PFN - 04 112029 SD Received - 04/20/2004 Panther Lake Ridge

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# TARGETED DRAINAGE REPORT FOR PANTHER LAKE RIDGE SNOHOMISH COUNTY, WASHINGTON

PFN 04-112029 SD

April 20,



HARMSEN &



ANTICIPATEUNDERSTANDGUIDEDELIVER

# DRAINAGE INFORMATION SUMMARY

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# DRAINAGE INFORMATION SUMMARY FORM

Project Name: Cimarron West ZA or PFN: 04-\_ Project

Engineer: Scott Peterson, P.E.

Project Applicant: Tim Albers Project Total Area: 107.5 acres Project Development Area: 10.39 acres

Number of Lots: 32

#### SUMMARY TABLE

Drainage Basin Information		Individual Basin Designation I		
On-site Sub Basin Area (acres)		10.39		
Type of Storage Proposed		Wet Pond		
Approx. Storage Volume (cf)		36 590*`Live' Soil Types Tokul Pre-		
developed Runoff Rate O (cfs)	2 year	0.51		
	10 year	1.42		
Post Development Area	100 vear	2.72		
Post-developed Runoff Rate/Co	ontrolled Rate			
O (cfs)	2 year	2.62/0.25		
Offsite Upstream_Area	10	4 50 /1 00		
Number of Acres		N/A		
Offsite Downstream Flow				
O WS)	100 year	2.72**		

<sup>\*</sup> Includes 30% factor of safety for `live' storage.

<sup>\*\*</sup> Controlled 100 year release rate.

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#### **EXECUTIVE SUMMARY**

#### DRAINAGE PLAN DESCRIPTION

The drainage plan for this site will consist of collection, treatment and detention of the storm water runoff from the proposed roadways and roofs of future homes. The runoff will be collected and conveyed to the detention facility through the use of an asphalt thickened edge, catch basins and drainage pipe. A nutrient control wet pond will provide treatment for the storm water runoff. The detention pond combined with the flow control device will control the release of storm water runoff to 1/2 the existing 2 year rate and matching the existing 10 and 100 year WATER QUALITY

Water quality will be provided through the use of a nutrient control wet pond. The pond will be designed to provide the required dead storage equal to the runoff volume from the 6 month storm event as well as providing a wetland treatment cell per the Snohomish County Addendum to the Department of Ecology Manual (SCADOE).

#### DRAINAGE BASINS

The drainage basin consists of the area within the limits of development as other portions of the site will remain undisturbed. The basin includes all of Road A and Road B that access the site an proposed lots, the roof areas of the future residences, and lawn runoff that will be intercepted by the road drainage system.

DRAINAGE SYSTEM SKETCH See following page for sketch.

#### **DOWNSTREAM ANALYSIS**

Runoff from this site will drain to the large Category I wetland located west and downhill of the proposed lots. This wetland continues north and offsite. For additional information see the Downstream Analysis section of this report.

**UPSTREAM ANALYSIS** 

The proposed development is located on a ridge line. There is no upstream basin.

CIMARRON WEST PAGE 3 163RD AVE SE Z,  $\blacksquare$ 1" = 300' DRAINAGE SYSTEM

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#### **EXISTING SITE CONDITIONS**

#### **DESCRIPTION**

The proposed rural cluster subdivision comprises four parcels of land containing approximately 107.5 acres. The properties are currently undeveloped and can be accessed by 163<sup>rd</sup> Avenue SE, see Figure 1: Vicinity Map. The surrounding parcels are either undeveloped or contain single family residences. A Public Utility District (PUD) easement containing power transmission lines runs north/south along the west portion of the proposed development area.

The site is generally forested with both deciduous and conifer trees. There are Category I and III wetlands within and beyond the property boundary, as well as a Type IV stream. The proposed access road will impact a portion of the wetlands. Refer to the report prepared by Wetland Resources Inc for mitigation plans.

The proposed lots will be located on a ridge in the central portion of the development. This ridge contains multiple knolls and a large portion of the western slopes are considered critical slopes. These steep areas will be contained within NGPAE. There is an approximate 80 ft change in elevation between the ridge and the toe of slope, see Figure 2: Existing Conditions.

Existing drainage patterns for this basin consist of sheet and shallow flow to the existing wetlands. The wetlands drain to the north.

