Report of Geological Engineering Services
Chen/Scarsella Proposed Harvest Unit
Potentially Unstable Slopes and Landforms Evaluation
Section 36, Township 22 North, Range 2 East
Vashon Island, King County, Washington

September 20, 2016
ICE File No. 1212-001

Prepared For:
Eric Chen and Tony Scarsella

Prepared By:
Icicle Creek Engineers, Inc.

ICICLECREEK ENGINEERS
Geotechnical Geologic Hydrogeologic Environmental

September 20, 2016

Eric Chen
2444 109th Place NE
Bellevue, Washington 98004

Tony Scarsella
Scarsella Cutting & Logging
P.O. Box 452
Onalaska, Washington 98570

Report
Geological Engineering Services
Chen Proposed Harvest Unit – Phase 2
Potentially Unstable Slopes and Landforms Evaluation
Section 36, Township 22 North, Range 2 East
Vashon Island King County, Washington
ICE File No. 1212-001

1.0 INTRODUCTION

This report presents the results of Icicle Creek Engineers' (ICE's) geological engineering services for an evaluation of potentially unstable slopes and landforms related to the harvest of mature trees from an approximately 192-acre area on Vashon Island in King County, Washington. The property consists of several legal tax parcels that are located in the southeast part of Vashon Island within Section 36, Township 22 North, Range 2 East, Willamette Meridian. In this report, the proposed timber harvest is referred to as Chen/Scarsella Proposed Harvest Unit (PHU). The location of the Chen/Scarsella PHU is shown relative to nearby physical features on the Vicinity Map, Figure 1. The harvest plan for the Chen/Scarsella PHU is shown on the Activity Map, Figure 2.

The Chen/Scarsella PHU is situated along the southeast side of Vashon Island and includes an upland nearly-level area in the west part of the property and a hillside that descends to Puget Sound in the east part of the property. Chen Creek crosses the property from west to east.

This report was prepared by Brian R. Beaman, PE, LEG, LHG of ICE. Mr. Beaman is a "Qualified Expert" (DNR – Qualified Experts List, Engineering Geologist License No. 671) as described in WAC 222-10-030(5) SEPA Policies for Potentially Unstable Slopes and Landforms.

The Chen/Scarsella PHU contains conditions that are consistent with Forest Practices Board Manual WAC 222-16-050 (1)(d)(C) *Groundwater recharge areas for glacial deep-seated landslides.* These conditions are consistent with triggering a Class IV-Special Forest Practices Application (FPA), which requires a geotechnical report to address WAC 222-10-030 (1)(a,b,c).

On August 4, 2016, Mr. Beaman attended a pre-application meeting with representatives from the DNR (Jason Sharp and Martin Eversaul) and the Chen/Scarsella project team (John Breithaupt, Tony Scarsella and Kyle Stutesman). The purpose of this meeting was to allow the DNR to complete a preliminary review of site conditions and to discuss a potentially workable harvest plan. The primary concern of the meeting was the upland part of the Chen/Scarsella PHU which may be considered a *groundwater recharge area for glacial deep-seated landslides* and requires a geological report. This report by ICE is intended to describe these conditions related to groundwater recharge and mitigation, as appropriate.

2.0 CHEN/SCARSELLA PHU DESCRIPTION

Based on the results of the August 4, 2016 pre-application meeting and subsequent planning by the Chen/Scarsella team, a timber harvest plan was developed to include three harvest areas referred to as Units 1, 2 and 3 as shown on Figure 2. Units 1 and 2 (30 acres each) will occur in the nearly-level upland area as variable density thinning (50 percent average harvest) using ground-based equipment. The leave trees per acre on Units 1 and 2 will be 70 to 100 per acre. Unit 3 (40 acres) will occur in the southeast part of the property as a clear-cut (even-age harvest) in steeper terrain where tower/cable methods will be the primary method of timber harvest. Two short haul roads connecting to yarding roads along with three landings will be constructed for the logging activity within Units 1 and 2 as shown on Figure 2. The yarding roads will be decommissioned upon harvest completion by using a ripper to loosen surficial soils that had been compacted by truck traffic. The southern-most designated yarding road will be ditched and water-barred every 100 feet to reduce the risk of erosion.

3.0 BACKGROUND INFORMATION

For the purpose of this study, ICE reviewed the following documents.

- Chen/Scarsella, undated (received by ICE on August 1, 2016 from John Breithaupt of Matrix & Associates, LLC.
- DNR, May 2016, *Forest Practices Board Manual, Section 16, Guidelines for Evaluating Potentially Unstable Slopes and Landforms*, http://file.dnr.wa.gov/publications/bc_fpb_manual_section16.pdf, 93 pages.
- DNR, October 8, 2013, *Chapter 222-16 WAC, Definitions.*
- DNR, February 26, 2015, *Chapter 222-10 WAC, State Environmental Policy Act Guidelines.*
- DNR, Geologic Information Portal, http://www.dnr.wa.gov/geologyportal.
- Freeze R.A. and Cherry, J.A., 1979, Groundwater, 604 pages.
- Google Earth, 1990, 2002 and 2015 aerial photographs.
- J.R. Carr / Associates, December 1, 1983, Vashon/Maury Island Water Resources Study, http://your.kingcounty.gov/dnrp/library/water-and-land/groundwater/VMI_water_resources_study_1983.pdf, prepared for King County Department of Planning and Community Development Planning Division, 234 pages.
- King County iMAP, http://www.kingcounty.gov/operations/GIS/Maps/iMAP.aspx, **L**ight **D**etection **a**nd **R**anging (LiDAR) imagery; 1936 aerial photograph and 5-foot contour interval topographic plan.
- DHI Water and Environmental, October 2009, *Vashon-Maury Island Hydrologic Modelling Technical Report*, for King County, 88 pages, http://your.kingcounty.gov/dnrp/library/2009/kcr2080.pdf, prepared for King County Water and Land Services.
- Puget Sound LiDAR Consortium (PSLC), LiDAR raw data; ArcGIS topographic contour and slope mapping, http://pugetsoundlidar.ess.washington.edu/lidardata/.

- US Department of Agriculture (USDA) National Resources Conservation Service (NRCS – formerly the Soil Conservation Service) (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx).
- USGS (prepared by Savage, W.Z., Morrissey, M.M. and Baum, R.L.), 2000, *Geotechnical Properties for Landslide-Prone Seattle Area Glacial Deposits*, Open File Report 00-228.
- USGS, 1991, *Geologic Map of Vashon and Maury Islands, King County, Washington*, Miscellaneous Field Studies Map MF-2161, http:/ /ngmdb.usgs.gov/Prodesc/proddesc_5790.htm.
- USGS, Earth Explorer (http://earthexplorer.usgs.gov/), Aerial photographs dated 1951, 1968, and 1977.
- Washington State Department of Ecology (Ecology), 11 water well logs from Section 36, Township 22 North, Range 2 East, https://fortress.wa.gov/ecy/waterresources/map/WCLSWebMap/default.aspx.
- Washington State Department of Ecology, Coastal Atlas, https://fortress.wa.gov/ecy/coastalatlas/

4.0 REGULATORY CONSIDERATIONS

As previously mentioned, the Chen/Scarsella PHU contains conditions that are consistent with Forest Practices Board Manual WAC 222-16-050 (1)(d)(C) *Groundwater recharge areas for glacial deep-seated landslides.* These conditions (a "rule-defined landform") are consistent with requiring a Class IV-Special FPA, which requires a "geotechnical report" to address WAC 222-10-030 (1)(a,b,c).

The upland area west of the glacial deep-seated landslide (GDSL) in the east part of the Chen/Scarsella PHU has the potential for groundwater recharge. For this reason, it is important to evaluate if a groundwater recharge area exists within this upland area, and its aerial extent. As a first order evaluation, topographic contours can be used as a means to evaluate the groundwater recharge area. Section 16 of the DNR Forest Practices Board Manual (May 2016 – page 16-40) suggests that a high resolution Digital Elevation Model (DEM) generated from LiDAR is the most accurate tool available for this purpose. ICE used this method of groundwater recharge area delineation supplemented by "other sources of information" as described later in this report. These other sources of information include field observations, geologic maps, hydrogeologic reports and water well logs (the water well logs are included as Attachment A) that may describe the *vertical extent of rocks and sediments and providing information about grain size distributions, sorting, and other physical properties that may influence the hydraulic characteristics of hydrogeologic units* (DNR, May 2016, page 16-42).

For the purpose of this report, essentially all of the above listed other sources of information were used in evaluating groundwater recharge conditions and slope stability assessment for the Chen/Scarsella PHU.

5.0 PUBLIC RESOURCES DESCRIPTION

The Puget Sound (Quartermaster Harbor – a Shoreline of the State) borders the northeast part of the Chen/Scarsella PHU (north of Chen Creek). Based on our review of the Ecology's Coastal Atlas, Eelgrass beds are present along the full length of the shoreline. "Feeder bluffs" occur in local areas north of Chen Creek. Feeder bluffs occur where erosion along the Puget Sound shoreline has undercut the hillside which results in shallow landsliding and erosion. This erosion contributes sand and gravel (primarily sand as this location) to the beaches.

Private properties are located downgradient from and bordering the southeast part of the Chen/Scarsella PHU along the Puget Sound shoreline. These properties are described from north to south by King County iMAP (King County Department of Assessments) as the following:

- Parcel No. 362202-9042, owned by Karl and Christine Anderson, 4.12 acres, vacant (undeveloped).
- Parcel No. 362202-9037, owned by Donald and Annice Edwards, 0.92 acres, vacant.
- Parcel No. 362202-9038, owned by David and Kathleen Barber, 0.91 acres, vacant.
- Parcel No. 362202-9040, owned by Louisa Eastman, 0.91 acres, vacant.
- Parcel No. 362202-9043, owned by Louisa Eastman, 0.91 acres, vacant.
- Parcel No. 362202-9012 (28704 125th Place SW), owned by Bruce and Stephanie Fairweather, 2.16 acres, 350 square foot cabin built in 1950.
- Parcel No. 362202-9035 (28710 125th Place SW), owned by Charles Knight, 2.79 acres, 2,870 square foot house built in 1958 (renovated in 1989).
- Parcel No. 362202-9041 (28728 125th Place SW), owned by King County Parks, 1.9 acres, 580 square foot cabin built in 1964.
- Parcel No. 362202-9034, owned by King County Parks, 1.86 acres, vacant.

Rural residential properties and undeveloped forested areas border the property to the south, west and north. These properties are upgradient, or otherwise border (not downgradient) the Chen/Scarsella PHU. Vashon Highway borders a part of the west Chen/Scarsella PHU property line.

The Vashon Park District owns a 32-acre property (Parcel No. 362202-9001) bordering the northeast part of the Chen/Scarsella PHU. This parcel is referred to as "Lost Lake" and is considered a marine, freshwater and terrestrial conservancy. Access to the Lost Lake area is by foot trail, part of which crosses the Chen/Scarsella PHU.

Based on our review of water well logs that are on file with Ecology, 12 water wells (included as Attachment A) are registered within Section 36, Township 22 North, Range 2 East. The water wells range from 104- to 425-feet deep; the most common well depths ranged from about 100- to 150-feet deep. The wells tested at about 0.5 to 15 gallons per minute with an average yield of about 5 to 7.5 gallons per minute (considered a low, but acceptable yield, for a domestic water well).

Chen Creek crosses the Chen/Scarsella PHU from the west-northwest to the east as shown on Figure 2 and drains directly into Puget Sound. Chen Creek originates in the upland area northwest of the Chen/Scarsella PHU, but appears to receive primary base flow from springs that emerge at about Elevation 220 feet within the deeply incised ravine of Chen Creek within the Chen/Scarsella PHU. Based on our review of the DNR Forest Practices Application Review System (FPARS) Mapping Tool, Chen Creek is a Type F (fish habitat) stream. Untyped "wet areas" (sag ponds) and an untyped stream in the Lost Lake area are located on the hillside area of the Chen/Scarsella PHU as shown on the FPARS Mapping Tool.

6.0 SOIL CONDITIONS

Based on regional soils mapping by the US Department of Agriculture, Natural Resource Conservation Service (USDA NRCS), the Weathered Soils that mantle the unit and adjacent areas have been mapped as Alderwood and Kitsap (AkF), Everett (EvC), Everett-Alderwood (EwC) and Seattle Muck (Sk) as shown on the USDA NRCS Soils Map, Figure 3. The following is a summary description of the soil types as described by the USDA NRCS.

