INTRODUCTION

The decision to plant red alder is both biological and financial. This paper will address the biological aspects of red alder tree growing – will red alder seedlings survive well, grow fast, and be productive enough to yield financial gain. The target audience is the small land owner with a basic understanding of tree growing and that has access to the internet and is familiar with its use. **Consultation with an Extension forester, or National Resource Conservation Service (NRCS) forester or soil scientist, may be needed for soil interpretations and onsite visits.**

Frost/cold, very poor soil drainage, drought stress and exposure can negatively affect survival, stand uniformity, site productivity and wood quality (from top-breakage and sun-scald) of red alder plantations. These sites are generally not suitable for growing red alder. Site selection for red alder requires evaluation of site characteristics relative to:

1. Risk of high seedling mortality and/or slow early growth from environmental factors;
2. Frost/cold;
3. Heat/drought;
4. Weed competition; and
5. Red alder productivity potential.

The key to achieving good yields for red alder is to capture the early rapid growth. Red alder height growth is very much age dependent – factors that impede growth during the first 4-5 years of a plantation can reduce exhibited site productivity below expected productivity based on soil and physiographic factors.

The general steps to making the determination on site suitability for red alder are as follows:

1. Have a map showing the location (Section-Township-Range) and boundaries of the land parcel to be evaluated;
2. Evaluate the topography of the site;
3. Obtain NRCS Soil Series descriptions;
4. Estimate growing season precipitation (April through September) and soil water-holding capacity;
5. Fill out a site evaluation checklist;
6. Evaluate the site by applying the information on the checklist to the Relative Effect of Site Factors on Red Alder Site Quality (after Harrington, 1986) and rating each category as either Good (+), Intermediate (0), or Poor (-);
7. Make a judgement on the general site suitability for red alder based on the pluses, zeros and minuses; and
8. Conduct a site visit to verify the soil survey, assess the candidate area for within site frost pockets, heat/drought stress, and weed competition potential.

Information pertaining to topography and soils will be come from the internet. Industrial and public land managers can use Geographic Information System (GIS) technology to obtain the information needed.

Information on frost damage potential, expected weed competition and soil series verification will come from onsite visits.

TOPOGRAPHY

The purpose is to view the topographic features for the acreage you are considering to plant to red alder -- to collect information on elevation; slope; aspect; and freeze risk. Topographic maps are available free-of-charge from the U.S. Geological Survey at

http://www.usgs.gov/pubprod/

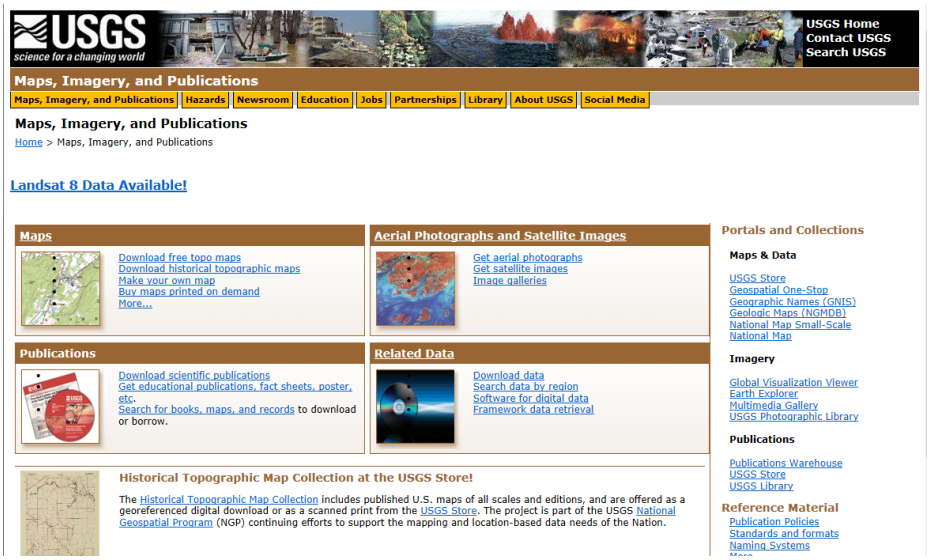


Figure 1. USGS Maps, Imagery and publications. Select, “Download free topo maps” under the Maps category.

The map locator allows you to drill down from the state level by double clicking on the state icon until you view the quadrangles. Then scroll to the to the USGS quadrangle of interest, mark the area of interest, select the map and download a map as a .pdf file for viewing with Acrobat Reader™. Screen shots can be taken and saved using Microsoft™ Snipping Tool. Some of the contour maps are of the 1950-1960 vintage but are more than suitable for determining landforms, slopes and predicting risk of cold damage. Contour maps are also available from other sources.

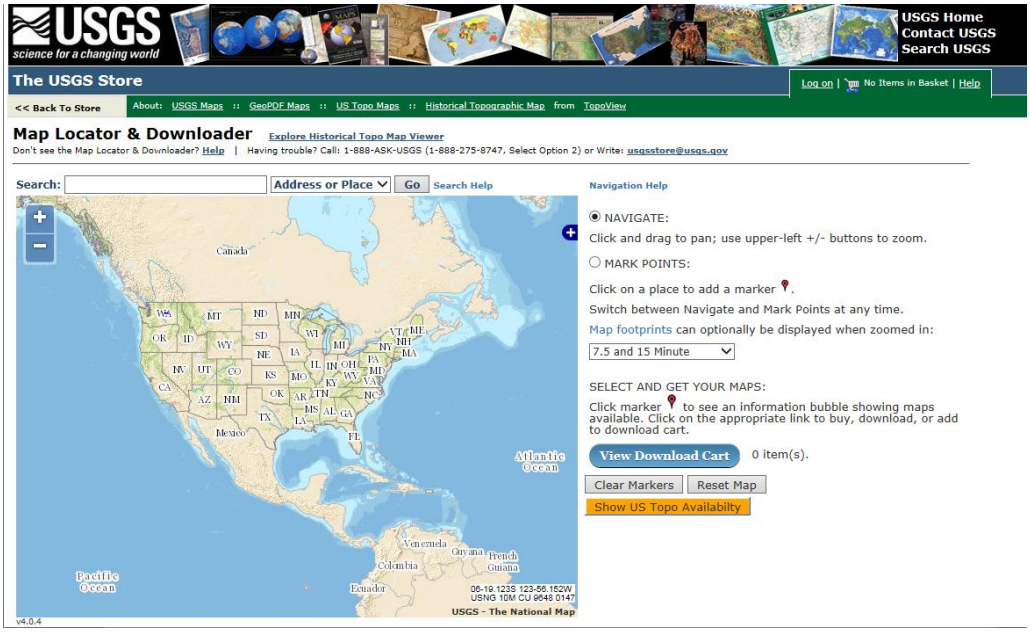


Figure 2. GSGS Map & Downloader – Select State – right-click mouse to zoom-in.

