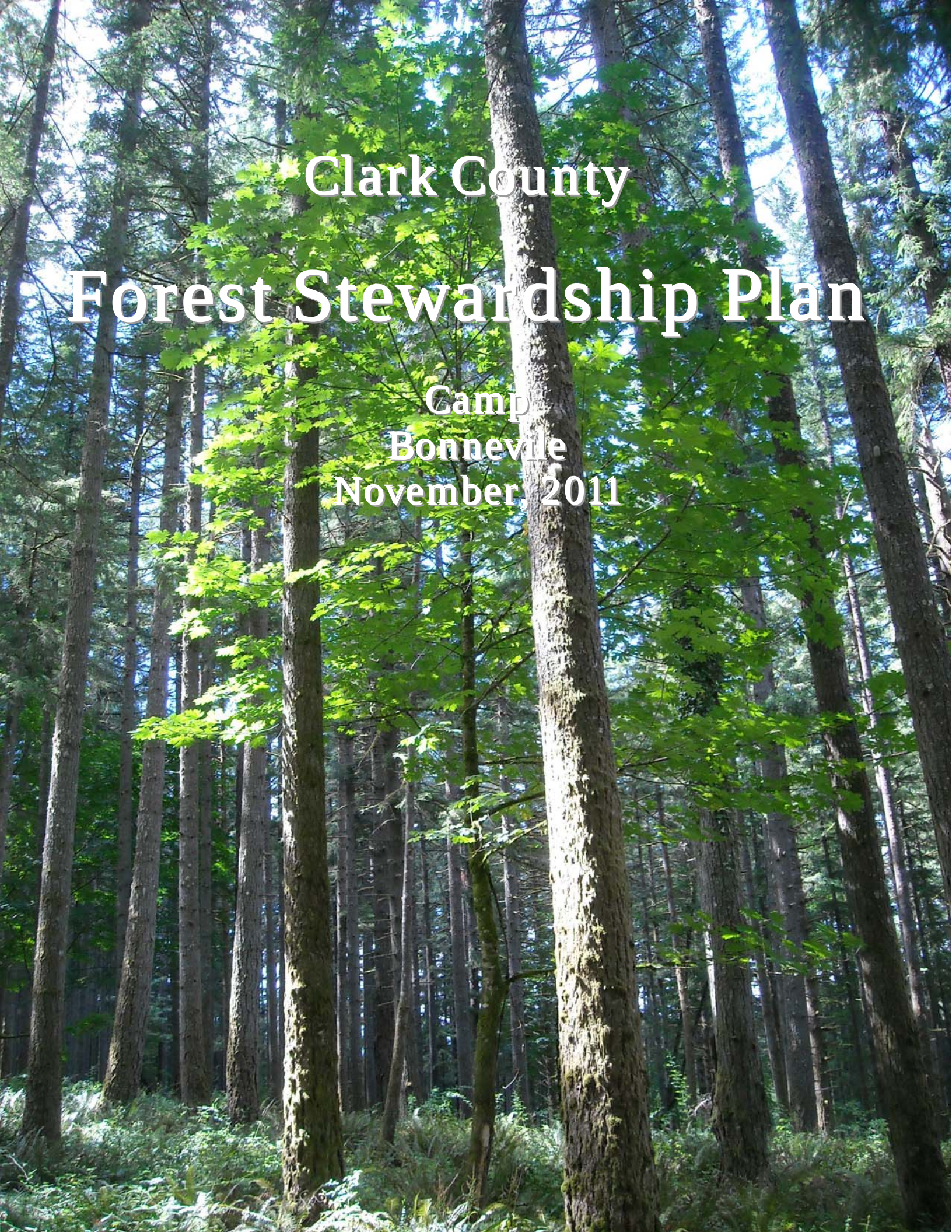

Clark County

Forest Stewardship Plan

Camp Bonneville

November, 2011

Forest Stewardship Plan

Forest name:	**Camp Bonneville**
# of acres plan covers:	**1,127 (of a total 3,840)**
Forest certification #:	
Plan prepared by:	**Kirk Hanson & Jim Vandling**
Date plan prepared:	**November, 2011**
County and state:	**Clark County, WA**

Plan revision dates	
Plan revised	**Monitoring data incorporated**

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Introduction

This document serves as the Phase 1 Forest Management Plan for Camp Bonneville and addresses 13 forest management units totaling 1,127 acres of the Camp's 3,840 total acres. A Phase 2 of the forest management plan will incorporate an additional 1,000 acres in 2012.

Camp Bonneville is located in southeastern Clark County, approximately 12 miles east of Vancouver and seven miles north of the Columbia River. The property is largely undeveloped comprising 3,840 acres, of which 2,100 acres will be managed as part of a timber management program. Camp Bonneville is one in a series of forested tracts owned by Clark County and managed by the County's Department of Environmental Services.

Camp Bonneville has been designated by Clark County as a "Forest Tier I" area through the County's Comprehensive Land Use Plan. This is defined as an area that is potentially capable of sustaining "long term production of commercially significant forest products".

The majority of the property is covered by dense, even-aged Douglas-fir stands with the majority of stands in the 60+ year age-class. These stands either naturally regenerated or where manually replanted following successive fires across the site. Selective thinning has been recommended to utilize the forest resources on the site in order to help fund the ongoing management of Camp Bonneville's forest resources, optimize tree growth, simulate the successional pattern of the original Douglas fir forest type, maximize forest health, and minimize fire hazard. Other forest management goals include creating a multiple-canopy forest structure, increasing wildlife habitat and optimizing growth and yield of high quality timber products for domestic mills.

Within the past 10 years the State of Washington executed a comprehensive modification of its Forest Practices Act. This followed the listing of several salmonoid species under the Endangered Species Act. At issue is the practice of even-aged silvicultural treatments (clear cutting), held as an industry standard for decades, and the impacts of intensive forest management practices near sensitive aquatic and wildlife habitat sites. Regulatory changes have primarily involved an increase in fixed buffer widths, which preclude silvicultural activity in critical areas such as riparian management zones, wetland buffers and habitats for rare, threatened and endangered species.

The region's long history of large-scale, even-aged clearcuts has created significant fragmentation of wildlife habitat, an epidemic of young, low quality Douglas-fir, and an oversimplification of the broad range of ecosystem services that historic, naturally diverse forests once provided. The industrial argument in favor of even-aged management has focused on the economic efficiencies of intensive plantation management. Smaller, non-industrial private forest (NIPF) landowners throughout the region follow a more diverse spectrum of silvicultural methods, including the industrial management policies of larger timber owners, as well as more of a natural, uneven-aged and mixed species approach to forestry.

There is a growing understanding of the ecosystem service benefits of structurally intact native forests. Natural forest ecosystems are highly resilient to and recover quickly from natural disturbance regimes, have superior storm water retention capacities, optimize the sequestration and long-term storage of carbon, provide a broad spectrum of habitat niches, produce multiple forest commodities, and supply recreational and hunting opportunities to local communities. However, the economics of

uneven-aged management practices have not been studied in great depth or at length on the west side of the Cascade Mountains. A study of this nature would require a demonstration or experimental forest with a timber base large enough to accommodate a wide range of silvicultural strategies. Clark County is proposing to implement a plan of uneven-aged structure based management utilizing Camp Bonneville as an experimental forest for these purposes.

Goal of forest management plan

The goal of Camp Bonneville's forest management plan is to research and demonstrate how former even-aged Douglas-fir forests can be managed to produce a sustained yield of commercial forest products and increased ecosystem services through the implementation of uneven-aged forest management practices. Camp Bonneville's timber management plan, which combines habitat conservation and enhancement, improved ecosystem functions and the production of a diversity of forest products, will provide other forest owners and managers with tested and validated silvicultural options.

Clark County has found that the silvicultural standards defined within the Forest Stewardship Council's U.S. Forest Management Standards provide significant guidance to forest owners seeking to emulate natural forest dynamics through their forest management practices. Therefore, the County will seek to follow, at a minimum, FSC's guidelines for forest management as well as seek third party independent certification through the FSC. This forest management plan will also be used to qualify for third-party certification under the American Tree Farm System.

A critical component of any sustainable forestry model is long-term economic viability. The Board of County Commissioners has required that the management of Camp Bonneville be financially self-sustaining while maintaining the natural environment at the site. Therefore, the primary financial goal of the forest management plan is to develop sufficient revenue to cover all management costs at Camp Bonneville. However, it is anticipated that by conducting past-due thinning and moving towards actively managing Camp Bonneville's forests, the forests can provide positive revenue back to the County. Therefore, timber revenue generated from Camp Bonneville could also be used to provide essential County services to the public.

Forest Management Objectives

Short term
The following short-term objectives will be implemented or achieved within the first 5-10 years after this plan has been approved:

1. Thin dense stands to enhance forest health and timber productivity
2. Improve wildlife habitat through snag creation, distribution of downed woody debris and forage planting
3. Begin restoring riparian forest cover by planting streamside areas with a mix of hardwoods and conifers
4. Develop and implement control and eradication measures for noxious non-native plant species
5. Begin a systematic monitoring program to inventory and assess forest resources and wildlife habitat
6. Develop an annual or semi-annual commercial thinning plan that provides sufficient income to pay for all forest management expenses and provide positive revenue to the County
7. Develop research and development program to demonstrate structure-based forest management principles

Long term
The following long-term objectives are expected to be achieved over the next 10 – 100+ years:

1. Restore historic species composition and habitat complexity throughout forest
2. Begin restoring areas of forest to late seral conditions
3. Produce periodic income through commercial thinning
4. Use forest resources as a model for structure-based forest management
5. Recruit or retain legacy trees, old and large trees, snags and downed woody debris in order to sustain populations of native plants, fungi, and animals, both within individual forest stand and across the entire forest
6. Monitor forest ecosystem dynamics, record and analyze trends and periodically update forest management plan to reflect new strategies for managing the forest

Property Description

Legal description
Portions of Township 3 North, Range 3 East, Sections 34, 35 & 36, and Township 2 North, Range 3 East, Sections 1, 2, 3 & 10

Property description
Camp Bonneville is a 3,840 acre property located in Southwest Clark County. The property is located at the tip of a portion of prairie habitat that extends into the foothills of the Cascade Mountains. Contained within the tract is the headwaters of the Lacamas Creek basin and its associated tributaries and wetlands. According to a recent GAP Analysis project completed by the Washington Cooperative Fish and Wildlife Unit of the University of Washington, the majority of the site is included in the "westside western hemlock" vegetation zone. However, since the area has burned periodically since 1900, the predominant forest types are comprised of even aged stands of Douglas fir. Scattered stands of western red cedar and western hemlock, remnants of the original plant community, still exist on the facility. Typical understory species include vine maple (*Acer circinatum*), salmonberry (*Rubus spectabilis*), elderberry (*Sambucus canadensis*), hazelnut (*Corylus sp*.), salal (*Gautheria shallon*), and sword fern.

The majority of the site is densely forested. Valley floors associated with Lacamas Creek are occupied by old fields and emergent wetlands which are associated with small drainages and depressions in the floodplain of the Lacamas basin. This habitat is associated with remnant stands of Garry oak (*Quercus garryana*), a dominant tree in former forests that once occupied the area. Common species associated with valley floor areas include red alder (Alnus rubra), Oregon ash (*Fraxinus sp.*), Douglas fir (*Pseudotsuga menziesii*), big leaf maple (*Acer macrophyllum*), Garry oak, cottonwood (*Populus deltoides*), crabapple (*Malus sp.*) and willow (*salix sp.*). Common understory species associated with valley floor habitats include vine maple, salmonberry, Indian plum (*Oemleria cerasiformis*), snowberry (*Symphoricarpos albus*), and Lady fern. Old fields are composed of native grasses and small shrubs including Scotch broom (*Andropogon sp.*)

Regional landscape
Camp Bonneville is located in Southwest Clark County just east of the City of Vancouver. Clark County lies in a long structural basin (Willamette-Puget Trough) between the Pacific Coast ranges to the west and the parallel Cascade Range to the east. The Columbia River, the major trunk stream of the Pacific Northwest, flows through the Cascade Range, borders Clark County as it crosses the trough, then passes through the Pacific Coast ranges into the Pacific Ocean to the west.

About 58 percent of Clark County is in woodland. About 93 percent of the woodland is privately owned, 6 percent is State owned, and about 1 percent is owned by the Federal Government. Economic development in Clark County is diversified. Farming is important, but it is secondary in value of total products to industrial products, which include lumber, pulp, paper, aluminum, and chemicals. About 42 percent of the county is cleared and in farmland; the rest is forested or logged-off land.

Property History
At the turn of the century, 3,840 acres of Camp Bonneville was contained within 20 homesteads ownerships. Several of these families still reside in Clark County. Camp Bonneville was established in 1909 as a drill field and rifle range for the U.S. Army's Vancouver Barracks and has been used primarily as a training camp for various branches of the military. After the Army closed the facility in

1995, the property was selected for transfer and reuse by the Base Realignment and Closure Commission. On October 3, 2006, after ten years of dialog and negotiation with the Army and the state Department of Ecology, the Board of Clark County Commissioners accepted transfer of property ownership from the Army to the county.

The U.S.Army has managed the forests and other vegetation on Camp Bonneville since 1957. Vegetation has been controlled by scarification and replanting subsequent to major forest fires which occurred in 1902, 1938, 1951, and 1979. Timber management activities by the Army ceased in 1981.

Forest Fire History
In 1902 the Yacolt Fire destroyed virtually the entire original forest and homesteads. Some of the stakeholders simply gave up and abandoned their claims following the fire, with the remainder selling out to the War Department in 1918 when it expressed an interest in acquiring a training range.

Year	Acres Burned	
1902	3,021	Yacolt Burn (238,000 ac.s in 3 Counties)
1938	1,220	1st Livingston Mtn.Fire
1951	1,400	2nd Livingston Mtn.Fire
1970	160	N.Fk Lacamas Cr.Fire

Forest Management History
Reforestation Record

Year	Method	Site Prep.	Acres
1951*	Planting	none	180
1952	Planting	none	190
1953	Planting	none	1,071
1958	Planting	scarification	23
1969	Planting	scarification	369
1969	Seeding	scarification	40
1970	Planting	scarification	300
1975	Planting	scarification	245
1976	Planting	scarification	95
		Total	2,531

**there was no record kept from CCC plantings in 1930's & 1940's*

Timber Harvest Record

Year	Vol. Bf	Acres	Prescription
1958*	393,000	114	Release Thin
1970	170,000	296	Release Thin
1971	125,000	n/a	Release Thin
1972	62,000	n/a	Release Thin
1973	63,000	n/a	Release Thin
1975	34,000	n/a	Release Thin
1978	8,000	n/a	Release Thin
1980	141,000	134	Release Thin & Salvage
1981	n/a	61	Release Thin
1982	n/a	159	Release Thin
1983	n/a	75	Release Thin
1984	n/a	102	Release Thin
1985	n/a	219	Release Thin

** there was no record kept on Salvage Volumes from the 1930's & 1940's*

Timber Stand Improvement Record

Year	Work Done	Acres	Method
1957	Pruning	n/a	Hand saw
1969	Herbicide Applic.	370	Aerial
1970	Herbicide Applic.	378	Aerial
1978	Brush Control	111	Mechanical Slashing
1979	Brush Control	65	Mechanical Slashing
1980	Brush Control	300	Mechanical Slashing
subtot.		1,224+	

Inventory Record

Year	Merchantable Standing Vol.(bf)	Available CFL ac.s	Growth per acre / yr (bf)	Composite Growth / yr. (mbf)
1966	3,892,000	794	650 (1)	516
1981	20,077,000	2,232	368 (2)	486
1998	27,411,000	2,450	188 (3)	387

(1) based on 794 acres of inventoried merchantable timber

(2) based on 1,320 acres of inventoried merchantable timber

(3) based on 2,060 acres of inventoried merchantable timber

Map 1. Aerial Photo

Climate & Geology

Climate

Clark County, approximately 70 miles inland from the Pacific Ocean and west of the Cascade Mountains, has the predominantly temperate marine climate typical of the West Coast. It has a dry season and pleasant temperature in summer, a mild but rather rainy winter, and a narrow range in temperature. Some of the factors that influence the climate are terrain and distance and direction from the ocean. The coastal mountains protect this area from the more intense winter storms that move inland from the ocean, and the Cascade Range shields it from the higher summer and lower winter temperatures of eastern Washington. Cold air in winter and the occasionally hot air in summer flowing west through the Columbia River Gorge has a decided influence on the climate.

Clark County has a mild marine climate that is typical of the northwestern part of Oregon and the western part of Washington. It has mild, wet winters and moderately warm, dry summers. The climate reflects the influence of the Cascade Mountains to the east and the parallel Coast Range to the west. Nearly 75 percent of the annual precipitation normally occurs from October 1 to March 31. The remaining 6 months, from April 1 to September 30, receive only 25 percent of the total precipitation. The average annual precipitation differs greatly from place to place. This difference is directly related to the effects of the two bordering mountain ranges. The average annual precipitation on much of the Coast Range and the Cascade Mountains exceeds 100 inches. Precipitation at lower altitudes and toward the center of the basin between the two mountain ranges is much less. The annual precipitation at Vancouver is about 37 inches; the precipitation reaches 114 inches in the Cascade Mountains in the northeastern corner of the county. During the growing season, however, the range in precipitation is small. For example, precipitation for July and August combined averages 1.40 inches at Vancouver, the driest station, in comparison with 2.77 inches at Cougar, the wettest station. The average annual snowfall at Vancouver is 8.4 inches, and it is estimated to exceed 200 inches at an elevation of 3,000 feet in the eastern and northeastern parts of the county.