- **Alderwood and Kitsap (AkF)** – Moderately well-drained gravelly ashy sandy loam and very gravelly sandy loam (Alderwood) or ashy silt loam and stratified silt to silty clay loam (Kitsap) forming on 25 to 70 percent slopes, derived from basal till with some volcanic ash (Alderwood) or lacustrine deposits with a minor amount of volcanic ash (Kitsap) to a depth of 60 inches. The permeability is estimated at 0.00 to 0.06 inches per hour (Alderwood) or 0.06 to 0.20 inches per hour (Kitsap).
- **Everett (EvC)** – Somewhat excessively-drained very gravelly sandy loam, very gravelly loamy sand and extremely cobbly coarse sand forming on 8 to 15 percent slopes, derived from sandy and gravelly glacial outwash to a depth of 60 inches. The permeability is estimated at 1.98 to 5.95 inches per hour.
- **Everett-Alderwood (EwC)** – Somewhat excessively-drained (Everett) or moderately well-drained (Alderwood) gravelly ashy sandy loam, very gravelly sandy loam and very gravelly coarse sand (Everett) or gravelly ashy sandy loam and very gravelly sandy loam (Alderwood), forming on 6 to 15 percent slopes, derived from glacial outwash with a component of volcanic ash in the upper part (Everett) or basal till with some volcanic ash (Alderwood) to a depth of 60 inches. The permeability is estimated at 1.98 to 5.95 inches per hour (Everett) or 0.00 to 0.06 inches per hour (Alderwood).
- **Seattle Muck (Sk)** – Very poorly-drained muck and stratified mucky peat to muck forming on 0 to 1 percent slopes, derived from grassy organic material to a depth of 60 inches. The permeability is estimated at 0.57 to 1.98 inches per hour.

7.0 GEOLOGIC SETTING

The surficial geologic soil conditions (unweathered soils and bedrock that underlie the surficial weathered soils and bedrock) were evaluated based on regional geologic mapping by the US Geological Survey (USGS, 1991), followed by ICE review of historical aerial photographs and field reconnaissance (by foot travel) of the unit and adjacent areas. We also reviewed water well logs (from Ecology – Attachment A). The geology of the Chen/Scarsella PHU and surrounding areas is shown on the Geologic Map, Figure 4.

As previously mentioned, the east part of the Chen/Scarsella PHU is regionally mapped by the USGS (1991) and the DNR (Geologic Information Portal) as a deep-seated landslide as shown on Figure 4. The DNR Geologic Information Portal (Natural Hazards) refers to this landform as Landslide Inventory Unique No. 59118 which is described by the DNR as a "*dormant, indistinct, deep-seated landslide*."

Based on the regional geologic mapping (USGS, 1991) and available information review (Ecology water well logs and the DNR Geologic Information Portal, the upland (west) part of the Chen/Scarsella PHU is mantled with Vashon age Glacial Till. The Glacial Till typically consists of a nonsorted mixture of silt, sand, gravel, cobbles and occasional boulders in a dense to very dense condition as a result of being overridden by glacial ice. Based on our review of Ecology's water well logs, the Glacial Till (often referred to as "hardpan" or "HP" on the water well logs) tends to range from about 40- to 135-feet thick. We expect that the Glacial Till is likely about 40- to 60-foot thick and may be misidentified on the logs by the well driller (some logs report the Glacial Till thickness at over 100 feet which is unlikely to actually occur).

The Glacial Till is underlain by Vashon age Advance Outwash. Advance Outwash typically consists of massive to stratified (layered) sand with variable amounts of silt and gravel in a dense to very dense condition as a result of being overridden by glacial ice. We observed "sand" as surficial soils on the steep hillside during our foot ascent from the lower area which supports the presence of the Advance Outwash at the location shown on Figure 4.

The Advance Outwash is underlain by Pre-Fraser age Glaciolacustrine Sediments (lakebed deposits) typically consisting of massive to thinly layered silt and sandy silt in a hard condition as a result of being overridden by glacial ice. Based on our field observations of a line of seepage within the Chen Creek ravine and our review of the Ecology water well logs, the contact with the overlying Advance Outwash and the underlying Glaciolacustrine Sediments occurs at about Elevation 200 to 220 feet. Pre-Fraser age Older Sediments consisting of stratified (horizontally layered) sand and gravel underlie the Pre-Fraser age Glaciolacustrine Sediments.

The geologic conditions of the hillside area are complicated by past movement of the GDSL. Large, relatively coherent blocks of the native soil have moved downslope during the active landslide process. Therefore, it is not unusual to observe Advance Outwash sand in the shoreline eroded bluffs where the Pre-Fraser age Glaciolacustrine Sediments would be expected. However, hard silt (Pre-Fraser age Glaciolacustrine Sediments) was observed in local areas at beach level.

Based on our site observations, Alluvium consisting of silt, sand and gravel deposited by Chen Creek occurs within the Chen Creek ravine at about Elevation 180 to 200 feet where the gradient flattens because of the ground downset (abrupt gradient change) created by the GDSL.

8.0 HYDROGEOLOGIC SETTING

As previously mentioned, as a first order evaluation, topographic contours can be used as a means to evaluate the groundwater recharge area. Section 16 of the DNR Forest Practices Board Manual (May 2016 – page 16-40) suggests that a high resolution DEM generated from LiDAR is the most accurate tool available for this purpose. ICE processed LiDAR data available from the Puget Sound LiDAR Consortium to obtain a better understanding of topographic conditions within the upland area (potential groundwater recharge area) for the Chen/Scarsella PHU. This topographic contour data was used to draw "flowlines" for surface and shallow groundwater relative to Chen Creek and the GDSL in the east part of the property as shown on the Surface Water Flow Direction Map, Figure 5.

As shown on Figure 5, the majority of the flowlines (based on topography), show that most of the ground surface either drains to the west (the area in green on Figure 5) or to the Chen Creek ravine. Relatively small areas are directed to the east (the area in yellow on Figure 5) toward the GDSL. These include about 3.5 acres within Unit 1 and Unit 3 (total Unit 1 and Unit 3 area is about 70 acres) and about 7.5 acres in Unit 2 (total Unit 2 area is about 30 acres).

Considerable other sources of information are available for the Chen/Scarsella PHU and nearby areas including the J.R. Carr/Associates hydrogeologic report (J.R. Carr/Associates, 1983) for Vashon Island and the more recent hydrogeologic modelling study by DHI Water and Environment (2009), both of which were prepared for King County. Both reports conclude that there are two primary aquifers including the Primary Aquifer that occurs in the Advance Outwash at Elevation 400 feet to sea level, and a Deep Aquifer that occurs in Pre-Fraser age Older Sediments 100 to 300 feet below sea level (J.R. Carr/Associates, 1983, page S-2). The Pre-Fraser age Older Sediments (layered sand and gravel) are confined under the previously described Glaciolacustrine Sediments.

Vashon Island's water supply is substantially obtained from the Primary Aquifer (J.R. Carr/Associates, 1983).

We estimated the permeability of the Glacial Till, Advance Outwash, Glaciolacustrine Sediments and Pre-Fraser age Older Sediments based on visual soil classification and ranges developed by the USGS (2000) and Freeze, R.A. and Cherry, J.A. (1979), and our experience. The standard range of vertical permeabilities for the geologic units in the Chen/Scarsella PHU area include the following:

Soil Type	Permeability (centimeters per second – cms)
Glacial Till	$10^{-6} – 10^{-10}$
Advance Outwash (Primary Aquifer)	$1 – 10^{-4}$
Glaciolacustrine Sediments	$10^{-5} – 10^{-8}$
Older Sediments (Deep Aquifer)	$1 – 10^{-6}$

Local precipitation is the primary recharge for the Primary Aquifer. In the past (prior to 1983), the source of groundwater on Vashon Island was considered to originate in the Olympic Mountains, or from Mt. Rainier. This theory was eliminated because Puget Sound is relatively deep surrounding Vashon Island (over 400-feet deep) and would truncate any possible aquifer connection to the mainland (J.R Carr/ Associates, 1983, page 1-2).

J.R. Carr/Associates (1983, figure 6.13) evaluated potential groundwater recharge areas across Vashon Island by combining slope, soil, vegetation and permeability to develop a map of Vashon Island showing Potential Recharge Levels. This map suggests that most of the Chen/Scarsella PHU is a "Low" recharge potential area with the east part of the upland area south of Chen Creek as a "High" recharge potential area. The High potential recharge area likely drains to the west and south, rather than toward the GDSL.

Based on our site observations, the Primary Aquifer underlies the upland part of the Chen/Scarsella PHU. The depth to groundwater below the upland (west) part of the Chen/Scarsella PHU is estimated by observation of springs and review of groundwater elevations in nearby water wells (Ecology) to be at least 100 feet below the ground surface. We observed a relatively distinct "spring/seepage line" within the Chen Creek ravine during our field reconnaissance emerging at about Elevation 220 feet. The depth of the Primary Aquifer is consistent with the findings presented in the J.R. Carr/Associates report (1983, figure 3.6).

A complicating condition for groundwater recharge at the Chen/Scarsella PHU is that the upland area (the groundwater recharge area) is likely mantled by Glacial Till that tends to intercept (perches) infiltrating water from precipitation, causing this water to migrate laterally, following surface topographic contour rather than vertical water infiltration. This condition of groundwater flow is consistent with the findings of DHI Water and Environment (2009) that suggested that groundwater that is perched on top of the Glacial Till "*generally follows topography in the surficial layer*" (page 22). The DHI Water and Environment report (2009) suggests that the Primary Aquifer "*follow the same general pattern*" as the shallow, perched aquifer, though at "*much shallower gradients*." We disagree with this statement, at least on a site-specific basis. In our opinion, the Primary Aquifer has a gradient underlying the Chen/Scarsella PHU down to the east toward Puget Sound (Quartermaster Harbor).

We expect that there are "windows" in the Glacial Till (where the Glacial Till is absent in the upland area) where water can infiltrate unimpeded to the Primary Aquifer within the underlying Advance Outwash. Some infiltration does occur through Glacial Till, but at a very slow rate. The implication of these conditions is that the Primary Aquifer is likely recharged from an area much larger than the Chen/Scarsella PHU area. This groundwater recharge area likely includes the Chen Creek watershed as shown on the Chen Creek Watershed Map, Figure 6.

Based on groundwater mapping by J.R Carr/Associates (1983, figure 3.6), the groundwater flow direction on a regional basis in the area of the Chen/Scarsella PHU is from west to east, as would be expected based on the overall topography of Vashon Island. This is contradictory to topographic controls on groundwater flow. However, because the upland area of the Chen/Scarsella PHU is mantled with nearly impermeable Glacial Till, this is not a surprising condition. What is important is that what occurs at the surface of the Chen/Scarsella PHU likely has no measureable effect on the Primary Aquifer. This shallow, perched groundwater either flows inland (away) from the GDSL, or infiltrates into the Chen Creek ravine to be discharged as surface water or recharges the Primary Aquifer to the south, considering the broad well-defined swale that occurs in the south part of Vashon Island.

J.R Carr/Associates (1983, figure 6.13) evaluated Recharge Potential Levels for Vashon Island. Based on our review of information, the upland portion of the Chen/Scarsella PHU to the south of Chen Creek is considered a High Recharge Potential area and the remainder of the unit is considered a Low Recharge Potential area. We expect that within the upland High Recharge Potential Area this perched groundwater would be directed to the west, and infiltrate to the Primary Aquifer west of the Chen/Scarsella PHU.

9.0 GEOMORPHIC SETTING

Vashon Island was formed during the most recent ice age where a large lake formed in the Puget Sound area as a result of glacial ice advancing into Puget Sound resulting in the deposition of the Glaciolacustrine Sediments. As the glacial ice advanced further south into Puget Sound, Advance Outwash was deposited by stream and rivers emanating from the front of the glacier. Eventually, the Advance Outwash was overridden by up to 3,000 feet of glacial ice with Glacial Till being deposited directly on the ground surface at the base of the glacial ice. Upon retreat, the glacier scoured the ground surface creating the current condition of Puget Sound with many islands and north-south trending waterways.

As previously mentioned in Section 7.0 of this report, a deep-seated landslide (GDSL) has been mapped in the east part of the Chen/Scarsella PHU. The DNR has classified this landslide as a "*dormant, indistinct, deep-seated landslide.*" Based on our site observations, we concur with this description, however, we consider the landform as distinct rather than indistinct. The landslide is very large and parallels the shoreline. Groundwater can exacerbate the movement of a deep-seated landslide coupled with the toe being undercut. It does not appear that this particular GDSL has been formally studied.