#### SOILS DESCRIPTION

According to SCS the underlying soil is Tokul gravelly loam. This moderately deep, moderately well drained soil is found on till plains and is formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of about 31 inches. According to the DOE Manual soils with a similar profile are in

#### RAINFALL DATA

The rainfall events used in the calculations are the SCS type IA distribution of the 24 hour rainfall event for the 6 month, 2, 10 and 100 year return periods. Total precipitation, taken from isopluvial maps of the Puget Sound region, is as follows:

Return Period	Rainfall
6 Month	1.22 inches (64% of the 2 year event)
2 Year	1.9 inches
10 Year	2.8 inches
100 Year	3.8 inches

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#### EXISTING BASIN

The existing drainage basin consists of the area that will be occupied by the proposed roadways, roof areas, and any lawn runoff that will be intercepted by the road drainage system. The roadways include the offsite road that will connect the proposed lots to to  $163r^d$  Avenue SE. The rest of the property will remain undisturbed. Time of concentration was calculated using a flowpath from the top of ridge to the Category I wetland to the east. For the purpose of this analysis, the existing conditions will be taken as undisturbed forested land The runoff rates and volumes are summarized below:

EXISTING CONDITIONS Basin area: 10.39 acres.

Return Period	Peak Rate(cfs) Volume(cf)			
2 Year	0.51	20,444		
10 Year	1.42	43,809		

For additional information see StorrnShedTM output in Appendix B.

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#### DEVELOPED SITE CONDITIONS

#### DESCRIPTION

The proposed development consists of 30' wide paved public roads that will connect 31 new single family residential lots to 163' Avenue SE. The length of road will be approximately 2,770 ft and terminate in a 40' radius cul de sac. There will be a temporary hammerhead turn around where the roads intersect, see Figure 3: Developed Conditions. Lot 32 is located in the southwest corner of the west parcel. This lot currently contains an existing residence. There is no proposed development activity for Lot 32 and it is excluded from drainage calculations. Impervious lot coverage is considered to be 4,000 sf each.

A detention pond will be constructed north of proposed Road A, adjacent to the wetland buffer on the west side of the main wetland/stream system. This pond will provide for water quality and streambank erosion control using a flow restriction structure. Discharge from the pond will occur at the edge of the Category I wetland east of the new lots. Point discharge will be minimized by utilizing a level spreader in the design.

There is the possibility that high ground water may be present on the site due to the wetland location. However, the pond excavation and storm drain system will be above the elevation of the wetland so interception of the groundwater is not expected. Therefore no increase in detention is proposed for intercepted ground water.

A wetland mitigation plan has been prepared for this development and addresses the impacts to the sensitive areas on site. Refer to the wetland mitigation report included in Section 8 of this report.

DEVELOPED BASIN Basin Area: 10.39 acres.

Return Period	Peak Rate(c	fs) Volume(cfl
6 Month	1.32	23,257
2 Year	2.62	45,299

For additional information see StormShedtm output in Appendix **B.** 

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#### PROPOSED DRAINAGE SYSTEM

#### **RUNOFF TREATMENT BMP'S**

BMP RD.06, Extended Detention Wet Pond (Nutrient Control) as modified by Snohomish County Addendum to the DOE Manual, September 21, 1998.

Runoff from the site will be treated by the use of "dead" storage in the detention facility. The required "dead" storage is the developed runoff volume from the 6 month storm event. The analysis of the 6 month storm runoff volume is 23,600 cubic feet. The detention facility will be split into two cells with an open water cell for settlement of suspended solids and a wetland treatment cell for nutrient control.

#### TREATMENT POND VOLUMES

Required "Dead" Storage Volume	24,257 cf
Depth of Open Water Cell	<b>4.5</b> feet

Volume of Open Water Cell 25,400 cf

Depth of Wetland Treatment Cell 2.0 feet

### STREAM BANK EROSION CONTROL BMP'S

BMP RD.06, Wet Pond (Nutrient Control) as modified by Snohomish County Addendum to the DOE Manual, September 21, 1998.

Streambank erosion control will be accomplished through the use of a detention pond. This detention pond has been sized to contain the 100 year storm with a preliminary design volume of 31,800 cf including a 30% factor of safety applied without changing depth. The factor of safety has been applied by decreasing the pond surface areas prior to inputting into the Stormshedtm software. A minimum of 1.5 foot of freeboard will be provided above the 100 year storage elevation. The pond will have 3:1 interior sides slopes. Slopes outside of the pond freeboard will be at 2:1. A 4 ft bench will be constructed where slope transitions are necessary. The outfall of the pond is to the Category I wetland to the east. A level spreader will be incorporated into the design to minimize point discharge effects.