Late in spring and in summer large high-pressure centers over the north Pacific Ocean bring a prevailing flow of cool and comparatively dry air from a northwesterly direction. As the air moves inland, it becomes warmer and drier. As a result a dry season begins late in spring and reaches a peak in midsummer. In July and August, it is not unusual for 2 or 3 weeks to pass without measurable rainfall.

In fall and winter, low-pressure centers in the Gulf of Alaska intensify and high-pressure centers become smaller and move south. Circulation of air around these pressure centers in the north Pacific bring a prevailing flow of warm, moist air into this part of the State from a southwesterly direction. As a result, winter temperatures are mild and the rainy season begins in fall, reaches a peak in midwinter, and decreases in spring.

In the warmest summer months, afternoon temperatures range from the middle seventies to the lower eighties, and nighttime temperatures are in the fifties. Maximum temperatures exceed 90° F. on 5 to 15 days each summer and reach 100° or slightly higher in one summer out of three. Temperatures in the foothills and higher elevations of the county are slightly lower than those recorded in the valleys. The hottest weather generally occurs when hot, dry, easterly winds reach the area. In this kind of weather, humidity is low and the risk of forest fires is high. Following 1 or 2 days of unusually warm weather, cooler air from the ocean moves inland and afternoon temperatures return to the seventies and eighties.

In the coldest months, afternoon temperatures range from the upper thirties to the middle forties, and nighttime readings from 25° to 35°. In most winters, a minimum temperature of below freezing occurs on 40 to 75 nights and a maximum temperature of freezing or below occurs on a few days. The coldest weather generally occurs when a high pressure area develops over the Pacific Northwest and cold air from east of the Cascades reaches this area. The sky is frequently clear under these conditions; minimum temperatures range from 5° to 15° and maximum temperatures remain below freezing. In an average year, the relative humidity ranges from about 50 percent in midafternoon to 85 percent at sunrise in the warmest and driest months and from 75 percent in midafternoon to 85 percent or higher early in the morning in winter.

The average annual precipitation ranges from approximately 40 inches in the vicinity of Vancouver to between 75 and 110 inches along the foothills and higher elevations in the eastern part. Available records indicate that the heaviest precipitation probably occurs in the northeastern part of the county. The annual precipitation near Cougar, in the Lewis River valley, ranges from 72 to 172 inches. Rain fall of more than half an inch per hour can be expected once in
2 years. During the rainy season, precipitation is usually moderate in intensity and continuous over a period of time, rather than a downpour for a brief period. Rainfall of heavy intensity, however, occurs occasionally as the more intense weather systems move across the area. Precipitation amounting to 2 to 4 inches in a 24-hour period is recorded in the areas of heavier rainfall almost every year.

Vegetative History

Historic trends of the vegetation of western Washington since the recession of the Pleistocene glaciers has been inferred from pollen records in lake sediments. The lowland forests across much of Western Washington during the Pleistocene were composed of mountain hemlock, spruces and pines. Grass, sedge, and sagebrush pollen was also present, indicating an open steppe community. As climate warmed between 18,000 and 12,000 years BP, pine pollen increased, and Douglas-fir and Sitka spruce are present as well.

The Holocene, or modern glacial period, marked a series of changes culminating in the modern vegetation assemblage. The early Holocene period (10,000-6,000 BP) was likely warmer and drier than at present, and was characterized by Douglas-fir, red alder, oak, bracken fern, grasses, and various prairie herbs. This community type is still present today, likely sustained through the more mesic late Holocene period by a combination of edaphic factors and application of fire by Native American groups.

Cooling temperatures and increasing precipitation in the late Holocene, or last 4-6,000 years, ushered in a final set of changes to the regional forest composition. Douglas-fir, western hemlock, and red alder increase dramatically in the pollen profile, and western red-cedar joined the assemblage about 5,000 years BP.

Pollen cores analysis taken north of the site reveals an initial community of pine, spruce, and mountain hemlock resulting from post-glacial conditions. Western hemlock is present, but is a minor component of the pollen record until the cooler period of the late Holocene (4000 years BP until present). Western red cedar is the last major tree species to arrive on the scene, completing the modern assemblage.

Based on this history, it can be inferred that the forest at Camp Bonnevile has the arboreal diversity necessary to adjust to climatic change, as it has many times before. The key difference today is that there is a broader range of anthropogenic impacts than ever before which will influence the response of the biotic community to changes in moisture and temperature regimes. The vegetation of Camp Bonneville may experience dramatic changes over the next millennium due to climate change and

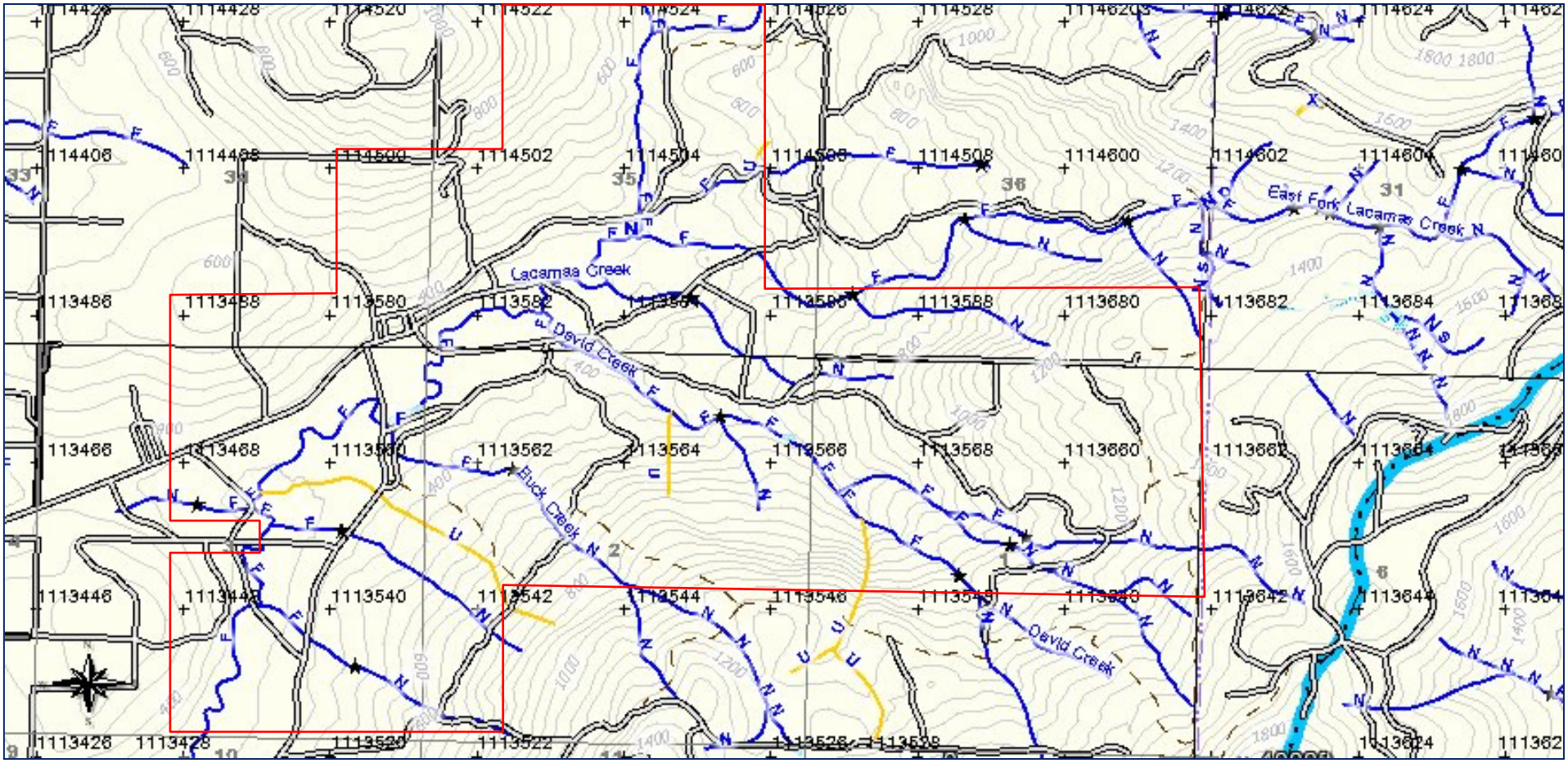
forest management; however, a few species will certainly be represented. Douglas-fir and red alder would be present. Western red cedar and western hemlock, preferring cooler and moister sites, may eventually recede from the site and seek higher ground or north facing slopes.

Geology

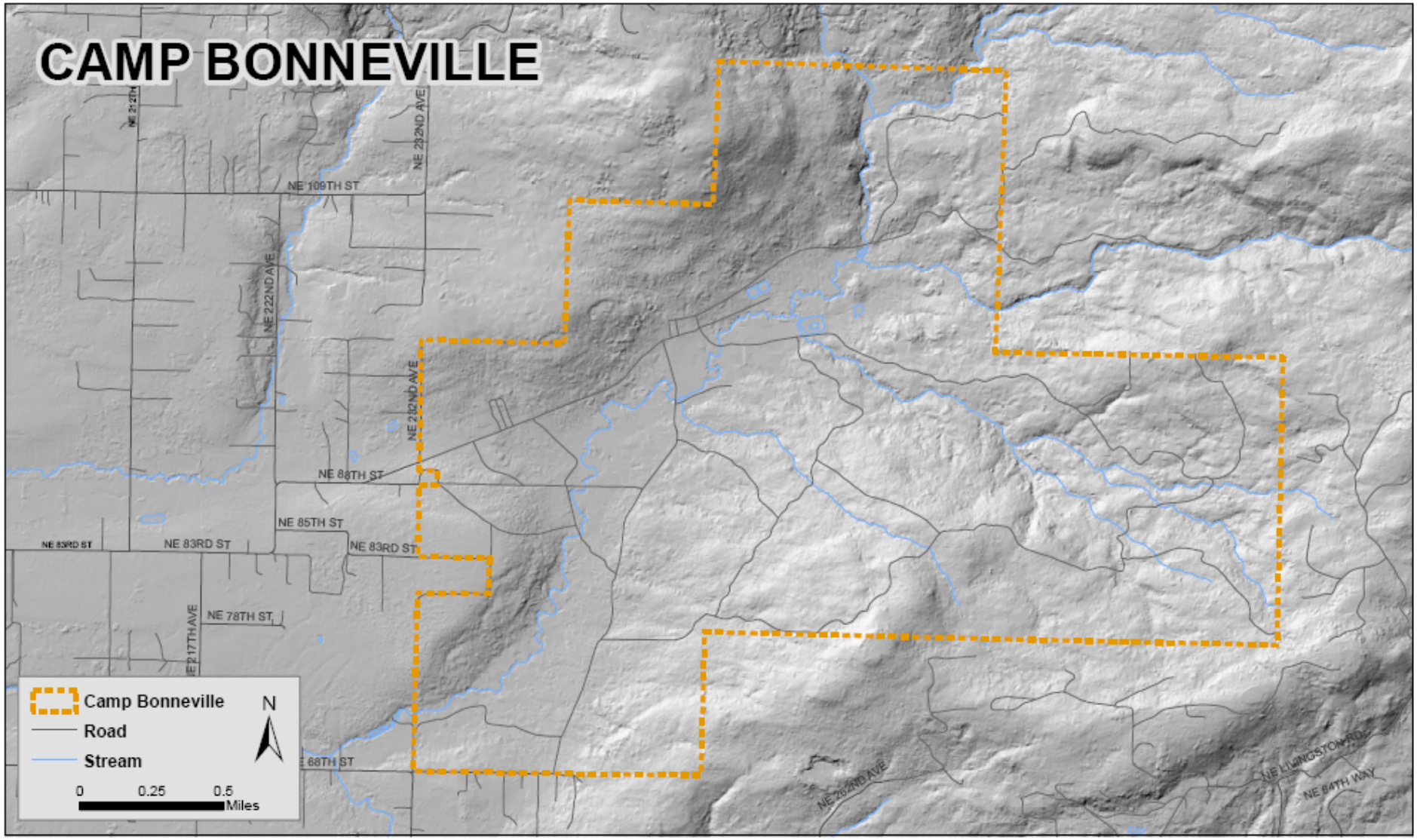
Clark County lies in a long structural basin (Willamette-Puget Trough) between the Pacific Coast ranges to the west and the parallel Cascade Range to the east. The Columbia River, the major trunk stream of the Pacific Northwest, flows through the Cascade Range, borders Clark County as it crosses the trough, then passes through the Pacific Coast ranges into the Pacific Ocean to the west.

The western part of the county consists of a series of gently rolling alluvial terraces that form plains and benches rising steplike from the present level of the Columbia River. The elevations in these areas range from a few feet to more than 800 feet above sea level. The eastern part of the county consists of high old alluvial terraces against volcanic foothills and mountains of the western slopes of the Cascade Range. Along the eastern margin of the county, some of the higher peaks rise to an elevation of nearly 4,000 feet. Mountain ridges 2,000 to 3,000 feet in elevation are common. Much of this area is very steep, and a fall of 1,000 feet within a lateral distance of half a mile is not uncommon. The mountainous terrain is heavily dissected by streams that originate in this area and to the east. Most of the important streams that drain the county flow in a westerly direction. The more prominent streams are: the North Fork of the Lewis River; the East Fork of the Lewis River; the Washougal and Little Washougal Rivers; and Lacamas, Salmon, Big Tree, Cedar, Canyon, Mason, and Lockwood Creeks.

