



ENGINEERING NORTHWEST PLLC

ENGINEERING WITH INTEGRITY

**CRITICAL AREA REPORT
FOR**

PARCEL # 253124-000

**Submitted to:
City of Camas**

FOR:

Camvest GM LLC

7905 NE 173rd Ave

Vancouver WA 98682

GENERAL PROJECT INFORMATION

Property Owners: Camvest GM LLC
7905 NE 173rd Ave
Vancouver WA 98682

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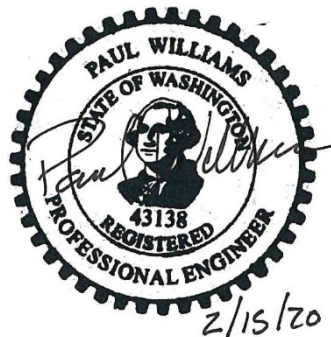


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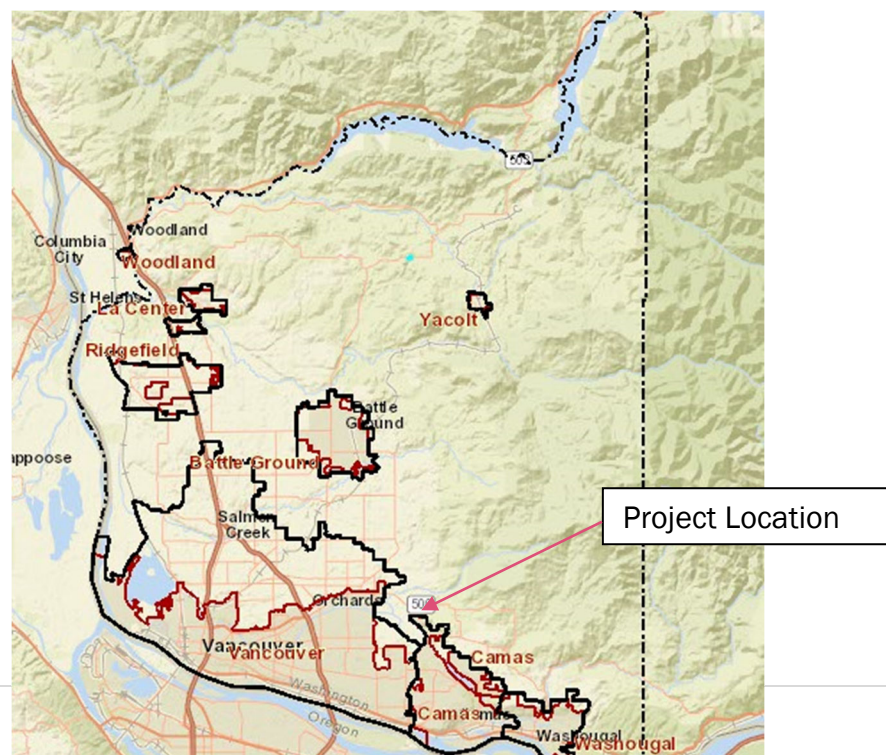
To the best of my knowledge and understanding, all information required by the City of Camas Critical Areas 16.59 and IRC 2003, and IBC 2012 is included in this submittal and the proposed project compliances with Critical Areas Protection ordinances and standards

Introduction

Engineering Northwest has prepared a geological hazard assessment report for parcel number 986043-773 in the City of Camas, Washington. The purpose of this report is to address City of Camas assessment for potential geological hazards on-site and within 100 feet of the proposed home and stormwater system located within the proposed 14-lot subdivision. This report is based on visual observation and review of available geologic and property information. The geological hazard site investigation was conducted on November 15, 2019

Site Characteristic and Location

The parcel is located on the Southwest quarter of Section 27, Township 2 North, Range 3 East, Willamette Meridian. The parcel is identified as serial number 986043773. The site consists of approximately 7.61-acre however approximately 1.1-acre is located within a BPA easement. BPA will not allow homes to be built within BPA easement. The project is located east side of NE Ingle Road in the City of Camas, Washington. The highest ground within the parcel is located 100-feet from the southeast property corner along the east boundary line at 336 feet above mean sea level (amsl). The lowest ground within the parcel area, is located southwest corner of the property boundary line (adjacent to Ingle Road) at 260 feet above mean sea level (amsl). The approximate elevation difference between the highest elevation point and the lowest elevation point on the parcel, equates to an approximate average slope of 14.5%. Historically the parcel has large trees. As of today, parcel has good vegetation with tree growth on the parcel excluding BPA easement. The owner is proposing to construct a 14-lot subdivision.



Site Specific Soil Conditions

According to the Soils Conservation Service (SCS) manual, the soils on the site are identified below.

Symbols	Soil Name	USDA Texture
OmE	Olympic	Clay Loam

Clark County GIS indicates the site consist of mostly Olympic type of soil, which is deep, well- drained, gently sloping to very steep soils underlain by basalt bedrock. These are moderately fine textured soils that formed on mountainous foot slopes in weather igneous lava flows.

Regional Geology

Geologic Unit Age: Pleistocene

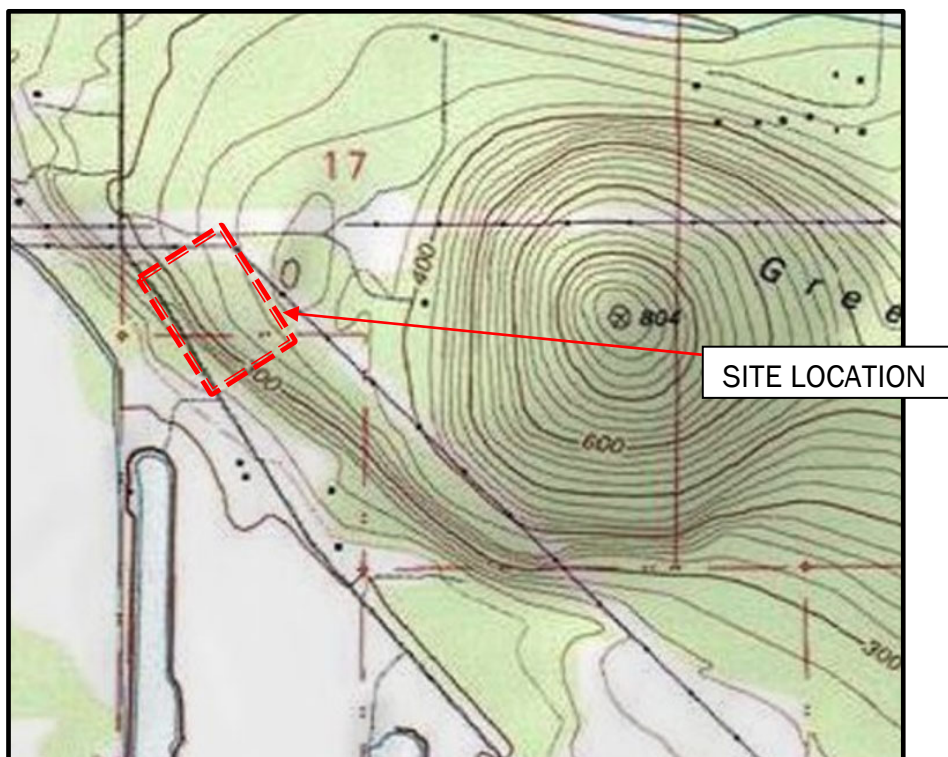
Geologic Unit Name: Basaltic andesite of Green Mountain