An emergency overflow will allow a second safe point for discharge of storm runoff in excess of the 100 year event. It will discharge to the wetland buffer. It will be constructed with an overflow elevation 0.5 feet above the 100 year peak pond elevation. The rip rap rock lining will be grouted solid below the overflow elevation to prevent the release of stormwater below the overflow elevation. The emergency overflow is sized as follows:

$$L = (Q100 \ / \ (3.21 \ H \ 3/2)) \ - \ (2.4H^2) \ ; \ 6' \ minimum \\ with \ Q_{100} = 6.71 \ cfs, \ H = 0.5' \\ L = 6'$$

**Emergency Overflow Elevation = 459.20** 

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The flow control device will provide detention of the 2 year event to % the existing 2 year rate and match the existing rates for the 10 and 100 year events. The flow control information is as follows:

2 Year Orifice Size 2-5/16 inch

2 Year Orifice Elevation 453.50 feet

Notch Length 1.88 feet

Notch Elevation 458.46 feet

The allowable release rates using this flow control are as follows:

Storm Event	Allowable Release	Actual Release
2 Year	0.25 cfs	0.25 cfs
10 Year	1.42 cfs	1.00 cfs
100 Year	2.72 cfs	2.72 cfs

For additional pond storage, discharge and level pool information see StormShedTM output in Appendix B.

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#### EROSION CONTROL RISK ASSESSMENT

#### PROJECT DESCRIPTION

The proposed development is a rural cluster subdivision that will create 32 lots Most of the 107.5 acres of the project will be placed into Tracts, NGPA, and NGPAE. A proposed 30' public road system will provide access to the lots from 163<sup>rd</sup> Avenue SE. Stormwater will be conveyed to a nutrient control wet pond before being discharged to the Category I wetland east of the proposed lots. The wet pond will provide water quality and quantity controls.

#### **EROSION-POTENTIAL IMPACTS**

#### **SLOPE**

A topographic map of the development area of the site shows an elevation change of approximately 80' from toe of slope to ridge line. There are steep slopes on the west side of the ridge that will be placed into NGPAE on the lots. These slopes will remain undisturbed.

The site is currently undeveloped with a ground covering of various deciduous and coniferous trees and brush.

#### **SOIL TYPE**

According to SCS the underlying soil is Tokul gravelly loam. This moderately deep, moderately well drained soil is found on till plains and is formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of about 31 inches. According to the DOE Manual soils with a similar profile are in hydrologic group C.

#### RISK OF WINTER EROSION

Disturbed soils during the winter months will increase the threat of erosion. Any winter grading will require specific approval from Snohomish County.

#### **CRITICAL AREAS**

There are Category I and III wetlands located both on and beyond the site. A Type IV stream is associated with the Category I wetland east of the ridge. The proposed roadway has been designed to minimize impacts to the wetlands while creating a workable layout. The existing culverted stream crossing location will be used as well as utilizing the old railroad bed area. However wetland and stream impacts will occur at the stream crossing for construction of the wider roadway and buffer impacts for construction of the roadway between two of the smaller wetlands on the site.

A critical area study and wetland mitigation plan has been prepared by Wetland Resources Inc. A copy of this report can be found in Section 8.

#### FISH BEARING STREAMS

There are no fish bearing streams on the site or immediately downstream of the site. The Critical Areas Study by Wetland Resources indicates that fish are not present in the wetland/stream corridor.

#### SLIDE/GROUND MOVEMENT

No evidence has been seen to indicate that the ground is unstable or that any past large scale land movement has occured.

#### SOURCES OF WATER

The source of water that will cause erosion is direct rainfall. The potential for erosion from rainfall will be minimized by use of BMPs and minimizing exposure time of bare earth by weather responsive construction scheduling. The wetlands and the storm water conveyed through them will be protected by establishment of the required 100 and 50 foot buffers and managed clearing limits.

#### MEASURES TO PREVENT/MINIMIZE EROSION

There are several measures proposed to protect/minimize the site and the downstream system from the hazard of soil erosion.

- An erosion control plan will be prepared as part of the construction drawing permit. This plan will detail BMP's acceptable for this development A list of BMP's and their uses is provided in the next section.
- Runoff from the roadway will be directed to sedimentation pond via the storm drain system once it is installed. This pond will detain the runoff allowing sediment to settle out prior to discharge. The sediment pond will be converted to the wet pond once the site is stabilized.
- The roadway construction and detention pond excavations are the areas of greatest exposure and will be protected by use of filtration fence and ground cover as indicated above.
- It is expected that the construction will take place during the dry weather time of the year. Special provisions will be provided for wet season construction.

#### **CONCLUSION**

A temporary erosion control plan will be prepared as part of the construction drawing approval by the County and when implemented by the contractor should minimize the risk of erosion. Following is discussion of the SWPPP required elements and a list the erosion control BMP's to be used on this site and a description of the protection each one provides. There is nothing on this site to preclude an erosion control system that meets the requirements of 24.30.020.

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### PROPOSED EROSION CONTROL BMP'S

An erosion control plan will be prepared for this project as part of the construction drawings. The plan will include several of the following erosion control Best Management Practices:

BMP E1.10, Temporary Seeding of Stripped Areas:

Temporary seeding of topsoil stockpiles and other stripped areas may be necessary during construction.