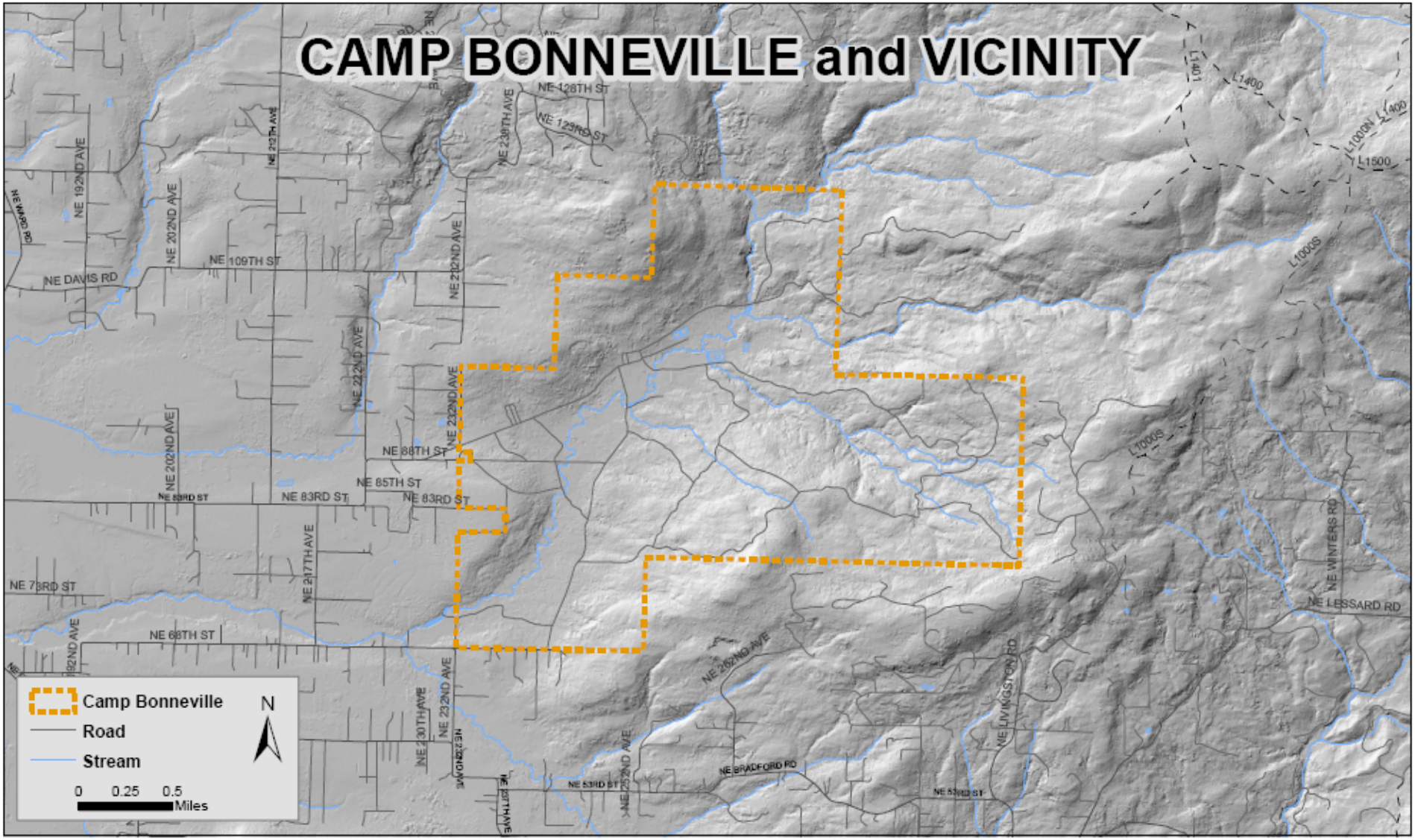
Map 2. Topography & streams



Map 3. LIDAR of Camp Bonneville



Map 4. LIDAR of Camp Bonneville Vicinity



Soils

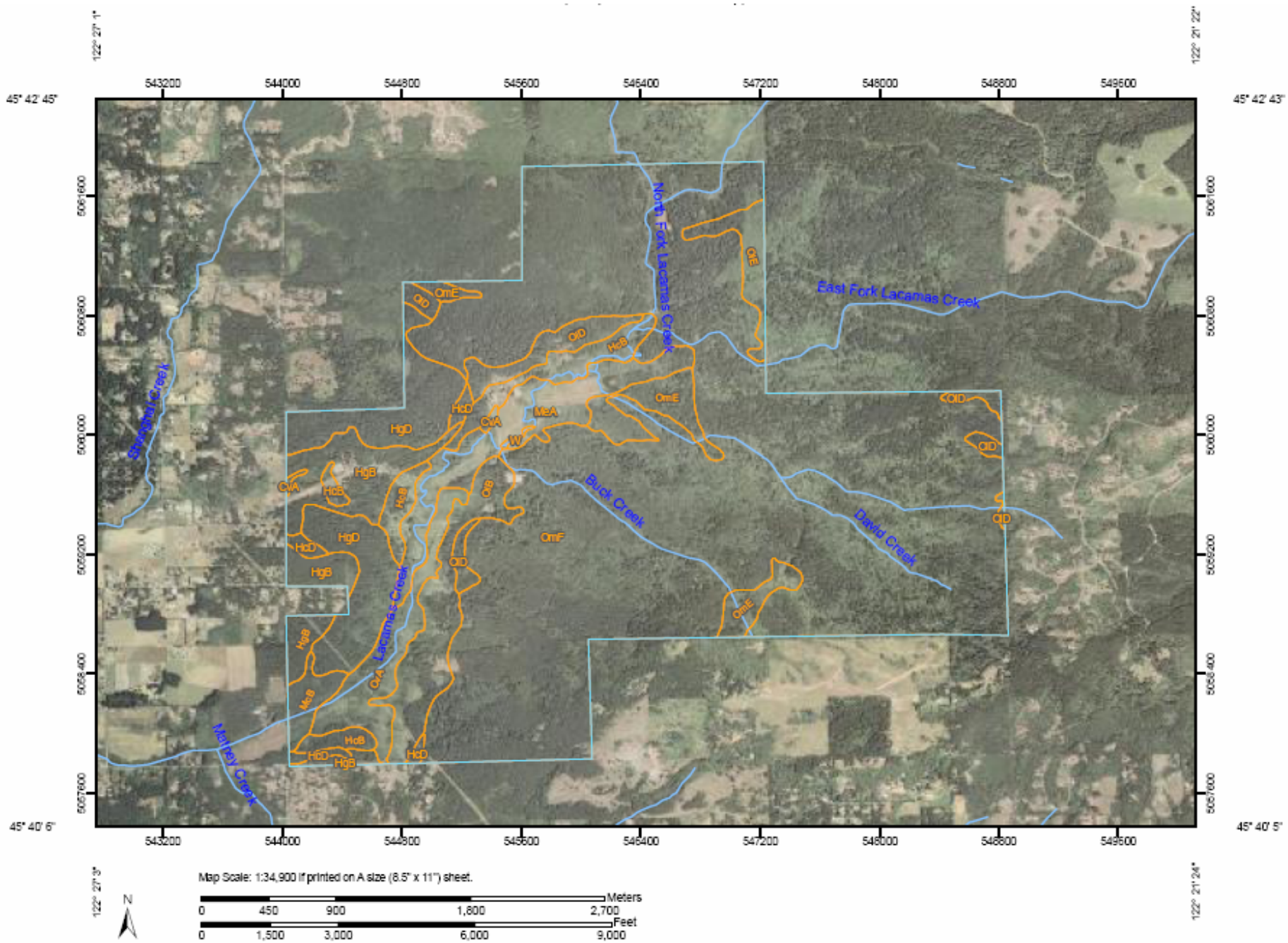
The typical soil profile at Camp Bonneville, starting at the surface layer, is stony, dark reddish-brown clayey sandy silt. The subsoil layer is composed of three slightly differing layers. In sequence from the top, the thin upper portion is friable, dark reddish-brown clayey sandy silt; the next layer is firm, reddish-brown heavy clayey sandy silt; and the lower portion is very firm, dark-brown gravelly clayey sandy silt. The underlying material is weathered basalt bedrock. The depth to the basalt bedrock differs as the topography differs. Generally, as the slope increases the soil becomes shallower. In the extreme western portion of the site the surface is more gently rolling. The soil is well drained and slowly permeable. The available water capacity is high. Surface runoff is rapid to very rapid, and the hazard of erosion is severe to very severe if the surface is left bare.

The following map unit legend lists the major soil types identified on the soil map on the following page:

Map Unit Legend

Clark County, Washington (WA011)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
CvA	Cove silty clay loam, 0 to 3 percent slopes	99.9	3.2%
HcB	Hesson clay loam, 0 to 8 percent slopes	97.0	3.1%
HcD	Hesson clay loam, 8 to 20 percent slopes	21.2	0.7%
HgB	Hesson gravelly clay loam, 0 to 8 percent slopes	144.8	4.7%
HgD	Hesson gravelly clay loam, 8 to 20 percent slopes	197.0	6.4%
McB	McBee silt loam, 0 to 5 percent slopes	28.3	0.9%
MeA	McBee silty clay loam, 0 to 3 percent slopes	140.8	4.6%
OlB	Olympic clay loam, 3 to 8 percent slopes	119.9	3.9%
OlD	Olympic clay loam, 8 to 20 percent slopes	77.9	2.5%
OlE	Olympic clay loam, 20 to 30 percent slopes	40.0	1.3%
OmE	Olympic stony clay loam, 3 to 30 percent slopes	89.2	2.9%
OmF	Olympic stony clay loam, 30 to 60 percent slopes	2,030.9	65.8%
W	Water	1.6	0.1%
Totals for Area of Interest		**3,088.6**	**100.0%**

Map 5. Soil type distribution across Camp Bonneville



Soil type descriptions

The soil types at Camp Bonneville are comprised of two primary series: Hesson and Olympic. The following soil descriptions have been excerpted from the Clark County Soil Survey.

Hesson Series
The Hesson series consists of deep, well-drained soils that are mostly level to gently rolling. Some areas are hilly and very steep. These are moderately fine textured soils that have a fine textured subsoil. The parent material is deeply weathered, mixed old alluvium that contains varying amounts of gravel. The original vegetation is a heavy growth of Douglas-fir and a scattering of western red cedar and grand fir. The understory consists principally of vine maple, salal, Oregon grape, ferns, and red huckleberry.

All the acreage has been logged. Areas not in cultivation are in second-growth timber. The understory is similar in composition to that of the native stands. Red alder is dominant in some areas. The annual precipitation ranges from 50 inches to more than 60 inches.

Hesson clay loam, 0 to 8 percent slopes (HcB).-This is the dominant soil of the high terraces along the mountain foot slopes in the county. In most places the slope is 2 to 5 percent. The relief is undulating. Slopes are generally short to moderate in length. In a typical profile the surface layer is dark reddish brown clay loam about 8 inches thick. The subsurface layer is dark reddish-brown clay loam about 4 inches thick. Below this layer is friable, dark reddish-brown clay loam about 10 inches thick. The next layer, to a depth of about 91 inches, is reddish-brown clay. In sequence from the top, the uppermost 18 inches is friable, the next 39 inches is firm, and the lower 12 inches is very firm.

Included in mapping were some areas that are nearly level or are slightly depressional and have a slightly mottled layer at a depth of 30 to 40 inches. This indicates reduced permeability and a temporary perched water table during rainy periods. This soil is well drained and has moderately slow permeability. The available water capacity is high, and fertility is moderate.
Avg. Site Index: 154

Hesson gravelly clay loam, 0 to 8 percent slopes (HgB).-
This soil is similar to Hesson clay loam, 0 to 8 percent slopes, except that tillage is more difficult. Permeability is moderately slow, and the available water capacity is high.
Avg. Site Index: 154

Hesson clay loam, 8 to 20 percent slopes (HcD).-This soil is similar to Hesson clay loam, 0 to 8 percent slopes, except that the surface layer generally is 1 to 2 inches thinner. In places where erosion has been active, the surface layer is 2 to
4 inches thinner. The slopes are generally single and are moderate in length.
Runoff is medium, and the erosion hazard is moderate where the surface is left bare in winter.
Avg. Site Index: 154

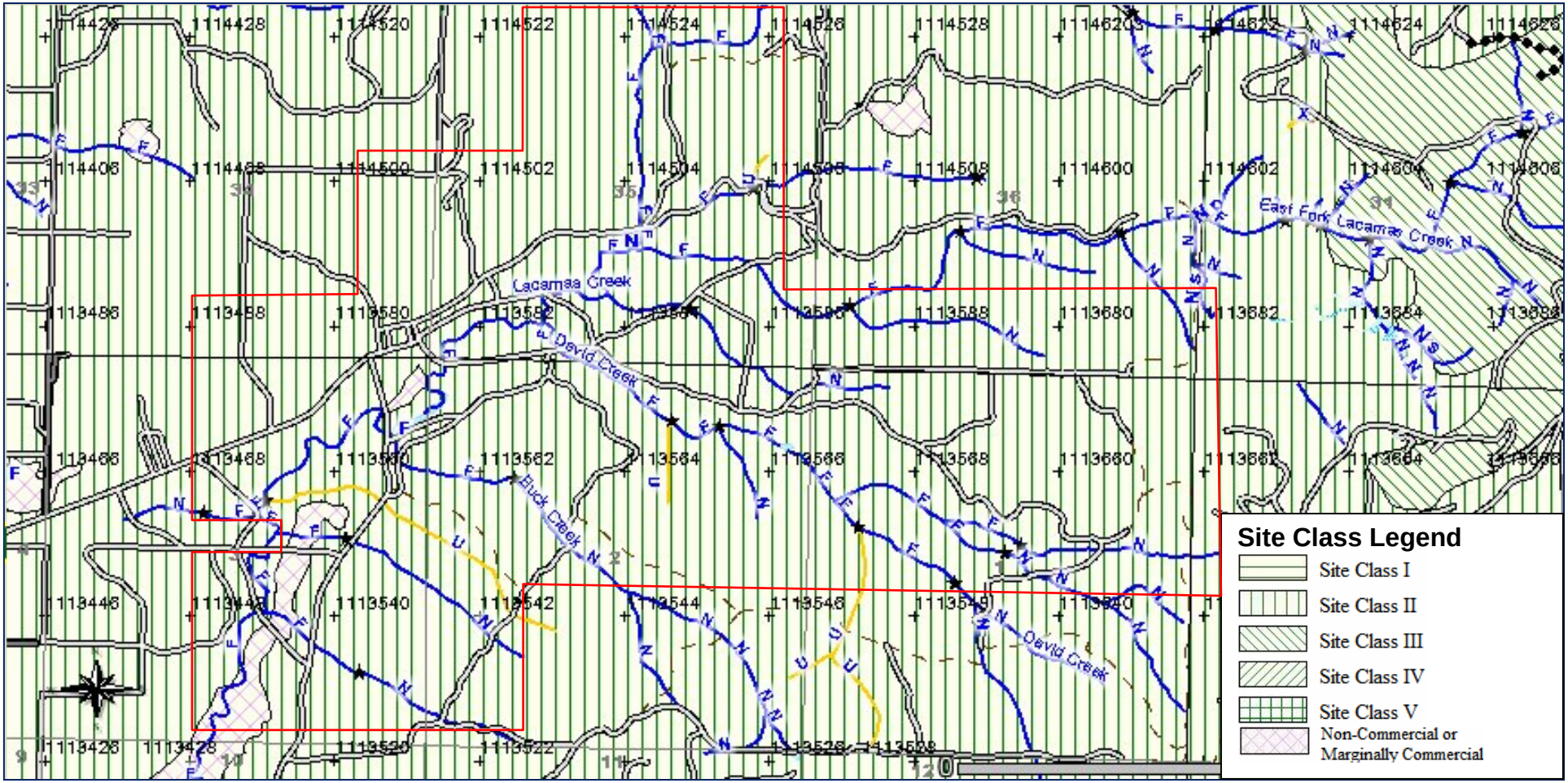
Hesson gravelly clay loam, 8 to 20 percent slopes (HgD).-
This soil is similar to Hesson clay loam, 0 to 8 percent slopes, except that the surface layer is gravelly and the subsoil contains more gravel. Surface runoff is medium, and the erosion hazard is moderate. The available water capacity is
moderate.
Avg. Site Index: 154

Olympic Series
The Olympic series consists of well-drained, gently sloping to very steep soils underlain by basalt bedrock at a depth of 40 inches or more. These are moderately fine textured soils that formed on mountainous foot slopes in
weathered igneous lava flows. Most of the soils formed in place, but in small areas they formed in material moved by gravity. The original vegetation was Douglas-fir, grand fir, hemlock, western red cedar, and Oregon white
oak. The understory plants were vine maple, salal, Oregon grape, ferns, and grasses. The annual precipitation is 45 to 80 inches.

Olympic clay loam, 8 to 20 percent slopes (OlD).-
This soil is on rolling, strongly sloping mountain foot slopes and long straight side slopes below ridgetops. In most places the slope is 10 to 15 percent. In a typical profile the surface layer is dark reddishbrown clay loam about 13 inches thick. The next layer is 46 inches thick. In sequence from the top, the upper 7 inches is friable, dark reddish-brown clay loam; the next 12 inches is firm, reddish-brown heavy clay loam; and the lower 15 inches is very firm, dark-brown gravelly clay loam. The underlying material is weathered basalt bedrock.
Avg. Site Index: 154

Olympic stony clay loam, 30 to 60 percent slopes (OmF).-
This soil is on long side slopes in the mountains and on short slopes along drainage-ways in the foothills. It is similar to Olympic clay loam, 8 to 20 percent slopes, except that it is very steep and the surface layer is stony. In places this soil developed in material moved through gravity. Some of these areas are still unstable. Surface runoff is rapid to very rapid, and the hazard of erosion is severe to very severe if the surface is left bare. The slope and the stony surface layer limit use of this soil to timber.
Avg. Site Index: 139

Map 6. Soil Site Class

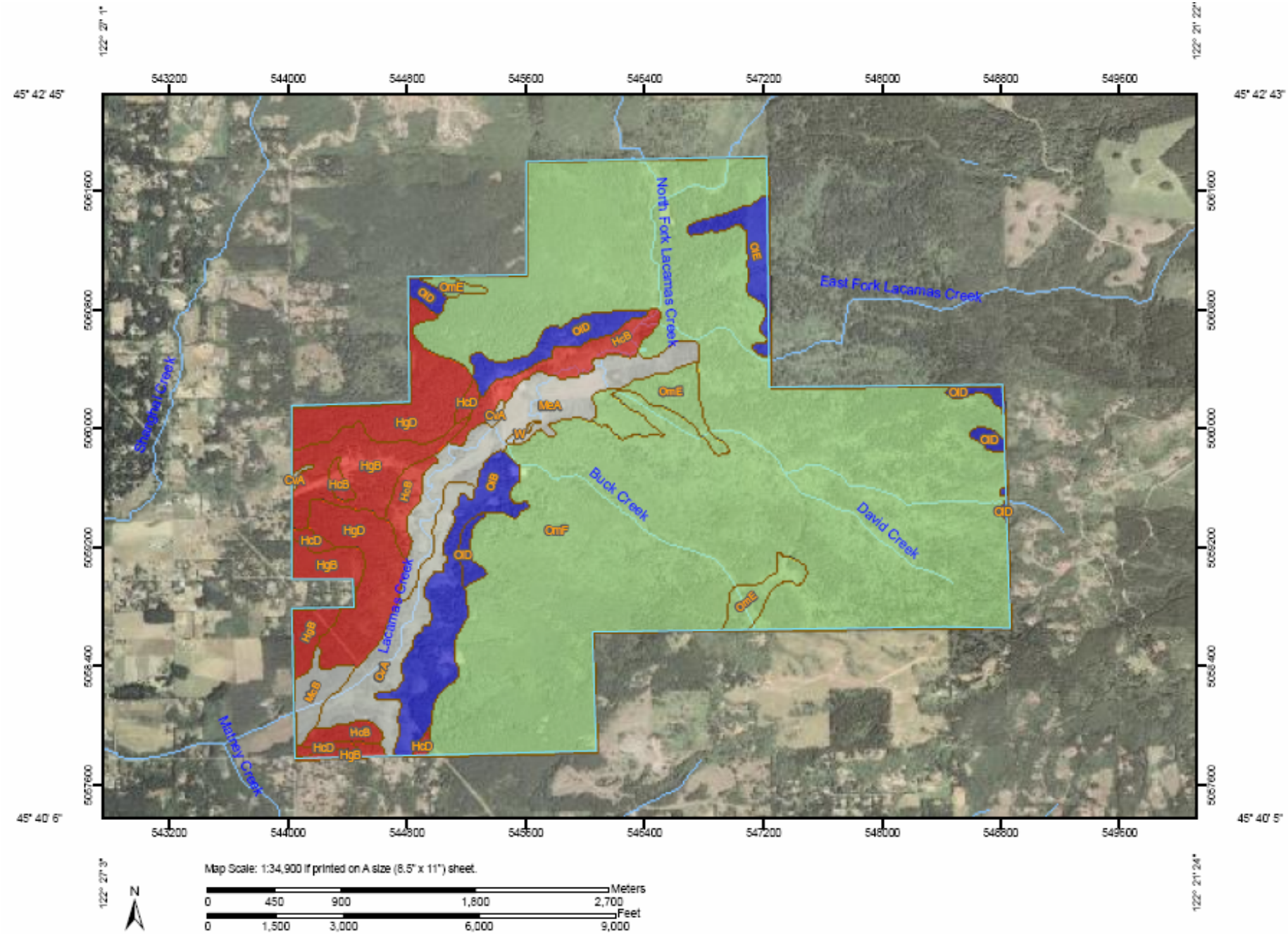


Soil Site Index
The "site index" is the average height, in feet, that dominant and co-dominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands.