Unit Description: Olivine phyric basaltic andesite erupted from cinder cone at west end of Green Mountain. Light-gray, microvesicular, generally platy lava flow, extending about 1 km to northwest of Green Mountain, consists of olivine phenocrysts (2-4 percent; 0.5 to 3 mm across; contains inclusions of chromian spinel; rims variably replaced by iddingsite) in a fine-grained trachytic groundmass of plagioclase, clinopyroxene, orthopyroxene, and Fe-Ti oxide; locally contains quartzite pebbles and small, dark, fine-grained clots that may be sedimentary xenoliths, both presumably derived from underlying gravels (units QTc and Ttfc). Conical hill at west end of Green Mountain consists largely of deeply weathered basaltic ash; platy basaltic andesite lava crops out at summit and presumably fills vent. Lava flow has normal magnetic polarity (J.T. Hagstrum, written commun., 1999) and yielded an $^{40}\text{Ar}/^{39}\text{Ar}$ age of 575 ± 7 ka (table 2)

Age-Lithology: Quaternary volcanic rocks



<https://geologyportal.dnr.wa.gov/>



USGS National Map

Site Investigation

Engineering Northwest, PLLC conducted a site visit on November 15, 2019 to characterize the potential geological hazard areas on site. The proposed building setbacks within the subdivision will set on a descending section of the parcel with a slope of 5% to 14% slope. The building setback areas shown on the proposed preliminary subdivision plan don't meet the criteria for designation of a specific hazard area. The building setback area show no signs of following

- No previous slope failures including area of unstable old or recent landslides.
- No ground water seepage during site visit
- No slopes that are parallel or sub-parallel to planes of weakness such as bedding planes joint systems and fault planes in the subsurface materials.
- No mapped area in the location of the building setback designated as potential instability, historical or active landslide.
- No slopes grater than eighty percent, subject to rock fall during earthquake shaking
- No areas potentially unstable as result of rapid stream incision, stream bank erosion and stream undercutting the toe of a slope
- No areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows, debris torrents or catastrophic flooding.

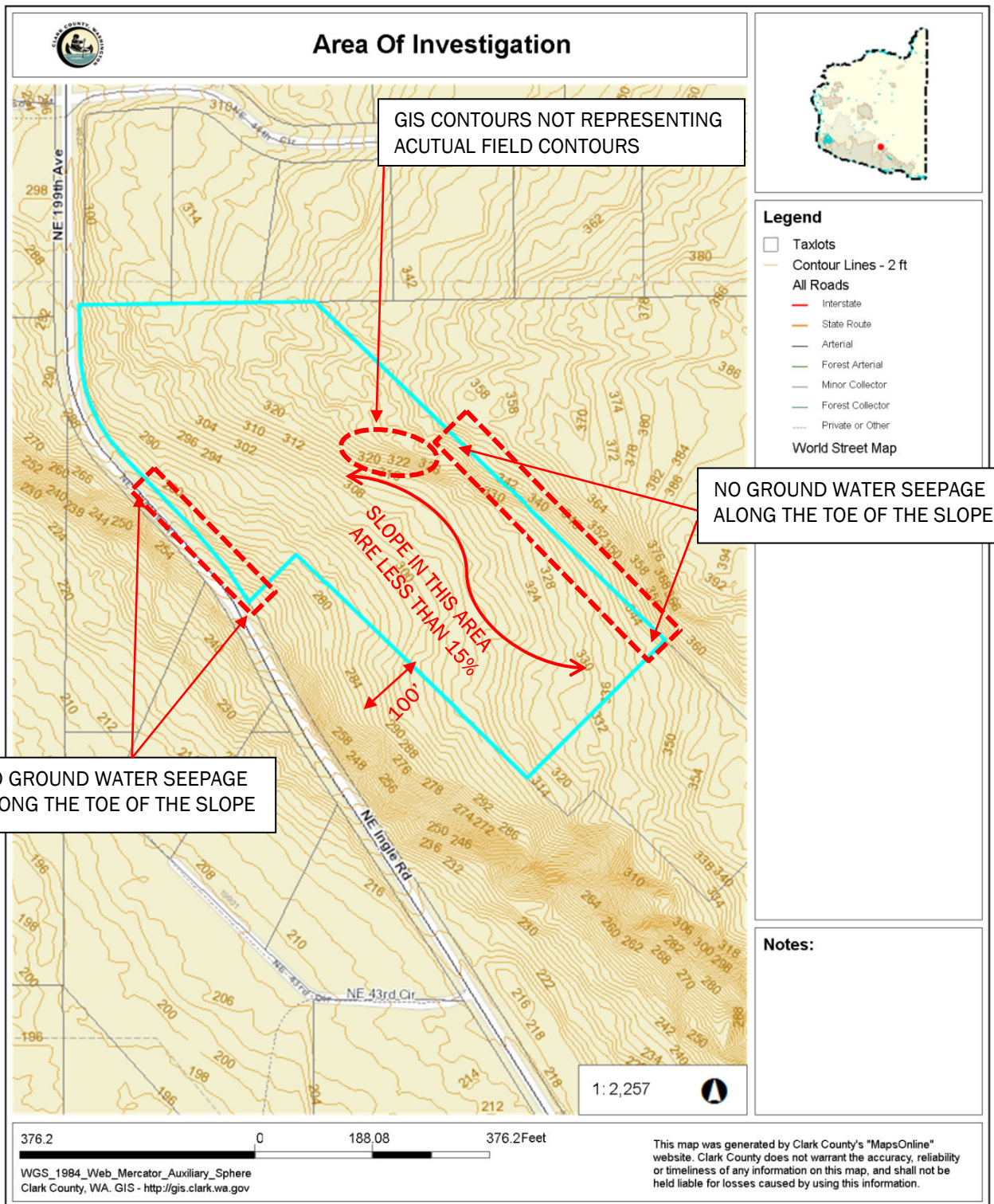
The project site slopes generally from east to west with a defined ridge located along portion of the east property line and a ridge located along a portion of NE Ingles road. The base of the slope for the eastly ridge runs along the backyards for proposed lots 9 thru 14. The height from the top of ridge to the base of the slope ranges from 28-feet to 30-feet in height for lots 9 thru 14 this is based on field measurements. The rear yard setback requirement for R-10 zone is 30-feet. Engineering Northwest recommends an additional 15-foot setback geotechnical setback along with the rear zoning setback to protect the integrity of the hill side and prevent serve erosion due to construction activities. During the site wood stakes were place along the recommend building setback for lot 9 thru 14 to ensure that the building envelope is greater than 15-feet away from the base of the slope.