BMP E1.15, Mulching and Matting:

During construction, mulch can be placed to prevent raindrops from impacting exposed soils causing erosion. Straw is the most common method of mulching.

BMP E1.20, Clear Plastic Covering:

This involves covering a bare area with clear plastic that protects the immediate area to the detriment of downstream areas. This BMP will be used on this site only if required for immediate site protection.

BMP E1.25, Preserving Natural Vegetation:

The wetland areas will be protected by a mitigated buffer of native or enhancement of the existing vegetation. Where possible other areas of the native vegetation will be maintained for cover and runoff treatment.

BMP E1.30, Buffer Zones:

A buffer is required to protect the wetland areas on the site. This buffer will be established in the field prior to any clearing or grading activities. BMP E1.35, Permanent Seeding and Planting:

The exposed surfaces will be seeded or landscaped when construction is completed. BMP E1.45, Topsoiling:

Topsoil may be reserved for landscape usage to promote the health of new vegetation. BMP E2.10, Stabilized Construction Entrance and Tire Wash:

A construction entrance will be installed off of 163<sup>rd</sup> Avenue SE.

BMP E2.20, Dust Control:

Dust control will be used on this site during constriction activities when dry weather causes loose soil to be transported by the wind. The soil will be moistened to hold down the dust. BMP E2.70, Outlet Protection:

Riprap will be used to protect every storm drainage outlet, as applicable. This will prevert concentrated runoff from eroding the existing soils by dissipating energy.

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#### BMP EM 0, Filter Fabric:

Filter fabric fencing will be used along wetland buffer corridors, and downhill of grading activities where insufficient existing vegetation exists to filter the runoff. BMP E3.30, Storm Drain Inlet Protection:

There are no existing storm inlets near the construction area. New catch basins will have temproary filtering devices installed until the site is permanently stabilized. BMP E3.40, Temporary Sediment Pond:

The proposed detention pond will be temporarily used as a sediment pond during construction.

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# **UPSTREAM ANALYSIS**

There is no upstream basin tributary to the road system or subdivision that will be collected by the proposed storm drainage system. The primary development is along a ridge line.

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#### **DOWNSTREAM ANALYSIS**

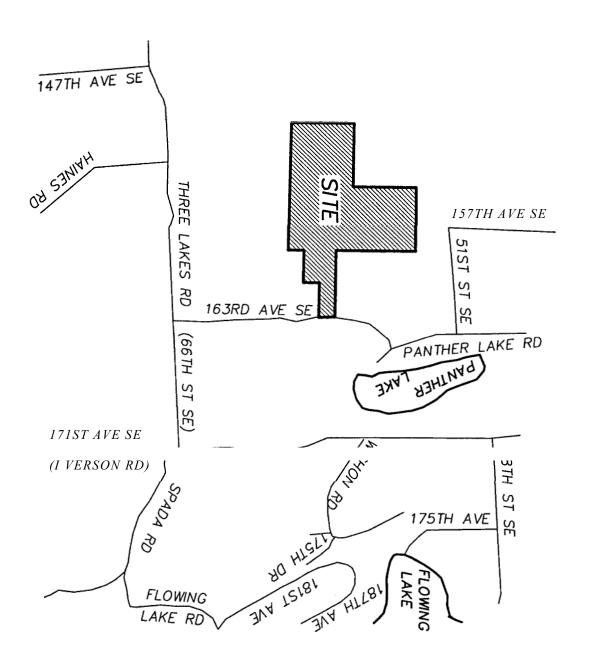
Stormwater runoff from the site will be discharged at the edge of the Category I wetland directly east of the proposed pond. This wetland does not contain a canopy of trees, but is mostly open with dense shrub cover consisting mainly of salmonberry and vine maple. Horsetail, skunk cabbage and reed canary grass can be found as well. This wetland is extensive and continues off the site to the north for more than a <sup>1</sup>/<sub>14</sub> mile. Refer to the Downstream Analysis Map and Aerial Image in the Figures & Basin Maps section of this report, as well as Appendix C for downstream photographs.