Based on our informal discussion with a Vashon Island geologist familiar with this GDSL, a leading opinion is that this landslide most likely occurred as a result of a large seismic event (earthquake). In the Puget Sound area, these large scale seismic events are estimated at a 500-year reoccurrence interval. For this reason, there may have been at least 10 large-scale seismic events since the last glacier melted from the area. Based on our overall knowledge of the landslide area, we concur with this opinion that the primary "trigger" for the GDSL was a large seismic event.

Based on our field observations, the current trees and old-growth stumps within the GDSL mass are vertical suggesting stable conditions of at least 150 years.

Chen Creek has deeply incised the GDSL. This benefits the stability of the upland and hillside area by providing a "drain" for the Primary Aquifer (lowers groundwater level and reduces pore pressures).

10.0 HISTORICAL AERIAL PHOTOGRAPH REVIEW

10.1 GENERAL

ICE reviewed historical aerial photographs for the Chen/Scarsella PHU area dated 1936 (King County iMAP), 1951, 1968, 1977 (USGS Earth Explorer), 1990, 2002 and 2015 (Google Earth). A brief summary of the conditions shown on the historic aerial photographs are as follows:

10.2 1936 AERIAL PHOTOGRAPH

The 1936 aerial photograph (Figure 7 – good image quality) shows that the most of the central and south part of the unit appears to have been recently clear-cut. The west-central and north part of the unit along with the steeper areas of the hillside south of Chen Creek are forested. Vashon Highway SW is visible west of the unit. The adjacent areas are generally undeveloped. No bare soil areas are visible, other than that along the shoreline, that could suggest erosion or recent landslide movement.

10.3 1951 AERIAL PHOTOGRAPH

The 1951 aerial photograph (Figure 8 – very good image quality) shows that the area south of Chen Creek is reforesting. The area north of Chen Creek appears to have been recently clear-cut. Lost Lake and the sag ponds in the south part of the unit are visible. A single skid trail with spurs is partially visible in the reforesting area south of Chen Creek. A main logging road along with numerous skidder trails are visible in the recently clear-cut area north of Chen Creek. This road is still present as a walking trail. Vashon Highway SW is visible. A road is visible south of the southeast corner of the unit (125th Place SW). Adjacent properties are generally undeveloped and forested. Rural residential development is present along Vashon Highway SW northwest and southwest of the Chen/Scarsella PHU. No bare soil scarps are visible, other than that along the shoreline, that could suggest erosion or recent landslide movement.

10.4 1968 AERIAL PHOTOGRAPH

The 1968 aerial photograph (Figure 9 – good image quality) shows that the Chen/Scarsella PHU and adjacent areas are reforesting. Lost Lake and the sag ponds in the south part of the unit are visible. No roads or trails are visible within the unit because of tree canopy closure. Vashon Highway SW and 125th Place SW are visible. Adjacent properties are generally undeveloped and forested. Rural residential development is present along Vashon Highway SW northwest and southwest of the Chen/Scarsella PHU. No bare soil scarps are visible, other than that along the shoreline, that could suggest erosion or recent landslide movement.

10.5 1977 AERIAL PHOTOGRAPH

The 1977 aerial photograph (Figure 10 – good image quality) is similar to the 1968 aerial photograph. No bare soil scarps are visible, other than that along the shoreline, that could suggest erosion or recent landslide movement.

10.6 1990 AERIAL PHOTOGRAPH

The 1990 aerial photograph (Figure 11 – good image quality) is similar to the 1968 and 1977 aerial photographs. Considerable new rural residential development has occurred along Vashon Highway SW, 125th Place SW and the upland area north of the Chen/Scarsella PHU (SW 276th Street). No bare soil scarps are visible, other than that along the shoreline, that could suggest erosion or recent landslide movement.

10.7 2002 AERIAL PHOTOGRAPH

The 2002 aerial photograph (Figure 12 – good image quality) shows that the Chen/Scarsella PHU is continuing to reforest. Considerable new rural residential development has occurred along Vashon Highway SW, 125th Place SW, the upland area north of the Chen/Scarsella PHU (SW 276th Street) and adjacent to the southwest corner of the unit. No bare soil scarps are visible, other than that along the shoreline, that could suggest erosion or recent landslide movement.

10.8 2015 AERIAL PHOTOGRAPH

The 2015 aerial photograph (Figure 13 – good image quality) is similar to the 2002 aerial photograph. No bare soil scarps are visible, other than that along the shoreline, that could suggest erosion or recent landslide movement.

11.0 LiDAR IMAGERY REVIEW

Our review of LiDAR imagery (PSLC) as shown on the LiDAR Image, Figure 14 (good quality) shows the nearly level upland in the west part of the Chen/Scarsella PHU bordered to the east by the GDSL. The GDSL is depicted as two paralleling downset benches, and an elevated "peninsula" adjacent to the headscarp north of Chen Creek and three or four paralleling downset benches south of Chen Creek. The difference in geometry of the downset benches is likely because Chen Creek divided this landform (and existing ravine) when it was active resulting in (or at least allowing for) differential ground movement; the end result being the same. Chen Creek is further incised and has deposited sediment at a distinctive grade change at the creek intersection with the east property line (shown as "Alluvium" on Figure 4). An active deep-seated landslide would likely exhibit some encroachment into the shoreline or other semi-circular offshore features suggest active deep failure circles. These features do not exist along the shoreline adjacent to the Chen-Scarsella PHU.

Lost Lake (sag pond) is visible in the north part of the unit. Two other sag ponds are visible in the south part of the unit as shown on Figure 14.

12.0 SLOPE MAPPING

Based on the LiDAR topography (PSLC – 10-foot contour interval), we prepared a map showing the approximate location of slopes that exceed 70 percent grade within and adjacent to the unit as shown on the Slope Map, Figure 15.

13.0 FIELD OBSERVATIONS

13.1 GENERAL

Mr. Beaman and Jeff Schwartz, LEG of ICE completed a field reconnaissance of the Chen/Scarsella PHU on July 20, 2016 (the weather was warm and dry). The purpose of this site visit was to complete a detailed review of site conditions, including the shoreline and private property areas that border the east side of the unit. On August 4, 2016, Mr. Beaman attended a pre-application meeting with representatives from

the DNR (Jason Sharp and Martin Eversaul) and the Chen/Scarsella project team (John Breithaupt and Kyle Stutesman) (the weather was warm and dry). The purpose of this meeting was to provide the DNR with an initial review of the Chen/Scarsella PHU and to discuss a reasonable harvest plan considering the site conditions.

Both foot traverses followed similar routes. The exception is that in the south part of the Chen/Scarsella PHU the DNR group opted to remain in the extreme south part of the unit where potential harvest area and access/yarding corridors were discussed. The area around the north end of the sag ponds that was observed by ICE will be avoided from the harvest plan. Our field reconnaissance of the Chen/Scarsella PHU for July 20 and August 4, 2016 are shown on the Field Reconnaissance Route Map, Figure 16.

13.2 CHEN CREEK RAVINE

Chen Creek enters the Chen/Scarsella PHU at the northwest corner of the unit draining to the south then turns to the east-southeast where the ravine become incised into a "V-shaped" ravine at the point where the creek is crossed by a culvert and road fill (abandoned logging road) at about Elevation 270 feet. The creek is dry at this point with no distinctive, or at least well-connected channel. Downstream of the abandoned logging road crossing, the gradient of Chen Creek steepens into a V-shaped ravine. The hillside on both sides of Chen Creek are typically more than 70 percent grade in this area. We observed a line of groundwater seepage on the south-facing hillside at about Elevation 220 feet. Sandy soils, typical of Advance Outwash, were observed on the hillside above this seepage line. Silt and clay soils (Glaciolacustrine Sediments) were observed in local areas typically at about Elevation 200 feet and lower within the Chen Creek ravine.

Surface water in Chen Creek was observed at about Elevation 240 feet. Chen Creek enters a grade change (flattens abruptly) at about Elevation 180 feet where Alluvium has deposited as shown on Figure 4. The creek channel gradient steepens again at about Elevation 160 feet to eventually flow into Puget Sound. At the time of our July 20, 2016 observation at the discharge point, the flow rate of Chen Creek was estimated (visually) at about 15 gallons per minute. The beach area downgradient from the Chen Creek discharge point was noticeably raised in a fan shape suggesting that a considerable amount of sediment is being transported by Chen Creek.

We observed localized evidence of soil slumps along the seepage line area (about Elevation 220 feet) along the south-facing hillside of Chen Creek. We observed (from a distance while on the south-facing hillside) what appeared to be a relatively recent shallow landslide that extends up the north-facing hillside for a few hundred feet. The possible shallow landslide area was lacking mature trees and several groups of fallen trees were observed.

The entire Chen Creek ravine regardless of slope (some ravine hillside areas are less than 70 percent grade), downstream of the abandoned logging road crossing at about Elevation 270 feet is excluded (avoided) from the harvest plan.

13.3 AREA NORTH OF CHEN CREEK RAVINE

The area north of the Chen Creek ravine is characterized by a nearly-level upland area in the east part of the Chen/Scarsella PHU then abruptly breaks into the GDSL paralleling Puget Sound. As previously mentioned, a localized "peninsula" of a nearly-level elevated area occurs along the south part of this

hillside that appears to be a "perched bench"; this is likely a partially detached block from the upland area that did not offset as much as the lower hillside benches within the GDSL.

Our foot traverse followed a trail along the seam of the upper major bench that continues north to Lost Lake. The surface of this bench and the bordering headscarp within the upland area is dry, with sandy soils, mature straight-trunked conifer trees and occasional old-growth stumps. Lost Lake appears to be a shallow, linear pond related to the prehistoric landslide movement (referred to as a "sag pond").

From the south end of Lost Lake, we continued on foot to the east eventually descending a bare sand bluff to the shoreline of Puget Sound.

The landforms throughout the area north of the Chen Creek ravine are indicative of a deep-seated landslide (bench topography, sag ponds, prominent headscarp), but also indicate that the GDSL is inactive (straight-trunked conifer trees and old-growth stumps, no tension cracks).

13.4 SHORELINE AREA

The shoreline is characterized as a gently sloping beach consisting primarily of sand and silty sand, consistent as a material type of the "feeder bluffs" and beachfront erosion areas that expose sand (Advance Outwash) and minor fine gravel. Rock bulkheads consisting of large boulders (3- to 5-feet in diameter) are present along most of the private properties on either side of where Chen Creek drains to Puget Sound and most of the beachfront area to the south. Local areas are without a rock bulkhead and higher tide wave action erosion is evident at the toe of the hillside. Hard silt is exposed in the beach near where Chen Creek drains into Puget Sound.

Springs and seepage were observed in localized beachfront areas.

We did not observe evidence that the GDSL is moving (encroaching) into the shoreline area, which could be evidenced by beach uplift, large deposits of recent mass wasting material on the beach, or obvious problems with the hillside where private properties have been developed with cabins or a residential structure.

13.5 AREA SOUTH OF CHEN CREEK RAVINE

The area south of the Chen Creek ravine is characterized by a nearly-level upland area in the east part of the Chen/Scarsella PHU then abruptly breaks into the GDSL paralleling Puget Sound. We ascended the hillside from a boat ramp at the shoreline to 125th Place SW, then continued further up the hillside to gain access to the southeast corner of the Chen/Scarsella PHU. We continued to ascend through two distinctive benches to the uppermost bench where timber harvest is planned. The surface of this area is dry, with sandy soils, mature straight-trunked conifer trees and occasional old-growth stumps. The two sag ponds on the lower benches are long and linear, with less open water compared with Lost Lake.

From the uppermost bench, we ascended the headscarp of the GDSL observing that the hillside soils consisted of sand (Advance Outwash).

The landforms throughout the area south of the Chen Creek ravine are indicative of a deep-seated landslide (bench topography, sag ponds, prominent headscarp), but also indicate that the deep-seated landslide is inactive (straight-trunked conifer trees and old-growth stumps, no tension cracks).

14.0 WATER BALANCE

ICE has reviewed the DNR protocol (DNR, May 2016, page M16-47) for suggested water balance methods. The DNR Forest Practices Board Manual (May 2016, page 16-48) provides a summary of typical values of water infiltration (recharge) that increase as a result of "forest conversion to shrub." The highest value is an increase of 50 percent of gross annual precipitation, with a more typical increase of about 21 to 35 percent. Another factor that is not known is the loss to surface water. For a water balance to be confidently evaluated, we would need historical stream gauge data from Chen Creek.

In our opinion, none of the methods suggested in the DNR Forest Practices Board Manual are of practical use because insufficient data exists to confidently determine evapotranspiration (ET) and surface water runoff for the Chen/Scarsella PHU site.

