.3 Operational Status

2.4.3.1 Through the 1980's and 1990's, numerous civilian groups and organizations have used portions of Camp Bonneville for camping, picnics, and environmental studies. All active training units ceased operations at Camp Bonneville by October 1995, and by November 1996 the cancellation of all out-grants for use of the post facilities was started. This action, however, did not include the FBI Range. The FBI continues to train at Camp Bonneville under the current reuse proposals.

SECTION 3

SITE CHARACTERIZATION

3.1 INTRODUCTION

3.1.1 Washington State MTCA Chapter 173-340-350 (70(a)) WAC identifies the requirements for a Remedial Investigation (RI), wherein it states "The purpose of the remedial investigation is to collect data necessary to adequately characterize the site for purpose of developing and evaluating cleanup action alternatives. Site characterization may be conducted in one or more phases to focus sampling efforts and increase the efficiency of the remedial investigation."

3.1.2 The Camp Bonneville RAU 3 site characterization has been conducted in multiple phases of work, with each subsequent phase building upon the findings and conclusions of the prior investigations. The site characterization efforts have included:

- USACE-St. Louis conducted a historical records search and prepared an Archives Search Report in 1997 which details historical findings on Camp Bonneville.
- USAESCH conducted a statistical-based MEC site characterization at Camp Bonneville in 1998.
- USACE Topographic Engineering Center performed a historical aerial photo-analysis of Camp Bonneville in 2000 to identify areas of potential concern (AOPC).
- USAESCH conducted an instrument-aided field reconnaissance to evaluate and document the MEC-related characteristics of the AOPCs in 2001.
- A comprehensive Conceptual Site Model for MEC activities was collaboratively developed by representatives of Washington State Department of Ecology, U.S. EPA Region X, Clark County, and the U.S. Army in 2002.
- USAESCH conducted an additional round of instrument-aided reconnaissance in 2002 to evaluate MEC-related characteristics in the proposed future regional park lands, including the roads and trails, and to confirm/refute the conceptual site model.

3.1.3 The Camp Bonneville RAU 3 site characterization also included the performance of two interim removal actions. These two time critical removal actions (TCRAs) were conducted to address risks associated with the discovery of unexploded

ordnance (UXO) at sites with potential receptor interaction. The following sections discuss the findings of the site characterization studies at Camp Bonneville RAU 3.

3.2 RAU 3 SITE CHARACTERIZATION

3.2.1 1997 USACE Archives Search Report

3.2.1.1 In 1997, the USACE St. Louis District conducted a site inspection, historical records search and interviews of former Camp Bonneville personnel (USACE, 1997). The final archives search report (ASR), dated July 1997, and outlined the nature and degree of potential MEC/UXO contamination at Camp Bonneville. A map showing the locations of reported historical MEC finds on Camp Bonneville is included in the ASR and is shown on Figure 3.1. The ASR concluded that the potential for MEC exists throughout a majority of the installation. The types of items present may range from small arms ammunition to 155mm artillery rounds, up to 4.2-inch mortars, 2.36-inch and 3.5-inch rockets, and hand and rifle grenades. The areas recommended by the ASR for further assessment included the identified ranges and safety fans, mortar positions, artillery firing points, demolition areas, and the central impact area.

3.2.2 1998 USAESCH MEC Site Characterization

3.2.2.1 USAESCH contracted with UXB International Inc. (UXB) to conduct an MEC site characterization of Camp Bonneville in 1998. The purpose of the site characterization study was to determine both the presence and density of MEC at Camp Bonneville. QuantiTech, under contract to USAESCH, used the statistical model SiteStats / GridStats to define the portions of Camp Bonneville to be investigated. SiteStats / GridStats are interactive computer programs that direct UXO sampling and statistically estimate the amount of UXO present at a site based on the UXO sampling data. The UXO sampling results are continually entered into the computer until the programs indicate that sufficient data has been collected to make a statistically valid estimate of the average UXO density in a given area. SiteStats / GridStats have been used for dispersed UXO sites when sufficient site information, usually provided from the ASR, is present to define the sectors.

3.2.2.2 The SiteStats / GridStats basis for sampling is the sequential probability ratio test (SPRT). Implementation of SPRT may result in a reduction in the sample size of up to 50% compared to a fixed-sampling plan approach. For SiteStats, each homogeneous sector is divided into a grid of equal-sized rectangular sampling grids. SiteStats' sector level characterization provides for random (by the software) or user selection of grids for intrusive investigations. Grids are randomly selected and sampled until SiteStats indicates that a sufficient number of grids have been sampled to provide a statistically valid estimate of the average UXO density for the sector. SiteStats also contains mathematical routines that test the hypothesis that the UXO density is sufficiently homogeneous within the sector. If SiteStats determines that the sector is not homogeneous, it will recommend breaking up the sector into smaller sectors. Typical investigation amounts as a percentage of area, assuming sector homogeneity, decrease with increasing sector size. SiteStats is appropriate in cases where prior site activity is understood from historical information.

Figure 3.1 Historical Ordnance Findings

3.2.2.3 GridStats directs sequential sampling within grids. Because some grids contain very large numbers of anomalies, 100% sampling of one of these grids could take weeks to investigate. The application of GridStats to a grid allows the decision-maker to characterize the grid by only investigating a fraction of the total anomalies located within that grid. The idea behind SiteStats / GridStats is to accept a nominal amount of uncertainty in characterizing the individual grids in exchange for a more comprehensive understanding of the MEC distribution of the overall site. The grids are randomly selected for geophysical surveying, and the number of anomalies is identified. The number of anomalies identified is entered into the GridStats program. The anomalies are then selected randomly and excavated to identify the source of the anomaly.

3.2.2.4 QuantiTech, under contract to USAESCH, determined the portion of Camp Bonneville to be surveyed for MEC site characterization purposes using the SiteStats / GridStats statistical sampling model. Camp Bonneville was divided into nine sectors (Figure 3.2). The sectors were selected by reviewing historical range groups from the ASR. A total of 207 geophysical survey grids (each 100-feet by 100-feet) were located throughout the nine sectors. This site characterization sampling strategy created a total survey area of approximately 50 acres. Due to heavy vegetation in some areas, 79 of these 207 grids were "star cut" and surveyed along the cuts. This reduced the total survey area to approximately 40 acres.

3.2.2.5 Visual and geophysical techniques were utilized to locate MEC during the 1998 MEC site characterization study. UXB personnel visually scanned the surface terrain to locate surface MEC or evidence suggesting the presence of subsurface MEC. Geophysical surveys were conducted using the Geonics EM61 High Sensitivity Metal Detector. The EM61 is a time domain metal detector used to detect both ferrous and non-ferrous metals.

3.2.2.6 The software GridStats was used to determine which anomalies were excavated in grids containing more than twenty anomalies. The GridStats guideline indicated that the first 20 anomalies of any grid had to be investigated. If more than twenty anomalies were identified, 32% of the remaining anomalies were excavated. All identified anomalies were investigated on "star cut" grids, regardless of quantity. During UXB's operation, UXO items were found by one of three means: UXB personnel providing escort to survey teams from grid to grid, UXB personnel providing grid surface sweeps prior to brush clearing, and UXB intrusive actions after EM61-determined anomalies were selected by the geophysicist.

3.2.2.7 UXO items were found in four of the nine sectors during the 1998 site characterization. Table 3.1 summarizes the results of the 1998 MEC site characterization findings. Figure 3.2 shows the location of the grids that were mapped and intrusively investigated for the site characterization.

Figure 3.2 1998 Site Characterization Grid Location Map

TABLE 3.1
SECTOR SUMMARY

Sector Number	Sector Description	Approx. Area (Acres)	Approx. Area Sampled (Acres))	Number of Grids	UXO Items Found in Grids*	Total UXO Items Found**
1	Camp Area	320.91	5.33	26	0	0
2	Demolition Area	392.29	5.28	27	2	2
3	Impact Area A	429.04	6.89	30	1	1
4	Impact Area B	223.96	4.04	20	0	0
5	Impact Area C	648.15	4.41	28	0	0
6	Impact Area D	685.32	4.91	25	4	4
7	Impact Area E	763.65	4.76	30	0	0
8	Impact Area F	398.70	3.72	17	0	0
GR	M203 Grenade Ranges	93.85	.92	4	4	9
TOTAL	All Sectors	3955.87	40.26	207	11	16

* Numbers indicate UXO found in dig sheet summarization and do not indicate UXO found between grids.

** Total includes 5 additional UXO recovered during brush clearance and/or movement between grids.

3.2.2.8 UXB investigated a total of 2,468 anomalies during the 1998 site characterization study. The following materials were found:

- 185 pounds of non-MEC related scrap,
- 213 pounds of munitions debris (i.e., inert scrap remnants of munitions),
- 16 UXO items (Eleven during intrusive activities and five during surface clearance and movement between grids),

3.2.2.9 The MEC sampling results were consistent with the data released in the ASR and are summarized as follows:

- Direct fire weapons (i.e. 2.36" and 3.5" rockets) were found in Sectors 6 and 5.
- Indirect fire munitions (mortar and artillery) were found in Sectors 6, 7, and 8.
- Inert, sand-filled Stokes mortar rounds were found in Sector 3.
- No 40mm HE or Light Anti-tank Weapon (LAW) High Explosive Anti-Tank (HEAT) munitions were encountered, and surveillance of the range targets revealed no surface indication of their presence (i.e. fragmentation marks, singed holes, explosive component debris). However, within the 40mm/LAW ranges in Sector 3, numerous inert 40mm training rounds and inert LAW sub-caliber components were discovered.

- The survey within the demolition range located in Sector 2 (Demo 1) revealed both UXO and MEC scrap. These findings represent "kick-out" from disposal activities. In Sector 3 near grid 116, deep craters and MEC scrap indicate the location of a suspected demolition range (Demo 3).

3.2.3 USAESCH 1998 Time Critical Removal Action

3.2.3.1 USAESCH contracted with UXB to conduct an interim removal action (TCRA) at the conclusion of the 1998 site characterization study. This interim removal action consisted of a surface clearance of 10 acres at the Open Burning / Open Demolition (OB/OD) site located in the northwestern portion of the Camp Bonneville property, at the area known as "Demo 1". A total of eight (8) UXO items, including two 2.75-inch HEAT rockets and six (6) 35mm LAW subcaliber practice rounds (with spotting charges) were removed dduring the 10-acre surface clearance at the Demo 1 area. Figure 3.3 shows the location of the TCRA grids at Demo 1.

3.2.4 USAESCH 1999 Time Critical Removal Action

3.2.4.1 USAESCH contracted with UXB to conduct a second interim removal action (TCRA) at Camp Bonneville in 1999. The TCRA required the removal of all live and inert MEC to a depth of two feet in the two former M203 rifle grenade ranges. The two former ranges were located in the central portion of the site adjacent to Lacamas Creek (Figure 3.4). USAESCH required the contractor (UXB) to geophysically map the areas after the removal operation was concluded for quality assurance purposes.

3.2.4.2 The original area of clearance was expanded from 12 acres to 19 acres. This 7-acre buffer addition was included to cover additional acreage suspected of MEC contamination at the ranges. One hundred percent of the cleared area passed UXB's quality control and USAESCH's quality assurance inspections. Upon discovery of an MEC item that could not be positively identified as inert, the item was treated as UXO for safety purposes. Subsequently, the item in question would be explosively destroyed where it was found. The final UXO determination was made by observations of the final demolition. If there was no contribution to the initial demolition charge, the item was identified as munitions debris (MD). Table 3.2 lists the items and locations of suspect items that were shown to be MD through explosive demolition.

3.2.4.3 A total of three (3) UXO items were discovered during the removal action at the two former M203 rifle grenade ranges. These three 40mm M382 practice projectiles added a noticeable contribution to the donor charge at the time of demolition and were found at the M203 Practice Range. Based on this observation, the items were classified as UXO items. Table 3.3 lists the projectiles and their locations.

3.2.4.4 UXB located over 3,800 pounds of inert MD and 684 pounds of non-MEC related scrap during the 1999 TCRA. When the scrap was located, it was inspected and certified as free of explosives. Table 3.4 lists the quantity of Inert MD located during their 1999 removal action at the two former M203 rifle grenade ranges.

Figure 3.3 Demolition Area 1 Interim Removal Action

Figure 3.4 M203 Ranges Interim Removal Action

TABLE 3.2
SUSPECT MUNITIONS DEBRIS

Item	Quantity	Location
Rocket, 35mm, Practice, Sub-caliber, M73	1	Sector 3, Grid 1
Rocket, 35mm, Practice, Sub-caliber, M73	1	Sector 3, Grid 4
Rocket, 35mm, Practice, Sub-caliber, M73	1	GR, Grid 2
Rocket, 35mm, Practice, Sub-caliber, M73	2	GR, Grid 3
Rocket, 35mm, Practice, Sub-caliber, M73	1	GR, Grid 5

Note: All six suspect munitions debris recovered from a range of 4 to 9-inches below ground surface.

TABLE 3.3
UXO ITEMS

Item	Quantity	Location
Projectile, 40mm, Practice, M382	1	Sector 3, Grid 12
Projectile, 40mm, Practice, M382	1	Sector 3, Grid 13
Projectile, 40mm, Practice, M382	1	Sector 3, Grid 16

Note: All three UXO items recovered from a depth less than two inches below ground surface.

TABLE 3.4
INERT MUNITIONS DEBRIS

Item	Quantity	Status	Depth Range
40mm Practice Grenade	6,666	Inert	0 to 9 inches
Cartridge Case (Brass)	21,730	Inert	0 to 6 inches
Sub-caliber	3,003	Inert	0 to 14 inches
Grenade Fuze	145	Inert	0 to 3 inches
3” Stokes Mortar	43	Inert	0 to 6 inches
MK II Practice Grenade	2	Inert	0 to 2 inches
Slap Flare	52	Inert	0 to 2 inches
M583 White Star Flare	1	Inert	0 to 2 inches
M661 Green Star Flare	2	Inert	0 to 2 inches
81mm Mortar, Practice, M68	11	Inert	2 to 6 inches
MK 2 Impulse Cart	1	Inert	0 to 1 inch
Smoke Grenades	9	Inert	0

3.2.5 USACE 2000 Aerial Photograph Examination

3.2.5.1 The USACE Topographic Engineering Center (TEC) analyzed available historical aerial photographs for the Camp Bonneville area to identify and map suspect features. Photo-analysis was based upon the interpretation of black and white aerial photography over the project area from 1940 through 1980. Also, historical range maps for the time frame of 1926 through 1991 and digital orthophotos (photomaps) from the time period of 1990 and 1998 were used in order to identify suspect features on the installation. TEC photo-analysis identified approximately 677 features as a result of the aerial photograph analysis. The photo-identified features selected were described as structures, berms, ground scars, depressions, and cleared areas.

3.2.5.2 These features were subsequently characterized as "areas of concern" (AOCs) if the area could be identified as historical training locations, munition practice ranges, demolition areas, impact areas, or munition storage facilities. Alternatively, if TEC-identified areas could not be identified based on Camp Bonneville's historical records, these areas were characterized as Areas of Potential Concern (AOPCs).

3.2.6 2001 USAESCH Instrument-Aided Field Reconnaissance

3.2.6.1 USAESCH contracted with Parsons to conduct an instrument-aided reconnaissance site characterization study (reconnaissance investigation). The reconnaissance investigation field work was accomplished during November and December of 2001. This site characterization study was conducted to confirm the positional location and characterize the MEC-related characteristics of AOCs/AOPCs at Camp Bonneville.

3.2.6.2 The AOCs and AOPCs investigated during the 2001 field effort were originally identified based on historical aerial photographs by the USACE TEC. Parsons evaluated each of these 677 TEC-identified features from year to year and identified 108 unique features that potentially required further characterization. This process of identification was performed by eliminating repeat areas, areas not considered AOPCs, (i.e. lagoons, ponds, buildings, and roads), and areas recognized as the result of tree harvesting operations. Of the 108 AOC/AOPC identified as unique features, 79 were determined to require reconnaissance (Parsons, 2001). The remaining 29 AOPC sites were not identified for reconnaissance because they were associated with small arms ranges or were co-located with other areas already identified for reconnaissance efforts. The AOC/AOPCs identified for reconnaissance were geo-rectified using ArcView geographic information system (GIS). The geo-rectification resulted in describing the positional location of each of the AOC/AOPC, with the latitude and longitude for each of these features. The geographic location of the AOCs/AOPCs is shown on Figure 3.5.

3.2.6.3 The AOC/AOPCs were characterized for MEC-related and terrain/vegetation/cultural feature characteristics during the 2001 reconnaissance investigation. During the 2001 reconnaissance investigation field effort, the positional location of each AOC/AOPC, as described by the longitude and latitude coordinates of

Figure 3.5 AOC/AOPC Locations

the center or the points identified on the perimeter of the AOC/AOPC, were imported into the GPS units at the beginning of each day. The reconnaissance team navigated to the latitude and longitude of the AOC/AOPC. Upon reaching the desired AOC/AOPC location, the reconnaissance team members formed a line with the spacing specified by the type of weapons system used in the area under investigation. Table 3.5 summarizes the reconnaissance line spacing.

TABLE 3.5
2001 RECONNAISSANCE LINE SPACING

AOC/AOPC	Reconnaissance Spacing (Meters)
Target/Impact Areas - 75mm Weapons System - 105mm Weapons System - 2.36”/3.5”/14.5mm Weapons - Individual MEC Items	 50 100 20 5
Munition Disposal Areas	5
Troop Training / Maneuver Areas	10
Firing Points	5
Safety Fans	No Reconnaissance Proposed
Ammunition Storage	No Reconnaissance Proposed

3.2.6.4 A 50-foot buffer around each AOC/AOPC was used. The reconnaissance buffer was utilized to compensate for the potential positional error associated with using varied data sources and data analysis processes, including aerial photographic maps, topographic maps, geo-rectification, and GPS. The teams performed a reconnaissance survey at each AOC/AOPC in a linear fashion and conducted additional transects as necessary until each AOC/AOPC had been fully characterized. Reconnaissance data was collected in accordance with the Reconnaissance Standard Operating Procedure (SOP)(Parsons, 2002). The field data was collected on hand-held personal digital assistants (PDAs) using a site-specific collection format created using Pendragon™ software. In addition to recording information regarding possible MEC, information regarding terrain, vegetation, and cultural features was also recorded.

3.2.6.5 The 2001 reconnaissance investigation of 79 AOCs/AOPCs resulted in the collection of 3,195 data points (Figure 3.6). The reconnaissance team surveyed approximately 700 acres of known/suspect MEC-related source sites. Of the 3,195 points collected, 146 identified the location of military related items. A detailed description of the types of munition related items located is included in Appendix A. The MD scrap and UXO findings of the 2001 reconnaissance field effort are presented in Table 3.6 and Table 3.7, respectively. The location of these items is plotted on Figure 3.7.

Figure 3.6 AOC/AOPC Locations and 2001 Reconnaissance Waypoints

Figure 3.7 OE Scap and UXO Item Locations 2001 Reconnaissance

TABLE 3.6
MUNITIONS DEBRIS FOUND DURING 2001 INVESTIGATION

Item	Quantity
Rocket, 3.5in, Practice, M29 warhead, empty	1
Rocket, 3.5in, Practice, M29 w/M405 Dummy fuze, fired	10
Rocket, 3.5in, motor, expended	1
Rocket, 2.75in, Mk40, Mod7 motor, expended	1
Rocket, 2.36in, Practice, M7, expended	1
Pyrotechnic, Signal, Illumination, M126 series, expended	5
M49 Trip Flare Housing, expended	1

3.2.6.6 A single UXO item was located during the 2001 investigation in the central impact area of Camp Bonneville.

TABLE 3.7
UXO FOUND DURING 2001 INVESTIGATION

Item	Quantity
Projectile, 105mm, HE, M1, fired	1

3.2.7 MEC Conceptual Site Model

3.2.7.1 The MEC Conceptual Site Model (MEC CSM) for Camp Bonneville serves as the overarching framework for organizing all available archival information about MEC-related activities, munition uses, and expected MEC contamination at Camp Bonneville. The CSM was developed through collaborative efforts of Washington State Department of Ecology, Clark County, U.S. EPA, and U.S. Army representatives in March-June 2002. Table 3.8 summarizes the components of the CSM for Camp Bonneville. The components of the MEC CSM include:

- MEC Related Activities;
- MEC Source Types;
- Primary Release Mechanisms;
- Expected MEC Contamination; and
- Likelihood of MEC Contamination.

TABLE 3.8
MEC CONCEPTUAL SITE MODEL COMPONENTS

MEC Related Activity	Primary Source	Likelihood of MEC Contamination
Ordnance Storage	Storage Magazines/ Transfer Point	Low
Weapons Training	Firing Point	Medium
	Target Areas	High
	Range Safety Fan	Low
Troop Training	Training Area	High
	Maneuver Area	Low
Ordnance Demilitarization	Open Burn/Open Detonation Area (OB/OD)	High

3.2.7.2 The MEC CSM described all of the MEC-related activities that historically occurred on Camp Bonneville as one of the following:

- Ordnance Storage – includes the storage and issuance of munitions used on Camp Bonneville.
- Weapons Training – the training of military personnel in the use of weapons systems within fixed, established firing ranges. On Camp Bonneville, weapons training occurred for artillery, mortars, hand grenades, practice land mines, rifle grenades, and rockets.
- Troop Training – the training of military personnel in combat techniques and maneuvers.
- Ordnance Disposal – the disposal of munitions that had undergone incomplete detonation and UXO at fixed, established Open Burn/Open Detonation (OB/OD) areas.

3.2.7.3 Each of the MEC-related activities listed above had one or more MEC Source types associated with it. For Camp Bonneville, seven MEC Source types were identified.

The MEC Source types associated with the listed munition-related activities are:

- Ordnance Storage
  - Storage Magazine/Transfer Point – the buildings in which munitions were stored, and from which it was issued to personnel.
- Weapons Training

- Target Area – a fixed area at which weapons training exercises were targeted; target areas for the larger weapons systems may contain vehicles and old appliances as target items.
- Firing Point – the fixed point from which the weapons were fired during weapons training exercises.
- Range Safety Fan – the buffer area, fanning out from the firing point to beyond the target area, established to ensure weapons training was carried out safely.

- Troop Training
  - Training Area – areas used to train military personnel in offensive and defensive techniques. On Camp Bonneville, this training included the establishment of defensive perimeters (using training or practice munitions, with or without spotting charges), the infiltration of defensive perimeters, the use of small arms with blank ammunition, and the establishment of bivouac areas.
  - Maneuver Area – areas used for small unit (platoon/squad) troop maneuvers, without the intentional deployment of weapons.
- Ordnance Disposal
  - Open Burn/Open Detonation (OB/OD) Area – a fixed area used to dispose of MEC through detonation or burning

3.2.7.4 The mechanisms by which MEC was released into areas on Camp Bonneville fell into two categories, based upon the types of activities and MEC sources associated with the areas. The first release type was described as releases that resulted from intentional activities, such as firing into a target area, the placement of signaling devices (trip flares) during the establishment of a defensive perimeter, or the disposal of MEC by detonation in an OB/OD area. The second category of MEC release types are releases that were incidental to the MEC-related activities, such as a long- or short-round fired rounds into a range safety fan, the loss of hand grenades during troop maneuvers, or the burial of excess rounds at an isolated firing point. The third column of Table 3.9 shows the release mechanisms associated with each MEC Source type.

3.2.7.5 The Camp Bonneville MEC CSM addressed the expected MEC contamination that may result in an explosive hazard. Contamination that may result in an explosive hazard includes UXO and buried munitions that were not deployed. The fourth column of Table 3.9 shows the expected contamination associated with each MEC Source type and MEC release mechanism, while the fifth column shows the anticipated likelihood of MEC contamination for each MEC Source type. Potential contamination from explosive residuals, including the potential for release of explosives into the soil through low-ordered detonations and the corrosion of the cases of buried munitions is not addressed in this RAU 3 RI/FS Report.

TABLE 3.9
MEC RELEASE MECHANISMS

MEC Related Activity	MEC Source	Primary Release Mechanism	Expected MEC Contamination	Likelihood of MEC Contamination
Ordnance Storage	Storage Magazines/ Transfer Point	Mishandling/Loss	Non-deployed munitions	Low
Weapons Training	Firing Point	Mishandling, Loss or Abandonment	Non-deployed munitions	Medium
		Burial	Non-deployed munitions	Medium
	Target Areas	Firing – Incomplete Detonation	Deployed Munitions that failed to function as designed	High
		Firing – UXO	Deployed Munitions that failed to function as designed	High
		Firing – Complete Detonation	Non-explosive debris	High
	Range Safety Fans	Firing – Incomplete Detonation	Deployed Munitions that failed to function as designed	Low
		Firing – UXO	Deployed Munitions that failed to function as designed	Low
		Firing – Complete Detonation	Inert MD / Non-explosive debris	Low
Troop Training	Training Area	Mishandling or Loss	Non-deployed (fuzed or unfuzed) training/practice munitions	High
		Burial (Bivouac Areas only)	Non-deployed (fuzed or unfuzed) training/practice munitions	High
		Placement	Emplaced Training Munitions (fuzed or unfuzed)	High
	Maneuver Area	Mishandling or Loss	Non-deployed (fuzed or unfuzed) training / practice munitions	Low
Ordnance Demilitarization	Open Burn/Open Detonation (OB/OD)	Kick-Out/ Incomplete Detonation (OD)	Deployed/Non-deployed munitions that have undergone unsuccessful demilitarization	High
		Complete Detonation	Inert MD / Non-explosive debris	High
		Burning	Deployed or Non-deployed munitions that have undergone unsuccessful demilitarization	High

3.2.7.6 The CSM ranking factors address the explosive safety hazards resulting from the release of explosives. Two factors were used to develop the explosive hazard ranking for the seven primary source types. The first factor was the likelihood of MEC contamination, and the second factor was the explosive hazard severity.

3.2.7.7 The likelihood of MEc contamination was a qualitative ranking of the relative likelihood that MEC/UXO contamination was present at an AOC/AOPC. The default values for this factor were based on the MEC Source types. MEC Source types that were the subject of intentional releases of munitions (e.g., target areas) were assigned a high likelihood of MEC contamination. MEC Source types where the release of MEC was unintentional (e.g., maneuver areas) were assigned a low likelihood of MEC contamination. A medium likelihood of MEC contamination was assigned to the Firing Point primary source type. The CSM for Firing Points hypothesized a potential for the intentional abandonment or burial of unfired munitions. This scenario was a case where the release was the result of intentional activity, but the activity was not sanctioned.

3.2.7.8 Table 3.9 summarizes the components of the CSM for Camp Bonneville. The appropriate MEC Source type for each AOC/AOPC was obvious for most areas. Since all of Camp Bonneville was designated for troop training, in the absence of other information about an area, an area was assigned the Maneuver Area MEC Source type.

3.2.7.9 The MEC anticipated to be located at the Camp Bonneville MEC Sources was characterized by the likelihood of detonation and the resultant explosive safety hazard. Table 3.10 provides the Hazard Severity Ranking (HSR) and Explosive Safety Hazard (ESH), with items categorized as 1 having the highest explosive safety hazard and 5 having the lowest explosive safety hazard.

TABLE 3.10
HAZARD SEVERITY RANKING (HSR) AND EXPLOSIVE SAFETY HAZARD (ESH)

Hazard Severity Ranking (HSR)	Title	Explosive Safety Hazard	Description
1	UXO with sensitive fuzing	Catastrophic	Deployed munitions; e.g.: fired munitions with sensitive fuzing that have failed to function as designed
2	UXO	Critical	Deployed munitions; e.g.: fired munitions with less sensitive fuzing than HSR 1, that have failed to function as designed and/or have undergone unsuccessful demilitarization (detonation)
3	Military Munitions damaged during handling	Marginal	Non-deployed munitions; e.g.: never been fired munitions that have undergone unsuccessful demilitarization (detonation) that may have stressed the fuze; emplaced training munitions (trip flares, booby traps) in which the fuzing is armed
4	Military Munitions, Training Munitions	Negligible	Non-deployed munitions; e.g., buried/ abandoned munitions; emplaced training munitions (trip flares, booby traps) whose fuzing is not armed; bulk explosives or explosive soil; complete, ready-to-fire small arms ammunition. Deployed munitions; e.g.: practice and training munitions with spotting charges
5	Munitions Residue	Non-explosive	Non-explosive debris; e.g.: munition fragments; training munitions with no spotting charges; and explosive residue (3X AEDA material with no visible ordnance contamination)

3.2.7.10 The Camp Bonneville MEC CSM is a comprehensive evaluation of past MEC activities at the Camp Bonneville site. Each MEC-related activity performed at Camp Bonneville has been identified through a rigorous and methodical evaluation of

archival information and the activities conducted during military troop training for artillery and infantry missions. In addition, each MEC Source type, expected MEC release method(s) and expected MEC contamination has been identified and fully evaluated for explosive safety risk factors. Table 3.11 shows the compilation of the MEC CSM for Camp Bonneville, and includes a relative ranking of explosive safety risk by MEC Source type.

TABLE 3.11
EXPLOSIVE SAFETY RELATIVE RISK RANKING FOR CAMP BONNEVILLE, WA

MEC Related Activity	Primary MEC Source	Non-deployed munitions (4)	Practice munitions without spotting charge (4)	Practice munitions with spotting charge (4)	Unsuccessfully demilitarized non-deployed ordnance (3)	Unsuccessfully demilitarized deployed ordnance (2)	Deployed munitions that failed to function as designed (2/1)	Munition Fillers	Likelihood of MECContamination	Explosive Safety Relative Risk Ranking
Ordnance Storage	Storage Magazines/ Transfer Points	X						E, P	Low	6
Weapons Training	Firing Point	X						E, P	Medium	3
	Target Area						X	E, P	High	1
	Range Safety Fan						X	E, P	Low	5
Troop Training	Training Area		X	X				P	High	4
	Maneuver Area	X						P	Low	7
Ordnance Demilitarization	Open Burn/Open Detonation Area				X	X		E, P	High	2
		Least Severe	⇨				Most Severe	Munition Filler: E =Explosive P = Pyrotechnic	Highest Explosive Safety Relative Risk Ranking is 1 and Lowest is 7	
		Hazard Severity Ranking								

3.2.8 2002 USAESCH Instrument-Aided Field Reconnaissance

3.2.8.1 USAESCH contracted with Parsons to conduct a supplementary round of site characterization using instrument-aided reconnaissance (reconnaissance investigation). The reconnaissance investigation field work was accomplished during December 2002 through February 2003.

3.2.8.2 The area covered by the 2002 reconnaissance investigation included the approximate 1,200 acres of the proposed future regional park and the existing trails and roadways that cross Camp Bonneville. The investigation resulted in the collection of 12,809 reconnaissance data waypoints. The proposed Regional Park (RP) area was divided into fifteen (15) discrete sections for data management purposes. The section boundaries generally corresponded to a physical feature, such as a creek bed, fence-line, or roadway. These subdivided areas were labeled "RP- X", with X being a numeral between 1 and 15 (Figure 3.8). An additional RP area (designated RP-16) was subsequently identified by USAESCH for reconnaissance investigation. This RP-16 area

Figure 3.8 Regional Park Section Boundaries 2002 Reconnaissance

is described to encompass the area between Demo 1 and the confluence of the north and south forks of Lacamas Creek and is also shown on Figure 3.8.

3.2.8.3 The RP areas were characterized for potential MEC-related activities, as well as terrain, vegetation, and cultural features. The RP areas were surveyed individually by the field reconnaissance teams. The reconnaissance team would navigate to the RP area to be surveyed and would then form a line with a distance between individuals of 10-15 meters as specified by the Final Reconnaissance Work Plan (Parsons, 2001b). The team members proceeded along the reconnaissance transects, collecting data in the PDA Pendragon™ format discussed in section 3.2.6.

3.2.8.4 When the RPs were completed, the teams surveyed the existing roads and trails across the Camp Bonneville site. The procedure for road and trail coverage was for a team member to survey the center of the road while the remaining team members were located approximately 30 feet on either side of the road. This technique was used to establish a buffer around the roads and trails. While surveying the previously mapped roads and trails, the reconnaissance discovered a number of previously unknown roads or trails. These newly discovered roads and trails were also characterized to obtain information on potential MEC-related activities, terrain, and vegetation along the roads and trails.

3.2.8.5 The roadways and trails throughout the entire Camp Bonneville facility, as shown on Figure 3.9. No UXO items surveyed were located during the 2002 reconnaissance investigation of the proposed regional park lands or along the roads and trails across the Camp Bonneville site.

3.2.8.6 A total of 315 of the 12,809 waypoints obtained were military-related features. Of these 315 military-related features, a total of 38 were inert MD items. Training-related items located during the 2002 reconnaissance investigation were classified as either MEC scrap (i.e., expended slap flares and expended smoke grenades) or training-related scrap (i.e., meal-ready-to-eat (MRE) bags and small arms cartridges). Identified areas that were previously used for military training were identified as training features (i.e.: obstacle course and small arms ranges). The MD scrap items located during the 2002-2003 reconnaissance field effort are presented in Table 3.12 and the location of these items is plotted on Figure 3.10.

3.2.8.7 The 2002 reconnaissance investigation characterized the location and distribution of MEC-related items and features on the 1,200 acres of the proposed future regional park lands and along approximately 46 miles of trails and roads across the entire Camp Bonneville site. A total of 12,809 data waypoints were collected and recorded. Not a single UXO item was discovered in the 1,200 acres surveyed by the 2002 reconnaissance efforts. A total of 38 inert MEC scrap items were located, including expended trip flares, expended slap flares, expended smoke grenades, and expended, inert practice 40mm projectiles and expended practice 2.36-inch rocket body. None of the MEC-related items located within the proposed future regional park or along the roads and trails during the 2002 reconnaissance poses an explosive safety risk.

Figure 3.9 Road and Trail Waypoints 2002 Reconnaissance

Figure 3.10 OE Scrap Item Locations 2002 Reconnaissance

TABLE 3.12
MD FOUND DURING THE 2002-2003 RECONNAISSANCE

Item	Quantity
Grenade, Hand, Smoke (HC), AN-M8 w/M201A1 fuze, expended	1
Grenade, Hand, Smoke, M18 series w/M201A1 fuze, expended	6
Projectile, 40mm, Practice, M781, fired, expended, nose cap	8
Projectile, 40mm, Signal-Illumination, M661, expended	1
M49 Trip Flare Housing, expended	2
Pyrotechnic, Signal, Illumination, M126 series, expended	14
Pyrotechnic, Simulator, Illumination, Parachute, M583A1, expended	1
Pyrotechnic, Simulator, M117 series, expended	2
Pyrotechnic, Simulator-artillery, M74A1, expended	1
Pyrotechnic, Simulator-Ground Burst, M115A2, expended	1
Rocket, 2.36in, Practice, M7, expended	1

3.3 RAU 3 SITE CHARACTERIZATION SUMMARY

3.3.1 Camp Bonneville has been thoroughly characterized for the presence, location, and density of MEC that are artifacts of past troop training activities conducted during the period of active use (1910 – 1995) for the installation. The Camp Bonneville RAU 3 site characterization has been conducted in multiple phases of work, with each subsequent phase building upon the findings of the prior investigation findings.

3.3.2 A total of 207 MEC sampling grids, totaling approximately 40 acres, were geophysically mapped and intrusively sampled. A total of sixteen (16) UXO items were recovered during this phase of site characterization. All of these UXO items were recovered from the Central Impact Target Area, the M203 Grenade Range, and the Demolition Areas 1 and 3. As a result of these site characterization findings, an additional 29 acres of land was cleared of MEC during the implementation of interim removal actions. The initial interim removal action (TCRA) was performed at Demolition Area 1 and recovered a total of eight (8) UXO items from 10 acres of surface clearance. The second interim removal action (TCRA) was performed at the M203 Grenade Ranges in 1999 and recovered a total of three (3) UXO items from 19 acres. Figure 3.11 shows the locations of UXO items located during the Camp Bonneville site characterization. A detailed description of UXO and MEC scrap items located is included in Appendix A.

3.3.3 A total of 16,004 discrete reconnaissance data waypoints have been collected, analyzed, and mapped using digital technology and GIS geo-spatial analysis during the 2001/2002 site reconnaissance efforts. Over 2,400 acres of the 3,980 acre site has been characterized for the presence of potential MEC-related activities. A solitary UXO item (105mm artillery shell) was located in the Central Impact Target Area. A total of

Figure 3.11 UXO Site Characterization Findings

SECTION 4

RISK EVALUATION

4.1 BACKGROUND

4.1.1 MTCA cleanup regulations listed in WAC 173-340-357 mandate that site cleanups protect human health and the environment. The selection and evaluation of cleanup action alternatives must be demonstrated through the use of either quantitative or qualitative risk assessments. The purpose of the risk assessment is to evaluate current and future adverse health effects caused by hazardous substance releases from a site in the absence of any actions to control or mitigate these releases.

4.1.2 According to MTCA, the results of the risk assessment should be used in developing cleanup alternatives and to establish acceptable remediation levels for use during the feasibility study. In addition, the risk assessment is used to communicate the magnitude of the risk at the site and the primary causes of that risk, and to aid in the development, evaluation, and selection of appropriate response alternatives.

4.1.3 Risk assessments are site-specific evaluations and may vary in both detail and extent to which qualitative and quantitative inputs are used. The characteristics of the risk assessment depend on the complexity and particular circumstances of the site, as well as the availability of applicable or relevant and appropriate requirements (ARARs) and other guidance. The risk assessment should consider the potential risks associated with current land use and activities, as well as reasonably anticipated future land use. Site conditions following the proposed land transfer to Clark County were evaluated to provide a baseline risk in the absence of any actions to control or mitigate that risk for this risk assessment.

4.2 NATURE OF RISK

4.2.1 The 1997 Presidential/Congressional Commission on Risk Assessment and Risk Management defines risk as follows:

Risk is the probability that a substance or situation will produce harm under specified conditions and is a combination of two factors: (1) the probability that an adverse event will occur, and (2) the consequences of an adverse event.

4.2.2 Washington State Department of Ecology has developed general risk assessment methods for evaluating human health and environmental risks at hazardous and toxic waste sites. These general risk assessment methods are conducted through four basic

steps: (1) hazard identification, (2) dose response modeling, (3) exposure assessment, and (4) risk characterization. These methods are typically used to quantify risk from long-term, chronic exposure to low levels of contamination. MTCA cleanup regulations have no provisions for evaluating ordnance explosive safety risk.

4.2.3 Military munitions at closed or transferred ranges are regulated as solid wastes under WAC 173-303-578 and fall under the category of dangerous wastes under WAC 173-303-090 because of their characteristic of reactivity and/or ignitability. Dangerous wastes are designated as hazardous substances under RCW 70.105.010 and subject to risk assessment requirements under WAC 173-340-357. However, military munitions do not include any wholly inert items (WAC-173-303-040), such as certified inert munitions debris (MD) and expended munitions components that do not pose any explosive safety threat, and therefore these items are not evaluated in this risk assessment.

4.2.4 The risk assessment processes that have been developed for chemical contaminants do not lend themselves to an ordnance explosive safety risk assessment because of the unique properties of military munitions. Thus the potential for human interaction with military munitions needs to be evaluated differently than processes developed for chemical contaminants.

4.2.5 The primary release mechanisms for the occurrence of MEC are related to the type of munitions activity, or result from the improper functioning of the munition. When a munition item (artillery shell) is fired it will do one of three things:

- It will detonate completely. This is called a high order detonation.
- It will undergo incomplete detonation. This is also called low order detonation.
- It will fail to function. This results in unexploded ordnance, UXO.

4.2.6 In addition, MEC may be lost, abandoned, or buried, resulting in non-deployed munitions that could be fuzed or unfuzed.

4.2.7 Munitions demilitarization through open burning/open detonation (OB/OD) is used to destroy excess, obsolete, or unserviceable munitions by combustion (OB) or by detonation (OD). An OD operation can result in high order detonation, low order detonation and UXO. In addition, the munitions may possibly spread beyond the immediate vicinity by the detonation ("kick-outs"). Incomplete combustion can leave uncombusted explosives.

4.2.8 Explosive safety risk is defined as the probability for a military munition to detonate and potentially cause harm as a result of human activities. An explosive safety risk exists if a person can come into contact with a military munition and act upon it to cause a detonation. The threat from military munitions typically results from a single interaction and may have one of three outcomes: no effect, injury, or death.

4.2.9 The potential for an explosive safety risk depends upon the presence of three critical elements: a source (presence of military munitions); a receptor or person; and an interaction between the source and receptor (such as picking up the item or disturbing the item by plowing). There is no risk if any one of these three elements is missing. Each of the elements provides a basis for implementing effective risk-management responses.

4.3 EXPLOSIVE SAFETY HAZARDS

4.3.1 The consequences of a military munitions detonation is associated with physical forces resulting from blast pressure, fragmentation hazards, thermal hazards and shock hazards. Some practice munitions contain an energetic, (low explosive or pyrotechnic charge) and include a fully functional fuzing system, while other practice munitions are wholly inert. A practice round UXO item poses less of a hazard than a HE-filled UXO. The hazard from a practice round UXO may result from a fuze or spotting charge contained in order to produce a flash or smoke upon impact. Unexpended spotting charges may cause a flesh burn. The wholly inert practice items have no explosive parts, including fuze components, and do not pose an explosive safety hazard.

4.3.2 Different types of military munitions vary in their likelihood of detonation and their potential for harm. The classification of energetic materials used in military munitions can be divided by their primary uses: explosives, propellants, and pyrotechnics (U.S. EPA, 2002). Explosives and propellants, if properly initiated, will evolve large volumes of gas over a short period of time. The key difference between explosives and propellants is the reaction rate. Explosives react rapidly, creating a high-pressure shock wave and are designed to break apart a munitions casing and cause injury. Propellants react at a slower rate, creating a sustained lower pressure. Propellants are designed to provide energy to deliver a munition to its target. Pyrotechnics produce heat but less gas than explosives or propellants. Pyrotechnics are used to send signals, to illuminate areas, simulate other weapons during training, and as ignition elements for certain weapons. When initiated, pyrotechnics produce heat, noise, smoke, light or infrared radiation. Incendiaries are a class of pyrotechnics that are highly flammable and are used to destroy a target by fire.

4.3.3 Explosives can be further subdivided into low explosive and high explosive based on the velocity of the explosion. When a HE munition is initiated, it decomposes almost instantaneously and the detonation can be lethal. Low explosives undergo decomposition or combustion at rates from a few centimeters per minute to approximately 400 meters per second (U.S. EPA, 2002). Black powder is a common low explosive and when used as a spotting charge it can cause injury or burns. In a 37mm projectile, the black powder is fully encased and if initiated can be lethal.

4.3.4 The explosive hazards depend upon the nature and condition of the explosive fillers and fuzes. The safety risk associated with practice items is significantly different than HE-filled UXO. For example, an HE-filled UXO (item that has been deployed but failed to function) is more hazardous than a deployed practice item containing a small spotting charge. However it may be difficult to distinguish between the practice and HE-

filled munitions in the field and this difficulty is compounded when the item is buried beneath the surface or subjected to weathering making any markings indistinguishable.

4.3.5 At military training facilities, including Camp Bonneville, it was customary to conduct training exercises using practice munitions, including those ranges designated for use of HE-filled munitions. Only after troops demonstrated proficiency in firing tactics were troops allowed to use HE-filled munitions. As a result, training ranges contain a preponderance of practice munitions. At Camp Bonneville, the ASR report indicated that artillery units only conducted firing exercises about twice per year from 1969 – 1985, resulting in approximately 50 rounds being fired into the Central Impact Area during each training session. Sometime in the 1970's, however the military switched from live ammunition to sub-caliber rounds for training purposes (USACE, 1997). Overall, the likelihood of encountering HE-filled UXO at Camp Bonneville's training ranges is considered small as a result of the small number of firing exercises.

4.4 CAMP BONNEVILLE EXPLOSIVE HAZARDS EXPOSURE ASSESSMENT

4.4.1 Approach

4.4.1.1 Development of a qualitative risk model is an essential component of an MEC risk assessment and is used to help identify the population that is reasonably expected to be exposed to munitions hazards at Camp Bonneville. The qualitative risk model for Camp Bonneville was developed around the three causal elements for an explosive safety hazard: MEC source, receptor, and interaction between the receptor and the MEC.

4.4.1.2 The nature and location of the MEC Source sites was evaluated based on historical records of the MEC-related activities and confirmed munition findings, plus site characterization studies. MEC-related activities describe how munitions were stored, transported, deployed and/or destroyed. The primary MEC-related activities conducted in an area are indicative of the type of explosive safety hazards that are likely to be encountered. The analysis of MEC-related activities at Camp Bonneville is documented in the Camp Bonneville Conceptual Site Model (CSM), which was developed collaboratively with Washington State Department of Ecology, U.S. EPA, Clark County and U.S. Army representatives. The Camp Bonneville CSM resulted in the identification of seven MEC Source site types.

4.4.1.3 The current and future land reuse will determine the amount of activity and potential for interaction between human receptors and an MEC source and is an integral part of the qualitative risk model. The potential for an explosive safety risk exists when there is any direct contact between a source and receptor. The depth of the MEC source and depth and frequency of the intrusive activity serve to characterize the interaction and complete the qualitative risk model.

4.4.1.4 The explosive hazards exposure assessment approach developed for Camp Bonneville addresses each of the three causal elements for an explosive safety hazard. The approach for Camp Bonneville is a site-specific qualitative method that is used to

describe and estimate the relative risk or likelihood of adverse consequences from an ordnance source and human receptor interaction. The approach is a two-step process that provides an initial relative ranking of explosive safety risk. The factors applied in the first step address the MEC source. The factors applied in the second step address the likelihood for interaction between the MEC source and receptor.

4.4.1.5 The factors applied in the first step of developing the qualitative risk model to assess the relative ranking of explosive safety risk take into account the expected munition type, MEC characteristics, and the presence or likelihood of MEC based on the MEC-related activities conducted in an area as confirmed during the site reconnaissance. The second step involves estimating the likelihood for human interaction between an MEC source and a receptor based on site accessibility and future land reuse. The relative risk ranking and likelihood for human interaction are combined to develop an overall explosive hazards exposure score. This scoring can then be used to describe the magnitude of the risk and support the evaluation and selection of appropriate risk management options.

4.4.1.6 The relative ranking of explosive safety risk is based upon the following factors:

- Hazard severity (most hazardous type of munition expected to be found);
- Munition filler (explosive or pyrotechnic); and
- Likelihood of MEC being present (low, medium, or high).

4.4.1.7 The hazard severity is based on findings from past and present studies at Camp Bonneville and is related to the most hazardous type of military munition found or expected in an area. The munition filler factor takes into account whether a military munition is likely to contain high explosives or pyrotechnics. The likelihood of MEC contamination factors in the expected MEC density in a given area. Table 4.1 provides the summary of the explosive safety relative risk ranking (based on the CSM to reflect clearance activities). Each of the primary source areas listed on Table 4.1 is discussed in detail in Sections 4.4.5 through 4.4.12.

4.4.1.8 As shown in Table 4.1, four out of the seven source areas have a "negligible" explosive safety risk; three of these four areas also have a remote likelihood of MEC contamination (i.e., storage magazines/transfer points, training areas, and maneuver areas), and the remaining "negligible" explosive safety risk source area has a medium likelihood of MEC contamination (i.e., firing points). Two areas have a high likelihood of MEC contamination and an explosive hazard greater than negligible (i.e., target areas and OD/OD areas). Lastly, the range safety fans have a critical/catastrophic explosive safety risk, but a low likelihood of MEC contamination. The explosive safety risk for each source area has been assessed irrespective of current or future land use.

TABLE 4.1
EXPLOSIVE SAFETY RELATIVE RISK RANKING

MEC Related Activity	Primary Source	Non-deployed munitions	Practice munitions without spotting charge	Practice munitions with spotting charge	Unsuccessfully demilitarized non-deployed ordnance	Unsuccessfully demilitarized deployed ordnance	Deployed munitions that failed to function as designed	Munitions Filler	Likelihood of MEC Contamination	Explosive Safety Relative Risk Ranking
Munitions Storage	Storage Magazines/Transfer Points	X						E, P	Remote	5
Weapons Training	Firing Point	X						E, P	Medium	3
	Target Area						X	E, P	High	1
	Range Safety Fan						X	E, P	Low	4
Troop Training	Training Area		X	X				P	Remote	7
	Maneuver Area	X						P	Remote	6
Munition Demilitarization	Open Burn/Open Detonation Area				X	X		E, P	High	2
		4 (Negligible)	4 (Negligible)	4 (Negligible)	3 (Marginal)	2 (Critical)	2/1(Critical/ catastrophic)	Munitions Filler: E =Explosive P = Pyrotechnic		Highest Explosive Safety Relative Risk Ranking is 1 and Lowest is 7
		Least Severe	⇨				Most Severe			
		Hazard Severity Ranking								

The explosive safety risk can be reevaluated as necessary if future removal actions identify conditions not anticipated in the MEC CSM.

4.4.1.9 The second step of the explosive hazards exposure assessment for Camp Bonneville involves an evaluation of the likelihood for interaction between an MEC source and receptor. The likelihood for interaction between an MEC source and receptor is evaluated for current land use and future land use. The land use, accessibility of an area, and activity level(s) of subsurface intrusion influence the potential for human interaction with an MEC item. The likelihood for interaction is based on three primary factors:

- Accessibility factor (related to the slope of the terrain and vegetation density);
- Land use intensity (low, medium, or high); and
- Depth of activity (surficial or subsurface based on the land use).

4.4.2 Exposure Hazards Assessment – Current Land Use

4.4.2.1 As noted previously, vehicular access to Camp Bonneville is restricted to a single entrance and the facilities manager monitors this entrance. With the exception of training conducted at the FBI Range, there is no current use of the Camp Bonneville property (grants for use of the site were cancelled beginning in November 1996). The FBI Range, located within a former range fan area, has no intrusive activities associated with it, and therefore, the likelihood of interaction between a receptor and a historic MEC source is negligible.

4.4.2.2 Other possible receptors include trespassers accessing Camp Bonneville from adjacent properties. The location and history of Camp Bonneville is well known to the local community and it is unlikely that anyone would wander onto the property without the knowledge that it was a former military installation. Although there are no documented accounts of trespassers, the possibility exists for people to illegally access Camp Bonneville. These trespassers would likely be hikers, and due to generally dense vegetation and steep terrain, it is expected that the hikers would remain on existing trails and roads. The likelihood of interaction between a receptor and a historic MEC source is considered negligible because all roads and trails within Camp Bonneville were searched for UXO during the 2002 reconnaissance effort.

4.4.2.3 Overall, the risk associated with current land use activities is considered negligible because there is very limited possible interaction between receptors and an ordnance source.

4.4.3 Exposure Hazards Assessment – Future Land Use

4.4.3.1 The proposed future land use is recreational with varying levels of reuse intensity. The future land reuse intensity was determined based on the January 2003 Camp Bonneville Preliminary Site Plan. This factor takes into account the relative number of potential receptors and frequency they are likely to enter a given area. The undeveloped land within the proposed wildlife management area was designated as low reuse intensity. This includes the central impact area and DNR leased lands. Those areas within the proposed Regional Park that are located between specific designated reuses (classrooms, recreation vehicle [RV] camping, parking, etc.) were assigned medium reuse intensity. Roads and trails and specific designated reuse areas (classrooms, RV camping, parking, etc.) were assigned high reuse intensity.

4.4.3.2 The accessibility of an area reflects the ease of public access based on the presence or absence of roads and trails and slope of terrain. Sites with limited accessibility are not only very difficult to access, but do not pose the same level of hazard as an accessible site containing the same relative explosive safety risk. The accessibility factor for a given source area was designated one of three categories: accessible, limited, or inaccessible. An area was assigned one of the three accessibility factors using the terrain slope record in waypoints recorded during the site reconnaissance and then modified accordingly based on the presence or absence of roads and trails. The initial accessibility factor was assigned accessible if the terrain slope was described as flat or

gentle; limited if the terrain slope was moderate; or inaccessible if the terrain slope was described as steep or cliff. If a road or trail traversed an area, or is within 50 feet of the area, it was designated as accessible.

4.4.3.3 The depth distribution of MEC is not included as an evaluation factor in the ranking of explosive risk since all historical UXO findings at Camp Bonneville were at a depth of less than 18 inches below ground surface. However, the depth distribution of UXO findings is considered in developing site-specific cleanup levels.

4.4.3.4 Different activities involve different levels of subsurface intrusion and affect the potential for coming into contact with an ordnance item. The depths of activities likely to be conducted in those areas designated as high land reuse intensity were further categorized into surficial or subsurface based on the January 2003 Camp Bonneville Preliminary Site Plan. Representative surficial activities include hiking, picnicking, RV camping, archery, outdoor studies, education, and training. Subsurface intrusive activities include road repair and maintenance, camping, and new building construction for the proposed reuse and/or future expansion. The level of subsurface intrusion or depth of activity is designated as not applicable (NA) for those sites that are not located in high reuse intensity areas in the following summary tables contained in this section (only portions of the high reuse areas have proposed subsurface intrusive activities).

4.4.4 Source Type Exposure Hazards Assessment -Future Land Use

4.4.4.1 This following section describes the application of the explosive hazards exposure assessment for Camp Bonneville. An explosive hazards exposure assessment is presented for each of the seven primary MEC source types identified for Camp Bonneville:

1. Target Areas;
2. Open Burn/Open Detonation Areas;
3. Firing Points;
4. Range Safety Fans
5. Storage Magazines/Transfer Points;
6. Maneuver Areas, and
7. Training Areas

4.4.4.2 The source type areas are discussed in the order of their explosive safety relative risk ranking. The first two (Target Areas and OB/OD Areas) are similar in that both have a high likelihood of ordnance contamination coupled with an explosive risk of "marginal" or greater. The last three areas (Storage/Transfer, Maneuver Areas, Training Areas) are similar in risk ("negligible") and likelihood of MEC contamination (remote). The firing points and range safety fans fall between these two groupings.

4.4.4.3 In addition, the Central Impact Area which has MEC characteristics of both the range safety fan and target area source types; and is evaluated separately because of the potential presence of UXO in this area.

4.4.5 Target Areas

4.4.5.1 The Target Area MEC Source sites at Camp Bonneville consist of eight (8) target areas. Three of these target areas (West Impact Area Car Target 2, Combined Impact Area 1, and Combined Impact Area 2) comprise the sum of all identified target features located within the Central Impact Area. These three MEC Source sites are located outside the proposed regional park. The Central Impact Target Area is addressed separately in Section 4.4.4.

4.4.5.2 Additional Target Areas MEC Source sites include the 3.5-inch Rocket Range Target, Rifle Grenade Range Target, and Hand Grenade (HE) Range Target. These sites are located outside the boundary of the proposed regional park. Additionally, the M203 HE Grenade Range Target and 2.36-inch Rocket Target are Target Area MEC Source sites that are located within the proposed regional park boundary. Locations of Target Areas are shown in Figure 4.1. The positional locations of Target Areas MEC Source sites were confirmed during the site reconnaissance. Evidence of Target Areas included target area features, such as automobile / appliance targets, engineered wooden structures, and expended MEC items located downrange.

4.4.5.3 No UXO were identified or recovered during the site characterization in the 3.5-inch Rocket Range, Rifle Grenade Range or Hand Grenade (HE) Range; nor were any historical ordnance discoveries reported in these areas. A total of four (4) UXO items were recovered in the intrusive grid sampling at the M203 HE Grenade Ranges during the 1998 site characterization. An additional four (4) UXO items were recovered on the ground surface as the intrusive sampling teams were moving between sampling grids at the M203 Ranges. The recovered items were 35mm M73 practice rockets. The 35mm M73 practice rocket may still contain a small explosive safety risk due to the unconsumed signaling charge if it is fired, and fails to function. No 40mm HE or LAW HEAT munition items were encountered, and observations of the range revealed no indication of their presence (i.e., fragmentation marks, singed holes, explosive component debris). An interim removal action (TCRA) was performed at the M203 ranges in 1999. This clearance was conducted on 19 acres to a depth of two (2) feet. No UXO items were recovered during the interim removal action at the M203 HE Grenade Range. Over 3,800 pounds of inert OE scrap were recovered from the M203 Ranges during this clearance action.

4.4.5.4 One (1) intact 2.36-inch rocket was identified embedded near a tree on the east side of Munsell Hill during the 2001 site reconnaissance. This area was selected for reconnaissance due to the presence of ground scars that were identified from historic aerial photos. The 2.36-inch rocket was destroyed in place by the 707th Ord Co (EOD), Fort Lewis, Washington in February 2003. A buried 3.5-inch practice rocket was also reported being found near this location in the ASR (USACE, 1997). No evidence of any 3.5-inch rockets was found during the site reconnaissance at the reported location.

Figure 4.1 Target Area Location Map

4.4.5.5 The munition release mechanism resulting in the presence of MEC in the vicinity of the Target Areas is from deployed munitions that failed to function (UXO) and low-order detonation. Residual UXO poses the greatest explosive safety threat to the public as these items are fuzed and armed but failed to function. The hazard severity ranking for a Target Area is the most severe of all site types. The explosive safety relative risk ranking for Target Areas is 1 on a scale of 1 – 7 with 1 representing the highest explosive risk.

4.4.5.6 The accessibility of the M203 HE Grenade Range Target Area and Hand Grenade (HE) Range Target Area are designated as accessible based on a flat or gentle topographic slope and adjacent roadways. The accessibility of the other Target Areas is categorized as limited, based on a moderate topographic slope. The planned FBI Firing Range (different location than the existing FBI Range) and Law Enforcement Ranges overlie portions of the 3.5-inch Rocket Range, Rifle Range, and Hand Grenade (HE) Range Target Areas, and therefore are designated a high reuse intensity. The activities that will be conducted at the proposed firing range locations that overlie the historical Target Areas are categorized as surficial and non-intrusive activities.

4.4.5.7 The explosive hazards exposure assessment ranking for Target Area MEC Source sites was assigned Rank A on a scale of A – E with A representing the greatest exposure risk. This ranking is due to the high relative explosive safety risk of Target Areas and their locations within the proposed Regional Park and/or co-location with high reuse areas. The M203 HE Grenade Range Target Area was assigned Rank D because of the prior removal action completed in that area and medium (non-intrusive) future reuse. The explosive hazards exposure characteristics associated with Target Areas are summarized in Table 4.2.

4.4.6 Central Impact Target Area

4.4.6.1 The Central Impact Target Area MEC Source site is composed of three adjacent target areas, known as the West Impact Area Car Target 2, Combined Impact Area 1, and Combined Impact Area 2. The Central Impact Target Area is located in the central portion of Camp Bonneville (Figure 4.2) and comprises approximately 83 acres. This area is unique in that all six mortar and seven artillery firing positions could each fire into the Central Impact Target Area. The acreage of target areas were defined by a probability analysis using Field Manual No. 6-40 (HQDA, 1996), and calculating the spatial distribution of OE items fired from a fixed point to a fixed point based on the 96th percentile. An additional 100-foot buffer was then added to the 96th percentile area. Figure 4.3 shows a graphical representation of this spatial analysis. The Central Impact Target Area was segregated from the other target areas as it may require a different risk management strategy because of the greater potential for larger sized HE-filled UXO located in this area and its remote location.

TABLE 4.2
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR TARGET AREAS

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse[1]	
3.5-inch Rocket Range Target	1	Limited	High	Surface / Firing Range	A
Rifle Grenade Range Target	1	Limited	High	Surface / Firing Range	A
Hand Grenade (HE) Range	1	Accessible	High	Surface / Firing Range	A
M203 HE Grenade Range	* [2]	Accessible	Medium	NA / Regional Park	D
2.36-inch Rocket Target Area	1	Limited	Medium	NA / Regional Park	A

(1) The level of subsurface intrusion or depth of activity is designated as not applicable (NA) for those sites that are not located in high reuse intensity areas.

(2) Removal Action completed to a depth of two feet in the M203 HE Grenade Range Target in 1999.

4.4.6.2 The frequency of use of the Central Impact Target Area is identified in the ASR. The ASR report indicated that artillery units conducted firing exercises at Camp Bonneville twice a year from 1969 – 1985, resulting in approximately 50 rounds being fired into the Central Impact Target Area during each training session. Sometime in the 1970's, however the military switched from live ammunition to sub-caliber rounds for training purposes.

4.4.6.3 MEC release mechanisms that may have resulted in the presence of MEC at the Central Impact Target Area are from deployed munitions that failed to function. UXO items that are potentially present and pose the greatest explosive safety threat include HE-filled munitions ranging in size from 4.2-inch mortars to 155mm artillery rounds. Four (4) UXO items were recovered during the site characterization of the Central Impact Area. These recovered UXO items, including one 2.36-inch HE rocket and three 105mm HE-filled artillery rounds, were located in the Central Impact Target Area. Additionally, one (1) 105mm artillery round was identified during the 2001 site reconnaissance within this Central Impact Target Area.

4.4.6.4 Residual HE-filled UXO items potentially present in the Central Impact Target Area pose the greatest hazard severity ranking of all site types. The likelihood that additional UXO items are present in the Central Impact Target Area is considered high. The high severity ranking and likely presence for additional UXO result in an explosive safety relative risk ranking of 1 on a scale of 1 – 7 for the Central Impact Target Area.

4.4.6.5 The Central Impact Target Area is partially accessible by 4-wheel drive roads, although the majority of it is nearly inaccessible due to very steep terrain. This area is

Figure 4.2 Central Impact Target Area Location Map

Figure 4.3 Figure 4.2 Central Impact Target Area Probabilistic Model

designated a low reuse intensity as it is located within the Wildlife Management Area and there are no designated reuse or facilities planned in this area. The Central Impact Target Area is wholly contained within a fenced area with signage warning trespassers of potential for danger. People are not expected to venture into this area due to the fencing, signage and steep terrain. As a result, there are very few potential human receptors. The high likelihood of an MEC source combined with the very limited number of potential receptors in the area, results in an explosive hazards exposure assessment ranking of Rank B for each of the targets in the Central Impact Target Area. The explosive hazards exposure characteristics associated with the Central Impact Target Area is summarized in Table 4.3.

TABLE 4.3
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR CENTRAL IMPACT TARGET AREA

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse[1]	
West Impact Area Car Target 2	1	Limited	Low	NA / Wildlife Mgt Area	B
Combined Impact Area 1	1	Limited	Low	NA / Wildlife Mgt Area	B
Combined Impact Area 2	1	Limited	Low	NA / Wildlife Mgt Area	B

(1) The level of subsurface intrusion or depth of activity is designated as not applicable (NA) for those sites that are not located in high reuse intensity areas.