Forest Productivity (Tree Site Index): Douglas-fir (King 1966 (795))

Forest Productivity (Tree Site Index): Douglas-fir (King 1966 (795))— Summary by Map Unit — Clark County, Washington (WA011)				
Map unit symbol	Map unit name	Rating (feet)	Acres in AOI	Percent of AOI
CvA	Cove silty clay loam, 0 to 3 percent slopes		99.9	3.2%
HcB	Hesson clay loam, 0 to 8 percent slopes	120	97.0	3.1%
HcD	Hesson clay loam, 8 to 20 percent slopes	120	21.2	0.7%
HgB	Hesson gravelly clay loam, 0 to 8 percent slopes	120	144.8	4.7%
HgD	Hesson gravelly clay loam, 8 to 20 percent slopes	120	197.0	6.4%
McB	McBee silt loam, 0 to 5 percent slopes		28.3	0.9%
MeA	McBee silty clay loam, 0 to 3 percent slopes		140.8	4.6%
OlB	Olympic clay loam, 3 to 8 percent slopes	133	119.9	3.9%
OlD	Olympic clay loam, 8 to 20 percent slopes	133	77.9	2.5%
OlE	Olympic clay loam, 20 to 30 percent slopes	133	40.0	1.3%
OmE	Olympic stony clay loam, 3 to 30 percent slopes	125	89.2	2.9%
OmF	Olympic stony clay loam, 30 to 60 percent slopes	125	2,030.9	65.8%
W	Water		1.6	0.1%
Totals for Area of Interest			**3,088.6**	**100.0%**

Map 7. Tree Site Index



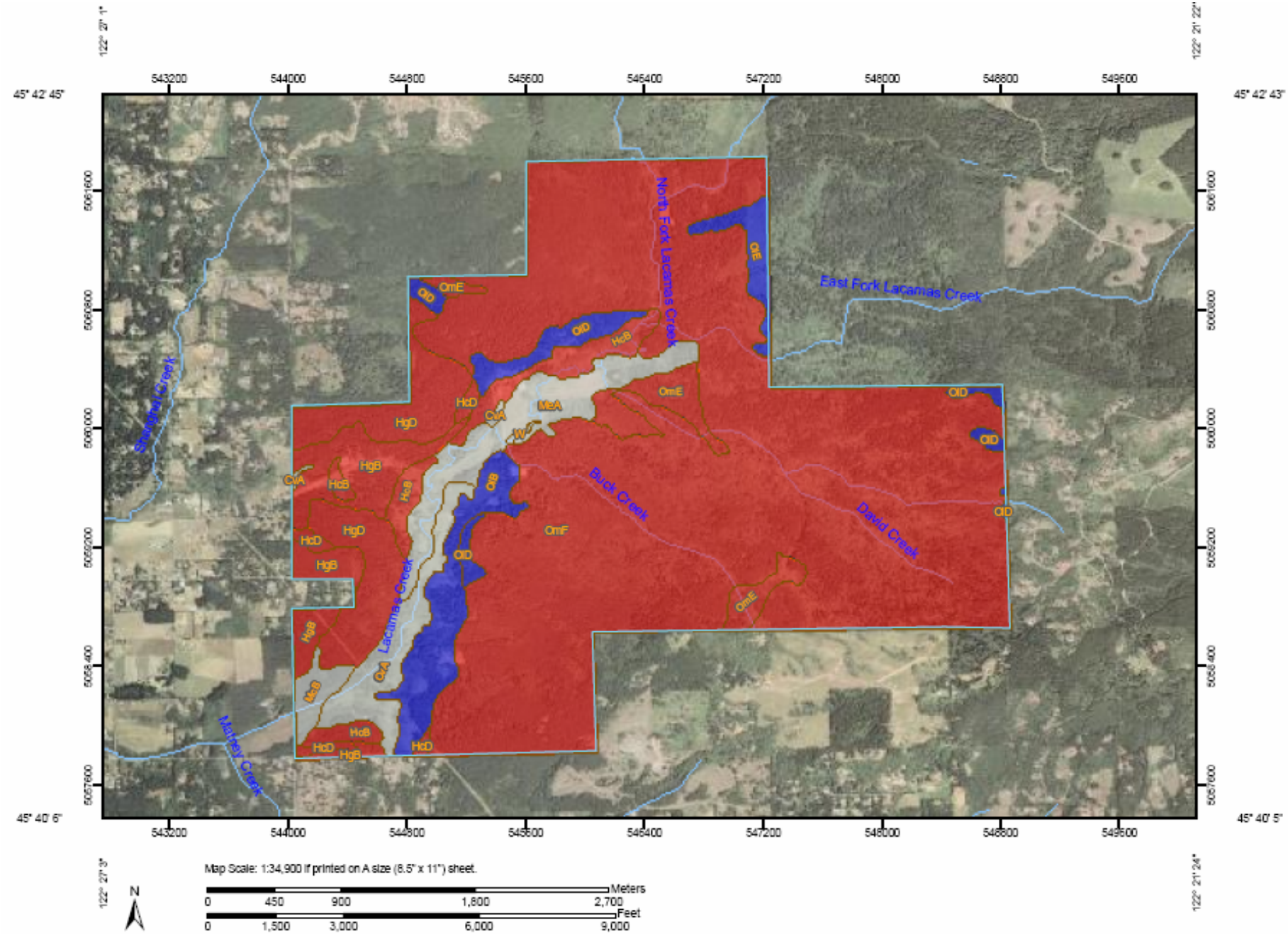
Soil Productivity

Forest productivity is the volume of wood fiber that is the yield likely to be produced by the most important tree species. This number, expressed as cubic feet per acre per year and calculated at the age of culmination of the mean annual increment (CMAI), indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

Forest Productivity (Cubic Feet per Acre per Year): Douglas-fir (King 1966 (795))

Forest Productivity (Cubic Feet per Acre per Year): Douglas-fir (King 1966 (795))— Summary by Map Unit — Clark County, Washington (WA011)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
CvA	Cove silty clay loam, 0 to 3 percent slopes		99.9	3.2%
HcB	Hesson clay loam, 0 to 8 percent slopes	172.00	97.0	3.1%
HcD	Hesson clay loam, 8 to 20 percent slopes	172.00	21.2	0.7%
HgB	Hesson gravelly clay loam, 0 to 8 percent slopes	172.00	144.8	4.7%
HgD	Hesson gravelly clay loam, 8 to 20 percent slopes	172.00	197.0	6.4%
McB	McBee silt loam, 0 to 5 percent slopes		28.3	0.9%
MeA	McBee silty clay loam, 0 to 3 percent slopes		140.8	4.6%
OlB	Olympic clay loam, 3 to 8 percent slopes	186.00	119.9	3.9%
OlD	Olympic clay loam, 8 to 20 percent slopes	186.00	77.9	2.5%
OlE	Olympic clay loam, 20 to 30 percent slopes	186.00	40.0	1.3%
OmE	Olympic stony clay loam, 3 to 30 percent slopes	172.00	89.2	2.9%
OmF	Olympic stony clay loam, 30 to 60 percent slopes	172.00	2,030.9	65.8%
W	Water		1.6	0.1%
Totals for Area of Interest			**3,088.6**	**100.0%**

Map 8. Soil Productivity



Present Site Conditions

Forest Management Units

Forest management units (FMU's) are discrete polygons on a landscape that are defined by natural disturbances and forest management practices. The forest stands within Camp Bonneville were originally identified and inventoried in 1978 by Lester Hansen, the Post Forester for the Army at Fort Lewis.

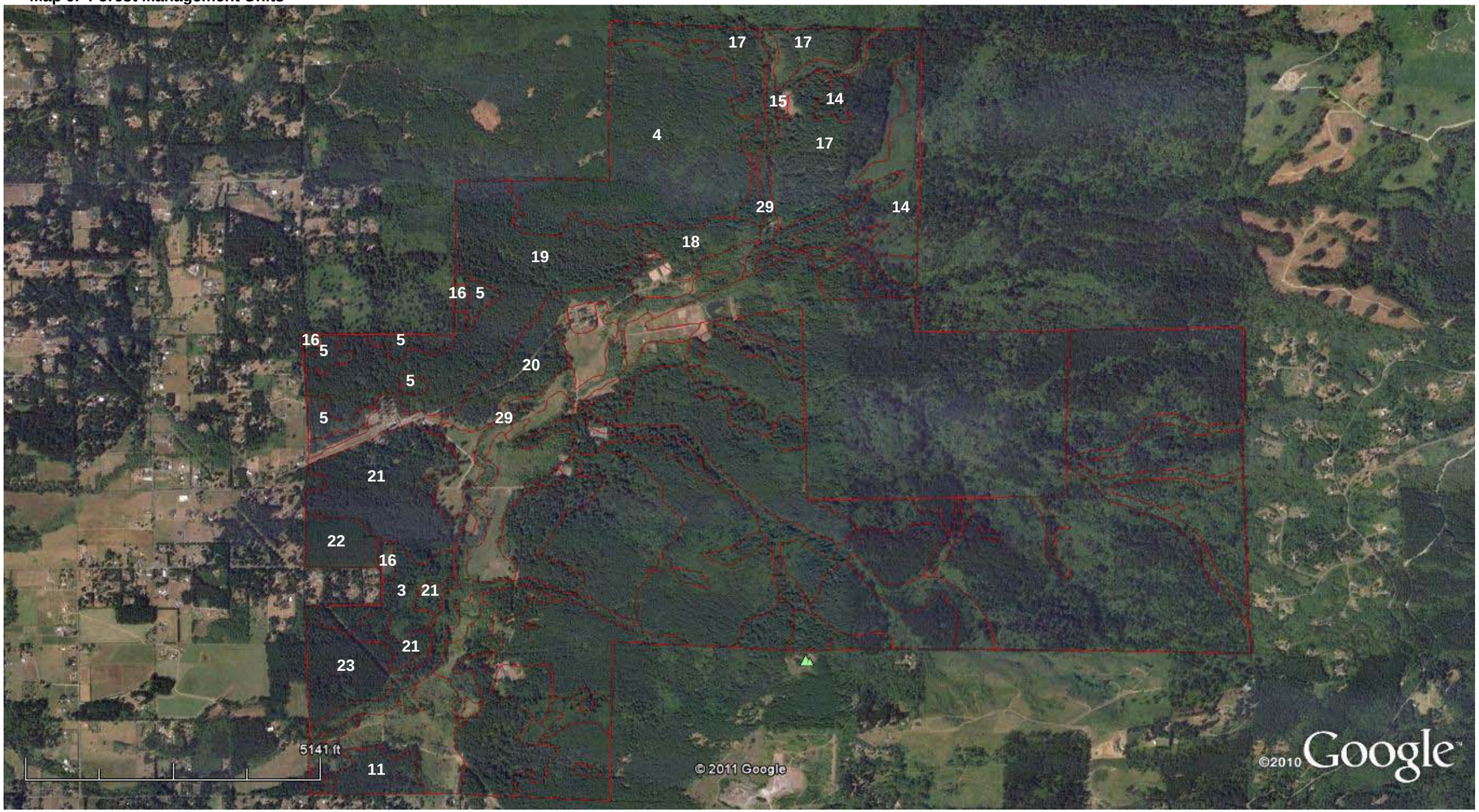
This plan covers the following forest management units, which run approximately from the Northeast corner of the property down to the Southwest corner, and primarily on either side of or to the west of Lacamas Creek:

FMU #	FMU Category	Acres	Age
3	Commercial II	34	38
4	Commercial I	184	38
5		32	35
11	Commercial III	33	93
14	Commercial III	87	34
17	Commercial I	191	73
18-20	Commercial II	89	63
19	Commercial I	175	73
21	Commercial II	102	63
22	Commercial I	23	38
23	Commercial III	47	98
	Tot Conifer Stands	**997**	
29	Riparian Mgt.Zone	130	
	2011 Plan acres	**1,127**	

In the following FMU descriptions, the following conventions have been used:

1. Priority: refers to the management priority of an FMU. Priority I indicates an FMU that should be thinned within the next 1- 5 years in order to maintain the health and vigor of the stand. Priority II should be thinned within the next 5 – 15 years. Priority III may not require additional thinning, or can be selectively thinned for specialty products.

Map 9. Forest Management Units



FMU 17

Category/ Priority	Acres	Age 2011	PAI %	Soil Type	Site Index	Site Class	
Commercial I Priority III	191	73	0.53	OmF	139	II	
Avg. DBH	**Avg. HT.**	**HDR**	**LCR**	**Growth/ Acre/Yr (BF)**	**Total Growth/Yr (MBF)**	**Total Vol/ Acre (MBF)**	**Total Vol. Gross (MBF)**
19.7	150	94	0.30	245.92	46,971	46.40	8,862

This FMU encompasses three discrete stands in the Northeast corner of the property. This FMU has been thinned in the past and stocking density is much lower than the majority of the stands across Camp Bonneville (<200 TPA). As with most stands across the property, the stands in this FMU are dominated by single cohort of mature Douglas-fir. A small component of mature red alder and big leaf maple occur as individuals or in small patches sporadically throughout the site. Small ¼ acre gaps occur throughout the FMU, which tend to be colonized by vine maple. The dense canopy and droughty soils is effectively suppressing understory vegetation, with sword fern and salal being the dominant species. Additionally, there is no understory regeneration of a second conifer cohort. Snags and downed coarse woody debris are largely absent throughout this FMU.

Although timber across this FMU was thinned, the height-to-diameter ratio (HDR) remains very high (94) and the live crown ratio is still very low. There was no evidence of blow down throughout this FMU, so wind firmness remains strong despite the high HDR. The low crown ratio will limit annual volume growth, but increase the density and long-term quality of the timber. Short-term log quality will be relatively low due to large branches that are still being retained by the majority of the trees.

The North Fork of Lacamas Creek bisects the FMU running from North to South.

Management recommendations

This is a Priority III FMU, which indicates that no short term timber management is necessary to improve the health or vigor of timber across the FMU. The following recommendations address Clark County's structure-based forest management objectives:

1. Conduct small (1- 2 acre) patch cuts to regenerate Douglas-fir and create a patch mosaic of age classes and canopy structures throughout the FMU.
2. Variable density thinning can be used to diversify spatial complexity and open the canopy to allow for more robust understory regeneration of a second conifer cohort as well as groundcover and understory shrubs.

3. Thin dominant and co-dominant timber classes around big leaf maple and other hardwoods in the understory to promote a more viable hardwood component throughout the FMU.
4. Where soils will support western red cedar, western hemlock or grand fir, these shade tolerant species can be underplanted to introduce a second conifer cohort
5. Where hardwoods are absent, underplant big leaf maple at a spacing of no more than 1 per two acres.
6. Create snags by topping or girdling lower value dominant and co-dominant trees. Target: 3-10 snags/acre.
7. Create coarse downed woody debris by cutting and leaving lower value dominant and co-dominant trees. Target: 3-10 snags/acre.
8. Follow other structure-based management practices as described later in this plan.

FMU 14

Category/ Priority	Acres	Age 2011	PAI %	Soil Type	Site Index	Site Class	
Priority I	87				133	II	
Avg. DBH	**Avg. HT.**	**HDR**	**LCR**	**Growth/ Acre/Yr (BF)**	**Total Growth/Yr (MBF)**	**Total Vol/ Acre (MBF)**	**Total Vol. Gross (MBF)**

This FMU was clearcut approximately 25 years ago and the resulting pioneering hardwoods were not controlled. Thus, this FMU is primarily dominated by extremely dense red alder (approx. 800+ tpa). Residual Douglas-fir occur as individuals throughout the stand, but are struggling to compete with the alder and are generally in poor condition. Understory vegetation is dominated by sword fern, with a small component of elderberry.

Management recommendations

This is a Priority I FMU, which indicates that short-term management will be essential to improving forest health and vigor. Given the lack of hardwoods across the majority of Camp Bonneville, the following recommendations are intended to facilitate the rehabilitation of this FMU as a hardwood dominated forest type.

1. Pre-commercially thin red alder within 1-5 years, favoring dominant trees with the best form class.
2. Thin more heavily around residual conifer to release conifer to achieve dominance in the canopy
3. In areas where alder are not expected to respond to thinning, patch cuts may be used to reintroduce either Douglas-fir or a combination of western red cedar and western hemlock.
4. Thinned material can either be left on site or may be extracted as merchantable biomass for local co-gen or CHP facilities.
5. Thinned material can also be piled into habitat piles and constructed downed logs to optimize habitat for amphibians and small mammals.
6. Follow other structure-based management practices as described later in this plan.