15.0 QUANTITATIVE SLOPE STABILITY ANALYSIS

Quantitative slope stability analysis is usually completed for recent, active shallow or deep-seated landslides where sufficient data (landslide geometry, soil type distribution, soil strength parameters and groundwater conditions) are well-documented. For most quantitative slope stability analyses the reviewer usually has site conditions consisting of a landslide mass with recent movement. Therefore, the factor of safety (FOS) is 1.0 (the FOS is a ratio of the resisting forces divided by the driving forces). By having a FOS equal to 1.0, the site reviewer can "back-calculate" other soil or groundwater parameters that are not confidently known.

The only confident input parameter for slope stability analysis is the surface topography for the Chen/Scarsella PHU. Other key input parameters missing include subsurface soil and groundwater conditions. The lack of this data, combined with the failure condition (FOS of unity) not being known, allows for too many variables being "guessed." Quantitative slope stability analysis using input parameters with no substantial validation open up the possibility of multiple interpretations and outcomes, none of which can be confidently defended from a current standard of engineering and geologic practice.

16.0 CHEN/SCARSELLA PHU CONCLUSIONS

It is our opinion that the proposed Forest Practices for the Chen/Scarsella PHU can be successfully/safely completed. Our responses to WAC 222-10-030 (1)(a,b,c) are as follows:

WAC 222-10-030 (1) a – The likelihood that the proposed forest practices will cause movement on the potentially unstable slopes and landforms; or contribute to further movement of a potentially unstable slope or landform.

It is our opinion that the proposed Forest Practices for the Chen/Scarsella PHU has a low risk of re-activating movement within the GDSL that occurs in the east part of the unit. This conclusion is based (in summary) on the following:

- The GDSL in the east part of the unit is considered dormant (inactive) by the USGS, the DNR and Ecology.

- Based on our site observations, we concur that the GDSL is inactive (dormant). Our observations included certain identification of landforms caused by deep-seated landsliding, along with widespread groups of straight-trunked trees/old growth stumps and no tension cracks.
- The most likely mechanism of failure of this landslide was a large earthquake several thousand years ago.
- Groundwater certainly had a role in the landslide failure, but based on the scale (very large) and geometry (planar failure landforms rather than arcuate), the presence of groundwater did not appear to be a primary driving force. In other words, other external forces (such as a large earthquake), were needed to activate this landslide area.
- Based on topographic relief, only about 11 acres of the Chen/Scarsella PHU drain toward the GDSL (the entire Chen/Scarsella PHU covers about 192 acres with about 100 acres planned for harvest) as shown on Figure 5.
- Glacial Till, often referred to as hardpan, likely underlies most of the upland area where Units 1 and 2 are planned. Glacial Till is nearly impermeable, therefore creates seasonal perched groundwater conditions that drain laterally based on topography.
- Most of the surface water runoff from the seasonal perched aquifer overlying the Glacial Till flows toward Chen Creek, so much of the precipitation in the upland area of the unit runs off as surface water or as perched groundwater that drains to Chen Creek.
- Chen Creek has incised a deep, V-shaped ravine across the Chen/Scarsella PHU. The ravine is deep enough to expose the Advance Outwash and the underlying Glaciolacustrine Sediments. Because of this exposure, the Primary Aquifer is exposed as a line of seepage which acts to provide pore pressure release (groundwater drainage) from the downgradient landslide mass.
- Units 1 and 2 are planned as a partial harvest (thinning) with about 50 percent of the trees to remain. Unit 3 will be clear-cut (even-age harvest) using tower/cable methods, which is a preferred harvest method. Thinning of the upland area will provide some benefit with reducing aquifer recharge, but is difficult to quantify.
- Groundwater recharge to the Primary Aquifer is likely by perched groundwater, flowing primarily to the west and south, then infiltrating into the Advance Outwash where the Glacial Till is absent. The Primary Aquifer likely flows to the east under the Chen/Scarsella PHU.
- We considered a water balance and slope stability analysis approach. In our opinion there are too many key data input requirements (stream flow gauging of Chen Creek, subsurface geologic conditions including the failure plan, soil and groundwater conditions) missing for these types of analyses.

These items listed above are summary of conditions observed and evaluated that are discussed in detail in the preceding sections of this report.

WAC 222-10-030 (1) b – The likelihood of delivery of sediment or debris to any public resource, or in a manner that would affect public safety.

As previously described, it is our opinion that the proposed Forest Practices have a low risk of reactivating the GDSL. For this reason, any sediment delivery or debris associated with this type of ground movement is also low risk.

The primary source of sediment to the shoreline area is Chen Creek and the exposed "feeder bluffs" north of where Chen Creek enters the shoreline area. The feeder bluffs and the entire Chen Creek ravine downstream of the abandoned road/culvert is excluded (avoided) from the harvest plan. For this reason, the normal geomorphic processes occurring along the shoreline bluffs and within the Chen Creek ravine (slumps and shallow, rapid landslides) will continue.

Based on our evaluation, the likelihood that the ground movement as a result of the current harvest plan that would threaten public safety is low. The cabins and house that are located adjacent to the southeast corner of the unit are in a naturally unstable area. The natural erosional and landslide processes associated with these developed areas will continue.

WAC 222-10-030 (1) c – Any possible mitigation for the identified hazards and risks.

It is our opinion that risk associated with Potentially Unstable Slopes and Landforms has been adequately mitigated by excluding (avoiding) harvest in a portion of the hillside area in the east part of the unit where public resources are most vulnerable. The vulnerable areas include the hillside area north of Chen Creek that contains Lost Lake, the entire Chen Creek ravine downstream of the abandoned road/culvert and the sag ponds area in the lower benches south of Chen Creek as shown on Figure 2.

Standard Forest Practices should apply. New roads (haul road and yarding roads) and landings shown on Figure 2 should be decommissioned upon harvest completion. The Chen/Scarsella PHU should be replanted as soon as practical (within six months of each unit harvested).

17.0 USE OF THIS REPORT

We have prepared this report for use by Eric Chen and Tony Scarsella to supplement the forest practice permit process for the Chen/Scarsella PHU; this report is not applicable to other locations or for other purposes. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

There are always risks related to slope stability issues in mountainous areas. These areas are naturally active geologically with respect to mass wasting, erosional and sedimentation processes exacerbated by other factors such as earthquakes, extreme precipitation events and climate change. This risk related to slope stability issues can be reduced using currently accepted prescribed methods, but the risk cannot be eliminated. Proper logging methods, including road construction/decommissioning, drainage and erosion control, before and after logging are key to reducing risks of slope instability.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time this report was prepared. No warranty, express or implied, should be understood.

****

We trust this report meets your present needs. Please call if you have any questions or need additional information.

Yours very truly,
Icicle Creek Engineers, Inc.

Kathy S. Killman, LEG
Principal Engineering Geologist

Brian R. Beaman, PE, LEG, LHG
Principal Engineer/Geologist/Hydrogeologist

State of Washington
Engineering Geologist
671
Licensed Geologist
BRIAN R. BEAMAN

Document ID: 1212001.rep

Submitted via email (PDF) and surface mail (two original copies)

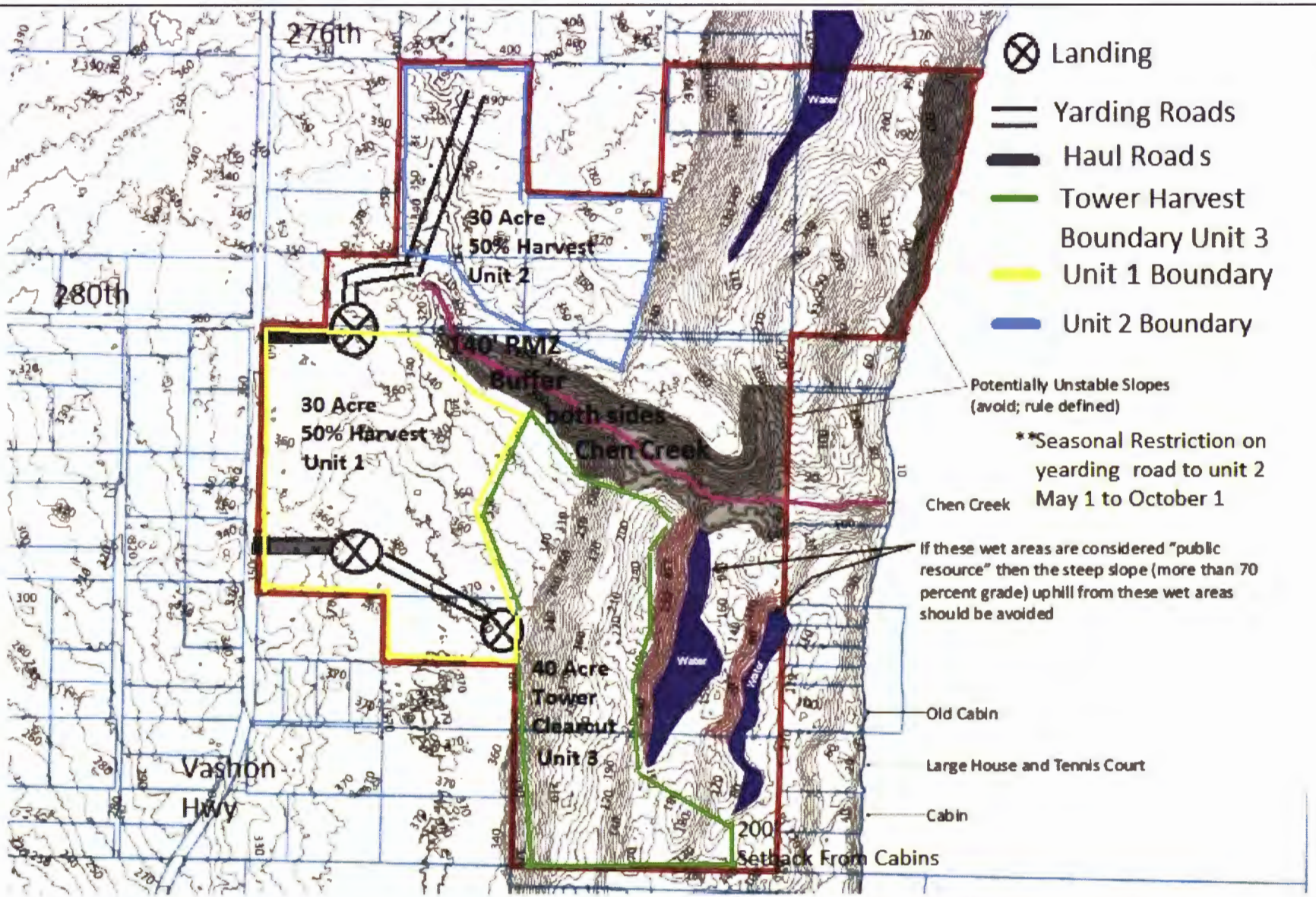
Attachments: Vicinity Map – Figure 1
Activity Map – Figure 2
USDA NRCS Soils Map – Figure 3
Geologic Map – Figure 4
Surface Water Flow Direction Map – Figure 5
Chen Creek Watershed Map – Figure 6
1936 Aerial Photograph – Figure 7
1951 Aerial Photograph – Figure 8
1968 Aerial Photograph – Figure 9
1977 Aerial Photograph – Figure 10
1990 Aerial Photograph – Figure 11
2002 Aerial Photograph – Figure 12
2015 Aerial Photograph – Figure 13
LiDAR Image – Figure 14
Slope Map – Figure 15
Field Reconnaissance Route Map – Figure 16

Ecology Water Well Logs – Attachment A

cc: John Breithaupt, Matrix & Associates, LLC (email)

FIGURES

VICINITY MAP	ICICLECREEK ENGINEERS 29335 NE 20th Street Carnation, Washington 98014 (425) 333-0093	SCALE: As shown DESIGNED: --- DRAWN: BRB CHECKED: KSK DATE: 09/20/16	ICE FILE NO. 1212-001 Figure 1
CHEN/SCARSELLA PHU			



Activity map provided to ICE by John Breithaupt of Matrix & Associates LLC

EXPLANATION

Chen/Scarsella PHU

N

0 500 1,000
Approximate Scale in Feet

ACTIVITY MAP	ICICLECREEK ENGINEERS 29335 NE 20th Street Carnation, Washington 98014 (425) 333-0093	SCALE: As shown DESIGNED: --- DRAWN: BRB CHECKED: KSK DATE: 09/20/16	ICE FILE NO. 1212-001 Figure 2
CHEN/SCARSELLA PHU			

Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

N

EXPLANATION

AkF — Alderwood and Kitsap - Moderately well-drained gravelly ashy sandy loam and very gravelly sandy loam (Alderwood) or ashy silt loam and stratified silt to silty clay loam (Kitsap) forming on 25 to 70 percent slopes, derived from basal till with some volcanic ash (Alderwood) or lacustrine deposits with a minor amount of volcanic ash (Kitsap) to a depth of 60 inches. The permeability is estimated at 0.00 to 0.06 inches per hour (Alderwood) or 0.06 to 0.20 inches per hour (Kitsap).