4.4.7 Open Burn/Open Detonation Areas

4.4.7.1 The OB/OD MEC Source sites consists of three OB/OD sites at Camp Bonneville, known as Demolition Area 1, 2 and 3. Demolition Area 1 is located in the northwest quadrant of the site, east of Little Elkhorn Mountain; Demolition Area 2 is located adjacent to and west of the Central Impact Area; while Demolition Area 3 is located in the southwest quadrant of the site adjacent to Lacamas Creek and the natural gas pipeline (Figure 4.4).

4.4.7.2 Demolition Area 1 sits atop Landfill 4. Landfill 4 was used for disposal of building demolition debris from the Vancouver Barracks and possible military wastes (Shannon and Wilson, 1999). The USACE has conducted an interim removal action and physically removed Demolition Area 1 (2.5 acres) in 2004 as part of the Landfill 4 removal action.

4.4.7.3 Demolition Area 1 was reportedly used by the Air Force and Army Explosive Ordnance Disposal (EOD), local fire departments and law enforcement agencies (USACE, 1997). It was used for destruction of unserviceable munitions, and confiscated

Figure 4.4 Open Burn/Open Demolition Area Location Map

firearms and fireworks since the late 1950's. The ASR reported that the Demolition Areas were used to destroy 20mm ammunition, 2.75-inch rockets, and one AIM 7E missile. The rocket motors were destroyed by burning and the warheads destroyed by detonation. The ASR also reported that automobiles, railroad ties, and other objects were brought onto the range for explosive training. Since 1993, the destruction of unserviceable munitions by any method (burning or detonation) was not permitted.

4.4.7.4 A wide range of explosives and ordnance were disposed of at the OB/OD areas. During the site characterization, a 2.36-inch HEAT rocket and an HE-filled 2.75-inch rocket were recovered in the vicinity of Demolition Area 1/Landfill 4. As a result of these findings, a 10-acre surface clearance was performed at Demolition Area 1/Landfill 4. Eight UXO items were recovered during the surface clearance and included two HE-filled 2.75-inch rockets and six 35mm M73 practice rockets. Also, a 4.5-inch rocket was recovered near Demolition Area 3.

4.4.7.5 The demolition of discarded or unused military munitions may sometimes result in the "kick-out" of munitions to some distance from the demolition area. Munition release mechanisms that may have resulted in the presence of MEC in the vicinity of an OB/OD Areas are from UXO kick-outs, and low-order or incomplete detonation. At an OB/OD area, the unsuccessful demilitarization of a UXO item poses the greatest explosive safety threat to the public. The hazard severity ranking for an OB/OD Area is the second most severe of all MEC Source site types (marginal/critical explosive safety hazard). The explosive safety relative risk ranking for OB/OD Areas is 2 on a scale of 1 – 7 with 1 representing the highest explosive risk.

4.4.7.6 The three OB/OD sites are accessible by roads and trails. Demolition Areas 1 and 2 are located outside the boundary of the proposed regional park. A "Logging Camp" is proposed at the location of Demolition Area 2, and this site is therefore designated high reuse intensity. Intrusive activities may be conducted in the logging camp. The explosive hazards exposure assessment ranking for Demolition Area 2 is Rank A because of the potential intrusive activities, site accessibility, and high relative explosive risk ranking. Demolition Area 3 is not within any designated reuse area, but is north of the planned Environmental Study Area (ESA); it is designated a medium (non-intrusive) reuse intensity. The explosive hazards exposure ranking for Demolition Area 3 is Rank A because of the potential for human interaction due to its accessibility and proximity to the planned ESA in combination with the high relative explosive risk ranking. The explosive hazards exposure ranking for Demolition Area 1 can be subdivided into two areas. The immediate OB/OD area for Demolition Area 1 (2.5 acres) is Rank E because it has physically been removed in 2004 as part of the Landfill 4 removal action. The surrounding kick-out area associated with Demolition Area 1 is Rank B. The kick-out area associated with Demolition Area 1 is lower than the other two OB/OD areas primarily because a ten acre surface sweep was conducted in 1998, and there are expected to be fewer potential receptors as it is located in the proposed Wildlife Management Area (WMA) which is a low reuse intensity area. The explosive hazards exposure characteristics associated with each of the OB/OD Areas are summarized in Table 4.4.

TABLE 4.4
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR OB/OD AREAS

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse[1]	
Demolition Area 1 (Kick-out area only)[2]	2	Accessible	Low	NA / Wildlife Mgt Area	B
Demolition Area 2	2	Accessible	High	Subsurface / Logging Camp	A
Demolition Area 3	2	Accessible	Medium	NA / Regional Park	A

(1) The level of subsurface intrusion or depth of activity is designated as not applicable (NA) for those sites that are not located in high reuse intensity areas.

(2) The OB/OD area associated with Demolition Area 1 was removed in 2004 and has an explosive hazard exposure rank E.

4.4.8 Firing Points

4.4.8.1 The Firing Points MEC Source Site type at Camp Bonneville consist of six mortar firing positions, seven artillery firing positions, one rifle grenade range firing point, one 3.5-inch rocket range firing point, and one M203 40mm HE Grenade Range (Range 4). Firing Points are located near the apex of each range. The positional location of each Firing Point was confirmed during the site reconnaissance. No UXO items were discovered at any Firing Points locations during the reconnaissance efforts. The location of each Firing Point is shown in Figure 4.5.

4.4.8.2 A wide variety of ordnance may have been used at the Firing Point locations. The ASR (USACE, 1997) described the munitions potentially used at each of the Firing Points. The six mortar firing points may have included 4.2-inch, 60mm and 81mm mortars filled with either HE or pyrotechnics. The artillery firing positions included 105mm and 155mm Howitzers and 37mm sub-caliber devices. A variety of rifle grenade munitions may have been used at the rifle grenade range including practice, smoke, white phosphorus (WP), fragmentation, and HEAT. Practice, HEAT, WP, or smoke-filled 3.5-inch rockets may have been used at the 3.5-inch rocket range.

4.4.8.3 The ordnance release mechanism at Firing Points is a result of abandonment, burial, or mishandling of non-deployed munitions in shallow pits. Any residual military munitions would likely be located at a close distance behind the Firing Point location where the munitions were prepared. The likelihood that military munitions are present at a Firing Point location is medium.

Figure 4.5 Firing Point Location Map

4.4.8.4 Only non-deployed military munitions are anticipated to be present at Firing Points. The type of ordnance utilized at a particular firing position would determine if the item was internally or externally fuzed. Military munitions require a specific action, i.e., turning of timer rings, or applying power or force in order to activate the fuzing system. Most artillery munitions are required to be fired in order to activate the fuzing mechanism. If a military munition has not been acted upon, the fuzing has not been activated, and the overall probability that the munition can be detonated by a person uncovering or picking up the item is extremely remote. However, if the item were to be acted upon in an inappropriate, specific and forceful manner, i.e., applying heat or pressure to the outside casing, it could detonate. The hazard severity ranking for a Firing Point location is considered very low (negligible explosive safety hazard). Due to the "medium" likelihood of MEC contamination, however, the explosive safety relative risk ranking for Firing Points is 3 on a scale of 1 – 7, with 1 representing the highest explosive risk.

4.4.8.5 The Firing Points are categorized as accessible based on their proximity to roads. Although Mortar Firing Positions 1, 2, and 5 are located outside the proposed regional park, within the wildlife management area, they are in very close proximity to the proposed park boundary and are therefore designated a medium reuse intensity. Any Clark County-proposed future use areas which overlie the Firing Point locations have activities which will be non-intrusive. Artillery Position 5 overlies the planned Trailhead & Parking Area and the 3.5-inch Rocket Range and Rifle Grenade Range firing positions overlie the FBI and Law Enforcement Firing Ranges.

4.4.8.6 The explosive hazards exposure assessment ranking for Firing Points which overlie a proposed future use area was assigned Rank B on a scale of A – E, with A representing the greatest exposure risk. Other Firing Points were assigned Rank C based on a combination of accessibility and future land reuse criteria. The M203 HE Grenade Range Firing Point was assigned Rank D because of the prior removal action completed in that area. The explosive hazards exposure characteristics associated with Firing Points are summarized in Table 4.5.

4.4.9 Training Areas

4.4.9.1 Camp Bonneville contained a wide variety of troop training areas. Some of these training areas utilized small arms ammunition such as the rifle, pistol, known distance firing ranges, pop up target ranges, and the close combat course. Other training areas utilized no ammunition, such as the bayonet and obstacle courses. Training areas evaluated in this section include the Practice Hand Grenade Range, Training Land Mine Range, Artillery Training Ranges (14.5mm sub-caliber), and M203 40mm Practice Grenade Range, and Range 8 - Mortar Practice Training Range. Training Area locations are shown in Figure 4.6.

TABLE 4.5
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR FIRING POINTS

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse[1]	
Mortar Firing Pos 1	3	Accessible	Medium	NA / WMA	C
Mortar Firing Pos 2	3	Accessible	Medium	NA / WMA	C
Mortar Firing Pos 3	3	Accessible	Medium	NA / Regional Park	C
Mortar Firing Pos 4	3	Accessible	Medium	NA / Regional Park	C
Mortar Firing Pos 5	3	Accessible	Medium	NA / WMA	C
Mortar Firing Pos 6	3	Accessible	Medium	NA / Regional Park	C
Artillery Pos 1	3	Accessible	Medium	NA / Regional Park	C
Artillery Pos 2	3	Accessible	Medium	NA / Regional Park	C
Artillery Pos 3	3	Accessible	Medium	NA / Regional Park	C
Artillery Pos 4	3	Accessible	Medium	NA / Regional Park	C
Artillery Pos 5	3	Accessible	High	Surface / Trail Head & Parking	B
Artillery Pos 6	3	Accessible	Medium	NA / Regional Park	C
Artillery Pos 7	3	Accessible	Medium	NA / Regional Park	C
Rifle Grenade Range	3	Accessible	High	Surface / Firing Range	B
3.5-inch Rocket Range	3	Accessible	High	Surface / Firing Range	B
M203 HE Grenade Range	*[2]	Accessible	Medium	NA / Regional Park	D

(1) The level of subsurface intrusion or depth of activity is designated as not applicable (NA) for those sites that are not located in high reuse intensity areas. WMA = Wildlife Management Area.

(2) Removal Action completed to a depth of two feet in the M203 HE Grenade Range Target in 1999.

4.4.9.2 The Practice Hand Grenade Range was located west of the Live Hand Grenade Range. No UXO or MEC items have been identified in this area based on historic records or during the site characterization activities. An Mk1A1 training hand grenade made of cast iron would have likely been used for practice in grenade throwing at the Practice Grenade Range. This item contains no explosive components and does not pose any explosive safety risk. The Practice Grenade Range does not possess an MEC Source risk, and is not carried forward to the Feasibility Study (FS).

4.4.9.3 The Practice Landmine Training Area was located west of the Mortar Practice Training Range. No UXO or MEC items have been identified in this area based on historic records or during the site characterization activities. The Practice Land Mine Training Area was used for training in the proper methods and precautions in arming and disarming of HE antipersonnel mines. The practice antipersonnel mine, M68 is completely inert and was reportedly used in this area. This item contains no explosive components and does not pose any explosive safety risk. The Practice Landmine Training Area does not possess an MEC Source risk, and is not carried forward to the Feasibility Study.

Figure 4.6 Training Location Area Map

4.4.9.4 The ASR report indicated the locations of four 14.5mm sub-caliber ranges. Two of these ranges are located along the south and southwest perimeter of the M203 HE Grenade Range. The third 14.5mm range is co-located with the Mortar Practice Training Range, while the fourth 14.5 mm range is located west of the 3.5-inch Rocket Range and is referred to on ASR maps as the M-31 Artillery Range. The 14.5mm cartridge is a sub-caliber munition for training simulations for a 75mm to 155mm Howitzer. Two versions have either 1) a delay element (fuzing), providing an airburst of a loud report and a puff of smoke or, 2) contained an internal percussion fuze and upon impact produces a loud report and a puff of smoke. Munitions that are 30mm and smaller are classified as small arms by the U.S. Military (USACE, 1994). The 14.5mm is considered small arms and pose a very low explosive safety threat to the public.

4.4.9.5 For small arms a deliberate effort must be applied to a very specific and small point (the primer) to make the round function. If the round functions outside the weapons chamber, the propellant gas would cause the bullet and cartridge to separate and, in addition, the cartridge could also rupture. If this took place in close proximity to a person, possible injury could result (USACE, 1999). The explosive safety risk posed by small arms ammunition is very small and is not further discussed in this report.

4.4.9.6 Maps in the ASR report indicate that Range 8 was used for LAW sub-caliber (35mm M73) and the M203 practice projectiles (M382 and M781). This area was also co-located with the Mortar Practice Training Range and a 14.5mm Range. USAESCH conducted an interim removal action to clear MEC items to a depth of two feet within the M203 Practice Range. A total of three (3) 40mm M382 practice projectiles were recovered during this removal action. These three UXO items were located at a depth of less than 2 inches below ground surface. These items are classified as UXO because of a small spotting charge. The 40mm M382 practice projectile if fired, and failed to function, may still contain a small explosive safety risk due to the unconsumed signaling charge. This item is not lethal but can cause bodily injury from the unconsumed signaling charge.

4.4.9.7 Several thousand expended 40mm practice projectiles (M781) and 35mm M73 practice rockets were also recovered at depths ranging from 0 – 14 inches below ground surface during the removal action in the M203 Practice Range. These items were determined to be inert and pose no explosive safety risk.

4.4.9.8 Practice 60mm and 81mm mortar rounds (M68 and M69, respectively) were constructed of cast iron and were used at the Mortar Practice Training Range during the 1940 – 1960s time frame. If fired, these items pose no explosive safety risk. Later variants, known as the 60mm Sabot and 81mm Sabot (M3 and M1, respectively), were reusable and incorporated the 22mm sub-caliber cartridges, M744 series. The M744 series cartridges contained a small signaling charge. If fired, and failed to function, these items may still contain a small explosive safety risk due to the unconsumed signaling charge.

4.4.9.9 During the removal action conducted in the M203 Practice Range, 43 sand-filled Stokes Mortars were recovered. The practice stokes mortars have cast iron bodies

and dummy fuzes. These items were determined to be inert, and pose no explosive safety risk.

4.4.9.10 The M203 Practice and Mortar Practice Training Ranges are co-located in Range 8 and readily accessible. UXO has been recovered in this area and a removal action to a depth of 2 feet has been completed. The likelihood that any UXO remains at this site is extremely remote. The area is designated as high reuse intensity since it is located inside the Regional Park, and is proposed for a Tent and Yurt Camping Site. Construction of Yurt camping sites may include grading and excavation. Intrusive activities associated with camping include driving tent stakes into the ground and excavation of fire pits. The remote probability of UXO being present in this area following the removal action, results in an explosive hazards exposure assessment ranking of Rank D. The explosive hazards exposure characteristics associated with the identified Training Area is summarized in Table 4.6.

TABLE 4.6
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR TRAINING AREAS

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse	
M203 Practice Range co-located with Mortar Practice Range	7[1]	Accessible	High	Subsurface / Tent and Yurt Camping	D

(1) Although Training Areas were ranked 4th on the MEC CSM relative risk ranking, a removal action was completed to a depth of two feet in this Practice Range Training area in 1999 resulting in a relative risk ranking of 7 (lowest ranking).

4.4.10 Range Safety Fans

4.4.10.1 The Range Safety Fan MEC Source sites consists of a total of sixteen (16) range safety fans associated with each of the sixteen Firing Point locations. Locations of the Range Safety Fans are shown in Figure 4.7. Range Safety Fans are designed to contain those single event items that fall at some distance from their intended target. These items are sometimes referred to as undershoot and overshoot. Based on the range of artillery used at Camp Bonneville, it is possible that rounds could have impacted off the installation. The likelihood of encountering ordnance in a Range Safety Fan is negligible, because of the relatively large size of the Range Safety Fan. Note that small arms range safety fans are not considered in this explosive hazards exposure assessment due to the non-explosive nature of small arms.

4.4.10.2 Munition release mechanisms that may have resulted in the presence of MEC in Range Safety Fans are from single event deployed munitions that failed to function (UXO) and low-order detonation. Residual UXO poses the greatest explosive safety threat to the public as these items are fuzed and armed but failed to function. The

Figure 4.7 Range Safety Fan Map

explosive safety relative risk ranking for Range Safety Fans is 4 on a scale of 1 – 7 with 1 representing the highest explosive risk. Due to the very low probability for encountering UXO in Range Safety Fans at Camp Bonneville, the explosive hazards exposure assessment ranking for Range Safety Fan OE Source sites is Rank D. The explosive hazards exposure characteristics associated with the Range Safety Fans is summarized in Table 4.7.

TABLE 4.7
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR RANGE SAFETY FANS

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse	
Range Safety Fans	4	Accessible	Low - High	Surface and Subsurface / Varied[1]	D

(1) Future land use associated with the Range Safety Fans is varied but predominantly includes the Wildlife Management Area. Other reuse includes surface and subsurface activities within the proposed Regional Park. These various activities are identified and discussed in detail in the land reuse section.

4.4.11 Storage Magazines/Transfer Points

4.4.11.1 The solitary Storage magazine / Transfer Point MEC Source site at Camp Bonneville is Building 2950. Building 2950 area is an ammunition storage area consisting of three bunkers located approximately 1000 feet northeast of the Camp Bonneville cantonment area (Figure 4.8). The bunkers were inspected during the ASR Site Visit in 1997 and the western bunker was locked and found to contain black powder and rifle powder (smokeless). The black powder and rifle powder were subsequently disposed of under a contract issued by the Seattle District Corps of Engineers to Garry Struthers Associates, Inc. (Warren Fjeldos, personal communication). The other two bunkers were open and empty during the ASR Site Visit. During the 2002 field reconnaissance effort, the ammunition storage area was found to be fenced and locked.

4.4.11.2 The munition release mechanism at Storage Magazines/Transfer Points results from mishandling, loss or burial. The likelihood of non-deployed military munitions to be present in the area is remote. If military munitions were present, they would likely be non-deployed and unfuzed. The hazard severity ranking for these non-deployed military munitions is very low (negligible explosive safety hazard). The explosive safety relative risk ranking is 5 on a scale of 1 – 7 with 1 representing the highest explosive risk.

4.4.11.3 Building 2950 is currently fenced and secure with a high-security padlock. The current land use is institutional. The future land use is recreational and has a medium reuse intensity as there are no proposed reuse activities planned at this location. The overall explosive hazards exposure is Rank E is on a scale of A – E with A representing the greatest exposure risk. Table 4.8 summarizes the exposure characteristics and ranking of the Building 2950 Storage Magazine/Transfer Point.

Figure 4.8 Storage Magazine/Transfer Point Location Map

TABLE 4.8
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR STORAGE MAGAZINE/TRANSFER POINT

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse[1]	
Building 2950	5	Inaccessible	Medium	NA / Regional Park	E

(1) The level of subsurface intrusion or depth of activity is designated as not applicable (NA) for those sites that are not located in high reuse intensity areas.

4.4.12 Maneuver Areas

4.4.12.1 Maneuver Areas are those areas that were not specifically identified on maps as training areas. Maneuver Areas overlay in many places with range safety fans because of the number and size of the range safety fans. Maneuver Areas included the roads and trails, bivouac, and maneuver areas, including the Killpack and Bonneville cantonment reas (Figure 4.9). In the Maneuver Areas, pyrotechnics and blank ammunition were typically employed to evaluate the reactionary responses of troops and convoys to an ambush and to train in tactics. Military munitions containing high explosives were not used for reactionary training in maneuver areas.

4.4.12.2 There is a remote possibility that pyrotechnic devices (i.e. flares, smoke grenades) may be present as a result of abandonment, mishandling, or loss in Maneuver Areas. Any residual non-deployed pyrotechnics that may be present are potentially flammable, and may contain a small, low explosive charge that may cause bodily injury. However, large portions of the pyrotechnics were constructed with fiberboard containers and are therefore extremely susceptible to exposure to the elements and resultant weathering. Over time, the photo-flash powder has likely been exposed to moisture and deteriorated. The hazard severity ranking for Maneuver Areas is considered extremely low (negligible explosive safety hazard). The explosive safety relative risk ranking for Maneuver Areas is 6 on a scale of 1 – 7 with 1 representing the highest explosive risk.

4.4.12.3 Maneuver Areas are located throughout Camp Bonneville and are accessible by roads and trails. The future reuse intensity of Maneuver Areas ranges from low intensity for those areas in the proposed WMA, to high intensity in proposed future use areas located in the regional park. Because of its extremely low explosive safety risk, those areas where a Maneuver Area overlays a designated area with camping, construction, or other subsurface intrusive activities, the explosive hazards exposure assessment ranking is Rank E on a scale of A – E with A representing the greatest exposure risk. The explosive hazards exposure characteristics associated with Maneuver Areas is summarized in Table 4.9.

Figure 4.9 Maneuver Area Location Map

TABLE 4.9
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR MANEUVER AREAS

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse[1]	
Maneuver Areas	6	Accessible	Low – High	Surface and Subsurface / Varied[1]	E

(1) Future land use associated with the Maneuver Areas is varied but predominantly includes the Wildlife Management Area. Other reuse includes surface and subsurface activities within the proposed Regional Park. These various activities are identified and discussed in detail in the land reuse section.

4.4.13 Central Impact Area

4.4.13.1 The Central Impact Area is 465 acres in size. It is comprised of the 83 acre Central Impact Target Area and 382 acres of associated Range Safety Fans (Figure 4.10). As such, the Central Impact Area has ordnance-related characteristics common to both Target Area and Range Safety Fan MEC Source site types. The Central Impact Area Targets (83 acres) were discussed previously in Section 4.4.6. The remaining Central Impact Area (382 acres) was selected for explosive hazard exposure assessment due to its remote location and its varied MEC exposure characteristics, suggesting that this area may require a unique risk management strategy. The entire Central Impact Area is wholly fenced off with a three-strand barbed wire fence encircling the area. Additionally, signage warning of the potential danger to trespassers is in place.

4.4.13.2 Munition release mechanisms that may have resulted in the presence of MEC in the vicinity of the Central Impact Area are from deployed munitions that failed to function. Residual HE-filled UXO items potentially present in the Central Impact Area pose the greatest hazard severity ranking of all site types. The likelihood that additional UXO items are present in the Central Impact Area is considered low – medium as the vast majority of the Central Impact Area is located within the Range Safety Fans. The high severity ranking and low – medium presence of additional UXO result in an explosive safety relative risk ranking of 3 on a scale of 1 – 7 for the Central Impact Area.

4.4.13.3 The overall accessibility of the Central Impact Area is considered limited as the entire site is fenced and signed, while only a small portion of this site is accessible by four-wheel drive road. The vast majority of the Central Impact Area is either limited or inaccessible due to very steep terrain. It is designated as low reuse intensity since it is located within the Wildlife Management Area. There are no overlying proposed future use sites or facilities planned in this area. People are not expected to venture into the area because of the fencing, signage, and steep terrain; therefore the number of potential human receptors is considered negligible. The low – medium likelihood of an MEC source combined with the very limited number of potential receptors in the area, result in

Figure 4.10 Central Impact Area Location Map

an explosive hazards exposure assessment ranking of Rank C. The explosive hazards exposure characteristics associated with the Central Impact Area is summarized in Table 4.10.

TABLE 4.10
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR CENTRAL IMPACT AREA

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse[1]	
Central Impact Area	3	Limited	Low	NA / Wildlife Mgt Area	C

(1) The level of subsurface intrusion or depth of activity is designated as not applicable (NA) for those sites that are not located in high reuse intensity areas. No reuse is proposed for this area.

4.4.14 Summary of Exposure Hazards by Primary Source Types

4.4.14.1 Each of the MEC Source sites identified in the site characterization were evaluated as part of this MEC risk assessment. Several Training Area sites were determined not to pose any explosive safety risk and were screened out of the exposure hazards assessment. In general, Target Areas, Firing Points and OB/OD Areas were determined to pose the greatest explosive safety exposure hazard; the remaining site types pose a negligible risk. Figure 4.11 shows the exposure hazard by MEC Source type and Table 4.11 summarizes the scoring results.

4.4.15 Exposure Hazards Assessment by Land Reuse Type

4.4.15.1 The foregoing exposure hazards assessment addresses the interaction between MEC source areas and future human activities based on the proposed land use designated as part of the planned regional park. Other types of future land use areas were also selected for risk analysis in order to determine if they require a specific risk management strategy. The following land reuse areas were evaluated in this analysis:

- Roads and Trails;
- High Intensity Reuse Areas;
- Medium Intensity Reuse Areas;
- High Accessible – Medium Intensity Reuse Areas; and
- Wildlife Management Area.

4.4.16 Roads and Trails

4.4.16.1 There are approximately 46 miles of Roads and Trails throughout Camp Bonneville of which 21 miles are located within the proposed regional park (Figure 4.12).

Figure 4.11 Explosive Hazards Exposure Ranking by OE Source Site

TABLE 4.11
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHRACTERISTICS FOR PRIMARY SOURCE TYPES

Explosive Safety Relative Risk Ranking	Primary Source	Accessibility Factor								
		Accessible	Limited	Inaccessible	Accessible	Limited	Inaccessible	Accessible	Limited	Inaccessible
		Future Use Intensity								
		Low			Medium			High		
7 Least Risk	Training Area							D		
	Maneuver Area	E			E			E		
	Storage Magazines/Transfer Point						E			
	Range Safety Fan	D	D	D	D	D	D	D		
	Firing Point				C			B		
	Open Burn/Open Detonation Area	B			A			A		
1 Most Risk	Target Area	B			D	A		A	A	

Explosive Hazards Exposure:
A = Highest Hazard Level
E = Lowest Hazard Level

Shaded conditions are not present at Camp Bonneville.

The Roads and Trails have the same munition related historical use and characteristics as the Maneuver Areas. Roads and Trails were segregated for analysis because of the greater potential for human use which may require a different risk management strategy.

4.4.16.2 The reconnaissance efforts resulted in 100% coverage of Roads and Trails in Camp Bonneville. The only items recovered within a 50-foot buffer along the Road and Trails during the reconnaissance were expended pyrotechnics and small arms ammunition. The hazard severity ranking for Roads and Trails is the same as Maneuver Areas and is considered extremely low (i.e., negligible explosive safety hazard and remote likelihood of contamination). The explosive safety relative risk ranking for Roads and Trails is 6 on a scale of 1 – 7 with 1 representing the highest explosive risk.

4.4.16.3 Roads and Trails are located throughout Camp Bonneville. The future reuse intensity of Roads and Trails is considered high. In addition to pedestrian and equestrian traffic, maintenance will be conducted along the Roads and Trails. These activities are non-intrusive. The explosive hazards exposure assessment ranking for Roads and Trails is Rank E, despite the relatively large number of potential receptors, because of its negligible explosive safety risk. The explosive hazards exposure characteristics associated with Roads and Trails is summarized in Table 4.12.

Figure 4.12 Roads and Trails

TABLE 4.12
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR ROADS AND TRAILS

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse	
Roads and Trails	6	Accessible	High	Surface / Hiking and Horseback Riding	E

4.4.17 High Intensity Reuse Areas

4.4.17.1 The proposed Clark County Regional Park has approximately 210 acres of specific reuse activity sites, based on the January 2003 Camp Bonneville Preliminary Site Plan (Figure 4.13). This explosive hazards exposure assessment has designated these areas as High Intensity Reuse Areas. Those portions of High Intensity Reuse Areas that overlie an MEC Source site are addressed within that MEC Source risk analysis, and will be carried forward in the feasibility study. The remaining High Intensity Reuse Areas are categorized as having the munition activity and MEC characteristics of a Maneuver Area. Camp Bonneville in its entirety is considered a Maneuver Area, and barring other information, this designation is applied to the High Intensity Reuse Areas located within the proposed regional park. The hazard severity ranking for High Reuse Areas are defined to be equivalent to a Maneuver Area (i.e., negligible explosive safety hazard) and the likelihood of ordnance contamination is remote. The explosive safety relative risk ranking for High Reuse Areas is 6 on a scale of 1 – 7 with 1 representing the highest explosive risk.

4.4.17.2 The greatest amount of human activity will occur in the High Intensity Reuse Areas. Examples of intrusive activities include tent camping and construction. Non-intrusive activities include RV camping, parking, archery or firing range training. Because of the relatively large number of receptors in the High Intensity Reuse Areas, the explosive hazards exposure assessment ranking for High Intensity Reuse Areas is Rank D. The explosive hazards exposure characteristics associated with High Intensity Reuse Areas is summarized in Table 4.13.

4.4.18 High Accessible - Medium Intensity Reuse Areas

4.4.18.1 High Accessible-Medium Intensity Reuse Areas consists of selected areas within the proposed regional park that are located between High Intensity Reuse Areas. A High Accessibility Area is defined as area that generally has a gentle topographic slope (<15%) and has low vegetative cover. These sites provide the opportunity to draw people together for informal recreational activities, such as ball toss, Frisbee games and picnic areas. The High Accessible-Medium Intensity Reuse Areas comprise approximately 180 acres within the proposed regional park as shown in Figure 4.14. The High Accessible-Medium Intensity Reuse Areas have the same ordnance related historical use and

Figure 4.13 Proposed High Intensity Reuse Areas

Figure 4.14 High – Accessible Medium Intensity Reuse Area

characteristics as the High Intensity Reuse Areas, categorized as Maneuver Areas (i.e., negligible explosive safety hazard and remote likelihood of contamination).

TABLE 4.13
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR HIGH INTENSITY REUSE AREAS

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse	
High Intensity Reuse Areas	6	Accessible	High	Surface and Subsurface / Varied	D

4.4.18.2 The High-Accessible Medium Intensity Reuse Areas differ only from the High Intensity Reuse Areas in the number of people and type of activities likely to occur in these areas. The High-Accessible Medium Intensity Reuse Areas are categorized to be those areas where people may gather to conduct impromptu recreational activities. These recreational activities are likely to be surficial, non-intrusive activities. A moderate number of people are expected to enter the High-Accessible Medium Intensity Reuse Areas. The explosive hazards exposure assessment ranking for Highly Accessible Medium Intensity Reuse Areas is Rank D due to the moderate number of potential receptors in the Highly Accessible Medium Intensity Reuse Areas and negligible explosive risk rating. The explosive hazards exposure characteristics associated with Highly Accessible Medium Intensity Reuse Areas is summarized in Table 4.14.

TABLE 4.14
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR HIGH ACCESSIBLE -MEDIUM INTENSITY REUSE AREAS

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse	
High- Accessible Medium Intensity Reuse Areas	6	Highly Accessible	Medium	Surficial / Recreation	D

4.4.19 Remaining Medium Intensity Reuse Areas

4.4.19.1 The Remaining Medium Intensity Reuse Areas (Figure 4.15) consist of those areas within the proposed Regional Park that are located between specific designated reuse areas, and do not have the high accessibility characteristics of gentle slope and low vegetation characteristics. The Remaining Medium Intensity Reuse Areas comprise approximately 786 acres, and have the same ordnance related historical use and

Figure 4.15 Remaining Medium Intensity Reuse Area

characteristics as the High Intensity Reuse Areas, categorized as Maneuver Areas (i.e., negligible explosive safety hazard and remote likelihood of contamination).

4.4.19.2 The Remaining Medium Intensity Reuse Areas differs from the High Intensity Reuse Areas in the number of people and the types of activities likely to occur in these areas. Very few people are expected to enter the Remaining Medium Intensity Reuse Areas, as most people would be expected to use the accessible Roads and Trails, and these areas have significant vegetative cover and or moderate-steep terrain characteristics. The anticipated activities within this area are limited to walking. The explosive hazards exposure assessment ranking for Remaining Medium Intensity Reuse Areas is Rank E based on the small number of potential receptors in the Remaining Medium Intensity Reuse Areas. The explosive hazards exposure characteristics associated with Accessible Medium Intensity Reuse Areas is summarized in Table 4.15.

TABLE 4.15.
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR ACCESSIBLE MEDIUM INTENSITY REUSE AREAS

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse	
Accessible Medium Intensity Reuse Areas	6	Accessible	Medium	Surficial / Short-cuts	E

4.4.20 Wildlife Management Area

4.4.20.1 The Wildlife Management Area is comprised of approximately 2307 acres and includes the DNR leased lands (Figure 4.16). The Wildlife Management Area does not include the Central Impact Area which requires a separate risk management strategy and is addressed separately above. The majority of the Wildlife Management Area overlies one or more Range Safety Fans.

4.4.20.2 The Wildlife Management Area is categorized as having the ordnance related historical use and characteristics similar to those as the Range Safety Fans (critical/catastrophic explosive safety risk and low likelihood of munition contamination). The explosive safety relative risk ranking for the Wildlife Management Area is 4 on a scale of 1 – 7 with 1 representing the highest explosive risk similar to Range Safety Fans.

4.4.20.3 The overall accessibility of the Wildlife Management Area is considered limited as only a small portion of this site is accessible by road. The vast majority of the Wildlife Management Area is categorized as either limited or inaccessible due to very steep terrain. It is designated as low reuse intensity, with no overlying proposed future use sites or facilities planned in this area. Timber harvesting and subsequent timber planting are the sole human activities proposed for the Wildlife Management Area.

Figure 4.16 Wildlife Management Area

People are not expected to venture into the area because of the steep terrain; therefore the number of potential human receptors is considered very low. The low likelihood of an MEC source combined with the very limited number of potential receptors in the area, result in an explosive hazards exposure assessment ranking of Rank D. The explosive hazards exposure characteristics associated with the Wildlife Management Area is summarized in Table 4.16.

TABLE 4.16
SUMMARY OF EXPLOSIVE HAZARDS EXPOSURE CHARACTERISTICS FOR WILDLIFE MANAGEMENT AREA

Site	MEC Source	Receptor Interaction			Explosive Hazards Exposure Rank
	Explosive Relative Risk Ranking	Accessibility	Future Land Reuse	Depth of Activity / Reuse	
Wildlife Management Area	4	Accessible	Low	Surface and Subsurface / Silviculture, Short-cuts	D

4.4.21 Summary of Exposure Hazards by Land Use

4.4.21.1 Each of the Clark County proposed land reuse areas identified for Camp Bonneville was evaluated as part of this risk assessment. None of these proposed reuse areas were determined to pose an appreciable explosive exposure hazard based on an evaluation of the MEC source and receptor interaction.

SECTION 5

CLEANUP STANDARDS

5.1 BACKGROUND

5.1.1 MTCA (WAC 173-340) indicates that cleanup standards be identified for hazardous substances at a site and for the specific interaction pathways, such as soil or groundwater, where humans and the environment can become exposed to these substances. The regulation provides uniform methods for identifying cleanup standards and requires that all cleanups performed under the MTCA meet these standards. The actual degree of cleanup may vary from site to site and is determined by the cleanup action alternative selected during the feasibility study. Establishing cleanup standards for individual sites requires the specification of the following:

- Hazardous substance concentrations that protect human health and the environment ("cleanup levels");
- The location on the site where those cleanup levels must be attained ("points of compliance"); and
- Additional regulatory requirements that apply to a cleanup action because of the type of action and/or the location of the site (applicable state and federal laws).

5.1.2 MTCA (WAC 173-340-200) defines “permanent cleanup action” as an action in which the cleanup standards are met without further action being required at a site. At sites where a “permanent cleanup action” is not practicable, “remediation levels” may be selected using a disproportionate cost analysis. MTCA (WAC 173-340-200) defines “remediation levels” as a concentration (or other method of identification) above which a particular cleanup action component will be required as part of a cleanup action at a site. Remediation levels are not the same as “cleanup levels”. A “cleanup level” defines the concentration above which a medium must be remediated. Remediation levels, by definition, exceed cleanup levels. Sites using remediation levels should also use institutional controls to assure continued protection of human health and the environment and to prevent land uses that could result in a higher level of exposure (WAC 173-34-440).

5.1.3 The methodology in MTCA for establishing cleanup levels involves identification of the nature and extent of contamination, evaluation of exposure pathways, current and potential receptors, and current and potential land use. Based on this information one of three methods (MTCA Method A, B, or C) is then used to calculate cleanup levels. MTCA Method A uses published tables to determine the cleanup action level for sites

undergoing routine cleanup with relatively few hazardous substances. MTCA Method B uses risk assessment equations to determine the cleanup action level at sites contaminated with hazardous substances not listed under MTCA Method A. MTCA Method C uses less stringent exposure assumptions than Method B and is used when attainment of Method A or Method B cleanup levels are not possible or would result in a significantly greater overall threat to human health and the environment.

5.1.4 MTCA does not identify a cleanup level for MEC; nor does MTCA identify exposure factors for MEC that could be used to develop a site-specific cleanup level. The MTCA methods which were developed for chemical contaminants are not applicable for establishing cleanup levels for MEC. Furthermore, the State of Washington presently has no quantitative legal standards governing cleanup of MEC. However, the State of Washington has determined that MEC is within the statutory definitions of "hazardous waste" and must be managed and cleaned up as required for such materials in accordance with MTCA (WAC 173-340).

5.2 DEVELOPMENT OF CLEANUP STANDARDS TO CAMP BONNEVILLE

5.2.1 The intent of MTCA is to select cleanup standards that are protective of human health and the environment. Proposed site-specific cleanup standards (remediation levels and points of compliance) to address the explosive safety risk posed by different site types located within Camp Bonneville are presented based on the baseline explosive safety exposure assessment, described in Section 4. Specifically, the remediation level and points of compliance are defined to ensure protection of the human health and the environment and to be consistent with the planned future land use.

5.2.2 MTCA (WAC 173-340-7490) requires that the impact of hazardous substances on terrestrial ecological receptors be considered in the establishment of cleanup standards. Although an animal may come into direct contact with an OE item located on the ground surface, they are not likely, except in the rarest of circumstances, to act on it in a forceable manner to initiate an unintentional detonation. Unlike chemical hazardous substances, MEC does not pose an appreciable threat to soil biota, plants or animals. Therefore ecological receptors are not considered further in development of the cleanup standards at Camp Bonneville.

5.2.3 MEC clearance actions will reduce the concentration of MEC and the resulting explosive safety threat to the public. The depth to which MEC clearance is required depends upon a number of factors, including: the future use of the site; the estimated intrusion into the soil associated with likely future activities; and, consideration of natural processes that might increase the future potential for receptor interaction (i.e. frost heave, erosion).

5.2.4 Over time, recurring natural processes such as flooding and frost heave can displace MEC located on or beneath the ground surface, making it more accessible for human interaction. There are no MEC source areas that overlie Lacamas Creek other than the Range Safety Fans and Maneuver Areas. As such, the potential for increased MEC exposure from erosion along Lacamas Creek is not considered to be an important

factor for increased human exposures due to the lack of significant MEC source areas overlying Lacamas Creek (with low to remote likelihood of muniton contamination). Therefore, erosion along Lacamas Creek is not considered in the development of the Camp Bonneville cleanup standards.

5.2.5 Consideration of the effects of frost heave on the determination of clearance depths ensures that the response action will be effective. Frost heave is the movement of soils during a freeze-thaw cycle. When water freezes, it expands and creates uplift pressure. Silt and clay rich soils are more susceptible to frost heave than granular (sandy) soils and vegetation reduces the effects of frost heave. Althought the majority of Camp Bonneville is heavily vegetated, over time, MEC buried above the frost line may migrate upwards through frost heave action. The frost penetration depth at Camp Bonneville is approximately 14 inches (USACE, 2000).

5.2.6 Complete excavation to depth and restoration of the entire Camp Bonneville to allow unrestricted use is impracticable due to its inordinately high costs, its excessive time-frame to accomplish excavation, the resulting near-total ecological destruction and the decades-long time frame for environmental restoration. Additionally, this extreme measure is not necessary to ensure public safety. The MEC risk assessment identified a qualitative level of exposure hazard posed by each site type that is based on realistic assumptions and supported by actual data regarding the MEC source and receptor interaction. The level of exposure hazard varied for each of the site types and therefore each site type poses different opportunities for employing risk management strategies.

5.2.7 Eliminating all risk at Camp Bonneville is not practicable, even after MEC cleanup is complete. Since exposure to MEC is assumed to result in some level of explosive safety risk, “a clean MEC site ” generally means that a site is cleaned up to a point that the likelihood for MEC source and receptor interaction is negligible. The remediation level proposed for Camp Bonneville is the condition where “the likelihood for MEC source and receptor interaction is negligible”. The points of compliance will be based on those areas (measured in both horizontal and vertical dimensions) where the MEC source and receptor interactions are likely to occur. MEC clearance actions will be limited to the footprint of those specific areas that allow an MEC source and receptor interaction to occur, as only those specific areas pose an unacceptable MEC exposure hazard.

5.2.8 The Firing Points, OB/OD Areas, and Target Areas at Camp Bonneville were determined in the MEC risk assessment to pose an unacceptable MEC exposure hazard. These site types will be evaluated for a range of risk management strategies in the feasibility study that will result in a condition where the likelihood for MEC source and receptor interaction is negligible. The actual depth of clearance for these areas will be determined during the evaluation of cleanup action alternatives in the feasibility study by consideration of the MEC source and receptor interactions.

SECTION 6

DEVELOPMENT AND SCREENING OF ALTERNATIVES

6.1 INTRODUCTION

6.1.1 The purpose of the feasibility study (FS) is to develop and evaluate cleanup action alternatives to enable a cleanup action to be selected for the site. This section presents the development and description of cleanup action alternatives that are considered for this FS. This section also presents the initial screening of cleanup action alternatives to eliminate alternatives that do not meet the requirements specified in MTCA (WAC 173-340-350).

6.1.2 Alternatives retained from the initial screening will be evaluated further in Section 7 consistent with the criteria specified in MTCA (WAC 173-340-360). This evaluation will determine the most practicable permanent solution to reduce explosive safety risk posed by the different MEC sites located within Camp Bonneville. As described in Section 4, a number of these former MEC sites pose an explosive safety risk to the public.

6.2 DEVELOPMENT OF ALTERNATIVES

6.2.1 Consistent with MTCA (WAC 173-340-350), the FS shall include the following:

- Alternatives that are protective to human health and environment by eliminating, reducing, or otherwise controlling risks posed by the site;
- A reasonable number and type of alternatives based on the characteristics and complexity of the site, including current site conditions and physical constraints;
- At least one permanent cleanup action alternative as defined in MTCA (WAC 173-340-200) to serve as a baseline against which other alternatives shall be evaluated for the purpose of determining whether the cleanup action selected is permanent to the maximum extent practicable;
- Alternatives that consist of one or more cleanup action components, including, but not limited to: components that remove MEC from the site; provide for on-site or offsite demolition and disposal of MEC; and, on-site isolation of MEC with engineering and institutional controls; and

- Alternatives that may include remediation levels to define when particular cleanup action components will be used. Alternatives may also include different remediation levels for the same component.

6.2.2 Based on the above requirements, six alternatives, including the no further action alternative, were developed for consideration at Camp Bonneville. The remaining five alternatives are: institutional controls, MEC surface clearance, MEC clearance to frost depth (14 inches), MEC subsurface clearance, and excavation and restoration (E&R). The following sections describe these alternatives.

6.3 ALTERNATIVE DESCRIPTION

6.3.1 Alternative 1: No Further Action

6.3.1.1 No further action (NFA) means no cleanup action will be implemented to reduce the potential explosive safety risk posed by different sites located within Camp Bonneville. This alternative, if implemented, would involve the continued use of the site in its current condition. If the potential exposure and hazards associated with MEC are compatible with the current conditions and future use of the site, then the implementation of NFA would be warranted. NFA is included as a baseline alternative in this FS for comparison with the remaining alternatives.

6.3.2 Alternative 2: Institutional Controls

6.3.2.1 Institutional Controls (ICs) are measures undertaken to limit public exposure to residual explosives materials at Camp Bonneville. These preventive measures may include educational awareness and training programs, legally enforceable restrictions on future land use, and physical access controls. Clark County will have authority and responsibility for implementing and monitoring ICs. The ICs for this FS are developed consistent with MTCA (WAC 173-340-440). The following sections provide a brief description of the IC components that are considered for implementation at Camp Bonneville.

6.3.2.1 Access Control

6.3.2.1.1 Access controls limit future receptor usage of the site by implementing various restrictions or dedicating the property to compatible use. Access controls can take the form of signage, fencing, and land-use restrictions and/or regulatory control.

6.3.2.1.2 Signage describes a comprehensive sign posting system that entry to a site is prohibited, that activities within the property are restricted, and/or that the area has a history of past munition-related activity. For Camp Bonneville, it is recommended that the signs present both historic and current designations such as for roads and trails, the sign will be designed to communicate both past site usage activities and current / future site activities. For example, the signage would read “Artillery Range Road” with a sub-header of “Jogging Trail 8”.

6.3.2.1.3 Fencing provides a physical barrier to inadvertent future receptor entry. Enforcement of trespass restrictions will be more effective if fencing is present. The

construction / maintenance of fencing is recommended for specific sites at Camp Bonneville, both as a feature for beneficial economic purposes and also as an enforcement tool to deny access to the public to areas designated as off-limits. As with signage, fencing will also reinforce the link between appropriate access points and explosive safety.

6.3.2.1.4 Land use restrictions and regulatory controls dictate the type of development that will occur on a site and the methods in which that development occurs. Currently, the land use designation for Camp Bonneville is an institutional designation illustrated as "Tier 1 Forest" on the land use map. Future updates of the Clark County land re-use plan will reflect the site as recreation and park land uses. However, it will be still used for institutional purposes as the Clark County owns it.

6.3.2.2 Educational Awareness Program

6.3.2.2.1 Clark County will have the responsibility to educate the public and park visitors about the potential hazards associated with visiting and recreation activities on a former military installation. The education awareness programs of potential safety hazards will modify public behavior at Camp Bonneville. This education / awareness program should be implemented by Clark County and its stakeholder agencies that have interest in using the site. Behavior modification is dependent upon the awareness and personal responsibility of the site user. If there is open access to existing munitions-related site, there is negligible risk to a potential receptor if the individual's behavior is appropriate for the site conditions. For behavior to be appropriate, one must understand the situation and voluntarily react in a responsible manner.

6.3.2.2.2 Raising public education for the potential hazards that exist within the Camp Bonneville can be facilitated with local awareness programs such as land use controls and notifications during permitting. Restrictive covenants on the land uses of Camp Bonneville should be detailed in an official site plan and adopted by Clark County for enforcement. Restrictive covenants and site plan requirements for Camp Bonneville should be included in the update of the County and Regional Comprehensive Plan.

6.3.2.2.3 Clark County notifications should be sent through the permitting of utility connections, infrastructure construction, land surveying, timber harvesting, and related physical land disturbance tasks. Standard application forms and brochures that explain the procedures involved in the construction notification and building permit approval processes should be updated to reflect training and circumstances dealing with any munitions that may be present at Camp Bonneville. The standard permit application process of the City of Vancouver and Clark County should be amended to include information about the possibility of MEC hazards, and specific Camp Bonneville site plan information and restrictive covenants.

6.3.2.3 Printed Media Awareness Program

6.3.2.3.1 Munitions awareness and education, acknowledgement of the potential explosive safety risk involved, and reinforcement of the message will minimize the hazards of exposure to residual MEC at Camp Bonneville. The avenue recommended for this education and awareness of MEC is through printed media, in the form of brochures,

fact sheets, newspaper articles, and other information packages. The opportunity to disseminate information through the printed media is readily available and can be easily facilitated through the numerous media outlets in Metropolitan Portland. Through the use of printed media, park visitors, nearby property owners and residents within Clark County and the region can be informed about the potential existence of residual hazards within the former Camp Bonneville.

6.3.3 Alternative 3: Surface Clearance with Institutional Controls

6.3.3.1 Surface clearance will require clearance of MEC items located on the ground surface. Prior to performing any MEC clearance activities at the site, control points will be established by a land surveyor for the areas that will undergo surface clearance. UXO-qualified personnel will perform a magnetometer-assisted surface sweep to locate metallic objects. The sweep will be performed in fixed width intervals. During the surface sweep, metallic objects located on the ground surface will be identified as metallic scrap or MEC items and removed.

6.3.3.2 Metallic objects identified as MEC items during the surface clearance will be inspected to ensure its stability. During this inspection, a determination will be made whether the recovered MECitem can be moved. If a determination is made that the MEC item is not acceptable to move, then the OE will be destroyed in place. Otherwise, the item will be moved to a remote location for onsite destruction and disposal. If necessary, engineering controls will be used to minimize the need for evacuation of the public. Inert MD items will be removed from the area and transported offsite for disposal.

6.3.3.3 ICs (Alternative 2) will be implemented in conjunction with the MEC surface clearance to limit public exposure to possible residual explosives materials at Camp Bonneville.

6.3.4 Alternative 4: Clearance to Frost Depth (14 inches) with Institutional Controls

6.3.4.1 Clearance to frost depth at Camp Bonneville will require clearance of MEC items located on the ground surface and within 14 inches below the ground surface. Clearance to frost depth at Camp Bonneville is due to the published frost penetration depth of 14 inches and potential for the resulting frost heave of buried items at or above this depth. Based on the minimal amount of UXO recovered todate all being less than 18 inches below ground surface, it is anticipated that the majority of remaining UXO at the site is within this frost depth interval. MEC clearance activities at the site, control points will be established by a land surveyor for the areas that will undergo surface clearance. Brush clearing crews will clear sufficient undergrowth so that the MEC clearance crews can adequately perform their work. The brush clearance crews will be accompanied by UXO-qualified safety personnel.

6.3.4.2 Upon completion of land surveying and brush clearing, surface clearing will be conducted in accordance with Alternative 3. The clearance of surface clutter and MD scrap will enhance the discrimination capability of digital geophysical mapping (DGM).

6.3.4.3 Once the surface clutter is removed, DGM of the site will be performed to map metallic anomalies located below ground surface. The DGM will provide a permanent record of the geophysical mapping results. The DGM will be conducted with a metal detection device capable of locating metallic anomalies to the depth of clearance. The DGM data will be analyzed by a qualified geophysicist to identify subsurface metallic anomalies. "Dig sheets" will be created from these analyses to describe the positional locations of subsurface metallic anomalies.

6.3.4.4 Locations of the metallic anomalies identified on the dig sheets will be reacquired at the site for intrusive investigation. The intrusive investigation would require that each anomaly location listed on the dig sheets be excavated until the anomaly source is identified or until a clearance depth of 14 inches has been reached. During the intrusive investigation, engineering controls may have to be used to decrease the evacuation distance that will be required for conducting these intrusive investigations. Evacuation distances will be based on a reasonable worst-case scenario for the potential detonation of an ordnance item that could be found at the site. All non-essential personnel are evacuated based on this distance to maximize the safety of the operation. Metallic objects obtained during the intrusive investigations will be identified as metallic scrap or MEC items. The disposal of MEC items will be performed as described in the surface clearance alternative (Alternative 3).

6.3.4.5 ICs (Alternative 2) will be implemented in conjunction with the MEC frost depth clearance to limit public exposure to possible residual explosives materials at Camp Bonneville.

6.3.5 Alternative 5: Subsurface Clearance with Institutional Controls

6.3.5.1 Subsurface clearance will require clearance of MEC items to a specified depth based on the projected end use of the site and the resulting potential for exposure to MEC. Under this alternative, each anomaly will be intrusively investigated until the anomaly is identified or until the site-specific risk-based specified depth is reached.

6.3.5.2 Implementation of this alternative will involve land surveying and brush clearing operations as described in the clearance to frost depth alternative. This alternative will also involve a magnetometer-assisted surface sweep to remove all surface clutter which includes metallic scrap items and MEC items. The surface sweep will be performed by experienced UXO-qualified personnel. Any MEC items identified during the surface sweep will be disposed as described in Alternative 3.

6.3.5.3 Once the surface clutter is removed, digital geophysical mapping (DGM) of the site will be performed to map metallic anomalies located below ground surface. The DGM will be conducted with a metal detection device capable of locating metallic anomalies to the depth of clearance. The DGM data will be analyzed by a qualified geophysicist to identify subsurface metallic anomalies. Dig sheets will be created from these analyses to present the locations of subsurface metallic anomalies.

6.3.5.4 Locations of the metallic anomalies identified on the dig sheets will be reacquired at the site for intrusive investigation. The intrusive investigation would require that each anomaly location be excavated until the anomaly source is identified or

until the predetermined clearance depth has been reached. During the intrusive investigation, engineering controls may have to be used to decrease the evacuation distance that will be required for conducting these intrusive investigations. Evacuation distances will be based on a reasonable worst-case scenario for the potential detonation of a munition that could be found at the site. All non-essential personnel are evacuated based on this distance to maximize the safety of the operation. Metallic objects obtained during the intrusive investigations will be identified as metallic scrap or MEC items. The disposal of MEC items will be performed as described in the surface clearance alternative (Alternative 3).

6.3.5.5 ICs (Alternative 2) will be implemented in conjunction with the MEC subsurface clearance to limit public exposure to possible residual explosives materials at Camp Bonneville.

6.3.6 Alternative 6: Excavation and Restoration

6.3.6.1 Excavation and restoration involves excavation of the complete area for removing all metallic and MEC items located at the site. The default excavation depth for this alternative evaluation will range ten (10) feet based on the assumption that future reuse for Camp Bonneville is recreational. Under this alternative, prior to excavating any site soils all existing vegetation, including tree cover, will be cleared. No geophysical survey will be performed for this alternative. All the soils located at the site will be excavated to a depth of 10 feet and will be sifted to identify MEC items for proper disposal. The soils free of any MEC items will be reused at the site for backfilling the excavations. As a result of the process, this alternative will require extensive repair of all ecological damages during the MEC removal action. This alterantive is considered as the permanent cleanup action for this FS.

6.4 SCREENING OF ALTERNATIVES

6.4.1 MTCA (WAC 173-340-350) indicates that an initial screening of cleanup action alternatives be performed to eliminate alternatives that do not meet minimum threshold requirements as presented in MTCA (WAC 173-340-360) or if they are not technically possible to implement at the site. These MTCA minimum threshold requirements must be met by an alternative such that the alternative can be carried forward for further evaluation.

6.4.1 Protect Human Health and Environment

6.4.1.1 This initial screening requirement considers the overall protection each alternative provides to human health and the environment including the degree to which existing risks are reduced, the time required to reduce risk and obtain cleanup standards, the off-site and on-site risks resulting from the implementation of the alternative and the degree of improvement of the overall environmental quality. In the analysis of alternatives, this requirement will be utilized to evaluate whether the alternatives developed for this FS will reduce the potential for harm and the level of protectiveness at the site if the alternative is implemented, as compared to the existing baseline condition.

6.4.2 Comply with Cleanup Standards

6.4.2.1 Alternatives will be evaluated for this minimum threshold requirement to investigate if they comply with the cleanup standards. According to MTCA (WAC 173-340-700), a cleanup standard consists of cleanup levels and the locations where these cleanup levels shall comply at the site (points of compliance). Cleanup levels define the concentration of a particular substance which does not threaten human health or the environment.

6.4.2.2 MTCA Cleanup Regulation provides for methods (Method A, B, and C) to establish cleanup levels for hazardous substances found in soil, groundwater, and air. However, MTCA does not identify a cleanup level for MEC at residential or non-residential sites (Methods A and B, respectively) nor does it identify exposure factors for ordnance that could be used to develop a site-specific cleanup level (Method C).

6.4.2.3 Camp Bonneville site-specific cleanup standards (remediation levels and points of compliance) were developed based on the baseline risk assessment and proposed future land use. As the purpose of this FS report is to select a most practicable permanent solution for reducing public safety risk associated with MEC that may exist within Camp Bonneville, and since MTCA fails to describe the appropriate manner of assessing potential risk from MEC, site specific cleanup standards were developed to address explosive safety risk posed by different site types located within Camp Bonneville. Section 5 presented the development of site specific cleanup standards.

6.4.2.4 Cleanup action standards were developed for those site types at Camp Bonneville that pose an unacceptable MEC hazard exposure risk: Firing Points, OB/OD Areas, and Target Areas. The remediation level at these sites is the condition where the likelihood for MEC source and receptor interaction is negligible. The points of compliance are defined based on those areas (x, y, and z) where the potential MEC source and receptor interactions are likely to occur.

6.4.3 Comply with State and Federal Laws

6.4.3.1 This requirement evaluates whether alternatives comply with state and federal laws that pertain to the site. Applicable state and federal laws will include legally applicable requirements and those requirements that are relevant and appropriate. According to MTCA (WAC-340-710), legally applicable requirements are cleanup standards, standards of control, and other environmental protection requirements, criteria, or limitations adopted under state or federal law that specifically address a hazardous substance, cleanup action, location or other circumstances at the site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other environmental requirements, criteria, or limitations established under state or federal law that, while not legally applicable to the hazardous substance, cleanup action, location, or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site.

6.4.3.2 Three categories of ARARs are evaluated for the Camp Bonneville. These ARAR categories are: chemical-specific ARARs, location-specific ARARs, and action-specific ARARs. Chemical-specific ARARs are health-based or risk-based numerical

values that establish the acceptable amount or concentration of a chemical that may remain in, or be discharged to, the ambient environment. Location-specific ARARs generally are restrictions placed upon the concentration of hazardous substance or the conduct of activities solely because they are in special locations. Some examples of special locations include flood plains, wetlands, historic places, and sensitive ecosystems or habitats. Action-specific ARARs are usually technology or activity-based requirements or limitations placed on actions taken with respect to cleanup actions, or requirements to conduct certain actions to address particular circumstances at a site. Table 6.1 summarizes the ARARs identified for Camp Bonneville.

6.4.3.3 No chemical-specific ARARs were identified for the cleanup action alternatives because the primary concern of this project is to reduce public safety risk associated with MEC that may exist within Camp Bonneville. After selected cleanup actions are implemented, an evaluation of potential chemical contamination, if warranted, may be conducted as part of an environmental investigation.

6.4.3.5 Several location-specific ARARs have been identified for this RI/FS. These ARARs shall be reviewed prior to implementation of cleanup action alternatives at Camp Bonneville. The location-specific ARARs include protection of historical and archeological resources, protection of Native American interests and other cultural issues, protection of wildlife and habitat resources (including endangered species, fish, migratory birds, and wetlands), and management considerations for forest and range lands. Table 6.1 lists the location-specific ARARs with their legislative citation and a brief description of the requirements.

6.4.3.6 One action-specific requirement, Army Regulation (AR) 385-64, specifies that safety measures be taken for handling of MEC. Moreover, DoD 6055.9-STD requires that specialized personnel be employed to detect, remove, and dispose of ordnance. This standard also defines safety precautions and procedures for the detonation or disposal of ordnance.

6.4.4 Provide Compliance Monitoring

6.4.4.1 This requirement evaluates whether the proposed remedial alternatives provide compliance monitoring. MTCA requires compliance monitoring be performed after cleanup action has been implemented at the site. As described in MTCA (WAC 173-340-410), compliance monitoring includes three types of monitoring: protection, performance, and confirmational monitoring.

6.4.4.2 Protection monitoring confirms that human health and the environment are adequately protected during the implementation of the cleanup action. Performance monitoring confirms that the cleanup action has attained cleanup standards and, if appropriate, remediation levels or other performance standards such as construction quality control measurements or substantive requirements of other laws. Confirmational monitoring confirms the long-term effectiveness of the cleanup action.

TABLE 6.1
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Activity	ARAR/TBC	Citation	Applicability or Relevance
Chemical-Specific			
Any residual chemical contamination of a hazardous nature will be addressed by the efforts being conducted at the site for Hazardous, Toxic, and Radioactive Wastes (HTRW) issues. Therefore, no chemical-specific ARARs apply.			
Location-Specific			
Location of an action within an area where it may cause irreparable harm, loss or destruction of significant artifacts or historic landmarks	Section 106 of the National Historic Preservation Act, as amended	36 CFR 800 23 CFR 771 36 CFR 60 36 CFR 63 Executive Order 11593	During removal action, any material that may be considered of archeological or historical value will be reported pursuant to requirements
	Preservation of Historical and Archeological Data	16 USC 469a 36 CFR 66	Preserve historical and archeological data from loss or destruction
	Protection of Wetlands	33 CFR 320 et. seq. 23 CFR 777 Executive Order 11990	Requires Section 404 Clean Water Act permit for disposal of dredged or fill material in waters of the United States, including wetlands
	Endangered Species Act of 1973, as amended	16 USC δ 1531 et. seq.	Requires that authorized actions do not jeopardize the continued existence of endangered or threatened species, or their habitats.
	Native American Graves Protection and Repatriation Act (NAGPRA)	43 CFR Part 10	Requires consultation with Native Americans prior to the excavation of ancestral remains and related objects to establish appropriate disposition of these items
	Archaeological Resources Protection Act	43 CFR Part 7 (also: 36 CFR Part 296, 32 CFR Part 229, and 18 CFR Part 1312 - same regulations)	Requires a permit to excavate, remove, or otherwise alter any archaeological resource
	Act for the Preservation of American Antiquities	16 CFR 251.50-64 43 CFR Part 3	Requires a permit for the examination of ruins, excavation of archaeological sites, and gathering of objects of antiquity
	Public Rangelands Improvement Act of 1978	43 U.S.C. §§ 1901-1908, October 25, 1978	Requires development updating and maintenance of an inventory of range conditions and a record of trends of conditions on the public rangelands

TABLE 6.1
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CON'T.)

Activity	ARAR/TBC	Citation	Applicability or Relevance
Location-Specific (Con't)			
	Wilderness Act of 1964	PL 88-577 16 U.S.C. 1131-1136	Requires preservation and protects wilderness areas in their natural state for present and future generations
	National Forest Management Act of 1976	PL 94-588	Requires preparation of resource management plans that provide for multiple-use and sustained-yield of products and services; portions of study area within NFS land are included in plans
	Migratory Bird Treaty Act of 1918	16 U.S.C. 703-712	Protects migratory birds, nests and eggs from disturbance, damage, or movement from place to place
	Bald and Golden Eagle Protection Act of 1940	16 U.S.C. 668-668d, 54 Stat. 250) as amended -	Prohibits, except under certain specified conditions, the taking, possession and commerce of bald eagles
	Fish and Wildlife Coordination Act of 1958	PL 85-654 16 U.S.C. 661-667d	Requires measures for conservation, maintenance and management of wildlife resources
	Sikes Act of 1960, 1974 and Amendments 1986, 1997 Title XXIX.	PL 86-797, PL 93-205, PL 99-561, PL 105-85	Program of planning for, and the development, maintenance, and coordination of, wildlife, fish, and game conservation and rehabilitation in each military reservation
	Fish and Wildlife Conservation Act of 1980	PL 99-645	Encourages states to develop conservation plans for non-game fish and wildlife of ecological, educational, aesthetic, cultural, recreational, economic or scientific value; requires determination of the effects of environmental changes and human activities on same
	Lacey Act Amendments of 1981	PL 97-79 16 U.S.C. § 701, May 25, 1900.	Authorizes the Secretary of the Interior to adopt measures to aid in restoring game and other birds in parts of the U.S. where they have become scarce or extinct and to regulate the introduction of birds and animals in areas where they had not existed.