FMU 4

Category/	Acres	Age	PAI %	Soil Type	Site Index	Site Class	

Priority		2011					
Commercial I Priority I	184	38	0.83	HgD	139	II	
Avg. DBH	**Avg. HT.**	**HDR**	**LCR**	**Growth/ Acre/Yr (BF)**	**Total Growth/Yr (MBF)**	**Total Vol/ Acre (MBF)**	**Total Vol. Gross (MBF)**
10.7	97	86.3	0.45	146.08	26,879	17.60	3,238

This large FMU covers a diverse topography in the Northwest corner of the property. This FMU was clear cut in approximately 1972 and replanted with Douglas-fir in 1973. Likely natural reseeding took place, thus resulting in the current excessively high stocking density (600+ tpa). Patches of dense red alder (800+ tpa) occur in the southeast portion of the FMU. Soil moisture is higher in this area resulting in a more robust understory of sword fern, hazelnut and salal. Additionally, there is no understory regeneration of a second conifer cohort. Snags and downed coarse woody debris are largely absent throughout this FMU.

Since this stand has developed under high density, the height-to-diameter ratio (HDR) of the majority of the trees is very high (86.3). These two factors, stand density and high HDR, contribute to a very unstable stand that is becoming more susceptible to wind storms and other natural disturbances.

Management Recommendations
Note: See Appendix 2 for 2012 harvest plan

This FMU is a Priority I, indicating that short-term management will be necessary to improve stand conditions, forest health and vigor.

1. Commercially thin 20% - 30% basal area within next 1-5 years by thinning from below. Thinning intensity should vary across the site based on stocking density and aspect in order to minimize future wind throw potential.
2. Use of processor or feller-buncher will minimize soil disturbance, ground impacts and damage to residual trees
3. Create snags and downed logs during thinning operations. Target: 3-10 snags and downed logs per acre.
4. Conduct second-entry variable density thinning in 5 - 10 years
5. Conduct third-entry variable density thinning in 10-15 years and reduce canopy to 30% to allow for natural (or planted) understory regeneration of a 2nd conifer cohort.
6. Follow other structure-based management practices as described later in this plan.

North reach of Lacamas Creek

FMU 29
No inventory data for this stand

This 130 acre FMU comprises the riparian management zone along Lacamas Creek. The FMU follows Lacamas creek from where it enters the property along the northern boundary line, to where the creek exists the property at the southwest corner. Vegetation within the RMZ is comprised of sparsely populated hardwoods (primarily red alder), brush (primarily vine maple and hazelnut) and grass (primarily reed canary). There is very little conifer cover along the creek as likely the majority of the conifer was harvested during a previous regulatory environment that allowed for harvesting streamside corridors.

The Lacamas Creek stream channel is deeply incised in many areas, particularly through the reaches in the northern part of the property. This is likely due to a lack of large woody debris throughout the stream system and increased "flashiness" of water flow due to poor water retention in the heavily logged upper part of the watershed. The substrate in the stream channel is comprised of cobbles and fine gravel.

Management recommendations

1. Within 1-5 years replant RMZ's with a mix of conifers and hardwoods, including: Douglas-fir, Western Red Cedar, Western Hemlock, Grand fir, Sitka Spruce, red alder, big leaf maple, cottonwood and Oregon ash.
2. Add large wood debris to stream channel to slow water velocity and create pool's and riffles.

FMU 18 & 20

Category/ Priority	Acres	Age 2011	PAI %	Soil Type	Site Index	Site Class	
Commercial II Priority 2	89	63 - 93	0.42	HgD	154	III	
Avg. DBH	**Avg. HT.**	**HDR**	**LCR**	**Growth/ Acre/Yr (BF)**	**Total Growth/Yr (MBF)**	**Total Vol/ Acre (MBF)**	**Total Vol. Gross (MBF)**
21.4	120	67	0.35	237.72	21,157	56.60	5,037

FMU's 18 & 20 follow the main access road through the central part of the property. These stands share common characteristics with others across the property given that they are dominated by an even-age class of Douglas-fir, have minimal understory development, and minimal to no snags and downed logs. Understory vegetation is comprised of sword fern, salal, and vine maple. There is a small, dispersed population of big leaf maple beginning to emerge in the understory through FMU 18 and the north portion of FMU 20.

Stand 18

FMU 18 is younger (approx. 63 years old) and more densely stocked than FMU 20 with an average of >600 TPA. Given the high stocking density, the LCR is low. There is greater diameter class differentiation throughout this stand, with a higher percentage of trees expressing dominance. Although the majority of intermediate and suppressed trees have a very high HDR, the dominant class is better established with an average HDR of 67.

Trees across FMU 20 tend to be older (approx. 93 years, and more lightly stocked). This stand was thinned from below approximately 30 years ago, therefore the average LCR is higher and the average HDR is lower, thus making this stand much more stable against wind-based natural disturbances. Given the lighter canopy, understory development on the north side of the road is much more robust. The south side of the road shows evidence of past grazing as there is little to now understory development. Additionally, this section of FMU 20 has been thinned much more heavily, and currently has a stocking density of approx. 100 – 150 TPA.

Stand 20 – north side of road

Management Recommendations

These are high visibility stands with easy access from the road and therefore will receive a higher level of management attention in order to demonstrate structure-based forest management practices. The long-term objective is to manage these stands for late successional characteristics.

Stand 20 - south side of road

1. Thin across diameter classes 30% of basal area in FMU 18 and north portion of FMU 20 within 5-10 years.
2. Thin more heavily around hardwoods to promote growth and position in canopy.
3. Create snags and large wood debris – targets: 3-10 snags and downed logs per acre over time.
4. Variable density thin 30 % basal area in 10-15 years across both FMU's to favor multiple diameter classes and increased spatial heterogeneity. Bring stocking density down to <200 TPA.
5. Follow other structure-based management practices as described later in this plan.

FMU 19

Category/ Priority	Acres	Age 2011	PAI %	Soil Type	Site Index	Site Class	
Commercial I P1	175	73	0.57	OiD	154	III	

Avg. DBH	Avg. HT.	HDR	LCR	Growth/ Acre/Yr (BF)	Total Growth/Yr (MBF)	Total Vol/ Acre (MBF)	Total Vol. Gross (MBF)
29.0	122	50.4	0.20	200.64	35,112	35.20	6,160

FMU 19 is a large stand that straddles a diverse topography. Soils tend to be wetter, contributing to higher growth potential and trees that are larger in diameter for their height (HDR of 50%). However, as with other stands across the property, stocking density is high (>450 TPA) contributing to a live crown ratio of only 20%. Therefore, the current growth of this stand is very stagnant. The dense canopy is suppressing development of understory vegetation and a 2nd cohort of conifers. Current understory vegetation is limited to hazelnut, vine maple and sword fern. Big leaf maple occurs as individuals sporadically throughout the stand. Decadence is low throughout the stand, with minimal to no snags or large woody debris.

Management recommendations

This is a Priority I FMU due to the high stocking density and low crown ratio. In order to optimize the growth on these higher productivity soils, the stand should be thinned soon and frequently over the next 15 years.

1. Thin 30% of basal area from below within 1-5 years.
2. Variable density thin 30% of basal area across diameter classes in 5-10 years after stand has regained wind-firmness.
3. Variable density thin 30% of basal area across diameter classes in 10-15 years. Utilize small patch cuts (<6 acres) to begin introducing greater stand level structural hetereogeneity and opportunities for Douglas-fir regeneration.
4. After 2nd thinning, being underplanting grand fir, western red cedar and western hemlock in low spots and wetter sites
5. Thin more heavily around hardwoods to promote growth and position in canopy.
6. Create snags and large wood debris – targets: 3-10 snags and downed logs per acre over time.
7. Follow other structure-based management practices as described later in this plan.

FMU 5

Category/ Priority	Acres	Age 2011	PAI %	Soil Type	Site Index	Site Class	
Priority I	32	35	NA	**OiD**	**154**	III	
Avg. DBH	**Avg. HT.**	**HDR**	**LCR**	**Growth/ Acre/Yr (BF)**	**Total Growth/Yr (MBF)**	**Total Vol/ Acre (MBF)**	**Total Vol. Gross (MBF)**

NA	NA	NA	NA				

FMU 5 combines approximately five non-contiguous parcels along the western property line. These areas were clearcut in approximately 1977-1978 and immediately replanted. Likely natural reseeding took place, thus resulting in the current excessively high stocking density (600+ TPA). The species composition of the dominant trees runs approximately 75% Douglas-fir and 25% red alder. The red alder occurs in clumps and as individuals throughout the FMU. Soil moisture is higher in this area resulting in a more robust understory of sword fern, hazelnut and salal. Additionally, there is no understory regeneration of a second conifer cohort. Snags and downed coarse woody debris are largely absent throughout this FMU.

Management Recommendations

This is a Priority I FMU indicating that it should be commercially thinned within 1-5 years in order to bring stand density down and promote stand growth, vigor and health.

1. Commercially thin 30% basal area from below within 1-5 years. Target majority of commercially viable alder for removal as quality is low and life-span short on these soils. Leave small component of red alder as part of biological matrix.
2. Create snags and downed logs during thinning operations. Target: 3-10 snags and downed logs per acre.
3. Conduct 2nd entry thinning in 5-10 years to thin an additional 30% basal area from below
4. Begin Variable density thinning in 10-15 years.
5. Follow other structure-based management practices as described later in this plan.

FMU 21

Category/ Priority	Acres	Age 2011	PAI %	Soil Type	Site Index	Site Class	
Commercial II Priority 2	102	63	0.4	HgB	154	III	
Avg. DBH	**Avg. HT.**	**HDR**	**LCR**	**Growth/ Acre/Yr (BF)**	**Total Growth/Yr (MBF)**	**Total Vol/ Acre (MBF)**	**Total Vol. Gross (MBF)**

26.1	120	54.5	0.32	160.4	16,361	40.10	4,090

This FMU is spread across three distinct stands in the southwest corner of the property. The composition of the dominant tree species is approximately 95% Douglas-fir and 5% red alder. The alder is generally of poor condition, which is typical for rocky, well drained soils. The stand is heavily stocked for its age (350 – 450 TPA), but not as heavily stocked as other FMU's throughout the property. There is greater differentiation amongst dominant, co-dominant and intermediate trees, as well as across the diameter classes. The HDR tends to be lower across this site, but the LCR is also lower, indicating that stand growth is slowing significantly due to canopy competition. Root rot is quite prevalent throughout this site, and is beginning to create gaps ranging from ¼ acre to ¾ acre in size. Red alder and hazelnut are dominating the root rot pockets. Big leaf maple occurs as individuals sporadically throughout the stand. Despite the prevalence of root rot, snags are still minimal throughout the stand as it appears that trees tend to blow over versus persist as standing dead. Beyond the root rot pockets, downed logs are minimal to non-existent.

Management Recommendations

This is a Priority II FMU, indicating that thinning should occur in approximately 5-10 years after all Priority I FMU's have been treated.

Root rot pocket

1. Commercially thin 30% basal area from below within 5-10 years.
2. Patch cuts of 1-6 acres may be utilized to increase stand-level heterogeneity and regenerate Douglas-fir. Patch cuts can be focused on root rot pockets, however, in these locations western red cedar and red alder should be replanted.
3. Create snags and downed logs during thinning operations. Target: 3-10 snags and downed logs per acre.
4. Conduct 2nd entry variable density thinning of 30% basal area in 10-15 years, focusing thinning across the diameter classes.
5. Conduct 3rd entry variable density thinning of 30% basal area in 15-20 years.
6. Follow other structure-based management practices as described later in this plan.

FMU 22

Category/ Priority	Acres	Age 2011	PAI %	Soil Type	Site Index	Site Class	
Commercial I Priority I	23	38	1.1	HgB	154	III	
Avg. DBH	**Avg. HT.**	**HDR**	**LCR**	**Growth/ Acre/Yr (BF)**	**Total Growth/Yr (MBF)**	**Total Vol/ Acre (MBF)**	**Total Vol. Gross (MBF)**
12.3	96	93	0.15	243.1	5,591	22.10	508

This FMU is comprised of a young and highly stocked (450+ TPA) stand of Douglas-fir. This stand has been in the stem exclusion phase for over 10 years, resulting in an LCR of <30 percent and an HDR of 93. This stand is highly susceptible to wind-based natural disturbance, especially given its location along a property line where urban development has significantly reduced the buffering effect of the adjacent forest. The low LCR and high stocking density is also contributing to stagnant growth. Understory vegetation is comprised of ocean spray, vine maple, hazel nut and salal. Root rot is evident in scattered pockets throughout the FMU, with the aforementioned brush species heavily colonizing these areas. Despite the effects of root rot, very few snags or downed logs occur throughout the site.

Management Recommendations

Note: See Appendix 2 for 2012 harvest plan

This is a Priority I FMU, indicating that commercial thinning should be conducted within the next 1-5 years in order to reduce the stocking density and improve the growth, vigor and health of this stand.

1. Commercially thin 30% basal area from below within 1-5 years
2. Thin more lightly along stand boundaries to minimize wind disturbance.
3. Underplant stand boundaries with grand fir to begin developing more complex edge and canopy to further mitigate wind disturbance.
4. Conduct small patch cuts in root rot pockets. Replant with western red cedar.
5. Create snags and downed logs during thinning operations. Target: 3-10 snags and downed logs per acre.
6. Conduct 2nd entry variable density thinning in 5-10 years of 30% basal area. Begin thinning across diameter classes to create more complex stand and canopy structure.
7. Conduct 3rd entry variable density thinning in 10-15 years.
8. Follow other structure-based management practices as described later in this plan.

FMU 3

Category/ Priority	Acres	Age 2011	PAI %	Soil Type	Site Index	Site Class	
Commercial II Priority III	34	38	1.05	HgD	154	II	
Avg. DBH	**Avg. HT.**	**HDR**	**LCR**	**Growth/ Acre/Yr (BF)**	**Total Growth/Yr (MBF)**	**Total Vol/ Acre (MBF)**	**Total Vol. Gross (MBF)**
19.7	128	0.42	0.42	203.9	6,105	17.10	581

This is a Priority III FMU indicating that now management activity will be required for another 10-15 years. The stand in this FMU is comprised of a mix of 95 percent Douglas-fir and 5 percent red alder. Red alder occurs in patches and as individuals throughout the FMU. The stand appears to have been high graded in the past, and current timber quality is fairly low. Stand density varies significantly throughout this FMU, with an average stocking of >450 TPA. Despite the high stocking density for the age of the timber, LCR's remain high and the HDR is low. Understory vegetation is comprised of vine maple, hazelnut and sword fern. Root rot is evident throughout this stand.

Management recommendations

1. Commercially thin 30% basal area from below in 10-15 years.
2. Patch cut red alder at maturity and replant with white pine and western red cedar
3. Harvest all Douglas-fir within at least one tree length of root rot pockets and replant sites with western red cedar and Douglas-fir
4. When thinning stand, maintain higher densities along property lines to minimize wind effects from non-forested neighboring lands.
5. Follow other structure-based management practices as described later in this plan.

FMU 23

Category/ Priority	Acres	Age 2011	PAI %	Soil Type	Site Index	Site Class	
Commercial III Priority III	47	98	2.4	HgD	154	III	
Avg. DBH	**Avg. HT.**	**HDR**	**LCR**	**Growth/ Acre/Yr (BF)**	**Total Growth/Yr (MBF)**	**Total Vol/ Acre (MBF)**	**Total Vol. Gross (MBF)**
30.5	114	44.8	45.6	1161.6	54,595	48.40	2,275

This FMU comprises the oldest stand at Camp Bonneville. The stand has been thinned at least once over the past 30 years and the average stocking density is very reasonably below 250TPA. This FMU provides a good example of how active management can improve stand productivity, vigor, health and quality of timber products. The LCR is high for the age of the timber, thus contributing to optimal growth across the stand. This is evidenced by the low HDR and high average DBH. The more open canopy also has resulted in much more robust understory vegetation, predominantly hazelnut and sword fern. However, understory regeneration of a 2nd conifer cohort is non-existent, as are any signs of decadence

(e.g. snags and downed logs).

Management Recommendations
This is a Priority III FMU, which indicates that little to no management will be required for the foreseeable future. Given the advanced age of this stand, as well as the history of past thinning and active management, this stand lends itself more readily to management for late successional characteristics. Additionally, given the unique size and quality of the timber throughout this stand, management will be focused on the production of specialty log products, in particular oversize dimension, clear lumber and poles.

1. Use individual tree selection for harvest of specialty products
2. Use variable density thinning across the diameter classes to promote greater stand level structural heterogeneity and to open the canopy in places to allow for understory regeneration of a 2nd conifer cohort.
3. Plant understory with western red cedar, big leaf maple
4. Follow other structure-based management practices as described later in this plan.

FMU 11

Category/ Priority	Acres	Age 2011	PAI %	Soil Type	Site Index	Site Class	
Commercial III Priority II	33	93	1.2	HgB	154	III	
Avg. DBH	**Avg. HT.**	**HDR**	**LCR**	**Growth/ Acre/Yr (BF)**	**Total Growth/Yr (MBF)**	**Total Vol/ Acre (MBF)**	**Total Vol. Gross (MBF)**
30.1	131	52.4	0.44	631.2	20,830	52.60	1,736

This FMU is comprised of a well spaced (approx. 250 TPA) mature Douglas-fir with a small component big leaf maples scattered as individuals. As with FMU 23, this stand has benefited from past active management and therefore has a much more robust LCR and lower HDR. Annual growth throughout the stand is strong and the quality of timber is superior to other FMU's. Despite the more open condition of this FMU, understory vegetation is limited to sword fern. This may be due to droughty soils. Additionally, snags and downed logs are largely absent throughout the majority of the FMU with the exception of small pockets of root rot.