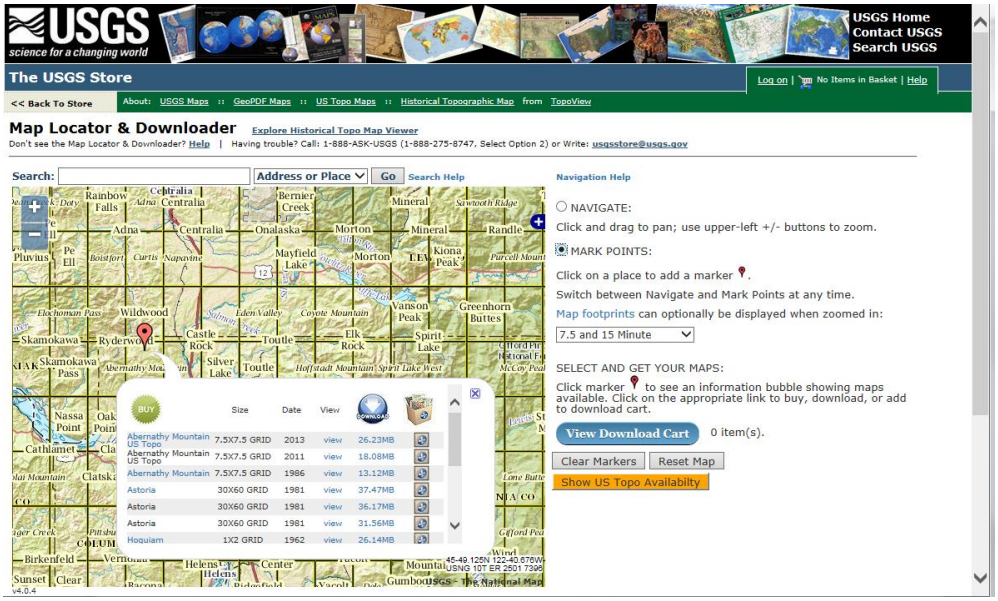


Figure 2. GSGS Map & Downloader – Navigate & Mark points – click on marker to see available maps.

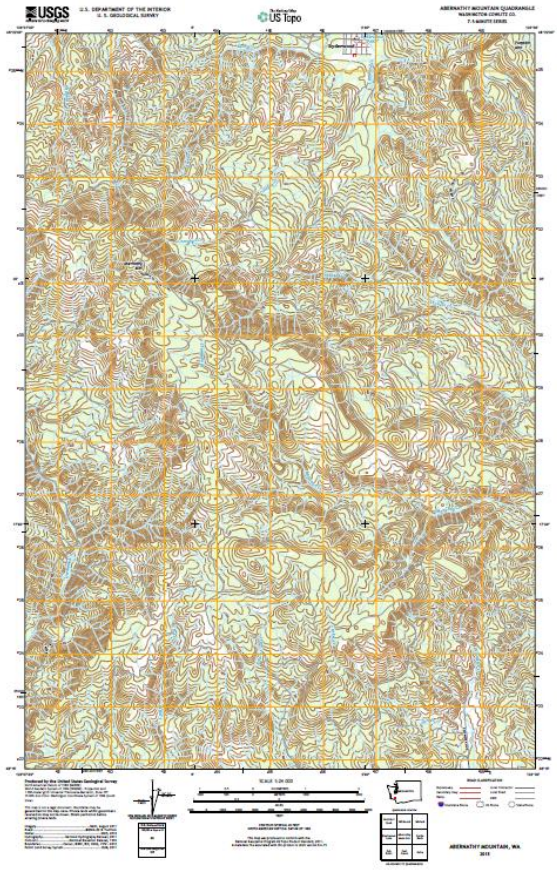


Figure 4. Map .pdf displayed in Acrobat Reader™. You can zoom in to the specific area of interest

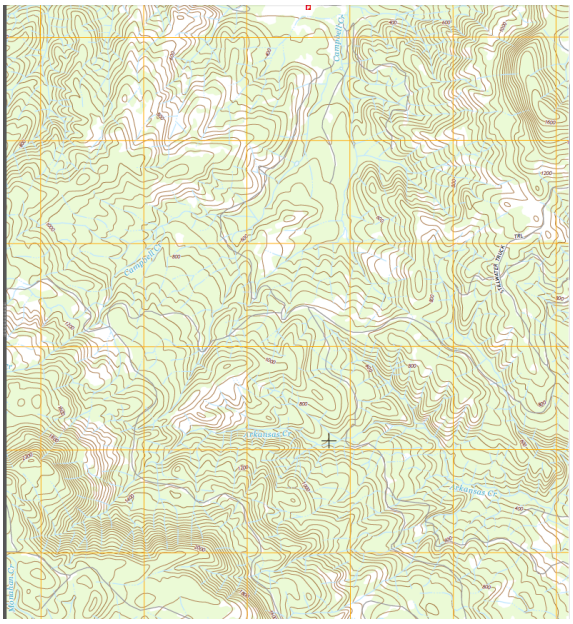
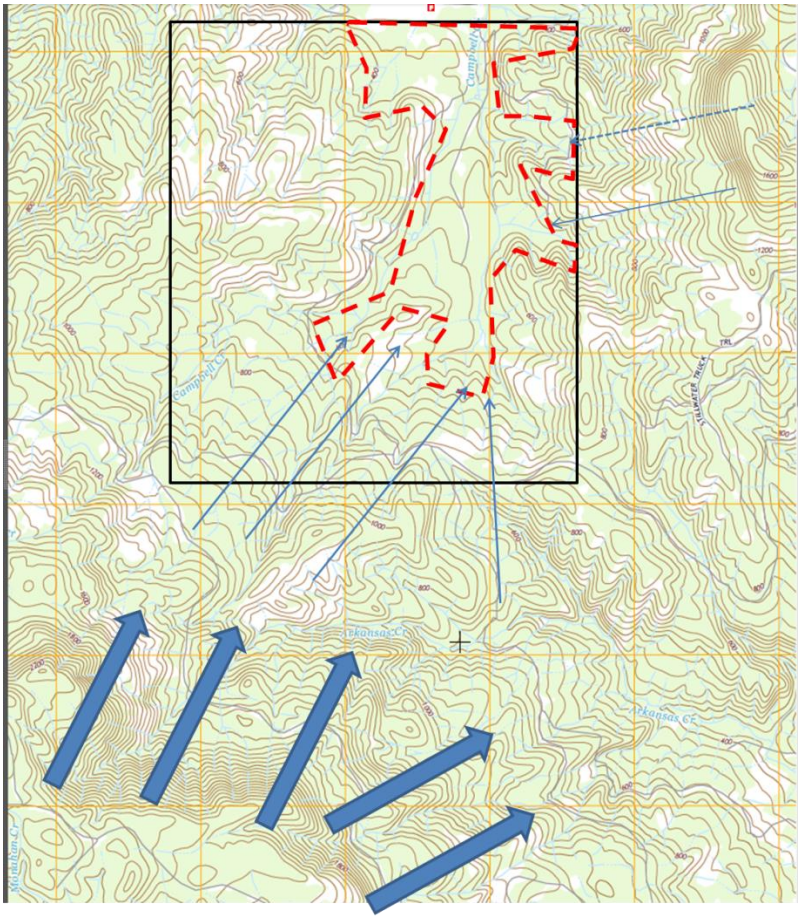


Figure 5. Detailed topography for an area of interest.