EvC — Everett - Somewhat excessively-drained very gravelly sandy loam, very gravelly loamy sand and extremely cobbly coarse sand forming on 8 to 15 percent slopes, derived from sandy and gravelly glacial outwash to a depth of 60 inches. The permeability is estimated at 1.98 to 5.95 inches per hour.

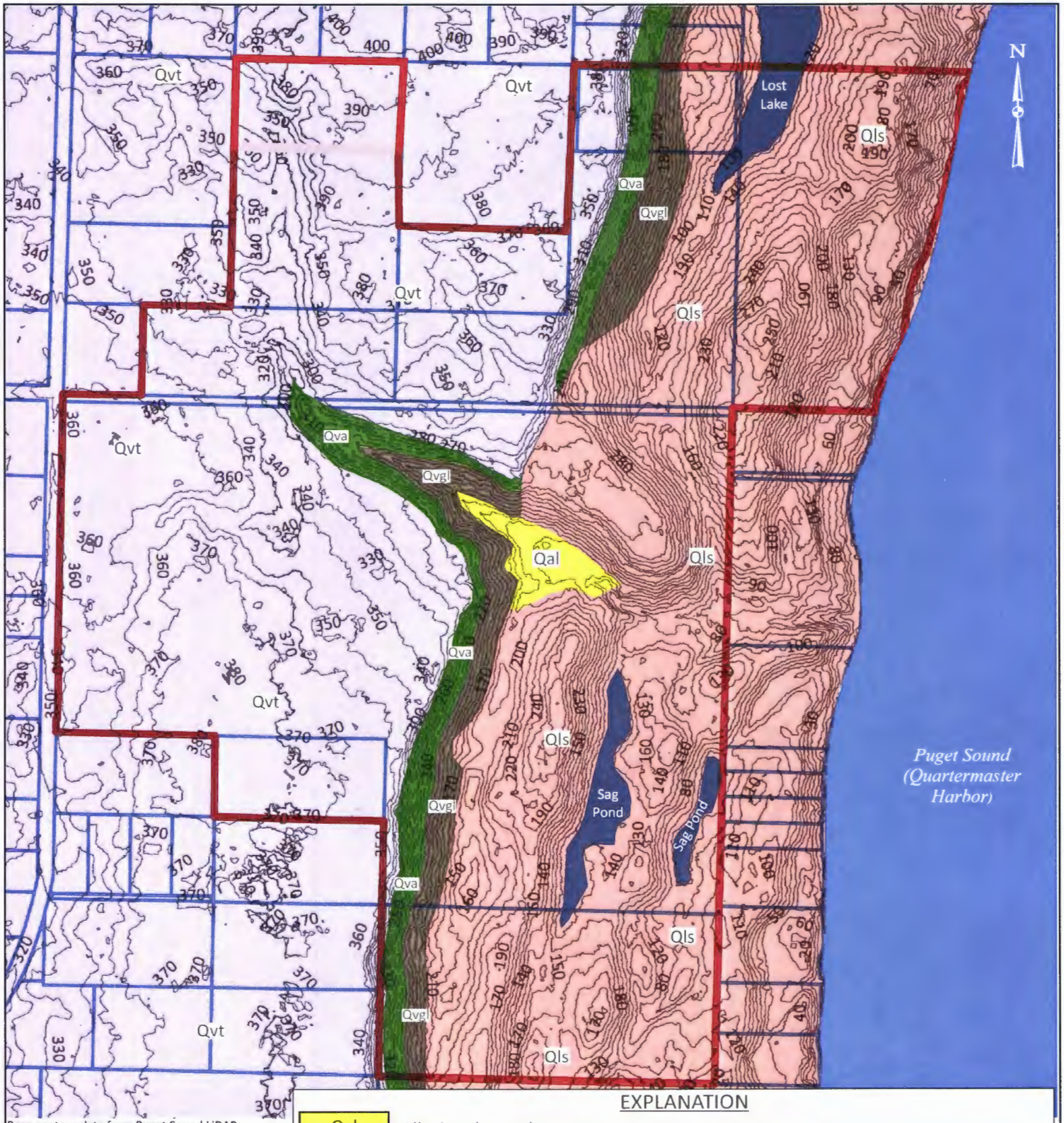
EwC — Everett-Alderwood - Somewhat excessively-drained (Everett) or moderately well-drained (Alderwood) gravelly ashy sandy loam, very gravelly sandy loam and very gravelly coarse sand (Everett) or gravelly ashy sandy loam and very gravelly sandy loam (Alderwood), forming on 6 to 15 percent slopes, derived from glacial outwash with a component of volcanic ash in the upper part (Everett) or basal till with some volcanic ash (Alderwood) to a depth of 60 inches. The permeability is estimated at 1.98 to 5.95 inches per hour (Everett) or 0.00 to 0.06 inches per hour (Alderwood).

Sk — Seattle Muck - Very poorly-drained muck and stratified mucky peat to muck forming on 0 to 1 percent slopes, derived from grassy organic material to a depth of 60 inches. The permeability is estimated at 0.57 to 1.98 inches per hour.

Chen/Scarsella PHU Boundary

Soils mapping based on USDA National Resources Conservation Service,
http://websoilsurvey.nrc.usda.gov/app/WebSoilSurvey.aspx

USDA NRCS SOILS MAP	ICICLECREEK ENGINEERS 29335 NE 20th Street Carnation, Washington 98014 (425) 333-0093	SCALE: As shown DESIGNED: -- DRAWN: BRB CHECKED: KSK DATE: 09/20/16	ICE FILE NO. 1212-001
CHEN/SCARSELLA PHU			Figure 3



Base contour data from Puget Sound LiDAR Consortium (processed by ICE)

Geologic Mapping Reference: US Geological Survey (USGS), Booth, D.B., 1991, *Gealagic Map of Vashan and Maury Islands, King County, Washington*, Miscellaneous Field Studies Map MF-2161. Modified by ICE based on LiDAR data review (hillshade, contours and slope), historical aerial photographs and field observations.

0 500 1,000
Approximate Scale in Feet

EXPLANATION

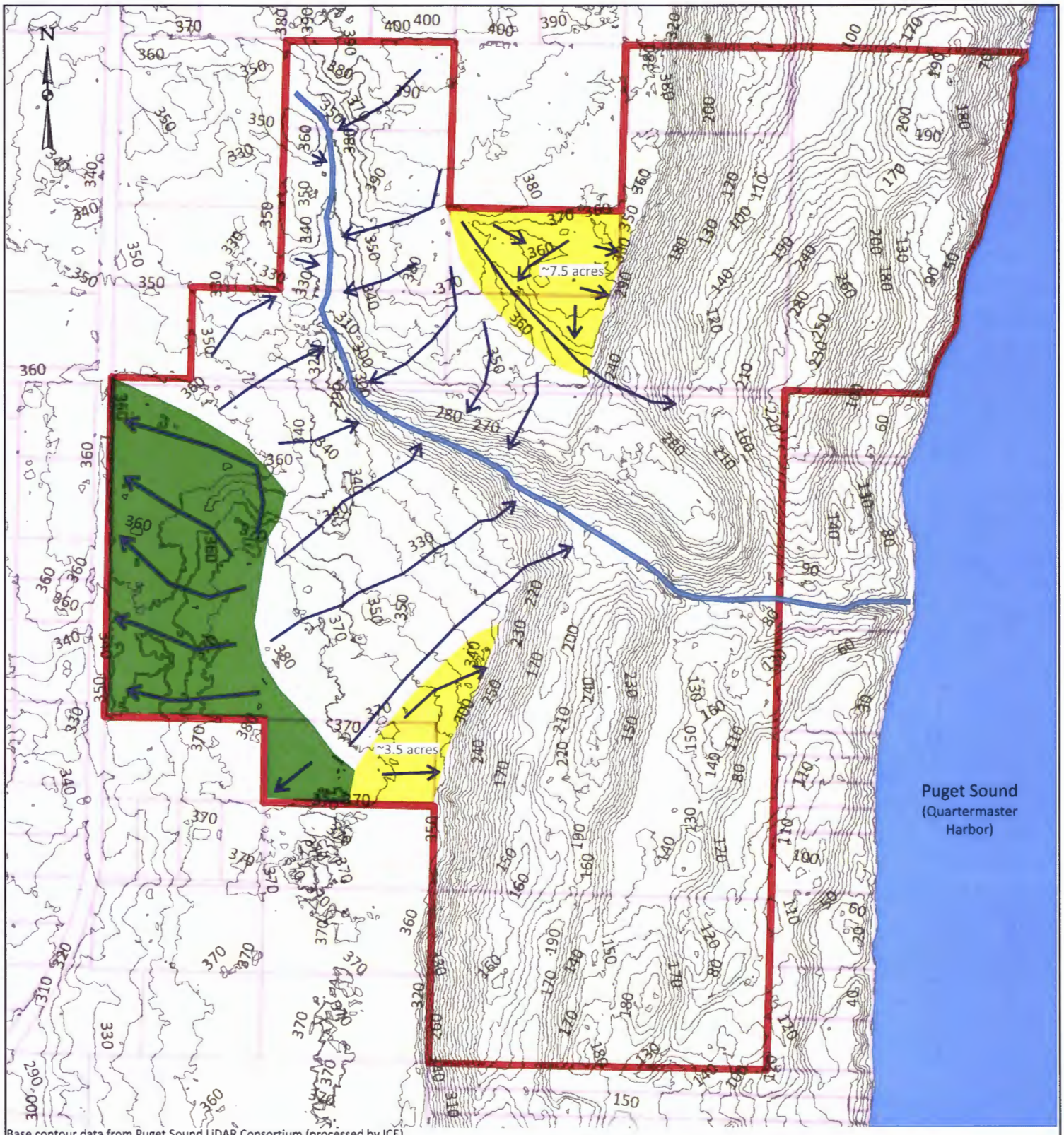
Qal	Alluvium (recent) - Silt, sand and gravel deposited by Chen Creek.
Qls	Glacial Deep-Seated Landslide (Holocene age) - Ancient (inactive) deep-seated landslide consisting of displaced upland blocks forming a series of benches from the upland to the Puget Sound shoreline.
Qvt	Glacial Till (Vashon age) - A nonsorted mixture of silt, sand, gravel, cobbles and occasional boulders in a dense to very dense condition as a result of being overridden by glacial ice.
Qva	Advance Outwash (Vashon age) - Massive to stratified (layered) sand with variable amounts of silt and gravel in a dense to very dense condition as a result of being overridden by glacial ice.
Qvgl	Glaciolacustrine Sediments (Pre-Fraser age) - Massive to thinly layered silt and sandy silt in a hard condition as a result of being overridden by glacial ice.
	Chen/Scarsella PHU

GEOLOGIC MAP

CHEN/SCARSELLA PHU

ICICLECREEK ENGINEERS
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: As shown	ICE FILE NO.
DESIGNED: ---	1212-001
DRAWN: BRB	Figure
CHECKED: KSK	4
DATE: 09/20/16	



Base contour data from Puget Sound LiDAR Consortium (processed by ICE)