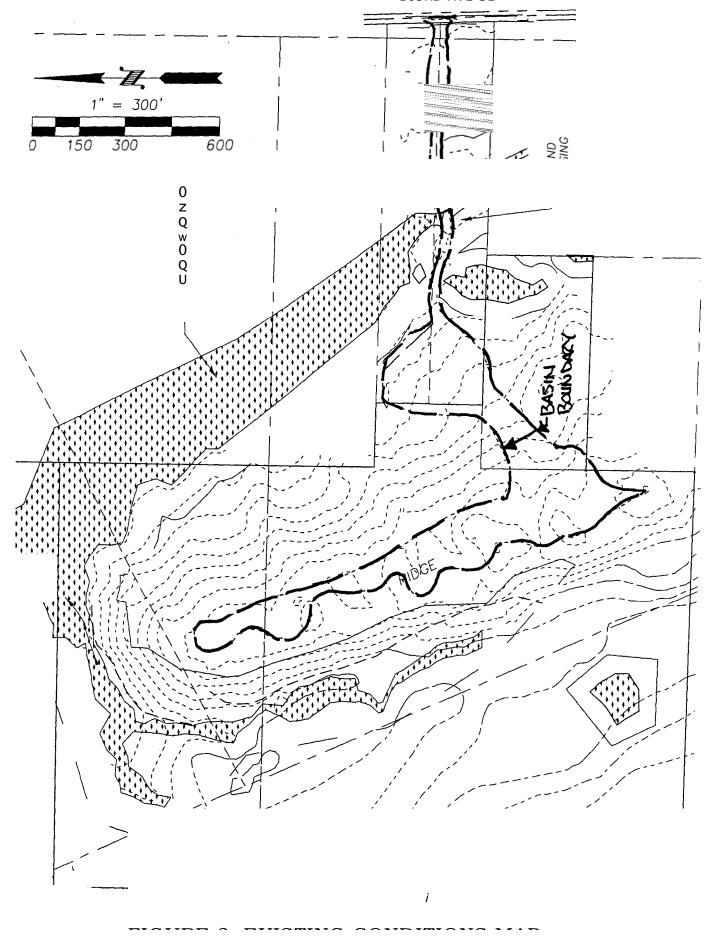
CIMARRON WEST PAGE 15

# **GEOTECHNIC**AL OR OTHER REPORTS

A Critical Areas Study and Wetlands Mitigation Report has been prepared for this site by Wetland Resources Inc. The report details the existing stream and wetland on the site and includes the proposed wetland mitigation for the site. For more spedfic information see the report.