The first step in to evaluate the flow of cold air from higher elevations. Cold air flows down slope following major stream channels and slopes with uninterrupted downward gradients. Figure 6 shows a depiction of cold air flow and pooling. Assuming that the black colored rectangle is the area being considered for red alder – the area bounded in red has an extremely high risk of cold damage in spring, late-summer and fall when red alder are still actively growing or not hardened-off. **DO NOT PLANT RED ALDER!** Areas outside of this area have enough slope to keep cold area moving making the risk of serious cold damage low. An exception to this is where there is a mature stand of trees downslope of clear-cuts or very young stands – in this case the mature stand acts as a dam causing cold to pool increase the risk of cold damage. Aerial photography is provided on the NRCS Soil Survey (see SOILS)

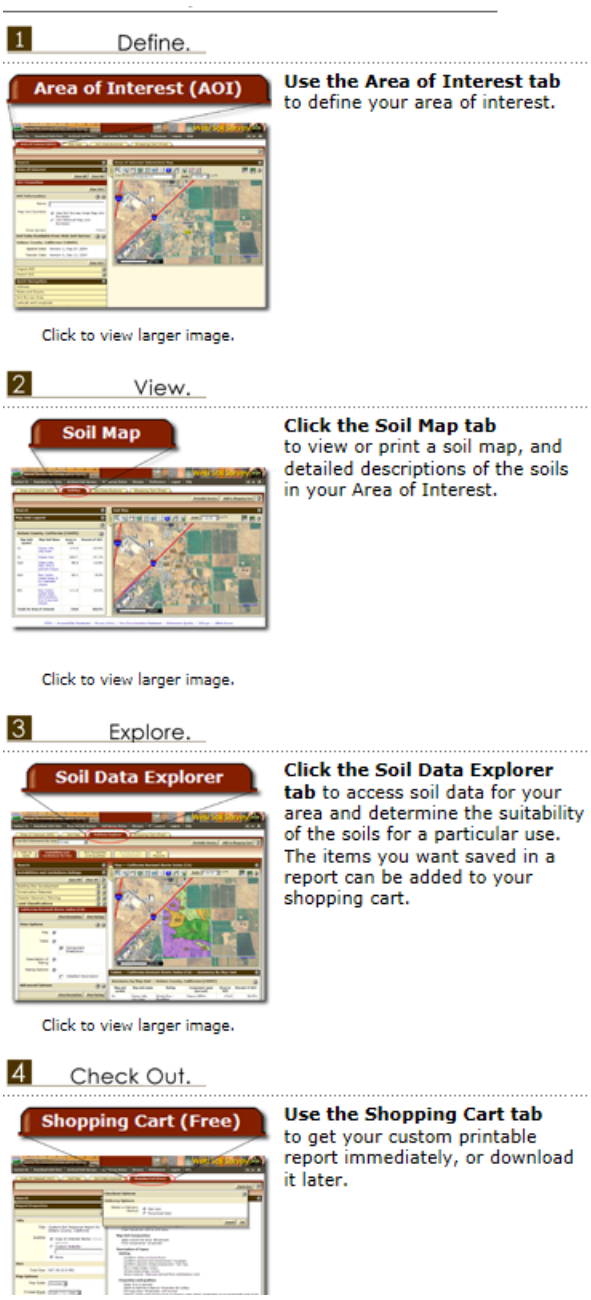


COLD AIR FLOW EARLY AND LATE IN THE GROWING SEASON. FLOWS DOWN SLOPES AND DRAINAGES TO POOL WHERE THE LAND FLATTENS. CAUSING A VERY HIGH POTENTIAL FOR SERIOUS COLD DAMAGE TO RED ALDER PLANTATIONS.

Figure 6. Assessing the risk of cold damage.

SOILS

Soils information can be obtained from the National Resource Conservation Service (NRCS) Soil Survey for your county. This is best done on-line at the webpage, http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm. This homepage shows the four general steps for determining the soil series for a parcel of land.



To access the soil survey map click on

.

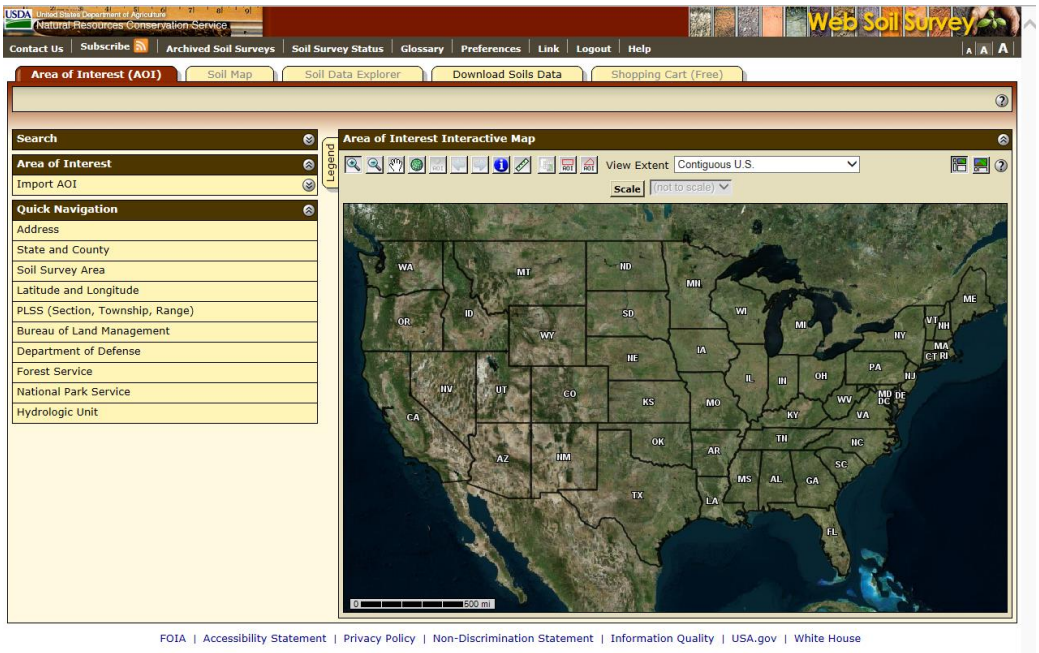


Figure 7. Navigating to your Area of Interest.