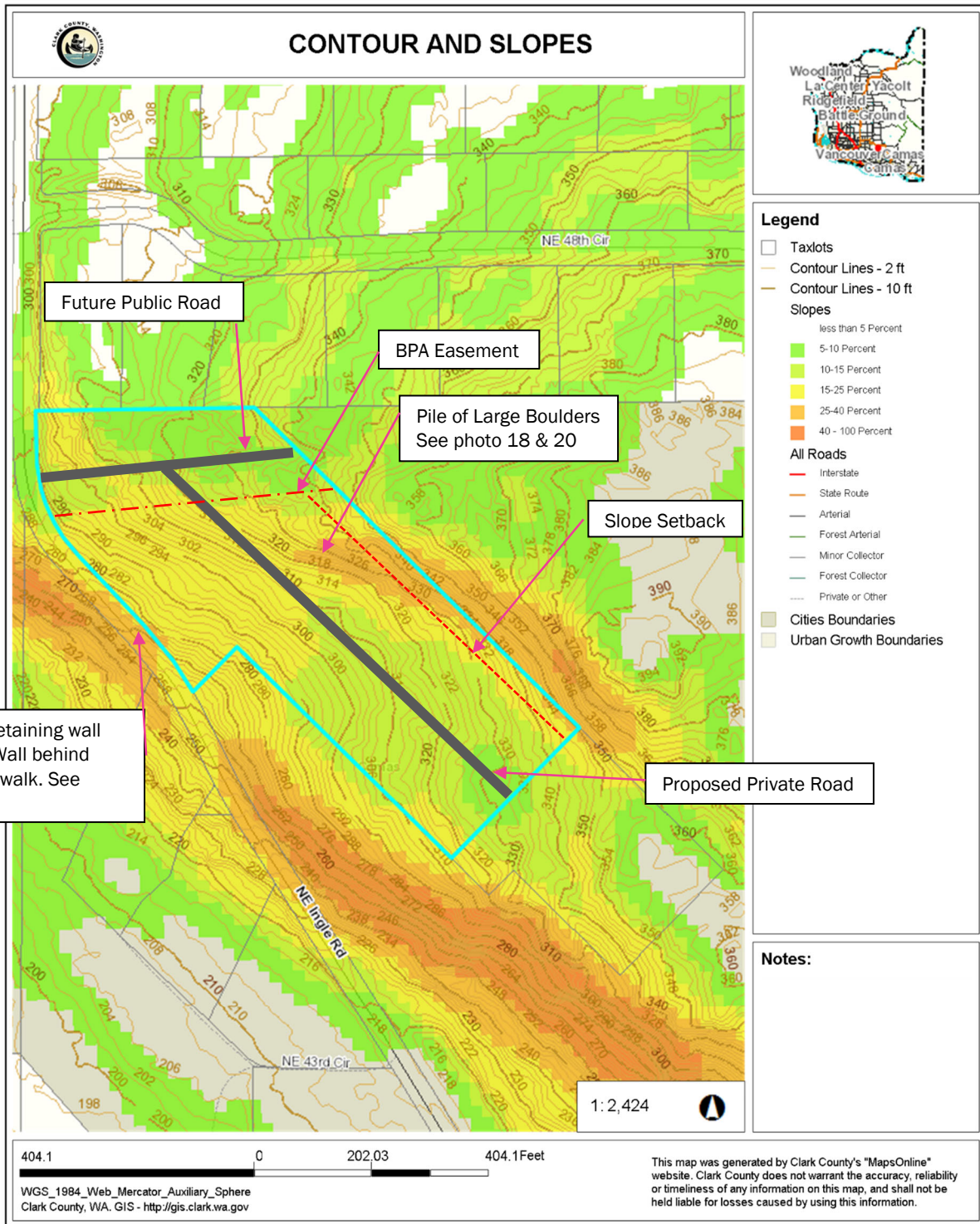
The base of the slope for the westly ridge runs along NE Ingles road. The west property line for lot 3 is adjacent to the westly ridge. The proposed building envelope for lot 3 is 25-feet away from the top of the ridge that runs along NE Ingles road. The height from the top of the ridge to the base of the slope ranges from 4-feet to 5-feet in height along NE Ingles road. No recommends for additional geotechnical setbacks for lot 3.

According to Clark County GIS mapping information, the site is mapped as containing areas with slopes greater than a 15% grade. Please note that Clark County contour maps are not accurate and because of this have been field verified. Clark County GIS does not indicate any areas on the parcel as a historical or active landslide.