EXPLANATION

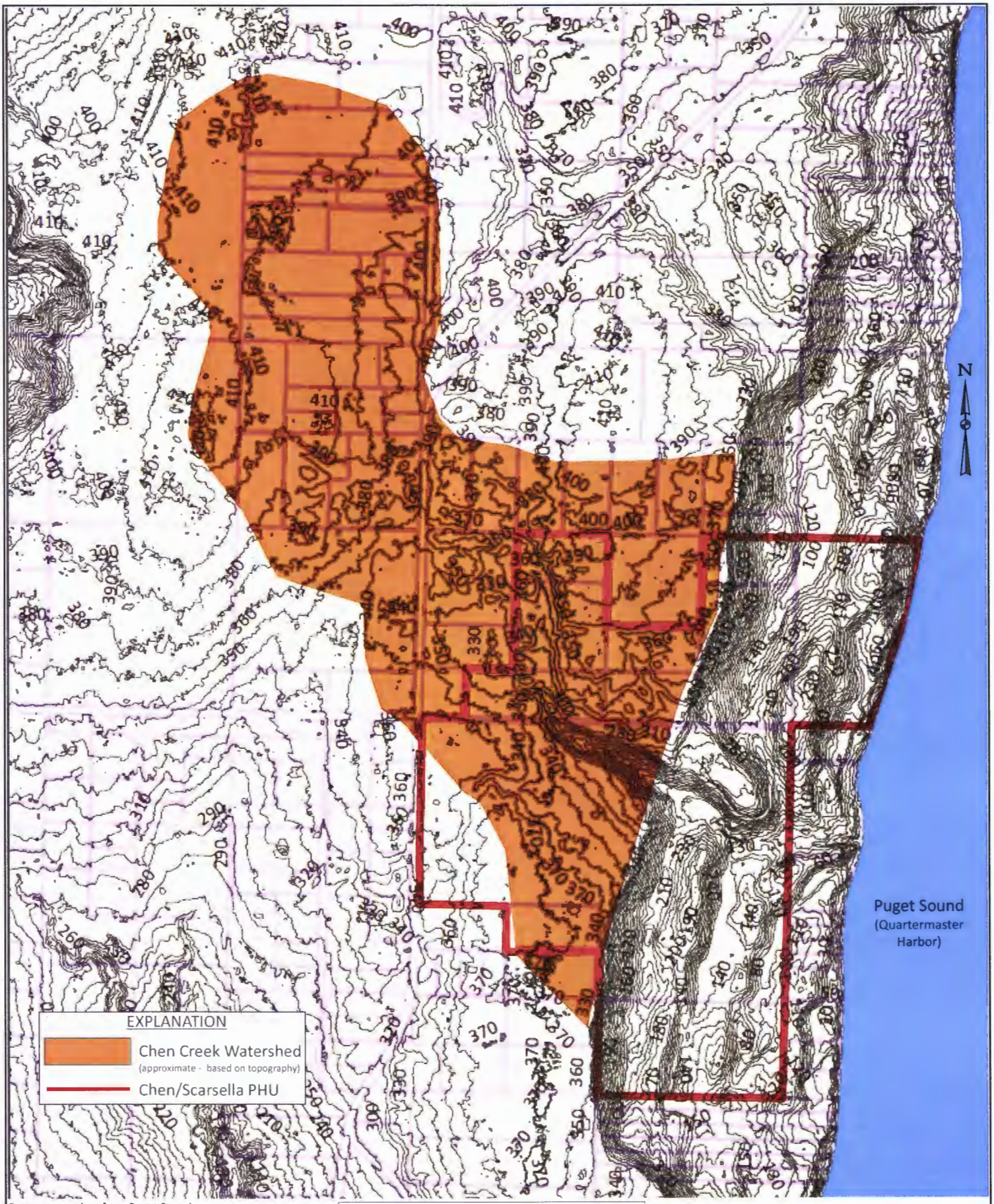
Surface Water Flow Direction (yellow = toward GDSL; green = away from GDSL); no color = toward Chen Creek)

Chen/Scarsella PHU

0 500 1,000

Approximate Scale in Feet

SURFACE WATER FLOW DIRECTION MAP	ICICLECREEK ENGINEERS 29335 NE 20th Street Carnation, Washington 98014 (425) 333-0093	SCALE: As shown DESIGNED: --- DRAWN: BRB CHECKED: KSK DATE: 09/20/16	ICE FILE NO. 1212-001 Figure 5
CHEN/SCARSELLA PHU			



Base contour data from Puget Sound LiDAR Consortium (processed by ICE)

0 1,000 2,000
Approximate Scale in Feet

CHEN CREEK WATERSHED MAP

CHEN/SCARSELLA PHU

ICICLECREEK ENGINEERS
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: As shown	ICE FILE NO.
DESIGNED: ---	1212-001
DRAWN: BRB	Figure
CHECKED: KSK	6
DATE: 09/20/16	

Aerial photograph obtained from King County iMAP

1936

EXPLANATION

Chen/Scarsella PHU

1936 AERIAL PHOTOGRAPH	ICICLECREEK ENGINEERS 29335 NE 20th Street Carnation, Washington 98014 (425) 333-0093	SCALE: No Scale DESIGNED: --- DRAWN: BRB CHECKED: KSK DATE: 09/20/16	ICE FILE NO. 1212-001
CHEN/SCARSELLA PHU			Figure 7

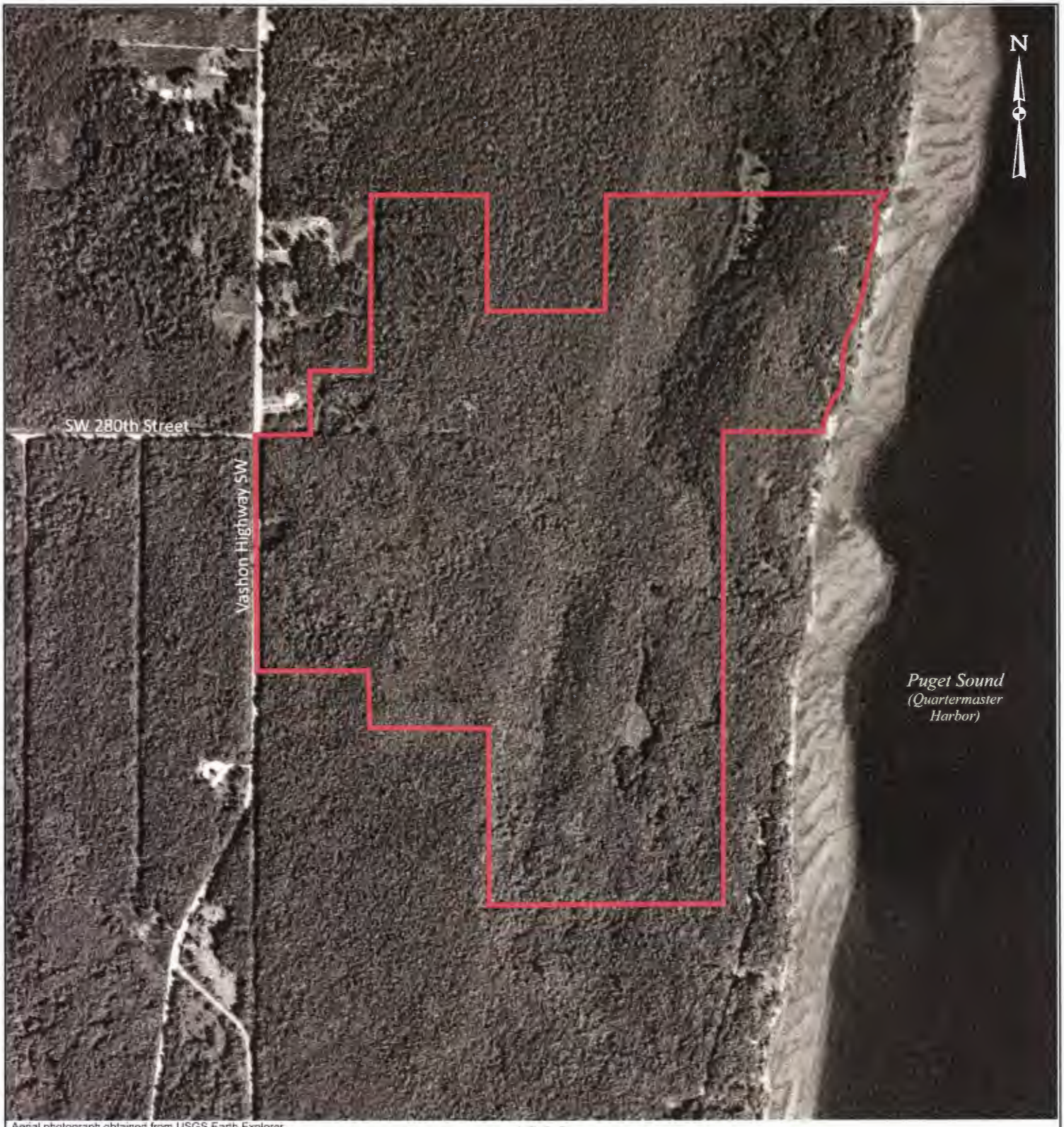
Aerial photograph obtained from USGS Earth Explorer

1951

EXPLANATION

Chen/Scarsella PHU

1951 AERIAL PHOTOGRAPH	ICICLECREEK ENGINEERS 29335 NE 20th Street Carnation, Washington 98014 (425) 333-0093	SCALE: No Scale DESIGNED: --- DRAWN: BRB CHECKED: KSK DATE: 09/20/16	ICE FILE NO. 1212-001
CHEN/SCARSELLA PHU			Figure 8



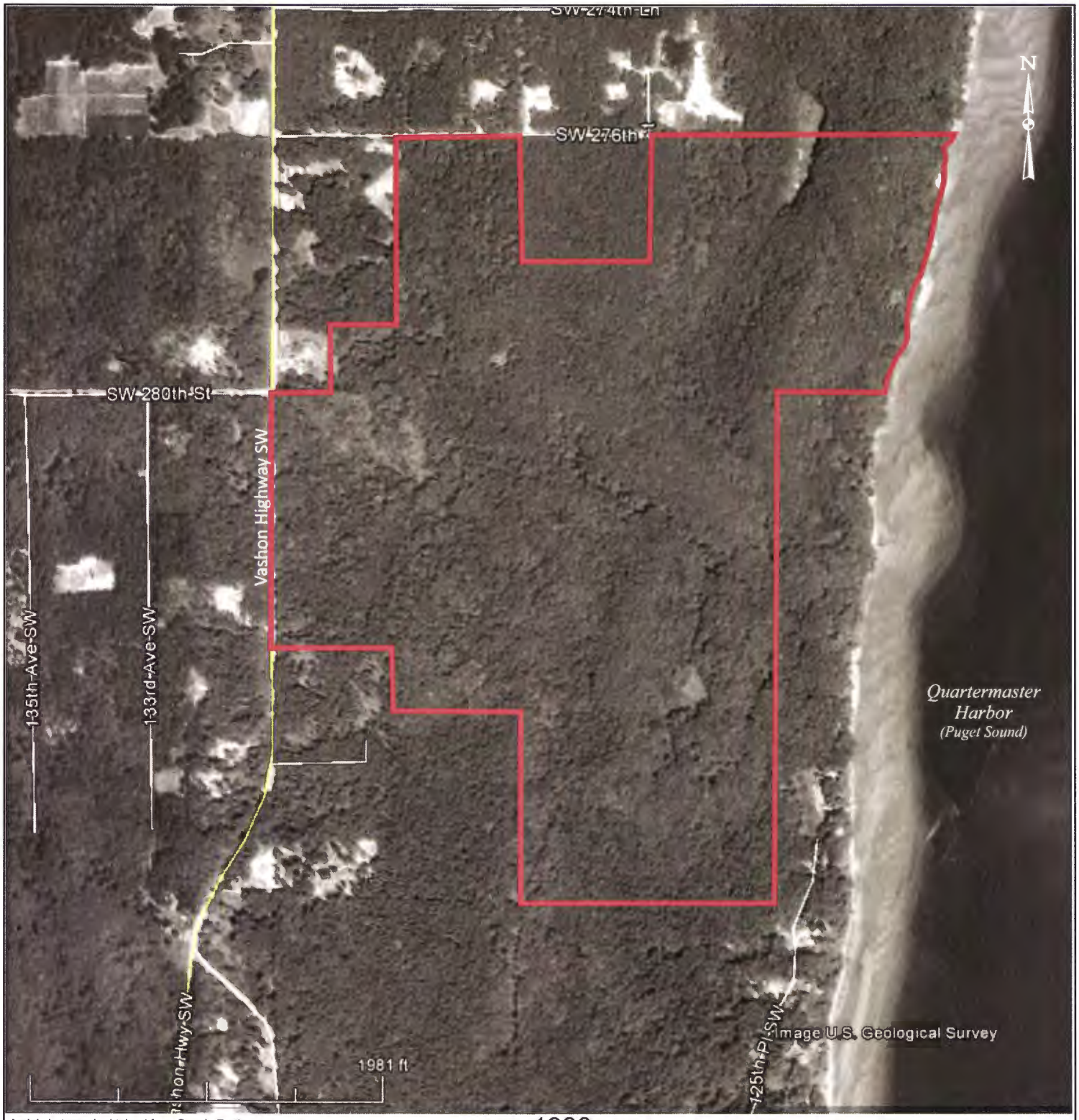
Aerial photograph obtained from USGS Earth Explorer

1968

EXPLANATION

Chen/Scarsella PHU

1968 AERIAL PHOTOGRAPH	ICICLECREEK ENGINEERS 29335 NE 20th Street Carnation, Washington 98014 (425) 333-0093	SCALE: No Scale DESIGNED: --- DRAWN: BRB CHECKED: KSK DATE: 09/20/16	ICE FILE NO. 1212-001
CHEN/SCARSELLA PHU			Figure 9