There are a number of ways to locate your parcel on the soil survey – Section-Township-Range and Latitude/Longitude work well. Enter Section, Township and Range – then click on View.

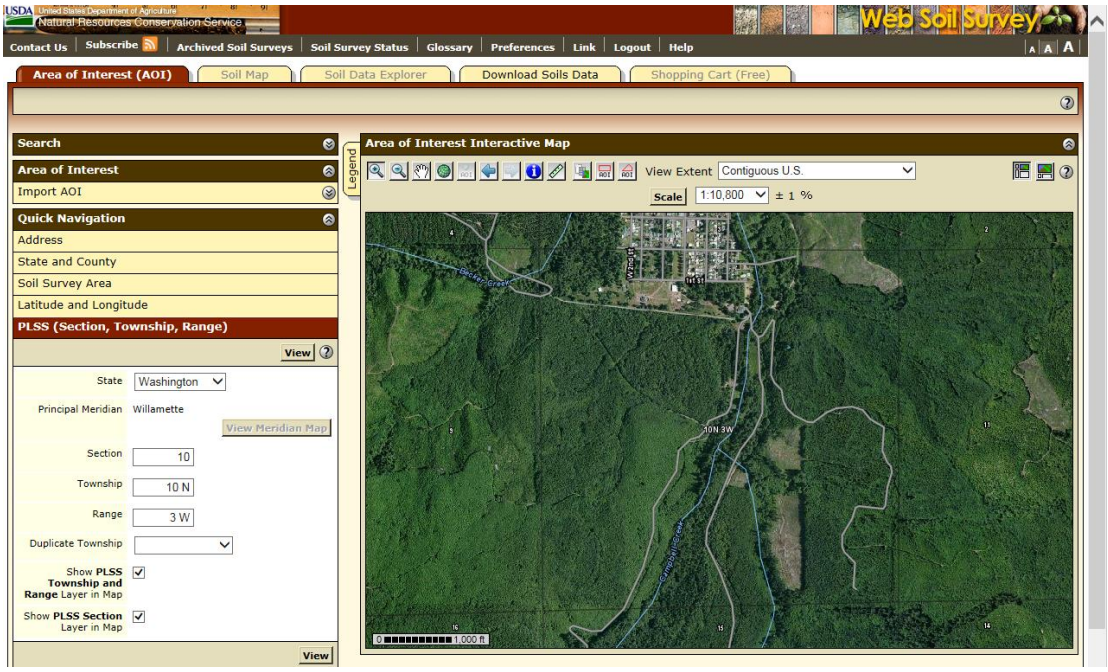


Figure 8. Navigating by Section-Township-Range.

The area of interest is set by using the either AOI by Rectangle or AOI by polygon tool located on the tool bar above the map.

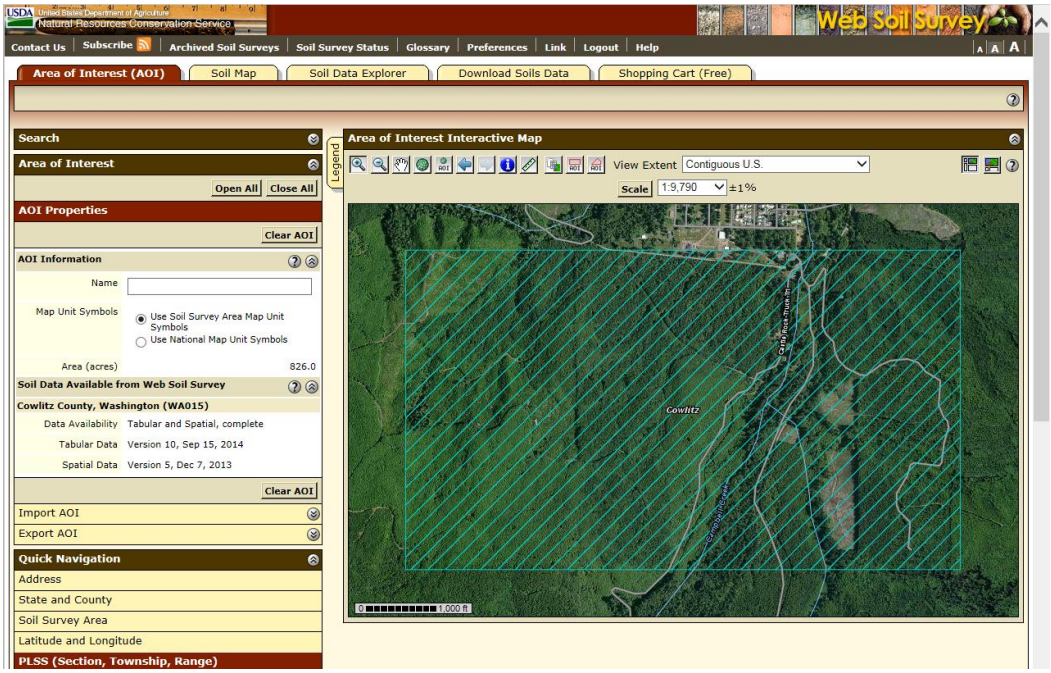


Figure 9. Setting the Area of Interest for soil survey information.

Click on the Soil Map tab to display the soil map for the Area of Interest. Shown are the soil series by slope class. At this point you can print or add map to the shopping chart.

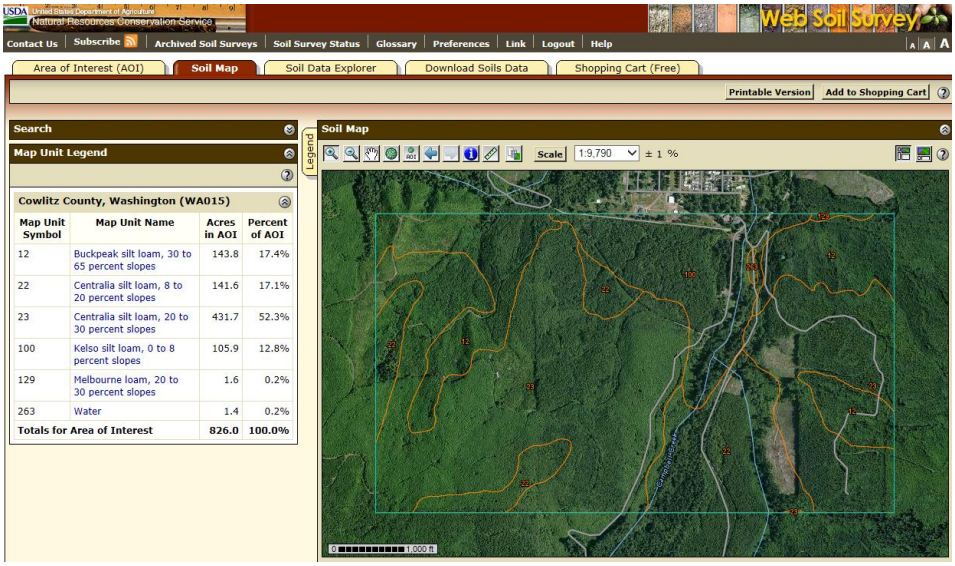


Figure 10. Soil Map for the Area of Interest.