# FIGURES & BASIN





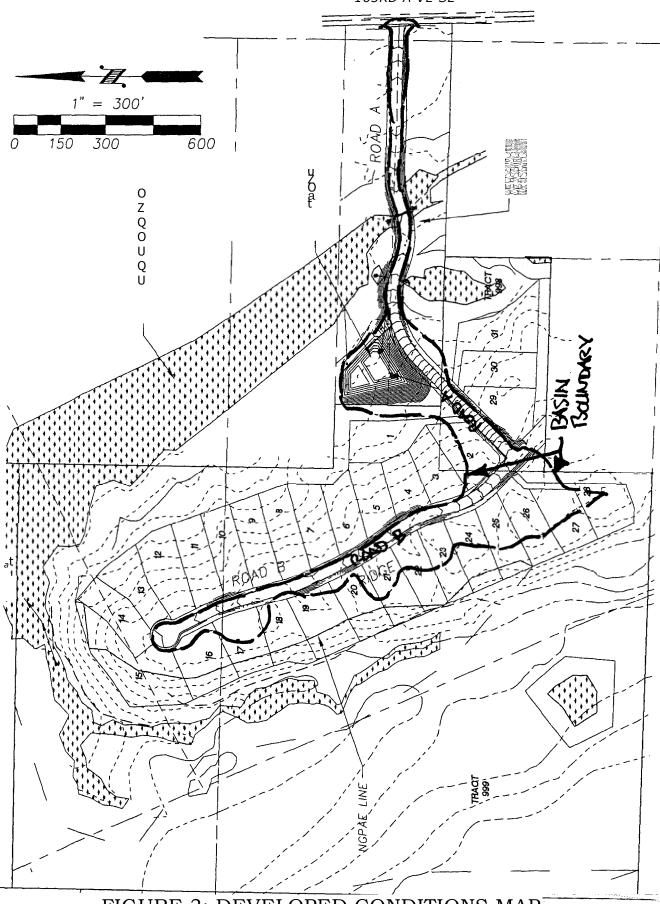


FIGURE 3: DEVELOPED CONDITIONS MAP

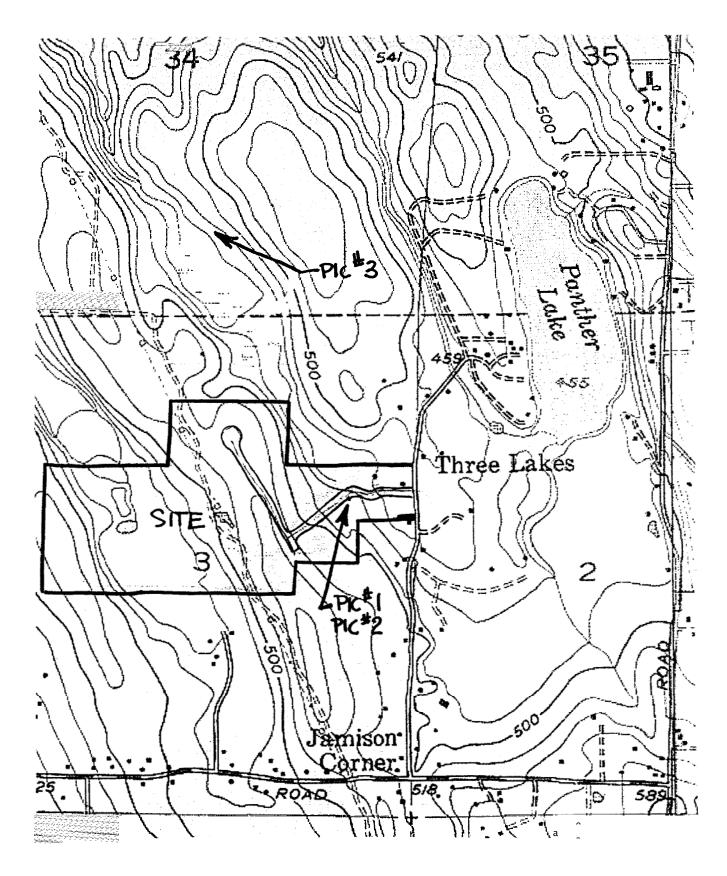
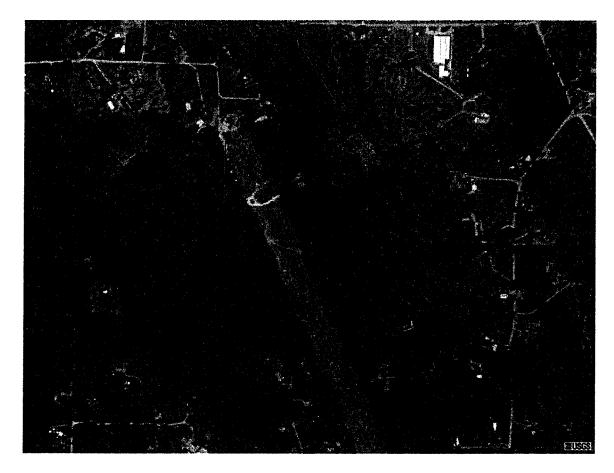
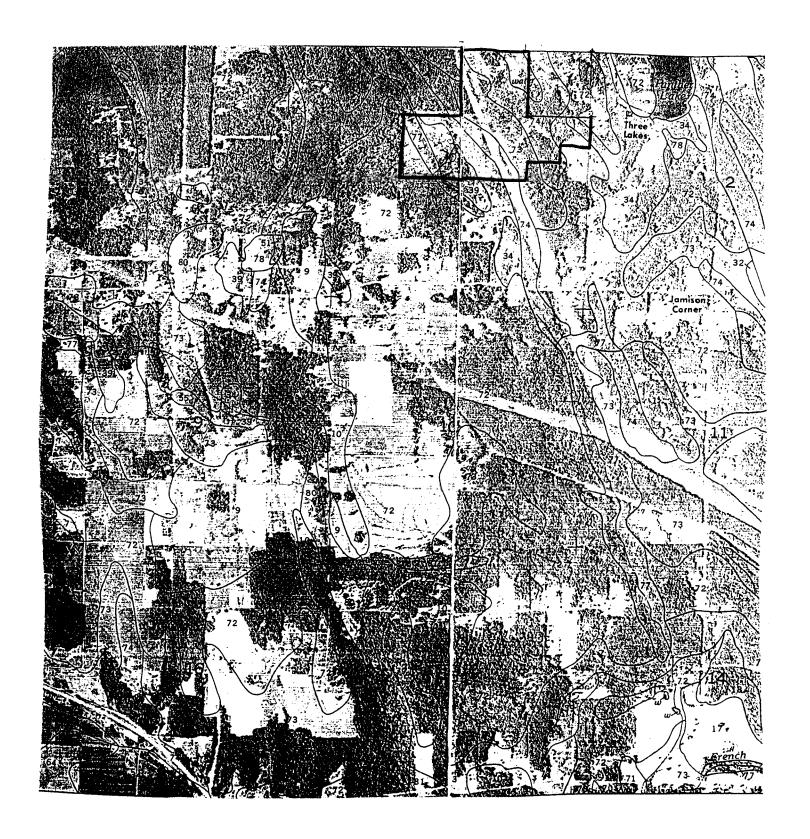


FIGURE 4: DOWNSTREAM ANALYSIS MAP



Map shows approximate site boundary and downstream flowpath

# APPENDIX A SCS SOILS MAP &



SCS SOILS MAP

72-Tokul gravelly loam, 0 to 8 percent slopes. This moderately deep, moderately well drained soil is on till plains. It formed in glacial till and volcanic ash. Areas are long and narrow and are oriented from northwest to southeast. They are 40 to 100 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam

about 9 inches thick. A hardpan is at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is cobbly loam or the soil does not have a hardpan but is underlain by compact glacial till at a depth of 20 to 40 inches.