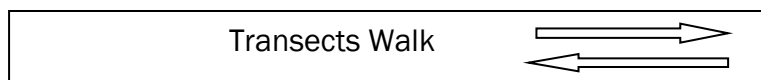
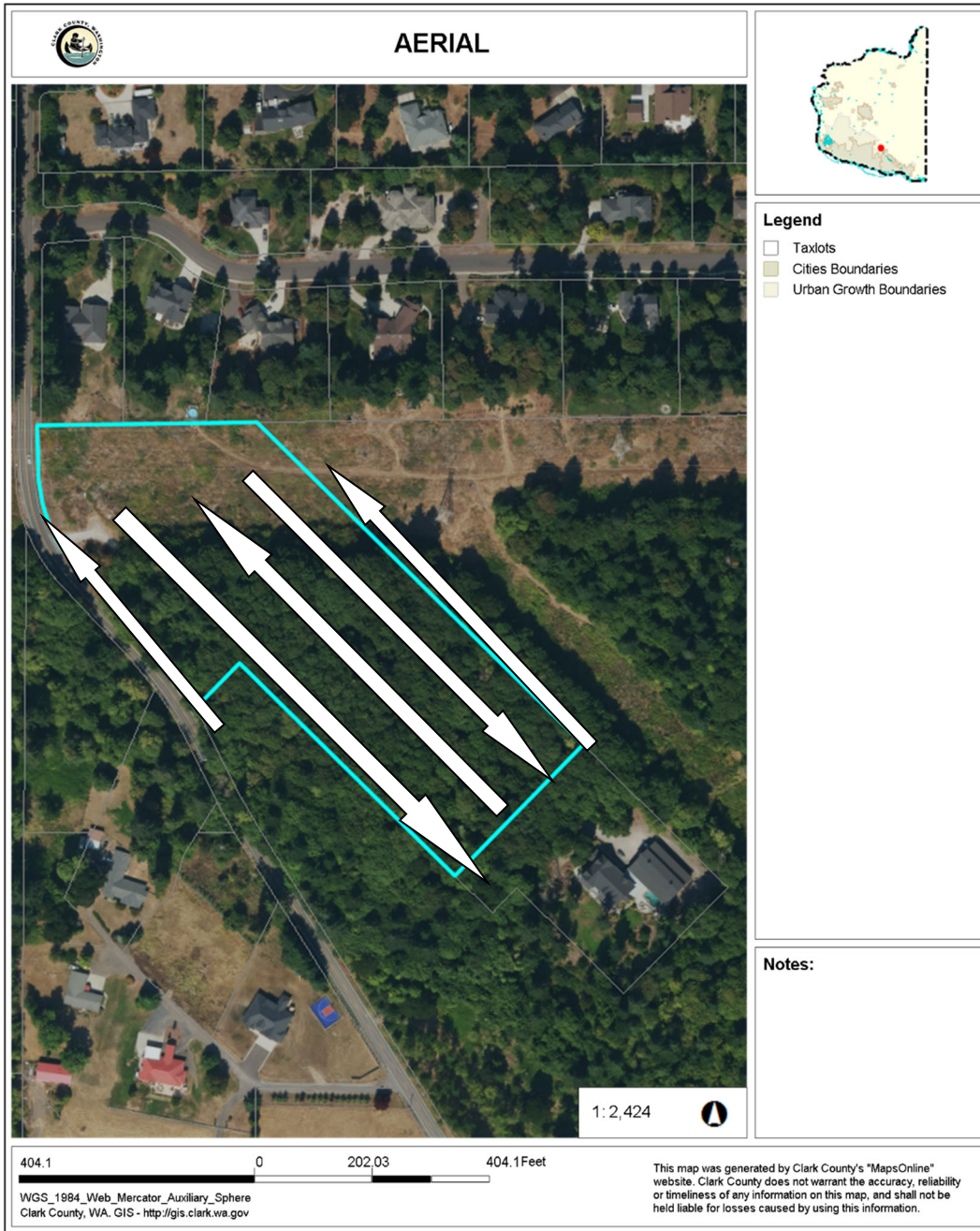
Site investigation performed, included measuring the slope and reviewed the topographic survey provided by Clark County GIS. Field investigation found slope grades within the proposed building envelopes to be less than 14.5%. The slopes along the proposed structure supports vegetation consisting of young established trees and Douglas fir and mixed understory bushes, grasses, ferns, and shrubs. No shallow groundwater seepage and no surface water was observed along the base of the slopes during the site investigation.

The proposed homes will be built on slopes ranging from 5 to 14.5 percent. an area containing 8% slopes. The slopes in the area of the proposed building envelopes are based on filed measurements. Clark County GIS indicates that the slopes on the subject site range from more than 5% (green) to greater than 40% (dark orange) with the intermediate slope broken into categories including 5-10% (green), 10-15% (yellow-green) 15-25% (yellow) and 25-40% (light-orange).





GIS Contour and Slope Map



16.59.020 Designation of Specific Hazard Areas

- A. Erosion Hazard Areas. Erosion hazard areas are areas where there is not a mapped or designated landslide hazard, but where there are steep slopes equal to or greater than forty percent slope. Steep slopes which are less than ten feet in vertical height and not part of a larger steep slope system, and steep slopes created through previous legal grading activity are not regulated steep slope hazard areas.

The project is located within a erosion hazard Engineering Northwest PPLC recommends construction erosion control plan be submitted to the City of Camas for review and approval before the start of construction.

- B. Landslide Hazard Areas. Landslide hazard areas are areas potentially subject to landslides based on a combination of geologic, topographic, and hydrologic factors. They include areas susceptible because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors. Examples of these may include, but are not limited to the following:

1. Areas of previous slope failures including areas of unstable old or recent landslides;
During the field visit no visible signs of areas of unstable old or recent landslides.

2. Areas with all three of the following characteristics:

- a) Slopes steeper than fifteen percent,
The parcel does have areas of slopes greater than 15%.
- b) Hillside intersecting geologic contacts with permeable sediment overlying a low permeability sediment or bedrock, and
No intersecting geologic contacts with permeable sediment overlying a low permeability sediment or bedrock onsite
- c) Any springs or ground water seepage;

During the field visit no visible signs of springs or groundwater seepage.

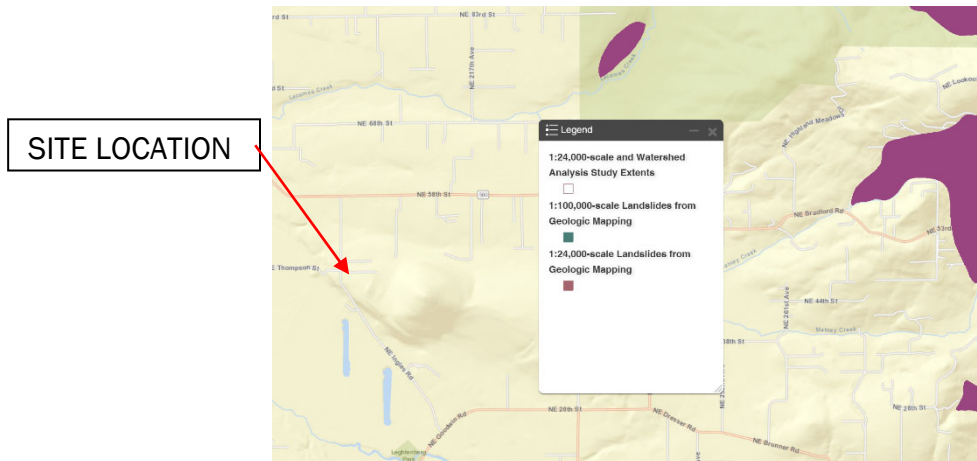
3. Slopes that are parallel or sub-parallel to planes of weakness, such as bedding planes, joint systems and fault planes in subsurface materials;

No subsurface investigation along the east property line to determine parallel or sub-parallel to planes of weakness. Because no subsurface investigation or lab results were conducted Engineering Northwest PLLC recommends a 15-foot setback from the project east property line. However, City of Camas zoning requires 30-foot rear setback, the future home will be located 45-feet from the project east property line.

Engineering Northwest recommends that the slope setback be 30-feet to avoid confusion with the zoning setback.

4. Areas mapped by:

- a) Washington Department of Natural Resources Open File Report: Slope Stability of Clark County, 1975, as having potential instability, historical or active landslides, or as older landslide debris, and



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There are no potential instability, historical or active landslides on the parcel. The nearest known landslide area is located 1.5 miles to the east of the project site.

- b) The Washington Department of Natural Resources Open File Report Geologic Map of the Vancouver Quadrangle, Washington and Oregon, 1987, as landslides; **see above**

5. Slopes greater than eighty percent, subject to rock fall during earthquake shaking;

No slopes on the parcel are greater than 80%.

6. Areas potentially unstable as a result of rapid stream incision, stream bank erosion, and stream undercutting the toe of a slope;

The project is not located within an area of potentially unstable as a result of rapid stream incision, stream bank erosion and stream undercutting the toe of a slope.

7. Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows, debris torrents or catastrophic flooding.

The project area is no located with a canyon or on an active alluvial fan.

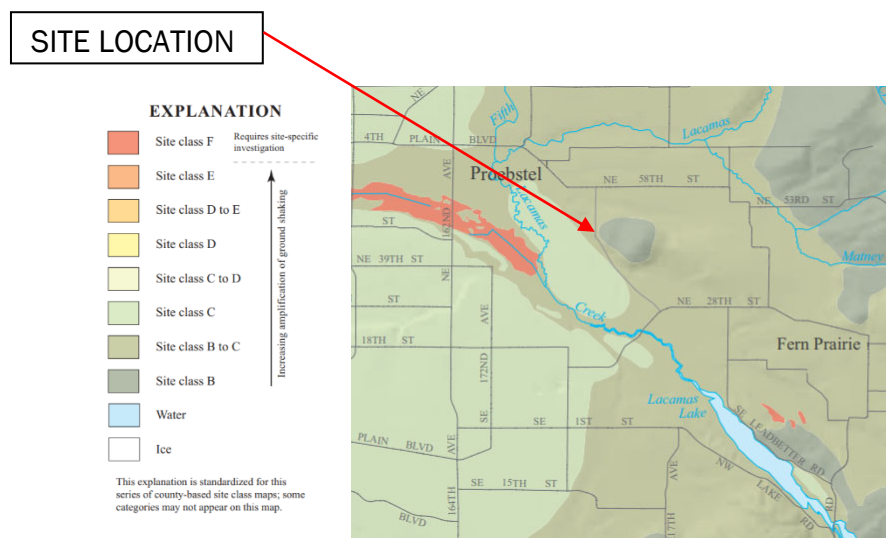
SEISMIC HAZARD EVALUATION

Onsite soil evaluation of the subsurface conditions encountered during the site investigation and the evaluation of geologic maps, a review of ASCE 7 an evaluation of well report adjacent to the site. Overall, the supportive soil at the project site consists primarily of dense Clay loam. Soil encountered at the site are classified as type “D” soil in accordance with ASCE 7 Chapter 20.3.1 Table 20.3-1 site classification.

The project site is located within 900 feet of the Lucama’s Lake fault (see map below). All earthquakes occur along faults; surfaces between two rock masses where one mass slides past other. Where a fault is located at the surface, movement of the fault can damage structures built on the fault. The most recent rupture of the Lacamas Lake Fault occurred sometime between 10,000 and 100,000 years ago.

During an earthquake, unconsolidated sediment (typically loose, saturated sand found in river valleys and along lakeshores) can lose strength and behave like liquid. This is called liquefaction.

Based on the dense soil conditions encountered and the absence of near surface groundwater table, it is not likely that soil liquefaction would occur at the subject site during a seismic event.



- C. Other Hazard Areas. Geologically hazardous areas shall also include areas determined by the city to be susceptible to other geological events, including mass wasting, debris flows, rock falls, and differential settlement.

The city of Camas has not indicated any additional geological hazard on the project site.

Erosion Hazard Area Assessment

Clark County GIS mapping does indicate that parcel 986043-773 contains areas identified as a severe erosion hazard area. During construction of the proposed subdivision the potential for erosion is increased. Construction activities would involve excavation (construction of road improvements, mass-grading of the site, install utilities), grading and cut-and-fill for roads, tree removal, heavy equipment movement, and materials lay-down. These activities would disturb soils and remove or damage vegetative cover. The exposed soil would be vulnerable to movement off-site through water runoff, wind dispersal, or movement by gravity (soil and rocks rolling downhill). Soil erosion could increase sedimentation in streams and wetlands, which would affect surface and groundwater resources (drinking water) and aquatic habitat. The risk for soil erosion would be greatest during and immediately after construction, when protective vegetation and topsoil have been removed and the soil is being actively disturbed and exposed. Typically, as vegetation becomes reestablished on disturbed surfaces, or the surface is covered (such as by a road, of future home), the potential for erosion decreases. Construction on steep slopes would occur in soils moderately to severely susceptible to erosion and temporary increases in soil erosion could occur. Limiting site disturbance is the single most effective method for reducing erosion (Ecology 2004). Preserving vegetative cover to the maximum extent feasible helps shield the soil from the elements, slowing runoff velocity and holding soils in place. Temporary erosion control measures would be maintained until vegetation is reestablished or permanent erosion control measures were in place. Erosion control measures shall include implementing a SWPPP and designing roads to control runoff and prevent erosion. With implementation of these Best Management Practices (BMPs), the impacts would be low-to-moderate. Additional measures such as performing construction during the dry season could further prevent or reduce erosion.

Soil compaction would occur if soil particles are pressed together by heavy equipment, by heavy materials storage and staging areas, or repeated vehicle traffic. When soils are compacted, the pore spaces between soil particles are reduced, restricting infiltration and deep rooting, and reducing the amount of water available for plant growth. When infiltration is reduced, runoff may occur and lead to erosion, nutrient loss, and potential water quality problems (NRCS 1996, 2004). Soil water content influences compaction such that the risk is greatest when soils are moist or wet; dry soils are much more resistant to compaction

than moist or wet soils (NRCS 1996, 2004). Other factors affecting compaction include the pressure exerted upon the soils (from heavy equipment or vehicles), soil characteristics (organic matter content, clay content and type, and texture), and the number of passes by equipment or vehicle traffic (NRCS 1996). Soils in the project area generally have low to moderate resistance to soil compaction. This means that the traffic and equipment operating directly on soils would likely compact the soil, especially if the soils are moist or wet. Mitigation measures should be in place to reduce soil compaction on the individual lots and or restore existing surface soil condition according to Best Management Practice (BMPs). These measures should apply to the entire lots because the future home location or size is unknown at the time of the subdivision final construction improvements approval from the City of Camas.

Foundation/Building Setback to Slopes

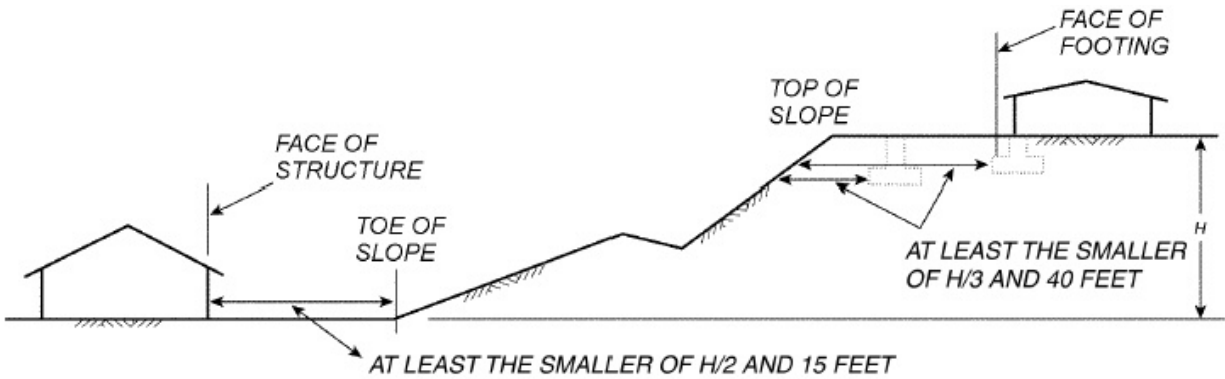
IBC 2012 1808.7.1 Building clearance from ascending slopes.