Detailed information about the soil series in the AOI can be accessed by getting the description for a soil series from the NRCS. Return to the NRCS Homepage and select Official Soil Series Descriptions.

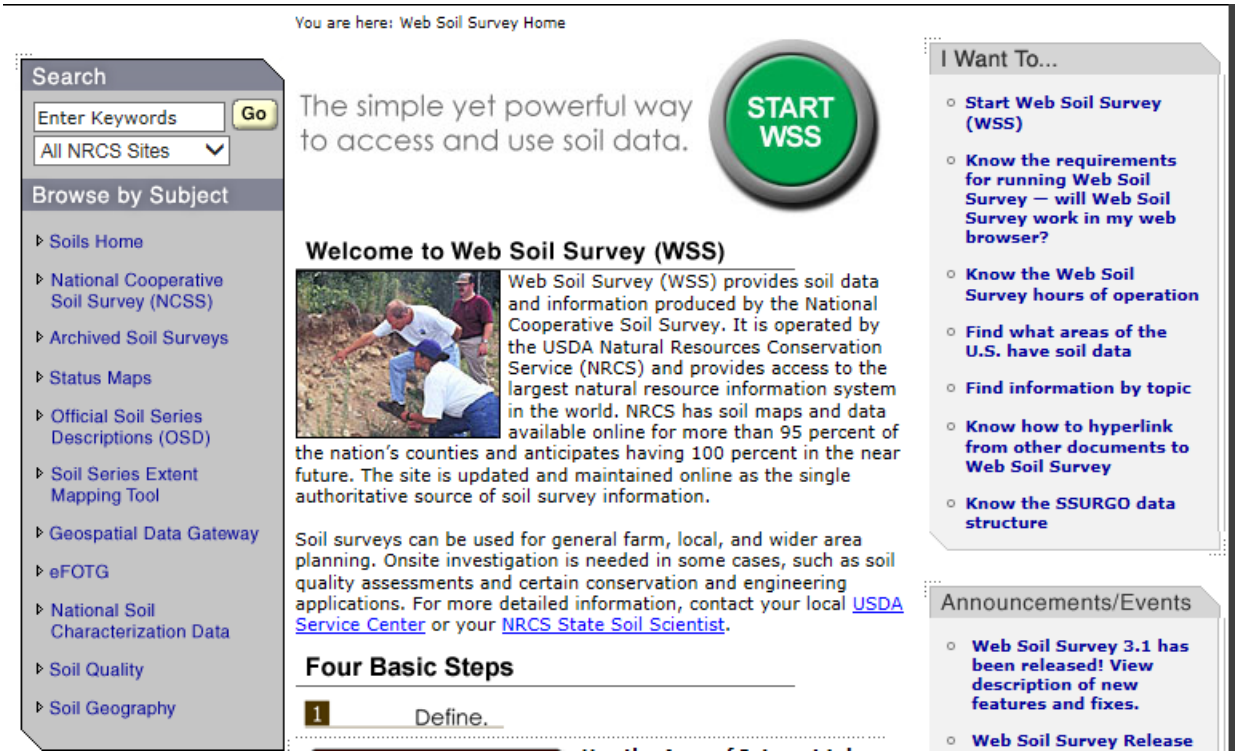


Figure 11. Getting Soil Series Descriptions for an Area of Interest.

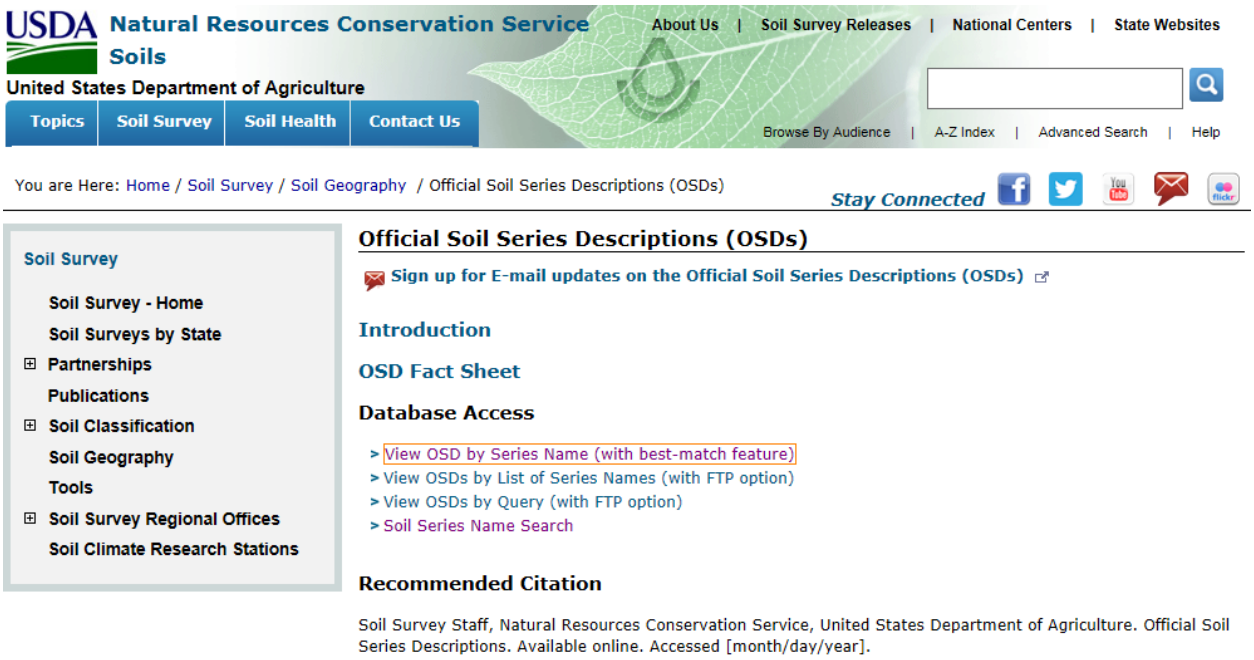


Figure 12. View OSD by Series Name (with best-match feature)