TABLE 6.1
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CON'T.)

Activity	ARAR/TBC	Citation	Applicability or Relevance
Location-Specific (Con't)			
	Protection and Enhancement of Sacred Indian Sites, 1976	Executive Order 13007	Provides for the protection of sacred Indian sites.
	CERCLA Procedures for Planning and Implementing Off-Site Response Actions	40 CFR 300.440	Outlines the management requirements for off-site response actions.
	Archaeological Resources Protection Act	16 CFR 1312 32 CFR 229 36 CFR 296	Requires preservation and protection of archeological resources from physical disturbance.
Action-Specific			
	EPA RCRA Subpart X-Miscellaneous Units	40 CFR 264 Subpart X	Outlines the management requirements of OB/OD areas during a removal action.
	Clearance of Explosive Hazards and Other Contamination from Proposed Excess land and Improvements	32 CFR Part 644.516-535	Outlines certain requirements and responsibilities related to the clearance and transfer of excess land.
	Occupational Safety and Health Act	29 USC 651-667	This act authorizes OSHA to set and enforce safety and health standards to promote worker safety during OE removal actions.
	RCRA Military Munitions Rule	62 CFR 6654	This rule outlines the identification and management of residual munitions.
	Community Environmental Response Facilitation Act (CERFA)	CERCLA Section 120(h)	Obtains certain requirements for notice to public and community during response actions.
	CERCLA Review Requirements	CERCLA 121(c)	Addresses the recurring review requirements where wastes left in place.
	Environmental Effects of Army actions	AR 200-2 (NEPA-40 CFR 1500-1508)	An Environmental Assessment (EA) or an Environmental Impact Statement (EIS) would be required to ensure that commercial or residential development would not have an adverse impact on the environment.

TABLE 6.1
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CON'T.)

Activity	ARAR/TBC	Citation	Applicability or Relevance
Action-Specific (Con't)			
	Environmental Protection and Enhancement	AR 200-1	Prescribes Army policies, responsibilities, and procedures to protect and preserve the quality of the environment.
	Safety and Health Requirements on Conventional Ordnance and Explosives Activities	ER 385-1-95	Identifies safety and health responsibilities and procedures for OE response actions.
	Ordnance and Explosives Response	EP-1110-1-18	Establishes roles and responsibilities for USACE elements in managing and executing OE response actions.
To Be Considered (TBC) Criteria			
	DoD Ammunition and Explosive Safety Standards	DoD 6055.9-STD	Primary DoD regulation that requires UXO cleanup of DoD lands prior to transfer.
	EPA Guidance for Conducting Non-Time Critical Removal Actions Under CERCLA	EPA/540.R-93/057	Guidance for conducting removal and response actions under CERCLA.
	Explosives Safety Submissions for Removal of Ordnance and Explosives from Real Property	DDESB Memorandum	Memorandum that includes the policy for submitting explosive safety submissions for removal actions.
	Explosives Safety Policy for Real Property Containing Conventional Ordnance and Explosives	Letter, Dept. of Army	This letter prescribes the policies and procedures for explosives safety controls on real property containing MEC.
	Guidance for Consideration of ARARs During Removal Actions	EPA/540/P-91/011	EPA Guidance for considering ARARs during removal at a Superfund site.

6.4.4.3 The protection monitoring for ordnance related projects will require usage of UXO-qualified safety personnel to conduct MEC related activities at the site. This would include providing UXO safety training and UXO safety supervisory personnel to the land surveying, brush clearing, and geophysical survey crews. It also requires establishment of evacuation distances during the implementation of MEC clearance activities at the site. These distances will provide adequate protection to humans from potential explosive risk that may be posed by the site during the MEC clearance activities.

6.4.4.4 Performance monitoring for ordnance related projects will involve implementation of quality control measures. These measures may include conducting a geophysical survey on ten percent (10%) of the total area that has been subsurface cleared for MEC related items. This quality control monitoring will ensure that the implemented

MEC cleanup actions attained the required cleanup standards. The performance monitoring will also involve implementation of measures to verify that the cleanup action alternatives meet the ARARs.

6.4.4.5 Confirmation monitoring for this project will include preparation of an annual report to describe any MEC findings occurring at the Camp Bonneville site in the prior year and the management actions taken to address the explosive risk of such a potential find. This annual report will provide long-term effectiveness evaluation of the cleanup actions implemented at the site.

6.5 APPLICATION OF SCREENING CRITERIA BY ALTERNATIVE

6.5.1 This section discusses the performance of the six cleanup action alternatives relative to the MTCA screening criteria presented in Section 6.4. Alternatives that meet these criteria will be carried forward for further evaluation in Section 7. The cleanup action alternative evaluation presented in Section 7 will compare the MTCA-specified criteria for each of the alternatives for each of the different MEC and future use site types. Section 8 present the preferred alternative to reduce explosive safety risk for each of the different site types located within Camp Bonneville. The preferred alternative shall be the most practicable permanent solution as determined by the criteria specified in MTCA (WAC 173-340-360).

6.5.2 No Further Action (Alternative 1) does not provide overall protection to human health and environment, as it does not implement any cleanup action to reduce explosive safety risk at Camp Bonneville. Implementation of this alternative does not meet other minimum threshold requirements which include attaining the cleanup standards, complying with the ARARs, and providing compliance monitoring. Although, this alternative does not meet threshold requirements, it will be retained for further evaluation in Section 7 as a baseline alternative for comparative purposes only.

6.5.3 Implementation of ICs (Alternative 2) will meet the minimum threshold requirements for future use site types located within Camp Bonneville with negligible MEC safety hazards. ICs such as brochures and signage will provide the public with information of the past ordnance-related activities at Camp Bonneville. This increased public awareness / education will modify their behavior while performing activities at these sites. Behavior modification results in minimal receptor interaction and resulting exposure to residual MEC-related items. However, implementation of ICs alone will not attain all the threshold requirements for those MEC site types which possess an explosive safety risk. ICs will be effective at these site types when used in conjunction with an active cleanup action alternative (e.g., clearance to frost depth). ICs will be retained for further evaluation based on the attainability of minimum threshold requirements either by themselves or in combination with other cleanup action alternatives.

6.5.4 Surface clearance action with ICs (Alternative 3) will be effective in reducing the explosive safety risk by removing residual surface ordnance items that may be located at Camp Bonneville. This alternative will increase the level of protectiveness to the public using the site for non-intrusive purposes (e.g., hiking). In addition, the surface clearance alternative preserves environmental and ecological resources that may be

damaged or destroyed during implementation of Alternatives 4, 5 or 6. Implementation of surface clearance alone will not attain all the threshold requirements for those MEC site types that possess the greatest explosive safety risk or areas with proposed future intrusive activities. Surface clearance (Alternative 3) will achieve the cleanup standards in a reasonable time frame and will be retained for further evaluation based on compliance with minimum threshold requirements.

6.5.5 Clearance action alternatives with ICs (Alternative 4 and Alternative 5) will be effective in reducing the explosive safety risk by removing residual ordnance items that may be located at Camp Bonneville. These alternatives will increase the level of protectiveness to the public using the site. Selection of Clearance to frost depth (Alternative 4) or Subsurface Clearance (Alternative 5) will be based on the factors of documented MEC findings and future reuse plans for the specific site type. The removal actions involved with these alternatives should achieve the cleanup standards in a reasonable time frame. Implementing these cleanup action alternatives, however, may damage the ecological environment since it involves removal of the undergrowth (all but the largest trees will be removed) for accurate geophysical mapping. In addition to removal of vegetation, soil will be disturbed at the dig locations. Dependent upon the density of vegetation and the density of subsurface items removed, the existing habitat may be greatly impacted. In terms of habitat preservation, implementation of subsurface clearance action alternatives may not comply with the ARARs identified for the site. These cleanup action alternatives will provide compliance monitoring. Clearance to Frost Depth with ICs (Alternative 4) and Subsurface Clearance with ICs (Alternative 5) will be retained for further evaluation based on their compliance with minimum threshold requirements.

6.5.6 Excavation and restoration (Alternative 6) will involve excavation of all the site soils for a depth of 10 feet below ground surface. Prior to the excavation of site soils, all vegetation, including trees, will be removed. Excavated soils will be sifted for the removal of any MEC items. Soils free from MEC items will be placed back into the excavated areas. Upon completion of backfilling, these areas will be re-vegetated / restored to their original condition. Implementation of E&R alternative (Alternative 6) will be effective in reducing the potential for harm by removing MEC, and it provides for an increased level of protectiveness to the public using the site. Cleanup standards will be achieved by implementing this alternative at the site. However, implementing this cleanup action alternative will severely and irreparably damage the ecological environment since it involves total removal of all vegetation and disturbance of soils to a depth of 10 feet at the site. ARARs will not be complied by implementing this alternative since it will disrupt and destroy the wildlife habitat, totally disturb the wilderness areas from their natural state, and disrupt / destroy the habitat for migratory birds. This alternative will require decades for site restoration efforts to be completed. Despite not accomplishing the ARARs and requiring an exceptional restoration timeframe, the E&R alternative will be retained for further evaluation as a permanent cleanup action alternative since MTCA requires the FS include one permanent cleanup action alternative.

SECTION 7

DETAILED ANALYSIS OF ALTERNATIVES AND SELECTION OF PREFERRED ALTERNATIVE

7.1 INTRODUCTION

7.1.1 Six cleanup action alternatives were evaluated against the minimum threshold requirements of (i) protectiveness of human health and environment; (ii) compliance with the cleanup standards; (iii) compliance with the state and federal laws; and (iv) providing compliance monitoring. The cleanup action alternatives included No Further Action (NFA), Institutional Controls (ICs), surface clearance, clearance to frost depth, subsurface clearance, and excavation and restoration (E&R). This section presents the detailed analysis of these six cleanup action alternatives to identify the preferred cleanup action alternative for the various site types located within Camp Bonneville.

7.1.2 As discussed in Section 6, four cleanup alternatives (NFA, ICs, surface clearance and E&R) did not meet one or more of the minimum threshold requirements for all sites. The NFA alternative has been retained in this detailed analysis as the baseline alternative for comparative purposes only. The ICs alternative will meet the threshold requirements and therefore the ICs alternative has been retained for detailed analysis for those sites that pose only a minimal MEC exposure hazard. The ICs alternative may also be effective at those sites which pose an elevated explosive exposure hazard if implemented in conjunction with other clearance action alternatives. The surface clearance alternative was retained for those areas that may possess sensitive environmental or ecological resources that would be adversely impacted by another clearance alternative. The E&R alternative was retained in this detailed analysis as a permanent cleanup action alternative since MTCA requires the FS include one permanent cleanup action alternative. The clearance to frost depth and subsurface clearance alternatives were retained for this detailed analysis based on their compliance with minimum threshold requirements.

7.1.3 Due to the variability of MEC source types and the different risk associated with each, no single alternative, by itself, is appropriate for site-wide implementation. Alternative 2 (ICs), for example, may be appropriate for certain low risk areas of the site, but would not be sufficient in reducing the risk for areas of future intrusive activity. Therefore, an analysis and ranking of the six cleanup action alternatives is conducted for MEC source type areas and specific future reuse areas. This process allows each area of the site to be appropriately evaluated.

7.1.4 Based on this evaluation, a preferred cleanup action alternative will be selected for each of the site types to reduce explosive safety risk. Consistent with MTCA (WAC 173-340-360), the selected action shall: (i) use a permanent solution to the maximum

extent practicable; (ii) provide for a reasonable restoration time frame; and (iii) consider public concerns.

7.1.5 If a permanent cleanup action can not be implemented, MTCA requires that a disproportionate cost analysis be performed to evaluate whether the cleanup action uses permanent solutions to the maximum extent practicable. Although the E&R cleanup alternative is a permanent remedy, implementation of this cleanup action at Camp Bonneville, requires near-total ecological destruction, and as such, does not meet the minimum threshold requirements. The disproportionate cost analysis compares the costs and benefits of each of the six cleanup action alternatives. The cleanup action comparison will be performed consistent with the seven MTCA evaluation criteria, as presented in Section 7.2. Alternatives will be ranked from most permanent to least permanent based on the evaluation criteria. The ranking of alternatives for each of the site types is presented in Section 7.3. Section 7.4 describes whether the selected cleanup actions can be accomplished within a reasonable time frame.

7.2 EVALUATION CRITERIA

7.2.1 Cleanup action alternatives are compared and evaluated with the seven evaluation criteria as presented in WAC 173-340-360 for conducting a disproportionate cost analysis. The disproportionate cost analysis is performed by scoring each cleanup action alternative relative to the other alternatives for each of the seven evaluation criteria. Numerical values ranging from 0 to 10 were used for scoring the alternatives. A value of 0 represents the worst alternative and a value of 10 is the best alternative for satisfying the requirements of the respective evaluation criterion.

7.2.2 Upon completion of scoring the seven evaluation criteria for each alternative, the scores were summed to obtain the overall scoring for each cleanup action alternative. An alternative with the highest score was ranked as the most practicable permanent solution in reducing the MEC exposure hazard at the site. The following sections provide a description of each of the seven criteria and the ranking process used for performing the disproportionate cost analysis.

7.2.1 Protectiveness

7.2.1.1 The overall protectiveness to human health and the environment was evaluated based on the impact each cleanup action alternative has on the factors of MEC exposure hazard and environment. The human health protectiveness factor considers the impact that an alternative has on the MEC exposure hazard. As discussed in Section 4, the MEC exposure hazard is comprised of two components; the MEC source characteristics and the receptor interaction. Both of these two components are required in order to pose an explosive safety threat to the public. The environmental protectiveness factor considers the impact that implementation of a cleanup action alternative has on the existing environmental / ecological factors at Camp Bonneville.

7.2.1.2 The “Protectiveness” criterion was evaluated by scoring each cleanup action alternative relative to the other alternatives for MEC source and environmental protectiveness factors. For the MEC source factor, a cleanup action alternative was

scored highly if the alternative has the most impact on reducing the MEC source at the site. An alternative was scored least for the MEC source factor if the alternative has no impact on reducing the MEC source (i.e., Alternatives 1 and 2). Due to a greater overall reduction of risk, MEC source types with a high likelihood of munitions contamination (i.e., target areas and OB/OD areas), were scored higher than reduction of MEC source types with a low likelihood of ordnance contamination. Historically, UXO recovered from the site has been located within the upper 18-inches of the ground surface. Based on UXO recovered to date, most UXO would likely be removed by implementing Alternative 4 (frost depth clearance). Alternative 5 was often scored the same as Alternative 6 as there is little added MEC source risk reduction associated with the greater excavation depth of Alternative 6.

7.2.1.3 The environmental protectiveness factor was scored based on the detrimental impact an alternative will have on the existing environment and ecology at Camp Bonneville. Implementing a cleanup action alternative that has nominal detrimental effect on environment is scored as zero (i.e., Alternatives 1 and 2). An alternative which produces a large detrimental impact on the environment was assigned a score of – zero. Implementation of the E&R alternative will have a severe detrimental impact on the environment since it will result in near-total ecological destruction, and permanent loss in the viability of the local ecosystem. Therefore, the Alternative 6 was nearly always assigned a score of 0. Due to the removal of undergrowth required for DGM, Alternatives 4 and 5 were assigned variable scores dependent upon vegetation sensitivity and density.

7.2.2 Permanence

7.2.2.1 The "Permanence" criterion will evaluate the degree to which the cleanup action alternative permanently reduces or eliminates the explosive exposure hazard. Non-clearance cleanup alternatives (ICs and NFA) will have negligible impact in reducing MEC source and explosive exposure hazards; the MEC source risk will remain and, therefore, has little permanence. Alternative 3 (Surface Clearance) will score lower than intrusive MEC clearance alternatives (clearance to frost depth, subsurface clearance, and E&R) because of the possibility of residual subsurface UXO. Residual UXO within the upper14-inch soil horizon has the possibility to present a future risk due to frost heave bringing the item to the surface. Alternative 4 (frost depth clearance) greatly reduces the possibility of UXO items being brought to the surface through frost heave mechanisms, but there is still a potential risk associated with future intrusive activities. Alternatives 5 and 6 were given high scores for the ability to remove all (or nearly all) possible UXO.

7.2.3 Cost

7.2.3.1 The "Cost" criterion evaluates the financial cost to implement the cleanup action alternative. The cost criterion includes direct, indirect, and long-term operation and maintenance costs. Direct costs are considered to be those costs associated with the implementation of the alternative. Indirect costs are those costs associated with administration, oversight and contingencies. Cost estimates presented are order-of-magnitude level estimates. These costs are based upon a variety of information including

productivity estimates (based on terrain and vegetation), cost estimating guides, and prior experience. The actual costs will depend upon true labor rates, actual site conditions (e.g., number of anomalies, terrain, etc.), final project scope and other variable factors. Detailed cost estimates associated with each alternative are included in Appendix C. Alternatives 1 through 6 were scored according to cost. The cost criterion was evaluated by assigning the highest numerical score for the alternative with the lowest cost to implement and the lowest numerical score for the alternative with the highest cost to implement. Alternative 1 was always scored highest (the NFA alternative does not have costs associated with it) and costs increased with each alternative.

7.2.4 Effectiveness over the Long-Term

7.2.4.1 The "Effectiveness over the Long-Term" criterion evaluates the degree of effectiveness in reducing the MEC risk once the cleanup action alternative has been implemented at the site, the magnitude of residual risk with the alternative in place, and the effectiveness of controls to manage the residual risk. An alternative was assigned with the lowest numerical score if it does not provide long-term effectiveness; while a high numerical score was assigned to the alternative that provides the best long-term effectiveness. Alternative 6 has the greatest "Effectiveness over the Long-Term" because there is no long term ICs associated with it and the site will have no restrictions on use (little or no residual risk). This benefit of reduction in risk, however, is only realized if the initial risk is great. ICs can be effective in managing residual risk as well and were scored accordingly for each area. Alternative 1 (No Further Action) scored lowest (0) at providing an alternative for managing risk.

7.2.5 Management of Short-Term Risks

7.2.5.1 The "Management of Short-Term Risks" criterion addresses the potential consequences and effects of an alternative during the implementation phase. Cleanup action alternatives were evaluated for their effects on human health and the environment prior to the cleanup action being completed. Short-term risks address adverse impacts to the workers and community during the construction and implementation phases of the cleanup action. Since a high score is favorable, this criterion was evaluated by assigning a high relative numerical score to an alternative that presents less short-term risks during the implementation phase. A low numerical score was provided to an alternative that presented greater short-term risks during the implementation phase. Alternative 6 predominantly scored zero (0) due to the much greater risk to workers conducting deep excavation (up to 10-feet) and sifting operations while using heavy equipment. Due to the inherent risk to UXO technicians, MEC clearance work (Alternatives 3 through 6) scored lower than non-clearance work (Alternatives 1 and 2). Intrusive work scored lower (greater risk) than non-intrusive work due to brush clearance requirements. In addition, scoring was adjusted for terrain hazards (greater risk, and thus a lower score, is associated with steep, rugged terrain). Intrusive work associated with the frost depth clearance (Alternative 4) can be completed using shovels, whereas greater depths associated with Alternative 5 (up to 4-foot depth) and Alternative 6 (10-foot depth) requires heavy equipment.

7.2.6 Technical and Administrative Implementability

7.2.6.1 The "Technical and Administrative Implementability" criterion evaluates the difficulty of implementing a specific cleanup action alternative. The evaluation included consideration of whether the alternative is technically possible; availability of necessary on-site and off-site facilities, services and materials; administrative and regulatory requirements; monitoring requirements; and access for construction operations. Alternatives were scored with low numerical values if it is technically and/or administratively difficult to implement at the site. Similarly, alternatives that are technically and/or administratively less difficult to implement were assigned with high numerical scores. Each successive alternative is more difficult to implement, and the alternatives were scored accordingly.

7.2.7 Consideration of Public Concerns

7.2.7.1 The "Consideration of Public Concerns" criterion based on the degree of assumed acceptance from the local public, including Clark County (representing the interests of the local community) and federal and state agencies regarding the implementation of cleanup action alternatives. Alternatives were scored with low numerical values if public acceptance was thought unlikely, and alternatives were scored numerically high if the public acceptance level is thought high.

7.2.8 Alternative Ranking by MEC Source Site Type

7.2.8.1 As noted in the Risk Assessment (Section 4), Camp Bonneville was divided into seven MEC source types, and were ranked according to relative explosive safety risk. The seven source types were ranked from highest to lowest risk as follows:

- Target Areas;
- Open Burn/Open Detonation Area;
- Firing Points;
- Range Safety Fans;
- Storage Magazines/Transfer Points;
- Maneuver Areas; and
- Training Areas.

7.2.8.2 In general, Target Areas, OB/OD Areas, and Firing Points were determined in the risk assessment to pose the greatest explosive safety exposure hazard; the remaining site types pose a negligible risk. The Target Areas, OB/OD Areas, and Firing Points are the primary focus of the detailed analysis of the cleanup action alternatives, based on MEC source types. Tables 7.1, 7.2, 7.3, and 7.4 present the scoring and detailed analysis of the Target Areas, Central Impact Target Areas, OB/OD Areas, and Firing Points, respectively.

TABLE 7.1
ALTERNATIVE ANALYSIS AND SCORING TARGET AREAS

Target Sites	Acres	Explosive Risk Rank	Depth of Activity/Reuse
3.5-inch Rocket Range Target	5.2	Highest	Surface/Firing Range
Rifle Grenade Target	4.0	Highest	Surface/Firing Range
Hand Grenade (HE) Target	1.1	Highest	Surface/Firing Range
2.36-inch Rocket Target	0.3	Highest	None/Regional Park
M203 HE Grenade Target	4.0	Negligible[1]	None/Regional Park

(1) Removal Action completed to 2-feet and not included in the detailed analysis below. This area will be discussed in Section 8.

Alternative	**Protectiveness - MEC Source**	**Protectiveness - Environmental**	**Permanence**	**Cost**	**Long-term Effectiveness**	**Short-term Effectiveness**	**Implementability**	**Public Concerns**	**Score**	**Rank**
1) No Further Action	0 No source Reduction	10 No Impacts to Environment	0 No reliability	10 $0	0 Risk remains (and may increase if receptors increase)	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	0 Concerns about risk and accessibility of 2.36" Rocket Target in Park.	40	**6**
2) Institutional Controls	0 No source Reduction	10 No Impacts to Environment	4 Limited reliability. Potential receptor interaction remains.	8 $22,900	4 Limited effectiveness. Receptor awareness, but high MEC source risk remains	10 No risk increase to community or workers in short-term.	7 Signs and education material to be installed.	5 Concerns about risks associated with high MEC source areas within RP.	49	**3**
3) Surface Clearance	3 Limited source reduction. Surface reconnaissance previously conducted.	7 Limited impacts. Some brush clearance may be required.	5 Reliable method for surface UXO. Subsurface risk remains.	7 $130,500	5 Limited effectiveness due to potential frost heave of shallow, buried UXO.	7 Potential risk to UXO surface sweep technicians. Difficult terrain.	6 Requires use of qualified/trained UXO personnel.	6 Concerns that MEC source remains subsurface and frost heave may cause near surface items to daylight.	46	**4**
4) Clearance to Frost Depth	8 Great reduction in MEC source. Based on historic data and weapons type, most UXO likely within upper 14"	5 Significant habitat destruction due to removal of brush/undergrowth. Not as critical for target areas that will be used as firing ranges.	7 Reliable and eliminates risk of frost heave bringing UXO to surface.	6 $273,000	8 Effective at reducing risk given future reuse (firing ranges and non-intrusive, non-developed park area).	5 Risk to brush clearance, DGM, and UXO crews due to brush clearance equipment, terrain, and UXO.	5 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	10 Given the proposed reuse, there will likely be support for this alternative.	54	**1**

TABLE 7.1 (Continued)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
5) Subsurface Clearance	9 Should eliminate nearly all risk from MEC source.	4 Similar to Alternative 4. Deeper excavations may have greater impact.	10 Reliable and likely eliminates MEC source.	5 $382,000	8 Effective and targets areas available for almost any use. Little residual risk.	4 Similar to Alt. 4 with added risk due to heavy equipment for anomaly excavations.	4 Similar to Alternative 4 with added heavy equipment for anomaly excavations.	8 Although protective, there is little added benfit over Alternative 4. Additional costs are unessesary given intended reuse.	52	**2**
6) Excavation and Restoration	10 Should eliminate all risk from MEC source.	2 Complete habitat destruction for 2.36" target within RP. Not as critical for target areas that will be used as firing ranges.	10 Reliable and eliminates MEC source.	0 $1,353,000	10 Effective and targets areas available for any use. Little residual risk.	2 Great risk to workers associated with deep excavations and sifting operations.	2 Most difficult alternative to implement due to logistics and heavy equipment required.	4 Likely seen as excessive and expensive given the intended reuse.	40	**5**

Note: Detailed cost estimates are included as Appendix C. Alternative 5 cost is an average of the 24-inch and 48-inch subsurface clearance.

TABLE 7.2
ALTERNATIVE ANALYSIS AND SCORING – CENTRAL IMPACT TARGET AREAS

Central Impact Target Sites	Acres	Explosive Risk Rank	Depth of Activity/Reuse
West Impact Target 2	8	Highest	None/None
Combined Impact Area 1	32	Highest	None/None
Combined Impact Area 2	43	Highest	None/None

Alternative	**Protectiveness - MEC Source**	**Protectiveness - Environmental**	**Permanence**	**Cost**	**Long-term Effectiveness**	**Short-term Effectiveness**	**Implementability**	**Public Concerns**	**Score**	**Rank**
1) No Further Action	0 No source Reduction	10 No Impacts to Environment	0 No reliability	10 $0	0 Risk remains (and may increase if receptors increase)	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	4 Concerns about risk, but no intended reuse.	44	**3**
2) Institutional Controls	0 No source Reduction	10 No Impacts to Environment	4 Fencing and signage w/ land use controls. Potential receptor interaction remains.	8 $124,500	4 Fencing is effective. Receptor awareness, but high MEC source risk remains	10 No risk increase to community or workers in short-term.	6 Signs and education material to be installed (fencing is in place). Land use controls require legal documentation.	5 Concerns about risks associated with high MEC source areas.	47	**1**
3) Surface Clearance	4 Limited source reduction. Surface reconnaissance previously conducted.	8 Limited impacts. Some brush clearance may be required.	5 Reliable method for surface UXO. Subsurface risk remains	4 $1,344,000	6 Limited effectiveness due to potential frost heave of shallow, buried UXO.	7 Potential risk to UXO surface sweep technicians. Difficult terrain.	5 Requires use of qualified/trained UXO personnel.	6 Concerns that MEC source remains subsurface.	45	**2**
4) Clearance to Frost Depth	7 Great reduction in MEC source. Most UXO likely within upper 14" based on historic data and steep, rocky terrain in the target areas.	4 Significant habitat destruction due to removal of brush/undergrowth. Especially in a "natural" area.	7 Reliable and eliminates risk of frost heave bringing UXO to surface.	3 $3,078,000	7 Effective at reducing risk given future reuse (non-intrusive).	4 Risk to brush clearance, DGM, and UXO crews due to brush clearance equipment, terrain, and UXO.	4 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	5 Given the proposed reuse, concerns about habitat destruction and long term impacts associated with removal of all undergrowth. There will likely not be public support for this alternative.	41	**5**

TABLE 7.2 (Continued)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
5) Subsurface Clearance	10 Should eliminate nearly all risk from MEC source, although little advantage over Alt. 4, given the intended reuse.	3 Similar to Alternative 4. Deeper excavations may have greater impact.	8 Reliable, likely eliminates MEC source, although little advantage over Alt. 4, given intended reuse.	2 $4,288,000	8 Effective and targets areas available for intended reuse.	3 Similar to Alternative 4 with added risk due to heavy equipment for anomaly excavations	3 Similar to Alternative 4 with added heavy equipment for anomaly excavations.	5 Similar to Alternative 4, with little additional benefit associated with Alternative 5 given the cost and intended reuse.	42	**4**
6) Excavation and Restoration	10 Should eliminate all risk from MEC source, although little benefit over Alternative 5.	0 Steep terrain, dense vegetation. Complete habitat destruction in sensitive environment.	10 Reliable and eliminates MEC source.	0 $10,899,000	10 Effective and targets areas available for any use.	0 Great risk to workers associated with deep excavations and sifting operations.	0 Most difficult alternative to implement due to logistics and heavy equipment required.	0 Excessive and expensive given the intended reuse. Ecological destruction likely not tolerated.	30	**6**

Note: Detailed cost estimates are included as Appendix C. Alternative 5 cost is an average of the 24-inch and 48-inch subsurface clearance.

TABLE 7.3
ALTERNATIVE ANALYSIS AND SCORING – OPEN BURN/OPEN DEMOLITION AREAS

OB/OD Sites	Acres	Explosive Risk Rank	Depth of Activity/Reuse
Demo Area 1	2.5	None[1]	None/ Wildlife Mgt Area
Demo Area 2	2.0	Highest	Subsurface/Logging Area
Demo Area 3	2.0	Highest	None/Regional Park

(1) Demo Area 1 removed as part of 2004 removal action and not included in detailed analysis below. The kick-out areas associated with the OB/OD areas are discussed in Section 8.

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
1) No Further Action	0 No source Reduction. MEC source remains high.	10 No Impacts to Environment	0 No reliability	10 $0	0 Risk remains (and may increase if receptors increase)	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	0 Concerns about remaining risk.	40	**6**
2) Institutional Controls	0 No source reduction, remains high.	10 No Impacts to Environment	4 Limited reliability. Potential receptor interaction remains.	9 $4,500	2 Limited effectiveness. Receptor awareness, but high MEC source risk remains. Subsurface activities proposed at Demo 2	10 No risk increase to community or workers in short-term.	7 Signs and education material to be installed.	2 Concerns about risks associated with high MEC source areas in an area of subsurface activities (i.e., logging camp) and Regional Park.	44	**4**
3) Surface Clearance	3 Limited source reduction. Surface reconnaissance previously conducted.	8 Limited impacts. Some brush clearance may be required.	5 Reliable method for surface UXO. Subsurface risk remains.	7 $ 47,000	5 Limited effectiveness due to potential frost heave of shallow, buried UXO.	7 Potential risk to UXO surface sweep technicians. Accessible terrain.	6 Requires use of qualified/trained UXO personnel.	4 Concerns that MEC source remains subsurface.	45	**3**
4) Clearance to Frost Depth	7 Great reduction in MEC source. Most UXO likely within upper 14”	6 Some habitat destruction due to removal of brush/undergrowth. Small areas - not as critical.	7 Reliable and eliminates risk of frost heave bringing UXO to surface. Not appropriate for subsurface activities.	5 $ 95,000	6 Not effective at reducing risk given future intrusive reuse at Demo 2. Likely effective for Demo 3.	6 Risk to brush clearance, DGM, and UXO crews due to brush clearance equipment, terrain, and UXO.	4 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	6 Given the proposed reuse, and high MEC source – approval unlikely for Demo Area 2. Possible approval for Demo 3.	47	**2**

TABLE 7.3 (Continued)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
5) Subsurface Clearance	9 Should eliminate nearly all risk from MEC source.	5 Similar to Alternative 4. Deeper excavations may have greater impact.	10 Reliable and likely eliminates MEC source.	4 $135,000	8 Effective and areas available for almost any use.	4 Similar to Alt. 4 with added risk due to heavy equipment for anomaly excavations	3 Similar to Alternative 4 with added heavy equipment for anomaly excavations.	10 Approval likely for intended reuse. Conservative approach for risk reduction.	53	**1**
6) Excavation and Restoration	10 Should eliminate all risk from MEC source.	2 Complete habitat destruction.	10 Reliable and eliminates MEC source.	0 $513,000	10 Effective and areas available for any use.	2 Great risk to workers associated with deep excavations and sifting operations.	2 Most difficult alternative to implement due to logistics and heavy equipment required.	4 Likely seen as excessive and expensive given the intended reuse.	40	**5**

Note: Detailed cost estimates are included as Appendix C. Alternative 5 cost is an average of the 24-inch and 48-inch subsurface clearance.

TABLE 7.4
ALTERNATIVE ANALYSIS AND SCORING – FIRING POINT AREAS

Firing Point Sites	Acres	Explosive Risk Rank	Depth of Activity/Reuse
Mortar Position 1	0.5	Medium	None/WMA
Mortar Position 2	0.5	Medium	None/WMA
Mortar Position 3	0.5	Medium	None/Regional Park
Mortar Position 4	0.5	Medium	None/Regional Park
Mortar Position 5	0.5	Medium	None/WMA
Mortar Position 6	0.5	Medium	None/Regional Park
Artillery Position 1	2	Medium	None/Regional Park
Artillery Position 2	2	Medium	None/Regional Park

Firing Point Sites	Acres	Explosive Risk Rank	Depth of Activity/Reuse
Artillery Position 3	2	Medium	None/Regional Park
Artillery Position 4	2	Medium	None/Regional Park
Artillery Position 5	2	High	Surface/Trailhead Parking
Artillery Position 6	2	Medium	None/Regional Park
Artillery Position 7	2	Medium	None/Regional Park
Rifle Grenade Firing Pt.	1	High	Surface/Firing Range
3.5" Rocket Firing Pt.	1	High	Surface/Firing Range
M203 HE Grenade Pt.		Negligible[1]	None/Regional Park

(1) Removal Action completed to 2-feet and not included in the detailed analysis below. This area will be discussed in Section 8.

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
1) No Further Action	0 No source reduction, source remains medium.	10 No Impacts to Environment	0 No reliability	10 $0	0 Risk remains (and may increase if receptors increase)	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	0 Concerns about risk.	40	**5**
2) Institutional Controls	0 No source reduction.	10 No Impacts to Environment	4 Limited reliability. Potential receptor interaction remains.	8 $33,000	4 Limited effectiveness. Receptor awareness, but MEC source risk remains. No subsurface activities proposed.	10 No risk increase to community or workers in short-term.	7 Signs and education material to be installed.	5 Concerns about risks associated with medium MEC source areas in the Regional Park, especially the 3 high reuse areas.	48	**3**
3) Surface Clearance	3 Limited source reduction. Surface reconnaissance previously conducted.	7 Limited impacts. Some brush clearance may be required.	5 Reliable method for surface UXO. Subsurface risk remains.	7 $ 211,000	5 Limited effectiveness due to potential frost heave of shallow, buried UXO.	7 Potential risk to UXO surface sweep technicians. Accessible terrain.	6 Requires use of qualified/trained UXO personnel.	6 Concerns that MEC source remains subsurface.	46	**4**

TABLE 7.4 (Continued)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
4) Clearance to Frost Depth	8 Great reduction in MEC source. Most UXO likely within upper 14" based on historic data	6 Some habitat destruction due to removal of brush/undergrowth. Small areas - not as critical.	7 Reliable and eliminates risk of frost heave bringing UXO to surface. Not appropriate for subsurface activities.	5 $ 421,000	7 Effective at reducing risk given no future intrusive reuse.	6 Risk to brush clearance, DGM, and UXO crews due to brush clearance equipment, terrain, and UXO.	5 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	9 No intrusive reuse proposed. Alternative should be considered adequate.	53	**1**
5) Subsurface Clearance	9 Should eliminate nearly all risk from MEC source.	5 Similar to Alternative 4. Deeper excavations may have greater impact.	10 Reliable and likely eliminates MEC source.	4 $589,000	8 Effective and areas available for almost any use.	4 Similar to Alternative 4 with added risk due to heavy equipment for anomaly excavations	4 Similar to Alternative 4 with added heavy equipment for anomaly excavations.	8 Little added benefit over Alternative 4. Additional costs not warranted for non-intrusive future reuse.	52	**2**
6) Excavation and Restoration	10 Should eliminate all risk from MEC source.	2 Complete habitat destruction.	10 Reliable and eliminates MEC source.	0 $2,416,000	10 Effective and areas available for any use.	2 Great risk to workers associated with deep excavations and sifting operations.	2 Most difficult alternative to implement due to logistics and heavy equipment required.	0 Likely seen as excessive and expensive given the intended reuse.	36	**6**

Note: Detailed cost estimates are included as Appendix C. Alternative 5 cost is an average for the 24-inch and 48-inch subsurface clearance.

7.2.8.3 Due to the unique characteristics associated with the Central Impact Area (the area surrounding the Central Impact Targets), this area is assessed and scored in Table 7.5. The Storage Magazine/Transfer Point source type is a small area (2.0 acres) and although the relative risk is ranked "lowest", the scoring and analysis for this MEC source type is included as Table 7.6. The Range Fans and Maneuver Area source types are both quite large and reuse varies within each. The numerous and vastly different reuse scenarios associated with the Range Fans and Maneuver Area means that no single alternative (by itself) would be appropriate for the entire area. Therefore, the cleanup alternative analysis associated with the areas covered by the Range Fans and Maneuver Areas are addressed in the Reuse Area Assessment (Section 7.3). The last MEC Source Type area, Training Areas, includes the co-located M203 and Mortar Practice Range. As noted in the risk assessment, a removal action was completed in this area to a depth of 2-feet. Additional clearance is not anticipated for this area, and therefore, a detailed cleanup alternative analysis was not conducted. This training area, however, is discussed in more detail as par of the summary of recommended cleanup actions in Section 8.

TABLE 7.5
ALTERNATIVE ANALYSIS AND SCORING – CENTRAL IMPACT AREA (NOT INCLUDING TARGETS)

Site	Acres	Explosive Risk Rank	Depth of Activity/Reuse
Central Impact Area (excluding targets)	382	Medium	None/None

Alternative	**Protectiveness - MEC Source**	**Protectiveness - Environmental**	**Permanence**	**Cost**	**Long-term Effectiveness**	**Short-term Effectiveness**	**Implementability**	**Public Concerns**	**Score**	**Rank**
1) No Further Action	0 No source Reduction	10 No Impacts to Environment	0 No reliability	10 $0	0 Risk remains (and may increase if receptors increase)	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	4 Concerns about risk, but no intended reuse.	44	**3**
2) Institutional Controls	0 No source Reduction	10 No Impacts to Environment	4 Fencing and signage w/ land use controls. Potential receptor interaction remains.	8 $573,000	4 Fencing is effective. Receptor awareness, but medium MEC source risk remains	10 No risk increase to community or workers in short-term.	6 Signs and education material to be installed (fencing is in place). Land use controls require legal documentation.	5 Concerns about risks associated with medium MEC source areas.	47	**1**
3) Surface Clearance	4 Limited source reduction. Surface reconnaissance previously conducted in most of the area.	8 Limited impacts. Some brush clearance may be required.	5 Reliable method for surface UXO. Subsurface risk remains	5 $6,200,000	6 Limited effectiveness due to potential frost heave of shallow, buried UXO.	7 Potential risk to UXO surface sweep technicians. Difficult terrain.	5 Requires use of qualified/trained UXO personnel.	6 Concerns that MEC source remains subsurface.	46	**2**

TABLE 7.5 (Continued)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
4) Clearance to Frost Depth	7 Great reduction in MEC source. Most UXO likely within upper 14" based on historic data and steep, rocky terrain.	4 Significant habitat destruction due to removal of brush/undergrowth. Especially in a "natural" area.	7 Reliable and eliminates risk of frost heave bringing UXO to surface.	3 $14,200,000	7 Effective at reducing risk given future reuse (non-intrusive).	4 Risk to brush clearance, DGM, and UXO crews due to brush clearance equipment, terrain, and UXO.	4 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	5 Given the proposed reuse, concerns about habitat destruction and long term impacts associated with removal of all undergrowth. Unlikely to be public support for this alternative.	41	**4**
5) Subsurface Clearance	8 Should eliminate nearly all risk from MEC source, although little advantage over Alt. 4, given the intended reuse.	3 Similar to Alternative 4. Deeper excavations may have greater impact.	8 Reliable and likely eliminates MEC source, although little advantage over Alt. 4, given intended reuse.	2 $19,700,000	8 Effective and area available for intended reuse.	3 Similar to Alternative 4 with added risk due to heavy equipment for anomaly excavations	3 Similar to Alternative 4 with added heavy equipment for anomaly excavations.	5 Similar to Alternative 4, with little additional benefit associated with Alternative 5 given the cost and intended reuse.	40	**5**
6) Excavation and Restoration	10 Should eliminate all risk from MEC source, although little benefit over Alternative 5.	0 Steep terrain, dense vegetation. Complete habitat destruction in sensitive environment.	10 Reliable and eliminates MEC source.	0 $50,200,000	10 Effective and area available for any use.	0 Great risk to workers associated with deep excavations and sifting operations.	0 Most difficult alternative to implement due to logistics and heavy equipment required.	0 Excessive and expensive given the intended reuse. Ecological destruction likely not tolerated.	30	**6**

Note: Detailed cost estimates are included as Appendix C. Alternative 5 cost is an average for the 24-inch and 48-inch subsurface clearance.

TABLE 7.6
ALTERNATIVE ANALYSIS AND SOCRING – STORAGE MAGAZIZNE/TRANSFER POINT

Storage Magazines/Transfer Point Site	Acres	Explosive Risk Rank	Depth of Activity/Reuse
Building 2950	2.0	Lowest	None/ Regional Park

Alternative	Protectiveness – MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
1) No Further Action	0 No impact on negligible MEC Source.	10 No impact to environment. Fenced area with buildings nearby.	0 No appreciable decrease to negligible exposure hazard	10 $0	0 No appreciable decrease to negligible risk.	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	3 Concerns about location within Regional Park and historic use.	43	**2**
2) Institutional Controls	0 No impact on negligible MEC Source.	10 No impact to environment. Fenced area with buildings nearby.	0 No appreciable decrease to negligible exposure hazard	8 $3,000	0 No appreciable decrease to negligible risk.	10 No risk increase to community or workers in short-term.	8 Signs and education material to be installed.	8 Likely support for effective education regarding and historic use.	44	**1**
3) Surface Clearance	0 No impact on negligible MEC Source.	10 No impact to environment. Fenced area with buildings nearby. No surface items.	0 No appreciable decrease to negligible exposure hazard	7 $ 18,700	0 No appreciable decrease to negligible risk.	8 Little potential risk to UXO surface sweep technicians. Accessible terrain.	6 Requires use of qualified/trained UXO personnel.	6 Additional expense not warranted given the negligible MEC source.	37	**4**
4) Clearance to Frost Depth	0 No impact on negligible MEC Source.	10 No impact to environment. Fenced area with buildings nearby.	2 Little appreciable decrease to negligible exposure hazard	5 $ 33,300	2 Little appreciable decrease to negligible risk.	7 Operational risk to DGM, and UXO crews. No excavations anticipated	5 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	5 Additional expense not warranted given the negligible MEC source.	36	**5**

TABLE 7.6 (Continued)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
5) Subsurface Clearance	0 No impact on negligible MEC Source.	10 No impact to environment. Fenced area with buildings nearby.	3 Little appreciable decrease to negligible exposure hazard	4 $47,500	3 Little appreciable decrease to negligible risk.	7 Operational risk to DGM, and UXO crews. No excavation anticipated.	5 Similar to Alternative 4. No heavy equipment for excavations.	5 Additional expense not warranted given the negligible MEC source.	37	**3**
6) Excavation and Restoration	0 No impact on negligible MEC Source.	0 Impact to area due to excavation.	3 Little appreciable decrease to negligible exposure hazard	0 $250,000	3 Little appreciable decrease to negligible risk.	2 Great risk to workers associated with deep excavations and sifting operations.	2 Most difficult alternative to implement due to logistics and heavy equipment required.	0 Likely seen as excessive and expensive given the intended reuse.	10	**6**

7.3 ALTERNATIVE RANKING BY FUTURE REUSE AREA

7.3.1 The proposed future land use for Camp Bonneville is recreational with varying levels of reuse intensity. The future land reuse intensity was based on the January 2003 Camp Bonneville Preliminary Site Plan. As noted in Section 4.4.13, the site has been geographically segregated based on proposed future land reuse areas. These land reuse areas include:

- Roads and Trails;
- Wildlife Management Area;
- High Intensity Reuse Areas;
- High Accessible – Medium Intensity Reuse Areas; and
- Medium Intensity Reuse Areas;

7.3.2 The site reuse areas and the associated detailed cleanup alternatives analysis includes: Roads and Trails (Table 7.7), Wildlife Management Area (Table 7.8), High Intensity Reuse Areas within the Regional Park (Table 7.9), High-Access Medium Reuse Areas within the Regional Park (Table 7.10), and the Remaining Medium Intensity Areas within the Regional Park (Table 7.11). Unlike the other reuse areas, the High Intensity Reuse Areas include areas with varying depths of future reuse activity. Due to the diferences in the proposed depth of activity, the High Intensity Reuse Areas are separated into surficial (non-intrusive) and subsurface (intrusive) future reuse depths, and are analyzed separately.

TABLE 7.7
ALTERNATIVE ANALYSIS AND SCORING – ROADS AND TRAILS

Site	Miles	Explosive Risk Rank	Depth of Activity/Reuse
Roads and Trails	~45[1]	Lowest – Highest[2]	None/drive or hike

(1) Approximately 25 miles of trails are proposed in the Regional Park area and 20 miles in the Wildlife Management Area.
(2) The roads and trails travel across various MEC source type areas.

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
1) No Further Action	0 No source Reduction	10 No Impacts to Environment	0 No reliability	10 $0	0 Risk remains (and may increase if receptors increase)	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	1 Concerns about high risk areas.	41	**5**
2) Institutional Controls	0 No source Reduction	10 No Impacts to Environment	4 Potential receptor interaction remains.	8 $165,000	4 Receptor awareness, but MEC source risk remains	10 No risk increase to community or workers in short-term.	6 Signs and education material to be installed .	4 Concerns about risks associated with high MEC source areas.	46	**3**
3) Surface Clearance	2 Limited source reduction. Surface reconnaissance previously conducted.	9 Minimal impacts to existing roads/trails. Some brush clearance may be required.	5 Reliable method for surface UXO. Subsurface risk remains	5 $1,180,000	6 Limited effectiveness due to potential frost heave of shallow, buried UXO.	7 Potential risk to UXO surface sweep technicians. Difficult terrain.	5 Requires use of qualified/trained UXO personnel.	6 Concerns that MEC source remains subsurface.	45	**4**
4) Clearance to Frost Depth	7 Great reduction in MEC source. Most UXO likely within upper 14" based on historic data.	8 Little habitat destruction on existing roads/trails.	7 Reliable and eliminates risk of frost heave bringing UXO to surface.	3 $2,142,000	7 Effective at reducing risk given future reuse (non-intrusive).	5 Risk to DGM, and UXO crews due to equipment, terrain, and UXO.	4 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	8 Given the proposed reuse, the alternative is appropriate.	49	**1**

TABLE 7.7 (Continued)

Alternative	Protectiveness - MECSource	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
5) Subsurface Clearance	8 Should eliminate nearly all risk from MEC source, although little advantage over Alt. 4, given the intended reuse.	8 Little habitat destruction on existing roads/trails.	8 Reliable and likely eliminates MEC source, although little advantage over Alt. 4, given intended reuse.	2 $3,799,000	8 Effective and area available for intended reuse.	3 Similar to Alternative 4 with added risk due to heavy equipment for anomaly excavations	3 Similar to Alternative 4 with added heavy equipment for anomaly excavations.	7 Similar to Alternative 4, with little additional benefit associated with Alternative 5 given the cost and intended reuse.	47	**2**
6) Excavation and Restoration	10 Should eliminate all risk from MEC source, although little benefit over Alternative 5.	0 Steep terrain and complete destruction of roads/trails.	10 Reliable and eliminates MEC source.	0 $13,748,000	10 Effective and area available for any use.	0 Great risk to workers associated with excavations and sifting operations.	0 Most difficult alternative to implement due to logistics and heavy equipment required.	0 Excessive and expensive given the intended reuse.	30	**6**

NOTE: Detailed cost estimates are included in Appendix C. Alternative 5 cost is an average of 24-inch and 48-inch subsurface clearance.

TABLE 7.8
ALTERNATIVE ANALYSIS AND SCORING – WILDLIFE MANAGEMENT AREA

Site	Acres	Explosive Risk Rank	Depth of Activity/Reuse
Wildlife Mgmt Area	~2,000[1]	Lowest/Low[2]	None/WMA

(1) Does not include Central Impact Area nor roads and trails within the WMA.
(2) WMA includes former Range Fan areas and Maneuver Areas.

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
1) No Further Action	0 No source Reduction	10 No Impacts to Environment	0 No reliability	10 $0	0 Risk remains (and may increase if receptors increase)	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	4 Concerns about risk, but reuse is limited to wildlife management.	44	**3**
2) Institutional Controls	0 No source Reduction	10 No Impacts to Environment	4 Potential receptor interaction remains.	8 $3,000,000	5 Receptor awareness, but low MEC source risk remains	10 No risk increase to community or workers in short-term.	6 Signs and education material to be installed.	7 Concerns about residual (albeit low) risk.	50	**1**
3) Surface Clearance	4 Limited source reduction.	8 Limited impacts. Some brush clearance may be required.	5 Reliable method for surface UXO. Subsurface risk remains	5 $32,400,000	6 Limited effectiveness due to potential frost heave of shallow, buried UXO.	7 Potential risk to UXO surface sweep technicians. Difficult terrain.	5 Requires use of qualified/trained UXO personnel.	6 Concerns that MEC source remains subsurface. Excessive cost.	46	**2**
4) Clearance to Frost Depth	7 Great reduction in MEC source. Most UXO likely within upper 14" based on historic data	4 Significant habitat destruction due to removal of brush/undergrowth. Especially in a "natural" area.	7 Reliable and eliminates risk of frost heave bringing UXO to surface.	3 $74,200,000	7 Effective at reducing risk given future reuse (non-intrusive).	4 Risk to brush clearance, DGM, and UXO crews due to brush clearance equipment, terrain, and UXO.	4 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	5 Given the proposed reuse, concerns about habitat destruction and long term impacts associated with removal of all undergrowth. Unlikely public support.	41	**5**

TABLE 7.8 (Continued)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
5) Subsurface Clearance	10 Should eliminate nearly all risk from MEC source, although little advantage over Alt. 4, given the intended reuse.	3 Similar to Alternative 4. Deeper excavations may have greater impact.	8 Reliable and likely eliminates MEC source, although little advantage over Alt. 4, given intended reuse.	2 $103,500,000	8 Effective and area available for intended reuse.	3 Similar to Alternative 4 with added risk due to heavy equipment for anomaly excavations	3 Similar to Alternative 4 with added heavy equipment for anomaly excavations.	5 Similar to Alternative 4, with little additional benefit associated with Alternative 5 given the cost and intended reuse.	42	**4**
6) Excavation and Restoration	10 Should eliminate all risk from MEC source, although little benefit over Alternative 5.	0 Steep terrain, dense vegetation. Complete habitat destruction in sensitive environment.	10 Reliable and eliminates MEC source.	0 $262,600,000	10 Effective and area available for any use.	0 Great risk to workers associated with deep excavations and sifting operations.	0 Most difficult alternative to implement due to logistics and heavy equipment required.	0 Excessive and expensive given the intended reuse. Ecological destruction likely not tolerated.	30	**6**

NOTE: Detailed cost estimates are included in Appendix C. Alternative 5 cost is an average of 24-inch and 48-inch subsurface clearance.

TABLE 7.9
ALTERNATIVE ANALYSIS AND SCORING – HIGH INTENSITY REUSE AREAS WITHIN REGIONAL PARK

Site	Acres	Explosive Risk Rank	Depth of Activity/Reuse
High Intensity Reuse Areas (Non-intrusive)	160/1	Lowest/Low	Subsurface/Regional Park
High Intensity Reuse Areas (Intrusive)	50/1	Lowest/Low	Surface/Regional Park

(1) Primarily overlies Range fans and Maneuver areas. High use areas that overlie Firing Points and Target Areas were discussed previously.

ANALYSIS AND SCORING OF SUBSURFACE DEPTH OF ACTIVITY (INTRUSIVE)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
1) No Further Action	0 No source Reduction	10 No Impacts to Environment	0 No reliability	10 $0	0 Risk remains (and may increase if receptors increase)	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	1 Concerns about intrusive activities and possible UXO.	41	**4**
2) Institutional Controls	0 No source Reduction	10 No Impacts to Environment	4 Potential receptor interaction remains.	8 $75,00	2 Receptor awareness, but MEC source risk remains.	10 No risk increase to community or workers in short-term.	6 Signs and education material to be installed .	2 Concerns about risks associated with intrusive activities.	42	**2**
3) Surface Clearance	2 Limited source reduction. Surface reconnaissance previously conducted.	8 Minor impacts to park areas. Some brush clearance may be required.	5 Reliable method for surface UXO. Subsurface risk remains	5 $639,000	2 Limited effectiveness due to intended intrusive reuse.	7 Potential risk to UXO surface sweep technicians. Difficult terrain.	5 Requires use of qualified/trained UXO personnel.	3 Concerns that MEC source remains subsurface.	37	**6**
4) Clearance to Frost Depth	7 Great reduction in MEC source. Most UXO likely within upper 14" based on historic data	7 Significant habitat destruction due to removal of undergrowth, but likely acceptable given reuse plans.	7 Reliable and eliminates risk of frost heave bringing UXO to surface.	3 $1,502,000	4 Not effective at reducing risk given future reuse (intrusive).	5 Risk to DGM, and UXO crews due to equipment, terrain, and UXO.	4 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	4 Given the proposed intrusive reuse, the alternative is not appropriate.	41	**3**

TABLE 7.9 (Continued)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
5) Subsurface Clearance	10 Should eliminate nearly all risk from MEC source.	7 Significant habitat destruction due to removal of undergrowth, but likely acceptable given reuse plans.	8 Reliable and likely eliminates MEC source.	2 $2,048,000	8 Effective and area available for intended reuse.	3 Similar to Alternative 4 with added risk due to heavy equipment for anomaly excavations	3 Similar to Alternative 4 with added heavy equipment for anomaly excavations.	9 Likely acceptable as a conservative approach in light of MEC source and intended reuse.	50	**1**
6) Excavation and Restoration	10 Should eliminate all risk from MEC source, although little benefit over Alternative 5.	7 Significant habitat destruction due to removal of all vegetation, but likely acceptable given reuse plans.	10 Reliable and eliminates MEC source.	0 $6,565,000	10 Effective and area available for any use.	0 Great risk to workers associated with deep excavations and sifting operations.	0 Most difficult alternative to implement due to logistics and heavy equipment required.	0 Excessive and expensive given the intended reuse.	37	**5**

ANALYSIS AND SCORING OF SURFICIAL DEPTH OF ACTIVITY (NON-INTRUSIVE)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
1) No Further Action	0 No source Reduction	10 No Impacts to Environment	0 No reliability	10 $0	0 Risk remains (and may increase if receptors increase)	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	1 Concerns about MEC source.	41	**4**
2) Institutional Controls	0 No source Reduction	10 No Impacts to Environment	4 Potential receptor interaction remains.	8 $240,000	2 Receptor awareness, but MEC source risk remains.	10 No risk increase to community or workers in short-term.	6 Signs and education material to be installed .	2 Concerns about risks associated with intrusive activities.	42	**2**
3) Surface Clearance	2 Limited source reduction. Surface reconnaissance previously conducted.	8 Minor impacts to park areas. Some brush clearance may be required.	5 Reliable method for surface UXO. Subsurface risk remains	5 $2,044,000	4 Limited effectiveness due to possible frost heave..	7 Potential risk to UXO surface sweep technicians. Difficult terrain.	5 Requires use of qualified/trained UXO personnel.	3 Concerns that MEC source remains subsurface.	39	**5**

TABLE 7.9 (Continued)

ANALYSIS AND SCORING OF SURFICIAL DEPTH OF ACTIVITY (NON-INTRUSIVE) (Continued)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
4) Clearance to Frost Depth	7 Great reduction in MEC source. Most UXO likely within upper 14" based on historic data	7 Significant habitat destruction due to removal of undergrowth, but likely acceptable given reuse plans.	7 Reliable and eliminates risk of frost heave bringing UXO to surface.	3 $4,805,000	7 Effective at reducing risk given future reuse (non-intrusive).	5 Risk to DGM, and UXO crews due to equipment, terrain, and UXO.	4 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	9 Given the proposed non- ntrusive reuse, the alternative is appropriate.	49	**1**
5) Subsurface Clearance	8 Should eliminate risk from MEC source, but little benefit over Alternative 4.	7 Significant habitat destruction due to removal of undergrowth, but likely acceptable given reuse plans.	8 Reliable and likely eliminates MEC source.	2 $6,554,000	8 Effective and area available for intended reuse.	3 Similar to Alternative 4 with added risk due to heavy equipment for anomaly excavations	3 Similar to Alternative 4 with added heavy equipment for anomaly excavations.	8 Likely acceptable, however, additional costs are unwarranted given the future reuse (non-intrusive).	47	**2**
6) Excavation and Restoration	10 Should eliminate all risk from MEC source, although little benefit over Alternative 5.	7 Significant habitat destruction due to removal of all vegetation, but likely acceptable given reuse plans.	10 Reliable and eliminates MEC source.	0 $21,009,000	10 Effective and area available for any use.	0 Great risk to workers associated with deep excavations and sifting operations.	0 Most difficult alternative to implement due to logistics and heavy equipment required.	0 Excessive and expensive given the intended non-intrusive reuse.	37	**6**

TABLE 7.10
ALTERNATIVE ANALYSIS AND SCORING – HIGH-ACCESS MEDIUM INTENSITY REUSE AREAS WITHIN REGIONAL PARK

Site	Acres	Explosive Risk Rank	Depth of Activity/Reuse
High-access Medium Reuse Areas	~180[1]	Lowest/Low	Surficial/Regional Park

(1) Areas within the Regional Park that have gentle topographic slope (<15%) and low vegetative cover along Lacamas Creek valley floor area.

Alternative	Protectiveness – MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
1) No Further Action	0 No source Reduction	10 No Impacts to Environment	0 No reliability	10 $0	0 Risk remains (and may increase if receptors increase)	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	1 Concerns about number of receptors given historic use.	41	**5**
2) Institutional Controls	0 No source Reduction	10 No Impacts to Environment	3 Potential receptor interaction remains.	8 $270,000	2 Receptor awareness, but MEC source risk remains.	10 No risk increase to community or workers in short-term.	6 Signs and education material to be installed .	6 Concerns about risks to receptors given historic use of the site.	45	**3**
3) Surface Clearance	0 No source reduction. Surface reconnaissance previously conducted.	8 Minor impacts to park areas. Some brush clearance may be required.	5 Reliable method for surface UXO. Subsurface risk remains	5 $1,930,000	4 Limited effectiveness due to frost heave.	7 Potential risk to UXO surface sweep technicians.	5 Requires use of qualified/trained UXO personnel.	7 Concerns that MEC source remains subsurface.	41	**4**
4) Clearance to Frost Depth	8 Reduction in MEC source. Most UXO likely within upper 14" based on historic data	4 Significant habitat destruction due to removal of undergrowth.	8 Reliable and eliminates risk of frost heave bringing UXO to surface.	3 $4,643,000	7 Effective at reducing risk given future reuse (non-intrusive).	5 Risk to DGM, and UXO crews due to equipment, terrain, and UXO.	4 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	9 Given the proposed non-intrusive reuse, the alternative is appropriate.	48	**1**
5) Subsurface Clearance	10 Should eliminate nearly all risk from MEC source.	4 Significant habitat destruction due to removal of undergrowth.	8 Reliable and likely eliminates MEC source.	2 $6,217,000	8 Effective and area available for intended reuse.	4 Similar to Alternative 4 with added risk due to heavy equipment for anomaly excavations	3 Similar to Alternative 4 with added heavy equipment for anomaly excavations.	8 Although protective, additional expense is unessesary given the intended reuse.	47	**2**

TABLE 7.10 (Continued)

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
6) Excavation and Restoration	10 Should eliminate all risk from MEC source, although little benefit over Alternative 5.	0 Significant habitat destruction due to removal of all vegetation.	10 Reliable and eliminates MEC source.	0 $23,635,000	10 Effective and area available for any use.	0 Great risk to workers associated with deep excavations and sifting operations.	0 Most difficult alternative to implement due to logistics and heavy equipment required.	0 Excessive and expensive given the intended reuse.	30	**6**

TABLE 7.11
ALTERNATIVE ANALYSIS AND SCORING – REMAINING MEDIUM REUSE AREAS WITHIN REGIONAL PARK

Site	Acres	Explosive Risk Rank	Depth of Activity/Reuse
Remaining Medium Reuse Areas	~770[1]	Lowest/Low	Surficial/Regional Park

(1) Primarily overlies Range fans and Maneuver areas. Medium reuse areas that overlie Firing Points and Target Areas were discussed previously.