Management Recommendations
Note: see Appendix 2 for 2012 harvest plan

This is a Priority II FMU, which indicates that minimal management will be required into the foreseeable future. The small root rot pockets should be thinned around and isolated in order to control the spread of the disease. Given the advanced age of this stand, as well as the history of past thinning and active management, this stand lends itself more readily to management for late successional characteristics. Additionally, given the unique size and quality of the timber throughout this stand, management will be focused on the production of specialty log products, in particular oversize dimension, clear lumber and poles.

1. Salvage log root rot pockets and thin heavily around perimeter in order to control spread of disease. Replant root rot areas with western red cedar and big leaf maple.
2. Use individual tree selection for harvest of specialty products
3. Use variable density thinning across the diameter classes to promote greater stand level structural heterogeneity and to open the canopy in places to allow for understory regeneration of a 2nd conifer cohort.
4. Plant understory with western red cedar and big leaf maple
5. Follow other structure-based management practices as described later in this plan.

Streams & Wetlands

The topography of Camp Bonneville is highly variable with elevations ranging from a high of about 1,800 feet National Geodetic Vertical Datum (NGVD) at Livingston Mountain to a low of about 300 feet NGVD along Lacamas Creek. With the exception of short stream reaches north of Camp Bonneville, the Camp effectively serves as the headwaters to Lacamas Creek. Lacamas Creek drops approximately 400 feet per mile as it passes through the Camp. The area generally drains towards the west and southwest through the tributaries of Buck Creek and David Creek into Lacamas Creek. All the surface water drainage eventually empties into the Washougal River and flows southwest into the Columbia River near Camas, Washington.

The biological health of Upper Lacamas Creek has been defined as "fair" in the 2010 Clark County Stream Health Report (See Figure 1 on page 41). Recommendations for improving stream health identified in the Report include:

1. Protect remaining forested areas in watershed
2. Restore stream channels and riparian forests
3. Increase infiltration and storm water runoff
4. Promote health forest practices

Water quality has been monitored in the Lacamas Creek watershed since 1991. Based on data collected in 1991 and 1992 Lacamas, Dwyer, Fifth Plain, Matney and Shanghai Creeks, and China Ditch and China Lateral were included on the 1998 303(d) list, the listing of impaired surface waters in the state. Subsequent data collected by Clark County and Ecology show continued exceedances of water quality standards, and these creeks are included on the 2008 303(d) list.

In-stream and riparian conditions observed during an August, 2011 site visit are as follows:

1. Vegetation within the RMZ is comprised of sparsely populated hardwoods (primarily red alder), brush (primarily vine maple and hazelnut) and grass (primarily reed canary).
2. There is very little conifer cover along the creek as likely the majority of the conifer was harvested during a previous regulatory environment that allowed for harvesting streamside corridors.
3. The Lacamas Creek stream channel is deeply incised in many areas, particularly through the reaches in the northern part of the property. This is likely due to a lack of large woody debris throughout the stream system and increased "flashiness" of water flow due to poor water retention in the heavily logged upper part of the watershed.
4. The substrate in the stream channel is comprised of cobbles and fine gravel.

Seven different wetland types totaling approximately 130 acres were identified within Camp Bonneville during the National Wetland Inventory conducted by the U.S. Fish and Wildlife Service. The majority of wetlands consist of temporarily or seasonally flooded palustrine forested wetlands associated with the Lacamas Creek floodplain. The other types of habitats include palustrine emergent, palustrine open water, and riverine. An extensive emergent wetland system is located near the upper end of Lacamas Creek.

Management Recommendations

Forest management within the riparian zone of all streams, ponds and wetlands will, at a minimum, adhere to the following guidelines as set forth within the Forest Stewardship Council's U.S. Forest Management Standards.

1. Forest management will retain and recruit sufficient large, green trees; snags; understory vegetation; down logs; and other woody debris in riparian zones to provide shade, erosion control, and in-channel structures.

2. For Type F & S (fish bearing and Shorelines of the state) streams, and for lakes and wetlands larger than one acre, an inner buffer zone is maintained. The inner buffer is at least 50 feet wide (slope distance) from the active high water mark (on both sides) of the stream channel and increases depending on forest type, slope stability, steepness, and terrain. Management activities in the inner buffer:
    a. maintains or restore the native vegetation
    b. are limited to single-tree selection silviculture
    c. retain and allows for recruitment of large live and dead trees for shade and stream
    d. structure
    e. retain canopy cover and shading sufficient to moderate fluctuations in water temperature, to provide habitat for the full complement of aquatic and terrestrial species native to the site, and maintain or restore riparian functions
    f. exclude use of heavy equipment, except to cross streams at designated places, or where the use of such equipment is the lowest impact alternative
    g. avoid disturbance of mineral soil; where disturbance is unavoidable, mulch and seed are applied before the rainy season
    h. avoid the spread of pathogens3 and noxious weeds
    i. avoid road construction and reconstruction
3. For lakes and wetlands larger than one acre, an outer buffer zone is maintained. This buffer extends from the outer edge of the inner buffer zone to a distance of at least 150 feet from the edge of the active high water mark (slope distance, on both sides) of the stream channel. In this outer buffer, harvest occurs only where:
    a. single-tree or group selection silviculture is used
    b. post harvest canopy cover maintains shading sufficient to moderate fluctuations in water temperature, provide habitat for the full complement of aquatic and terrestrial species native to the site, and maintain or restore riparian functions
    c. new road construction is avoided and reconstruction enhances riparian functions and reduces sedimentation
    d. disturbance of mineral soil is avoided; where disturbance is unavoidable, mulch and seed are applied before the rainy season
4. For Np streams, a 25-foot (slope distance) inner buffer is created and managed according to provisions for inner buffers for Type F&S waters. A 75-foot (slope distance) outer buffer (for a total buffer of 100 feet) is created and managed according to provisions for outer buffer for Type F&S waters.
5. For Ns streams that support aquatic species, and for lakes and wetlands smaller than one acre, a buffer zone 75 feet wide (on both sides of the stream) is established that constrains management activities to those that are allowed in outer buffer zones of Type F&S streams.
6. For Ns streams that do not support aquatic species, management:
    a. maintains root strength and stream bank and channel stability
    b. recruits coarse wood to the stream system
    c. minimizes management-related sediment transport to the stream system

The following table summarizes the minimum riparian buffer guidelines that will be applied across Camp Bonneville's forest:

Table 1. Riparian management zone guidelines

Stream type	Management guidelines
Type F & S	Total Riparian management zone width: 200’ 50’ inner zone 150’ outer zone Single-tree selection in inner zone. No equip. in inner zone. Single & group tree selection in outer zone.
Type Np	25’ inner buffer. 75’ outer buffer. Single tree selection in inner buffer. Single & group tree selection in outer buffer
Type Ns	Stream supports aquatic species: 75’ buffer. Single & group tree selection.
	Stream does not support aquatic species: BMP’s

Figure 1. Lacamas Creek Stream Health Score Card

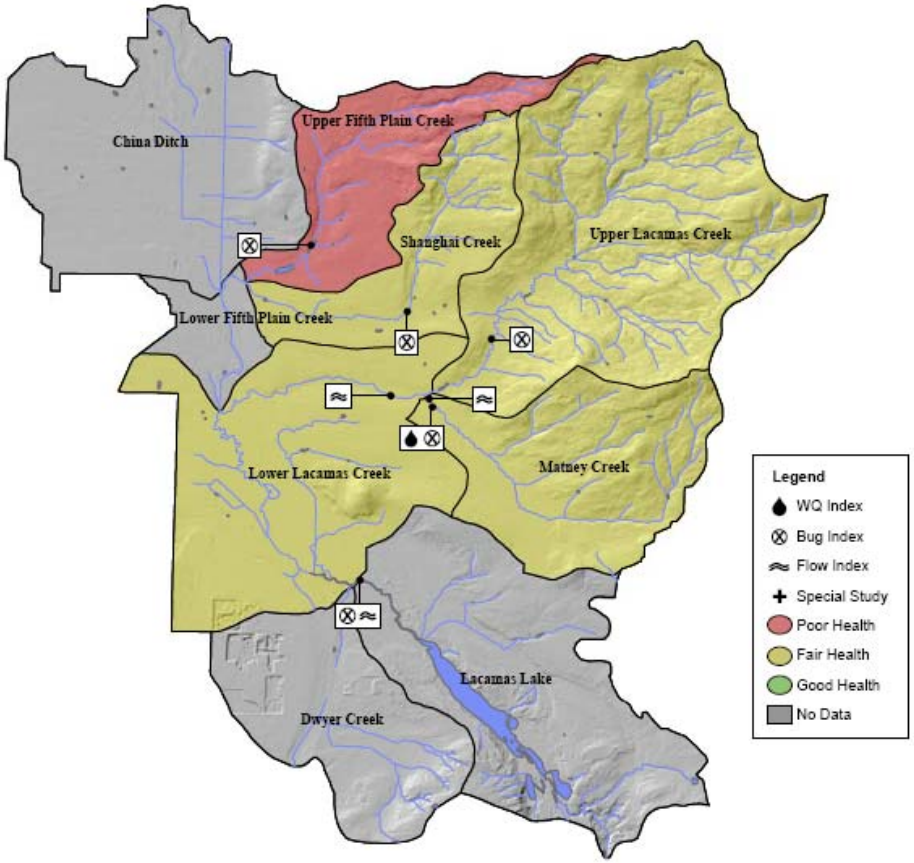
Lacamas Creek Stream Health Score Card

Subwatershed	Water Quality	Biological Health	Flow	Subwatershed Rating
Lower Lacamas Creek	--	Poor	Good	Fair
Matney Creek	Fair	Fair	Good	Fair
Upper Fifth Plain Creek	--	Poor	--	Poor
Shanghai Creek	--	Fair	--	Fair
Upper Lacamas Creek	--	Fair	Good	Fair
Indicator Rating	Fair	Fair	Good	
Overall Watershed Rating:				Fair

Data were not collected from the following subwatersheds: China Ditch, Dwyer Creek, Lacamas Lake, and Lower Fifth Plain Creek.

Score Summary:

- Ratings range from poor to good
- Historical data suggest subwatersheds without recent data likely have poor health
- Washington Department of Ecology will perform water quality monitoring and begin developing a state Water Cleanup Plan in 2010 and 2011



Wildlife Species and Habitats

The following federally-listed species may occur on or in the vicinity of Camp Bonneville:

Black bear at Camp Bonneville

Species of Concern:

- Tailed frog (Ascaphus truei)
- Northwestern pond turtle (Clemmys marmorata marmorata)
- Larch Mountain salamander (Plethodon larselli)
- Cascades frog (Rana cascadae)
- Pacific western big-eared bat (Corvnorhinus (Plecotus)
- Long-eared myotis (Myotis evotis)
- Long-legged myotis (Myotis volans)
- Northern goshawk (Accipiter gentilis)
- Olive-sided flycatcher (Contopus borealis)
- Clackamas corydalis (Corydalis aquae-gelidae)

Candidate Species

- Bull trout (Salvelinus confluentus)
- Spotted frog (Rana pretiosa)

Threatened Species

- Bald eagle (Haliaeetus leucocenphalus)

Endangered Species

- Northern spotted owl (Strix occidentalis)

Fawn at Camp Bonneville

The Washington Department of Fish and Wildlife provided the following list of state-listed species that occurs in the vicinity of Camp Bonneville:

Monitored

- Tailed frog (Ascaphus truei)
- Cope's giant salamander (Dicamptodon copei)
- Cascade torrent salamander (Rhyacotriton cascadae)

Endangered

- northern spotted owl (Strix occidentalis)

The following list of "areas of state concern for priority species" also occurs in the vicinity of Camp Bonneville:

1. 2 riparian zone areas that contain small concentrations of mule and blacktail deer (Odocoileus hemionus);
2. 2 snag-rich areas;

3. 2 areas with large concentrations of mule and blacktail deer;
4. 5 areas with small concentrations of mule and blacktail deer; and
5. 2 areas used by nesting wood ducks (Aix sponsa).

No additional information on the occurrence of rare or endangered species or natural conmmunities is known at this time. This does not mean that other state or federally listed species may not be present within the areas of interest. An on-site inspection by appropriate state and federal personnel may be necessary to verify the presence, absence or location of listed species, or natural communities if remedial action is recommended as part of the final monitoring process.

Clark County's long-term plans for implementing structure-based forest management practices across Camp Bonneville are intended to create great habitat complexity throughout the forest. Specific habitat enhancement objectives are described in detail in the following section on Management Strategies.

Forest Roads & Trails

An extensive network of forest access roads has been established throughout Camp Bonneville that provides easy access to all forest stands (see Map 11 on following page). The road system is well maintained with good drainage systems. The following table outlines basic forest road planning and maintenance guidelines that will be followed by Clark County.

Table 2. Forest road construction and maintenance

Standard	Source
The forest road system will be pre-planned, designed, located, constructed, maintained, and/or reconstructed to minimize the extent and impact of the system and its potential cumulative adverse effects on the surrounding environment.	FSC U.S. Standards 6.5.g.
Logging operations and the use of roads and skid trails occur only when soil compaction, erosion, and sediment transport do not result in degradation of water quality, site productivity, or habitats.	FSC U.S. Standards 6.5.a.
Landings will be designed and constructed to minimize soil erosion.	FSC U.S. Standards 6.5.h.
Access to temporary and permanent roads will be controlled to minimize impacts to soil and biota while simultaneously allowing legitimate access (e.g. recreationalists, forest workers, etc).	FSC U.S. Standards 6.5.i.
Access will be restricted and erosion controlled on infrequently used roads.	FSC U.S. Standards 6.5.k.
Unnecessary roads will be permanently decommissioned or put to bed.	FSC U.S. Standards 6.5.l.

Map 11. Forest Roads

Management Strategies

Introduction to Structure-based Management

The Douglas-fir forest types across Camp Bonneville tend to be even-age, older stands (60+ years) that are very dense with homogenous and highly simplified stand structures. Clark County proposes to implement a plan of uneven-aged *structure based management* that will utilize Camp Bonneville as an experimental forest with the goal of demonstrating strategies for managing structurally homogenous stand types towards increasing heterogeneity.

Structure-Based Management (SBM) prescribes a mix of active forest management techniques that produce an array of forest stand structures across the landscape - from areas where new trees are being established, to older forest structure featuring "old growth", or late successional characteristics such as numerous large trees, multi-layered canopies, and substantial numbers of down logs and large snags. Individual stand types may change constantly, through management and natural disturbance, but the range of stand types and their relative abundance across the land base is reasonably stable. Because the structures are in a dynamic balance across the landscape, the forest provides a steady flow of forest products, habitats, clean air and clean water.

Using an SBM approach, stand density is actively managed to accelerate stand successional development while simulating natural conditions and disturbance regimes. This is done through a combination of variable retention and variable density thinning. SBM techniques can be used to produce a variety of results. Some prescriptions will result in fast-growing, well-stocked stands with higher structural homogeneity. Other prescriptions will develop more complex stand structures, with rapid tree diameter growth, enough sunlight on the forest floor to maintain understory plants, and a complex forest canopy. The latter will be the dominant approach used by Clark County. Thinning can also be used to create or maintain other important structural components, such as snags, down wood, gaps in the canopy, and multiple canopy layers. A diversity of stand structures will provide for a broad range of ecosystems and biodiversity -- including a wide range of wildlife habitats. The structural components associated with the range of stand structures will benefit long-term forest productivity by maintaining the key structural linkages for nutrient cycling and soil structure. The high level of biodiversity should result in a more resilient forest that will be less prone to large-scale disturbance from environmental or climatic stresses.

The main emphasis of SBM is on the use of sound silvicultural approaches for producing timber, but equally combined with the production of a range of habitat types or forest structures that will provide for the vast majority of species and biodiversity. Instead of focusing on individual species, forest managers focus on producing habitats that will accommodate the range of indigenous species. If forest managers find that the broad scale production of habitats may be inadequate to provide for some indigenous species, then they use more site-specific or species-specific strategies as needed.

SBM emulates many aspects of natural stand development and produces structural components found in natural stands, but does so in a shorter period of time through active management. By anticipating future patterns of forest development, foresters predict the potential for individual stands to produce specific characteristics, such as a multi-layered canopy. Foresters can then develop appropriate silvicultural prescriptions, and influence the rates of stand development and the types of structures and products that forest stands actually produce. Individual stand management will vary greatly under SBM. Stands will be managed to emulate habitat conditions normally associated with older forests. These stands will also produce highly viable timber yields. A major emphasis in

managing stand structures will be to move stands through the early and middle forest stages as quickly as possible. This emphasis will require extensive thinning. These activities will produce significant volumes of smaller diameter timber from young stands. Final harvests of stands that have been intensively managed will result in the harvest of high volumes of large diameter wood. The stand structures are not an end in themselves: they represent the diversity of conditions historically associated with conifer forests in the Coast and Cascade ranges of Washington and Oregon. The management techniques used to produce the structures are sound timber management approaches that encourage vigorous tree and stand growth and that are applied to produce more diverse understory vegetation, snags, and coarse woody debris.