Aerial photograph obtained from Google Earth

1990

EXPLANATION

Chen/Scarsella PHU Boundary

1990 AERIAL PHOTOGRAPH	ICICLECREEK ENGINEERS 29335 NE 20th Street Carnation, Washington 98014 (425) 333-0093	SCALE: As shown DESIGNED: --- DRAWN: BRB CHECKED: KSK DATE: 09/20/16	ICE FILE NO. 1212-001
CHEN/SCARSELLA PHU			Figure 11

Aerial photograph obtained from Google Earth

2002

EXPLANATION

Chen/Scarsella PHU

2002 AERIAL PHOTOGRAPH	ICICLECREEK ENGINEERS 29335 NE 20th Street Carnation, Washington 98014 (425) 333-0093	SCALE: As shown DESIGNED: --- DRAWN: BRB CHECKED: KSK DATE: 09/20/16	ICE FILE NO. 1212-001
CHEN/SCARSELLA PHU			Figure 12

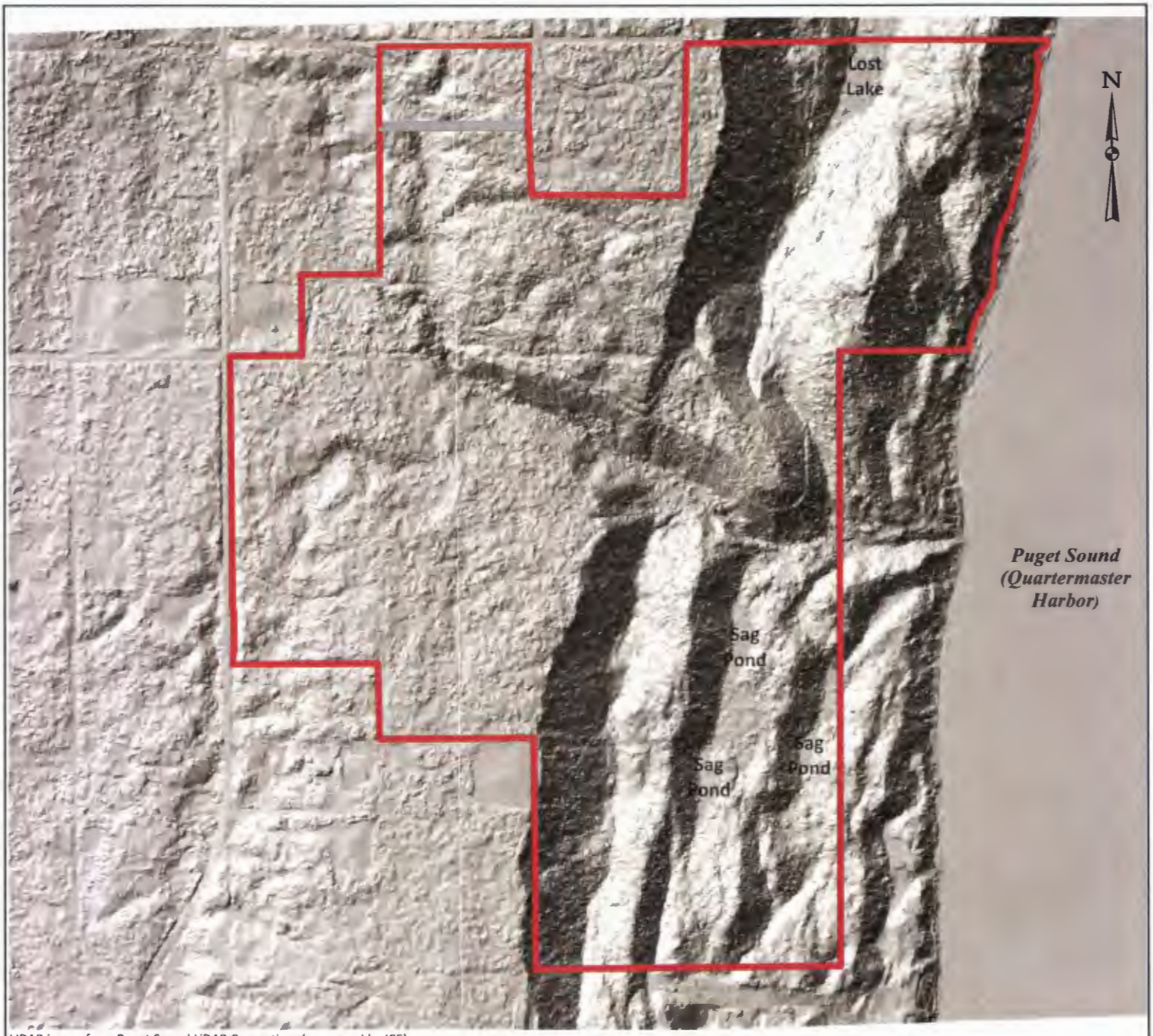
Aerial photograph obtained from Google Earth

2015

EXPLANATION

Chen/Scarsella PHU

2015 AERIAL PHOTOGRAPH	ICICLECREEK ENGINEERS 29335 NE 20th Street Carnation, Washington 98014 (425) 333-0093	SCALE: As shown DESIGNED: --- DRAWN: BRB CHECKED: KSK DATE: 09/20/16	ICE FILE NO. 1212-001
CHEN/SCARSELLA PHU			Figure 13



LIDAR image from Puget Sound LiDAR Consortium (processed by ICE)

N

EXPLANATION

Chen/Scarsella PHU

0 500 1,000

Approximate Scale in Feet

LiDAR IMAGE	ICICLECREEK ENGINEERS	SCALE: As shown	ICE FILE NO.
	29335 NE 20th Street	DESIGNED: ---	1212-001
CHEN/SCARSELLA PHU	Carnation, Washington 98014	DRAWN: BRB	Figure
	(425) 333-0093	CHECKED: KSK	14
		DATE: 09/20/16	

ATTACHMENT A

ECOLOGY WATER WELL LOGS

22/25/36 P

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. 072440

Water Right Permit No. _____

(1) OWNER: Name B. Welch Address 25905 Dockton Rd SW Vashon

(2) LOCATION OF WELL: County King SE ¼ SW ¼ Sec. 36 T. 22 N. R. 2E W.M.

(2a) STREET ADDDRESS OF WELL (or nearest address) 196th St & 130th Vashon

(3) PROPOSED USE: [X] Domestic [ ] Irrigation [ ] DeWater Industrial [ ] Test Well [ ] Municipal [ ] Other [ ]

(4) TYPE OF WORK: Owner's number of well (if more than one) _____
Abandoned [ ] New well [X] Deepened [ ] Reconditioned [ ]
Method: Dug [ ] Cable [ ] Rotary [X] Bored [ ] Driven [ ] Jetted [ ]

(5) DIMENSIONS: Diameter of well 6 inches
Drilled 160 feet Depth of completed well 159 ft

(6) CONSTRUCTION DETAILS:
Casing installed: 6" Diam from 0 ft to 154 ft
Welded [X] Liner installed [ ] Threaded [ ] _____" Diam. from _____ ft to _____ ft.

Perforations: Yes [ ] No [X]
Type of perforator used _____
SIZE of perforations _____ in by _____ in
_____ perforations from _____ ft to _____ ft
_____ perforations from _____ ft to _____ ft
_____ perforations from _____ ft to _____ ft.

Screens: Yes [X] No [ ]
Manufacturer's Name JOHNSON
Type STAINLESS Model No. _____
Diam 6 Slot size .014 from 154 ft to 159 ft
Diam _____ Slot size _____ from _____ ft to _____ ft

Gravel packed: Yes [ ] No [X] Size of gravel _____
Gravel placed from _____ ft to _____ ft

Surface seal: Yes [X] No [ ] To what depth? 18 ft
Material used in seal BENTONITE
Did any strata contain unusable water? Yes [ ] No [X]
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

(7) PUMP: Manufacturer's Name _____
Type _____ H.P. _____

(8) WATER LEVELS: Land-surface elevation above mean sea level _____ ft
Static level 127 ft below top of well Date 9/15/90
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by _____ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes [ ] No [ ] If yes, by whom? _____
Yield _____ gal./min with _____ ft. drawdown after _____ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test _____
Bailer test 7 gal./min with 8 ft. drawdown after 1 hrs.
Airtest _____ gal./min with stem set at _____ ft for _____ hrs.
Artesian flow _____ g.p.m. Date _____
Temperature of water _____ Was a chemical analysis made? Yes [ ] No [X]

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
GRAVELLY BROWN H.P.	0	45
BROWN SANDY GRAVELLY H.P.	45	60
BLUE CLAY	60	100
BROWN SILTY SAND	100	140
BROWN SAND & GRAVEL	140	159

RECEIVED
DEC 0 8 1990
DEPT. OF ECOLOGY

Work started 9/12 1990 Completed 9/15 1990

WELL CONSTRUCTOR CERTIFICATION:
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME STATEWIDE DRILLING CO. (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 1333 Beacon Way S. Renton, WA 98055 772-5771
(Signed) [signature] (WELL DRILLER) License No. 0220
Contractor's Registration No. STATEDCI806 Date 9/15 1990

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20 (10/87) 1329

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original with Department of Ecology
Second Copy - Owner's Copy
Third Copy - Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

ENTERED

Notice of Intent No. W119266 (2)
UNIQUE WELL I.D. # AFA-527
Water Right Permit No. _____

(1) OWNER: Name BOB CASWELL Address 12633 S.W. 276th WASHON W.

(2) LOCATION OF WELL: County KING NE 1/4 NW 1/4 Sec. 36 T. 22 N.R. 2E WM

(2a) STREET ADDRESS OF WELL: (or nearest address) SAME

TAX PARCEL NO.: 22-2E-36

(3) PROPOSED USE: ☑ Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐ DeWater

(4) TYPE OF WORK: Owner's number of well (if more than one) _____
☑ New Well ☐ Deepened ☐ Reconditioned ☐ Decommission
Method: ☐ Dug ☐ Cable ☑ Rotary ☐ Bored ☐ Driven ☐ Jetted

(5) DIMENSIONS: Diameter of well 6 inches
Drilled 180 feet. Depth of completed well 179 ft.

(6) CONSTRUCTION DETAILS
Casing installed: ☑ Welded 6" Diam. from 0 ft. to 179 ft.
☐ Liner installed _____" Diam. from _____ ft. to _____ ft.
☐ Threaded _____" Diam. from _____ ft. to _____ ft.

Perforations: ☐ Yes ☑ No
Type of perforator used _____
SIZE of perforations _____ in by _____ in
_____ perforations from _____ ft. to _____ ft.

Screens: ☐ Yes ☑ No ☐ K-Pac Location _____
Manufacturer's Name _____
Type _____ Model No. _____
Diam. _____ Slot Size _____ from _____ ft. to _____ ft.
Diam. _____ Slot Size _____ from _____ ft. to _____ ft.

Gravel/filter packed: ☐ Yes ☑ No ☐ Size of gravel/sand _____
Material placed from _____ ft. to _____ ft.

Surface seal: ☑ Yes ☐ No To what depth? 20 ft
Material used in seal BENTONITE
Did any strata contain unusable water? ☐ Yes ☑ No
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

(7) PUMP: Manufacturer's Name _____
Type: _____ H.P. _____

(8) WATER LEVELS: Land-surface elevation above mean sea level _____ ft
Static level 130 ft. below top of well Date 10/7/99
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by _____ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom? _____
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test 7/6
Bailer test 75 gal./min. with 5 ft. drawdown after 2 hrs.
Airlift _____ gal./min. with _____ ft. drawdown after _____ hrs.
Artesian flow _____ g.p.m. Date _____
Temperature of water _____ Was a chemical analysis made? ☐ Yes ☑ No

(10) WELL LOG or DECOMMISSIONING PROCEDURE DESCRIPTION
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. Indicate all water encountered

MATERIAL	FROM	TO
BROWN GRAVELLY HP	0	65
BROWN SANDY HP	65	120
BROWN HP	120	145
GRAY CLAY	145	160
GRAY GRAVEL HP	160	165
GRAY CLAY	165	172
GRAY GRAVEL	172	179
GRAY CLAY	179	180

RECEIVED
NOV 15 1999

Work Started _____ Completed 10/7/99

WELL CONSTRUCTION CERTIFICATION:
I constructed and/or accept responsibility for construction of this well, and it complies with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

Type or Print Name JOHNSON License No. 022
(Licensed Driller/Engineer)
Trainee Name _____ License No. _____
Drilling Company Stratamode
(Signed) [signature] License No. 022
(Licensed Driller/Engineer)
Address 1333 Renton Ave S
Contractor's Registration No. STATEC136P6 Date 10/7/99

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (360) 407-6600. The TDD number is (360) 407-6006.