Alternative	Protectiveness - MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
1) No Further Action	0 No source Reduction	10 No Impacts to Environment	0 No reliability	10 $0	0 Risk remains (and may increase if receptors increase)	10 No risk increase to community or workers in short-term.	10 Readily implemented. No action required.	2 Concerns about receptors hiking through the area on short cuts, given historic use.	42	**4**
2) Institutional Controls	0 No source Reduction	10 No Impacts to Environment	3 Potential receptor interaction remains.	8 $1,155,000	4 Receptor awareness, but MEC source risk remains.	10 No risk increase to community or workers in short-term.	6 Signs and education material to be installed.	5 Surface reconnaissance previously conducted. ICs should educate potential users. Low MEC source remains.	46	**1**
3) Surface Clearance	1 No source reduction. Surface reconnaissance previously conducted.	8 Minor impacts to park areas. Some brush clearance may be required.	5 Reliable method for surface UXO. Subsurface risk remains	5 $11,152,000	2 Limited effectiveness due to frost heave.	7 Potential risk to UXO surface sweep technicians.	5 Requires use of qualified/trained UXO personnel.	5 Concerns that MEC source remains subsurface.	38	**5**
4) Clearance to Frost Depth	7 Reduction in MEC source. Most UXO likely within upper 14" based on historic data	4 Significant habitat destruction due to removal of undergrowth.	8 Reliable and eliminates risk of frost heave bringing UXO to surface.	3 $25,841,000	7 Effective at reducing risk given future reuse (non-intrusive).	5 Risk to DGM, and UXO crews due to equipment, terrain, and UXO.	4 Requires use of qualified/trained UXO personnel and geophysicists with specialized (but readily available) equipment.	7 Concern over ecological damage. Significant cost given the intended reuse.	45	**2**

TABLE 7.11 (Continued)

Alternative	Protectiveness – MEC Source	Protectiveness - Environmental	Permanence	Cost	Long-term Effectiveness	Short-term Effectiveness	Implementability	Public Concerns	Score	Rank
5) Subsurface Clearance	7 Should eliminate nearly all risk from MEC source, but not more protective than Alternative 4 given the reuse.	4 Significant habitat destruction due to removal of undergrowth.	8 Reliable and likely eliminates MEC source.	2 $35,660,000	8 Effective and area available for intended reuse.	3 Similar to Alternative 4 with added risk due to heavy equipment for anomaly excavations	3 Similar to Alternative 4 with added heavy equipment for anomaly excavations.	7 Concern over ecological damage.	42	**3**
6) Excavation and Restoration	7 Should eliminate all risk from MECsource, although little benefit over Alternative 4.	0 Significant habitat destruction due to removal of all vegetation.	10 Reliable and eliminates MEC source.	0 $101,106,000	10 Effective and area available for any use.	0 Great risk to workers associated with deep excavations and sifting operations.	0 Most difficult alternative to implement due to logistics and heavy equipment required.	0 Excessive and expensive given the intended reuse.	27	**6**

7.4 REASONABLE RESTORATION TIME FRAME

7.4.1 In addition to the minimum threshold requirements, another requirement of MTCA [WAC 173-340-360(b)(ii)], is that the selected cleanup action shall provide for a reasonable restoration time frame. The most practicable permanent cleanup action alternatives identified in Sections 7.2 and 7.3 involve MEC clearance to frost depth, subsurface clearance, and institutional controls. It is estimated that a MEC clearance will take approximately 6 months to 1 year to complete at each site. Design and implementation of both site-wide and site-specific ICs can be completed in approximately 6 – 9 months. There are no other practical alternatives to MEC cleanup that would result in a shorter restoration time frame. The Camp Bonneville property should not be open to the public until the completion of the cleanup actions due to the residual explosive exposure hazard at a number of areas. Access to the site is currently restricted by a fence and gate and should be restricted until completion of the cleanup actions.

SECTION 8

RECOMMENDED CLEANUP ACTIONS

8.1 INTRODUCTION

8.1.1 Cleanup action alternatives have been evaluated for each of the site types located within Camp Bonneville. In general, Target Areas, Firing Points and OB/OD Areas were determined to pose the greatest explosive safety exposure hazard. Based on the explosive safety exposure hazard, a removal action is proposed for the Target Areas, Firing Points and OB/OD Areas. Although the remaining areas generally pose a negligible explosive safety hazard, additional removal actions are proposed within these areas based on future land use.

8.1.2 A preferred alternative was selected as the most practicable permanent solution for each of the site types to reduce the explosive hazard exposure Cleanup action alternatives were initially screened against minimum threshold requirements, as described in Section 6. The cleanup action alternatives were subsequently evaluated against the selection criteria using the disproportionate cost analysis methods specified in MTCA. This section presents the recommended cleanup action(s) for Camp Bonneville.

8.2 RECOMMENDATIONS BY MEC SOURCE SITE TYPE

8.2.1 Target Areas

8.2.1.1 The Target Area MEC Source sites at Camp Bonneville consist of eight (8) target areas. Three of these target areas (West Impact Area Car Target 2, Combined Impact Area 1, and Combined Impact Area 2) are located within the Central Impact Area and recommendations for these three targets are described separately in Section 8.2.2. The remaining five target areas include 3.5-inch Rocket Range Target, Rifle Grenade Range Target, Hand Grenade (HE) Range Target, M203 HE Grenade Range Target, and 2.36-inch Rocket Target. UXO items were previously identified at the M203 HE Grenade Range Target during the 1998 site characterization; however, this area was subsequently cleared of MEC in 1999 to a depth of 2 feet. No ordnance items were found below a depth of 14 inches at the M203 HE Grenade Range. Additional MEC clearance actions at this site would not provide additional public safety; therefore, additional clearance will not be conducted at the M203 HE Grenade Range Target.

8.2.1.2 The four remaining Target Areas (3.5-inch Rocket Range Target, Rifle Grenade Range Target, Hand Grenade (HE) Range Target, and 2.36-inch Rocket Target),

have the highest relative explosive safety risk, based on the type and likelihood of MEC occurrence. The results of the qualitative explosive hazards exposure assessment also indicated a relatively high level of exposure risk in these Target Areas ("A" ranking).

8.2.1.3 The frost depth (14-inch) clearance cleanup action alternative with ICs (Alternative 4) was determined to be the most practicable permanent solution for the four Target Areas based on the disproportionate cost analysis (Section 7.3). A frost depth clearance (Alternative 4) at the 3.5-inch Rocket Range Target, Rifle Grenade Range Target, Hand Grenade (HE) Range Target, and 2.36-inch Rocket Target would substantially eliminate the explosive hazard at these sites since the future activities anticipated to occur in these Target Areas are surficial and non-intrusive. The implementation of the site-specific ICs (included as part of Alternative 4) would provide for the necessary public awareness of the former military use of the site. Due to the prior removal action conducted at the M203 Range Target additional subsurface removal actions are not warranted. Site-specific ICs (Alternative 2), however, are recommended for the M203 Range Target. Table 8.1 summarizes the recommended cleanup actions for the Target Areas.

TABLE 8.1
SUMMARY OF RECOMMENDED CLEANUP ACTIONS – TARGET AREAS

Target Sites	Explosive Risk Rank	Depth of Activity/Reuse	Recommended Alternative
3.5-inch Rocket Range Target	Highest	Surface/Firing Range	Alt. 4 – Frost Depth (14-inch) clearance with ICs
Rifle Grenade Target	Highest	Surface/Firing Range	Alt. 4 – Frost Depth (14-inch) clearance with ICs
Hand Grenade (HE) Target	Highest	Surface/Firing Range	Alt. 4 – Frost Depth (14-inch) clearance with ICs
2.36-inch Rocket Target	Highest	None/Regional Park	Alt. 4 – Frost Depth (14-inch) clearance with ICs
M203 HE Grenade Target	Negligible[\1]	None/Regional Park	Alt. 2 - ICs

8.2.1.4 The clearance action will be conducted in the footprint of each the Target Areas as shown in Figure 8.1. The area and extent of the targets is based upon prior characterization and reconnaissance efforts. Removal actions will be initiated at the presumed target center and will proceed outward in a grid-based manner. The actual clearance area will be adjusted based upon items recovered during fieldwork. The size of the targets may increase or decrease depending upon the amount of UXO recovered. The calculated total area for the removal action is approximately 10.6 acres and the total area for ICs is approximately 14.6 acres. The depth of MEC clearance for each of the Target Areas is 14-inches based on the future surficial and non-intrusive reuse activities. A clearance to 14-inches will achieve the cleanup standard of negligible interaction with the MEC source at Target Areas. Site-specific ICs will include installation of signage at each of the Target Areas to increase the publics' awareness of the past military activities conducted at the site. The cost to implement the recommended cleanup action in the

Figure 8.1 Target Cleanup Action Areas

Target Areas is estimated at $279,000 and is summarized in Table 8.2 and Appendix C. The cost for site-specific ICs includes both the installation and maintenance costs of signage for 10 years.

TABLE 8.2
COST ESTIMATE FOR TARGET AREAS[1]

Item	Cost per Acre	Acreage	Total Costs
Alternative 4			
MEC Removal	$13,153	10.6	$139,000
A-E Field Oversight	$1578	10.6	$17,000
A-E Project Management	$1,052	10.6	$11,000
Land Survey	$500	10.6	$5,300
Brush Cut	N/A	10.6	$26,400
Institutional Controls	$1,500	10.6	$16,950
Costs Contracting & Oversight	N/A	N/A	$32,000
		Alternative 4 Subtotal	**$248,000**
10% Contingency			$24,800
		Total Cost Estimate Alternative 4	**$273,000**
Alternative 2 (M203 HE Grenade Range Target Only)			
Institutional Controls	$1,500	4.0	**$6,000**
		Total Cost Estimate*	**$279,000**

* Note: The total cost estimate is rounded to the nearest 1000 for the FS. Detailed cost estimates are presented in Appendix C.

8.2.2 Central Impact Target Area

8.2.2.1 The Central Impact Target Area OE Source site, located in the central portion of Camp Bonneville, is comprised of three adjacent target areas, known as the West Impact Area Car Target 2, Combined Impact Area 1, and Combined Impact Area 2. Four UXO items were recovered during the site characterization in 1998 and included one 2.36-inch HE rocket and three 105mm HE-filled artillery rounds. During the site reconnaissance in 2001, one additional 105mm artillery round was identified.

8.2.2.2 The Central Impact Target Area has a high relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. There are no planned future reuse activities for the Central Impact Target Area. This area is located within the fenced portion of the Central Impact Area. Due to the steep, rugged terrain and existing fencing, the number of potential receptors is very small and access to this area is very

limited. The results of the qualitative explosive hazards exposure assessment indicated a moderate – high level of exposure risk in the Central Impact Target Area.

8.2.2.3 Alternative 2 (ICs) was determined to be the most practicable permanent solution for the Central Impact Target Area. Implementation of site-specific ICs (signage) will inform the public about this area's past usage and land use controls in the form of restrictive covenants will prohibit any future development and/or forestry activities at this site.

8.2.2.4 The ICs will be implemented for the footprint of the Central Impact Target Area as shown in Figure 8.2. The total area is approximately 83 acres. Site-specific ICs include installation of signs and implementation and enforcement of land use controls at the Central Impact Target Area. The cost to implement the recommended ICs alternative action in the Central Impact Target Area is $124,500. The cost for site-specific ICs includes both installation and maintenance costs of signage and fencing, and land use controls for 10 years.

8.2.3 Open Burn/Open Detonation Areas

8.2.3.1 The OB/OD MEC Source sites consist of three OB/OD sites at Camp Bonneville, known as Demolition Area 1, Demolition Area 2 and Demolition Area 3. A wide range of explosives and ordnance were reportedly disposed of at the OB/OD areas. During the site characterization, a 4.5-inch rocket was recovered near Demolition Area 3 and a 2.36-inch HEAT rocket and an HE-filled 2.75-inch rocket were recovered in the vicinity of Demolition Area 1. As a result of these findings, a 10-acre surface clearance was performed at Demolition Area 1. Eight UXO items were recovered during the surface clearance and included two HE-filled 2.75-inch rockets and six 35mm M73 practice rockets. In addition, the entire Demolition 1 area (2.5 acres) has been removed as part of a removal action conducted in 2004. Therefore, additional subsurface clearance is not warranted in the immediate Demolition 1 Area.

8.2.3.2 The OB/OD Areas have a high relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. The three OB/OD sites are readily accessible by roads and trails. Demolition Area 1 is a low future reuse area as it is located in the proposed WMA. Demolition Area 2 is a high future reuse area since Clark County is proposing a "Logging Camp" at this location. Intrusive activities may be conducted in the logging camp. Demolition Area 3 is a medium future reuse area as it is near to the planned Environmental Study Area (ESA). The results of the qualitative explosive hazards exposure assessment indicated a medium to high level of exposure risk at the OB/OD sites.

8.2.3.3 The subsurface clearance cleanup action alternative (Alternative 5) was determined to be the most practicable permanent solution for OB/OD Demolition 2 and Demolition 3 Areas based on the disproportionate cost analysis. A subsurface clearance cleanup action alternative at these two OB/OD Source areas would eliminate substantially all of the explosive exposure risk. In addition, surface clearance

Figure 8.2 Central Impact Target Cleanup Action Areas

(Alternative 3) in a "buffer area" surrounding all three OB/OD sites will remove potential MEC that may have resulted from kick-outs. Kick-outs from demolition activities are expected to be located on the ground surface (not subsurface). The implementation of ICs (as part of Alternatives 2 and 5) would also provide the necessary public awareness of the former ordnance usage at these sites to park visitors. Therefore, the recommended cleanup action alternative is a subsurface clearance at the two OB/OD sites, with additional surface clearance in a buffer area adjacent to each site, and implementation of site-specific ICs. Performing this recommended cleanup action alternative will achieve the cleanup standard of negligible interaction with the OE source. The recommended alternatives are summarized in Table 8.3

TABLE 8.3
SUMMARY OF RECOMMENDED CLEANUP ACTIONS – OB/OD AREAS

OB/OD Sites	Acres	Explosive Risk Rank	Depth of Activity/Reuse	Recommended Alternative
Demo Area 1	2.5	None(1)	None/ Wildlife Mgt Area	Alt. 3 – Surface sweep with ICs (buffer)
Demo Area 2	2.0	Highest	Subsurface/Logging Area	Alt. 5 – Subsurface clearance, plus Alt. 2 – Surface sweep with ICs (buffer).
Demo Area 3	2.0	Highest	None/Regional Park	Alt. 5 – Subsurface clearance, plus Alt. 2 – Surface sweep with ICs (buffer).

(1) Demo Area 1 removed as part of 2004 removal action.

8.2.3.4 The subsurface clearance will be performed at the OB/OD sites as shown in Figure 8.3. The recommended depth of MEC clearance is 4-feet and will be performed in a 300-foot x 300-foot grid centered over the Demolition Areas 2 and 3. The area and extent of the OB/OD Areas is based upon prior characterization and reconnaissance efforts. Removal actions will be initiated at the presumed center and will proceed outward in a grid-based manner. The actual clearance area will be adjusted based upon items recovered during fieldwork. The size of the subsurface clearance area may increase or decrease depending upon the amount of UXO recovered. A surface clearance will also be performed extending 500 feet in all directions beyond the 300-foot x 300-foot grid over the Demolition Areas 2 and 3 as shown in Figure 8.3. No subsurface clearance cleanup action will be required at the Demolition Area 1 site since it is co-located with Landfill 4, and the entire 2.5-acre footprint has been removed as part of a removal action. However, a surface clearance will be performed at the Demolition Area 1 site in the footprint area (shown in Figure 8.3) similar to the Demolition Areas 2 and 3. The total area for the 4-foot clearance at Demolition Areas 2 and 3 is approximately four (4) acres (2 acres each). The total area for the surface clearance at Demolition Areas 1, 2, and 3 is approximately 110 acres (approximately 36 acres each). Site-specific ICs include installation of signs at the OB/OD sites to inform the public of the past military usage of the site. The cost to implement the recommended cleanup action at the OB/OD sites is $1,270,000 and is summarized in Table 8.4 and Appendix C. The cost for site-specific ICs includes both installation and maintenance costs of signage for ten (10) years.

Figure 8.3 Open Burn/Open Demolition Cleanup Action Areas

TABLE 8.4
COST ESTIMATE FOR OB/OD AREAS[1]

Item	Cost per Acre	Acreage	Total Costs
Alternative 5 (48" Clearance for Demo 2 & 3 only)			
MEC Removal	$21,600	4	$86,400
A-E Field Oversight	$2,592	4	$10,000
A-E Project Management	$1,728	4	$6,910
Land Survey	Lump-Sum	4	$2,000
Brush Cut	N/A	4	$10,000
Institutional Controls	$1,500	4	$3,000
Costs Contracting & Oversight	N/A	N/A	$17,800
		Subtotal	**$136,000**
10% Contingency			$13,648
		Total Alternative 5 Cost Estimate*	**$150,000**
Alternative 3 (Buffer areas for Demo 1, 2, & 3)			
MEC Removal	**$6,290**	110	$692,000
A-E Field Oversight	**$755**	110	$83,057
A-E Project Management	**$500**	110	$55,000
Land Survey		110	$55,000
Costs Contracting & Oversight	**$1,207**	110	$132,800
			$1,020,000
10% Contingency			$101,800
		Total Alternative 3 Cost Estimate*	**$1,120,000**
		Total Cost Estimate*	**$1,270,000**

* Note: The total cost estimate is rounded to the nearest 1000 for the FS. Detailed cost estimates are presented in Appendix C.

8.2.4 Firing Points

8.2.4.1 The Firing Points MEC Source sites at Camp Bonneville consists of six mortar firing positions, seven artillery firing positions, one rifle grenade range firing point, one 3.5-inch rocket range firing point, and one M203 40mm HE Grenade Range. No UXO or MEC items were discovered at any Firing Points locations during the site characterization efforts. Only non-deployed military munitions are anticipated to be present at Firing Points since the ordnance release mechanism at these locations is a result of abandonment, burial, or mishandling of non-deployed munitions in shallow pits. As discussed previously, the M203 40mm HE Grenade Range was cleared to a depth of 2 feet. Further clearance actions at this site would not provide additional public safety.

8.2.4.2 The Firing Points MEC Source sites have a medium relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. The Firing Points are accessible based on their proximity to roads and trails. The activities proposed for future

reuse areas which overlie the Firing Point locations are surficial and non-intrusive. The results of the qualitative explosive hazards exposure assessment indicated a medium to high level of exposure risk at the Firing Points locations.

8.2.4.3 The frost depth (14-inch) clearance cleanup action alternative was determined to be the most practicable permanent solution for the Firing Point OE Source sites based on the disproportionate cost analysis. A frost depth clearance cleanup action alternative at the Firing Point MEC Source areas would substantially eliminate the explosive exposure risk. The implementation of site-specific ICs would also provide the necessary public awareness of the former military use of the site to park visitors. Therefore, the frost depth clearance with site-specific ICs (Alternative 4) is recommended as the MEC cleanup action for the Firing Points.

8.2.4.4 The clearance action will be conducted in the footprint of each the Firing Points as shown in Figure 8.4. The total area for the removal action is approximately nineteen (19) acres. This is based on an approximate 2-acre clearance around each artillery firing position, a 0.5-acre clearance around each mortar firing position, and a 1-acre clearance around the 3.5-inch Rocket and Rifle Grenade firing points. The depth of MEC clearance for each of the Firing Points is frost depth (14-inches) based on the future surficial and non-intrusive reuse activities. A frost depth clearance to a depth of 14-inches will achieve the cleanup standard of negligible interaction with the MEC source at Firing Point locations. Site-specific ICs will include installation of signage at each of the Firing Points to increase the publics' awareness of the past military activities conducted at these sites. The cost to implement the recommended cleanup action at the Firing Point locations is $421,000and is summarized in Table 8.5 and Appendix C. The cost for site-specific ICs includes both the installation and maintenance costs of signage for 10 years.

TABLE 8.5
COST ESTIMATE FOR FIRING POINTS

Item	Cost per Acre	Acreage	Total Costs
MEC Removal	$11,294	19	$214,600
A-E Field Oversight	$1,355	19	$25,752
A-E Project Management	$903	19	$17,168
Land Survey	Lump-Sum	19	$9,500
Brush Cut	N/A	19	$32,500
Institutional Controls	N/A	19	$33,000
Costs Contracting & Oversight	N/A	N/A	$49,878
		Subtotal	**$382,000**
10% Contingency			$38,200
		Total Cost Estimate*	**$421,000**

* Note: The total cost estimate is rounded to the nearest 1000 for the FS. Detailed cost estimates are presented in Appendix C.

Figure 8.4 Firing Point Cleanup Action Areas

8.2.5 Training Areas

8.2.5.1 The OE risk assessment concluded that only one (1) Training Area (the M203 Practice Range co-located with the Mortar Practice Range) poses an explosive safety risk. The explosive safety risk at this site was described as low. As a result of the site characterization findings, an interim removal action to a depth of 2 feet depth was completed in 1998 on both of the M203 Grenade Ranges. Three (3) UXO items were recovered during the interim removal action at the M203 Practice Grenade Range. The likelihood that any UXO remains at this site is negligible. The overall explosive hazards exposure is considered to be low as the result of the site characterization and interim removal action findings for this site.

8.2.5.2 The ICs alternative (Alternative 2) is determined to be the most practicable permanent solution for the co-located M203 Practice Range and Mortar Practice Range based on the disproportionate cost analysis. The implementation of site-specific signage would provide the necessary public awareness of the former military usage of this site to park visitors and will achieve the cleanup standard of negligible interaction with the MEC source at this site. The cost to implement the site-specific ICs at this site is estimated at $6,000. The cost for site-specific ICs includes both the installation and maintenance costs of signage for 10 years.

8.2.6 Range Safety Fans

8.2.6.1 The Range Safety Fan OE Source sites consist of a total of sixteen (16) range safety fans associated with each of the sixteen Firing Point locations. The majority of Camp Bonneville site is overlain by one or more Range Safety Fans. The Range Safety Fans are designed to contain those single event items that fall at some distance from their intended target. The likelihood of encountering ordnance in a Range Safety Fan is negligible, because of the infrequent historical artillery firing practices and the large size of the Range Safety Fans.

8.2.6.2 The Range Safety Fans have a low relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. The proposed future reuse of these areas is considered low, except for those Range Safety Fans that overlie a High Reuse Intensity Area. The recommended cleanup actions for the High Intensity Reuse Areas are described in 8.3.11. The results of the qualitative explosive hazards exposure assessment indicated a low level of exposure risk at the Range Safety Fans.

8.2.6.3 The ICs alternative is determined to be the most practicable permanent solution for the Range Safety Fan MEC Source sites. The ICs at the Range Safety Fans will include implementation of site-wide ICs as described in Section 8.4. These site-wide ICs will inform the public of the past military history of Camp Bonneville and they will modify people's behavior should they encounter an MEC item. Implementation of site-wide ICs will achieve the cleanup standard of negligible interaction with the MEC source at these sites.

8.2.7 Storage Magazines/Transfer Points

8.2.7.1 The solitary Storage Magazine / Transfer Point MEC Source site at Camp Bonneville is Building 2950. Building 2950 area is an ammunition storage area consisting of three bunkers located approximately 1000 feet northeast of the Camp Bonneville cantonment area. The likelihood of any non-deployed military munitions at this site is remote. This site has a very low relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. This site is located within the proposed regional park and is fenced and there are no proposed reuse activities at this location. The overall explosive hazards exposure is very low.

8.2.7.2 The ICs alternative was determined to be the most practicable permanent solution for the Building 2950 areas based on the disproportionate cost analysis. The site-specific ICs include installation of signs at this site. Signs will inform the public of the past military history of the Building 2950 and they will modify people's behavior should they encounter an MEC item. Implementation of site-specific ICs will achieve the cleanup standard of negligible interaction with the MEC source at this site. The cost to implement the site-specific ICs is estimated $ 3,000. The cost for site-specific ICs includes both the installation and maintenance costs of signage for ten (10) years.

8.2.8 Maneuver Areas

8.2.8.1 The Maneuver Areas MEC Source sites are those areas that were not specifically identified as troop training areas. Maneuver Areas overlay the vast majority of the Camp Bonneville site. Maneuver Areas included the roads and trails, bivouac, and maneuver areas, including the Killpack and Bonneville cantonment areas. The Maneuver Areas have a very low relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. The results of the qualitative explosive hazards exposure assessment indicated a very low level of exposure risk at the Maneuver Areas.

8.2.8.2 The ICs alternative is determined to be the most practicable permanent solution for the Maneuver Areas MEC Source sites. The ICs proposed for the Maneuver Areas will include implementation of site-wide ICs as described in Section 8.4. These site-wide ICs will inform the public of the past military history of the Camp Bonneville and they will modify people's behavior should they encounter an MEC item. Implementation of site-wide ICs will achieve the cleanup standard of negligible interaction with the MEC source at these sites.

8.2.9 Central Impact Area

8.2.9.1 The Central Impact Area is approximately 458 acres in size. It is comprised of the 83 acre Central Impact Target Area and 375 acres of associated Range Safety Fans. The Central Impact Area is currently fenced off, with a three-strand barbed wire fence encircling the entire area. Additionally, signage warning of the potential danger to trespassers is currently in place. People are not expected to venture into this site due to the fencing, signage, and steep terrain; therefore the number of potential human receptors

is considered negligible. The Central Impact Area (not including the target areas) has a medium relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. The results of the qualitative explosive hazards exposure assessment indicated a medium level of exposure risk at the Central Impact Area.

8.2.9.2 The ICs alternative (Alternative 2) was determined to be the most practicable permanent solution for the Central Impact Area MEC Source (excluding the target areas) site based on the disproportionate cost analysis. Site-specific ICs include installation of additional signs, maintenance of the existing fence, and implementation and enforcement of land use controls at the Central Impact Area. The signage will inform the public about this area's past usage and the fence will restrict the entry to this area. The restrictive covenants will prohibit any future development and/or forestry activities in the Central Impact Area. Implementation of these site-specific ICs will achieve the cleanup standard of negligible interaction with the MEC source at this site. The estimated cost to implement the site-specific ICs is $573,000. The cost for implementation of site-specific ICs includes both the installation and maintenance costs for 10 years.

8.2.10 Roads and Trails

8.2.10.1 There are approximately 46 miles of Roads and Trails throughout Camp Bonneville, of which 25 miles are located within the proposed Regional Park (Figure 2.2). The Roads and Trails have the same munitions related historical use and characteristics as the Maneuver Areas. The 2002 reconnaissance field efforts resulted in complete coverage of the existing Roads and Trails located within Camp Bonneville. The only items recovered within a 50-foot buffer along the Road and Trails during the reconnaissance efforts were expended pyrotechnics and small arms ammunition.

8.2.10.2 The Roads and Trails have a very low relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. A relatively large number of potential receptors are expected along the Roads and Trails located in the proposed regional park, with fewer receptors expected on the Roads and Trails. The results of the qualitative explosive hazards exposure assessment indicated a very low level of exposure risk along the Roads and Trails.

8.2.10.3 The frost depth clearance with ICs alternative (Alternative 4) was determined to be the most practicable permanent solution for the Roads and Trails based on the disproportionate cost analysis. The frost depth clearance will include geophysical mapping of the roads and trails and excavation (up to a depth of 14-inches) of identified anomalies. The established roads and trails are reportedly 20-feet wide. Site-specific ICs will include installation of signs along the roads and trails at appropriate intervals to inform the public about the past military use of the site. Implementation of Alternative 4 will achieve the cleanup standard of negligible interaction with any OE items. The cost to implement Alternative 4 on the Roads and Trails is estimated at $2,142,000 and is summarized in Table 8.6 and Appendix C. The cost for site-specific ICs includes both the installation and maintenance costs of signage for ten (10) years.

TABLE 8.6
COST ESTIMATE FOR ROADS AND TRAILS

Item	Cost per Acre	Acreage	Total Costs
OE Removal	$11,160	110	$1,227,600
A-E Field Oversight	$1,339	110	$147,312
A-E Project Management	$892	110	$98,208
Land Survey	Lump-Sum	110	$55,000
Brush Cut	N/A	110	$0
Institutional Controls	$1,500	110	$165,000
Costs Contracting & Oversight	N/A	N/A	$253,968
		Subtotal	**$1,947,090**
10% Contingency			$194,709
		Total Cost Estimate*	**$2,142,000**

* Note: The total cost estimate is rounded to the nearest 1000 for the FS. Detailed cost estimates are presented in Appendix C.

8.2.11 High Intensity Reuse Areas

8.2.11.1 The High Intensity Reuse Areas are the designated reuse areas identified on the Clark County Preliminary Site Plan (January 2003). These sites comprise approximately 210 acres within the proposed regional park. The future visitors to Camp Bonneville will conduct a wide range of recreational and educational activities within the footprint of these High Intensity Reuse Areas. The High Intensity Reuse Areas have a low relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. The results of the qualitative explosive hazards exposure assessment indicated a low level of exposure risk in the High Intensity Reuse Areas.

8.2.11.2 For proposed intrusive activities within the High Intensity Reuse Areas the subsurface clearance with ICs alternative (Alternative 5) was determined to be the most practicable permanent solution, based on the disproportionate cost analysis. The recommendation is for a subsurface clearance cleanup action conducted at the proposed intrusive high intensity reuse sites due to the relatively large number of potential receptors at these areas. A subsurface clearance cleanup action alternative at these intrusive areas would eliminate substantially all of the explosive exposure and provide an additional measure of public safety. It is recommended that clearance to a depth of 4 feet be performed in the planned Logging Camp and within the footprints of any planned construction sites.

A frost depth clearance (14-inches) is the recommendation for those areas where the planned high intensity reuse areas have activities that are surficial and non-intrusive (RV camping, parking, archery and firing ranges, etc.). The clearance action will be conducted in the footprint of each the High Intensity Reuse Areas as shown in Figure 8.5. The site-specific ICs will include signage to inform the public about the past military use of each area. Implementation of the recommended clearance actions and site-specific ICs will achieve the cleanup standard of negligible interaction with any MEC items.

Figure 8.5 High Intensity Reuse Cleanup Action Areas

8.2.11.4 The total area estimated for conducting the frost depth clearance is approximately 160 acres as shown in Figure 8.5. The area estimated for requiring the 4-foot clearance is approximately 50 acres and includes the Rustic Retreat Future Expansion, Logging Camp, Tent and Yurt Camping sites and an estimated additional 5 acres for other construction sites. The cost to implement the recommended cleanup action in the High Intensity Reuse Areas is estimated at $7,069,000 and is summarized in Table 8.7 and Appendix C. The cost for site-specific ICs includes both the installation and maintenance costs of signage for 10 years.

TABLE 8.7
COST ESTIMATE FOR HIGH INTENSITY REUSE AREAS

Item	Cost per Acre	Acreage	Total Costs
Alternative 5 (48" clearance proposed intrusive areas only)			
MEC Removal	$24,000	50	$1,200,000
A-E Field Oversight	$2,880	50	$144,000
A-E Project Management	$1,920	50	$96,000
Land Survey	Lump-Sum	50	$25,000
Brush Cut	N/A	50	$250,000
Institutional Controls	$1,500	50	$75,000
Costs Contracting & Oversight	N/A	N/A	$268,500
		Subtotal	**$2,058,500**
10% Contingency			$205,850
		Alternative 5 Cost Estimate*	**$2,264,000**
Alternative 4 (14" clearance for non-intrusive areas)			
MEC Removal	$13,950	160	$2,232,000
A-E Field Oversight	$1,674	160	$267,840
A-E Project Management	$1,116	160	$178,560
Land Survey	Lump-Sum	160	$80,000
Brush Cut	N/A	160	$800,000
Institutional Controls	$1,500	160	$240,000
Costs Contracting & Oversight	N/A	N/A	$569,760
		Subtotal	**$4,368,160**
10% Contingency			**$436,816**
		Alternative 4 Cost Estimate*	**$4,805,000**
		Total	**$7,069,000**

*Note: The total cost estimate is rounded to the nearest 1000 for the FS. Detailed cost estimates are presented in Appendix C.

8.2.12 High-Accessible Medium Intensity Reuse Areas

8.2.12.1 High-Accessible Medium Intensity Reuse Areas comprise those areas in the proposed regional park that are located between the High Intensity Reuse Areas, have a gentle topographic slope and low vegetative cover, and therefore provide the opportunity to draw people together for informal recreational activities. These areas cover approximately 180 acres along the Lacamas Creek valley floor. The High-Accessible Medium Intensity Reuse Areas have a low relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. The results of the qualitative explosive hazards exposure assessment indicated a low level of exposure risk in the High-Accessible Medium Intensity Reuse Areas.

8.2.12.2 The frost depth clearance with ICs alternative (Alternative 4) was determined to be the most practicable permanent solution for the High-Accessible Medium Intensity Reuse Areas based on the disproportionate cost analysis. The recommendation is for a frost depth (14-inch) clearance cleanup action to a at the High-Accessible Medium Intensity Reuse Area due to the relatively large number of potential receptors at these areas. A frost depth clearance cleanup action alternative in the High-Accessible Medium Intensity Reuse Area would substantially eliminate the explosive exposure and provide an additional measure of public safety. The clearance action will be conducted in the footprint of the High-Accessible Medium Intensity Reuse Area as shown in Figure 8.6. The ICs will include signage to inform the public about the past military use of the area. Implementation of these site-specific ICs and the clearance action will achieve the cleanup standard of negligible interaction with any MEC items.

8.2.12.3 The total area estimated for conducting the frost depth clearance is approximately 180 acres as shown in Figure 8.6. The cost to implement the recommended cleanup action in the High-Accessible Medium Intensity Reuse Areas is estimated at $4,643,000 and is summarized in Table 8.8 and Appendix C. The cost for site-specific ICs includes both the installation and maintenance costs of signage for ten (10) years.

TABLE 8.8
COST ESTIMATE FOR HIGH-ACCESSIBLE MEDIUM REUSE AREA

Item	Cost per Acre	Acreage	Total Costs
MEC Removal	$11,160	180	$2,008,800
A-E Field Oversight	$1,339	180	$241,056
A-E Project Management	$892	180	$160,704
Land Survey	Lump-Sum	180	$90,000
Brush Cut	N/A	180	$900,000
Institutional Controls	$1,500	180	$270,000
Costs Contracting & Oversight	N/A	N/A	$550,584
		Subtotal	**$4,221,140**
10% Contingency			$422,114
		Total Cost Estimate*	**$4,643,000**

* Note: The total cost estimate is rounded to the nearest 1000 for the FS. Detailed cost estimates are presented in Appendix C.

Figure 8.6 High – Accessible Medium Intensity Reuse Cleanup Action Area

8.2.13 Remaining Medium Reuse Intensity Areas

8.2.13.1 The Remaining Medium Intensity Reuse Areas consist of those areas within the proposed Regional Park that are located between specific designated reuse areas, and do not have the high accessibility characteristics of gentle slope and low vegetation characteristics. The Remaining Medium Intensity Reuse Areas comprise approximately 770 acres. Very few people are expected to enter the Remaining Medium Intensity Reuse Areas since these areas have moderate-impassable vegetative cover and/or moderate-steep terrain characteristics. The Remaining Medium Reuse Intensity Areas have a low relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. The results of the qualitative explosive hazards exposure assessment indicated a low level of exposure risk in the Remaining Medium Intensity Reuse Areas.

8.2.13.2 The ICs alternative (Alternative 2) was determined to be the most practicable permanent solution for the Remaining Medium Intensity Reuse Areas based on the disproportionate cost analysis. The ICs at the Remaining Medium Intensity Reuse Areas will include implementation of site-wide ICs as described in Section 8.4. These site-wide ICs will inform the public of the past military history of the Camp Bonneville and they will modify people's behavior should they encounter an MEC item. Implementation of site-wide ICs will achieve the cleanup standard of negligible interaction with the MEC source at these sites.

8.2.14 Wildlife Management Area

8.2.14.1 The WMA is comprised of approximately 2,000 acres in the eastern portion of the Camp Bonneville site, and includes the DNR leased lands. The WMA acreage does not include the Central Impact Area nor the roads and trails located in the WMA portion of the Camp Bonneville site . The majority of the WMA was used as Maneuver Area and, as such, has a low relative explosive safety risk ranking based on the type and likelihood of MEC occurrence. The results of the qualitative explosive hazards exposure assessment indicated a low level of exposure risk in the WMA.

8.2.14.2 The ICs alternative was determined to be the most practicable permanent solution for the WMA based on the disproportionate cost analysis. The ICs at the WMA will include implementation of site-wide ICs as described in Section 8.4. These site-wide ICs will inform the public and the forestry workers about the past military history of the Camp Bonneville. The site-wide ICs will also aid in MEC recognition and the proper response and reporting procedures. The site-wide ICs will likely modify the timber worker and public behavior, resulting in a decrease in the potential for receptor interaction with potential MEC items. Implementation of these site-wide ICs will achieve the cleanup standard of negligible interaction with any MEC items at this site.

8.3 SITE-WIDE INSTITUTIONAL CONTROLS

8.3.1 Site-wide ICs consisting of land use controls and an education awareness program is recommended. The land use controls will consist of restrictive covenants to

ensure that the regional park remains a park, and the wildlife management area is only used for wildlife management and forestry/timber harvesting. These restrictive covenants will safeguard the public from conducting other actions or activities that may result in an increased level of explosive risk. The educational awareness program will consist of two components: a permit notification program and a printed media program. Permit notification will be conducted for utility connections, infrastructure construction, land surveying, timber logging, and related physical land disturbance tasks. The educational awareness program has several additional components. The printed media program will consist of brochures, newspaper articles, fact sheets, and information packages. An exhibit and display depicting the Camp Bonneville site history should be established as part of the proposed Clark College/Outdoor School in the RP. The cost to implement the recommended site-wide ICs is estimated at $250,000 and is summarized in Table 8.9 . The cost for the site-wide ICs includes both the initial capital costs and the ongoing implementation costs for a ten (10) year period

TABLE 8.9
COST ESTIMATE FOR SITE-WIDE INSTITUTIONAL CONTROLS

Item	Cost Basis	Total Costs
Public Education	LS	$100,000
Interpretive Center	LS	$50,000
Restrictive Covenants	LS	$20,000
Training	LS	$50,000
Miscellaneous	N/A	$30,000
	N/A	
	Total Cost Estimate*	**$250,000**

*Note: Costs are based on Parsons experience on similar projects.

8.4 SUMMARY OF RECOMMENDED CLEANUP ACTIONS BY SITE TYPE

8.4.1 Table 8.10 presents a summary of the recommended cleanup actions and their implementation costs for each of the site types at Camp Bonneville. The cost for implementing site-wide ICs is estimated at $250,000. The total estimated cost for implementing the recommended cleanup actions at Camp Bonneville including the site-wide ICs is $16,774,000. The cleanup actions and areas are shown in Figure 8.7.

TABLE 8.10
SUMMARY OF RECOMMENDED CLEANUP ACTIONS AND COSTS

Site Name	Recommended Cleanup Action	Cost
Target Areas	Frost Depth Clearance (14-inches) with Site-Specific ICs	$273,000
Central Impact Target Area	Site-Specific ICs	$124,000
Open Burn/Open Demolition Areas	Subsurface Clearance (4 feet) at Demolition Areas 2 and 3 in a 300-feet x 300-feet Grid; Surface Clearance near the Demolition Areas 1, 2, and 3 in a 500-feet x 500-feet Grid; and Site-Specific ICs	$150,000 $1,120,000
Firing Points	Froat Depth Clearance (14-inches) with Site-Specific ICs	$421,000
Training Areas (M203 Practice Range/ Mortar Practice Range)	Site-Specific ICs	$6,000
Range Safety Fans	Site-Wide ICs	N/A
Storage Magazines/Transfer Points (Building 2950)	Site-Specific ICs	$3,000
Maneuver Areas	Site-Wide ICs	N/A
Central Impact Area	Site-Specific ICs	$573,000
Roads and Trails	Frost Depth Clearance (14-inches) and Site-Specific ICs	$2,142,000
High Intensity Reuse Areas	Subsurface Clearance (4 feet) for Reuse Areas with Future Intrusive Activities; Frost Depth Clearance (14-inches) for the Reuse Areas with No Future Intrusive Activities; and Site-specific ICs	$2,264,000 $4,805,000
High Accessible – Medium Intensity Reuse Areas	Frost Depth Clearance (14-inches) with Site-Specific ICs	$4,643,000
Remaining Medium Reuse Intensity Areas	Site-Wide ICs	N/A
Wildlife Management Area	Site-Wide ICs	N/A
Site-Wide	Site-Wide ICs	$250,000

SECTION 9

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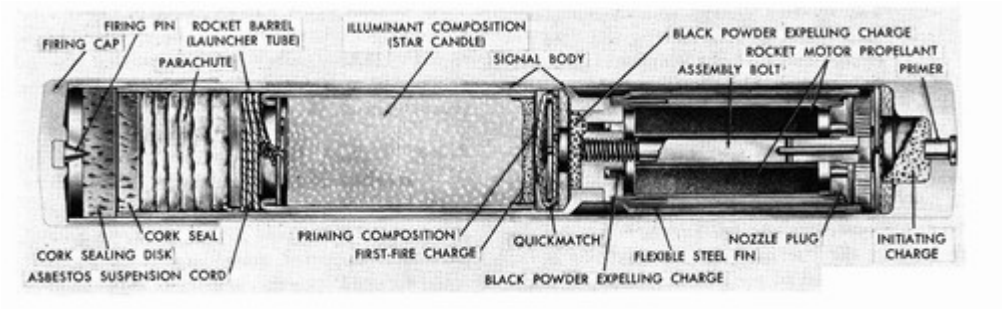
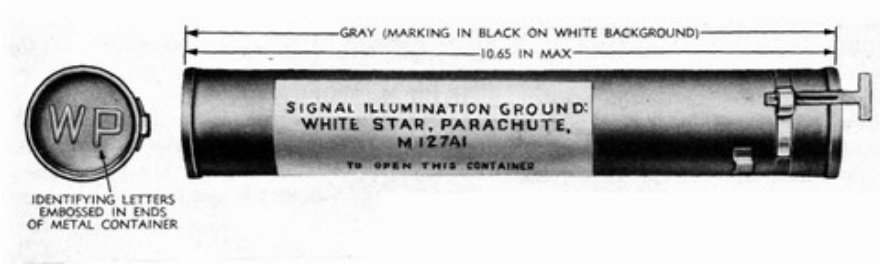
APPENDIX A
ORDNANCE ITEMS DESCRIPTION

Signal, Illumination, Parachute, M126 series





Description :

This signal is rocket propelled and fin stabilized. The expendable type launcher is integral with the signal and hence for firing does not require a grenade launcher attached to a rifle firing a special cartridge. It produces a white or red star.

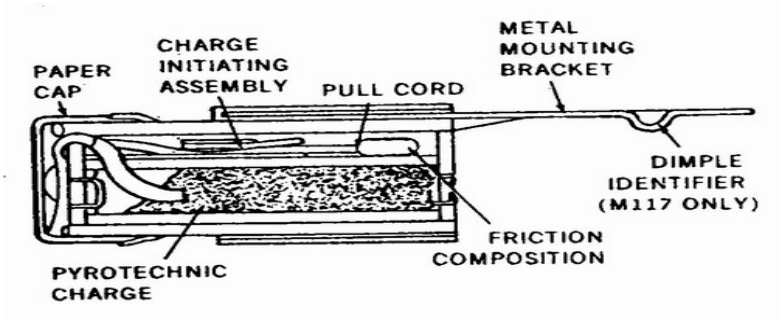
- Dimensions
  - Length - 244.86 mm
  - Diameter - 41.66 mm

Hazardous Components :

- Filler – Black powder

Source: **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**

Simulator; Flash M117, Illumination M118, Whistling M119



Description :
This pyrotechnic simulates an ambush. The simulator will illuminate, whistle, or produce a flash.
It has a white paper body with black markings.

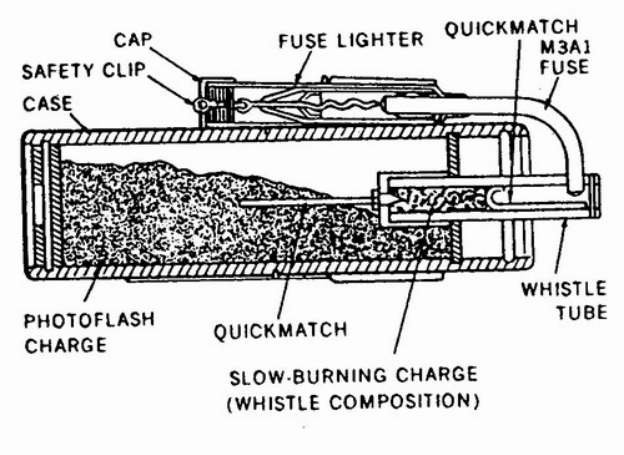
- Dimensions
  - Length - 99.00 mm
  - Diameter - 25.00 mm
  - Weight - 63.50 g

Hazardous Components :

- Filler – Pyrotechnic composition
- Filler weight – 2.55 g

Source: ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070

Simulator, Projectile, Ground Burst, M115A2



Description :

This a ground burst simulator that simulates a projectile impact. It produces a whistle and a loud report.

The old color code was a gray body with a white label and black markings. The new color code is a white body with black markings.

- Dimensions
    - Length - 181.00 mm
    - Diameter - 60.00 mm

Hazardous Components :

- Filler – Black powder
- Filler weight – 136.08 g

Source: **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**

Flare, Trip, M49A1

Description :

The flare has a grenade-shaped cylindrical body, with a nose fuze that protrudes 0.875-inch from the head end. A mounting bracket and a spring-loaded trigger mechanism are mounted on a metal base cap. The upper arm of the trigger is attached to a trip wire, and the lower arm of the trigger restrains the safety lever after the removal of the safety pin.

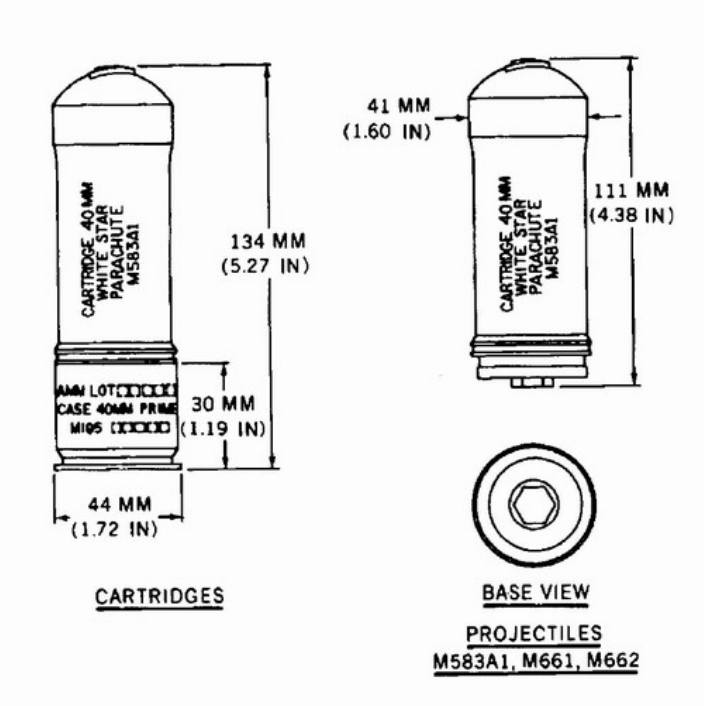
- Dimensions
    - Length - 96.52 mm
    - Diameter - 63.50 mm

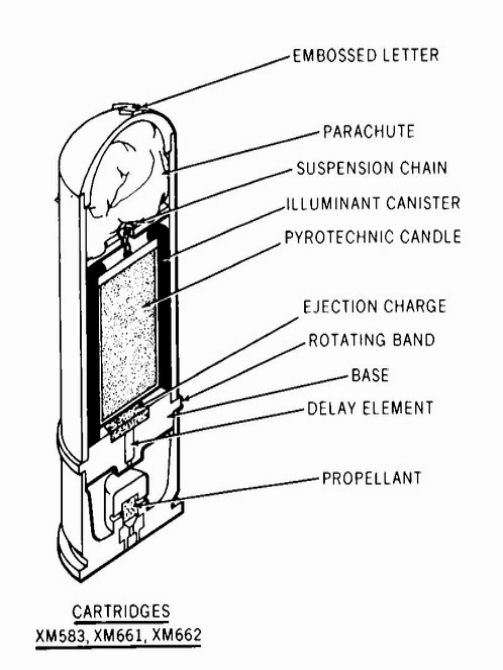
Hazardous Components :

- Filler – Pyrotechnic composition

Source: **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**

Simulator, Illumination, Parachute - XM583, M583A1, XM661, M661, XM662, M662





Description :

These are grenade-launcher-fired projectiles containing a nose-ejected, parachute-suspended pyrotechnic illuminating candle. Intensity ranges from 8,000 to 90,000 candlepower. The color of the burning pyrotechnic is as follows: XM583 and M583A1, white; XM661 and M661, green; XM662 and M662, red.

Simulator, Illumination, Parachute - XM583, M583A1, XM661, M661, XM662, M662 (Con't.)

The projectile body is painted white with identifying information stenciled on the side. The ogive is painted the color of the burning pyrotechnic, and is embossed with the raised letters W, G, or R, corresponding to the colors white, green, or red, respectively.

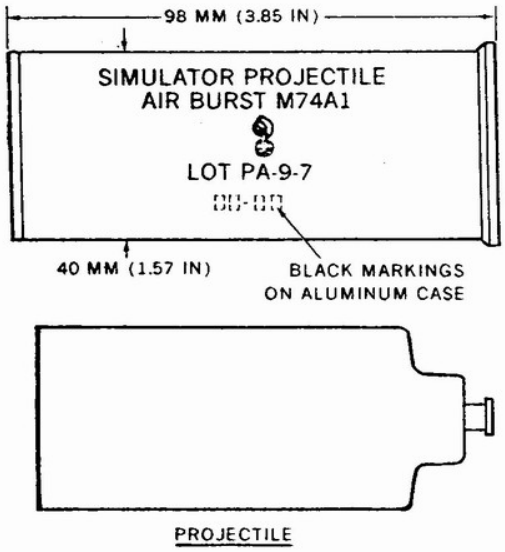
- Dimensions
    - Length - 111.00 mm
    - Diameter - 41.00 mm
    - Weight - 168.00 g

Hazardous Components :

- Filler – Illuminant Composition
- Filler weight – 93.00 g

Sources: ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1)
NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070

Simulator, Projectile, Airburst, M74A1



Description :

The figure shows the appearance and dimensions of the M74 and M74A1 simulator. The Flash and Sound Signal M74 is designed for simulation of air burst of artillery fire in training troops. It is fired from the Hand Projector M9 or the Pyrotechnic Pistol AN-M8. The signal consists of an outer case, an expelling charge, and an inner cylindrical case containing the delay fuze and bursting charge. The outer case resembles those of the aircraft double-star type.

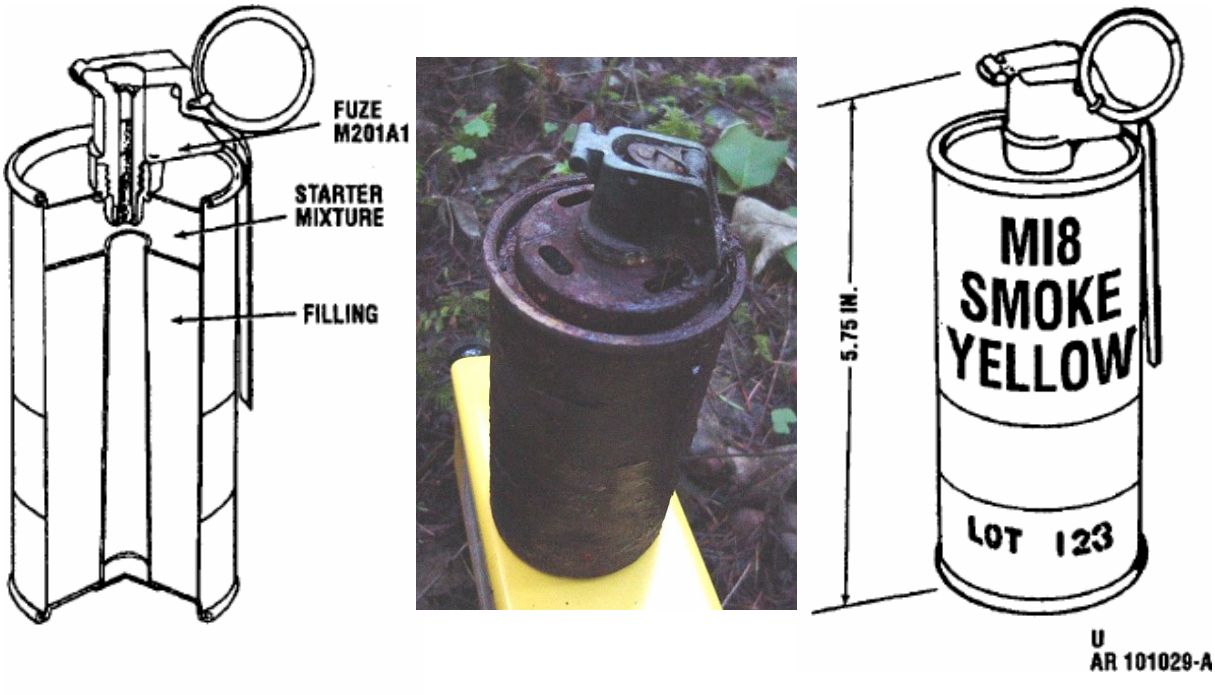
- Dimensions
    - Length - 98.00 mm
    - Diameter - 40.00 mm

Hazardous Components :

- Filler – Black powder
- Filler weight – 81.65 g

Source: **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**

Grenade, Hand, Smoke, M18



Use :
Hand Grenade M18 is used for ground-to-air or ground-to-ground signaling.

Description :
The grenades may be filled with any one of four smoke colors: red, green, yellow or violet. Each grenade will emit smoke for 50 to 90 seconds. The grenade body is constructed of thin sheet metal and is filled with red, green, yellow or violet smoke composition. The filler is topped with a starter mixture.

The hand grenade fuze M201A1 is a pyrotechnic delay-igniting fuze. The body contains a primer, first fire mixture, pyrotechnic delay column, and ignition mixture. Assembled to the body are a striker, striker spring, safety lever, and safety pin with pull ring. The split end of the safety pin has an angular spread.

Safety clips are not required with these grenades.

- Dimensions
  - Length - 5.75 inches
  - Diameter - 2.5 inches
- Weight
  - Complete - 1.19 lbs

Grenade, Hand, Smoke, M18 (Con't.)

Markings :
Light green with black markings. Fuze is gray or olive drab with black markings.

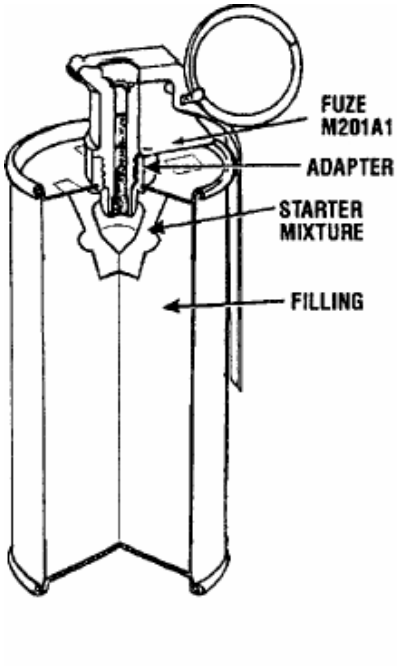
Operation :
Removal of the safety pin permits release of the safety lever. When the safety lever is released, it is forced away from the grenade body by a striker acting under the force of a striker spring. The striker rotates on its own axis and strikes the percussion primer. The primer initiates the first fire mixture. The fuze delay element, ignition mixture, and grenade starter mixture and filler are initiated in turn by the preceding component. The pressure sensitive tape is blown off the emission holes and the colored smoke emits from these holes.

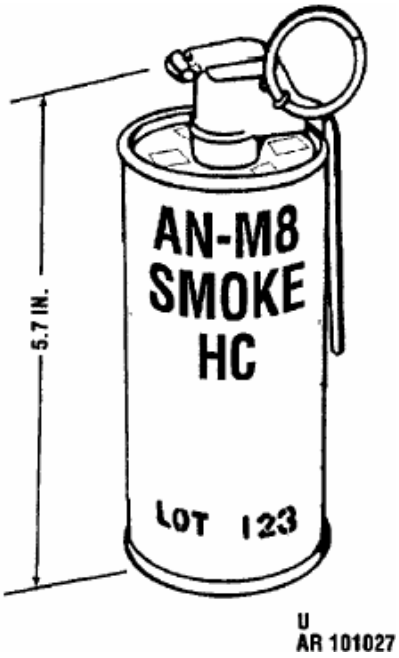
Hazardous Components :

- Filler - Smoke composition, 11.5 oz

Source: dudbusters.com (http://www.dudbusters.com/library/online.htm)

Grenade, Hand, Smoke, AN-M8





Use :
The HC Smoke Hand Grenade AN-M8 is a burning type grenade used to generate white smoke for screening activities of small units. It is also used for ground-to-air signaling.

Description :
The grenade body is a cylinder of thin sheet metal. It is filled with HC smoke mixture topped with a starter mixture directly under the fuze opening. The duration of smoke screen or signal is 105 to 150 seconds.

Hand grenade fuze M201A1 is a pyrotechnic delay igniting fuze. The body contains a primer, first-fire mixture, pyrotechnic delay column, and ignition mixture. Assembled to the body are a striker, striker spring, safety lever and safety pin with pull ring. The split end of the safety pin has an angular spread.

Safety clips are not required with these grenades.

- Dimensions
  - Length - 5.7 inches
  - Diameter - 2.5 inches
- Weight
  - Complete - 1.5 lbs

Grenade, Hand, Smoke, AN-M8 (Con't.)

Markings :
Light green with black markings. Safety lever is gray or olive drab with black markings.

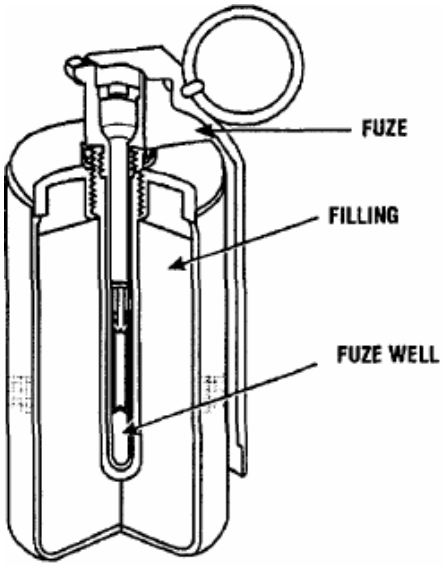
Operation :
Removal of the safety pin permits release of the safety lever. When the safety lever is released, it is forced away from the grenade body by a striker acting under the force of a striker spring. The striker rotates on its own axis and strikes the percussion primer. The primer initiates the first fire mixture. The fuze delay element, ignition mixture, and grenade starter mixture and filler are initiated in turn by the preceding component. The pressure sensitive tape is blown off the emission holes and smoke is emitted for 105 to 150 seconds.

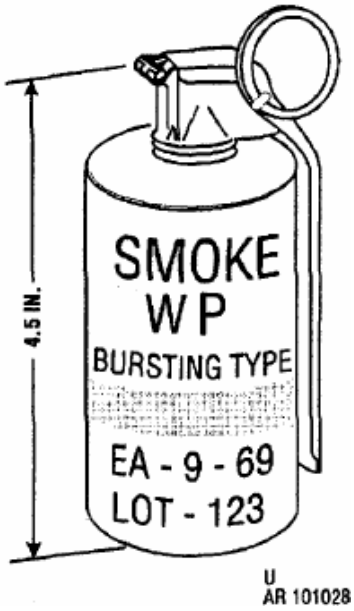
Hazardous Components :

- Filler - HC, 1.19 lbs

Source: dudbusters.com (http://www.dudbusters.com/library/online.htm)

Grenade, Hand, Smoke, WP, M15





Use :
WP smoke hand grenade M15 is a bursting type grenade used for signaling, screening and incendiary purposes.

Description :
The grenade body is of sheet steel and is cylindrical in shape. The body has a fuze well liner and is filled with WP.

The screening effect of the smoke is limited because WP burns with such intense heat, the smoke tends to rise rapidly. Pieces of WP will burn for about 60 seconds, igniting any flammable substance contacted. The hand grenade M206A1 and M206A2 pyrotechnic delay-detonating fuzes. They differ only body construction. The body contains a primer and pyrotechnic delay column. Assembled to the body are striker, striker spring, safety lever, safety pin with pull ring, and a detonator assembly. The split end of safety pin has an angular spread or a diamond crimp.

Safety clips are not required with these grenades.

- Dimensions
  - Length - 4.5 inches
  - Diameter - 2.37 inches
- Weights
  - Complete - 1.94 lbs

Grenade, Hand, Smoke, WP, M15 (Con't.)

Markings :
Gray with yellow band and yellow markings. The fuze is olive drab with black markings.

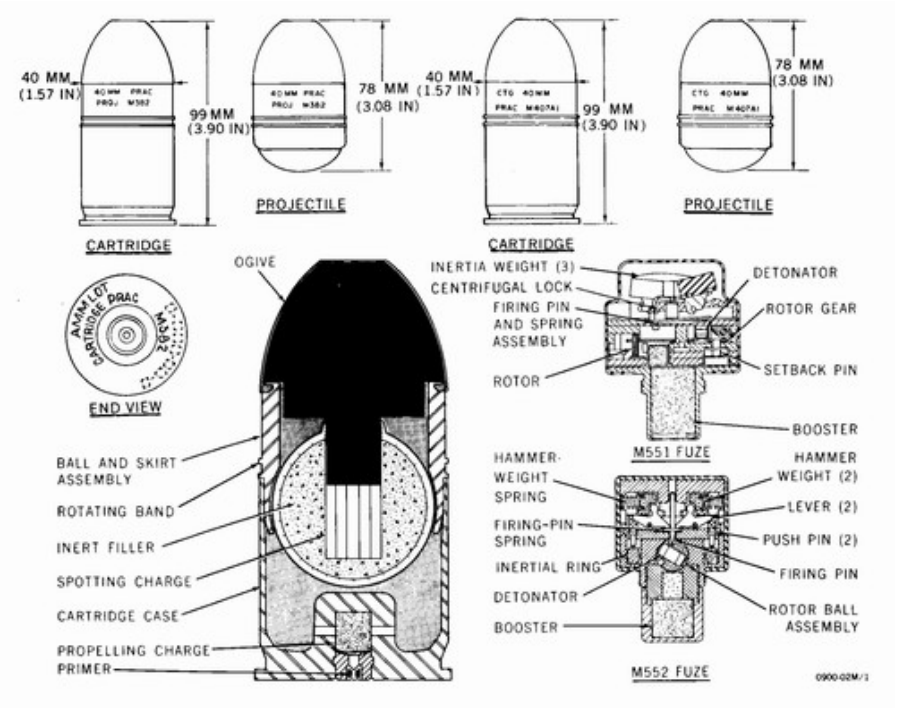
Operation :
Removal of the safety pin permits release of the safety lever. When safety lever is released, it is forced away from the grenade body by a striker acting under the force of a striker spring. The striker rotates on its axis and strikes the percussion primer. The primer emits small, intense spit of flame, igniting the delay element. The delay element burns for 4 to 5 seconds, then sets off the detonator. The detonator explodes rupturing the body and exposing the WP filler to air. The WP will burn approximately 60 seconds.

Hazardous Components :

- Filler - White Phosphorous, 15 oz.

Source: dudbusters.com (http://www.dudbusters.com/library/online.htm)

Projectile, 40mm, Practice, M382



Description :

These are practice rounds with smoke spotting charges. The fuzes are point-detonating (PD) and graze-sensitive. The M551 is setback and centrifugally armed; the M552 is centrifugally armed. Figure shows the appearance, dimensions, and general arrangement of the cartridges. The M382 uses the M552 fuze; the M407A1 uses the M551 fuze.

The M382 cartridge case and projectile are chemically finished to obtain an olive-drab color. The ogive is gray. Identification markings are yellow. The M407A1 cartridge case is olive drab; the projectile is blue. Markings are white.