Included in this unit are areas of soils that have slopes of more than 8 percent, McKenna and Norma soils in depressional areas along drainageways on till plains, Terric Medisaprists in depressional areas on till plains, Winston and Pastik soils on terraces and outwash plains, and Ragnar soils on outwash plains. Included areas make up about 25 percent of the total acreage.

Permeability of this Tokul soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used for urban development and for hay and pasture. Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet per acre for Douglas-fir at age 60 and 266 cubic feet per acre for western hemlock at age 50.

Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, red huckleberry, salal, and trailing blackberry.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the **soil** in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Brush competition is the main limitation in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and natural reforestation by western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the hardpan, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitations for hay and pasture are wetness and the death to the hardnan, which reduces the yield of deep-rooted plants. Excess water can be removed by open ditches or tile drains. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime. In some years supplemental irrigation is needed. Small stones may interfere with tillage operations. Subsoiling may be effective in breaking through the hardpan.

The main limitation for homesites is wetness, which can be reduced by installing drain tile around footings. The main limitations for septic tank absorption fields are the depth to the hardpan and wetness. Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

This map unit is in capability subclass Ille.

73-Tokul gravelly loam, 8 to 15 percent.slopes. This moderately deep, moderately well drained soil is on till plains. It formed in glacial till and volcanic ash. Areas are oriented from northwest to southeast and are 40 to 100 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is cobbly or the soil does not have a hardpan but is underlain by compact glacial till at a depth of 20 to 40 inches.

Included in this unit are small areas of Pastik and Winston soils on terraces and outwash plains; Nargar soils on high terraces, terrace escarpments, and outwash plains; and Ragnar soils on outwash plains. Included areas make up about 25 percent of the total acreage.

Permeability of this Tokul soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used for homesite development and for hay and pasture. Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet per acre for Douglas-fir at age 60 and 266 cubic feet per acre for western hemlock at age 50.

Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, red

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and natural reforestation by western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the hardpan, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This unit is suited to hay and pasture. The main limitations are wetness because of the seasonal perched water table and depth to the hardpan, which reduces the yield of deeprooted plants. Excess water can be removed by open ditches or tile drains. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime. In some years supplemental irrigation is needed. Small stones may interfere with tillage. Subsoiling may be effective in breaking through the hardpan.

The main limitation for homesites is the seasonal perched water table. Wetness can be reduced by installing drain tile around footings.

The main limitations for septic tank absorption fields are the depth to the hardpan and wetness. Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

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74-Tokul gravelly loam, 15 to 25 percent slopes. This moderately deep, moderately well drained soil is on till plains. If formed in glacial till and volcanic ash. Areas are oriented from northwest to southeast and are 40 to 100 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

**Typically,** the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is cobbly or the soil does not have a hardpan but is underlain by compact glacial till at a depth of 20 to 40 inches.

Included in this unit are areas of McKenna and Norma soils in depressional areas along drainageways on till plains, Terric Medisaprists in depressional areas on till plains, Winston and Pastik soils on terraces and outwash plains, and Ragnar soils on outwash plains. Included areas make up about 25 percent of the total acreage.

Permeability of this Tokul soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It is also used for homesite development.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet per acre for Douglas-fir at age 60 and 266 cubic feet per acre for western hemlock at age 50.

Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common forest understory plants are western swordfern, brackenfern, red huckleberry, salal, and trailing blackberry.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and that of western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the hardpan, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitation for homesites is the seasonal high water table. Wetness can be reduced by installing drain tile around footings. The main limitations for septic tank absorption fields are steepness of slope, wetness, and depth to the hardpan. Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall because of the pan. Access roads must be designed to control surface runoff and help stabilize cut slopes.

This map unit is in capability subclass IVe.

# APPENDIX B STORMSHED

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# **EXISTING CONDITIONS** EXISTING 415-04 Event Summary:

BasinID 	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Area ac	Method /Loss	Raintype	Event 2 vr
EXISTING 4-15-04	Ò.51 <sup>´</sup>	8.67´	0.4693	10.39	SBUH/SCS	ITFEIA	∠ yı
EXISTING 4-15-04	1.42	8.50	1.0057	10.39	SBUH/SCS	TYPE1A	10 yr
<b>EXISTING 4-15-04</b>	2.72	8.17	1.6921	10.39	SBUH/SCS	TYPE1A	100 yr