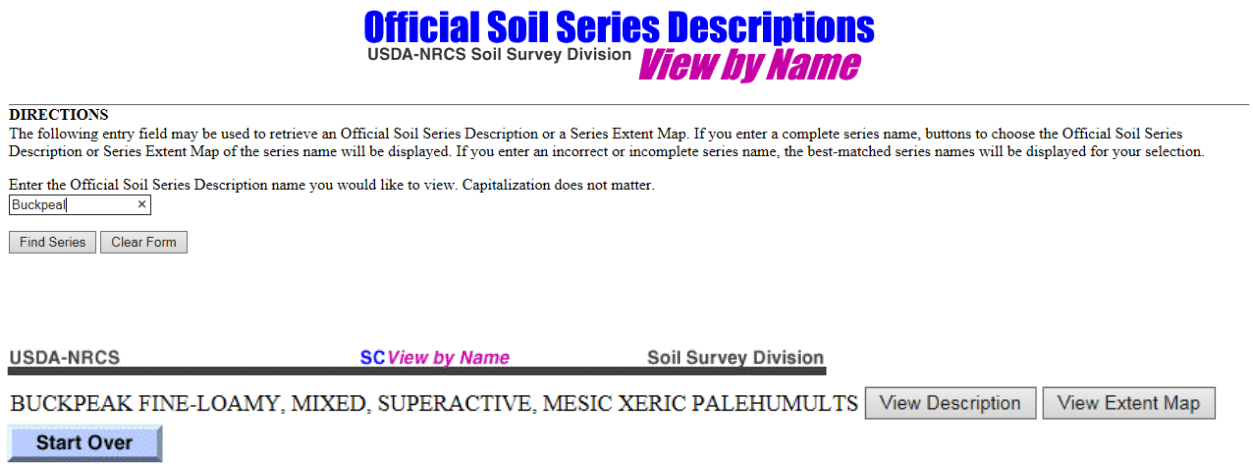


Figure 13. Enter soil series name from soil survey, find series and View Description.

See Appendix 2 for an example of a soils series description. All soils information needed for the red alder site assessment can be found in the soil series description.

PRECIPITATION AND WATER-HOLDING CAPACITY

Areas of Western Washington with higher amounts of growing season (April-September) rainfall are more productive for growing red alder. Soils with a high water-holding capacity store soil water from winter rains for longer periods than soils with a low water-holding capacity. High water-holding capacity also enables rainfall from late-spring and summer rain to be held in the surface rooting zone for a longer period allowing for uptake by red alder during these critical periods. Locales with higher growing season rainfall and higher water-holding capacity tend to have lower mortality from drought stress in the first growing season following planting.

For the purpose of assessing site suitability for red alder growing season precipitation can be estimated from long-term historical weather data (Western Regional Climate Center, wrcc@dri.edu 2015) for recoding stations that are located in the following physiographic/geographic zones for Washington: Coast Range-West slopes; Coast Range-East slopes; and foothills to the Southern Washington Cascades (Figure 14). Precipitation within a zone can vary – generally increasing with distance from the coast and elevation.

Table 1 gives the range of soil water holding capacity by soil texture class in inches/foot of soil. To estimate soil water-holding capacities for the surface soil horizon multiply these numbers by the depth of the horizon from the soil series description.

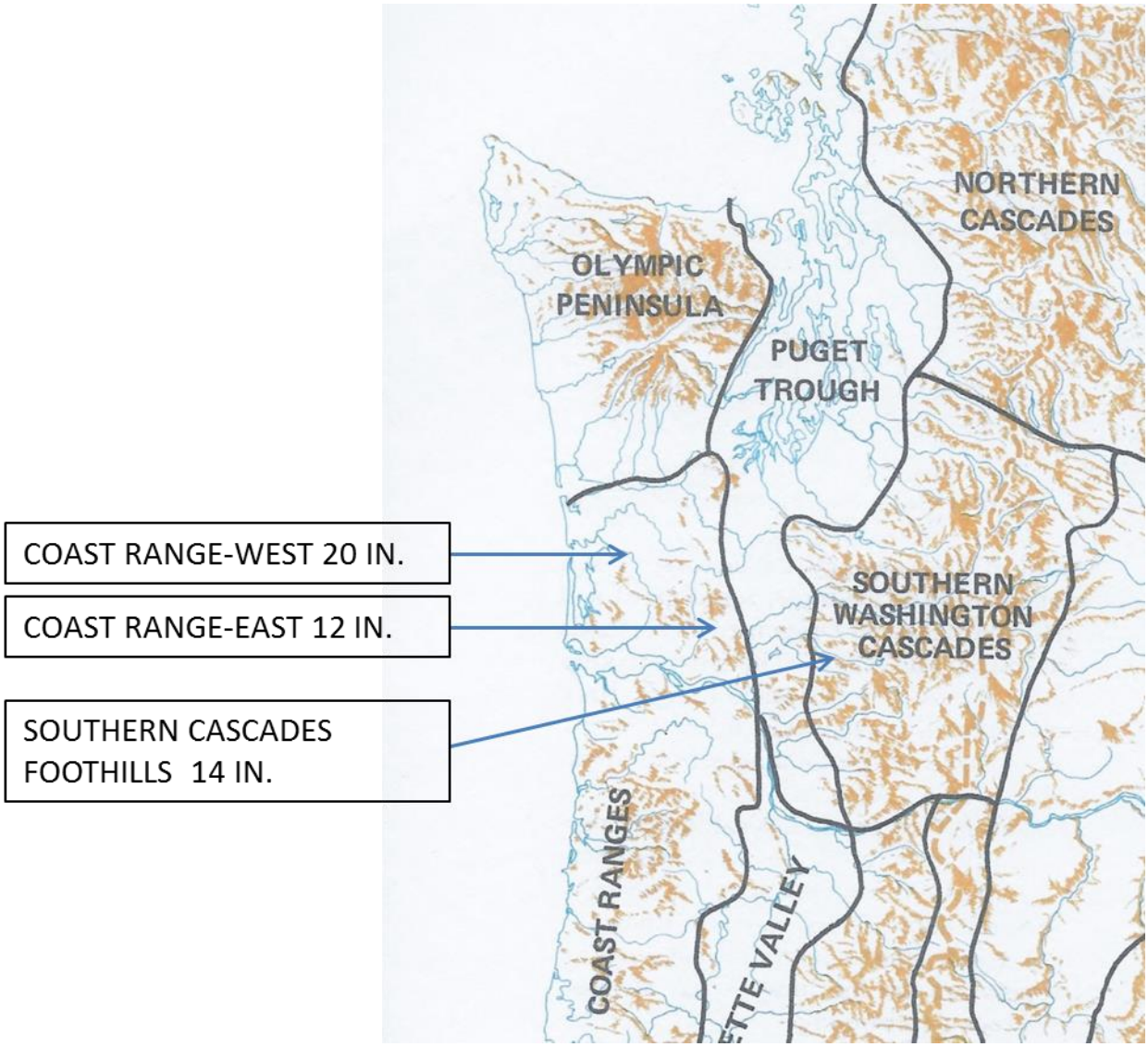


Figure 14. Physiographic and geological zones in Western Washington (After Franklin and Dyrness 1973). Shown is average growing season precipitation (April-Sept).