In general, buildings below slopes shall be set a sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures. Except as provided in [Section 1808.7.5](#) and Figure 1808.7.1, the following criteria will be assumed to provide this protection. Where the existing slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the toe of the slope shall be assumed to be at the intersection of a horizontal plane drawn from the top of the foundation and a plane drawn tangent to the slope at an angle of **45 degrees** (0.79 rad) to the horizontal. Where a retaining wall is constructed at the toe of the slope, the height of the slope shall be measured from the top of the wall to the top of the slope.

Based on reviewing the proposed plot plan, no additional setbacks are warranted.

1808.7.2 Foundation setback from descending slope surface.

Foundations on or adjacent to slope surfaces shall be founded in firm material with an embedment and set back from the slope surface sufficient to provide vertical and lateral support for the foundation without detrimental settlement. Except as provided for in [Section 1808.7.5](#) and Figure 1808.7.1, the following setback is deemed adequate to meet the criteria. Where the slope is steeper than 1 unit vertical in 1 unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degrees (0.79 rad) to the horizontal, projected upward from the toe of the slope.



Based on the review of the proposed subdivision plan and site invistrtion

Based on reviewing the proposed subdivision plan, Engineering Northwest PLLC recommends rear slope setback of 15-feet for lot 9 thru lot 14.

Engineering Northwest PLLC appreciates this opportunity to provide geotechnical services. Please call me at 360-931-3122 if you have any questions or need additional information.

References:

Fiksdal, A. J., 1975, Slope stability of Clark County, Washington: Washington Division of Geology and Earth Resources Open File Report 75-10, 4 p., 1 plate, scale 1:62,500.

[http://www.dnr.wa.gov/publications/ger_ofr75-10_slope_stability_clark_co_62k.pdf]

Mabey, Matthew A.; Madin, Ian P.; Palmer, Stephen P., 1994, Relative earthquake hazard map for the Vancouver, Washington, urban region: Washington Division of Geology and Earth Resources Geologic Map GM-42, 2 sheets, scale 1:24,000, with 5 p. text.

[http://www.dnr.wa.gov/publications/ger_gm42_eq_haz_urban_vancouver_24k.pdf]

Smith, Mackey, 1975, Earthquake hazards of Clark County, Washington: Washington Division of Geology and Earth Resources Open File Report 75-12, 2 p., 1 plate, scale 1:63,360.

[http://www.dnr.wa.gov/publications/ger_ofr75-12_earthquake_hazards_clark_co_62k.pdf]

Clark County GIS <http://gis.clark.wa.gov/mapsonline/?site=GeoHazards&ext=1>

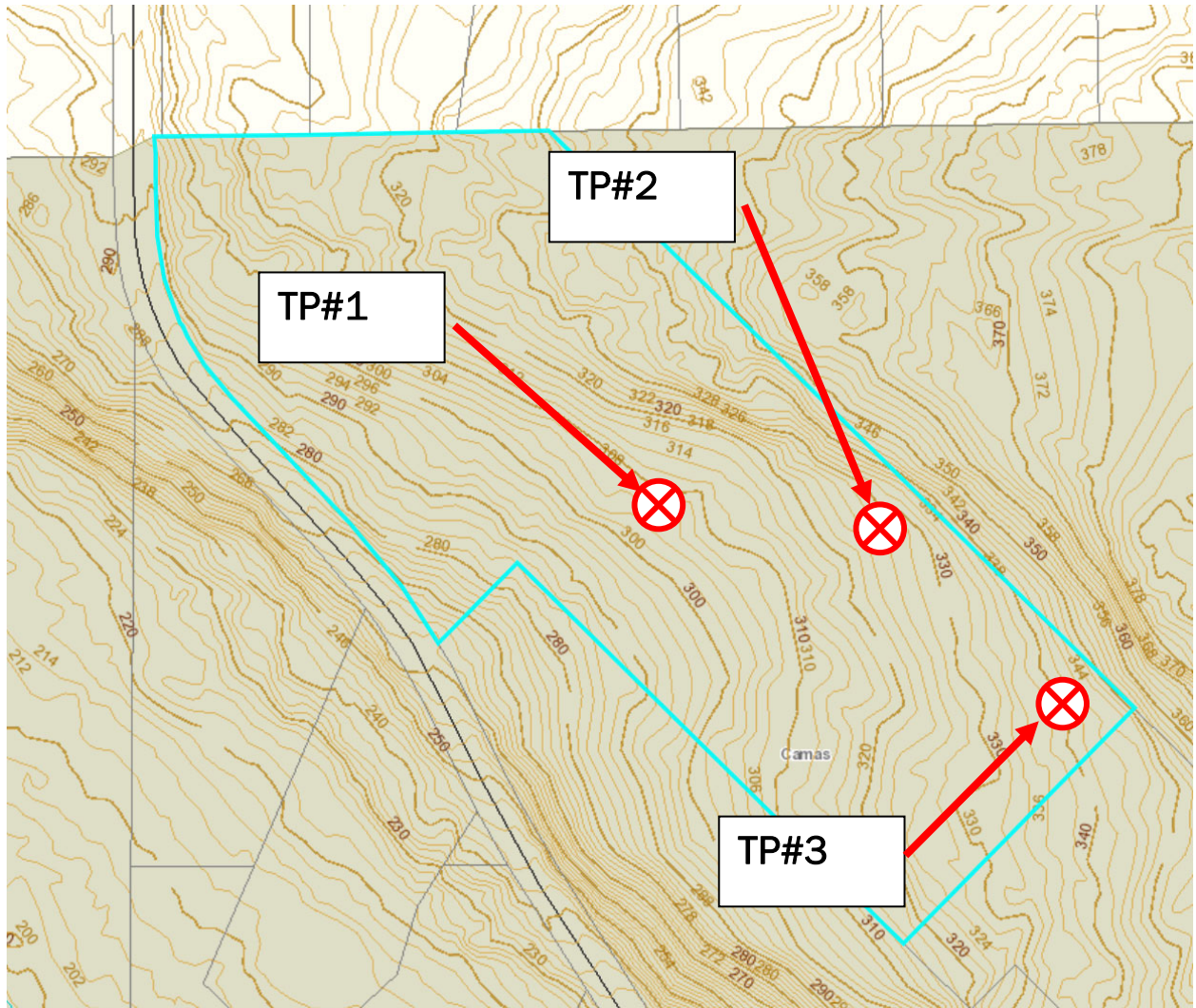
International Building Code (IBC), 2012, International Code Council.