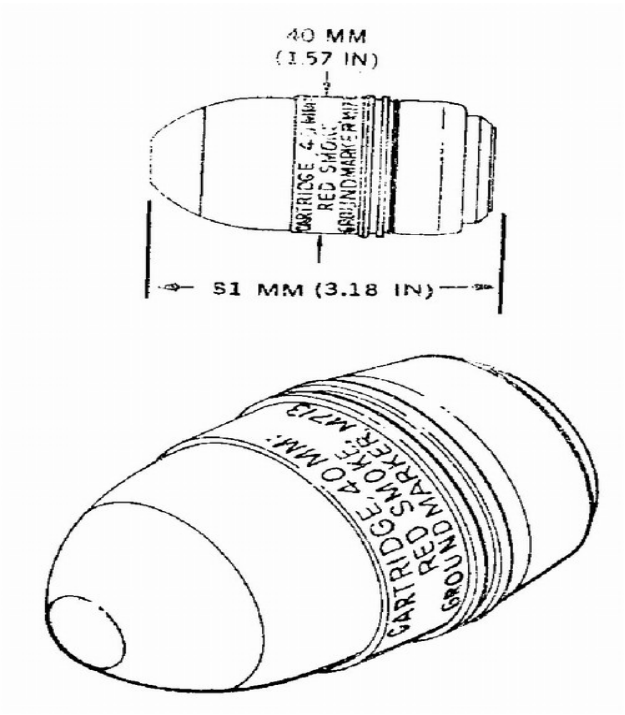
- Dimensions
    - Length – 78.00 mm
    - Diameter – 40.00mm
    - Weight – 227.00g

Hazardous Components :

- Filler – RDX
- Filler weight – 6.00 g

Source: **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**

Projectile, 40mm, Practice, M716



Description :
These spin stabilized projectiles are fired from 40-MM Grenade launchers. They are used to mark troop locations on the ground by emitting colored smoke.

The projectiles are light green with black markings.

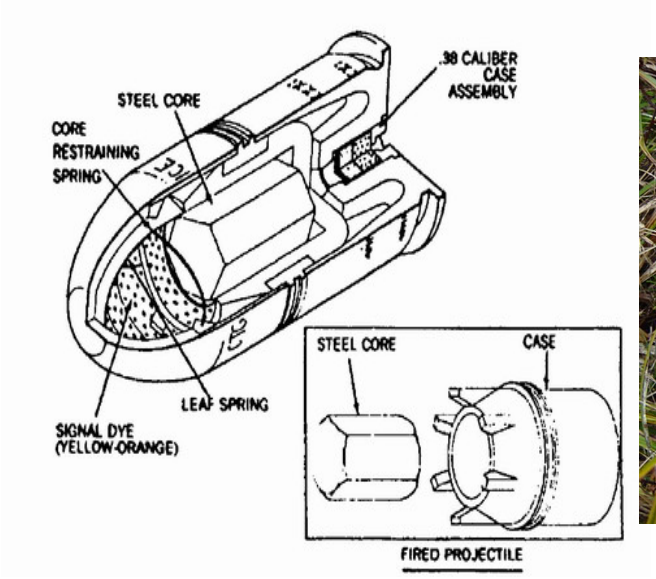
- Dimensions
  - Length – 81.00 mm
  - Diameter – 40.00mm
  - Weight – 222.26 g

Hazardous Components :

- Filler – Smoke Mix, Colored
- Filler weight – 75.00 g

Source: ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070

Projectile, 40mm, Practice, M781



Description :
This is a spin stabilized, target practice projectile fired from 40-MM Grenade Launchers. The projectile contains an orange, powdered dye which is dispersed on impact.

The projectile is blue plastic with white markings.

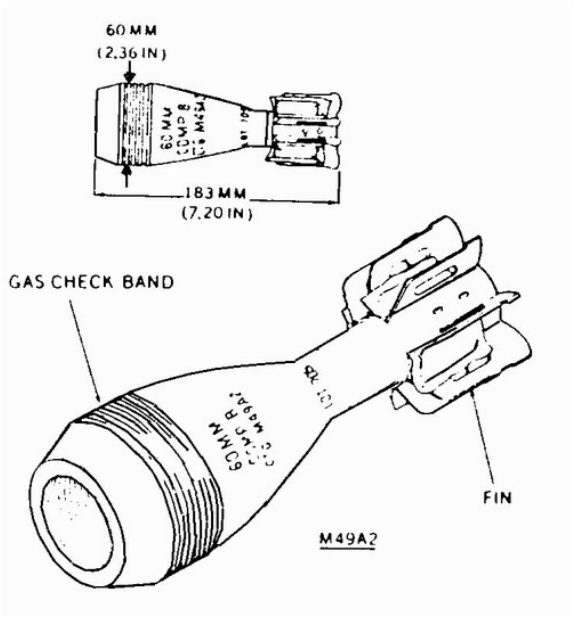
- Dimensions
    - Length – 103mm
    - Diameter – 40.00mm
    - Weight – 205.00 g

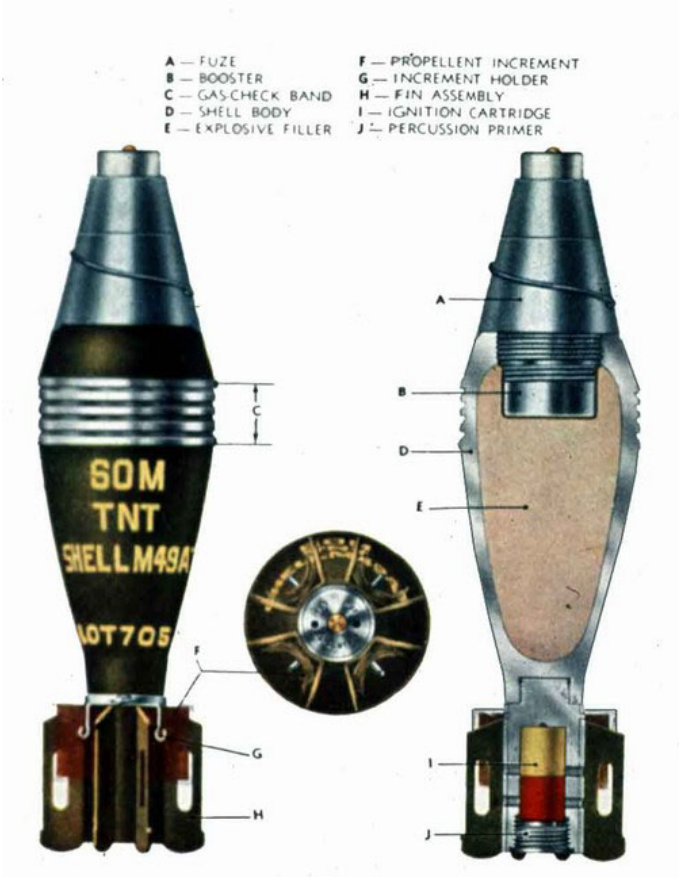
Hazardous Components :

- Filler – None

Source: **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**

Mortar, 60 mm, HE, M49A2





Description :

These are fin stabilized, mortar fired, high explosive projectiles.
The projectiles are painted olive drab with yellow identification markings.

- Dimensions
  - Length – 183.00 mm
  - Diameter – 60.00 mm
  - Weight – 1.41 kg

Hazardous Components :

- Explosive Filler – Composition B, 190.00 g

Source: **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1)**
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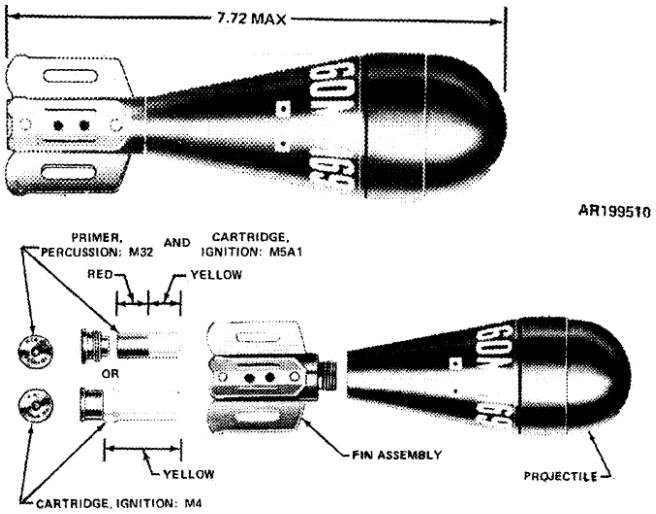
Mortar, 60 mm, Training, M69



Use :
This cartridge is used for training in the loading and firing of 60mm mortars M2 and M19.

Description :
Unlike other mortar ammunition, the components of this round are issued separately. This facilitates replacement of damaged, worn, or expended parts. The complete round consists of an inert projectile, a fin assembly, an ignition cartridge, and a percussion primer. The pear-shaped, cast iron projectile has no provision for a fuze and is internally threaded at the base to accept the fin assembly.

- Dimensions
  - Length, complete - 7.72 inches
- Weights
  - Complete - 4.43 lbs

Markings :
Black or blue with white markings.

Operation :
When the cartridge is loaded, it slides down the mortar tube until the percussion primer in the ignition cartridge strikes the firing pin in the base cap of the mortar. The primer detonates the ignition cartridge. Since this round is fired only at Charge 0, the gases from the ignition cartridge expel the projectile from the mortar tube and propel it to the target. The projectile is fin-stabilized in flight. Since the cartridge is inert, there is no detonation upon impact and the cartridge may be recovered for reuse.

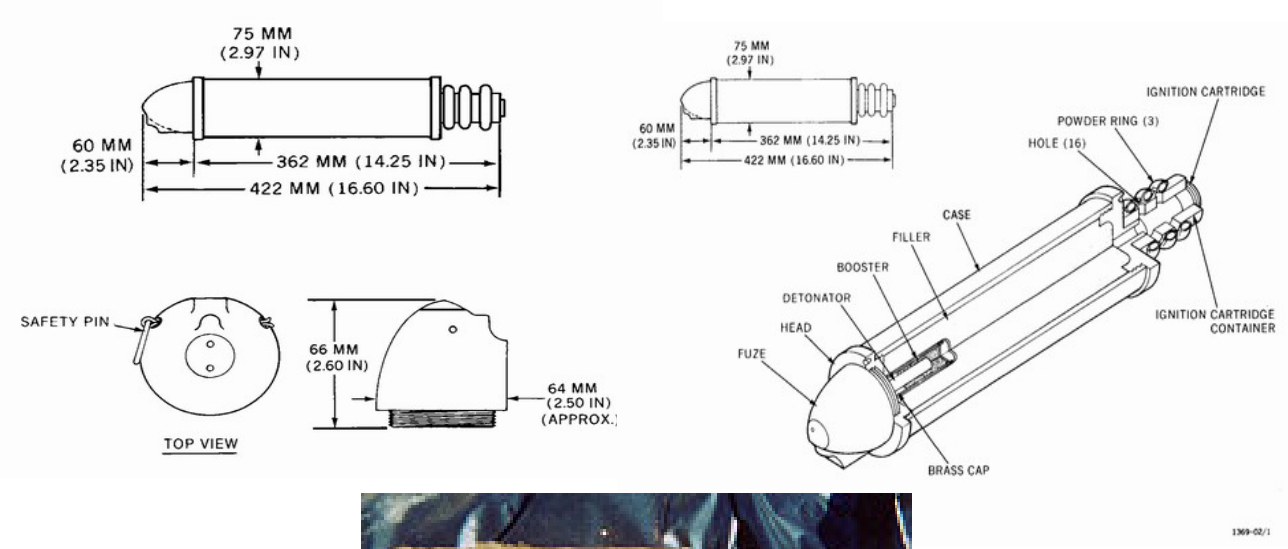
Mortar, 60 mm Training, M69 (Con't.)

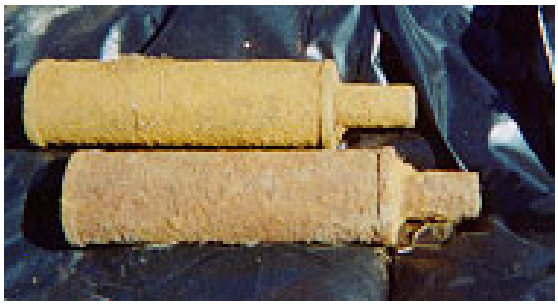
Hazardous Components :

- Ignition cartridge - M4, M5A1
- Propellant - None
- Primer - M32

Sources: (1) **dudbusters.com (http://www.dudbusters.com/library/online.htm)**
(2) **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**

Mortar, 3 inch Practice, Mk I (Stokes)





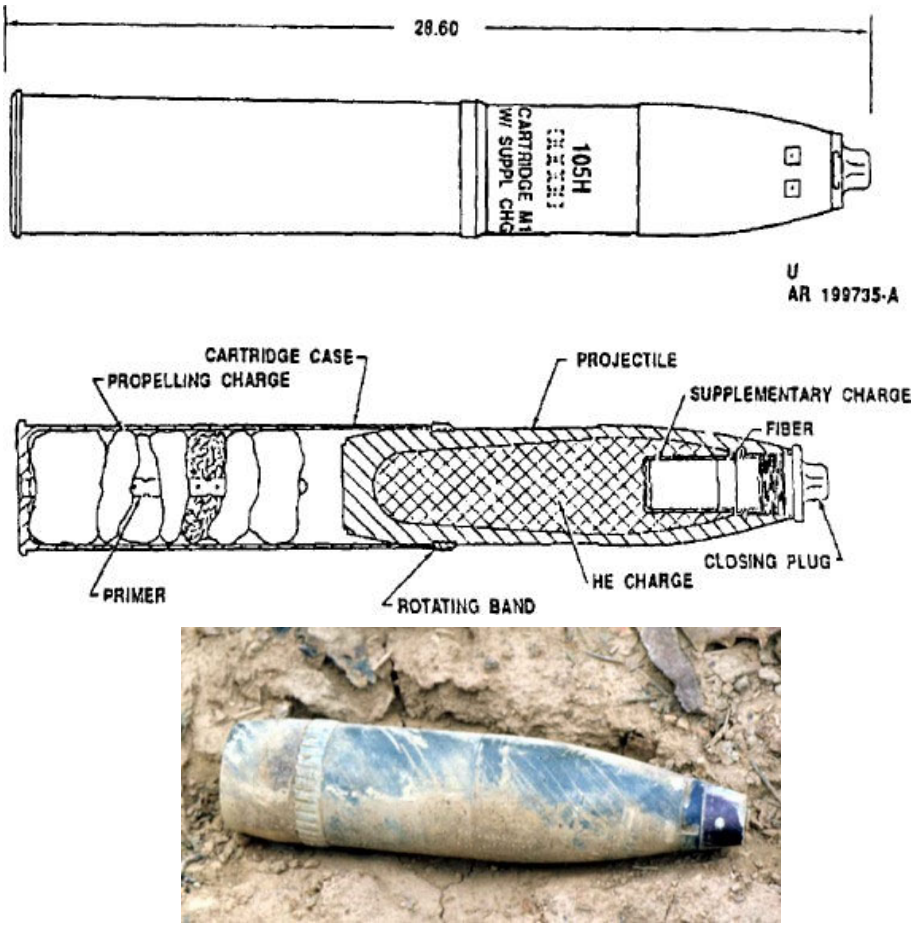
Description :*
The Stokes is a mortar-fired practice cartridge. They use a Mk VI fuze, which is a setback-armed, impact-inertia fired, all-way fuze.

The heads of all cases are stamped with the name and mark number of the case, lot number of unfilled cases, inspectors stamp, and initials or symbol of manufacturer of metal parts. The cases are stenciled to show the caliber and type, mark number, filler, lot number, and the date and place loaded. The ignition cartridge has a green case with a brass base, the bottom of which is stamped with its mark number and the manufacturer's initials or symbol. The fuze is painted black and stamped with the manufacturer's initials or symbol of the loading plant, and month and year of loading.

- Dimensions
    - Length – 362.00 mm
    - Diameter – 75.00 mm
    - Weight – 5.7 kg

***Source: ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**

Projectile, 105 mm HE, M1



Use :
The projectile contains high explosive and is used for fragmentation, blast, and mining in support of ground troops and armored columns.

Description :
The projectile consists of a hollow steel forging with a boat tail base, a streamlined ogive, and gilding metal rotating band. A base cover is welded to the base of the projectile for added protection against the entrance of hot gases from the propelling charge during firing. The high explosive (HE) filler within the projectile may be either cast TNT or Composition B. A fuze cavity is either drilled or formed in the filler at the nose end of the projectile. This cavity may be either shallow or deep. A cavity liner, to preclude dusting of HE during transportation and handling, is seated in the cavity and expanded into the lower projectile fuze threads. A supplementary charge is placed in the fuze cavity of projectiles having deep cavities. Projectiles with shallow cavities or deep cavities containing a supplementary charge use only short intrusion fuzes, PD, or MT. Those with deep cavities will accept the long intrusion proximity fuze after removing the supplementary charge. Projectiles may be shipped with a PD or MTSQ fuze or with a closing plug. When shipped with a closing plug, a chip board spacer is assembled

Projectile, 105 mm HE, M1 (Con't.)

between the supplementary charge and plug to limit movement of the former during transportation and handling.

The cartridge case contains a percussion primer assembly and seven individually bagged and numbered propelling charge increments. The base of the cartridge case is drilled and the primer assembly is pressed into the base. The percussion primer assembly consists of a percussion ignition element and a perforated flash tube containing black powder. The seven numbered increment bags are tied together, in numerical order, with acrylic cord. These are assembled into the cartridge case, around the primer flash tube, with Increment 1 at the base of the cartridge case and Increment 7 toward the mouth of the cartridge case.

- Dimensions
  - Length, with closing plug - 28.6 inches, 726.44 mm
- Weights
  - Complete - 39.92 lbs, 18.15 kg

Markings :

Olive drab with yellow markings.

Operation :

If the projectile is unfuzed, the closing plug is removed and a fuze assembled to the projectile prior to adjusting the charge and loading the cartridge into the weapon. Impact of the weapon firing pin results in the initiation of the percussion primer which, in turn, ignites the black powder in the flash tube. The flash tube provides for uniform ignition of the propelling charge producing a rapid expansion of the propellant gas which propels the projectile out of the weapon tube. Engagement of the projectile rotating band with the rifling of the weapon tube imparts spin to the projectile providing inflight stability. Projectile functioning is dependent upon the fuze used and may function on impact (instantaneous or delay), function above ground either at a predetermined height based upon time of flight or function in proximity with the target area. Fuze function detonates the HE projectile filler resulting in projectile fragmentation and blast.

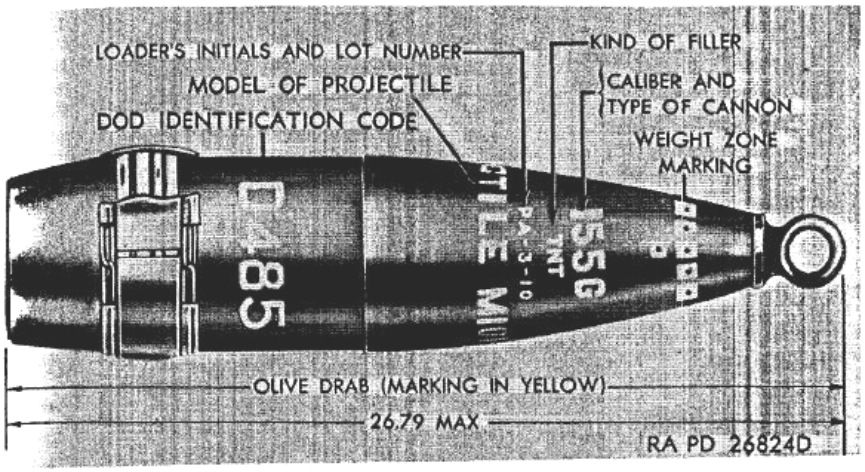
Hazardous Components :

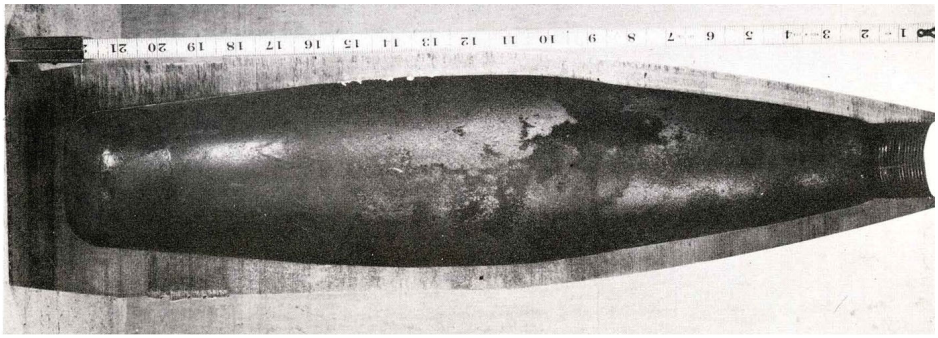
- Fillers
  - Composition B
    - Deep cavity - 5.08 lbs, 2.31 kg
    - Normal cavity - 4.60 lbs, 2.09 kg
  - TNT
    - Deep cavity - 4.80 lbs, 2.18 kg
    - Normal cavity - 4.25 lbs, 1.93 kg
- Cartridge case - M14 Brass, M14B1, M14B3, M14B4 Steel
- Propellant - M1, 2.83 lbs, 1.29 kg
- Primer - M28A2, M28B2
-

Sources: (1) **dudbusters.com (http://www.dudbusters.com/library/online.htm)**

(2) **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**

Projectile, 155 mm HE, M101





Use :
This is an Army, spin stabilized, gun fired, high explosive (HE) projectile.

Description :
The projectile is painted olive drab with yellow markings.

- Dimensions
  - Length - 605.00 mm
- Weights
  - Complete - 44.00 kg

Markings :

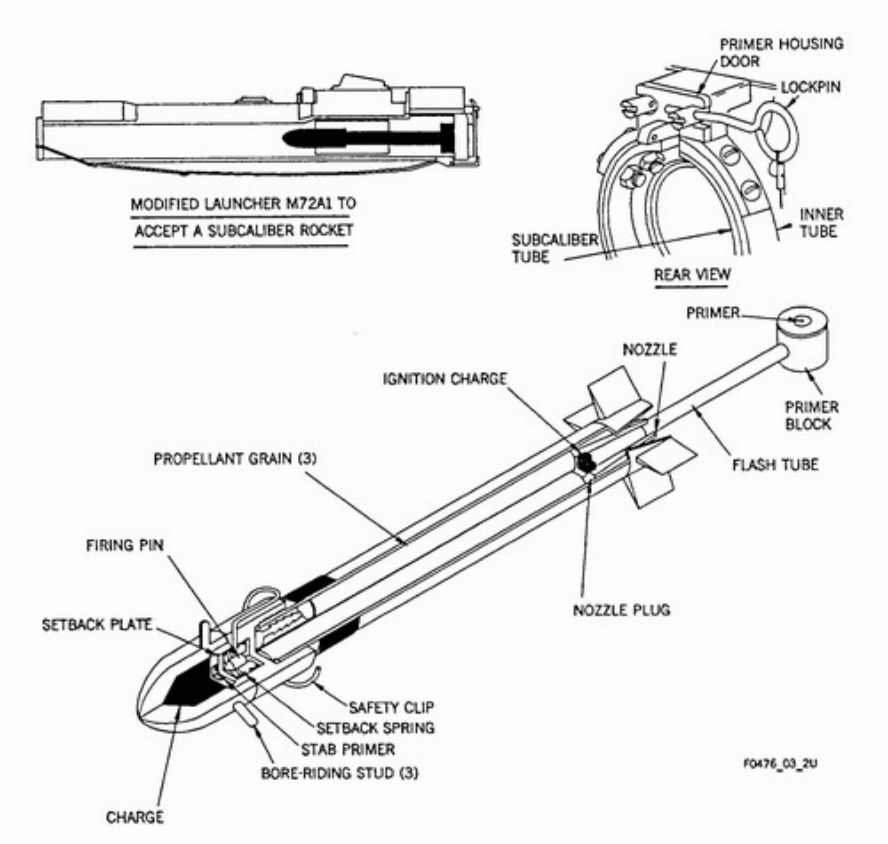
Yellow

Hazardous Components:

Filler - TNT

Source: ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070

Rocket, 35 mm Subcaliber, Practice, M73



(1)

Use :[(2)]

To train personnel in the operation and use of the 66 mm antitank rocket, M72 series.

Description :

The M190 subcaliber launcher with M73 subcaliber rocket can be used against all solid stationary or moving targets.

The M190 subcaliber launcher is a tubular, telescoping, smooth-bore, open breech weapon.

The M73 subcaliber rocket consists of a spotting head, a motor closure, a rocket motor and an igniter assembly. The spotting head contains the same flash composition used in the M80 explosive simulator to assist in locating the fired rocket. The forward end of the motor closure provides a cavity that contains a base detonating fuze and a primer. The motor case contains tubular grains or propellant. The rocket is stabilized by six molded, plastic fins.

Rocket, 35 mm Subcaliber, Practice, M73 (Con't.)

- Dimensions
  - Rocket
    - Length – 8.87 inches
    - Weight - 0.32 lbs
    - Diameter - 1.37 inches

Markings :
Black color.

Operation :
Extending the launcher into the extended or firing position automatically locks the weapon. After the trigger safety handle is released, the trigger can be depressed. This releases the channel assembly which drives the firing pin into the primer of the rocket motor igniter. This ignites the black powder in the flash tube, which, in turn, ignites the integral igniter of the rocket motor. The igniter initiates the propellant. The burning propellant propels the rocket from the launcher. When the spotting head of the rocket strikes a target, an inertia driven firing pin sets off the primer. The primer in turn sets off the spotting head which produces a flash, noise and white smoke.

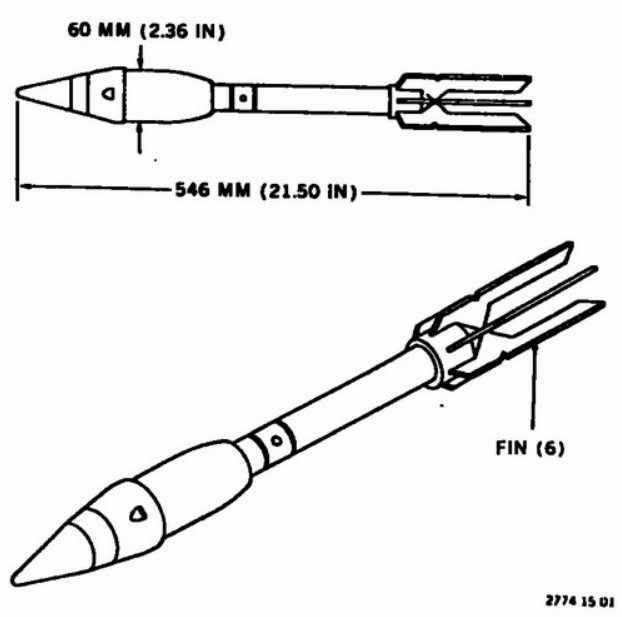
Hazardous Components :

- Primer - M26
- Propellant - M7, 0.02 lbs
- Filler - Flash composition, 0.05 oz

Differences Between Models :
The external appearance of the M190 subcaliber is almost identical to the M72A1. The M190 differs from the tactical launcher M72A1 by having a subcaliber rocket and a quick release primer housing door to simplify reloading. The used M72A1 launcher is modified by use of a conversion kit to produce the M190 subcaliber launcher.

Sources: (1) **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**
(2) **dudbusters.com (http://www.dudbusters.com/library/online.htm)**

Rocket, 2.36 inch Practice, M7



Use :
Target practice.

Description :
This rocket is similar in shape, size, and weight to the high explosive type. However, it is provided with only a propellant charge, the head being inert. No fuze is provided. The end of the stabilizer tube is extended to counter-weight the head and make the ballistics of this rocket similar to that of the HE type. A safety passes through the stabilizer tube at the upper end and in order to make the detail of firing this rocket similar to that necessary in the above HE type. Since there is no fuze, it naturally serves no useful function. In all other respects the rocket is similar to the HE type.

Markings :
Black with white markings.

Hazardous Components :

- Igniter - Black powder
- Propellant - Ballistite, 5 sticks (61.5 grams)

Sources: (1) **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**
(2) **dudbusters.com (http://www.dudbusters.com/library/online.htm)**

Rocket, 2.36 inch HEAT, M6A1

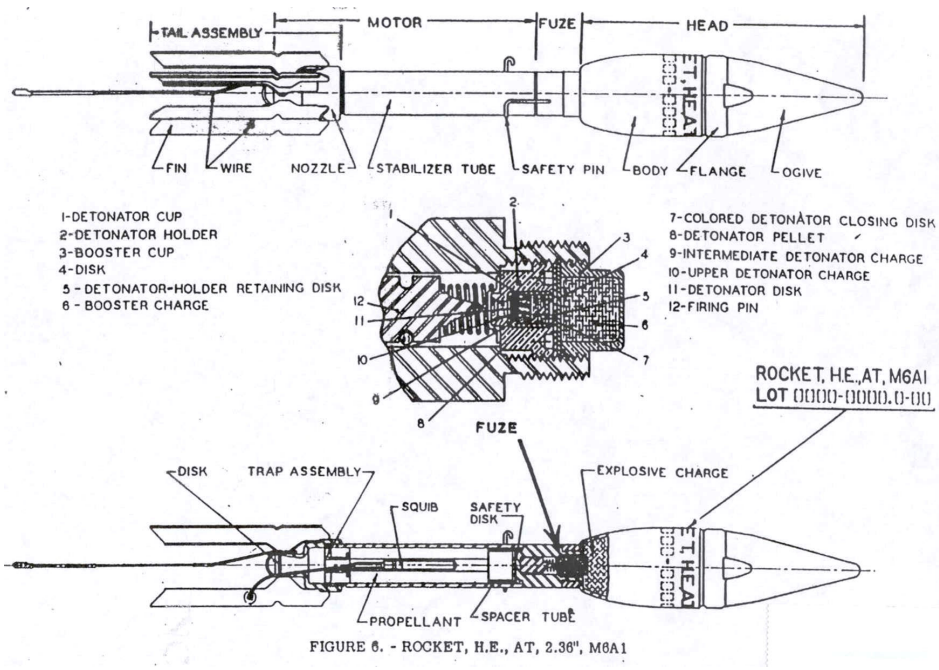


FIGURE 6. - ROCKET, H.E., AT, 2.36", M6A1

Use :
Pill boxes, tanks, and armored vehicles are prime targets. The rocket can also be used in a stationary emplacement for demolition or as an antitank mine or booby trap. The rocket can penetrate three inches of homogeneous steel armor plate at all ranges and at angles of impact as low as 30 degrees, employing the shaped charge explosive.

Description :
The M6 rocket consists of three principal parts: the high explosive head, the stabilizer tube, and the fin assembly.

The head consists of metal parts which are similar in function to the parts of the AT grenade head. These parts are the ogive and the body. The bursting charge is similar, both in that it is a "hollow" or a "shaped charge," and also in its composition which is mainly 50/50 pentolite with a 10/90 pentolite booster surround. The stabilizer tube consists of two principal parts: the fuze body, which threads into the union and contains the fuze mechanism, and the powder tube to which the fuze body is permanently joined, and which contains the propellant charge.

Rocket, 2.36 inch HEAT, M6A1 (Con't.)

The fuze is similar in all its components to that of the AT grenade. It is, however, of heavier construction, as is the entire rocket, and contains heavier booster and detonator charges. The parts of the fuze are a spring restrained striker; a detonator of priming mixture, lead azide, and tetryl; and a booster of tetryl. The striker is held in the unarmed position prior to loading into the launcher, by a safety pin which engages an annular groove in the striker as it passes through opposed holes in the fuze body. The safety pin clips to the stabilizer tube and must be removed prior to firing of the rocket.

The power tube or remainder of the stabilizer tube in this case serves as a housing for the propellant powder and an electric safety match or squib. The electric safety match with an igniting charge of black powder is located at the upper end of the powder tube. Two contact wires pass down through the powder tube and out through the nozzle portion of the fin assembly. The fin assembly consists of three parts: the nozzle, which is a venturi tube; the trap, which is a spider ring closing the nozzle opening above the venturi and holding the propellant powder in place; and finally, the fins themselves.

- Dimensions
    - Length, complete - 21.5 inches
    - Length, head - 8.6 inches
    - Length, body - 4.11 inches
    - Length, ogive
        - M6A1 (cone shaped) - 4.5 inches
        - M6A3 (hemispherical) - 4.56 inches
    - Length, motor tube - 6.32 inches
    - Diameter, body - 2.23 inches
    - Diameter, ogive - 2.25 inches
- Weights
    - Complete - 3.5 lbs

Markings :
Olive drab with yellow markings.

Operation :
The safety pin is removed and the rocket inserted into the rear opening of the launcher. It is held in place by a safety catch. Firing is accomplished by establishing an electric circuit between rocket and launcher. This causes ignition of the electric safety match, the black powder ignites, and the propellant powder gases issue through the nozzle, the venturi serving to increase their velocity. This back blast serves to propel the rocket forward. There is no recoil and back blast should not affect the firer since the powder is designed to be completely burned within the launcher.

Rocket, 2.36 inch HEAT, M6A1 (Con't.)

On impact with the target the striker, due to inertia, drives forward overcoming its restraining spring. It strikes and causes detonation of a detonator of priming mixture, lead azide, and tetryl, which in turn carries detonation of a tetryl booster, a 10/90 pentolite booster surround, and a 50/50 pentolite bursting charge.

Hazardous Components :

- Igniter - Black powder
- Propellant - Ballistite, 5 sticks (61.5 grams)
- Filler - 50/50 Pentolite with 10/90 Pentolite surround, 0.5 lbs

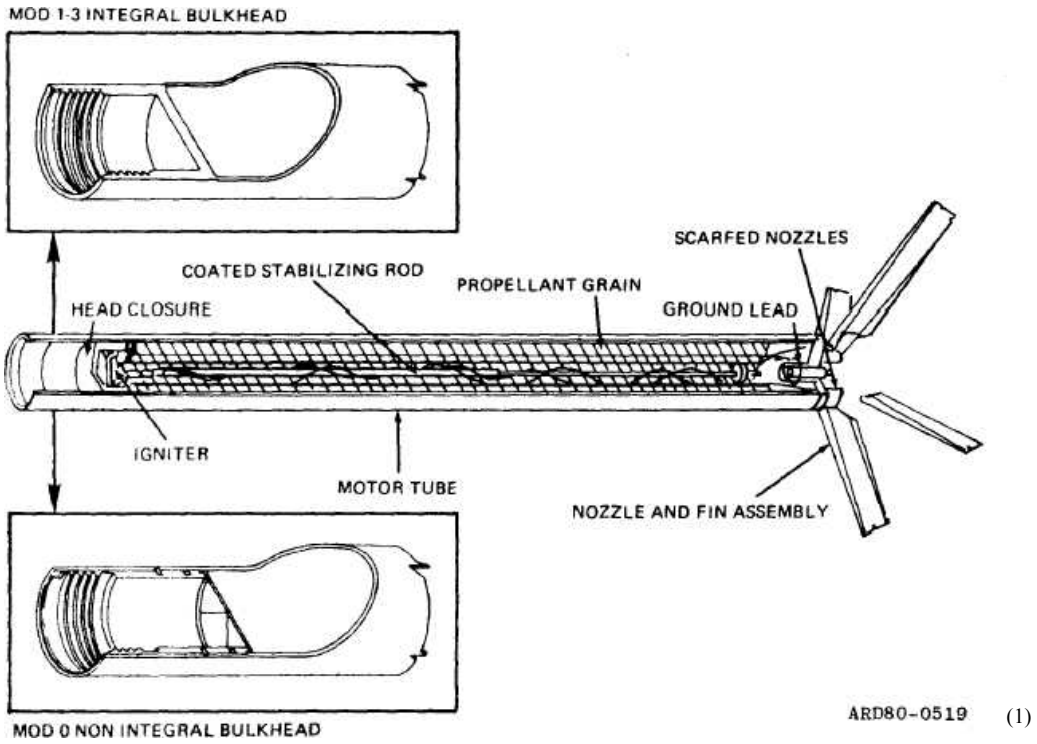
Possible Fuzes :
Fuze, Rocket, BD, M400

Fuze, Rocket, BD, M401

Differences Between Models :
The 2.36 inch A/T Rockets M6A1 and M6A3 are identical except for difference in the ogive and the tail assembly. In other respects the two rockets are similar, consisting of a hollow ogive crimped onto the body, a body union fitting into the base of the body with internal threads to receive the motor, and a fuze which is located in the forward end of the motor tube. The M6A1 has a conical ogive, whereas the M6A3 has a hemispherical ogive which gives better penetration by forming a stronger stand-off piece for the shaped-charge effect of the explosive. M6A4 is like the M6A3, except that it is lighter -- being made of high-strength alloys -- and also uses the Bore Safe Fuze M400. The M6A5 uses the Bore Safe Fuze M401 and has a larger propellant grain, which eliminates the safety disk.

Source: ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070

Rocket Motor, 2.75 inch, Mk 40



(1)

Use :[2]
The figure shows the appearance and dimensions of the Mks 1, 2, 3, 4; Mk 40 Mods 3, 10, & 13; and the SR 105-AJ-1 rocket motors. The appearance and dimensions of the rocket motors are essentially the same except that the Mk 40 employs scarfed (beveled) nozzles instead of straight nozzles. The Mk 40 Mods 3, 10, & 13 are low-spin, folding fin aircraft rockets. The Mks 1, 2, 3, 4 and SR-105-AJ-1 rocket motors are folding-fin, aircraft rockets. The Mk 40 Mods 3, 10, & 13 are electrically initiated, spin and fin-stabilized, solid-propellant rocket motors; the Mks 1, 2, 3, & 4, and the SR 105-AJ-1 are fin-stabilized, solid-propellant rocket motors. The Mks 1, 2, 3, 4; the Mk 40 Mods 3, 10, & 13; and the SR 105-AJ-1 rocket motors weigh approximately 11 and 13 pounds (5 and 6 kilograms), respectively, before firing and approximately 5 pounds (2 kilograms) after firing.

Rocket Motor, 2.75 inch, Mk 40 (Con't.)

- Dimensions
  - Length, overall - 39.9 inches
  - Length, without fins - 31.8 inches
  - Diameter - 2.75 inches
- Weights
  - Complete - 13.2 lbs

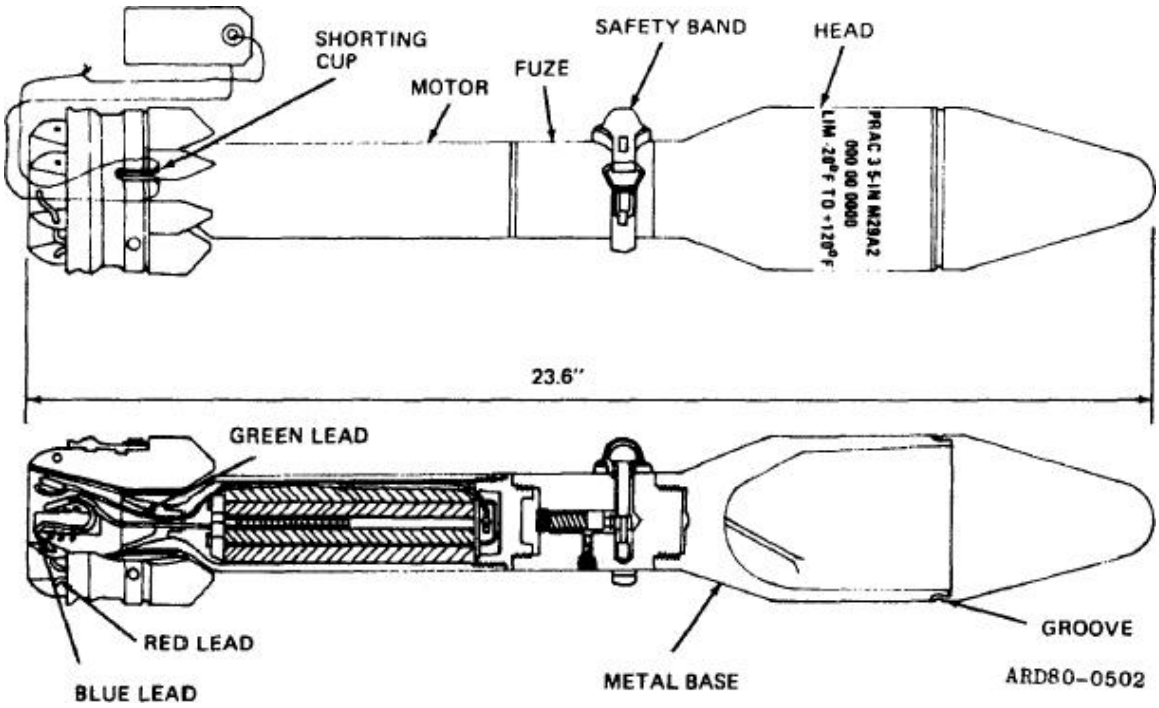
Markings :
White body, brown band, black markings.

Hazardous Components :

- Propellant grain - Double base, 7.99 lbs

Sources: (1) **dudbusters.com (http://www.dudbusters.com/library/online.htm)**
(2) **ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070**

Rocket, 3.5 inch Practice, M29A2



Use :
For training personnel in use, care and handling of service rockets.

Description :
The warhead is completely inert. The practice rockets can be fired at buttoned up, modified target tanks without danger to tank crews. The practice rockets have the same flight characteristics as the HEAT rocket.

Rocket, 3.5 inch Practice, M29A2 (Con't.)

The dummy fuze rocket M405 which series as a coupling for the warhead and motor, is cylindrical. It is threaded externally at the forward end to fit into the warhead assembly, and internally at the rear end to receive the motor assembly. A safety band fits around the seals and fuze. This fuze incorporates a double locking, bore riding, round ejection pin assembly simulating that used in base detonating (BD) fuze M404A2. The body of the fuze and the safety band are painted blue.

The motor assembly consists of a tube which houses the propellant and igniter. The fin assembly is securely attached to this tube. The front end of the tube is assembled to the base of the fuze. The rear end forms a nozzle. The cylindrical motor cavity is divided into four sections by two spacer plates which support the grains of propellant powder.

Each grain of propellant is 5" long and approximately 3/8" in diameter. Three grains are placed in each of the four sections formed by the spacer plates. Each lot of propellant is adjusted at the time of manufacture to give standard velocity. The igniter ignites the propellant.

The igniter consists of a short, cylindrical plastic case containing a small black powder charge and an electrical squib. It is assembled in the forward end of the motor on top of the propellant spacer plates. The leads of the electrical squib, running parallel to the grains of propellant, pass from the igniter through the nozzle into the expansion cone. A green lead (ground) wire is connected to the aluminum support ring of the contact ring assembly. A red lead (positive) wire is attached to a pin which is insulated from the support ring, but is in contact with the copper contact band. These connections are positioned 180° apart. Blue lead is used for test purpose only.

The fin assembly consists of six aluminum alloy fins and a contact ring assembly. The contact ring assembly, which encircles the fins, consists of three rings. An aluminum support ring, which is innermost, is separated from the copper contact ring by a plastic insulating ring. The fins are spot welded to the expansion cone; the expansion cone is press fitted to the rear of the motor tube.

- Dimensions*
  - Rocket
    - Length - 23.6 inches
    - Diameter - 3.5 inches
    - Weight - 9 lbs
  - Warhead
    - Length - 10.5 inches
    - Diameter - 3.5 inches
    - Weight - 4.47 lbs
  - Motor
    - Length - 10.41
    - Weight - 3.3 lbs

Rocket, 3.5 inch Practice, M29A2 (Con't.)

Markings :
Blue with white markings.

Hazardous Components :

- Propellant Initiating Train
  - Igniter - M20A1 (black powder, +/- 3.5 grams)
  - Squib - M2 electric
  - Propellant - M7, 0.44 lbs

Possible Fuzes :
Fuze, Rocket, Dummy, M405

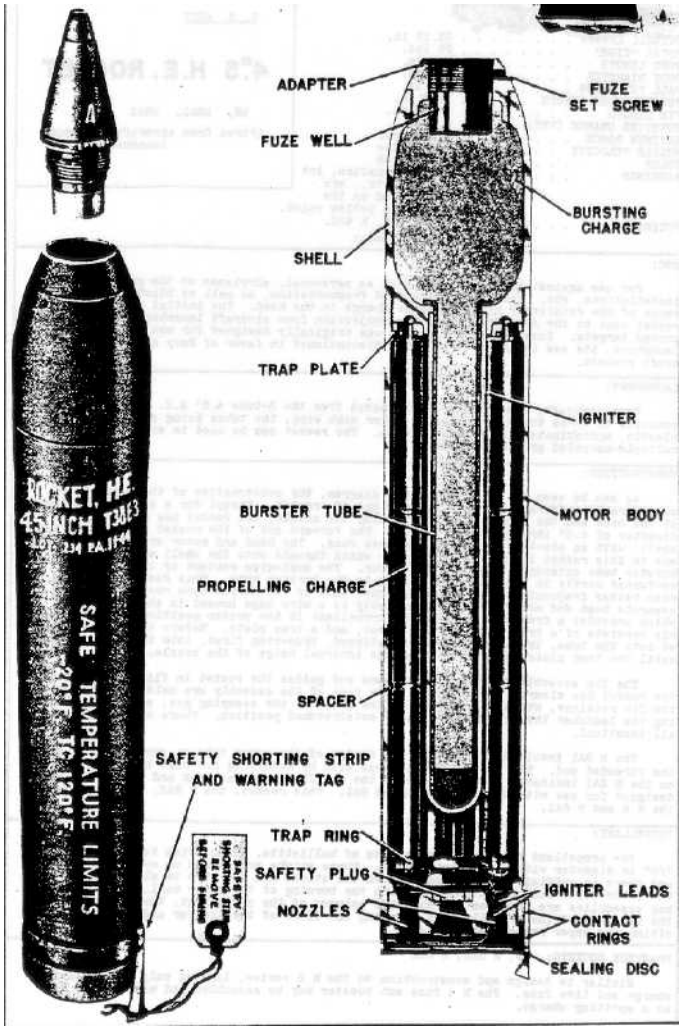
Differences Between Models :
The M29A1 and M29A2 rockets are similar in appearance to the M28A2. The M29 series differ in that they have a crimping groove at the juncture of the warhead body and ogive. The rockets of an early manufacture are assembled with M28A2 rocket warhead metal parts inert loaded with plaster of paris.

The M29A1 warhead differs from the M29A2 warhead in the head and trap and spacer assembly. The ogive is attached to the head body of four screws staked to the ogive. Some rockets may have the cast trap and square spacer blades.

The warhead being inert, no functions occur when the rocket is fired. The rocket is strictly for training purpose.

***Source: dudbusters.com (http://www.dudbusters.com/library/online.htm)**

Rocket, 4.5 inch HE, M16



Use :
The M16 is a spin stabilized rocket similar to the 4.5" M8 rocket.

Description :
The head, loaded with high explosives, contains a fuze well and buster tube. The burster tube projects about 15 inches into the center of the rocket motor to secure additional fragmentation. The motor body is a steel tube threaded at each end to receive the head and the nozzle plate, which contains eight nozzles equally spaced in a circle and one nozzle in the center. The eight nozzles are set at an angle in order to impart rotation to the round when fired. The center nozzle is normally closed by a blow-out disc which is designed to fail when the internal pressure in the body surpasses a predetermined limit. the nozzle openings are protected by a plastic sealing disc which remains in place during firing and is blown out by the rocket blast.

Rocket, 4.5 inch HE, M16 (Con't.)

The propelling charge consists of 30 grains of ballistite strung on wires of a cage-like trap. The igniter consists of a charge of black powder enclosed in a plastic tube attached to the trap and running the length of the charge. The tube also contains an electric squib. The leads of the squib pass through one of the nozzles, one lead being grounded to the motor body and the other connected to a contact ring.

- Dimensions
  - Length, overall - 31 inches
  - Length, head, with burster - 23.29 inches
  - Diameter, head - 4.5 inches
- Weights
  - Complete - 42.5 lbs

Markings :
Olive drab body.

Operation :
No information available on functioning.

Hazardous Components :

- Igniter - Black powder
- Propelling charge - Ballistite, 30 grains
- Filler - TNT, 4.3 lbs

Possible Fuzes :
Fuze, Rocket, PD, M81

Fuze, Rocket, Proximity, M402

Differences Between Models :
The M16E1 has a deeper fuze cavity for the VT Fuze M402 (Mk 173). Shipped with these rockets is a supplementary charge to fill part of this cavity in case the Fuzes M81 or M48A2 are used.

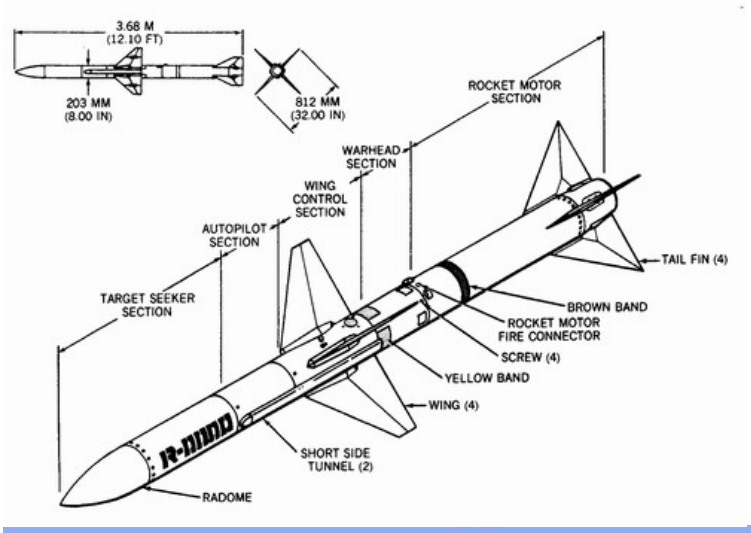
The M16E2 is like the M16E1, except that purge pellets of 411E composition have been added to eliminate chunks in burning.

The M17 and M21 are similar in design and construction but lack the explosive charge and live fuze.

The M20 is similar, differing only in that the ignition wires are attached to spools rather than contact rings.

Source: dudbusters.com (http://www.dudbusters.com/library/online.htm)

Guided Missile, Air-To-Air, AIM-7E (Sparrow)



Description :

This is a medium-range, supersonic, air-to-air semiactive (SAR) continuous wave (CW) radar-homing guided missile. The continuous rod (CROW) warhead is initiated by either a proximity fuze or a contact fuze. The Mk 4 Mod 0 exercise head may contain two flash signals.
The missile is painted white or gray. The warhead section is encircled by a broken yellow band. The exercise head is painted blue and is encircled by a yellow band, denoting the fuze booster. The rocket motor section is encircled by a brown band. Markings are stenciled in black.

Dimensions

- Length, complete – 3.7 m
- Diameter – 203.00 mm
- Weight – 154.20 kg

Hazardous Components :

- Explosive Filler - Diaminotrinitrobenzen
- Filler Weight – 9.20 kg

Source: ORDATA Online (http://www.maic.jmu.edu/ordata/search.asp?SearchMode=1) NAVEODTECHDIV, ATTN: Code 602, 2008 Stump Neck Road, Indian Head, MD, USA, 20640-5070

APPENDIX B
INSTITUTIONAL CONTROL ALTERNATIVES

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APPENDIX B
INSTITUTIONAL CONTROL ALTERNATIVES

B.1 INTRODUCTION

B.1.1 Institutional Controls (ICs) are measures undertaken to limit public exposure to hazardous materials. These preventive measures may be voluntary in nature or may be legally enforceable requirements. The ICs may consist of educational awareness programs, legal restrictions on land use, and physical access controls. The ICs recommended in this report are an important component of the overall risk management system for Camp Bonneville upon property transfer to Clark County. Clark County will have authority and responsibility for implementing and monitoring the ICs. The ICs proposed for application at Camp Bonneville were developed in response to Washington State Model Toxics Control Act requirements, listed in WAC 173-340-440. These ICs also address the concerns expressed in the public participation meetings and Camp Bonneville Reuse Planning process. These priority concerns were listed as follows:

- Public Safety
- Liability
- Property Values
- Land Use

B.1.2 The Camp Bonneville IC Plan addresses site-wide concerns as well as site-specific camp reuse plans. The proposed controls correspond to the site-wide and site-specific elements of the Camp Bonneville Reuse Plan (1998). The Reuse Plan includes an overall recreation focus with site-specific eco-preservation programs, active and passive recreation, education uses, stakeholder use of the park, maintenance and operations, and timber harvestings functions to generate income for economic development and self sufficiency of the park. This recommended program of institutional controls is designed to complement both specific engineering controls and ordnance removal actions. ICs are a key element of the overall risk management program to protect future visitors, contractors and employees at Camp Bonneville.

B.1.3 The importance of effective implementation of ICs is magnified by the population growth in Clark County. In the 2000 Census the population was 345,238, and it was ranked as the fastest growing county in the State of Washington. The County population in 2002, according to the Washington State Office of Financial Management, was 363,400. Clark County is expected to be the primary source of visitors to the future Camp Bonneville regional park. The adjacent Portland, Oregon area has a “metro” development plan that is guided by Urban Growth Boundaries. These Urban Growth

Boundaries inhibit rezoning and land development beyond established boundaries. Clark County is excluded from the Urban Growth Boundary since it is located within the jurisdiction of the State of Washington. As such it is subject to less restrictive growth management systems. Clark County is therefore an outlet for regional population growth and development in the metro Portland area. The ICs presented here anticipate that the proposed regional park will be intensively used since Clark County is the core of suburban growth and because the future regional park is the largest new recreation facility in the metro Portland area.

B.2 INSTITUTIONAL CONTROL REVIEW

B.2.1 Parsons has reviewed the Camp Bonneville Reuse Plan (1998) as it relates to the use of ICs as a means of risk management in coordination with Clark County and the City of Vancouver. In the initial process of review of the Camp Bonneville Reuse Plan for the proposed regional park, site-specific areas of concern were identified: 1) two proposed trails in locations that have not been investigated for the potential presence of ordnance; 2) a proposed camping site on a grenade testing range. The ICs will provide comprehensive assurances that safety planning considerations are incorporated into an effective adaptive reuse of Camp Bonneville.

B.2.2 In addition to meeting the legal and engineering requirements specified in the proposed ordnance removal actions, ICs are recommended to further reduce risk of public interaction with residual ordnance items that may remain at Camp Bonneville. The RI/FS report recommendations incorporate both residual ordnance removal actions and ICs together to facilitate the safe and comprehensive reuse of Camp Bonneville. ICs are proposed to be both site-wide and site-specific in nature. The recommendation of ICs included both implementation of specific IC measures and a collateral monitoring system designed to evaluate and regularly update the effectiveness of the ICs. The RI/FA – RAU3 also recommends responsibilities for implementation of ICs to the 10 specific site types and locations, as well as site-wide ICs for protection of human health and the environment.

B.3 SITE-WIDE ICs

B.3.1 Covenants

B.3.1.1 In large measure, the ICs proposed for Clark County prescribe broad legal land use of “restrictive covenants” on the Camp Bonneville acreage. The purpose of these restrictive covenants are to safeguard future park users, park operations, contractors for new construction, maintenance staff, utilities or infrastructure construction staff, timbering contractors, and for accurate monitoring purposes.

B.3.3.2 As noted earlier, Camp Bonneville is located within rapidly growing Clark County in the Portland Metropolitan Region. The County has very strong comprehensive planning regulations. The current land use designation is an institutional designation illustrated as Tier 1 Forest on the land use map. Future updates of the County plan will reflect the site as recreation and park land uses. Since the Camp will remain in

government ownership internal, land uses will remain institutional. Of more concern is the surrounding land use. Any increase of land uses surrounding the future park to higher development intensities will result in increased access to the area. It is recommended that the restrictive covenants on the site be amended to the County comprehensive plan and to the regional plan in order to discourage an increase in land use density near the park. The surrounding area is currently used for agriculture and large lot residentially zoned property. This is consistent with the mostly forested nature of Camp Bonneville.

B.3.2 Financial Assurances

The site-wide ICs includes a financial mechanism for funding of appropriate UXO-trained staff (UXO Tech 1) for an established period of time to ensure the transition to long-term effectiveness of engineered and ICs. The UXO-trained staff will provide maintenance for the park, continuity on maintenance of the ICs, and monitor effectiveness of the controls to the intent of the risk management program. Financial assurances will address changing conditions in the park, particularly in regards to increased visitation for a recommended 5-year period.

B.3.3 Education Outreach

Camp Bonneville has an 85 year history that encompasses American Military Heritage from WW I, to the Cold War and through Desert Storm. The education outreach program recommends audio, visual, written, and classroom outreach programs, both regionally and on site. The site-wide history lesson for visitors at Camp Bonneville should include tours, preservation lessons, environmental education, courses on 1950s Cold War threats illustrated by the Soviet Village, training bunkers, and training strategies. To facilitate an understanding of the history and the risk program, the ICs recommend site-wide retention of "signage" naming or designating roads, areas, districts and training areas for their original purposes. The signage should be amended with current recreational purposes and locations. The education process will include an expanded website; new video prepared for public television, cable television and for visitors; a school outreach program; the interpretive and retreat educational centers; a historical museum and exhibit on the Camp Bonneville site; and written materials to correspond to the identification of ordnance, safety and heritage protocols.

B.3.4 Regional and Clark County Comprehensive Plan

Covenants adopted by Clark County that restrict development on the former Camp Bonneville to a site plan for preservation, economic, recreational and educational uses will be amended to the Regional and Clark County Comprehensive Plans. This institutional control will assure that developers and property owners representing surrounding land uses, re-zonings and any new development in the fast growing area will be made aware officially of the history, safety plans, and associated issues related to development near Camp Bonneville.

B.4 SITE-SPECIFIC ICs

B.4.1 Access Control

B.4.1 The Camp Bonneville Reuse Plan includes key parcels of land that are designated for complete access restrictions. The recommendation for these restricted sites is to landscape gateways, signage, trails and roadway entrances with fencing and native prickly shrubbery that prevents easy access. All new construction site plans at Camp Bonneville will call for defensible space landscape measures on restricted areas. OE Source site types will be individually evaluated so that appropriate site-specific ICs can be customized for local applicability.

B.4.2 The proposed ICs at Camp Bonneville will utilize comprehensive access control and behavior modification through public education. However, it is also understood that public education may incite a reverse reaction from a small segment of the population that may view dangerous actions as an adventure. This possibility is accepted and it is understood that there will always be some portion of the populace who refuse to heed warnings or follow directions. Access controls are recommended for the Central Impact Area since this was the target site for most all of the ordnance activities. The strategy is to remove the human element from the chain of events that could lead to an accident. The controls recommended below summarize the proposed techniques for Camp Bonneville.

B.4.2 Signage and Fencing

B.4.2.1 Present a comprehensive sign posting system that entry is prohibited, that activities within the property are restricted in some manner, or that although the area is accessible, there is a history of a certain type of ordnance. Present this signage with dual information: historic and current designations, i.e., Artillery Range Road amended with "Jogging Trail 8 and College Center," or Mortar Range Road amended with "Lacamas Creek Fishing." The use of this signage system is based upon the safety, and institutional education. The link between *not trespassing/care in usage of Camp Bonneville* and *explosive safety* should be reinforced.

B.4.2.2 Fencing is a desired element of the ICs; and a comprehensive landscape plan with a fencing system is recommended. A fencing system is recommended for Camp Bonneville, both as a landscape feature for beneficial economic purposes and also as an enforcement tool to deny access to the public to areas designated as off limit. Fencing and gates will reinforce the link between appropriate access points, not trespassing and explosive safety. Because of the urbanization of Clark County there is greater importance to enforce trespass strictures on the large site and more effectiveness if fencing is present.

B.4.2.3 Signs and fencing will be extremely effective ICs on this site. They are valid for use in reducing the risk of exposure to potential accidents involving ordnance through personal restraint and identification of risks. The posting of signs along the perimeter and within the interior of the property provides "on the spot" warnings of the potential hazards of physical contact with residual ordnance items.

B.4.2.4 Fencing and signage are presently used at the Entrance to Camp Bonneville and on the property lines adjacent to single family developments that are 5 miles from the Vancouver City Limits at the southwest corner of the site. The wildlife management area does not have access and entry restrictions and may be accessed randomly by hunters. Signs and fencing should be concentrated near private property owners mostly in the west and southwest areas.

B.4.2.5 The installation of fencing and signage to limit access is recommended. The implementation of the Reuse Plan will include development of a landscape plan. Prior to opening the regional park for public access, a fencing and signage system should be developed and implemented. A comprehensive fencing and signage plan is recommended and can be developed at nominal cost with advice of Clark County and City of Vancouver Department of Parks and Recreation. The fencing and signage should be consistent with City and/or County Park and Recreation design guidelines.

B.5 EDUCATION & AWARENESS PROGRAMS

B.5.1 The Clark County Government will need to modify the behavior of the park visitors and general population through public education by utilizing County stakeholder agencies that have interest in using the site. In addition, the County should amend its comprehensive plan, land use and zoning maps to reflect the restrictive covenants on Camp Bonneville property.

B.5.2 Raising public education for the potential hazards that exist within the former Camp Bonneville should be facilitated with ICs as listed below.

- Notice – Notifications during timbering, utility and infrastructure construction, and permitting;
- General Printed Media - Including brochures and news articles;
- Visual and Audio Media - Including videotapes and announcements;
- Education Classes - Including ordnance identification, safety presentations to various audiences, and preparation of packages for administrators and public officials;
- Exhibits/displays;
- Internet Website; and
- Ad Hoc Committee.

B.5.3 Potential hazards must be considered in the design and use of any site improvements or activities. Notices should be placed on Camp Bonneville property to address visitation, maintenance, operations and construction. Clark County notifications should be sent through the permitting of utility connections, infrastructure construction, surveying, timbering, and related physical land disturbance tasks. Standard application forms and brochures that explain the procedures involved in the construction notification

and building permit approval processes should be updated to reflect training and circumstances dealing with ordnance at Camp Bonneville.

B.5.4 The cost for the initial brochures on Camp Bonneville ordnance identification, Maps and Reuse Plan information documents would cost approximately $5,000. A master copy can be created electronically for reproduction purposes and revisions as needed, and included as a part of the existing City of Vancouver and Clark County building permit information packets.

B.6 LAND USE CONTROLS

B.6.1 The inclusion of restrictive covenants and site plan requirements for Camp Bonneville in the update of the County and Regional Comprehensive Plan will discourage nearby development intensity on a voluntary basis. Restrictive covenants on the land uses of Camp Bonneville will be detailed in an official site plan and adopted by Clark County for enforcement and effectiveness of monitoring purpose. This approach will be effective because it focuses on traditional market and real estate pricing.