#### **Drainage Area: EXISTING 415-04**

Hyd Method: SBUH Hyd Loss Method: SCS CN Number

Peak Factor: 484.00 SCS Abs: 0.20 Storm Dur: 24.00 hrs Intv: 10.00 min

Area CN TC
Pervious 10.3890 ac 81.00 0.71 hrs
Impervious 0.0000 ac 0.00 0.00 hrs

Total 10.3890 ac Supporting Data: **Pervious CN Data:** 

FOREST 81.00 10.3890 ac

Pervious TC Data:

Flow type: Description:

Sheet FOREST

Shallow FOREST

Length: Slope: Coeff: Travel Time
300.00 ft 11.50% 0.4000 33.34 min
570.00 ft 11.50% 3.0000 9.34 min

# **DEVELOPED CONDITIONS** DEVELOPED 415-04 Event Summary:

BasinID 	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Area ac -	Method /Loss	Raintype	Event 2 vr
DEVELOPED 4-15-04	2.62	8.00	1.0399	10.39	SBUH/SCS		Z yı
DEVELOPED 4-15-04	4.50	8.00	1.7339	10.39	SBUH/SCS	TYPEIA	10 yr
DEVELOPED 4-15-04	6.71	8.00	2.5405	10.39	SBUH/SCS	TYPEIA	100 yr

#### Drainage Area: DEVELOPED 415-04

Hvd Method: SBUH Hvd Loss Method: SCS CN Number

Peak Factor: 484.00 SCS Abs: 0.20 Storm Dur: 24.00 hrs Intv: 10.00 min

TC Area CN Pervious 5.4650 ac 86.00 0.21 hrs Impervious 4.9240 ac 98.00 0.21 hrs

10.3890 ac Total

Supporting Data: Pervious CN Data:

ROAD SLOPES/LAWNS 86.00

5.4650 ac Impervious CN Data: 2.572 2.3520 ac ac **ROAD 98.00** 98.00

LOT IMPERVIOUS(4000SF EACH)

Pervious TC Data: Flow type: Description: Coeff: **Travel Time** Length: Slope: Sheet GRASS 50.00 ft 33.00% 0.1500 2.32 min Channel THICKENED EDGE/PIPE 1800.00 ft 0.50% 42.0000 10.10 min

Impervious TC Data:

Flow type: Description: Length: Slope: Coeff: Travel Time **Sheet GRASS** 2.32 min 50.00 ft 33.00% 0.1500 Channel THICKENED EDGE/PIPE 1800.00 ft 0.50% 42.0000 10.10 min

### PRELIMINARY POND DESIGN - Node ID:

Desc: WET POND

Start El: 100.0000 ft Max El: 106.5000 ft

Contrib Basin: Contrib Hyd: Storage Id: POND 4-15-04 Discharge COMBO 4-15-04

Node ID: POND 415-04 Desc: WET POND

Start El:100.0000 ft Max El: 106.5000 ft

Contri Basin: Contrib Hyd:

Stage Input Volume Volume 100.00 0.00 cf 0.00 cf 0.0000 acft 100.50 4593.00 cf 4593.00 cf 0.1054 acft 102.50 25836.00 cf 25836.00 cf 0.5931 acft 104.50 47351.00 cf 47351.00 cf 1.0870 acft 106.50 78811.00 cf 1.8093 acft 78811.00 cf

# Control Structure ID: COMBO 415-04 - Combination Control Structure

Descrip: COMBINATION Start El Max El Increment 100.0000 ft 108.0000 ft

0.10

ID List: ORIFICE 4-15-04 NOTCH 4-15-04

Descrip: Multiple Orifice

Start El Max El Increment 100.0000 ft 108.0000 ft 0.10

Orif Coeff: 0.62 Bottom El: 98.00 ft

Lowest Diam: 2.3125 in

#### Control Structure ID: NOTCH 415-04 - Rectangular weir

Start El Max El Increment 102.9600 ft 105.0000 ft 0.10

Lenath: 1 8800 ft

#### RLPCOMPUTE [POND RLP 4-15-04] SUMMARY

2 yr Match Q: 0.2546 cfs Peak Out Q: 0.2497 cfs - Peak Stg: 102.96 ft - Active Vol: 0.71 acft

10 vr Match O: 1 4180 cfs Peak Out O: 1 0046 cfs - Peak Sto: 103 21 ft - Δctive Vol: 0.77 acft

# APPENDIX C DOWNSTREAM PHOTOGRAPHS



#### PIC # 1

Looking south along the stream adjacent and west of 163r<sup>d</sup> where it crossed the Cimarron project roadway through a 36 inch Corrugated



#### PIC #2

Looking north along the stream adjacent and west of 163<sup>rd</sup> from where it crossed the Cimarron project roadway through a 36 inch Corrugated metal pipe. The wetland corridor



#### PIC #3

Looking westerly at 51" Street SE and 157th Avenue SE. The Category I wetland can be