The Washington State Geologic Portal (<https://fortress.wa.gov/dnr/geology/?Site=wigm>)

APPENDIX A

Soil Logs

Soil Log Location



LOG OF TEST PIT -1

Surface Elevation: 278
 Boring Date: 6/15/19
 Boring Location: 986043-773-000
 Dilling Method: Excavator

SOIL CLASSIFICATION

Depth	Remarks	COLOR	MOISTURE	MOISTURE CONTENT (%)	CONSISTENCY	Percent Pass	(ASHTO)	
0		Dark Brown	7	Stiff to	85	X	A-7	High organic content
5		Dark Brown	10	Very Stiff	65	■	A-7	Clay Loam
10								Clay Loam Large Rocks
15								No groundwater
20								
25								
30								
35								
END							Boring completed at and depth of about 6 feet below the ground surface.	

LOG OF BORING

ENGINEERING NORTHWEST

Hidden Ridge Estate
 Project No. 082021 Camas WA

Plate 1

LOG OF TEST PIT -2

Surface Elevation: 316
 Boring Date: 1/15/19
 Boring Location: 986043-773
 Dilling Method: Excavator

SOIL CLASSIFICATION

Depth	Remarks	COLOR	MOISTURE	MOISTURE CONTENT (%)	CONSISTENCY	Percent Pass	(ASHTO)	
0		Dark Brown		8	soft	80	X	High organic content
					to		■	Clay Loam with broken rock
5		Brown	Slightly Damp	12	Stiff	66	■	A-7
								Clay Loam Large Boulders
10		Brown & Red	Damp	18	Stiff			Clay with broken rock
								No groundwater
15								
20								
25								
30								
35								

END

Boring completed at and depth of about 10 feet below the ground surface.

LOG OF BORING

ENGINEERING NORTHWEST

Hidden Ridge Estate
 Project No. 082022 Camas WA

Plate 2

LOG OF TEST PIT -3

Surface Elevation: 340
 Boring Date: 1/15/19 Boring
 Location: 986043-773
 Dilling Method: Excavator

SOIL CLASSIFICATION

Depth	Remarks	COLOR	MOISTURE	MOISTURE CONTENT (%)	CONSISTENCY	Percent Pass	(ASHTO)	
0		Dark Brown		9	soft	82	X ■	A-7
5		Brown & Red	Damp	19	Stiff	72	X ■	
10		Brown & Red	Damp	21	Stiff			
15								
20								
25								
30								
35								

High organic content
 Clay Loam with large rock

Clay Loam Large Boulders

Clay Boulders
 No groundwater

END

Boring completed at and depth of about 10 feet below the ground surface.

LOG OF BORING

ENGINEERING NORTHWEST

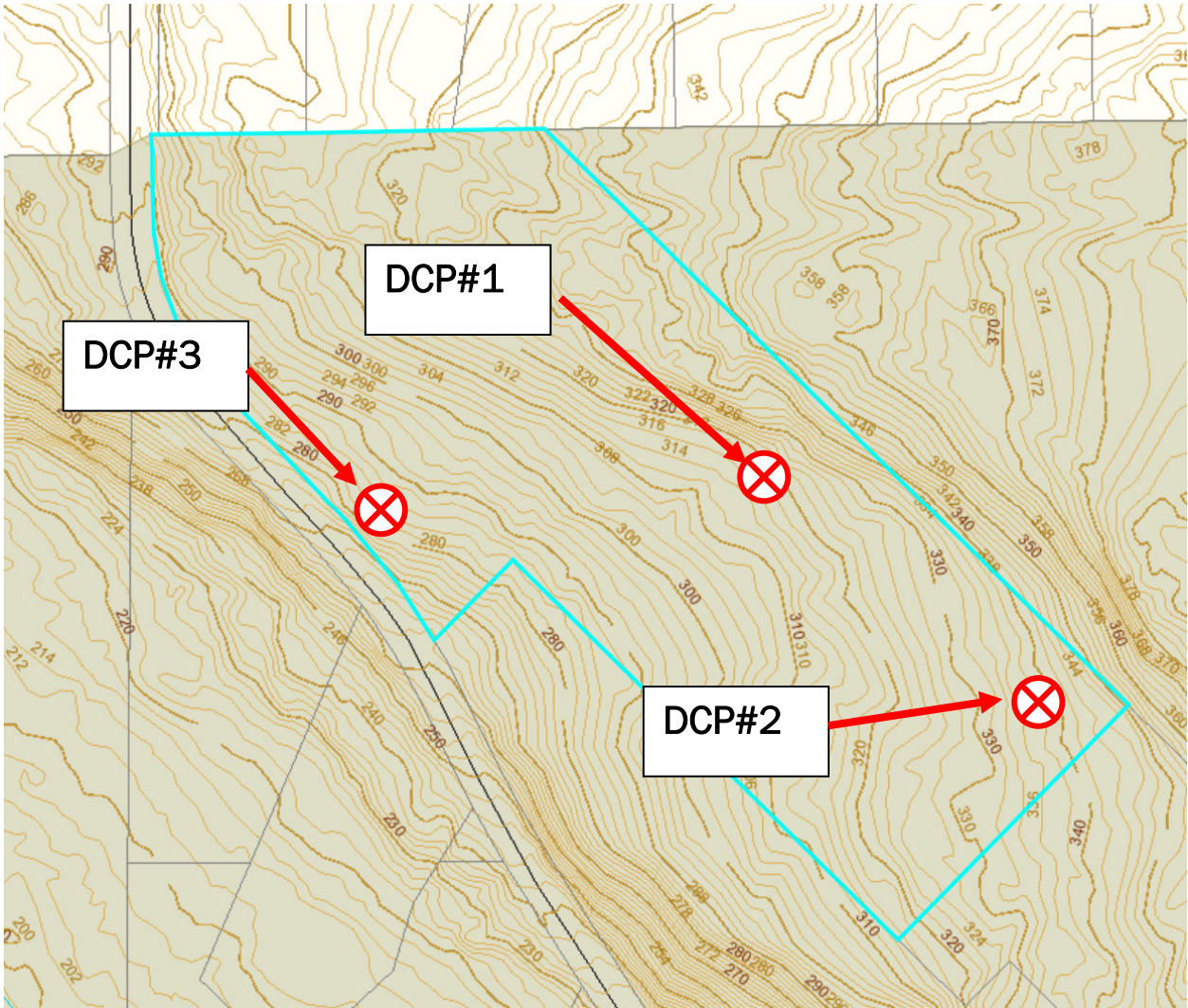
Hidden Ridge Estate
 Project No. 082022 Camas WA