B.6.2 The standard permit application process of the City of Vancouver and Clark County should be amended to include information about the possibility of ordnance hazards, and specific Camp Bonneville site plan information and restrictive covenants. The cost of updating geographic information systems to include the planning and to create the capability of identifying these parcels could be provided by Clark County. The cost to document all properties and to input this information into the County system, and train County employees to call up and provide the information is estimated to be between approximately $2,500 and $3,000.

B.7 PRINTED MEDIA AWARENESS PROGRAM

B.7.1 Ordnance education, acknowledgement of the risk involved, and reinforcement of the message are key in minimizing the hazards of ordnance. The avenue recommended to facilitate this education and understanding is through printed media in the form of brochures, fact sheets, newspaper articles, and other information packages. The opportunity to disseminate information through the printed media is readily available and can be easily facilitated because of the numerous media outlets in Metropolitan Portland. Through the use of printed media, property owners and residents from within the County and the region can be informed about the existence of ordnance hazards within the former Camp Bonneville.

B.7.2 Updated brochures and fact sheets describing the important history of the Camp, its new future as a large regional park, and explanation of ordnance hazards can be produced. Text and graphics can be used to describe how to identify ordnance, provide warnings to avoid physical contact in any way, provide instructions for dealing with ordnance if encountered, and how to report ordnance sightings. These printed materials could be produced by Clark County and should also include local sponsorship and ownership. They can be distributed as follows:

- Enclosed as flyer in local newspapers announcing the opening of the park
- Provided through schools to all students in the region
- Provided to stakeholders and community groups
- Provided as part of the City and County Park and Recreation Program

B.7.3 Newspaper articles and interviews provide another means of informing the public about the changeover from army use to County parkland. The articles can discuss the site as an environmental sanctuary as well as the potential presence of ordnance. News articles can continue to be supplied as press releases from Clark County. Interviews with Clark Count representatives, local residents, and other institutions can be included. Continued regular coverage should result in more tourism, visitor use and better information and understanding of the actual existence of and hazards of ordnance. Interviews with people who actually were involved in training at the Camp would add interest to these articles.

B.7.4 County Commissioners and City of Vancouver elected officials should be provided with more detailed current information on the risk management plan, the RI/FS Report the ICs recommended and the extent of ordnance hazards. An information package, including maps defining primary areas of concern, would be valuable for the public officials. It can also include a brief history of the site, areas of greatest concern, types and potential danger of the ordnance discovered, and other relevant organizations' contact information.

B.7.5 Regular updates to local elected officials are effective means of public outreach. Local elected officials are in regular contact with constituents and the media and are the logical broker of information regarding the new park and the Reuse Plan. The Army could provide a fact sheet about BRAC that can be customized for Camp Bonneville. Press releases should be prepared by Clark County and presented to the local newspapers. When a new fact sheet is prepared to describe the findings and recommendations of the BRAC and the proposed plans for creation of the Regional Park as well as removal tasks and ICs.

B.7.6 The estimated cost to produce an original professional quality, multi-color one page fact sheet on an 8 ½ x 11 format suitable as a mailer or handout is approximately $5,000.00. The fact sheet would be prepared to include primarily graphics with minimal text description to provide information about the presence of ordnance, plans for removal and ICs; plus information on the identification, handling, and reporting of ordnance. The cost to print and distribute the fact sheet will depend on the number of copies to be distributed. Assuming that 7,500 fact sheets are to be printed and mailed (at a cost of $2.00 each), and 5,000 fact sheets are to be printed and distributed by local institutions ($1.50 each). The total cost for design and preparation of the brochure (printing 12,500 copies and mailing 7,500 copies) will be $27,500.00. Revision of the fact sheet is anticipated to be done only once. Fact sheets or brochures should be utilized together with abstracts of additional information on ordnance cleanup, mapping, and proposed

removal and ICs. The production cost for these information packages is already included in the production cost of the fact sheets above.

B.8 VISUAL AND AUDIO MEDIA AWARENESS PROGRAM

B.8.1 Powerpoint presentations, audio and visual media (such as videos, segments on local television stations, and radio news and talk shows) should be prepared on an on going basis to inform and educate the public. Professional quality videos that contain similar information as described in the printed materials can be produced at a cost estimate of $1,000 per minute. The videos can be produced privately by the City, by the County, or through cable television franchise agreements and could include interviews with local citizens, sponsorship, and ownership. Videotapes can be produced for use as part of the classroom education as discussed in a later section. Copies should also be provided to local libraries.

B.8.2 Public television station should provide excellent local access. Public Service Announcements should be requested on how to identify and deal with ordnance. Local contact information on ordnance handling and emergencies can be provided. It is suggested that the television programs include interviews with USACE personnel, local residents, and others who have knowledge of the history of the former Camp.

B.8.3 Local radio stations should be invited to participate in events, such as the grand opening of the regional park, and to provide public service announcements for school programs and programs of stakeholder groups that fit the demographics of the individual stations. Talk shows or news reports are both possible formats for the radio programs.

B.8.4 The provision of information using visual and radio media is an effective method of modifying behavior and educating the public. This is currently a technique used by the Army. Periodic updating of the videotapes is recommended to ensure the accuracy and timeliness of the information presented. Cable and radio stations would readily agree to assist in distribution of the information and provide free air time for public service announcements.

B.8.5 The estimated cost to produce a 5- to 7-minute videotape for distribution to the community is approximately $5,000 to $8,000. Assuming 100 copies of videotapes at $5 each (including the cost of the videotape, dubbing, and postage) the cost would be approximately $500. Add to the cost a 30 second public service announcements at $1000 and the estimated total cost to implement a media program would be $6,500 to $9,500.

B.9 CLASSROOM EDUCATION PROGRAMS

B.9.1 The Camp Bonneville Reuse Plan includes the provision for a college environmental education center. This center should be the location for classroom education programs. In addition, the video and brochures should be the core of a public schools outreach program targeted to Clark County Public Schools. The public needs to understand the nature of ordnance hazards and be able to properly identify and avoid

ordnance if encountered. A properly educated public is more likely to make correct decisions related to the safe and proper precautions of found ordnance. Classroom education can be offered in two major categories:

- Ordnance Identification; and
- Ordnance Safety.

B.9.2 Because access to different parts of the site cannot be fully controlled, it is necessary to have public training in ordnance identification. The basic message should be to not touch anything that looks like ordnance, shrapnel, or any other unidentified material. Ordnance identification classes may be conducted through assistance from the County Public Schools Systems, all private schools, and universities. The City of Vancouver – Clark County Parks and Recreation Department should be the responsible agency.

B.9.3 The affected public should be educated about the potential dangers associated with ordnance and should understand the safety procedures to follow if they encounter any suspected ordnance item. Safety presentations should be made as a part of the ordnance identification classes. Providing education through the classroom is critical to modify children's behavior. Ordnance identification classes should be conducted on a regular basis and ordnance safety should be incorporated as a regular part of the classes held at Camp Bonneville. All visitors to the regional park should be given a brochure illustrating ordnance hazards.

B.9.4 Providing classroom education should be easily implementable. With team work between the City of Vancouver – Clark County Parks and Recreation and with the US Army providing the funding and the educational information package, local institutions would agree to participate and support the program. The USACE can provide experts to conduct ordnance identification and safety lectures. The ordnance expert presentations to local schools would be co-sponsored by the City, County or the school systems. The cost for travel and presentation materials (other than the videos) for an employee to make presentations and provide local training to local schools for one week is $500.00.

B.10 EXHIBITS/DISPLAYS

Placing historic Camp Bonneville exhibits/displays in museums or other areas where the public will be exposed to educational information is another method of generating and preserving general awareness and educating the public on the possible risk associated with the ordnance. An exhibit should be established at Camp Bonneville as part of the college center. The cost of producing, maintaining, and updating an exhibit will vary depending upon the scope. A replica of Camp Bonneville is recommended, complete with archival records and photos of the history of the site over the past 85 years. The Army could provide decommissioned examples of the weapons and ordnance used at Camp Bonneville.

B.11 INTERNET WEBSITE PROGRAM

B.11.1 The expansion of the City of Vancouver – Clarke County web pages on the Internet should be used in educating the public about Camp Bonneville and the presence of ordnance on the site. The web page could be designed to include the history of the camp, a background on ordnance finds and cleanup, and ordnance identification and procedures for dealing with it. The web pages would be very effective in terms of presenting substantial and updated information about ordnance hazards on the site. Creation and maintenance of the website can be sponsored by Clark County. Information to be included in the website will come from the USACE studies and other sources.

B.11.2 Existing website masters or County staff may be able to design, create and maintain a Camp Bonneville website. However, the cost to design a new website varies from $50.00 to $150 per hour. Assuming that the design would require 100 hours at $100.00 per hour (including review, revisions, and placing the site on the web), the total cost could be $10,000.00. The website enhancements can be prepared internally or externally. Any site will provide links to other important government agencies relevant to ordnance handling and identification.

B.12 AD HOC COMMITTEE AWARENESS PROGRAM

B.12.1 A new Clark County/City of Vancouver Parks and Recreation Committee should be enabled with a revised scope of service for community awareness. The original Committee was comprised of community leaders and a representative from the USACE and served as a mechanism for implementing ideas for the Reuse Plan. An ad hoc committee should serve as the primary proponent for public education of the ordnance issues. It will work to ensure the successful implementation of each of the recommended institutional control education programs. The committee will be responsible for analyzing the effectiveness of the different programs on an annual basis and recommending changes as necessary to bring the message to the largest sector of the public.

B.12.2 An ad hoc committee would be very effective in providing a proponent for public education. This group would provide a direct and flexible administration over information dissemination programs. With the committee's annual evaluation, more effective alternatives could be enhanced and less effective ones could be discontinued. This type of committee is most effective for ensuring the implementation of institutional control programs.

B.12.3 The City of Vancouver – Clark County Parks and Recreation will oversee the formation of the ad hoc committee. Community leaders, veterans, and agency representatives will be contacted and invited to join. Joining and serving within the ad hoc committee will be by appointment and voluntary except for the Tech 1 recommended for staff to Camp Bonneville. This person will act as staff to the ad hoc committee. The members will not be paid for their time. To implement ad hoc committees as a mechanism for information dissemination will cost approximately $2,000 for the first year and $2,000 for each subsequent year. The costs would include retaining services of

a stenographer to record meeting minutes, overhead administrative costs, and other miscellaneous expenses. To create an ad hoc committee, the City of Vancouver – Clark County Parks and Recreation, Clark County Commission and USACE must jointly meet and select community leaders to join the committee.

B.13 CONCLUSIONS

The goal of the Institutional Controls Program is to assure the maximum safety to citizens. It is technically and financially impossible to provide 100% clean up of unexploded ordnance at Camp Bonneville due to the 85 year history of ordnance use. However, ICs will demonstrably reduce risks as a protective remedy. The City of Vancouver Clark County Parks and Recreation Department will need to establish an ICs monitoring or surveying system for user suggestions, for a quick understanding of changing conditions, to identify problems and to identify shifts in the age of visitors (their capacity to relate or understand the written and audio visual information). An annual report card on ICs should be issued to the County Commission for policy and procedure revisions in all aspects of the program (education, legal, physical restrictions). Ongoing monitoring, quantification of input, and updated policy and park planning will enable Clark County to protect its citizens while enjoying access to one of the largest new urban parks in America.

DETAILED COST ESTIMATES
STORAGE MAGAZINES / TRANSFER POINTS
BONNEVILLE RI/FS

Site	Institutional Controls		
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls
Bldg 2950	2	1.00	$ 3,000

Site	Surface Clearance With Institutional Controls Alternative															
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Bldg 2950	2	1.00	$ 3,000	$ -	$ -	$ 4,500	$ 9,000	$ 12,000	$ 1,080	$ 720	$ 1,000	$ 14,800	$ 2,220	$ 1,702	**$ 18,722**	$ 9,361

Site	Frost Depth (14") Clearance With Institutional Controls Alternative															
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Bldg 2950	2	1.00	$ 3,000	$ -	$ -	$ 9,300	$ 18,600	$ 21,600	$ 2,232	$ 1,488	$ 1,000	$ 26,320	$ 3,948	$ 3,027	**$ 33,295**	$ 16,647

Site	Subsurface (24") Clearance With Institutional Controls Alternative															
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Bldg 2950	2	1.00	$ 3,000	$ -	$ -	$ 12,200	$ 24,400	$ 27,400	$ 2,928	$ 1,952	$ 1,000	$ 33,280	$ 4,992	$ 3,827	**$ 42,099**	$ 21,050

Site	Subsurface (48") Clearance With Institutional Controls Alternative															
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Bldg 2950	2	1.00	$ 3,000	$ -	$ -	$ 16,000	$ 32,000	$ 35,000	$ 3,840	$ 2,560	$ 1,000	$ 42,400	$ 6,360	$ 4,876	**$ 53,636**	$ 26,818

Site	Excavation & Restoration Alternative															
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excav & Rest.)	A-E Field Oversight	A-E Project Mgmt	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Bldg 2950	2	1.00	$ -	$ -	$ -	$ 80,667	$ 161,334	$ 4,000	$ 165,334	$ 19,360	$ 12,907	$ 197,601	$ 29,640	$ 22,724	**$ 249,965**	$ 124,983

Notes:

\1 The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

\2 Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 per acre based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

\3 Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

\4 Institutional Control Cost Estimates are based on the installation and maintenance costs for signs.

\5 A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

\6 A-E Project Management estimated at 8% of ordnance removal costs.

\7 Land survey costs are lump sum and it will include marking site boundaries and establishing a grid system within the site for clearance. $500 per acre

\8 Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

\9 Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

DETAILED COST ESTIMATES
TRAINING AREAS
BONNEVILLE RI/FS

Site	Institutional Controls		
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls
M203 Training Area	4	1.00	$ 6,000

Site						Surface Clearance Alternative										
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
M203 Training Area	4	1.00	$ 6,000	$ -	$ -	$ 4,500	$ 18,000	$ 24,000	$ 2,160	$ 1,440	$ 2,000	$ 29,600	$ 4,440	$ 3,404	**$ 37,444**	$ 9,361

Site						Frost Depth (14") Clearance Alternative										
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
M203 Training Area	4	1.00	$ 6,000	$ 500	$ 2,000	$ 9,300	$ 37,200	$ 45,200	$ 4,464	$ 2,976	$ 2,000	$ 54,640	$ 8,196	$ 6,284	**$ 69,120**	$ 17,280

Site						Subsurface (24") Clearance Alternative										
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
M203 Training Area	4	1.00	$ 6,000	$ 500	$ 2,000	$ 12,200	$ 48,800	$ 56,800	$ 5,856	$ 3,904	$ 2,000	$ 68,560	$ 10,284	$ 7,884	**$ 86,728**	$ 21,682

Site						Subsurface (48") Clearance Alternative										
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
M203 Training Area	4	1.00	$ 6,000	$ 500	$ 2,000	$ 16,000	$ 64,000	$ 72,000	$ 7,680	$ 5,120	$ 2,000	$ 86,800	$ 13,020	$ 9,982	**$ 109,802**	$ 27,451

Site						Excavation & Restoration Alternative										
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excav & Rest.)	A-E Field Oversight	A-E Project Management	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
M203 Training Area	4	1.00	$ -	$ 500	$ 2,000	$ 80,667	$ 322,668	$ 8,000	$ 332,668	$ 38,720	$ 25,813	$ 397,202	$ 59,580	$ 45,678	**$ 502,460**	$ 125,615

Notes:

\1 The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

\2 Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

\3 Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

\4 Institutional Control Cost Estimates are based on the installation and maintenance costs for signs.

\5 A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

\6 A-E Project Management estimated at 8% of ordnance removal costs.

\7 Land survey costs are lump sum and it will include marking site boundaries and establishing a grid system within the site for clearance. $500 per acre

\8 Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

(a) Cleared to a depth of 2-feet. Additional clearance costs not included.

DETAILED COST ESTIMATES
FIRING POINTS
BONNEVILLE RI/FS

Site	Institutional Controls		
	Size (Acres)		Institutional Controls ($1,500/acre)
Firing Points			
Mortar Firing Pos 1	0.5		$ 1,500
Mortar Firing Pos 2	0.5		$ 1,500
Mortar Firing Pos 3	0.5		$ 1,500
Mortar Firing Pos 4	0.5		$ 1,500
Mortar Firing Pos 5	0.5		$ 1,500
Mortar Firing Pos 6	0.5		$ 1,500
Artillery Pos 1	2		$ 3,000
Artillery Pos 2	2		$ 3,000
Artillery Pos 3	2		$ 3,000
Artillery Pos 4	2		$ 3,000
Artillery Pos 5	2		$ 3,000
Artillery Pos 6	2		$ 3,000
Artillery Pos 7	2		$ 3,000
Rifle Grenade Range	1		$ 1,500
3.5-inch Rocket Range	1		$ 1,500
M203 HE Grenade Range[(a)]			NA
Total	*19.0*		*$ 33,000*

Site	Surface Clearance With Institutional Controls Alternative																
	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Firing Points																
Mortar Firing Pos 1	0.5	1.35	$ 1,500	$ -	$ -	$ 4,500	$ 3,038	$ 4,538	$ 365	$ 243	$ 250	$ 5,395	$ 809	$ 620	**$ 6,825**	$ 13,649
Mortar Firing Pos 2	0.5	1.35	$ 1,500	$ -	$ -	$ 4,500	$ 3,038	$ 4,538	$ 365	$ 243	$ 250	$ 5,395	$ 809	$ 620	**$ 6,825**	$ 13,649
Mortar Firing Pos 3	0.5	1.35	$ 1,500	$ -	$ -	$ 4,500	$ 3,038	$ 4,538	$ 365	$ 243	$ 250	$ 5,395	$ 809	$ 620	**$ 6,825**	$ 13,649
Mortar Firing Pos 4	0.5	1.00	$ 1,500	$ -	$ -	$ 4,500	$ 2,250	$ 3,750	$ 270	$ 180	$ 250	$ 4,450	$ 668	$ 512	**$ 5,629**	$ 11,259
Mortar Firing Pos 5	0.5	1.35	$ 1,500	$ -	$ -	$ 4,500	$ 3,038	$ 4,538	$ 365	$ 243	$ 250	$ 5,395	$ 809	$ 620	**$ 6,825**	$ 13,649
Mortar Firing Pos 6	0.5	1.35	$ 1,500	$ -	$ -	$ 4,500	$ 3,038	$ 4,538	$ 365	$ 243	$ 250	$ 5,395	$ 809	$ 620	**$ 6,825**	$ 13,649
Artillery Pos 1	2	1.35	$ 3,000	$ -	$ -	$ 4,500	$ 12,150	$ 15,150	$ 1,458	$ 972	$ 1,000	$ 18,580	$ 2,787	$ 2,137	**$ 23,504**	$ 11,752
Artillery Pos 2	2	1.35	$ 3,000	$ -	$ -	$ 4,500	$ 12,150	$ 15,150	$ 1,458	$ 972	$ 1,000	$ 18,580	$ 2,787	$ 2,137	**$ 23,504**	$ 11,752
Artillery Pos 3	2	1.35	$ 3,000	$ -	$ -	$ 4,500	$ 12,150	$ 15,150	$ 1,458	$ 972	$ 1,000	$ 18,580	$ 2,787	$ 2,137	**$ 23,504**	$ 11,752
Artillery Pos 4	2	1.35	$ 3,000	$ -	$ -	$ 4,500	$ 12,150	$ 15,150	$ 1,458	$ 972	$ 1,000	$ 18,580	$ 2,787	$ 2,137	**$ 23,504**	$ 11,752
Artillery Pos 5	2	1.00	$ 3,000	$ -	$ -	$ 4,500	$ 9,000	$ 12,000	$ 1,080	$ 720	$ 1,000	$ 14,800	$ 2,220	$ 1,702	**$ 18,722**	$ 9,361
Artillery Pos 6	2	1.00	$ 3,000	$ -	$ -	$ 4,500	$ 9,000	$ 12,000	$ 1,080	$ 720	$ 1,000	$ 14,800	$ 2,220	$ 1,702	**$ 18,722**	$ 9,361
Artillery Pos 7	2	1.00	$ 3,000	$ -	$ -	$ 4,500	$ 9,000	$ 12,000	$ 1,080	$ 720	$ 1,000	$ 14,800	$ 2,220	$ 1,702	**$ 18,722**	$ 9,361
Rifle Grenade Range	1	1.20	$ 1,500	$ -	$ -	$ 4,500	$ 5,400	$ 6,900	$ 648	$ 432	$ 500	$ 8,480	$ 1,272	$ 975	**$ 10,727**	$ 10,727
3.5-inch Rocket Range	1	1.20	$ 1,500	$ -	$ -	$ 4,500	$ 5,400	$ 6,900	$ 648	$ 432	$ 500	$ 8,480	$ 1,272	$ 975	**$ 10,727**	$ 10,727
M203 HE Grenade Range[(a)]		1.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	
Total	*19.0*		*$ 33,000*				*$ 103,838*	*$ 136,838*	*$ 12,461*	*$ 8,307*	*$ 9,500*	*$ 167,105*	*$ 25,066*	*$ 19,217*	***$ 211,388***	*$ 11,126*

DETAILED COST ESTIMATES
FIRING POINTS
BONNEVILLE RI/FS

Site	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
	Frost Depth (14") Clearance With Institutional Controls Alternative															
Firing Points																
Mortar Firing Pos 1	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 9,300	$ 6,278	$ 9,028	$ 753	$ 502	$ 250	$ 10,533	$ 1,580	$ 1,211	**$ 13,324**	$ 26,648
Mortar Firing Pos 2	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 9,300	$ 6,278	$ 9,028	$ 753	$ 502	$ 250	$ 10,533	$ 1,580	$ 1,211	**$ 13,324**	$ 26,648
Mortar Firing Pos 3	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 9,300	$ 6,278	$ 9,028	$ 753	$ 502	$ 250	$ 10,533	$ 1,580	$ 1,211	**$ 13,324**	$ 26,648
Mortar Firing Pos 4	0.5	1.00	$ 1,500	$ 500	$ 250	$ 9,300	$ 4,650	$ 6,400	$ 558	$ 372	$ 250	$ 7,580	$ 1,137	$ 872	**$ 9,589**	$ 19,177
Mortar Firing Pos 5	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 9,300	$ 6,278	$ 9,028	$ 753	$ 502	$ 250	$ 10,533	$ 1,580	$ 1,211	**$ 13,324**	$ 26,648
Mortar Firing Pos 6	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 9,300	$ 6,278	$ 9,028	$ 753	$ 502	$ 250	$ 10,533	$ 1,580	$ 1,211	**$ 13,324**	$ 26,648
Artillery Pos 1	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 9,300	$ 25,110	$ 33,110	$ 3,013	$ 2,009	$ 1,000	$ 39,132	$ 5,870	$ 4,500	**$ 49,502**	$ 24,751
Artillery Pos 2	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 9,300	$ 25,110	$ 33,110	$ 3,013	$ 2,009	$ 1,000	$ 39,132	$ 5,870	$ 4,500	**$ 49,502**	$ 24,751
Artillery Pos 3	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 9,300	$ 25,110	$ 33,110	$ 3,013	$ 2,009	$ 1,000	$ 39,132	$ 5,870	$ 4,500	**$ 49,502**	$ 24,751
Artillery Pos 4	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 9,300	$ 25,110	$ 33,110	$ 3,013	$ 2,009	$ 1,000	$ 39,132	$ 5,870	$ 4,500	**$ 49,502**	$ 24,751
Artillery Pos 5	2	1.00	$ 3,000	$ 500	$ 1,000	$ 9,300	$ 18,600	$ 22,600	$ 2,232	$ 1,488	$ 1,000	$ 27,320	$ 4,098	$ 3,142	**$ 34,560**	$ 17,280
Artillery Pos 6	2	1.00	$ 3,000	$ 500	$ 1,000	$ 9,300	$ 18,600	$ 22,600	$ 2,232	$ 1,488	$ 1,000	$ 27,320	$ 4,098	$ 3,142	**$ 34,560**	$ 17,280
Artillery Pos 7	2	1.00	$ 3,000	$ 500	$ 1,000	$ 9,300	$ 18,600	$ 22,600	$ 2,232	$ 1,488	$ 1,000	$ 27,320	$ 4,098	$ 3,142	**$ 34,560**	$ 17,280
Rifle Grenade Range	1	1.20	$ 1,500	$ 500	$ 500	$ 9,300	$ 11,160	$ 13,160	$ 1,339	$ 893	$ 500	$ 15,892	$ 2,384	$ 1,828	**$ 20,103**	$ 20,103
3.5-inch Rocket Range	1	1.20	$ 1,500	$ 2,500	$ 2,500	$ 9,300	$ 11,160	$ 15,160	$ 1,339	$ 893	$ 500	$ 17,892	$ 2,684	$ 2,058	**$ 22,633**	$ 22,633
M203 HE Grenade Range[(a)]		1.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	
Total	*19.0*		*$ 33,000*		*$ 32,500*		*$ 214,598*	*$ 280,098*	*$ 25,752*	*$ 17,168*	*$ 9,500*	*$ 332,517*	*$ 49,878*	*$ 38,239*	***$ 420,634***	*$ 22,139*

Site	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
						Subsurface (24") Clearance With Institutional Controls Alternative										
Firing Points																
Mortar Firing Pos 1	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 12,200	$ 8,235	$ 10,985	$ 988	$ 659	$ 250	$ 12,882	$ 1,932	$ 1,481	**$ 16,296**	$ 32,591
Mortar Firing Pos 2	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 12,200	$ 8,235	$ 10,985	$ 988	$ 659	$ 250	$ 12,882	$ 1,932	$ 1,481	**$ 16,296**	$ 32,591
Mortar Firing Pos 3	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 12,200	$ 8,235	$ 10,985	$ 988	$ 659	$ 250	$ 12,882	$ 1,932	$ 1,481	**$ 16,296**	$ 32,591
Mortar Firing Pos 4	0.5	1.00	$ 1,500	$ 500	$ 250	$ 12,200	$ 6,100	$ 7,850	$ 732	$ 488	$ 250	$ 9,320	$ 1,398	$ 1,072	**$ 11,790**	$ 23,580
Mortar Firing Pos 5	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 12,200	$ 8,235	$ 10,985	$ 988	$ 659	$ 250	$ 12,882	$ 1,932	$ 1,481	**$ 16,296**	$ 32,591
Mortar Firing Pos 6	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 12,200	$ 8,235	$ 10,985	$ 988	$ 659	$ 250	$ 12,882	$ 1,932	$ 1,481	**$ 16,296**	$ 32,591
Artillery Pos 1	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 12,200	$ 32,940	$ 40,940	$ 3,953	$ 2,635	$ 1,000	$ 48,528	$ 7,279	$ 5,581	**$ 61,388**	$ 30,694
Artillery Pos 2	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 12,200	$ 32,940	$ 40,940	$ 3,953	$ 2,635	$ 1,000	$ 48,528	$ 7,279	$ 5,581	**$ 61,388**	$ 30,694
Artillery Pos 3	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 12,200	$ 32,940	$ 40,940	$ 3,953	$ 2,635	$ 1,000	$ 48,528	$ 7,279	$ 5,581	**$ 61,388**	$ 30,694
Artillery Pos 4	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 12,200	$ 32,940	$ 40,940	$ 3,953	$ 2,635	$ 1,000	$ 48,528	$ 7,279	$ 5,581	**$ 61,388**	$ 30,694
Artillery Pos 5	2	1.00	$ 3,000	$ 500	$ 1,000	$ 12,200	$ 24,400	$ 28,400	$ 2,928	$ 1,952	$ 1,000	$ 34,280	$ 5,142	$ 3,942	**$ 43,364**	$ 21,682
Artillery Pos 6	2	1.00	$ 3,000	$ 500	$ 1,000	$ 12,200	$ 24,400	$ 28,400	$ 2,928	$ 1,952	$ 1,000	$ 34,280	$ 5,142	$ 3,942	**$ 43,364**	$ 21,682
Artillery Pos 7	2	1.00	$ 3,000	$ 500	$ 1,000	$ 12,200	$ 24,400	$ 28,400	$ 2,928	$ 1,952	$ 1,000	$ 34,280	$ 5,142	$ 3,942	**$ 43,364**	$ 21,682
Rifle Grenade Range	1	1.20	$ 1,500	$ 500	$ 500	$ 12,200	$ 14,640	$ 16,640	$ 1,757	$ 1,171	$ 500	$ 20,068	$ 3,010	$ 2,308	**$ 25,386**	$ 25,386
3.5-inch Rocket Range	1	1.20	$ 1,500	$ 2,500	$ 2,500	$ 12,200	$ 14,640	$ 18,640	$ 1,757	$ 1,171	$ 500	$ 22,068	$ 3,310	$ 2,538	**$ 27,916**	$ 27,916
M203 HE Grenade Range[(a)]		1.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	
Total	*19.0*		*$ 33,000*		*$ 32,500*		*$ 281,515*	*$ 347,015*	*$ 33,782*	*$ 22,521*	*$ 9,500*	*$ 412,818*	*$ 61,923*	*$ 47,474*	***$ 522,215***	*$ 27,485*

DETAILED COST ESTIMATES
FIRING POINTS
BONNEVILLE RI/FS

Site	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Subsurface (48") Clearance With Institutional Controls Alternative: Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE)	A-E Field Oversight	A-E Project Mgmt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Firing Points																
Mortar Firing Pos 1	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 16,000	$ 10,800	$ 13,550	$ 1,296	$ 864	$ 250	$ 15,960	$ 2,394	$ 1,835	**$ 20,189**	$ 40,379
Mortar Firing Pos 2	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 16,000	$ 10,800	$ 13,550	$ 1,296	$ 864	$ 250	$ 15,960	$ 2,394	$ 1,835	**$ 20,189**	$ 40,379
Mortar Firing Pos 3	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 16,000	$ 10,800	$ 13,550	$ 1,296	$ 864	$ 250	$ 15,960	$ 2,394	$ 1,835	**$ 20,189**	$ 40,379
Mortar Firing Pos 4	0.5	1.00	$ 1,500	$ 500	$ 250	$ 16,000	$ 8,000	$ 9,750	$ 960	$ 640	$ 250	$ 11,600	$ 1,740	$ 1,334	**$ 14,674**	$ 29,348
Mortar Firing Pos 5	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 16,000	$ 10,800	$ 13,550	$ 1,296	$ 864	$ 250	$ 15,960	$ 2,394	$ 1,835	**$ 20,189**	$ 40,379
Mortar Firing Pos 6	0.5	1.35	$ 1,500	$ 2,500	$ 1,250	$ 16,000	$ 10,800	$ 13,550	$ 1,296	$ 864	$ 250	$ 15,960	$ 2,394	$ 1,835	**$ 20,189**	$ 40,379
Artillery Pos 1	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 16,000	$ 43,200	$ 51,200	$ 5,184	$ 3,456	$ 1,000	$ 60,840	$ 9,126	$ 6,997	**$ 76,963**	$ 38,481
Artillery Pos 2	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 16,000	$ 43,200	$ 51,200	$ 5,184	$ 3,456	$ 1,000	$ 60,840	$ 9,126	$ 6,997	**$ 76,963**	$ 38,481
Artillery Pos 3	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 16,000	$ 43,200	$ 51,200	$ 5,184	$ 3,456	$ 1,000	$ 60,840	$ 9,126	$ 6,997	**$ 76,963**	$ 38,481
Artillery Pos 4	2	1.35	$ 3,000	$ 2,500	$ 5,000	$ 16,000	$ 43,200	$ 51,200	$ 5,184	$ 3,456	$ 1,000	$ 60,840	$ 9,126	$ 6,997	**$ 76,963**	$ 38,481
Artillery Pos 5	2	1.00	$ 3,000	$ 500	$ 1,000	$ 16,000	$ 32,000	$ 36,000	$ 3,840	$ 2,560	$ 1,000	$ 43,400	$ 6,510	$ 4,991	**$ 54,901**	$ 27,451
Artillery Pos 6	2	1.00	$ 3,000	$ 500	$ 1,000	$ 16,000	$ 32,000	$ 36,000	$ 3,840	$ 2,560	$ 1,000	$ 43,400	$ 6,510	$ 4,991	**$ 54,901**	$ 27,451
Artillery Pos 7	2	1.00	$ 3,000	$ 500	$ 1,000	$ 16,000	$ 32,000	$ 36,000	$ 3,840	$ 2,560	$ 1,000	$ 43,400	$ 6,510	$ 4,991	**$ 54,901**	$ 27,451
Rifle Grenade Range	1	1.20	$ 1,500	$ 500	$ 500	$ 16,000	$ 19,200	$ 21,200	$ 2,304	$ 1,536	$ 500	$ 25,540	$ 3,831	$ 2,937	**$ 32,308**	$ 32,308
3.5-inch Rocket Range	1	1.20	$ 1,500	$ 2,500	$ 2,500	$ 16,000	$ 19,200	$ 23,200	$ 2,304	$ 1,536	$ 500	$ 27,540	$ 4,131	$ 3,167	**$ 34,838**	$ 34,838
M203 HE Grenade Range[(a)]		1.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	
Total	*19.0*		*$ 33,000*		*$ 32,500*		*$ 369,200*	*$ 434,700*	*$ 44,304*	*$ 29,536*	*$ 9,500*	*$ 518,040*	*$ 77,706*	*$ 59,575*	***$ 655,321***	*$ 34,491*

Site	Size (Acres)	Veg./Terrain Modifier	Institutional Controls	Brush Clear per Acre	Total Brush Clear	Excavation & Restoration Alternative: Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excav & Rest.)	A-E Field Oversight	A-E Project Management	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Firing Points																
Mortar Firing Pos 1	0.5	1.35	$ -	$ 2,500	$ 1,250	$ 80,667	$ 40,334	$ 1,000	$ 42,584	$ 4,840	$ 3,227	$ 50,650	$ 7,598	$ 5,825	**$ 64,073**	$ 128,145
Mortar Firing Pos 2	0.5	1.35	$ -	$ 2,500	$ 1,250	$ 80,667	$ 40,334	$ 1,000	$ 42,584	$ 4,840	$ 3,227	$ 50,650	$ 7,598	$ 5,825	**$ 64,073**	$ 128,145
Mortar Firing Pos 3	0.5	1.35	$ -	$ 2,500	$ 1,250	$ 80,667	$ 40,334	$ 1,000	$ 42,584	$ 4,840	$ 3,227	$ 50,650	$ 7,598	$ 5,825	**$ 64,073**	$ 128,145
Mortar Firing Pos 4	0.5	1.00	$ -	$ 500	$ 250	$ 80,667	$ 40,334	$ 1,000	$ 41,584	$ 4,840	$ 3,227	$ 49,650	$ 7,448	$ 5,710	**$ 62,808**	$ 125,615
Mortar Firing Pos 5	0.5	1.35	$ -	$ 2,500	$ 1,250	$ 80,667	$ 40,334	$ 1,000	$ 42,584	$ 4,840	$ 3,227	$ 50,650	$ 7,598	$ 5,825	**$ 64,073**	$ 128,145
Mortar Firing Pos 6	0.5	1.35	$ -	$ 2,500	$ 1,250	$ 80,667	$ 40,334	$ 1,000	$ 42,584	$ 4,840	$ 3,227	$ 50,650	$ 7,598	$ 5,825	**$ 64,073**	$ 128,145
Artillery Pos 1	2	1.35	$ -	$ 2,500	$ 5,000	$ 80,667	$ 161,334	$ 4,000	$ 170,334	$ 19,360	$ 12,907	$ 202,601	$ 30,390	$ 23,299	**$ 256,290**	$ 128,145
Artillery Pos 2	2	1.35	$ -	$ 2,500	$ 5,000	$ 80,667	$ 161,334	$ 4,000	$ 170,334	$ 19,360	$ 12,907	$ 202,601	$ 30,390	$ 23,299	**$ 256,290**	$ 128,145
Artillery Pos 3	2	1.35	$ -	$ 2,500	$ 5,000	$ 80,667	$ 161,334	$ 4,000	$ 170,334	$ 19,360	$ 12,907	$ 202,601	$ 30,390	$ 23,299	**$ 256,290**	$ 128,145
Artillery Pos 4	2	1.35	$ -	$ 2,500	$ 5,000	$ 80,667	$ 161,334	$ 4,000	$ 170,334	$ 19,360	$ 12,907	$ 202,601	$ 30,390	$ 23,299	**$ 256,290**	$ 128,145
Artillery Pos 5	2	1.00	$ -	$ 500	$ 1,000	$ 80,667	$ 161,334	$ 4,000	$ 166,334	$ 19,360	$ 12,907	$ 198,601	$ 29,790	$ 22,839	**$ 251,230**	$ 125,615
Artillery Pos 6	2	1.00	$ -	$ 500	$ 1,000	$ 80,667	$ 161,334	$ 4,000	$ 166,334	$ 19,360	$ 12,907	$ 198,601	$ 29,790	$ 22,839	**$ 251,230**	$ 125,615
Artillery Pos 7	2	1.00	$ -	$ 500	$ 1,000	$ 80,667	$ 161,334	$ 4,000	$ 166,334	$ 19,360	$ 12,907	$ 198,601	$ 29,790	$ 22,839	**$ 251,230**	$ 125,615
Rifle Grenade Range	1	1.20	$ -	$ 500	$ 500	$ 80,667	$ 80,667	$ 2,000	$ 83,167	$ 9,680	$ 6,453	$ 99,300	$ 14,895	$ 11,420	**$ 125,615**	$ 125,615
3.5-inch Rocket Range	1	1.20	$ -	$ 2,500	$ 2,500	$ 80,667	$ 80,667	$ 2,000	$ 85,167	$ 9,680	$ 6,453	$ 101,300	$ 15,195	$ 11,650	**$ 128,145**	$ 128,145
M203 HE Grenade Range[(a)]		1.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	
Total	19.0				$ 32,500	$ 1,210,005	$ 1,532,673	$ 38,000	$ 1,603,173	$ 183,921	$ 122,614	$ 1,909,708	$ 286,456	$ 219,616	**$ 2,415,780**	

DETAILED COST ESTIMATES
FIRING POINTS
BONNEVILLE RI/FS

Notes:

[1] The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

[2] Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 per acre based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

[3] Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

[4] Institutional Control Cost Estimates are based on the installation and maintenance costs for signs.

[5] A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

[6] A-E Project Management estimated at 8% of ordnance removal costs.

[7] Land survey costs are lump sum and it will include marking site boundaries and establishing a grid system within the site for clearance. $500 per acre

[8] Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

[9] Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

(a) Area cleared to a depth of 2-feet in 1999. Additional clearance costs not included.

DETAILED COST ESTIMATES
FIRING POINTS
BONNEVILLE RI/FS

DETAILED COST ESTIMATES
OB/OD BUFFER AREAS -
PREFERRED ALTERNATIVE SURFACE CLEARANCE
BONNEVILLE RI/FS

		Buffer Area Surface Clearance Alternative														
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Demolition Area 1	36.3	1.50	$ -	$ -	$ -	$ 4,500	$ 245,025	$ 245,025	$ 29,403	$ 19,602	$ 18,150	$ 312,180	$ 46,827	$ 35,901	**$ 394,908**	$ 10,879
Demolition Area 2	36.8	1.50	$ -	$ -	$ -	$ 4,500	$ 248,400	$ 248,400	$ 29,808	$ 19,872	$ 18,400	$ 316,480	$ 47,472	$ 36,395	**$ 400,347**	$ 10,879
Demolition Area 3	36.8	1.20	$ -	$ -	$ -	$ 4,500	$ 198,720	$ 198,720	$ 23,846	$ 15,898	$ 18,400	$ 256,864	$ 38,530	$ 29,539	**$ 324,933**	$ 8,830
Total	*109.9*		*$ -*				*$ 692,145*	*$ 692,145*	*$ 83,057*	*$ 55,372*	*$ 54,950*	*$ 885,524*	*$ 132,829*	*$ 101,835*	***$ 1,120,188***	$ 10,193

Notes:

\1 The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

\2 A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

\3 A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

\4 A-E Project Management estimated at 8% of ordnance removal costs.

\5 Land survey costs are lump sum and it will include marking site boundaries and establishing a grid system within the site for clearance. $500 per acre

\6 Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

DETAILED COST ESTIMATES
OB/OD AREAS
PREFERRED ALTERNATIVE BUFFER AREA
SURFACE CLEARANCE
BONNEVILLE RI/FS

DETAILED COST ESTIMATES
OB/OD AREA
BONNEVILLE RI/FS

	Institutional Controls		
Site	Size (Acres)		Institutional Controls ($1500/acre)
Demolition Area 1[(b)]	2.5		$ 1,500
Demolition Area 2	2.0		$ 1,500
Demolition Area 3	2.0		$ 1,500
Total	*6.5*		*$ 4,500*

	Surface Clearance With Institutional Controls Alternative																
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Demolition Area 1[(b)]		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Demolition Area 2	2.0	1.50	$ 3,000	$ -	$ -	$ 4,500	$ 13,500	$ 16,500	$ 1,620	$ 1,080	$ 1,000	$ 20,200	$ 3,030	$ 2,323	**$ 25,553**	$ 12,777
Demolition Area 3	2.0	1.20	$ 3,000	$ -	$ -	$ 4,500	$ 10,800	$ 13,800	$ 1,296	$ 864	$ 1,000	$ 16,960	$ 2,544	$ 1,950	**$ 21,454**	$ 10,727
Total	*4.0*		*$ 6,000*				*$ 24,300*	*$ 30,300*	*$ 2,916*	*$ 1,944*	*$ 2,000*	*$ 37,160*	*$ 5,574*	*$ 4,273*	***$ 47,007***	$ 11,752

	Frost Depth (14") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+Ordnance)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Demolition Area 1[(b)]		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Demolition Area 2	2.0	1.50	$ 1,500	$ 2,500	$ 5,000	$ 9,300	$ 27,900	$ 34,400	$ 3,348	$ 2,232	$ 1,000	$ 40,980	$ 6,147	$ 4,713	**$ 51,840**	$ 25,920
Demolition Area 3	2.0	1.20	$ 1,500	$ 2,500	$ 5,000	$ 9,300	$ 22,320	$ 28,820	$ 2,678	$ 1,786	$ 1,000	$ 34,284	$ 5,143	$ 3,943	**$ 43,369**	$ 21,685
Total	*4.0*		*$ 3,000*		*$ 10,000*		*$ 50,220*	*$ 63,220*	*$ 6,026*	*$ 4,018*	*$ 2,000*	*$ 75,264*	*$ 11,290*	*$ 8,655*	***$ 95,209***	$ 23,802

	Subsurface Depth (24") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+Ordnance)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Demolition Area 1[(b)]		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Demolition Area 2	2.0	1.50	$ 1,500	$ 2,500	$ 5,000	$ 12,200	$ 36,600	$ 43,100	$ 4,392	$ 2,928	$ 1,000	$ 51,420	$ 7,713	$ 5,913	**$ 65,046**	$ 32,523
Demolition Area 3	2.0	1.20	$ 1,500	$ 2,500	$ 5,000	$ 12,200	$ 29,280	$ 35,780	$ 3,514	$ 2,342	$ 1,000	$ 42,636	$ 6,395	$ 4,903	**$ 53,935**	$ 26,967
Total	*4.0*		*$ 3,000*		*$ 10,000*		*$ 65,880*	*$ 78,880*	*$ 7,906*	*$ 5,270*	*$ 2,000*	*$ 94,056*	*$ 14,108*	*$ 10,816*	***$ 118,981***	$ 29,745

Subsurface Depth (48") Clearance With Institutional Controls Alternative

Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+Ordnance)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Demolition Area 1[(b)]		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Demolition Area 2	2.0	1.50	$ 1,500	$ 2,500	$ 5,000	$ 16,000	$ 48,000	$ 54,500	$ 5,760	$ 3,840	$ 1,000	$ 65,100	$ 9,765	$ 7,487	**$ 82,352**	$ 41,176
Demolition Area 3	2.0	1.20	$ 1,500	$ 2,500	$ 5,000	$ 16,000	$ 38,400	$ 44,900	$ 4,608	$ 3,072	$ 1,000	$ 53,580	$ 8,037	$ 6,162	**$ 67,779**	$ 33,889
Total	*4.0*		*$ 3,000*		*$ 10,000*		*$ 86,400*	*$ 99,400*	*$ 10,368*	*$ 6,912*	*$ 2,000*	*$ 118,680*	*$ 17,802*	*$ 13,648*	***$ 150,130***	$ 37,533

Excavation & Restoration Alternative

Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excavation +Rest.)	A-E Field Oversight	A-E Project Management	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Demolition Area 1[(b)]		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Demolition Area 2	2.0	1.50	$ 1,500	$ 2,500	$ 5,000	$ 80,667	$ 161,334	$ 4,000	$ 170,334	$ 19,360	$ 12,907	$ 202,601	$ 30,390	$ 23,299	**$ 256,290**	$ 128,145
Demolition Area 3	2.0	1.20	$ 1,500	$ 2,500	$ 5,000	$ 80,667	$ 161,334	$ 4,000	$ 170,334	$ 19,360	$ 12,907	$ 202,601	$ 30,390	$ 23,299	**$ 256,290**	$ 128,145
Total	*4.0*		*$ 3,000*		*$ 10,000*		$ 322,668	$ 8,000	$ 340,668	$ 38,720	$ 25,813	$ 405,202	$ 60,780	$ 46,598	**$ 512,580**	$ 128,145

Notes:

[1] The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

[2] Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 per acre based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

[3] Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

[4] Institutional Control Cost Estimates are based on the installation and maintenance costs for signs.

[5] A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

[6] A-E Project Management estimated at 8% of ordnance removal costs.

[7] Land survey costs are lump sum and it will include marking site boundaries and establishing a grid system within the site for clearance. $500 per acre

[8] Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

[9] Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

(a) Demolition Area 1 removed with Landfill 4. Additional clearance costs not included (only ICs calculated).

DETAILED COST ESTIMATES
ROADS AND TRAILS
BONNEVILLE RI/FS

	Institutional Controls		
Site	Size (Acres)		Institutional Controls ($1500/acre)
Roads and Trails	110.0		$ 165,000

	Surface Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Roads and Trails	110.0	1.20	$ 165,000	$ -	$ -	$4,500	$ 594,000	$ 759,000	$ 71,280	$ 47,520	$ 55,000	$ 932,800	$ 139,920	$ 107,272	**$ 1,179,992**	$ 10,727

	Frost Depth (14") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Roads and Trails	110.0	1.20	$ 165,000	$ -	$ -	$9,300	$ 1,227,600	$ 1,392,600	$ 147,312	$ 98,208	$ 55,000	$ 1,693,120	$ 253,968	$ 194,709	**$ 2,141,797**	$ 19,471

	Subsurface (24") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Roads and Trails	110.0	1.20	$ 165,000	$ -	$ -	$ 12,200	$ 1,610,400	$ 1,775,400	$ 193,248	$ 128,832	$ 55,000	$ 2,152,480	$ 322,872	$ 247,535	**$ 2,722,887**	$ 24,754

	Subsurface (48") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Roads and Trails	110.0	1.20	$ 165,000	$ -	$ -	$ 16,000	$ 2,112,000	$ 2,277,000	$ 253,440	$ 168,960	$ 55,000	$ 2,754,400	$ 413,160	$ 316,756	**$ 3,484,316**	$ 31,676

	Excavation & Restoration Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excavation +Rest.)	A-E Field Oversight	A-E Project Mgt	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Roads and Trails	110.0	1.20	$ -	$ -	$ -	$ 80,667	$ 8,873,370	$ 220,000	$ 9,093,370	$ 1,064,804	$ 709,870	$ 10,868,044	$ 1,630,207	$ 1,249,825	**$ 13,748,076**	$ 124,983

Notes:

[1] The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

[2] Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 per acre based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

[3] Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

[4] Institutional Control Cost Estimates are based on the installation and maintenance costs for signs and land use controls and maintenance of the existing fence.

[5] A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

[6] A-E Project Management estimated at 8% of ordnance removal costs.

[7] Land survey ($500 per acre) includes marking site boundaries and establishing a grid system within the site for clearance.

[8] Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

[9] Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

[10] Brush clearance not required on established roads and trails.

[11] Assumed 45 miles of roads and trails, 20-feet wide (approximately 110 acres).

[12] Assumed average terrain (open) and moderate slope for V/T modifier of 1.20

DETAILED COST ESTIMATES
WILDLIFE MANAGEMENT AREA
BONNEVILLE RI/FS

	Institutional Controls		
Site	Size (Acres)		Institutional Controls ($1500/acre)
Wildlife Mgmt Area	2000.0		$ 3,000,000

	Surface Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Wildlife Mgmt Area	2000.0	2.00	$ 3,000,000	$ -	$ -	$4,500	$ 18,000,000	$ 21,000,000	$ 2,160,000	$ 1,440,000	$ 1,000,000	$ 25,600,000	$ 3,840,000	$ 2,944,000	**$ 32,384,000**	$ 16,192

	Frost Depth (14") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Wildlife Mgmt Area	2000.0	2.00	$ 3,000,000	$ 5,000	$ 10,000,000	$9,300	$ 37,200,000	$ 50,200,000	$ 4,464,000	$ 2,976,000	$ 1,000,000	$ 58,640,000	$ 8,796,000	$ 6,743,600	**$ 74,179,600**	$ 37,090

	Subsurface (24") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Wildlife Mgmt Area	2000.0	2.00	$ 3,000,000	$ 5,000	$ 10,000,000	$ 12,200	$ 48,800,000	$ 61,800,000	$ 5,856,000	$ 3,904,000	$ 1,000,000	$ 72,560,000	$ 10,884,000	$ 8,344,400	**$ 91,788,400**	$ 45,894

	Subsurface (48") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Wildlife Mgmt Area	2000.0	2.00	$ 3,000,000	$ 5,000	$ 10,000,000	$ 16,000	$ 64,000,000	$ 77,000,000	$ 7,680,000	$ 5,120,000	$ 1,000,000	$ 90,800,000	$ 13,620,000	$ 10,442,000	**$ 114,862,000**	$ 57,431

	Excavation & Restoration Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excavation +Rest.)	A-E Field Oversight	A-E Project Mgt	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Wildlife Mgmt Area	2000.0	2.00	$ -	$ 5,000	$ 10,000,000	$ 80,667	$ 161,334,000	$ 4,000,000	$ 175,334,000	$ 19,360,080	$ 12,906,720	$ 207,600,800	$ 31,140,120	$ 23,874,092	**$ 262,615,012**	$ 131,308

Notes:

[1] The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

[2] Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 per acre based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

[3] Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

[4] Institutional Control Cost Estimates are based on the installation and maintenance costs for signs and land use controls and maintenance of the existing fence.

[5] A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

[6] A-E Project Management estimated at 8% of ordnance removal costs.

[7] Land survey ($500 per acre) includes marking site boundaries and establishing a grid system within the site for clearance.

[8] Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

[9] Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

DETAILED COST ESTIMATES
MEDIUM INTENSITY REUSE AREAS
BONNEVILLE RI/FS

	Institutional Controls		
Site	Size (Acres)		Institutional Controls ($1500/acre)
Medium Intensity Areas	770.0		$ 1,155,000

	Surface Clearance With Institutional Controls Alternative																
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Medium Intensity Areas	770.0	1.75	$ 1,155,000	$ -	$ -	$4,500	$ 6,063,750	$ 7,218,750	$ 727,650	$ 485,100	$ 385,000	$ 8,816,500	$ 1,322,475	$ 1,013,898	**$ 11,152,873**	$ 14,484

	Frost Depth (14") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Medium Intensity Areas	770.0	1.75	$ 1,155,000	$ 5,000	$ 3,850,000	$9,300	$ 12,531,750	$ 17,536,750	$ 1,503,810	$ 1,002,540	$ 385,000	$ 20,428,100	$ 3,064,215	$ 2,349,232	**$ 25,841,547**	$ 33,560

	Subsurface (24") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Medium Intensity Areas	770.0	1.75	$ 1,155,000	$ 5,000	$ 3,850,000	$ 12,200	$ 16,439,500	$ 21,444,500	$ 1,972,740	$ 1,315,160	$ 385,000	$ 25,117,400	$ 3,767,610	$ 2,888,501	**$ 31,773,511**	$ 41,264

	Subsurface (48") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Medium Intensity Areas	770.0	1.75	$ 1,155,000	$ 5,000	$ 3,850,000	$ 16,000	$ 21,560,000	$ 26,565,000	$ 2,587,200	$ 1,724,800	$ 385,000	$ 31,262,000	$ 4,689,300	$ 3,595,130	**$ 39,546,430**	$ 51,359

	Excavation & Restoration Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excavation +Rest.)	A-E Field Oversight	A-E Project Mgt	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Medium Intensity Areas	770.0	1.75	$ -	$ 5,000	$ 3,850,000	$ 80,667	$ 62,113,590	$ 1,540,000	$ 67,503,590	$ 7,453,631	$ 4,969,087	$ 79,926,308	$ 11,988,946	$ 9,191,525	**$ 101,106,780**	$ 131,308

Notes:

[1] The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

[2] Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 per acre based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

[3] Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

[4] Institutional Control Cost Estimates are based on the installation and maintenance costs for signs and land use controls and maintenance of the existing fence.

[5] A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

[6] A-E Project Management estimated at 8% of ordnance removal costs.

[7] Land survey ($500 per acre) includes marking site boundaries and establishing a grid system within the site for clearance.

[8] Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

[9] Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

DETAILED COST ESTIMATES
HIGH ACCESS MEDIUM INTENSITY REUSE AREAS
BONNEVILLE RI/FS

	Institutional Controls		
Site	Size (Acres)		Institutional Controls ($1500/acre)
Medium Intensity/High Access	180.0		$ 270,000

	Surface Clearance With Institutional Controls Alternative																
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Medium Intensity/High Access	180.0	1.20	$ 270,000	$ -	$ -	$4,500	$ 972,000	$ 1,242,000	$ 116,640	$ 77,760	$ 90,000	$ 1,526,400	$ 228,960	$ 175,536	**$ 1,930,896**	$ 10,727

	Frost Depth (14") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Medium Intensity/High Access	180.0	1.20	$ 270,000	$ 5,000	$ 900,000	$9,300	$ 2,008,800	$ 3,178,800	$ 241,056	$ 160,704	$ 90,000	$ 3,670,560	$ 550,584	$ 422,114	**$ 4,643,258**	$ 25,796

	Subsurface (24") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Medium Intensity/High Access	180.0	1.20	$ 270,000	$ 5,000	$ 900,000	$ 12,200	$ 2,635,200	$ 3,805,200	$ 316,224	$ 210,816	$ 90,000	$ 4,422,240	$ 663,336	$ 508,558	**$ 5,594,134**	$ 31,079

	Subsurface (48") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Medium Intensity/High Access	180.0	1.20	$ 270,000	$ 5,000	$ 900,000	$ 16,000	$ 3,456,000	$ 4,626,000	$ 414,720	$ 276,480	$ 90,000	$ 5,407,200	$ 811,080	$ 621,828	**$ 6,840,108**	$ 38,001

	Excavation & Restoration Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excavation +Rest.)	A-E Field Oversight	A-E Project Mgt	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Medium Intensity/High Access	180.0	1.20	$ -	$ 5,000	$ 900,000	$ 80,667	$ 14,520,060	$ 360,000	$ 15,780,060	$ 1,742,407	$ 1,161,605	$ 18,684,072	$ 2,802,611	$ 2,148,668	**$ 23,635,351**	$ 131,308

Notes:

[1] The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

[2] Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 per acre based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

[3] Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

[4] Institutional Control Cost Estimates are based on the installation and maintenance costs for signs and land use controls and maintenance of the existing fence.

[5] A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

[6] A-E Project Management estimated at 8% of ordnance removal costs.

[7] Land survey ($500 per acre) includes marking site boundaries and establishing a grid system within the site for clearance.

[8] Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

[9] Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

DETAILED COST ESTIMATES
HIGH INTENSITY REUSE AREAS
BONNEVILLE RI/FS

	Institutional Controls		
Site	Size (Acres)		Institutional Controls ($1500/acre)
High Intensity Reuse (Intrusive)	50.0		$ 75,000

	Surface Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
High Intensity Reuse (Intrusive)	50.0	1.50	$ 75,000	$ -	$ -	$4,500	$ 337,500	$ 412,500	$ 40,500	$ 27,000	$ 25,000	$ 505,000	$ 75,750	$ 58,075	**$ 638,825**	$ 12,777

	Frost Depth (14") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
High Intensity Reuse (Intrusive)	50.0	1.50	$ 75,000	$ 5,000	$ 250,000	$9,300	$ 697,500	$ 1,022,500	$ 83,700	$ 55,800	$ 25,000	$ 1,187,000	$ 178,050	$ 136,505	**$ 1,501,555**	$ 30,031

	Subsurface (24") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
High Intensity Reuse (Intrusive)	50.0	1.50	$ 75,000	$ 5,000	$ 250,000	$ 12,200	$ 915,000	$ 1,240,000	$ 109,800	$ 73,200	$ 25,000	$ 1,448,000	$ 217,200	$ 166,520	**$ 1,831,720**	$ 36,634

	Subsurface (48") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
High Intensity Reuse (Intrusive)	50.0	1.50	$ 75,000	$ 5,000	$ 250,000	$ 16,000	$ 1,200,000	$ 1,525,000	$ 144,000	$ 96,000	$ 25,000	$ 1,790,000	$ 268,500	$ 205,850	**$ 2,264,350**	$ 45,287

	Excavation & Restoration Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excavation +Rest.)	A-E Field Oversight	A-E Project Mgt	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
High Intensity Reuse (Intrusive)	50.0	1.50	$ -	$ 5,000	$ 250,000	$ 80,667	$ 4,033,350	$ 100,000	$ 4,383,350	$ 484,002	$ 322,668	$ 5,190,020	$ 778,503	$ 596,852	**$ 6,565,375**	$ 131,308

DETAILED COST ESTIMATES
HIGH INTENSITY REUSE AREAS
BONNEVILLE RI/FS

	Institutional Controls		
Site	Size (Acres)		Institutional Controls ($1500/acre)
High Intensity Reuse (Non-Intrusive)	160.0		$ 240,000

	Surface Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
High Intensity Reuse (Non-Intrusive)	160.0	1.50	$ 240,000	$ -	$ -	$4,500	$ 1,080,000	$ 1,320,000	$ 129,600	$ 86,400	$ 80,000	$ 1,616,000	$ 242,400	$ 185,840	**$ 2,044,240**	$ 12,777

	Frost Depth (14") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
High Intensity Reuse (Non-Intrusive)	160.0	1.50	$ 240,000	$ 5,000	$ 800,000	$9,300	$ 2,232,000	$ 3,272,000	$ 267,840	$ 178,560	$ 80,000	$ 3,798,400	$ 569,760	$ 436,816	**$ 4,804,976**	$ 30,031

	Subsurface (24") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
High Intensity Reuse (Non-Intrusive)	160.0	1.50	$ 240,000	$ 5,000	$ 800,000	$ 12,200	$ 2,928,000	$ 3,968,000	$ 351,360	$ 234,240	$ 80,000	$ 4,633,600	$ 695,040	$ 532,864	**$ 5,861,504**	$ 36,634

	Subsurface (48") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
High Intensity Reuse (Non-Intrusive)	160.0	1.50	$ 240,000	$ 5,000	$ 800,000	$ 16,000	$ 3,840,000	$ 4,880,000	$ 460,800	$ 307,200	$ 80,000	$ 5,728,000	$ 859,200	$ 658,720	**$ 7,245,920**	$ 45,287

	Excavation & Restoration Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excavation +Rest.)	A-E Field Oversight	A-E Project Mgt	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
High Intensity Reuse (Non-Intrusive)	160.0	1.50	$ -	$ 5,000	$ 800,000	$ 80,667	$ 12,906,720	$ 320,000	$ 14,026,720	$ 1,548,806	$ 1,032,538	$ 16,608,064	$ 2,491,210	$ 1,909,927	**$ 21,009,201**	$ 131,308

Notes:

[1] The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

[2] Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 per acre based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

[3] Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

[4] Institutional Control Cost Estimates are based on the installation and maintenance costs for signs and land use controls and maintenance of the existing fence.

[5] A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

[6] A-E Project Management estimated at 8% of ordnance removal costs.

[7] Land survey ($500 per acre) includes marking site boundaries and establishing a grid system within the site for clearance.

[8] Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

[9] Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

DETAILED COST ESTIMATES
CENTRAL IMPACT AREA (NOT INCLUDING TARGETS)
BONNEVILLE RI/FS

	Institutional Controls		
Site	Size (Acres)		Institutional Controls ($1500/acre)
Central Impact Area (Not including Targets)	382.0		$ 573,000

	Surface Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Central Impact Area (Not including Targets)	382.0	2.00	$ 573,000	$ -	$ -	$4,500	$ 3,438,000	$ 4,011,000	$ 412,560	$ 275,040	$ 191,000	$ 4,889,600	$ 733,440	$ 562,304	**$ 6,185,344**	$ 16,192

	Frost Depth (14") with Institutional Controls Clearance Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Central Impact Area (Not including Targets)	382.0	2.00	$ 573,000	$ 5,000	$ 1,910,000	$9,300	$ 7,105,200	$ 9,588,200	$ 852,624	$ 568,416	$ 191,000	$ 11,200,240	$ 1,680,036	$ 1,288,028	**$ 14,168,304**	$ 37,090

	Subsurface (24") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Central Impact Area (Not including Targets)	382.0	2.00	$ 573,000	$ 5,000	$ 1,910,000	$ 12,200	$ 9,320,800	$ 11,803,800	$ 1,118,496	$ 745,664	$ 191,000	$ 13,858,960	$ 2,078,844	$ 1,593,780	**$ 17,531,584**	$ 45,894

	Subsurface (48") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Central Impact Area (Not including Targets)	382.0	2.00	$ 573,000	$ 5,000	$ 1,910,000	$ 16,000	$ 12,224,000	$ 14,707,000	$ 1,466,880	$ 977,920	$ 191,000	$ 17,342,800	$ 2,601,420	$ 1,994,422	**$ 21,938,642**	$ 57,431

	Excavation & Restoration Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excavation +Rest.)	A-E Field Oversight	A-E Project Mgt	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Central Impact Area (Not including Targets)	382.0	2.00	$ -	$ 5,000	$ 1,910,000	$ 80,667	$ 30,814,794	$ 764,000	$ 33,488,794	$ 3,697,775	$ 2,465,184	$ 39,651,753	$ 5,947,763	$ 4,559,952	**$ 50,159,467**	$ 131,308

Notes:

[1] The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

[2] Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 per acre based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

[3] Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

[4] Institutional Control Cost Estimates are based on the installation and maintenance costs for signs and land use controls and maintenance of the existing fence.