Primary silvicultural objectives

The primary silvicultural objectives for the forests at Camp Bonneville are to develop, at a landscape level, a forest structure that emulates natural forest conditions that would result under typical natural disturbance regimes for the site, while producing a steady flow of high quality timber products. To this end, the Camp will be managed to provide a variety of habitat types, including: early, mid and late seral forests, and forested and non-forested wetlands. To achieve these habitat types, it will be necessary to gradually alter existing forest conditions to achieve the desired results. Given the long history of even-aged management, some dramatic alterations may be necessary in order to introduce greater spatial and structural complexity into otherwise fairly homogenous stands.

The County is interested in developing a silvicultural system that allows the forest to achieve habitat conditions that would have resulted through normal natural disturbance regimes for the area. The primary natural disturbance regimes for the area include high winds, ice storms and fire. Forests that evolve naturally under these conditions tend to achieve a *patchiness* of varying age-classes, stocking densities and species mixes.

Structure-based Management Strategies

Restoring structural and plant species complexity into even-age, single species stands can facilitate the development of habitat features that attract a broader range of wildlife. Strategies such as variable density thinning, patch cuts, snag creation, downed coarse woody debris augmentation and underplanting can allow younger forests to begin providing similar habitat functions as much older forests.

Carey (1998) defines four key structuring processes that contribute to greater habitat diversification:

1. Crown class differentiation
   Competition among trees of the same age results in dominant, codominant, subordinate, and suppressed trees.
2. Decadence
   Trees get damaged, infected with fungi, break down, and recycle within the ecosystem.
3. Understory development
   Variability in light, temperature, and soil moisture promotes structurally-diverse growth on the forest floor.
4. Canopy stratification
   Trees of different ages and growth habits produce multiple layers of vegetation, including a well-developed midstory.

Providing for these four key processes can lead to two primary levels of structural complexity within a forest - individual and stand level. Examples include:

1. Individual structures
    a. Trees of diverse heights, diameters, branch sizes, and bark characteristics
    b. Large, dead standing trees (snags)
    c. Coarse woody debris (stumps and logs) in various states of decay
2. Stand-level structures
    a. Vertical heterogeneity—ever-changing distributions of foliage from the forest floor to the tree tops
    b. Horizontal heterogeneity—patchiness in the overstory, midstory, and understory

Additionally, Carey (1998) identifies two key processes influencing vegetative species composition that can lead to greater habitat diversification:

1. Development of habitat breadth
   Patchy canopies produce variability in light, temperature, and soil moisture, leading to patches of different types in the understory.
2. Pre-interactive niche diversification
   Expansion in forest structure and plant species composition provides diverse niches for animals, plants, and fungi; additional niche diversification occurs after species interact.

Complex forest structure and complex species composition lead to greater complexity in forest function. Primary benefits of more complex forest function include:

1. High carrying capacities for diverse animals
2. High productivity for plants
3. Effective regulation of nutrients and water cycling
4. Healthy, resilient forests

General silvicultural prescriptions

In early 2012 Clark County will embark on a process of variable density thinning within the Priority I forest types across Camp Bonneville. In general, stands will thinned from below to reduce stocking density and create a spacing pattern that will allow the remaining trees to develop late seral characteristics over the next 50+ years. Groups of trees in root rot pockets, as well as poorly performing sites, will be targeted for removal. This combination of thinning from below and group tree selection, also called “skip and gap” harvesting, will result in a highly variable structure to the forest with small openings (gaps), small patches of dense trees (skips) and otherwise a generally well spaced stand throughout. This approach will, over time, effectively break up the homogenous structure of the stands and set them on a trajectory to achieve greater spatial, structural and species diversity than the stands would have achieved if left unmanaged.

Clark County is committed to managing its forests to the highest silvicultural standards in the world as certified by the Forest Stewardship Council (FSC). The following chart of generalized silvicultural prescriptions has been extrapolated from the FSC U.S. Forest Management Standards and applies to all forest stands where active forest management activities will take place.

Table 3: FSC Silvicultural Prescriptions Relevant to Camp Bonneville

Prescription	Source
If patch cuts exceed 6 acres in size, 10-30% of pre-harvest basal area will be retained following harvest. The levels of green-tree retention will depend on such factors as: opening size, legacy trees, adjacent riparian zones, slope stability, upslope management, presence of critical refugia, and extent and intensity of harvesting across the forest management unit. Retention will be distributed as clumps and dispersed individuals, appropriate to site conditions. Retained trees will comprise a diversity of species and size classes, which includes large and old trees.	FSC U.S. Standards 6.3.e.5.
Streams, vernal pools, lakes, wetlands, seeps, springs, and associated riparian areas are managed to maintain and/or restore hydrologic processes, water quality, and habitat characteristics. Forested riparian buffers will be maintained around all rivers, streams, ponds and wetlands as per the guidance provided below.	FSC U.S. Standards 6.5.m
Legacy trees, old and large trees, snags and woody debris will be retained (or, if absent, recruited) to sustain populations of native plants, fungi, and animals, both within the harvest unit and across the FMU.	FSC U.S. Standards 6.3.e.1.
Habitat components necessary to support native species (e.g. vertical and horizontal structural complexity, understory species diversity, food sources, nesting, denning, hibernating, and roosting structures, habitats and refugia for sedentary species and those with special habitat requirements) will be protected, maintained, and/or enhanced within each harvest unit and across the entire forest management unit.	FSC U.S. Standards 6.3.b.3
Where necessary to protect against wind throw and to maintain microclimate, green trees and other vegetation are retained around snags, down woody debris, and other retention components.	FSC U.S. Standards 6.3.e.2.
Native hardwoods and understory vegetation will be retained as needed to maintain and/or restore the natural mix of species and forest structure.	FSC U.S. Standards 6.3.e.3.
Live trees and native understory vegetation will be retained within the harvest unit in proportions and configurations that are consistent with the characteristic natural disturbance regime in each community type, unless retention at a lower level is necessary for purposes of restoration.	FSC U.S. Standards 6.3.e.4.
Logging operations and the use of roads and skid trails occur only when soil compaction, erosion, and sediment transport do not result in degradation of water quality, site productivity, or habitats.	FSC U.S. Standards 6.5.a.
Silvicultural systems, integrated pest management, and strategies for controlling pests and/or unwanted vegetation will be developed that result in the least adverse environmental impact, with the goal of reducing or eliminating chemical use.	FSC U.S. Standards 6.6.b.
All major forestry operations (e.g. thinning, road building, etc.) will only occur outside the primary bird breeding season (April 15th – June 15th).	BMP

Variable density thinning

Variable-density thinning involves varying the thinning intensity across an ecologically appropriate scale (1⁄4 to 1 acre in size) to produce a mosaic of unthinned, moderately thinned, and heavily

thinned patches. Thinning with skips and gaps can also create this mosaic. Variable density thinning helps generate complex structures by promoting tree growth at different rates. It also encourages understory development through a diversity of species, a variety of patch types, and growth of tree seedlings and saplings. Variable-density thinning can improve forest health by increasing (a) resistance to disturbance, (b) ability to recover after disturbance, and (c) biological diversity that allows ecosystems to function well through climatic variation (Carey, 1998).

The majority of the Douglas-fir stands that occur across Camp Bonneville have a high stocking density for their age (avg. 450 - 600+ trees per acre). This high density is contributing to a number of issues that are increasingly affecting the forests health, stability and ability to support a diverse range of wildlife species. Applying variable density thinning across the majority of the Douglas-fir dominated stands at the park can help mitigate these issues. Some of these issues are:

1. High height/diameter ratio
   The height/diameter ratio of a tree is measured by dividing the tree height by the stem diameter at breast height with height and diameter in the same units (e.g., centimeters). This ratio changes with the degree of competition over time. At a given height, trees that have been crowded will not have as large a diameter as trees that have not been crowded. The crowded trees will therefore have a higher height/diameter ratio. Height/diameter ratios are indicative of a tree's ability to withstand wind and snow and ice loading. Concerns should be raised when ratios are above 80.

   Competition between trees in the dense forests of Camp Bonneville has caused the Douglas-fir to grow tall and skinny. Average *height-diameter ratios routinely exceed* 85:1, which is approaching the stage where wind throw becomes a significant concern. Routine thinning of the Douglas-fir stands at the Camp to gradually draw their stocking density down to below 200 trees per acre will allow the crowns of the remaining trees to fill out and promote diameter growth that will reduce the risk of wind throw.

2. Laminated root rot
   Laminated root rot (*Phellinus weirii*) is a naturally occurring soil based fungus that infects the roots and lower stems of Dougals-fir and Western hemlock. As per the name, the fungus de-laminates the soft sapwood between the rings of a trees roots and stem, essentially weakening the trees support system. Root rot systematically spreads through a stand via root grafts and almost always eventually kills the host tree. Root rot "pockets" in a Douglas-fir stand are distinguishable by sudden openings in the stand that are occupied by snags, downed logs and/or regenerating in hardwoods (typically alder and/or big leaf maple). Left unmitigated, root rot can create significant impacts to forests that are predominantly stocked with Douglas-fir.

   Attempting to completely eradicate root rot from a forest is difficult and can lead to significant impacts in the way of large patch cuts within the forest. Limiting its spread and impact is typically the preferred approach and can be accomplished through removing infected trees within a root rot pocket, and heavily thinning potentially infected trees around the perimeter of the pocket. Additionally, introducing non-host conifer species such as western cedar or white pine, or hardwood species such alder or big leaf maple can also help mitigate laminated root rot's effect in the forest.

   Clark County recognizes laminated root rot as a naturally occurring soil fungus that functions as an agent of stand diversification. Therefore, management practices will be adapted to accommodate its effects. When root rot pockets occur in areas where optimum timber production is preferred, more aggressive thinning and mitigation measures will be employed.

Where root rot pockets do not pose a threat to facilities, public safety, or long-term timber production objectives, they will be allowed to recruit snags and coarse woody debris into the forest system. As openings in the stand occur, they will be replanted as necessary with western cedar, white pine and/or a mix of hardwoods and wildlife forage.

3. Lack of canopy stratification
   Given that the Douglas-fir stands at Camp Bonneville were managed as even-age plantations by previous owners, and that little natural disturbance has affected the stands until currently, the stands have a single dominant canopy that has effectively suppressed the regeneration of low or mid story trees and second or third cohorts.

   Forests that have a diverse mid-story provide greater vertical heterogeneity and more habitat niches, especially for a wider range of bird species that prefer specific strata within a forests canopy. Root rot is an agent of canopy stratification as it introduces openings in a homogenous forests and therefore opportunities for a wider mix of tree and shrub species of varying ages to occupy the opening. Additionally, thinning a dense stand to open the canopy allows more sunlight to reach the forests floor, thereby promoting regeneration and height growth of more tree and shrub species.

Extend rotation age of timber harvest
Longer harvest rotations can produce healthy, complex forest landscapes. On industrial and private lands, rotations of 40 to 50 years are used to maximize profits and maintain cash flow. Public ownerships, which must consider other values in addition to timber revenues, use rotations of 60 to 80 years or longer. A shift to extended harvest rotations of 70 to 230 or more years has the advantages of:

1. Producing a variety of tree sizes and wood products over time,
2. Improving the age distributions of trees in the landscape,
3. Promoting healthier wildlife habitat,
4. Increasing carbon storage, and
5. Preserving options for adaptive management. Thinning also helps to establish diversity and minimize tree overcrowding.

Increase snags and downed woody debris
Given the history of even-age management and the necessity to protect public safety, large snags (>10” DBH) are uncommon through the majority of the forest. Additionally, large coarse woody debris (>10” diameter) are also lacking throughout the forest floor. Snags can provide important structure for cavity dependent bird and small mammal species, a food source for woodpeckers and other foragers and a slow release nutrient source for the forest in general. West of the Cascades in Oregon and Washington, 39 species of birds and 14 species of mammals depend on cavity trees for their survival. Terrestrial amphibians, small mammals, and birds also depend on large coarse woody debris for protection and foraging for insects, fungi, and seeds.

Snags fall into two primary decay class categories:
1. Hard snags, with the bark is still intact and with firm heart and sapwoods, and
2. Soft snags, which may have some bark remaining but with the wood beginning to soften.

Downed logs fall into four primary categories based on their decay class:
1. Class 1, bark is still intact and heart and sapwood is still firm
2. Class 2, log is in contact with ground; bark is beginning to deteriorate and inner wood is soft.

3. Class 3, log is in contact with ground; bark has completely fallen off and log is beginning to become incorporated into the forest floor
4. Class 4, log is partially buried and wood is very soft
5. Class 5, log is barely distinguishable from surrounding forest floor

Snag	Minimum Size	#/acre
Hard	17’ tall x 15” DBH	2-5
Soft	17’ tall x 15” DBH	2-5
Downed woody debris	Minimum size	#/acre
Class 1	16’ x 20” dia.	1-3
Class 2	16’ x 20” dia.	1-3
Class 3	16’ x 20” dia.	1-3
Class 4	16’ x 20” dia.	1-3
Class 5	16’ x 20” dia.	1-3

Clark County will strive to recruit an average of 3-10 snags and 3-10 downed logs across each decay class per acre. Where snags and downed logs either don’t exist, or exist in insufficient numbers or dimensions, manual recruitment will be necessary. Downed logs can be artificially created by cutting live trees and bucking the logs into a minimum of 16’ sections. Snags can be artificially created through two primary methods:

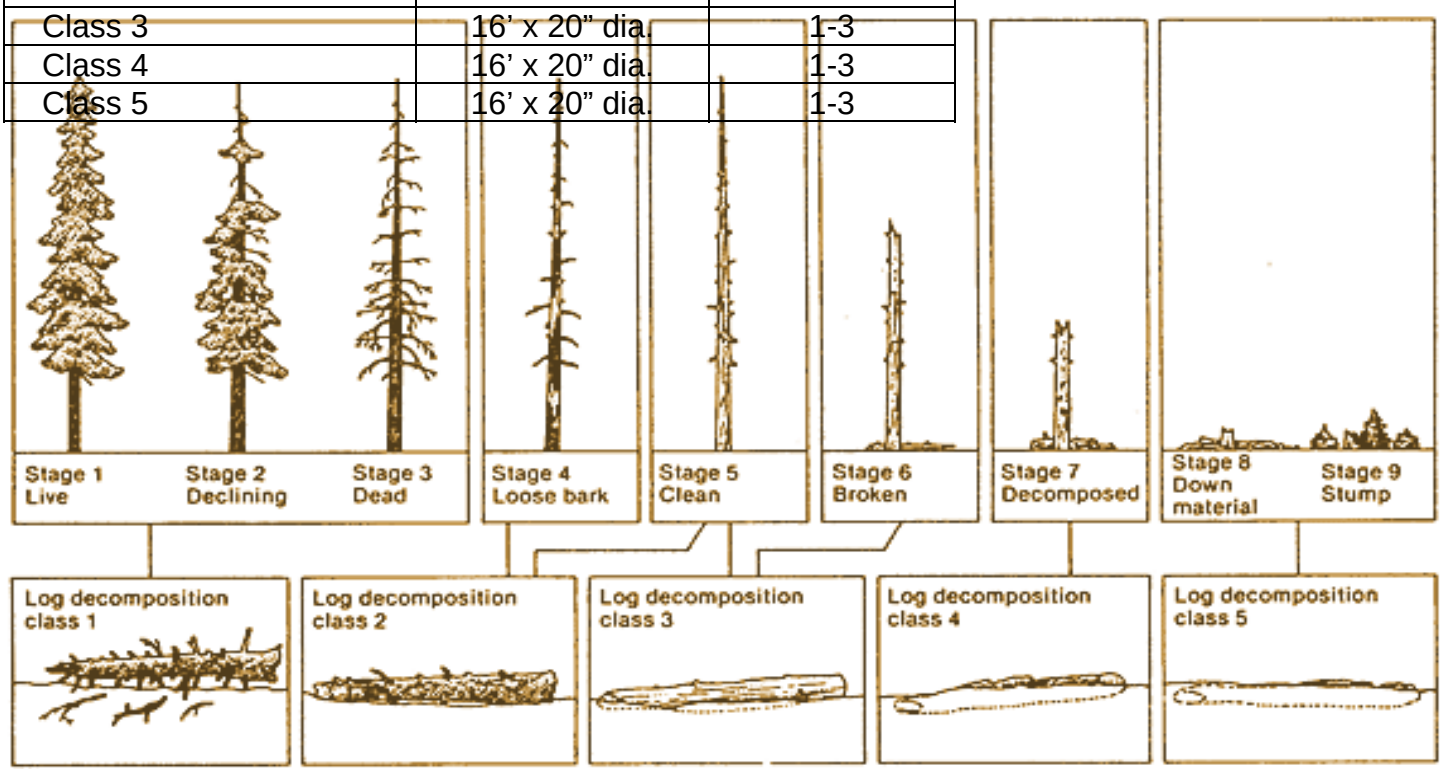
1. Girdling
   With a chainsaw, two horizontal rings are cut six inches apart entirely around the circumference of a tree deep enough to severe the cambium layer.
2. Topping

Figure 2. Decay classes of snags and downed logs

Using either a mechanical harvester or by climbing, a tree is topped a minimum of 30’ above the ground.