Table 1. Range of water holding capacity for different soil textures.

Textural class	*Water holding capacity, inches/foot of soil*
Coarse sand	0.25 - 0.75
Fine sand	0.75 - 1.00
Loamy sand	1.10 - 1.20
Sandy loam	1.25 - 1.40
Fine sandy loam	1.50 - 2.00
Silt loam	2.00 - 2.50
Silty clay loam	1.80 - 2.00
Silty clay	1.50- 1.70
Clay	1.20 - 1.50

CHECKLIST

Evaluate the site by applying the information on the checklist (Appendix 1) to the Relative Effect of Site Factors on Red Alder Site Quality (after Harrington, 1986) and rating each category as either Good (+), Intermediate (0), or Poor (-). Make a judgement on the general site suitability for red alder based on the pluses, zeros and minuses.

SITE VISIT

After the initial assessment of the AOI for red alder plantation establishment is made **it is absolutely essential to make a site visit**, preferably accompanied by a forester knowledgeable about red alder or a soil scientist. The site visit is necessary to verify the soil survey, assess the candidate area for frost pockets, heat/drought stress, and weed competition potential.

Verify the soil series by evaluating the top-soil against the NRCS description. Traverse the areas with average topography and dig small holes with a shovel. If observations more or less match the soil descriptions accept the mapping.

A frost pocket is a place where cold air is trapped or moves very slowly. Frost pockets are often associated with high water table. Frost pockets are frequently found in troughs or bowls (topographic depressions with no outlet for cold air flow). Frost pockets can also be found along streams or on flat terraces. Frost risk is increased if there is a cold-air dam such as a ridge of mature trees downhill or downwind. A planting unit that is surrounded by timber can create a frost pocket. Areas where fog hangs for long periods indicate potential for a frost pocket. Look for unhealthy hardwood brush and conifers with evidence of past freeze damage and wet site plant species. Frost pockets can be micro (1/10 to several acres) or macro (several hundred acres).

Sites typified by south-southwest aspects, steep slopes, coarser textured soils and lower soil-water holding capacity can be very prone to heat and drought stress.

Sites with expected very high levels of weed competition that cannot be adequately controlled to low levels (< 20% in midsummer) for the first growing seasons should not be planted to red alder. Examples are Salal (Gaultheria shallon) and highly invasive and aggressive grass/forbs/shrub communities (generally non-native plant species). Visit 1 and 2 year plantations in the vicinity of the site to get an indication of weed competition to expect.

Weed competition can be assessed by taking observation across a portion of the unit. Visualize an area on the ground approximately 3x3 feet on a side (or use a 3x3 ft. sample frame made from PVC pipe). Estimate cumulative ground cover (%) by estimating percent ground cover by plant form type – grasses, forbs, woody shrubs, and ferns. Each life form can have a maximum of 100% ground cover. Add these together to get cumulative ground cover -- it can be greater than 100%.

Cumulative vegetation ground cover in the first growing season of less than 10-15% is desirable for good survival and rapid tree growth. Cumulative ground cover in late-summer of the first growing season

greater than 30% will slow grow in years 1 and 2, greater than 75% will result in weed competition caused mortality and serious growth reduction in years 1 and 2, 100% weed competition can reduce seedling survival to 50% or less.

CONCLUSION

Following this process will give a reasonably accurate estimate of site suitability for red alder. Keep in mind that young red alder plantations will always be vulnerable to the effects of arctic outbreaks in the early-autumn because red alder tends to grow late into the growing season and is usually not hardened-off. Even on sites generally not prone to frost/cold. Unusually long periods of drought can also lead to higher than expected seedling mortality.

This process gives an estimate of general site productivity: Good site index > 100 feet and low < 90 feet. A method for estimating site index to the nearest 5 feet can be found in, "A method of site quality evaluation for red alder (Harrington, 1986)". However given the site to site variability within a site index class the estimates of Good (SI > 100), Intermediate (SI 90), and Poor (SI 80) given by the process described in this paper is, for practical purposes, as accurate of an estimate that can be made.

For information on red alder plantation establishment see, "RA Tree Growing-Plantation Establishment 10-27-09" on the Washington Hardwoods Commission webpage http://www.wahardwoodscomm.com/

Appendix 1.

Checklist for accessing the suitability of a site for planting red alder.

Factor	Value	Rating
Elevation (ft.) Min, Max, Average		
Slope Position		
Slope (%)		
Aspect		
Precipitation – Growing Season (April-September, in.)		
Frost Pockets		
Wind		
Soil Age and Parent Material		
Soil Moisture		
Soil Drainage/ Aeration during the growing season		
Top-Soil Texture		
Top-Soil Depth (in.)		
Top-Soil Soil Water-Holding Capacity (inches/foot)		
Top-Soil Water-Holding Capacity (in.)		
Sub-Soil Texture		
Sub-Soil Soil Depth (in.)		
Sub-Soil Water-Holding Capacity (inches/foot)		
Sub-Soil Water-Holding Capacity (in.)		
Surface Soil Organic Matter (%)		
Heat/Drought Stress		
Weed Competition in year 1 (Coverage %)		

Appendix 2.

Example of a Soil Series Description.

LOCATION BUCKPEAK WA

Established Series
Rev. RLE/RGC/RJE/TLA
10/2002

BUCKPEAK SERIES

The Buckpeak series consists of very deep, well drained soils formed in residuum and colluvium from siltstone, shale, and fine grained sandstone on uplands at elevations of 200 to 1,800 feet. Slopes are 8 to 90 percent. Average annual precipitation is about 65 inches and average annual temperature is about 51 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, mesic Xeric Palehumults

TYPICAL PEDON: Buckpeak silt loam-forest, on a 30 percent southeast- facing convex slope at an elevation of 660 feet. The soil was moist when described. (Colors are for moist soil unless otherwise stated.)

Oe--1 inch to 0; partially decomposed needles, twigs and bark.