[5] A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

[6] A-E Project Management estimated at 8% of ordnance removal costs.

[7] Land survey ($500 per acre) includes marking site boundaries and establishing a grid system within the site for clearance.

[8] Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

[9] Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

DETAILED COST ESTIMATES
CENTRAL IMPACT AREA TARGETS
BONNEVILLE RI/FS

	Institutional Controls		
Site	Size (Acres)		Institutional Controls ($1500/acre)
Central Impact Targets			
West Impact Area Car 2	8.0		$ 12,000
Combined Impact Area 1	32.0		$ 48,000
Combined Impact Area 2	43.0		$ 64,500
Total	*83.0*		*$ 124,500*

	Surface Clearance With Institutional Controls Alternative																
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Central Impact Targets																
West Impact Area Car 2	8.0	2.00	$ 12,000	$ -	$ -	$4,500	$ 72,000	$ 84,000	$ 8,640	$ 5,760	$ 4,000	$ 102,400	$ 15,360	$ 11,776	**$ 129,536**	$ 16,192
Combined Impact Area 1	32.0	2.00	$ 48,000	$ -	$ -	$4,500	$ 288,000	$ 336,000	$ 34,560	$ 23,040	$ 16,000	$ 409,600	$ 61,440	$ 47,104	**$ 518,144**	$ 16,192
Combined Impact Area 2	43.0	2.00	$ 64,500	$ -	$ -	$4,500	$ 387,000	$ 451,500	$ 46,440	$ 30,960	$ 21,500	$ 550,400	$ 82,560	$ 63,296	**$ 696,256**	$ 16,192
Total	*83.0*		*$ 124,500*				*$ 747,000*	*$ 871,500*	*$ 89,640*	*$ 59,760*	*$ 41,500*	*$ 1,062,400*	*$ 159,360*	*$ 122,176*	***$ 1,343,936***	

	Frost Depth (14") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Central Impact Targets																
West Impact Area Car 2	8.0	2.00	$ 12,000	$ 5,000	$ 40,000	$9,300	$ 148,800	$ 200,800	$ 17,856	$ 11,904	$ 4,000	$ 234,560	$ 35,184	$ 26,974	**$ 296,718**	$ 37,090
Combined Impact Area 1	32.0	2.00	$ 48,000	$ 5,000	$ 160,000	$9,300	$ 595,200	$ 803,200	$ 71,424	$ 47,616	$ 16,000	$ 938,240	$ 140,736	$ 107,898	**$ 1,186,874**	$ 37,090
Combined Impact Area 2	43.0	2.00	$ 64,500	$ 5,000	$ 215,000	$9,300	$ 799,800	$ 1,079,300	$ 95,976	$ 63,984	$ 21,500	$ 1,260,760	$ 189,114	$ 144,987	**$ 1,594,861**	$ 37,090
Total	*83.0*		*$ 124,500*		*$ 415,000*		*$ 1,543,800*	*$ 2,083,300*	*$ 185,256*	*$ 123,504*	*$ 41,500*	*$ 2,433,560*	*$ 365,034*	*$ 279,859*	***$ 3,078,453***	

	Subsurface (24") Clearance With Institutional Controls Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Central Impact Targets																
West Impact Area Car 2	8.0	2.00	$ 12,000	$ 5,000	$ 40,000	$ 12,200	$ 195,200	$ 247,200	$ 23,424	$ 15,616	$ 4,000	$ 290,240	$ 43,536	$ 33,378	**$ 367,154**	$ 45,894
Combined Impact Area 1	32.0	2.00	$ 48,000	$ 5,000	$ 160,000	$ 12,200	$ 780,800	$ 988,800	$ 93,696	$ 62,464	$ 16,000	$ 1,160,960	$ 174,144	$ 133,510	**$ 1,468,614**	$ 45,894
Combined Impact Area 2	43.0	2.00	$ 64,500	$ 5,000	$ 215,000	$ 12,200	$ 1,049,200	$ 1,328,700	$ 125,904	$ 83,936	$ 21,500	$ 1,560,040	$ 234,006	$ 179,405	**$ 1,973,451**	$ 45,894
Total	*83.0*		*$ 124,500*		*$ 415,000*		*$ 2,025,200*	*$ 2,564,700*	*$ 243,024*	*$ 162,016*	*$ 41,500*	*$ 3,011,240*	*$ 451,686*	*$ 346,293*	***$ 3,809,219***	

DETAILED COST ESTIMATES
CENTRAL IMPACT AREA TARGETS
BONNEVILLE RI/FS

DETAILED COST ESTIMATES
CENTRAL IMPACT AREA TARGETS
BONNEVILLE RI/FS

Subsurface (48") Clearance With Institutional Controls Alternative

Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Central Impact Targets																
West Impact Area Car 2	8.0	2.00	$ 12,000	$ 5,000	$ 40,000	$ 16,000	$ 256,000	$ 308,000	$ 30,720	$ 20,480	$ 4,000	$ 363,200	$ 54,480	$ 41,768	**$ 459,448**	$ 57,431
Combined Impact Area 1	32.0	2.00	$ 48,000	$ 5,000	$ 160,000	$ 16,000	$ 1,024,000	$ 1,232,000	$ 122,880	$ 81,920	$ 16,000	$ 1,452,800	$ 217,920	$ 167,072	**$ 1,837,792**	$ 57,431
Combined Impact Area 2	43.0	2.00	$ 64,500	$ 5,000	$ 215,000	$ 16,000	$ 1,376,000	$ 1,655,500	$ 165,120	$ 110,080	$ 21,500	$ 1,952,200	$ 292,830	$ 224,503	**$ 2,469,533**	$ 57,431
Total	*83.0*		*$ 124,500*		*$ 415,000*		*$ 2,656,000*	*$ 3,195,500*	*$ 318,720*	*$ 212,480*	*$ 41,500*	*$ 3,768,200*	*$ 565,230*	*$ 433,343*	***$ 4,766,773***	

Excavation & Restoration Alternative

Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excavation +Rest.)	A-E Field Oversight	A-E Project Mgt	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Central Impact Targets									$ -			$ -				
West Impact Area Car 2	8.0	2.00	$ -	$ 5,000	$ 40,000	$ 80,667	$ 645,336	$ 16,000	$ 701,336	$ 77,440	$ 51,627	$ 830,403	$ 124,560	$ 95,496	**$ 1,050,460**	$ 131,308
Combined Impact Area 1	32.0	2.00	$ -	$ 5,000	$ 160,000	$ 80,667	$ 2,581,344	$ 64,000	$ 2,805,344	$ 309,761	$ 206,508	$ 3,321,613	$ 498,242	$ 381,985	**$ 4,201,840**	$ 131,308
Combined Impact Area 2	43.0	2.00	$ -	$ 5,000	$ 215,000	$ 80,667	$ 3,468,681	$ 86,000	$ 3,769,681	$ 416,242	$ 277,494	$ 4,463,417	$ 669,513	$ 513,293	**$ 5,646,223**	$ 131,308
Total	*83.0*				*$ 415,000*		*$ 6,695,361*	*$ 166,000*	*$ 7,276,361*	*$ 803,443*	*$ 535,629*	*$ 8,615,433*	*$ 1,292,315*	*$ 990,775*	***$ 10,898,523***	

Notes:

\1 The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

\2 Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 per acre based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

\3 Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

\4 Institutional Control Cost Estimates are based on the installation and maintenance costs for signs and land use controls and maintenance of the existing fence.

\5 A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

\6 A-E Project Management estimated at 8% of ordnance removal costs.

\7 Land survey ($500 per acre) includes marking site boundaries and establishing a grid system within the site for clearance.

\8 Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

\9 Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

DETAILED COST ESTIMATES
TARGETS AREA
BONNEVILLE RI/FS

Site	Size (Acres)		Institutional Controls ($1500/acre)
Targets			
3.5-inch Rocket Range	5.2		$ 7,800
Rifle Grenade Range	4.0		$ 5,966
Hand Grenade (HE) Range	1.1		$ 1,679
2.36-inch Rocket Target	0.3		$ 1,500
M203 HE Grenade Range[(a)]	4.0		$ 6,000
Total	*14.6*		*$ 22,944*

Surface Clearance Alternative

Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Surface Sweep Cost/Acre	Total Surface Sweep Cost	Net Cost (ICs+Surface Sweep)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Targets																
3.5-inch Rocket Range	5.2	1.50	$ 7,800	$ -	$ -	$4,500	$ 35,100	$ 42,900	$ 4,212	$ 2,808	$ 2,600	$ 52,520	$ 7,878	$ 6,040	**$ 66,438**	$ 12,777
Rifle Grenade Range	4.0	1.35	$ 5,966	$ -	$ -	$4,500	$ 24,160	$ 30,126	$ 2,899	$ 1,933	$ 1,989	$ 36,946	$ 5,542	$ 4,249	**$ 46,737**	$ 11,752
Hand Grenade (HE) Range	1.1	1.35	$ 1,679	$ -	$ -	$4,500	$ 6,798	$ 8,476	$ 816	$ 544	$ 560	$ 10,396	$ 1,559	$ 1,195	**$ 13,150**	$ 11,752
2.36-inch Rocket Target	0.3	1.20	$ 1,500	$ -	$ -	$4,500	$ 1,404	$ 2,904	$ 168	$ 112	$ 130	$ 3,315	$ 497	$ 381	**$ 4,193**	$ 16,128
M203 HE Grenade Range[(a)]			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	NA
Total	*10.6*		*$ 16,944*				*$ 67,462*	*$ 84,406*	*$ 8,095*	*$ 5,397*	*$ 5,278*	*$ 103,177*	*$ 15,476*	*$ 11,865*	***$ 130,518***	*$ 12,364*

Frost Depth (14") Clearance Alternative

Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
Targets																
3.5-inch Rocket Range	5.2	1.50	$ 7,800	$ 2,500	$ 13,000	$9,300	$ 72,540	$ 93,340	$ 8,705	$ 5,803	$ 2,600	$ 110,448	$ 16,567	$ 12,702	**$ 139,717**	$ 26,869
Rifle Grenade Range	4.0	1.35	$ 5,966	$ 2,500	$ 9,943	$9,300	$ 49,931	$ 65,839	$ 5,992	$ 3,994	$ 1,989	$ 77,814	$ 11,672	$ 8,949	**$ 98,435**	$ 24,751
Hand Grenade (HE) Range	1.1	1.35	$ 1,679	$ 2,500	$ 2,798	$9,300	$ 14,049	$ 18,525	$ 1,686	$ 1,124	$ 560	$ 21,894	$ 3,284	$ 2,518	**$ 27,696**	$ 24,751
2.36-inch Rocket Target	0.3	1.20	$ 1,500	$ 2,500	$ 650	$9,300	$ 2,902	$ 5,052	$ 348	$ 232	$ 130	$ 5,762	$ 864	$ 663	**$ 7,289**	$ 28,034
M203 HE Grenade Range[(a)]			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	NA
Total	*10.6*		*$ 16,944*		*$ 26,390*		*$ 139,422*	*$ 182,756*	*$ 16,731*	*$ 11,154*	*$ 5,278*	*$ 215,918*	*$ 32,388*	*$ 24,831*	***$ 273,137***	*$ 25,875*

Subsurface (24") Clearance Alternative

Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
3.5-inch Rocket Range	5.2	1.50	$ 7,800	$ 2,500	$ 13,000	$ 12,200	$ 95,160	$ 115,960	$ 11,419	$ 7,613	$ 2,600	$ 137,592	$ 20,639	$ 15,823	**$ 174,054**	$ 33,472
Rifle Grenade Range	4.0	1.35	$ 5,966	$ 2,500	$ 9,943	$ 12,200	$ 65,501	$ 81,409	$ 7,860	$ 5,240	$ 1,989	$ 96,498	$ 14,475	$ 11,097	**$ 122,070**	$ 30,694
Hand Grenade (HE) Range	1.1	1.35	$ 1,679	$ 2,500	$ 2,798	$ 12,200	$ 18,430	$ 22,906	$ 2,212	$ 1,474	$ 560	$ 27,151	$ 4,073	$ 3,122	**$ 34,347**	$ 30,694
2.36-inch Rocket Target	0.3	1.20	$ 1,500	$ 2,500	$ 650	$ 12,200	$ 3,806	$ 5,956	$ 457	$ 305	$ 130	$ 6,848	$ 1,027	$ 787	**$ 8,662**	$ 33,317
M203 HE Grenade Range[(a)]			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	NA
Total	*10.6*		*$ 16,944*		*$ 26,390*		*$ 182,898*	*$ 226,232*	*$ 21,948*	*$ 14,632*	*$ 5,278*	*$ 268,089*	*$ 40,213*	*$ 30,830*	***$ 339,133***	*$ 32,127*

DETAILED COST ESTIMATES
TARGETS AREA
BONNEVILLE RI/FS

		Subsurface (48") Clearance Alternative															
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance Removal Cost/Acre	Total Ordnance Removal Cost	Net Cost (ICs+Brush Clr+OE Rmvl)	A-E Field Oversight	A-E Project Mgt	Land Survey Costs	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
3.5-inch Rocket Range	5.2	1.50	$ 7,800	$ 2,500	$ 13,000	$ 16,000	$ 124,800	$ 145,600	$ 14,976	$ 9,984	$ 2,600	$ 173,160	$ 25,974	$ 19,913	**$ 219,047**	$ 42,125
Rifle Grenade Range	4.0	1.35	$ 5,966	$ 2,500	$ 9,943	$ 16,000	$ 85,903	$ 101,811	$ 10,308	$ 6,872	$ 1,989	$ 120,980	$ 18,147	$ 13,913	**$ 153,040**	$ 38,481
Hand Grenade (HE) Range	1.1	1.35	$ 1,679	$ 2,500	$ 2,798	$ 16,000	$ 24,170	$ 28,646	$ 2,900	$ 1,934	$ 560	$ 34,040	$ 5,106	$ 3,915	**$ 43,061**	$ 38,481
2.36-inch Rocket Target	0.3	1.20	$ 1,500	$ 2,500	$ 650	$ 16,000	$ 4,992	$ 7,142	$ 599	$ 399	$ 130	$ 8,270	$ 1,241	$ 951	**$ 10,462**	$ 40,239
M203 HE Grenade Range[(a)]			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	NA
Total	*10.6*		*$ 16,944*		*$ 26,390*		*$ 239,866*	*$ 283,200*	*$ 28,784*	*$ 19,189*	*$ 5,278*	*$ 336,451*	*$ 50,468*	*$ 38,692*	***$ 425,610***	*$ 40,319*

		Excavation & Restoration Alternative														
Site	Size (Acres)	Veg./ Terrain Modifier	Institutional Controls ($1500/acre)	Brush Clear per Acre	Total Brush Clear	Ordnance/Soil Removal Cost/Acre	Total Removal Cost	Restoration	Net Cost (Brush Clr+Excavation +Rest.)	A-E Field Oversight	A-E Project Mgt	Subtotal	Contracting & Oversight	10% Contingency	**Total Estimate**	Approximate Cost per Acre
3.5-inch Rocket Range	5.2	1.50	$ -	$ 2,500	$ 13,000	$ 80,667	$ 419,468	$ 10,400	$ 442,868	$ 50,336	$ 33,557	$ 526,762	$ 79,014	$ 60,578	**$ 666,354**	$ 128,145
Rifle Grenade Range	4.0	1.35	$ -	$ 2,500	$ 9,943	$ 80,667	$ 320,813	$ 7,954	$ 338,709	$ 38,498	$ 25,665	$ 402,872	$ 60,431	$ 46,330	**$ 509,633**	$ 128,145
Hand Grenade (HE) Range	1.1	1.35	$ -	$ 2,500	$ 2,798	$ 80,667	$ 90,266	$ 2,238	$ 95,302	$ 10,832	$ 7,221	$ 113,355	$ 17,003	$ 13,036	**$ 143,394**	$ 128,145
2.36-inch Rocket Target	0.3	1.20	$ -	$ 2,500	$ 650	$ 80,667	$ 20,973	$ 520	$ 22,143	$ 2,517	$ 1,678	$ 26,338	$ 3,951	$ 3,029	**$ 33,318**	$ 128,145
M203 HE Grenade Range[(a)]			$ -	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	NA
Total	*10.6*		*$ -*		*$ 26,390*		*$ 851,521*	*$ 21,112*	*$ 899,023*	*$ 102,183*	*$ 68,122*	*$ 1,069,327*	*$ 160,399*	*$ 122,973*	***$ 1,352,699***	*$ 128,145*

Notes:

[\1] The costing is based on the assumption that the clearance will be implemented individually at this site type. The costs may be less if the clearance is contracted and implemented concurrently with other site types.

[\2] Cost for OE Removal is generally based on the USAESC-Huntsville Cost Estimating Guide. Cost is based on manual digital geophysical mapping (DGM) of each location's individual acreage.
The number of anomalies requiring investigation after DGM is estimated to be between 25 – 75 per acre based on the RI/FS data.
A multiplier ranging from 1.0 – 2.0 was used to account for vegetation and terrain of each individual site.

[\3] Brush cutting costs based on the vegetation density at each site and they are obtained from USAESC-Huntsville Cost Estimating Guide

[\4] Institutional Control Cost Estimates are based on the installation and maintenance costs for signs.

[\5] A-E Field Oversight estimated at 12% of total ordnance removal costs. Includes documentation and reporting.

[\6] A-E Project Management estimated at 8% of ordnance removal costs.

[\7] Land survey costs ($500/acre) include marking site boundaries and establishing a grid system within the site for clearance.

[\8] Costs for Contracting and Oversight are estimated at 15% of the subtotal cost.

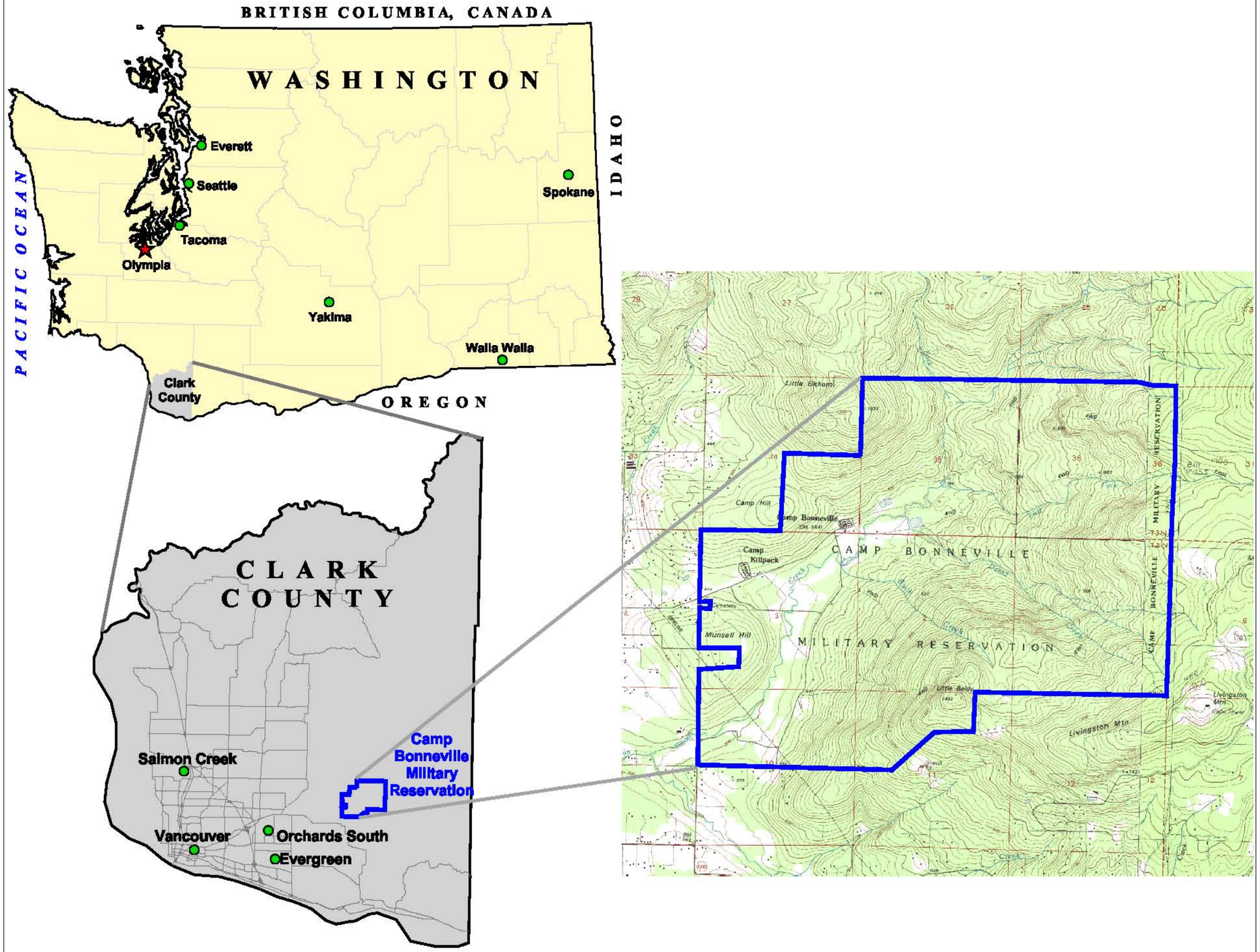
[\9] Costs for excavation is $5/cubic yard for excavation, screening and replacement. Restoration is $2,000 per acre

(a) Cleared to a depth of 2-feet and passed UXB QC and USAESCH QA. Additional clearance costs are not calculated (only ICs calculated).

Figure 2.1

Site Location Map

Camp Bonneville
Vancouver, WA



Legend

- State Capital
- City
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lecamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

N

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

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O:\Data\TWC\CLIENTS\Clark County\Vanc-Clark Parks\Camp Bonneville\GIS\Preliminary Site Plan 1-28-03 JR

Law Enforcement / Clark College / Rustic Retreat / Outdoor School Classrooms and Offices (C / O)

- Reuse / Renovate Existing Camp Killpack Buildings for Outdoor School, Retreat Center &/or Law Enforcement Training Center
- 3 to 6 Classrooms - New Building
- Administrative Offices
- Future Expansion As Needed
- Law Enforcement Training Areas

Rustic Retreat / Outdoor School (RR / OS)

- Reuse / Renovate Existing Camp Bonneville Buildings
- Classrooms
- Lodging
- Native American Cultural Center
- New Multi-Purpose Building and Other Building Expansion As Needed
- Park Administration Center
- Park Maintenance Headquarters

Rustic Retreat Future Expansion (RRFE)

- Future Building

Regional Park (RP)

- Hiking Trails
- Equestrian Trails
- Mountain Bike Trails
- Picnic Areas & Shelters
- Amphitheater & Stage
- Restrooms
- Tent/Yurt Camping
- RV Camping
- Park Watchperson's Residence
- Archery Range
- Park Entry / Control Station (Fee Collection Booth, Information Board, Kiosk & Turn Around)
- Tram Station & Route
- General Store
- Equestrian Center
- Trailhead & Parking

Firing Ranges (FR)

- Local Law Enforcement Range
- FBI Range
- Public Range
- Restrooms for Shooters
- Mine Gravel for Range Site

Environmental Study Area (ESA)

- Outdoor Studies
- CPU Well Field
- Water Resource Center (Wastewater Treatment Facility)

Trail and Nature Areas (TNA)

- Hiking Trails
- Equestrian Trails
- Mountain Bike Trails
- Wildlife Habitat Area

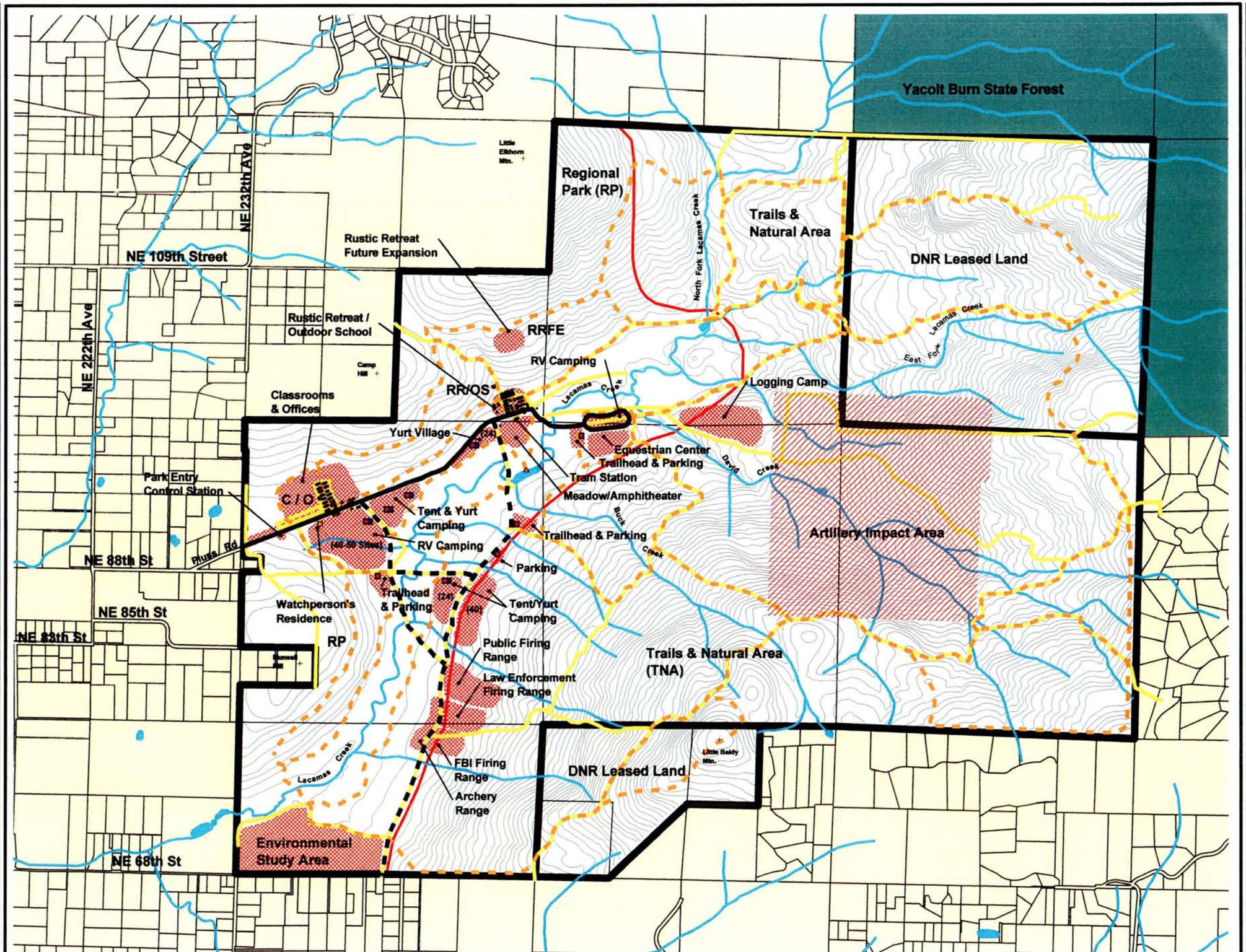


Figure 2.2

Camp Bonneville Reuse Plan

Preliminary Site Plan

LEGEND

- Restrooms & Showers
- Restrooms
- Watchperson's Residence
- Water Access
- Site Facilities
- 20 Foot Contour Intervals
- Trails
- Existing Unpaved Roads
- Gravel Road
- Paved Road
- Artillery Impact Area
- Regional Park Boundary
- Site Boundary Line
- Existing Buildings
- Taxlots
- Private Property
- Yalcolt Burn State Forest

N W E S

0 250 500 1,000 1,500 2,000 Feet

LAND AREA SUMMARY:

Camp Bonneville:	3,840 acres
DNR Land Area 'A':	620 acres
DNR Land Area 'B':	180 acres
TOTAL AREA:	4,640 acres

the jd white company, inc.

Creative Problem Solving

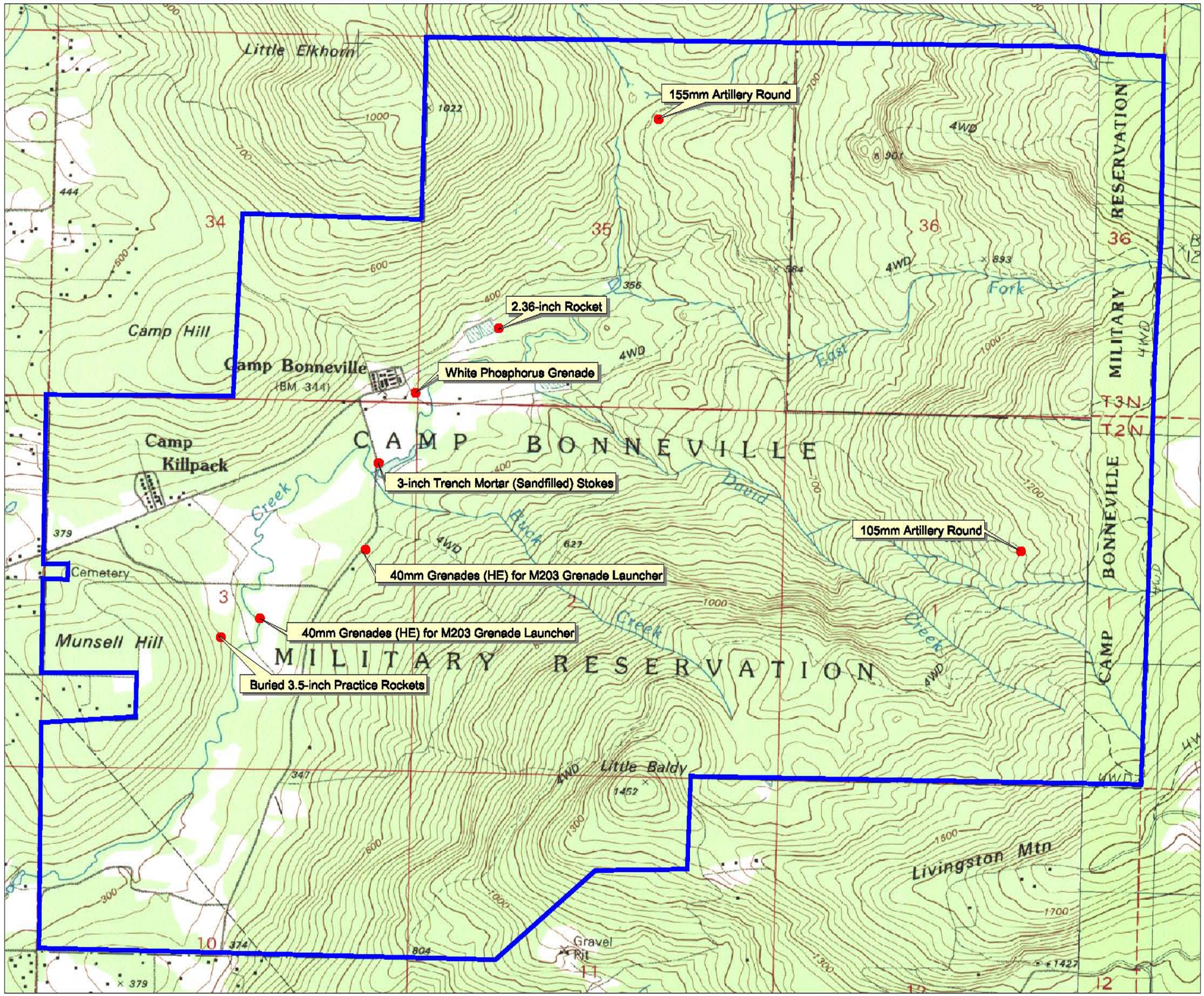
Plot Date: 1-28-03

Information Source: Clark County GIS Data Oct. 2002

Figure 3.1

Historical Ordnance Findings

Camp Bonneville
Vancouver, WA



Legend

- Item Location and Description
- Camp Bonneville Boundary

Data Source: ASR Plate 28 (USACE, 1997)

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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Figure 3.2

1998 Site Characterization Grid Location Map

Camp Bonneville
Vancouver, WA

Legend

Grid Locations
- UXO Present
- No UXO Present
- Sector Boundary & ID

Sector 1
Sector 2
Sector 3
Sector 4
Sector 5
Sector 6
Sector 7
Sector 8
Sector GR

Camp Bonneville
(BM 344)
Camp Killpack
Camp Hill
Munsell Hill
Little Elkhorn
Little Baldy
Livingston Mtn
Gravel Pit
Cemetery
Buck Creek
David Creek
East Fork
CAMP BONNEVILLE
MILITARY RESERVATION
CAMP BONNEVILLE MILITARY RESERVATION

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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	FILE: w:\bonneville\gis\mapfiles\report_rifs\chap3_fig.apr		

Figure 3.3

Demolition Area 1
Interim Removal Action

Camp Bonneville
Vancouver, WA

Legend

- Location of Interim Removal Action
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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SUBMITTED BY: GTM	DATE: October 2003	PAGE NUMBER:	
	FILE: w:\bonneville\gis\mapfiles\report_rifs\chap3_figs.apr		

Figure 3.4

M203 Ranges Interim Removal Action

Camp Bonneville
Vancouver, WA

Legend

- Location of Interim Removal Action
- Camp Bonneville Boundary

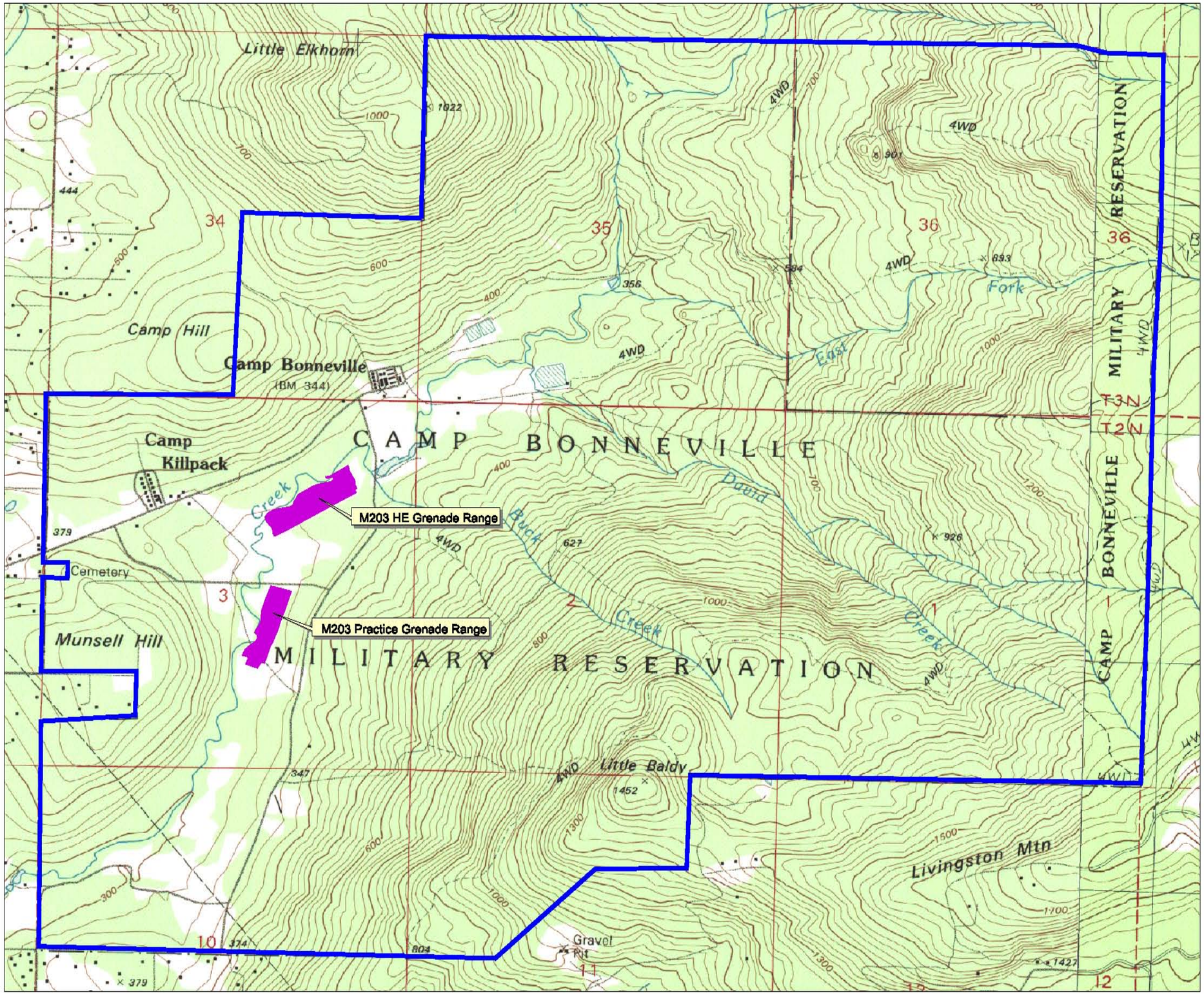

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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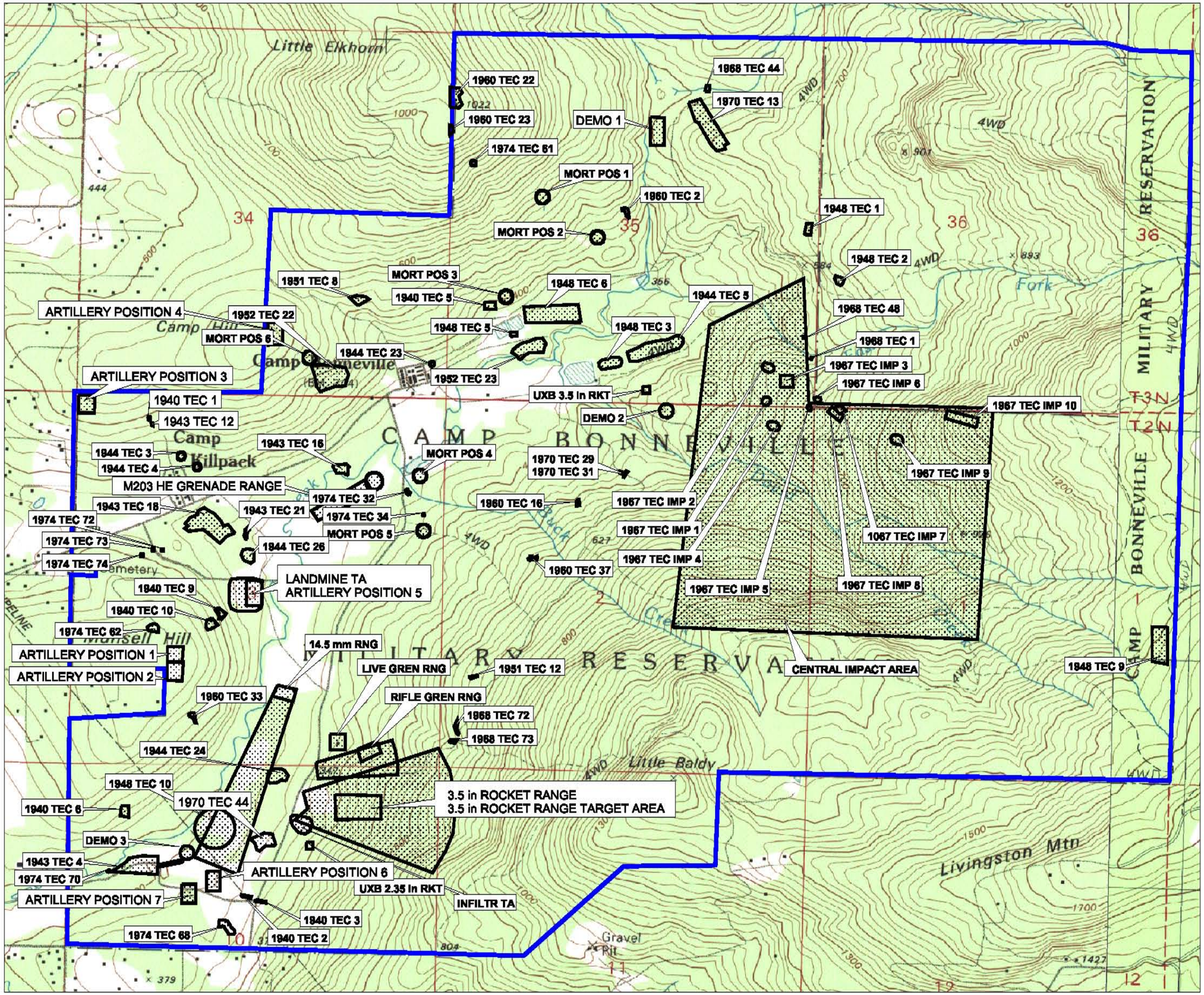
CHECKED BY: RLS	SCALE: As Shown	PROJECT NUMBER: 740973	
SUBMITTED BY: GTM	DATE: October 2003	PAGE NUMBER:	
	FILE: w:\bonneville\gis\mapfiles\report_rifs\chap3_figs.apr		

Figure 3.5

AOC/AOPC Locations

Camp Bonneville
Vancouver, WA



Legend

- 1943 TEC 16 — Location and Source of AOPC. Year Refers to Year of Aerial Photo and TEC 16 Refers to Feature Number Identified on Aerial Photo.
- MORT POS 1 — Location and Description of AOC
- AOC/AOPC Boundaries
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

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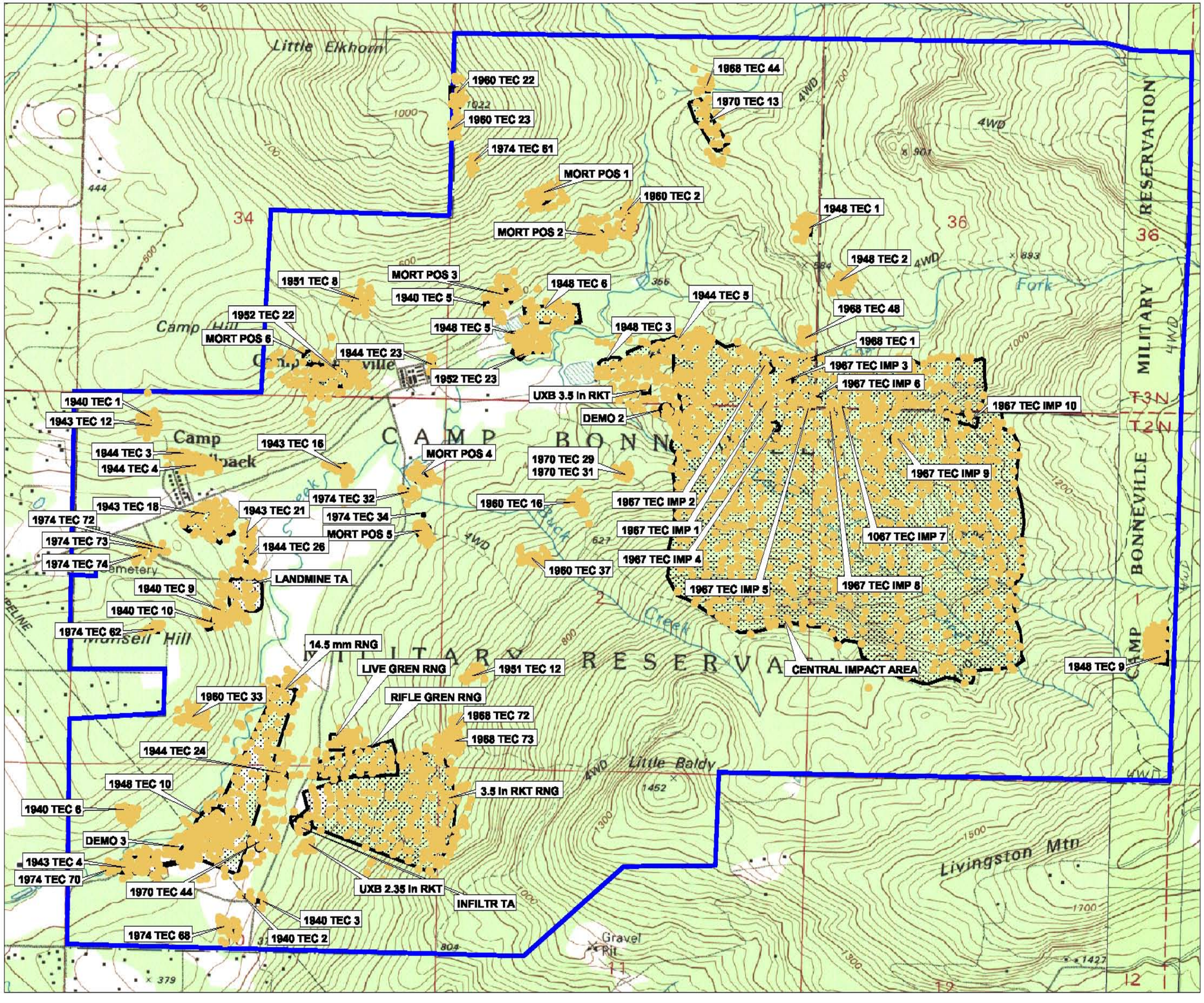
DRAWN BY: GLP	SCALE: As Shown	PROJECT NUMBER: 740973	
CHECKED BY: RLS	DATE: October 2003	PAGE NUMBER:	
SUBMITTED BY: GTM	FILE: w:\bonneville\gis\mapfiles\report_rifs\chap3_figs.apr		

Figure 3.6

AOC/AOPC Locations & 2001 Reconnnaissance Waypoints

Camp Bonneville
Vancouver, WA



Legend

- 2001 Recon Waypoint Locations
- 1943 TEC 16 — Location and Source of AOPC. Year Refers to Year of Aerial Photo and TEC 16 Refers to Feature Number Identified on Aerial Photo.
- MORT POS 1 — Location and Description of AOC
- AOC/AOPC Boundaries
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

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Figure 3.7

OE Scap & UXO Item Locations 2001 Reconnnaissance

Camp Bonneville
Vancouver, WA

1 Pyro, Signal, Illum, M126 series, expended
1 Pyro, Signal, Illum, M126 series, expended
1 M49 Trip Flare Housing, expended
1 RKT, 2.75in, Mk40, Mod7 motor, expended
1 Projo, 105mm, HE, M1, fired
1 RKT, 2.36in, Practice, M7, fired
1 Pyro, Signal, Illum, M126 series, expended
1 RKT, 3.5in, Prac, M29, fired
1 RKT, 3.5in, Prac, M29, fired
1 RKT, 3.5in, Prac, M29, fired
1 Pyro, Signal, Illum, M126 series, expended
1 RKT, 3.5in, Prac, M29 warhead, empty
3 RKT, 3.5in, Prac, M29, fired
4 RKT, 3.5in, Prac, M29, fired
1 RKT, 3.5in, motor, expended

Little Elkhorn
Camp Hill
Camp Bonneville
(BM 344)
Camp Killpack
Cemetery
Munsell Hill
CAMP BONNEVILLE
MILITARY RESERVATION
Little Baldy
Livingston Mtn
Gravel Pit
Buck Creek
David Creek
Fork
T3N
T2N

Legend

- OE Scrap Item Location and Description
- UXO Location and Description
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

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Figure 3.8

Regional Park Section Boundaries 2002 Reconnaissance

Camp Bonneville
Vancouver, WA

Legend

- 2002 Recon Waypoint Locations
- Park Boundary
- Reconnaissance Section Boundaries
- Camp Bonneville Boundary

Park Boundary Source: Clark County Camp Bonneville Preliminary Site Plan January, 2003

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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Figure 3.9

Road & Trail Waypoints 2002 Reconnaissance

Camp Bonneville
Vancouver, WA

Legend

- 2002 Road & Trail Waypoint Locations
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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Figure 3.10

OE Scrap Item Locations 2002 Reconnaissance

Camp Bonneville
Vancouver, WA

Legend

- OE Scrap Item Location and Description
- Camp Bonneville Boundary

1 Pyro, Signal, Illum, M126 series, expended
1 Pyro, Signal, Illum, M126 series, expended
1 Pyro, 40mm, Signal-Illum, M661, expended
1 Pyro, Signal, Illum, M126 series, expended
1 Gren, Hnd-Smk, M18 series w/M201A1 fuze, expended
1 Gren, Hnd-Smk, M18 series w/M201A1 fuze, expended
1 Pyro, Simulator-Ground Burst, M115A2, expended
1 Pyro, Simulator-artillery, M74A1, expended
1 M49 Trip Flare Housing, expended
4 Projo, 40mm, Prac, M781, fired, expended, nose cap
1 Gren, Hnd-Smk, M18 series w/M201A1 fuze, expended
1 Pyro, Signal, Illum, M126 series, expended
1 Pyro, Signal, Illum, M126 series, expended
1 Pyro, Signal, Illum, M126 series, expended
1 Pyro, Signal, Illum, M126 series, expended
1 Pyro, Signal, Illum, M126 series, expended
1 Pyro, Signal, Illum, M126 series, expended
1 RKT, 2.36in, Practice, M7, rkt motor, expended
1 Pyro, Simulator, M117 series, expended
1 Pyro, Signal, Illum, M126 series, expended
1 Gren, Hnd-Smk, M18 series w/M201A1 fuze, expended
1 Gren, Hnd Smk (HC), AN-M8 w/M201A1 fuze, expended
1 Gren, Hnd-Smk, M18 series w/M201A1 fuze, expended
1 Pyro, Simulator, M117 series, expended
1 Pyro, Simulator, Illum, Parachute, M583A1, expended
1 Pyro, Signal, Illum, M126 series, expended
1 Pyro, Signal, Illum, M126 series, expended
1 M49 Trip Flare Housing, expended
1 Projo, 40mm, Prac, M781, fired, unexpended
1 Gren, Hnd-Smk, M18 series w/M201A1 fuze, expended
1 Projo, 40mm, Prac, M781, fired, expended, nose cap
1 Pyro, Signal, Illum, M126 series, expended
1 Projo, 40mm, Prac, M781, fired, expended, nose cap
1 Projo, 40mm, Prac, M781, fired, expended, nose cap

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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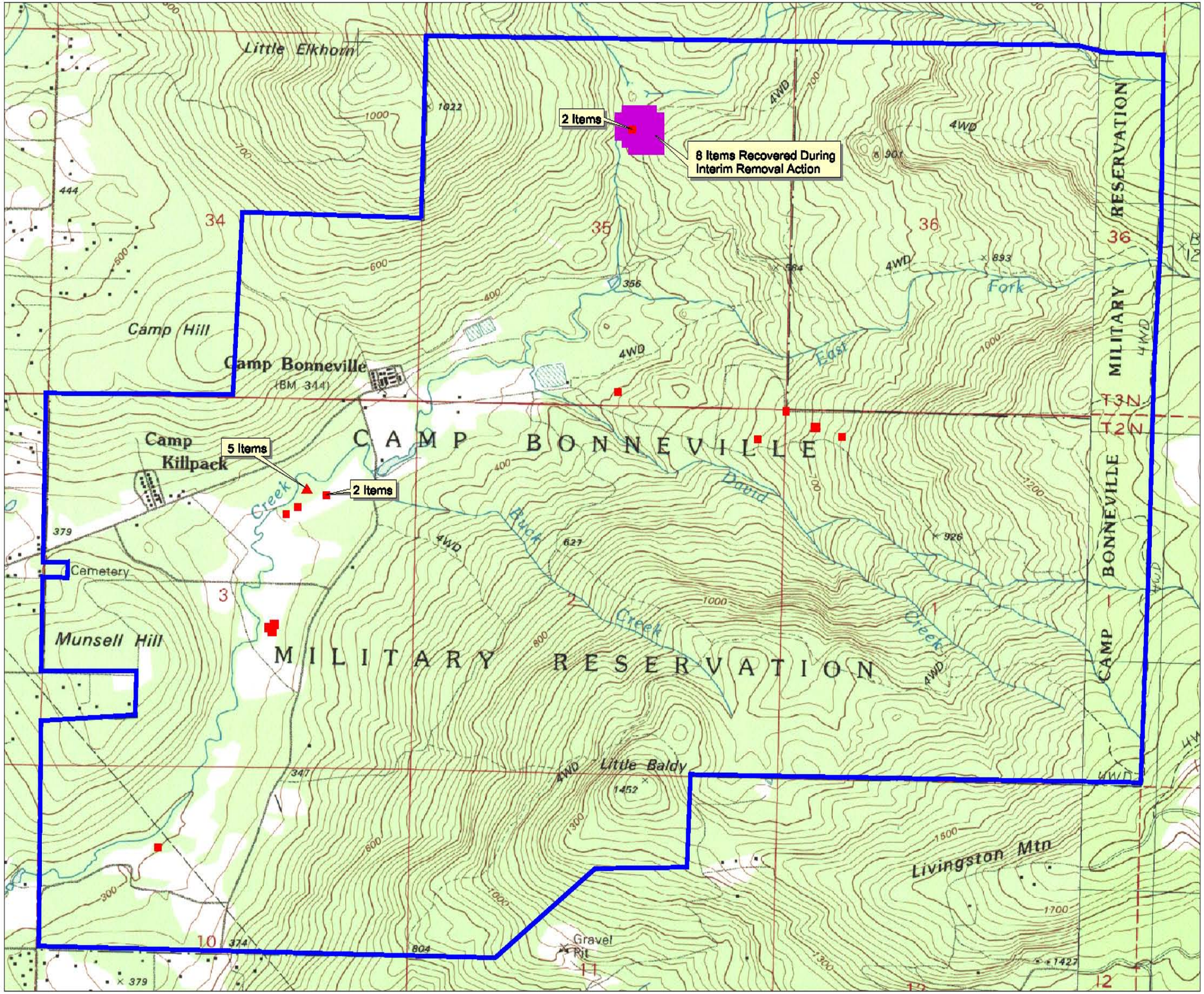
Figure 3.11

UXO Site Characterization Findings

Camp Bonneville
Vancouver, WA



Legend

- Location of UXO
- UXO Items Located Outside of Grids During 1998 Site Characterization
- Demolition Area 1 Interim Removal Action Location
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lecamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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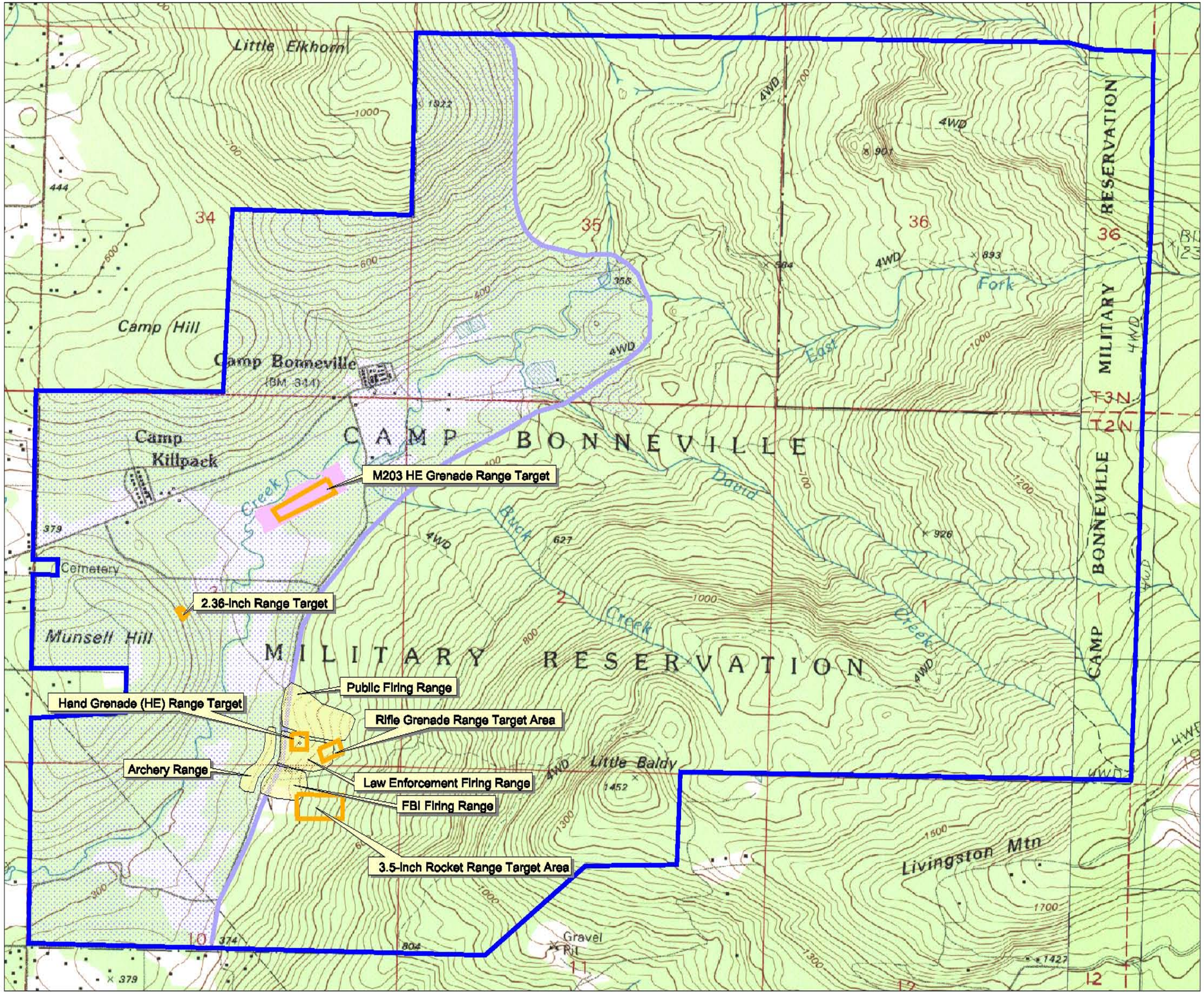
Figure 4.1

Target Area Location Map

Camp Bonneville
Vancouver, WA



Legend

- Range Target Areas
- Proposed Landuse Areas
- 1999 Removal Action Area
- Regional Park Boundary
- Camp Bonneville Boundary

Parkline.shp

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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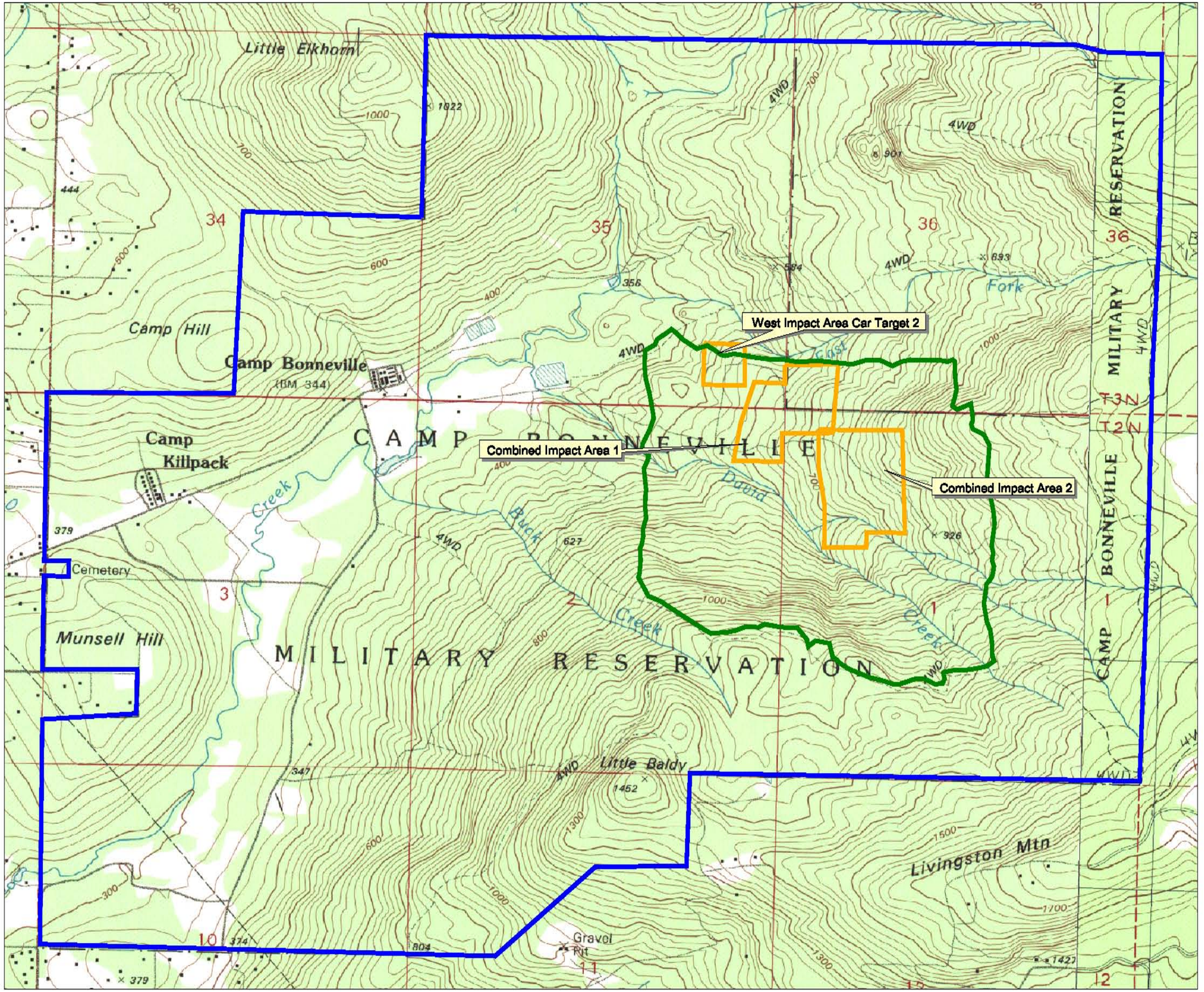
Figure 4.2

Central Impact Target Area Location Map

Camp Bonneville
Vancouver, WA



Legend

- Central Impact Target Areas
- Central Impact Area Boundary
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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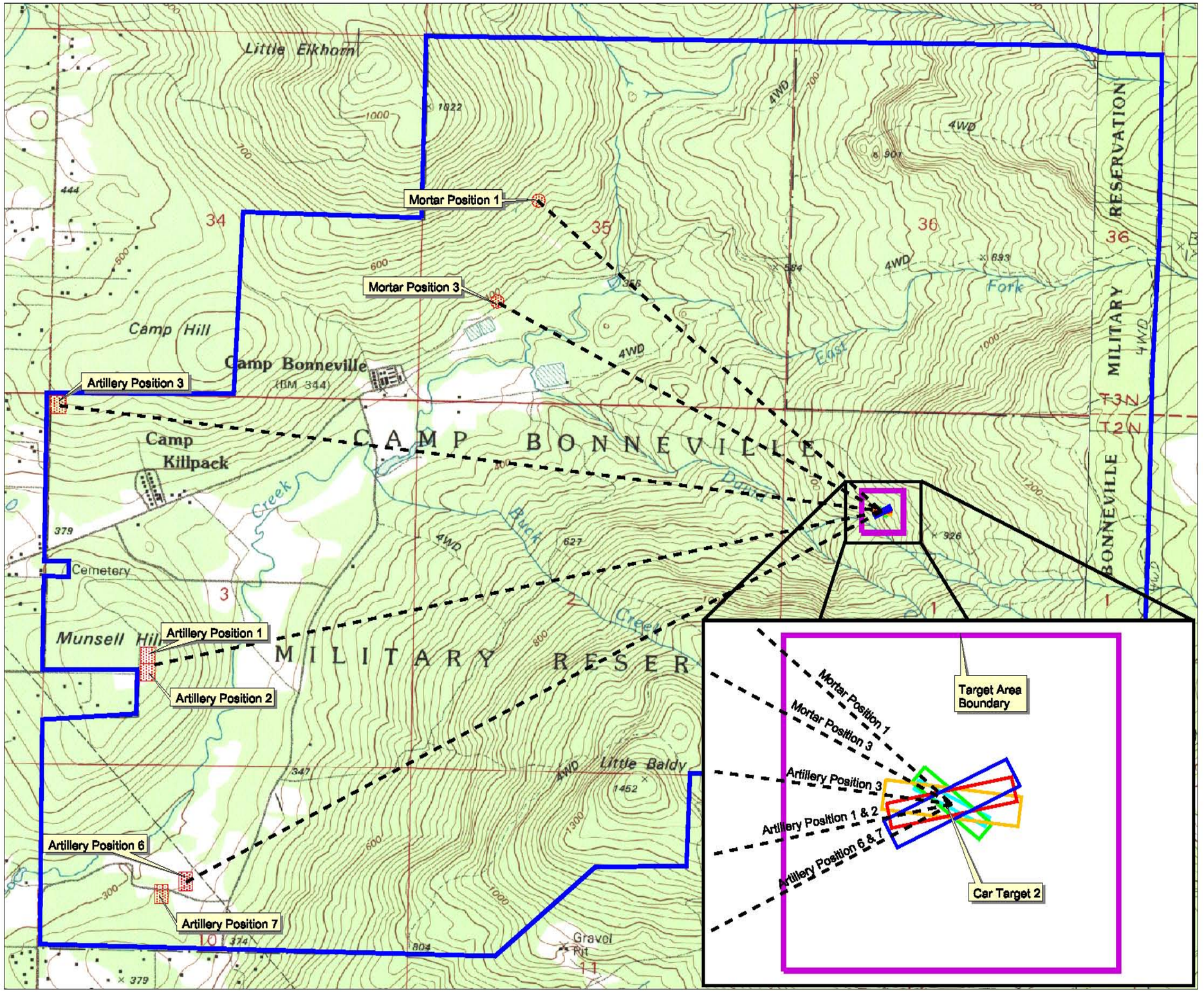
Figure 4.3

Central Impact Target Area Probabilistic Model

Camp Bonneville
Vancouver, WA



Legend

- Projected Path
- Camp Bonneville Boundary
- Firing Point Location

Car Target 2
Calculated Grid Sizes For 96% Coverage

Firing Point	Range (M)	Prob. Error Range (M)	Prob. Error Deflect. (M)	Grid Size
MP1	2315	9	2	54M x 12M (162FT x 36FT)
MP3	2183	8	1	48M x 6M (144FT x 18FT)
AP1/2	3700	13	2.5	78M x 15M (234FT x 45FT)
AP3	3954	14	3	84M x 18M (252FT x 54FT)
AP6/7	3848	14	3	84M x 18M (252FT x 54FT)

Note:
1. Probability Error Distances are 1 Standard Deviation

2. 96% Probability Grid Size Calculated by Probability Error Range and Probability Error Deflection Times Three.