Plate 3

APPENDIX B

DCP Results

DCP Test Location



APPENDIX C

Site Photos





PHOTO 1



PHOTO 2



PHOTO 3



PHOTO 4



PHOTO 5



PHOTO 6



PHOTO 7



PHOTO 8



PHOTO 9



PHOTO 10

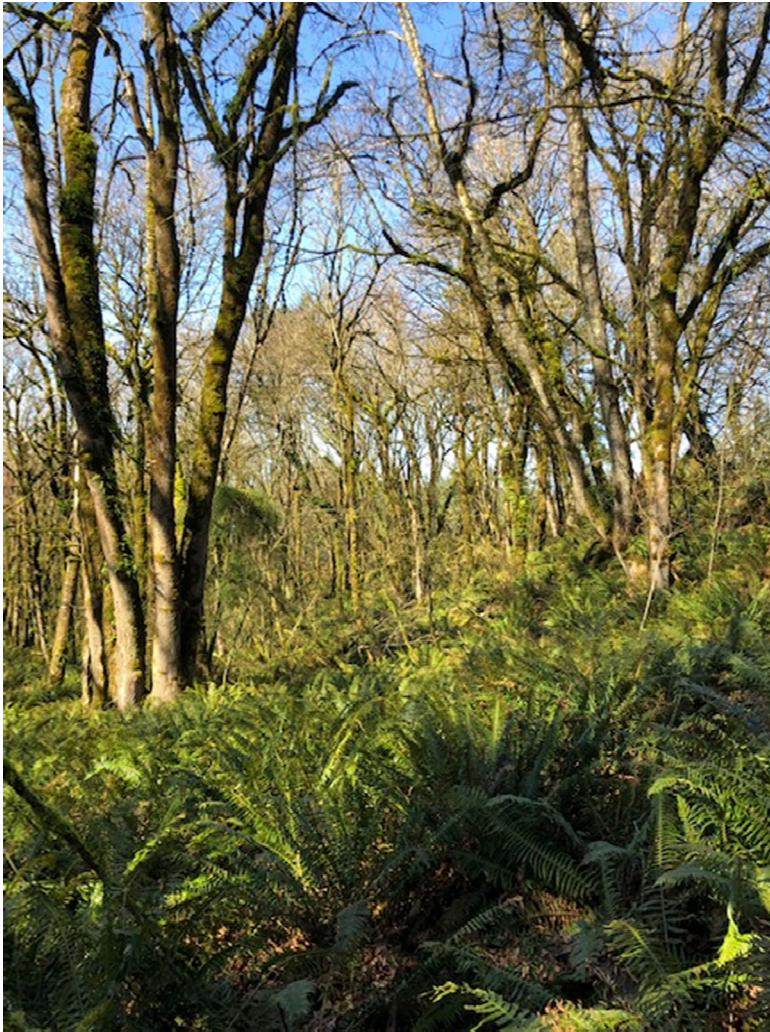


PHOTO 11



PHOTO 12



PHOTO 13



PHOTO 14



PHOTO 15



PHOTO 16



PHOTO 17

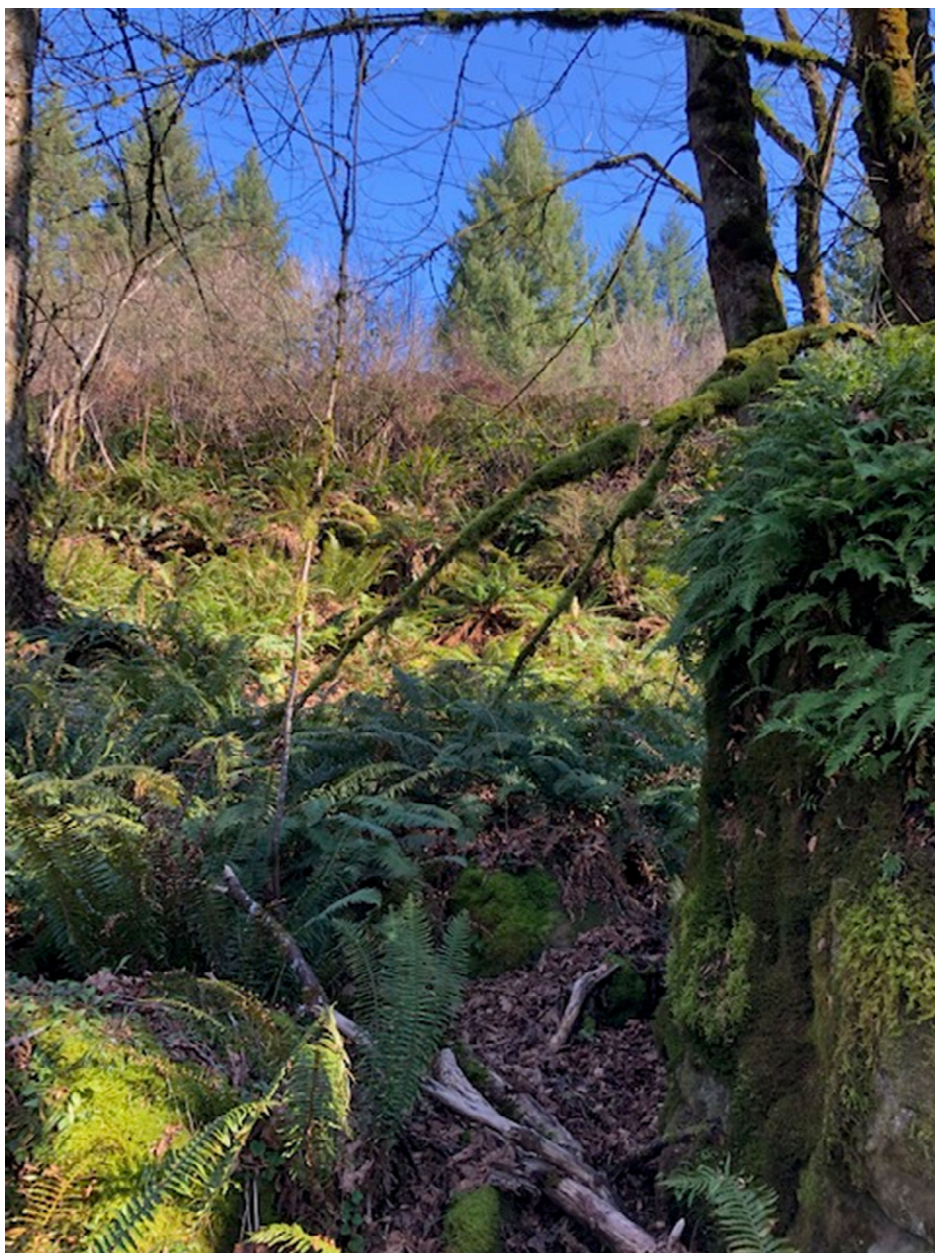


PHOTO 18



PHOTO 19



PHOTO 20



PHOTO 21



PHOTO 22



PHOTO 23



PHOTO 24