Ac--0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium and common coarse roots; 10 percent 2 to 5 mm shot-like concretions; medium acid (pH 5.8); clear wavy boundary. (6 to 9 inches thick)

AB--8 to 19 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure parting to fine and very fine granular; hard, friable, slightly sticky and plastic; common fine, medium and coarse roots; common fine tubular pores; 5 percent soft pebble-size siltstone fragments; strongly acid (pH 5.6); clear wavy boundary. (8 to 12 inches thick)

Bt1--19 to 31 inches; dark brown (7.5YR 4/4) silty clay loam, light brown (7.5YR 6/4) dry; weak fine and medium subangular blocky structure; hard, firm, sticky and plastic; few fine, medium and coarse roots; common fine and very fine tubular pores; common faint patchy clay films on faces of peds; 30 percent soft pebble-size siltstone fragments; strongly acid (pH 5.5); clear wavy boundary. (8 to 14 inches thick)

Bt2--31 to 44 inches; dark brown (7.5YR 4/4) silty clay loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; few fine medium and coarse roots; common fine and very fine tubular pores; many discontinuous faint clay films on faces of peds; 50 percent soft pebble-size siltstone fragments; strongly acid (pH 5.1); abrupt irregular boundary. (10 to 16 inches thick)

BCt--44 to 60 inches; dark brown (7.5YR 4/4) silty clay loam, light brown (7.5YR 6/4) dry; massive; hard, firm, sticky and plastic; few coarse roots; common fine and very fine tubular pores; continuous prominent clay films in vertical cracks and on faces of rock fragments; 75 percent soft pebble-size siltstone fragments; very strongly acid (pH 5.0).

TYPE LOCATION: Lewis County, Washington; about 2 miles southeast of Pe E11, 400 feet south and 50 feet east of the northwest corner of 12 N., R. 5W., W.M.

RANGE IN CHARACTERISTICS: These soils are usually moist, but are dry in the moisture control section for 45 to 60 consecutive days following summer solstice in most years. Average annual soil temperature ranges from 49 degrees to 54 degrees F. Soft siltstone and sandstone fragments average 35 to 60 percent in the particle-size control section. The particle-size control section is 20 to 35 percent clay.

The A & AB horizons have hue of 10YR or 7.5YR, value of 2 or 3 moist and 4 or 5 dry; and chroma of 2 or 3 moist or dry.

The Bt horizon has hue of 7.5YR or 10YR, value of 3 or 4 moist and 5 or 6 dry; and chroma of 3 through 5 moist and 4 through 6 dry. It is silt loam, silty clay loam or loam. Soft siltstone and sandstone fragments range from 25 to 60 percent.

The BCt horizon has 40 to 85 percent soft siltstone and sandstone fragments. It is silty clay loam, clay loam, or loam. This horizon is very strongly acid or strongly acid.

COMPETING SERIES: This is the Centralia series. Centralia soils lack weathered rock fragments in the argillic horizon.

GEOGRAPHIC SETTING: Buckpeak soils are on uplands at elevations of 200 to 1,800 feet. Slopes range from 8 to 90 percent. They formed in colluvium and residuum from siltstone, shale and fine-grained sandstone. Average annual temperature is 47 degrees to 52 degrees F. Annual precipitation ranges from 40 to 75 inches. Growing season (28 degrees F) is 150 to 240 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Galvin, Germany, Melbourne, Olympic, Raught, Thrash, Vader, and Walville soils. Galvin soils are fine-silty. Melbourne and Olympic soils are fine. Germany and Raught soils have a udic moisture regime. Thrash and Walville soils are medial. Vader soils are coarse-loamy and have a cambic horizon.

DRAINAGE AND PERMEABILITY: Well drained; medium or rapid runoff; moderate permeability.

USE AND VEGETATION: Used for timber production, wildlife habitat and watershed. Vegetation is Douglas-fir, western hemlock, western redcedar, bigleaf maple, and red alder, with an understory of vine maple, western swordfern , Oregongrape, red huckleberry, salal, longtube twinflower, trailing blackberry, western rattlesnake plantain, violet, and western brackenfern.

DISTRIBUTION AND EXTENT: Southwestern Washington. The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Portland, Oregon

SERIES ESTABLISHED: Grays Harbor County, Washington, 1979.

REMARKS: Diagnostic horizons and features recognized in this pedon are an umbric epipedon from the mineral surface to 19 inches and an argillic horizon from 19 to 60 inches. The classification change is based on laboratory data on the associated Centralia series (Sample Number S84WA- 015-005) and the re-establishment of Palehumults in Soil Taxonomy Handbook, Issue No.12.

National Cooperative Soil Survey
U.S.A.

Appendix 3a.

Relative Effect of Site Factors on Red Alder Site Quality (after Harrington, 1986)

	Relative Site Quality		
Site Factor	**Good**	**Intermediate**	**Poor**
Elevation	< 1000 ft.	1500 – 2000 ft.	> 2500 ft.
Slope Position	Flood Plain, Terrace, Bench, Gentle Lower Slope	Mid-Slope, Steep Lower Slope, Depressions	Upper Slope, Ridgetop
Slope and Aspect	Flat, < 30% Slope on N, NE, NW; < 20% on E or W	10-20% on S, SE, SW; 20-40% on E or W; 30-50% on N, NE, NW	> 25% on S, SE, SW; > 40% on E or W
	Relative Site Quality		
Site Factor	**Good**	**Intermediate**	**Poor**
Precipitation – Growing Season (April-September)	**> 12 in.**	**6-12 in.**	**< 6 in.**
Frost Pockets	**None**	**Small localized frost pockets that occur infrequently**	**Large frost pockets; Landscape-scale cold air accumulation**
Wind	**Protected**	**Moderate Winds**	**Constant exposure to wind; Periodic Exposure to high winds**

Appendix 3b.

Relative Effect of Site Factors on Red Alder Site Quality (after Harrington, 1986)

	Relative Site Quality		
Site Factor	**Good**	**Intermediate**	**Poor**
Soil Age and Parent Material	Young, Layered Alluvium; Sedimentary or Volcanic (low rock, some profile development and no leached horizons)	Glacial, Volcanic, or coarse Alluvium (high rock, some profile development and no leached horizons)	Highly Weathered with evidence of leaching; or Organic Soils
	Relative Site Quality		
Site Factor	**Good**	**Intermediate**	**Poor**
Soil Moisture	Abundant during the growing season; high soil water holding capacity; root access to water table	Limited due to shallow soils, excessive drainage	Subject to drought due to coarse texture, excessive drainage, rock fragments

Site Factor	**Good**	**Intermediate**	**Poor**
Soil Drainage/ Aeration during the growing season	Moderately well-drained; or adequately aerated soil above water table; or high water table with well-aerated (moving) water	Poor drainage limits soil aeration; poor drainage with micro-topography providing some aeration; poor drainage or high (stagnant) water table limits rooting	Very Poor drainage, anaerobic soils, very limited rooting from high water table, no aeration from micro-topography

Appendix 3c.

Relative Effect of Site Factors on Red Alder Site Quality (after Harrington, 1986)

Site Factor	Good	Intermediate	Poor
Soil Texture	Silt Loam, Silt Clay Loam, Loam, Silty Clay	Clay, Sandy Clay, Sandy Clay Loam, Sandy Loam	Sand, Loamy Sand
Surface Soil Organic Matter	5-25%	?	< 3% or > 25%; particularly excessive rotted wood
Soil Bulk Density	< 1.2	?	?
Soil Phosphorus	> 1000 ppm in rooting depth	?	?