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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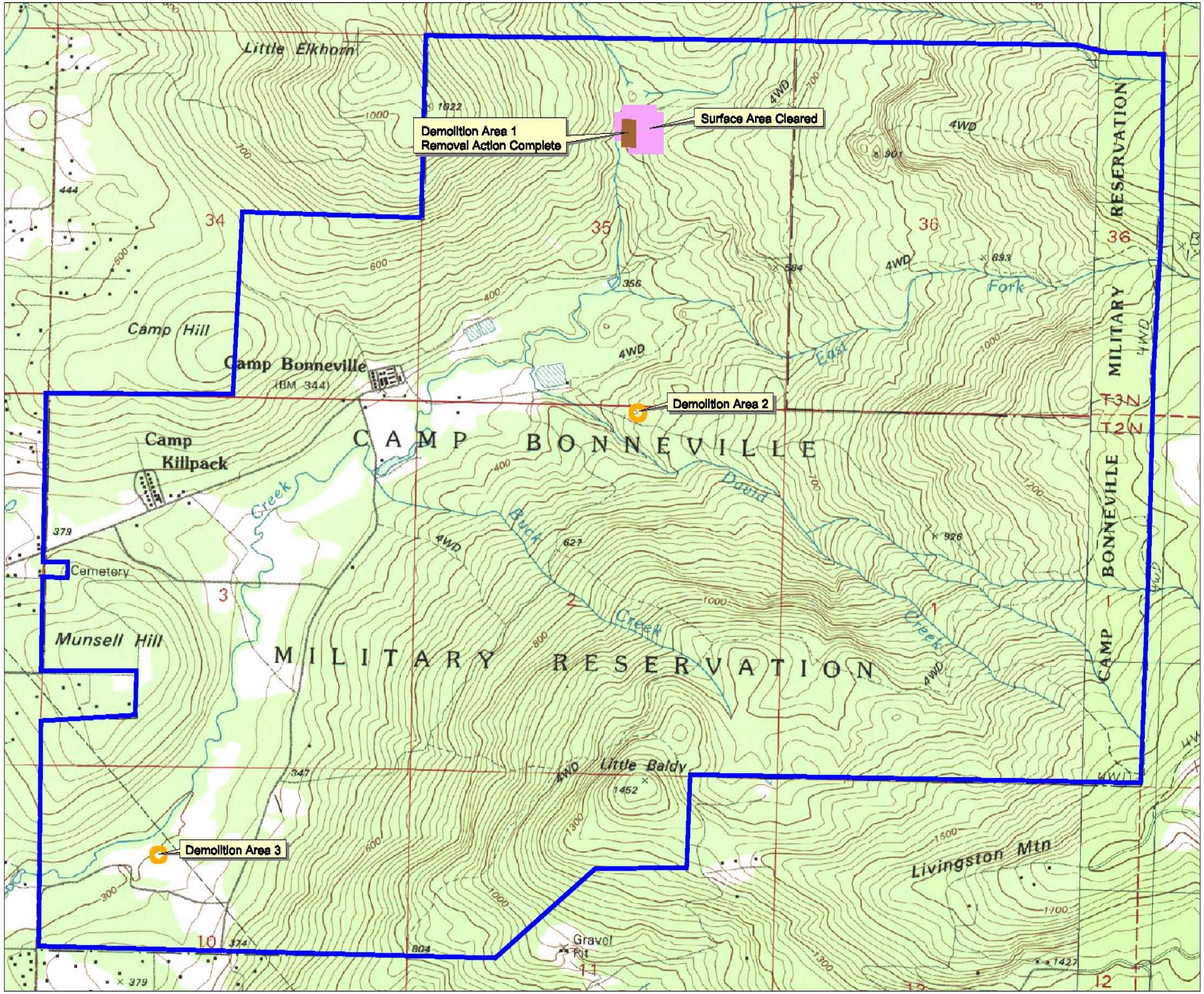
Figure 4.4

Open Burn / Open Demolition Area Location Map

Camp Bonneville
Vancouver, WA



Legend

- Removal Action Complete
- Surface Area Cleared
- Open Burn / Open Demolition Area
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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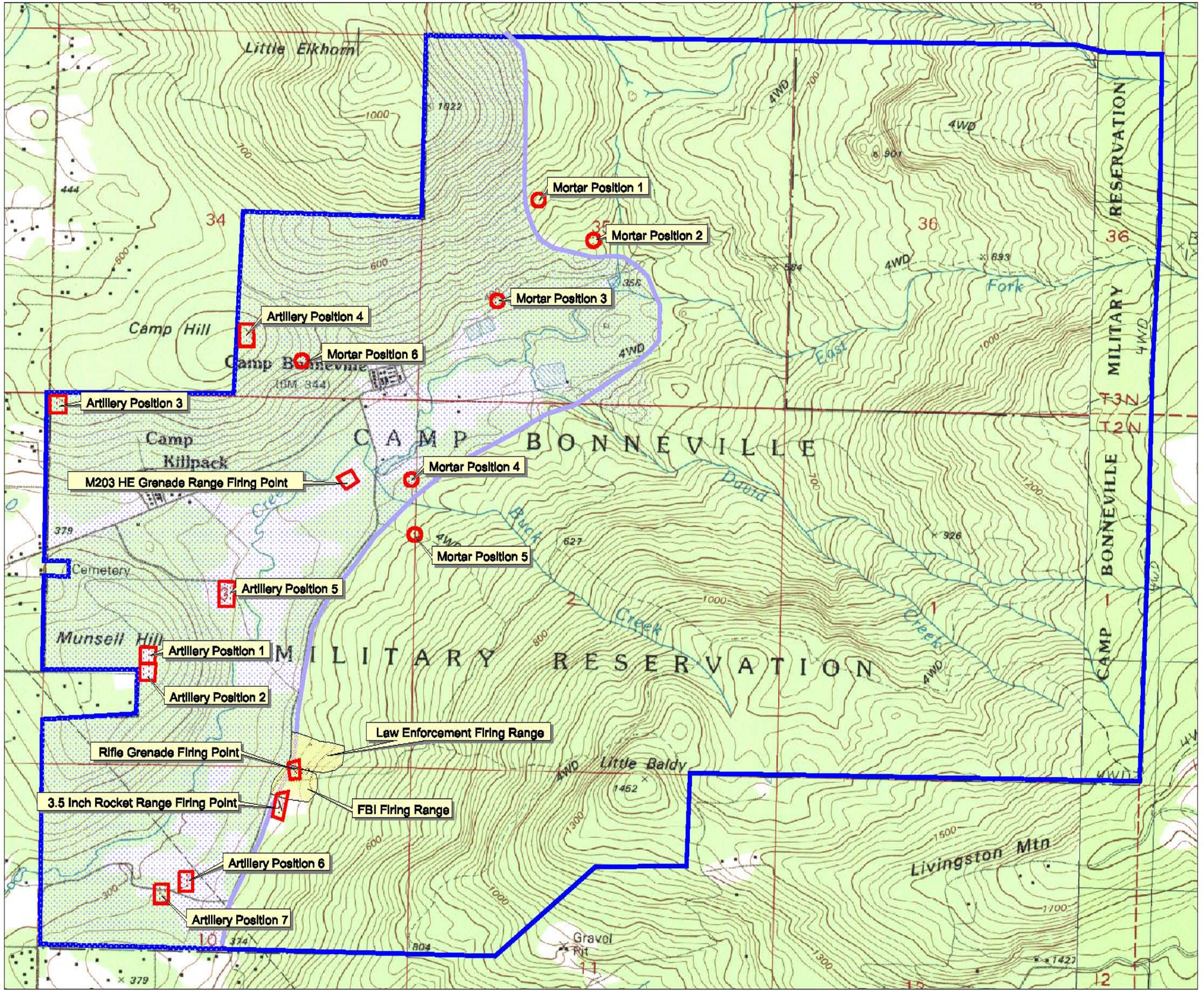
Figure 4.5

Firing Point Location Map

Camp Bonneville
Vancouver, WA



Legend

- Firing Points
- Regional Park Boundary
- Proposed Landuse Areas
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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Figure 4.6

Training Location Area Map

Camp Bonneville
Vancouver, WA

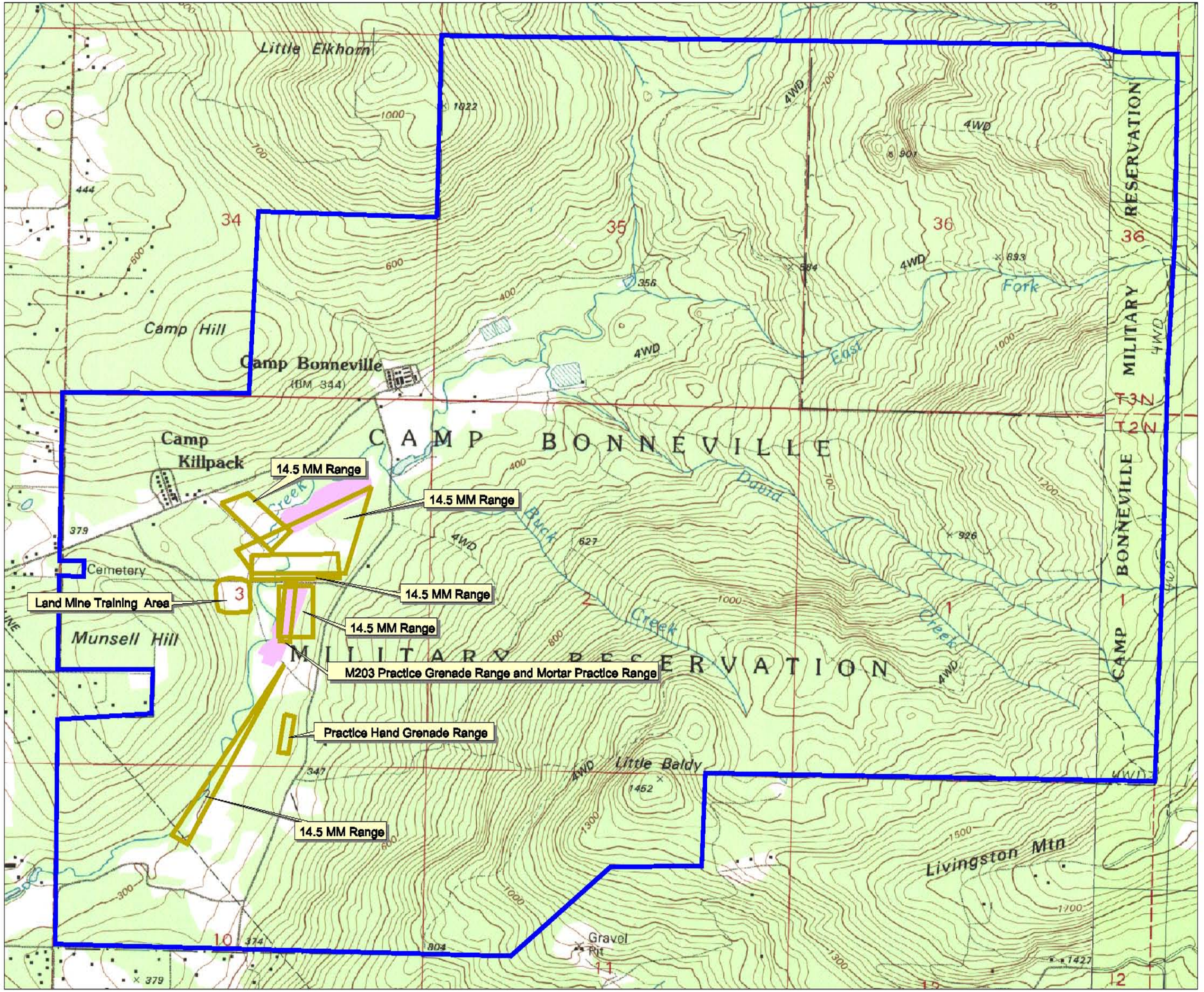

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Data Source: ASR Plate 29 (USACE, 1997)

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

Legend

- Training Areas
- 1999 Clearance Areas
- Camp Bonneville Boundary

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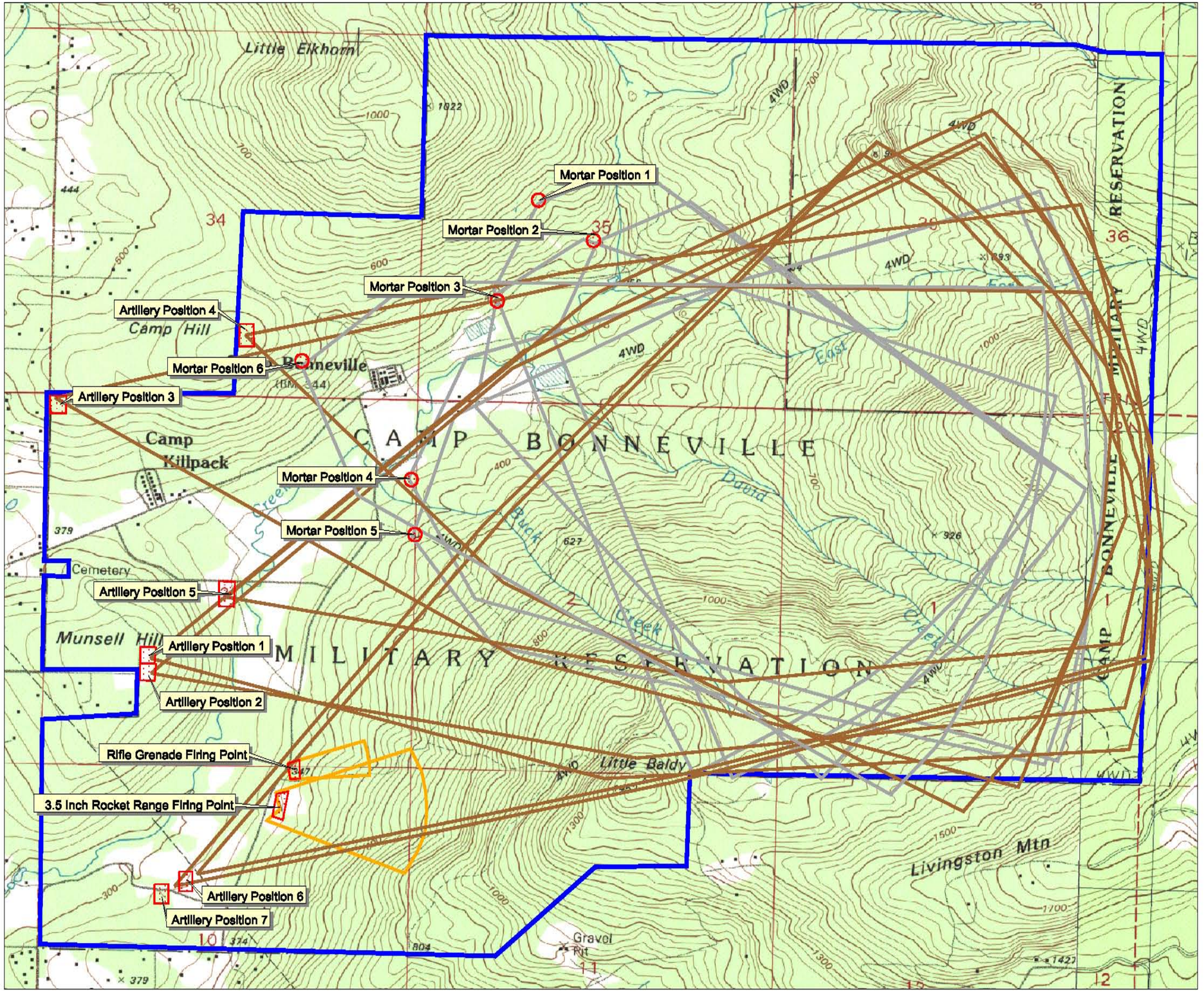
Figure 4.7

Range Safety Fan Map

Camp Bonneville
Vancouver, WA



Legend

- Firing Points
- Mortar Range Safety Fans
- Artillery Range Safety Fans
- Other Range Safety Fans
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Data Source: ASR Plate 32 (USACE,1997)

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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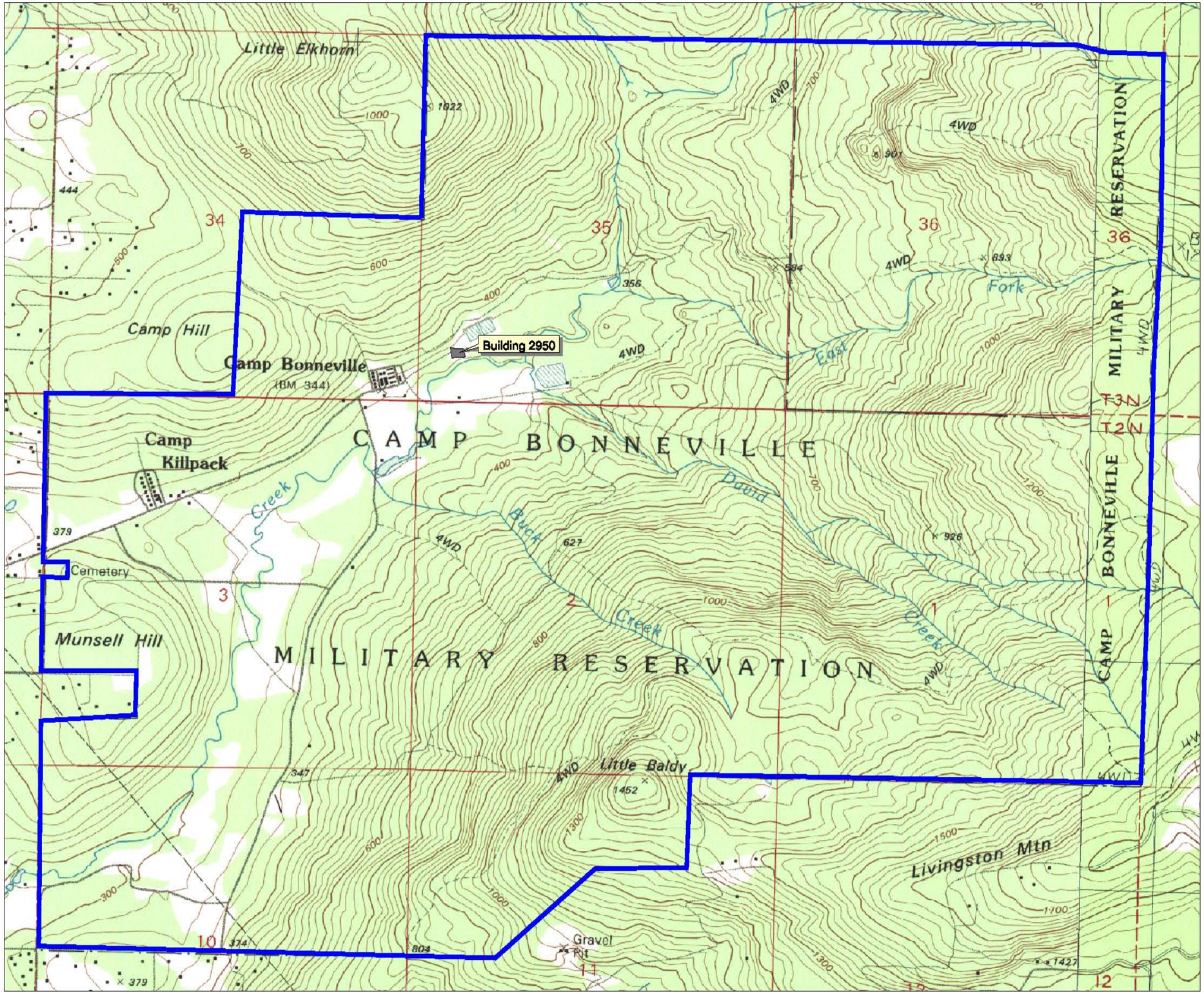
Figure 4.8

Storage Magazine/ Transfer Point Location Map

Camp Bonneville
Vancouver, WA



Legend

- Storage Magazine
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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Figure 4.9

Maneuver Area Location Map

Camp Bonneville
Vancouver, WA

Legend

- Maneuver Area
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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Figure 4.10

Central Impact Area Location Map

Camp Bonneville
Vancouver, WA

Legend

- Central Impact Area
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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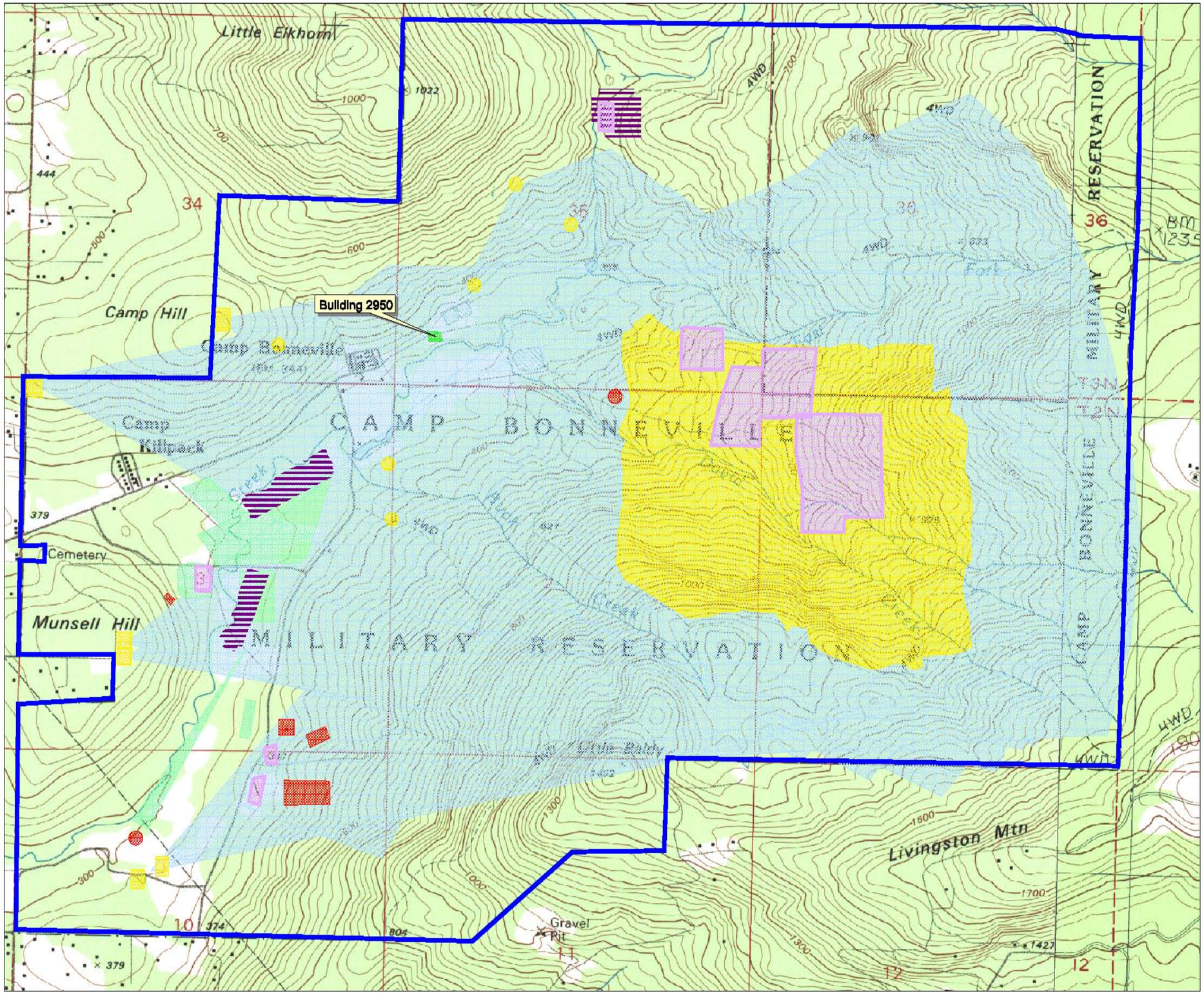
Figure 4.11

Explosive Hazards Exposure Ranking by OE Source Site

Camp Bonneville
Vancouver, WA



Legend

Explosive Hazard Exposure Ranking

- A - Highest Hazard
- B - High Hazard
- C - Medium Hazard
- D - Low Hazard
- E - Lowest Hazard
- Removal Actions Complete
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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Figure 4.12

Roads and Trails

Camp Bonneville
Vancouver, WA

Legend

- Roads and Trails
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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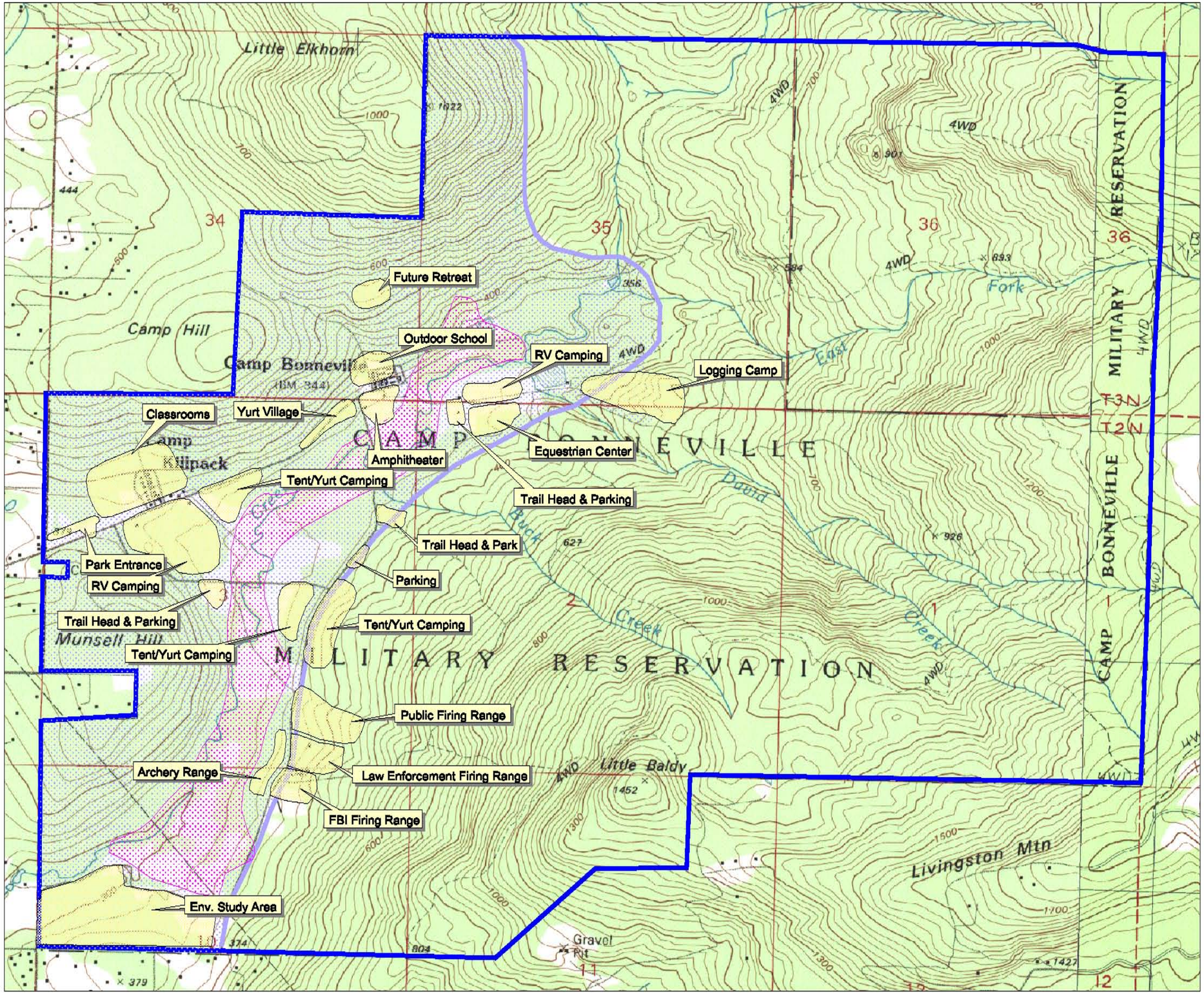
Figure 4.13

Proposed High Intensity Reuse Areas

Camp Bonneville
Vancouver, WA



Legend

- Proposed High Intensity Reuse Areas
- High-Accessible Medium Intensity Reuse Area
- Remaining Medium Intensity Reuse Area
- Camp Bonneville Boundary

High Intensity Reuse Areas & Park Boundary Source:
Clark County Camp Bonneville
Preliminary Site Plan January, 2003

Image Source: USGS 7.5' Lacamas Creek and
Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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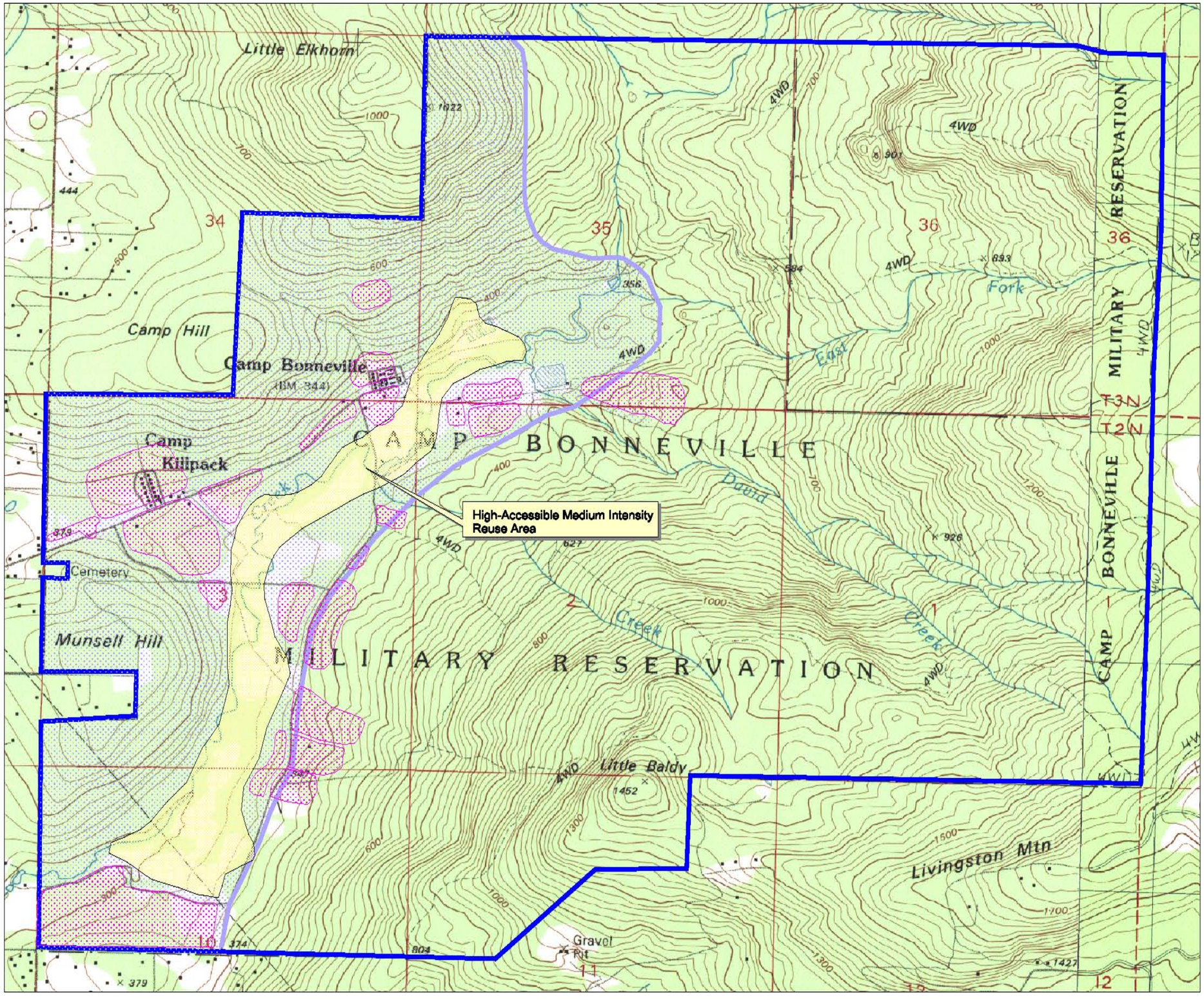
Figure 4.14

High-Accessible Medium Intensity Reuse Area

Camp Bonneville
Vancouver, WA



Legend

- High-Accessible Medium Intensity Reuse Area
- High Intensity Reuse Areas
- Remaining Medium Intensity Reuse Area
- Camp Bonneville Boundary

High Intensity Reuse Areas & Park Boundary Source:
Clark County Camp Bonneville
Preliminary Site Plan January, 2003

Image Source: USGS 7.5' Lacamas Creek and
Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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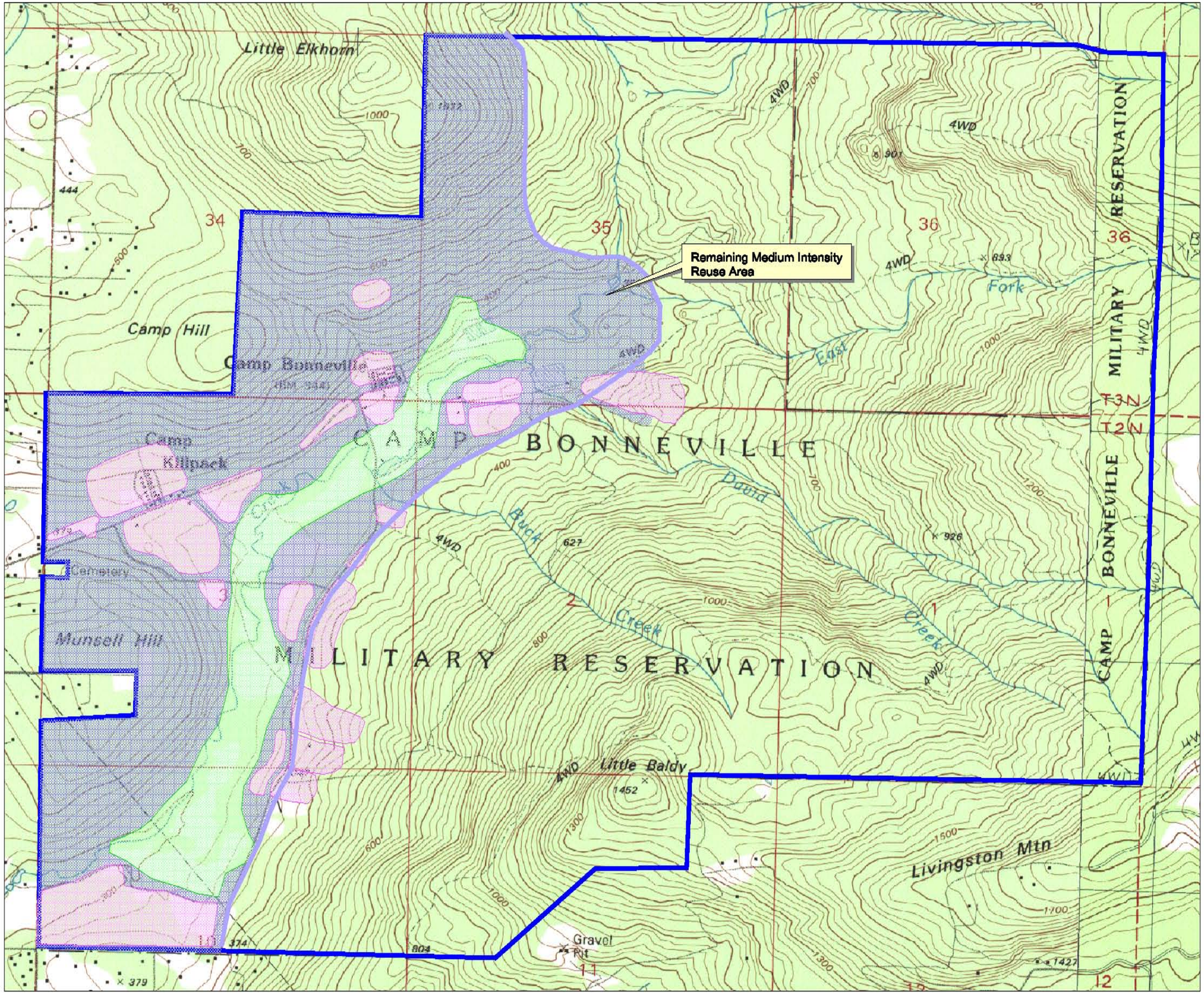
Figure 4.15

Remaining Medium Intensity Reuse Area

Camp Bonneville
Vancouver, WA



Legend

- High-Accessible Medium Intensity Reuse Area
- High Intensity Reuse Areas
- Remaining Medium Intensity Reuse Area
- Camp Bonneville Boundary

High Intensity Reuse Areas & Park Boundary Source:
Clark County Camp Bonneville
Preliminary Site Plan January, 2003

Image Source: USGS 7.5' Lacamas Creek and
Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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Figure 4.16

Wildlife Management Area

Camp Bonneville
Vancouver, WA

Legend

- Wildlife Management Area
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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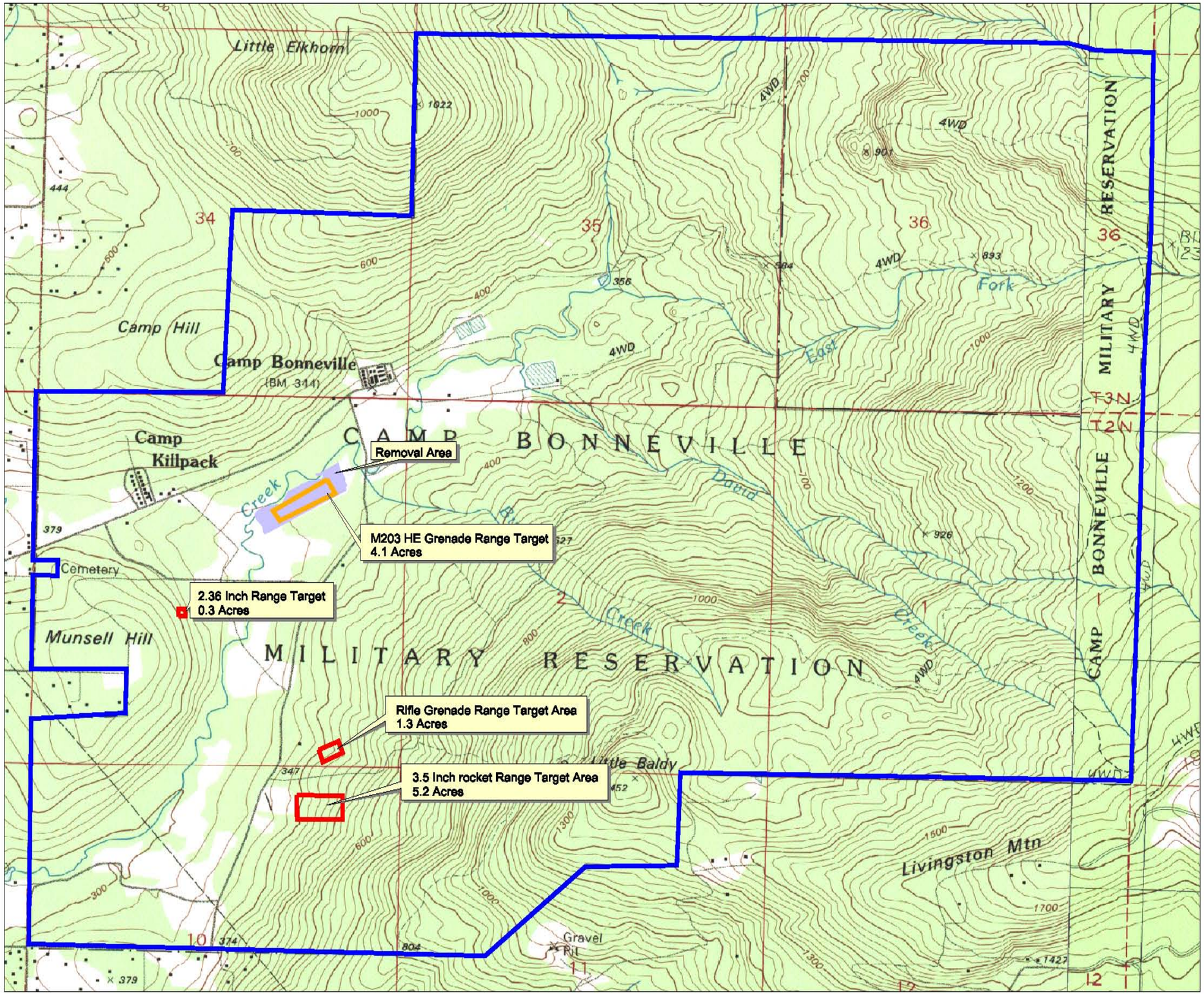
Figure 8.1

Target Cleanup Action Areas

Camp Bonneville
Vancouver, WA



Legend

- Target Areas Recommended for Frost Depth (14 Inches) Clearance and Institutional Controls
- M203 Target Area Recommended for Institutional Controls Only
- 1999 Removal Action Area
- Camp Bonneville Boundary

Note:
Total area proposed Frost Depth (14 Inches) subsurface clearance is 10.6 acres.
Total area proposed for institutional controls is 14.7 acres.

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

N

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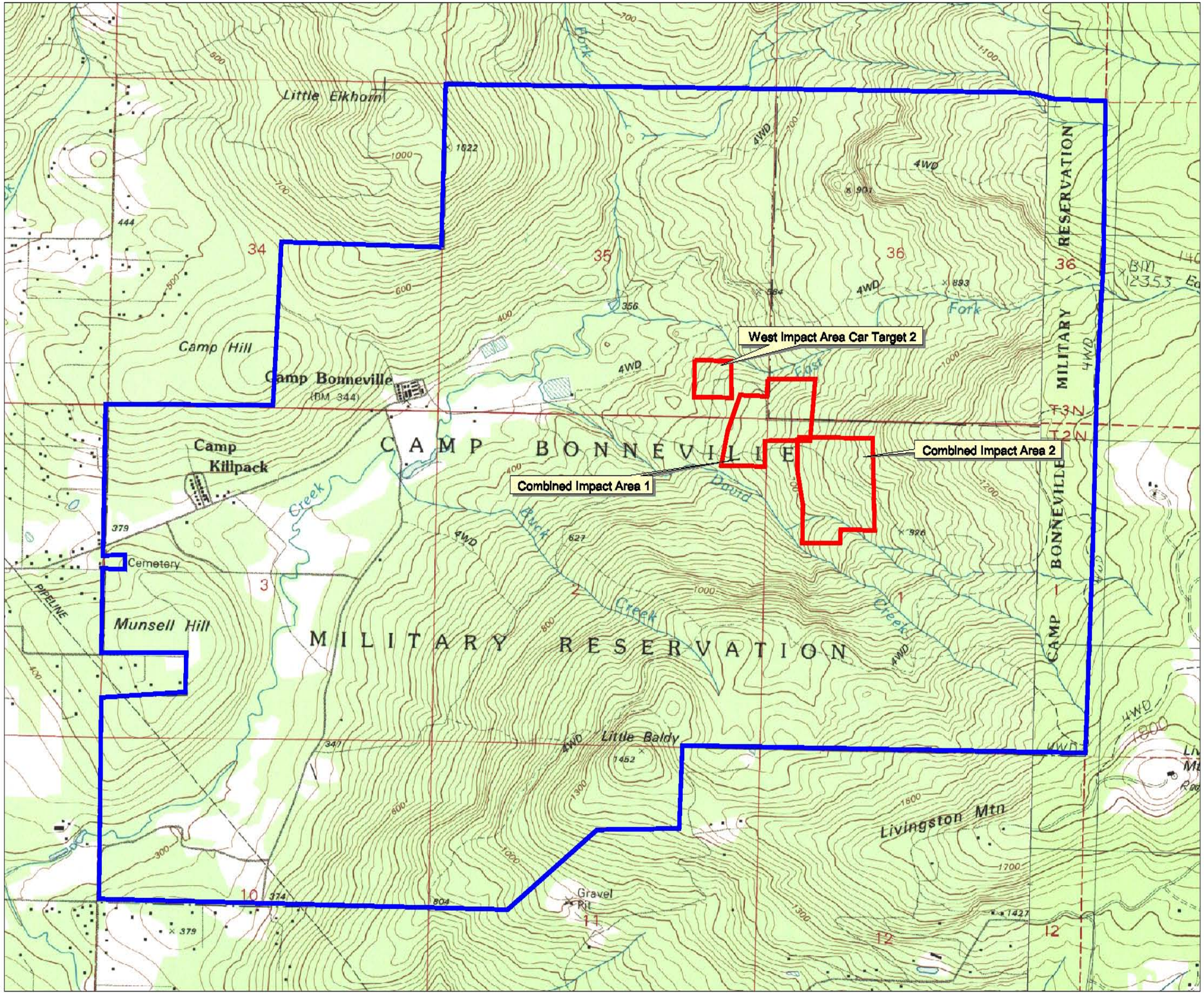
Figure 8.2

Central Impact Target Cleanup Action Areas

Camp Bonneville
Vancouver, WA



Legend

- Central Impact Target Areas Recommended for Institutional Controls
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

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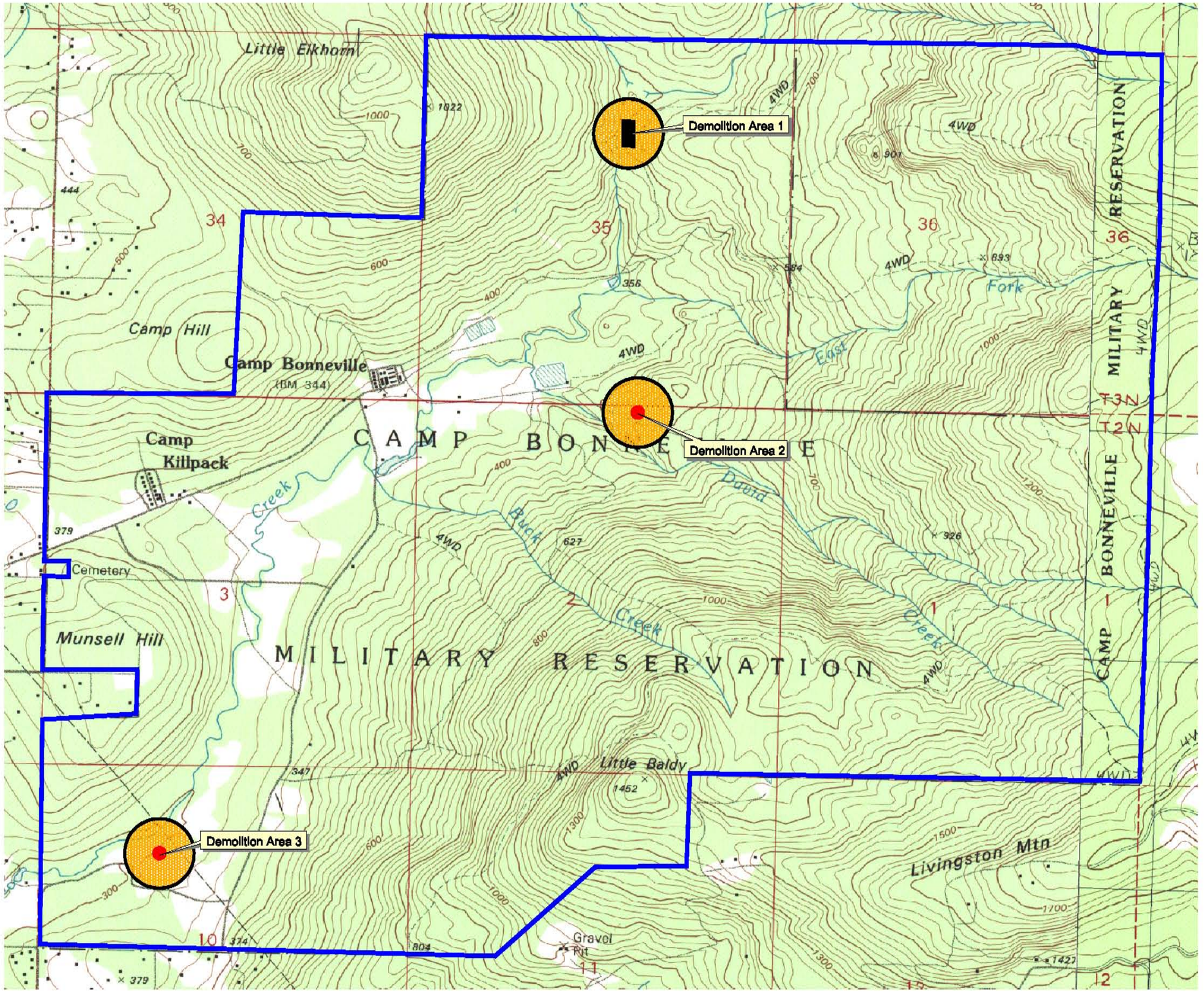
Figure 8.3

Open Burn/Open Demolition Cleanup Action Areas

Camp Bonneville
Vancouver, WA



Legend

- OB/OD Areas Recommended for 4-Foot Clearance
- Buffer Area Recommended for Surface Clearance
- Demolition Area 1 (Contents Previously Removed)
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

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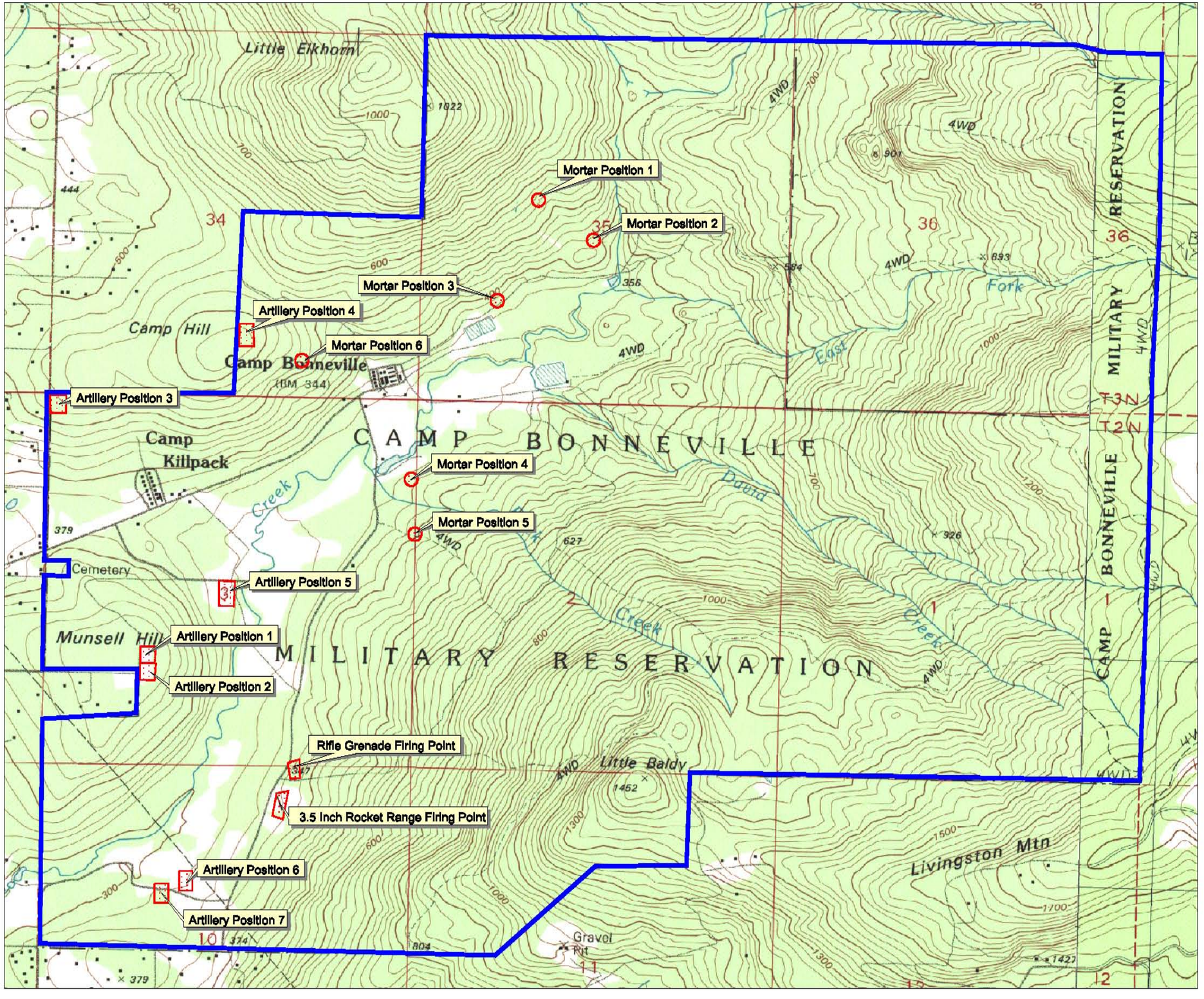
Figure 8.4

Firing Point Cleanup Action Areas

Camp Bonneville
Vancouver, WA



Legend

- Firing Point Areas Recommended for Frost Depth (14 Inches) Clearance
- Camp Bonneville Boundary

Image Source: USGS 7.5' Lacamas Creek and Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

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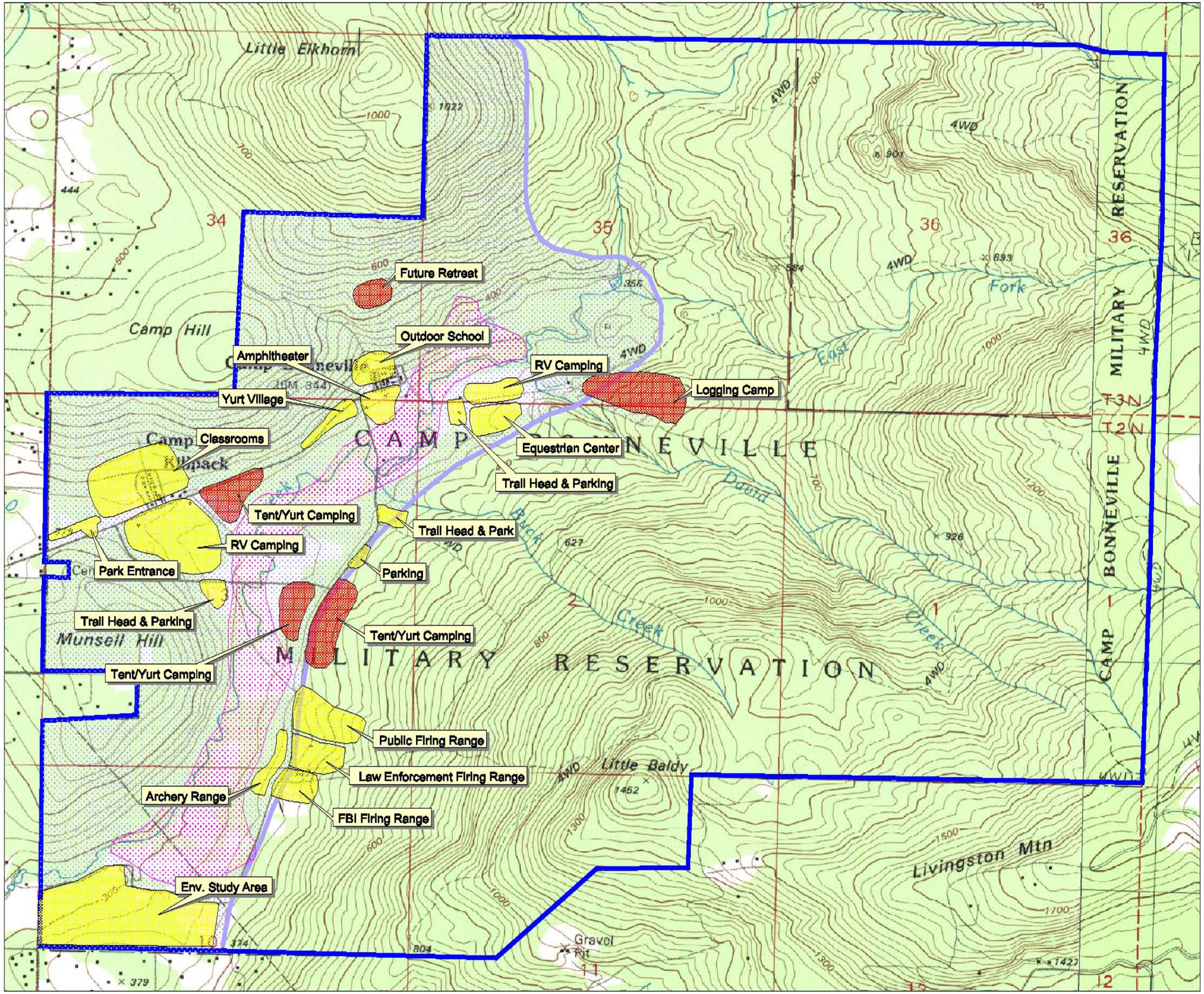
Figure 8.5

High Intensity Reuse Cleanup Action Areas

Camp Bonneville
Vancouver, WA



Legend

- High Intensity Reuse Areas Recommended for 4-Foot Clearance
- High Intensity Reuse Areas Recommended for Frost Depth (14 Inches) Clearance
- High-Accessible Medium Intensity Reuse Area
- Remaining Medium Intensity Reuse Area
- Camp Bonneville Boundary

High Intensity Reuse Areas & Park Boundary Source:
Clark County Camp Bonneville
Preliminary Site Plan January, 2003

Image Source: USGS 7.5' Lacamas Creek and
Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

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Figure 8.6

High-Accessible Medium Intensity Reuse Cleanup Action Area

Camp Bonneville
Vancouver, WA

Legend

- High-Accessible Medium Intensity Reuse Area Recommended for Frost Depth (14 Inches) And Institutional Controls
- High Intensity Reuse Areas
- Remaining Medium Intensity Reuse Area
- Camp Bonneville Boundary

High Intensity Reuse Areas & Park Boundary Source:
Clark County Camp Bonneville
Preliminary Site Plan January, 2003

Image Source: USGS 7.5' Lacamas Creek and
Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

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Figure 8.7

Recommended Cleanup Actions

Camp Bonneville
Vancouver, WA

Legend

- Areas Recommended for 4-Foot Clearance and Institutional Controls
- Areas Recommended for Frost Depth (14 Inches) Clearance and Institutional Controls
- Areas Recommended for Surface Clearance and Institutional Controls
- Areas Recommended for Site Specific Institutional Controls
- Camp Bonneville Boundary

Note:
1. Site-Wide ICs are not shown on this figure.

High Intensity Reuse Areas & Park Boundary Source:
Clark County Camp Bonneville
Preliminary Site Plan January, 2003

Image Source: USGS 7.5' Lacamas Creek and
Larch Mountain Topographic Quadrangles

Map Units: NAD 1983 Washington State Plane South (Feet)

1400 0 1400 Feet

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