The following table summarizes snag and downed woody debris targets for the forests at Camp Bonneville:

Table 4. Snag and downed log recruitment targets



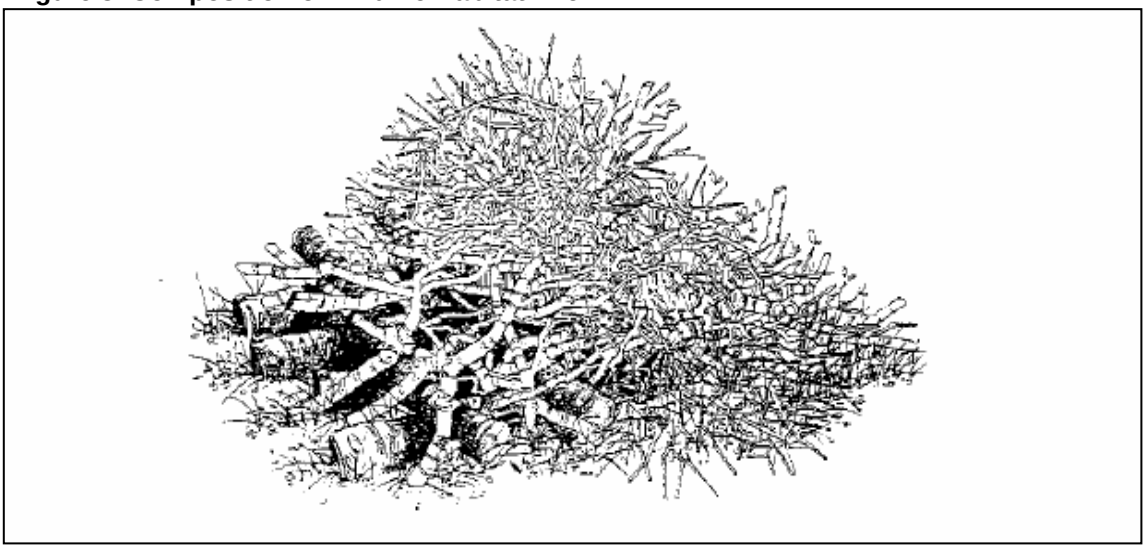
Construct wildlife habitat piles
Brush piles provide similar habitat provided by naturally occurring logs on the forest floor and can either be substituted when natural logs are not available or used in conjunction with naturally occurring or constructed downed logs. Widely distributed brush piles can also be an effective method for utilizing and dispersing slash that has been collected at a landing following logging operations.

To construct brush piles:

1. Lay at least four 6 ft logs, 6 - 10 inches in diameter parallel to each other 8 – 12 inches apart,
2. Lay an equal number of similarly sized logs on and perpendicular to the 1st base logs,
3. If desired, 4 feet section of 6 inch drainage tile, cinder blocks, or stumps can be placed under the base to allow easier access,
4. Add large limbs and then smaller branches on the top to create an intertwining tangle of brush 4 – 6 feet in height,
5. Piles should be placed no closer than 200 of each other, within 1000 feet of surface water if possible,
6. Should not exceed 3 piles per acre,
7. Maintain brush piles by periodically adding new limbs and branches.

Note: circular brush piles 12 or more feet in diameter or rectangular piles greater than 25 feet in length provide better cover but can attract large mammals such as coyote or black bear.

Figure 3. Composition of Wildlife Habitat Pile



Install bird boxes
It may take several years before natural and artificial snag recruitment produces the softer snags necessary for cavity nesters to occupy. In the interim, bird boxes can be placed throughout the forest to simulate cavities in trees. Bird boxes of varying sizes attract birds and small mammals of various sizes. If the park chooses to place bird boxes throughout the forest, the following guidelines will apply:

1. No more than four bird boxes will be placed per acre.
2. Boxes will be located primarily along the edges of clearings, roads, wetlands and lakes.
3. Small, medium and large boxes will be placed in the following ratio, respectively: 1:4:15.
4. Boxes will be inspected annually to remove old nests and debris.

Bird box dimensions for small, medium and large boxes should be based on optimum cavity dimensions for the following species:

1. Small: Western blue bird
2. Medium: Kestrel
3. Large: Wood duck

Underplanting
Planting multiple species of native trees promotes diversity and structural complexity in a forest. Managed stands often have insufficient tree regeneration to provide a midstory of shade-tolerant trees. The midstory connects the lower branches of the tree crowns to the upper branches of the tall shrubs, establishing a full vertical foliage profile. Underplanting helps to increase a forest's resistance and resilience to disturbance and also improve wildlife forage and habitat.

As root rot pockets and wind events continue to create openings in the forests, as well as following thinning operations, Clark County will continue to underplant a variety of native conifer and hardwood trees, as well as shrubs that provide wildlife forage. The following table lists some of the species that are endemic to the area and will be considered for introduction back into the park's forests:

Table 5. Native plant species recommended for planting in understory

Common name	Taxonomic name	Shade tolerance class	Function	Location
Western red cedar	*Thuja plicata*	Very shade tolerant	Canopy stratification	Understory of thinned Doug-fir, canopy gaps
Western hemlock	*Tsuga heterophylla*	Shade tolerant	Canopy stratification	Understory of thinned Doug-fir
Grand fir	*Abies grandis*	Shade tolerant	Canopy stratification	Understory of thinned Doug-fir
Western white pine	*Pinus monticola*	Moderately shade tolerant	Canopy stratification	Understory of thinned Doug-fir, canopy gaps
Douglas-fir	*Pseudotsuga menziesii*	Moderately shard tolerant	Canopy stratification	Canopy gaps greater than 1 acre
Pacific yew	*Taxus brevifolia*	Very shade tolerant	Canopy stratification	Understory of thinned Doug-fir

Big leaf maple	*Acer macrophyllum*	Shade tolerant	Canopy stratification, wildlife forage, nutrient cycle	canopy gaps
Red alder	*Alnus rubra*	Intolerant	Canopy stratification, wildlife forage, nutrient cycle	Canopy gaps greater than 1 acre
Oregon ash	*Fraxinus latifolia*	Moderately shade tolerant	Canopy stratification, wildlife forage	Canopy gaps
Pacific madrone	*Arbutus menziesii*	Shade tolerant	Canopy stratification, wildlife forage	Understory of thinned Doug-fir on dry sites
Pacific dogwood	*Cornus nuttallii*	Shade tolerant	Canopy stratification, wildlife forage	Understory of thinned Doug-fir
Hazelnut	*Corylus cornuta var. californica*	Shade tolerant	Canopy stratification, wildlife forage	Understory of thinned Doug-fir
Cascara	*Cascara sagrada*	Shade tolerant	Canopy stratification, wildlife forage	Understory of thinned Doug-fir
Bitter cherry	*Prunus emarginata*	Intolerant	Canopy stratification, wildlife forage	Canopy gaps
Western crab apple	*Malus fusca*	Intolerant	Canopy stratification, wildlife forage	Canopy gaps
Service berry	*Amelanchier alnifolia*	Shade tolerant	Wildlife forage	Understory of thinned Doug-fir
Indian plum	*Oemlaria cerasiformis*	Shade tolerant	Wildlife forage	Understory of thinned Doug-fir
Red elderberry	*Sambucus racemosa*	Shade tolerant	Wildlife forage	Understory of thinned Doug-fir
Blue elderberry	*Sambucus caerulea*	Intolerant	Wildlife forage	Canopy gaps
Red osier dogwood	*Cornus sericea*	Shade tolerant	Wildlife forage	Understory of thinned Doug-fir in wet sites
Pacific rhododendron	*Rhododendron macrophyllum*	Shade tolerant	Aesthetics	Understory of thinned Doug-fir
Ocean spray	*Holidscus discolor*	Shade tolerant	Wildlife forage	Understory of thinned Doug-fir on wetter sites

Chemical use policy

The Vegetation Management Division of Clark County DES provides weed control across Camp Bonneville, primarily by chemical application, secondarily by cultural or mechanical methods. Most of the weed control work takes place in areas previously swept by ordinance removal contractors, with some work done along rights-of-way and fences and around structures. Most of the spray work is conducted using ATVs and trucks, with a small amount conducted by backpack. Extra care is exercised in areas where the hairy stemmed checker mallow, a state-listed endangered species, is known to occur. The bulk of time is spent controlling meadow knapweed, bull thistle, Canada thistle, non-native blackberry, Scot's broom, and tansy ragwort. Forest management systems will be developed over time to promote environmentally friendly non-chemical methods of pest management and strive to avoid the use of chemical pesticides in the future.

Herbicides used include:

- Triclopyr amine (Garlon 3A);
- Aminopyralid (Milestone), used primarily in open areas;
- Glyphosate (Aquamaster/Roundup), used along rights-of-way and fences;
- Surfactants derived from either pine sap or soybean oil.

World Health Organization Type 1A and 1B and chlorinated hydrocarbon pesticides; pesticides that are persistent, toxic or whose derivatives remain biologically active and accumulate in the food chain beyond their intended use; as well as any pesticides banned by international agreement, will be prohibited. If chemicals are used, proper equipment and training shall be provided to minimize health and environmental risks.

Records of chemical use will be maintained, including the type of chemical, when and where it was applied, on what species it was applied and the effectiveness of the application. Clark County will abide by the following guidelines for chemical use.

Table 6. Chemical use guidelines

Standard	Source
Chemical pesticides, fungicides, and herbicides will be used only when and where research or empirical experience has demonstrated that less environmentally hazardous, non-chemical pest/disease management practices are ineffective.	FSC U.S. Standards 6.6.b.
When and where chemicals are applied, the most environmentally safe and efficacious chemicals are used. Chemicals are narrowly targeted, and minimize affects on non-target species.	FSC U.S. Standards 6.6.c.
Chemicals will be used only when and where they pose no threat to supplies of domestic water, aquatic habitats, or habitats of rare species.	FSC U.S. Standards 6.6.d.
When chemicals are used, the effects and impacts will be monitored and the results used for adaptive management. Records will be kept of pest occurrences, control measures, and incidences of worker exposure to chemicals.	FSC U.S. Standards 6.6.e.

Appendix 1. Timber management timetable

See individual FMU descriptions for more detailed prescriptions

Timeline	FMU #	Activity
Any time	17	Implement variable density thinning to diversify stand structure.
Any time	23	Implement variable density thinning to diversify stand structure.
Any time	11	Implement variable density thinning to diversify stand structure.
1-5 years	14	Pre-commercially thin red alder within 1-5 years. Implement habitat enhancement practices.
1-5 years	4	1st entry commercial thin & habitat enhancements
1-5 years	29	Replant RMZ's and place wood within stream channel.
1-5 years	19	1st entry commercial thin
1-5 years	5	1st entry commercial thin & habitat enhancements
1-5 years	22	1st entry commercial thin & habitat enhancements
5-10 years	4	2nd entry commercial thinning
5-10 years	19	2nd entry commercial thinning & habitat enhancements
5-10 years	5	2nd entry commercial thinning
5-10 years	18 & 20	1st entry commercial thin & habitat enhancements
5-10 years	21	1st entry commercial thin & habitat enhancements
5-10 years	22	2nd entry commercial thinning
10-15 years	18 & 20	2nd entry commercial thinning
10-15 years	14	1st entry commercial thin & habitat enhancements
10-15 years	19	1st entry commercial thin
10-15 years	21	2nd entry commercial thinning
10-15 years	5	3rd entry commercial thinning
10-15 years	4	3rd entry commercial thinning
10-15 years	22	3rd entry commercial thinning
10-15 years	3	1st entry commercial thin & habitat enhancements
15-20 years	21	3rd entry commercial thinning

Appendix 3. Camp Bonneville Wildfire Suppression Plan

(Updated 09/26/2011)

General Overview

During the Department of Army's ownership since the early 1900's, areas within Camp Bonneville have been used as a live fire exercise range. The Department of Natural Resources has fire protection responsibilities within the boundaries of Camp Bonneville.

DUE TO THIS HIGH POTENTIAL OF UNEXPLODED ORDINANCE, ENTRANCE TO LANDS LOCATED WITHIN THE BOUNDARIES OF CAMP BONNEVILLE SHOULD BE MADE ONLY AFTER CONTACT WITH A MEMBER OF CLARK COUNTY DEPARTMENT OF PUBLIC WORKS.

Suppression Plan Objectives - Safety

- Priority suppression objectives will be to provide for safety first, at all times.
- Protection of Human Life.
- Protection of Natural Resources on DNR protected lands.
- Minimize Resource Losses and Fire Costs.
- Ground forces should only be allowed into the boundaries of the Camp with qualified and knowledgeable guides after notification of a member of the Clark County Department of Public Works.
- Unified Command-(under the ICS system) by the responding agencies -should be initiated as soon as possible.

Fire Notification

All wildfires occurring within Camp Bonneville will require notification of the Clark County Department of Public Works Representative -

Clark County Department of Public Works Contact List, Priority Order

#1 Warren Fjeldos - Camp Residence (360) 892-4439. (360) 600-4192 cell

#2 Jerry Barnett - Clark County Department of Public Works; (360) 773-7664 cell
Camp Bonneville, Office; (360) 566-6990 (M-F 8:00-5:00)
Clark County Public Works, Office; (360) 397-6118 ext. 4969

#3 Jon Dunaway- Clark County Fire Marshal, Office; (360) 397-2186 ext. 3324

#4 Jim Vandling- Clark County Forester, Office; (360) 397-2375 ext. 4714
(360) 921-9563 cell

All wild fires within the boundaries of Camp Bonneville require notification of a DNR – Pacific Cascade Region Fire Manager -

Department of Natural Resources Fire Managers

#1 Tom North, Clark/Skamania Fire Unit Forester – (360) 577-2025/360-480-4074 cell

#2 Paul Tester, Clark/Skamania Fire Forester - (360) 577-2025/360-355-5433 cell

#3 Alan Lawson, Fire Operations District Manager - (360) 749-2652

#4 Chuck Turley, Pacific Cascade Region RP & S Asst - (360) 577-2025

Pacific Cascade Region Dispatch Center – (360) 575-5031

The County Fire Districts will be responsible for protection and suppression of structures and calls for medical assistance within the boundaries of Camp Bonneville -

Clark County Fire District Protection

Fire District #3; on the north side of Camp Bonneville- (360) 892-2331

Fire District #5; on west side, is contracted out to Vancouver Fire Department - (360) 892-4323

East County Fire and Rescue; on south side and east side- (360) 834-4908

Pre-suppression Actions

- Every year the suppression plan will be reviewed and a copy will be included in the Region MOB Guide each year.
- A pre-season briefing concerning suppression in Camp Bonneville will be conducted with permanent district personnel, seasonal fire suppression personnel, and Larch Camp Crew supervisors. A copy of this plan and maps will be disseminated at those briefings. These briefings will be done in coordination with the Clark/Skamania Fire Unit Forester.
- All region fire staff should be familiar with the Fireline Handbook, chapter 1, Firefighting Safety, page 70, titled Unexploded Ordnance (UXO) Safety and Reporting. This information is also in the Incident Response Packet Guide, gold pages-Specific Hazards, page 25.

Ground Forces

The Incident Commander should not consider placing ground forces on any fire within the boundaries of Camp Bonneville with out a member of the Clark County Department of Works on site with Incident Commander. **The entrance to Camp Bonneville is at NE Pluss Road, this would be the staging area for all fire personal before fire engagement, see staging areas on map.** Each firefighter will be briefed by the Incident Commander on Unexploded Ordnance Safety and Reporting procedures.

Control Lines

- The Incident Commander will not consider placement of any control lines without consulting with a representative from Clark County Department of Public Works.
- Use of existing roads, trails, and natural fuel breaks should be utilized wherever possible.
- Aerially placed chemical retardant control lines or helicopter bucket drops could be limited from 500 feet or higher above the drop area and should be used where appropriate to construct control lines.
- Consult with a Clark County Department of Public Works representative before the use of any explosives for fire line construction.

- Consult with a Clark County Department of Public Works representative before engaging in any fire suppression activities on or near any no entry areas.

Access and Location

- Vehicular access to Camp Bonneville is limited to the main entrance off of Pluss Road, address is 23201 NE Pluss Rd. Consult with a Clark County Department of Public Works representative before using all roads in the camp boundary, see map for all road locations.
- Camp Bonneville is located entirely in Sections 35 and 36 and the southeast quarter of Section 34 of Township 3 North, Range 3East. Additionally Camp Bonneville covers all of Sections 1,2, and 3 of Township 2 North, Range 3 East, as well as the North half of sections 10 and 11 of Township 2 North, Range 3 East, W. M., see map.

Fire Rehabilitation

All rehabilitation activities will be done in conjunction with a Clark County Department of Public Works representative, and Clark County Department of Environmental Services.

Known Safety Hazards

- Review the safety hazards as identified in the Fireline Handbook, Chapter 1,Firefighting Safety and also in the Incident Response Pocket Guide (gold pages-specific hazards).
- In the southwest corner of Camp Bonneville boundary is a natural gas pipe line owned and operated by Williams-Northwest Pipeline. There are two lines, a 30 inch and 26 inch.

  Emergency contact number for Northwest Pipeline is (800) 972-7733
  General information number is (360) 687-3156

Additional Considerations

- There's one area on the attached map listed as **CENTRAL IMPACT TARGET AREA** due to the high probability of containing Unexploded Ordinance, (UXO).
- All other areas should also be considered to have a high probability of containing Unexploded Ordinance. All Camp Bonneville boundaries should not be entered without Clark County Department of Public representative on site.
- The Clark County Departments of Public Works and Environmental Services are in the process of doing silvicultural activities and road maintenance. In 1995, the Military discontinued its road maintenance activities.
- From the late 1980's to present there have been many rural developments that have been placed close to the boundaries of Camp Bonneville. Careful planning and consideration of these developments should drive the operations plan in extended attack. Preplanning and coordination with local rural Fire districts should be implemented- should evacuation of these developments need to take place.