ECY 050-1-20 (11/96)

22-2E-36M (3)

Please print, sign and return to the Department of Ecology

Water Well Report

Original Ecology, 1st copy – owner, 2nd copy driller

Construction/Decommission 181590

☒ Construction

☐ Decommission *ORIGINAL INSTALLATION Notice of Intent Number*

Current Notice of Intent No. W189452

Unique Ecology Well ID Tag No AHH 127

Water Right Permit No

Property Owner Name DAVID STAMPER

Well Street Address 28520 VASHON Hwy S.W

City VASHON County KING

Location NW/4-1/4 SW/4 36 Twn 22 R 02 EWM or WWM

Lat Deg Lat Min Sec

Long Deg Long Min Sec

Tax Parcel No 362202 9026

PROPOSED USE

TYPE OF WORK:

DIMENSIONS: 6 143 143

CONSTRUCTION DETAIL: 6 0 138

Perforation

Screens ☒ Yes ☐ No ☒ K-Pac Location 137

Manufacturer Name JOHNSON STAINLESS

Diam 6 Slot size .016 from 138 143

Gravel Filter packed ☐ Yes ☒

20 BENTONITE

Static water Depth

Method

PUMP Manufacturer's Name

Type H.P.

WATER LEVELS Land surface 96 ft 7/12/05

Artesian pressure

Artesian water controlled

25 5 143 1/2

CONSTRUCTION OR DECOMMISSION PROCEDURE

MATERIAL	FROM	TO
BROWN CLAYEY H.P.	0	65
BROWN GRAVELLY H.P.	65	115
BROWN SAND & GRAVEL	115	125
GRAY CLAY	125	138
GRAY SAND & GRAVEL	138	143

RECEIVED

SEP 07 2005

DEPT OF ECOLOGY

Start Date 7/10/05 Completed Date 7/12/05

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accepted responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and information reported above are true to my best knowledge and belief.

Driller Engineer Trainee: L JOHNSON

Signature: [illegible]

Date: 0220

Company: STATEWIDE DRILLING

Address: 1333 BOREN WAY S RENTON, WA. 98055

Driller License No: STATEDC136RG 7/18/05

IF TRAINEE

Driller's Licensed No

Driller's Signature

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No [redacted] (4)

22/2C/36 F

Water Right Permit No

(1) OWNER: Name Gayland Young Address 33015 18th PL So. #F-302

(2) LOCATION OF WELL: County King SE ¼ NW ¼ Sec 36 T 22 N, R 2E WM

(2a) STREET ADDDRESS OF WELL (or nearest address) 131 Ave S.W VASHON

(3) PROPOSED USE: [X] Domestic [ ] Irrigation [ ] DeWater Industrial [ ] Test Well [ ] Municipal [ ] Other [ ]

(4) TYPE OF WORK: Owner's number of well (if more than one)
Abandoned [ ] New well [X] Deepened [ ] Reconditioned [ ]
Method Dug [ ] Cable [ ] Rotary [X] Bored [ ] Driven [ ] Jetted [ ]

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 104 feet Depth of completed well 100 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Diam from 0 ft to 95 ft
Welded [ ] " Diam from ft to ft
Liner installed [ ] Threaded [ ] " Diam from ft to ft.
Perforations: Yes [ ] No [X]
Type of perforator used
SIZE of perforations in by in
perforations from ft to ft
perforations from ft to ft
perforations from ft to ft
Screens: Yes [X] No [ ]
Manufacturer's Name JOHNSON
Type STAINESS Model No
Diam Slot size from ft to ft
Diam Slot size from ft to ft
Gravel packed: Yes [ ] No [X] Size of gravel
Gravel placed from ft to ft
Surface seal Yes [X] No [ ] To what depth? 18 ft
Material used in seal BENTONITE
Did any strata contain unusable water? Yes [ ] No [X]
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name 3/4 F/W
Type SUB HP 3/4

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 73 ft below top of well Date 4/28/92
Artesian pressure lbs per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes [ ] No [ ] If yes, by whom?
Yield: gal./min with ft drawdown after hrs
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)
Time Water Level Time Water Level Time Water Level
Date of test
Bailer test 10 gal./min with 4 ft drawdown after 1 hrs
Airtest gal./min with stem set at ft for hrs
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes [ ] No [X]

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
BROWN CLAYEY H.P.	0	12
BROWN GRAVELLY H.P.	12	53
BROWN SANDY H.P.	53	92
BROWN SAND	92	100
GREY SAND FINE	100	104

RECEIVED
JUN 30 1992
DEPT. OF ECOLOGY

Work started 19 Completed 4/28 1992

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)

Address

(Signed) [signature] (WELL DRILLER) License No. 0220

Contractor's Registration No STAINEDC136KA Date 4/28 1992

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050 1-20 (10/87) -1329

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. 20540 (B)

Water Right Permit No. 22/2E/36K

(1) OWNER: Name Gene Abbo Address 28642 VASHON Hwy S.W BURTON

(2) LOCATION OF WELL: County KING NW ¼ SE ¼ Sec. 36 T. 22 N., R. 2E W.M

(2a) STREET ADDDRESS OF WELL (or nearest address) 131ST AVE S.W. & 281 ST VASHON

(3) PROPOSED USE: [X] Domestic [ ] Irrigation [ ] DeWater Industrial [ ] Test Well [ ] Municipal [ ] Other [ ]

(4) TYPE OF WORK: Owner's number of well (if more than one)
Abandoned [ ] New well [X] Deepened [ ] Reconditioned [ ]
Method: Dug [ ] Cable [X] Rotary [X] Bored [ ] Driven [ ] Jetted [ ]

(5) DIMENSIONS: Diameter of well 6 inches
Drilled 425 feet. Depth of completed well 425 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Diam from 0 ft. to 420 ft
Welded [X] Liner installed [ ] Threaded [ ]
" Diam. from ft to ft.
" Diam. from ft to ft.

Perforations: Yes [ ] No [X]
Type of perforator used
SIZE of perforations in by in.
perforations from ft. to ft
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes [X] No [ ]
Manufacturer's Name SMITH
Type STAINLESS Model No.
Diam 6 Slot size .012 from 420 ft to 425 ft
Diam Slot size from ft to ft

Gravel packed: Yes [ ] No [X] Size of gravel
Gravel placed from ft to ft

Surface seal: Yes [X] No [ ] To what depth? 11 ft
Material used in seal BENTONITE
Did any strata contain unusable water? Yes [ ] No [X]
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 320 ft. below top of well Date 1/26/94
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes [ ] No [ ] If yes, by whom?
Yield: gal./min with ft. drawdown after hrs.
" " " "
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 10 gal./min. with 10 ft drawdown after 1 hrs.
Airlift gal./min with stem set at ft for hrs
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes [ ] No [X]

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
BROWN SANDY GRAVELY HP	0	135
GREY CLAY	135	155
BROWN SANDY HP	155	380
BROWN SAND (TIGHT)	380	400
GREY SAND	400	420
GREY SAND SMALL GRAVEL (TIGHT)	420	425

RECEIVED
FEB - 9 1994
DEPT. OF ECOLOGY

Work started 19 Completed 1/27 19 94

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME STATEWIDE DRILLING CO. (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
1333 Beacon Way S.
Renton, WA 98055
772-5771
Address

(Signed) [signature] (WELL DRILLER) License No. 0220
Contractor's Registration No. STATEWI936RL Date 1/29 19 94

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20 (10/87) 1329

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

22/28/36 C (6)

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No

Permit No

(1) OWNER: Name Henry Lee Address Rt 2 Box 34A Enumclaw

(2) LOCATION OF WELL: County King

NE ¼ NW ¼ Sec 36 T 22 N, R 5 W M

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)

New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.

Drilled 169 ft Depth of completed well 169 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from 0 ft to 169 ft

Threaded ☐ " Diam. from ft. to ft

Welded ☒ " Diam from ft to ft

Perforations: Yes ☐ No ☒

Type of perforator used

SIZE of perforations in by in.

perforations from ft to ft

perforations from ft to ft

perforations from ft to ft

Screens: Yes ☒ No ☐

Manufacturer's Name JOHNSON

Type STAINLESS Model No

Diam 6 Slot size 012 from 164 ft to 169 ft

Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel

Gravel placed from ft. to ft

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.

Material used in seal BENTONITE

Did any strata contain unusable water? Yes ☐ No ☐

Type of water? Depth of strata

Method of sealing strata off

(7) PUMP: Manufacturer's Name

Type H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft

Static level 150 ft. below top of well Date 7-21-82

Artesian pressure lbs per square inch Date

Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☐ If yes by whom?

ft. drawdown after hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test

Bailer test 7 gal./min with 2 ft drawdown after 1 hrs

Artesian flow g.p.m. Date

Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
BROWN SAND	0	2
BROWN GRAVELLY H.P.	2	60
BROWN SANDY H.P.	60	158
BROWN SAND	158	169

RECEIVED JUL 18 1983 DEPT. OF ECOLOGY

Work started 19 Completed 7-21 1982

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME STATEWIDE DRILLING CO (Person, firm, or corporation) (Type or print)

Address 1333 Beacon Way S. Renton, WA 98055 772-5771

[Signed] Lawrence R Johnson (Well Driller)

License No. 0224 Date 7-21 1982

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. 22/02-36D (7)

Permit No.

(1) OWNER: Name Jon Frederickson Address Rt 5 Box 62 Vashon 98070

(2) LOCATION OF WELL: County King SE¼NW¼ NW¼ Sec 36 T 23 N, R 2 W.M

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 144 ft. Depth of completed well 144 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: " Diam from ft. to ft
Threaded ☐ " Diam. from ft. to ft
Welded ☒ 6 " Diam from 0 ft. to 139 ft

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in by in.
perforations from ft. to ft
perforations from ft. to ft
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Cook
Type Model No
Diam 5 Slot size 12 from 139 ft. to 144 ft.
Diam Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ft. to ft

Surface seal: Yes ☒ No ☐ To what depth? 18 ft
Material used in seal Clay
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name TAIT
Type: Submersible HP. 1/2

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 95 ft. below top of well Date 10-1-81
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 6 gal./min with 35 ft drawdown after 2 hrs
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Surface Soil	0	10
Hard Pan	10	44
Sandy clay	44	58
Hard Pan	58	130
Gravel 6 gpm	130	144

RECEIVED JUN 1 3 1982 DEPARTMENT OF ECOLOGY NORTHWEST REGION

Work started 9-27, 19 81 Completed 10-1, 19 81

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Mueller Drilling (Person, firm, or corporation) (Type or print)

Address 4020 S 170 Seattle

[Signed] L. G. Mueller (Well Driller)

License No. 0930 Date 10-15, 1981

(USE ADDITIONAL SHEETS IF NECESSARY)

S F. No. 7356—OS—(Rev. 4-71)

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. 22/02/36B Permit No. 105 (8)

(1) OWNER: Name Ron Mitchell Address Rt. 2, Box 2248, Burton, Wa. 98013

(2) LOCATION OF WELL: County King — NW ¼ NE ¼ Sec. 36 T. 22 N., R. 2E W.M.

Bearing and distance from section or subdivision corner 362202 - 9050 - 0

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) ____

ABANDONED — New well ☒ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☒ Rotary ☐ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches. Drilled 115 ft. Depth of completed well 61 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from 0 ft. to 61 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used ____
SIZE of perforations ____ in. by ____ in.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.

Screens: Yes ☒ No ☐ Manufacturer's Name Johnsons
Type Stainless steel Model No. ____
Diam. 6 Slot size 70 from 50 ft. to 61 ft.
Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: ____
Gravel placed from ____ ft. to ____ ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? ____ Depth of strata ____
Method of sealing strata off ____

(7) PUMP: Manufacturer's Name ____
Type: ____ H.P. ____

(8) WATER LEVELS: Land-surface elevation above mean sea level ____ ft.
Static level 55 ft. below top of well Date 5/20/80
Artesian pressure ____ lbs. per square inch Date ____
Artesian water is controlled by ____ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom? ____
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test 5/20/80 Estimated ½ G.P.M.
Bailer test ____ gal./min. with ____ ft. drawdown after ____ hrs.
Artesian flow ____ g.p.m. Date ____
Temperature of water ____ Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Topsoil	0	2
Clay and gravel	2	6
Hardpan	6	34
Sand & clay	34	59
Sand and little water	59	60
Harpan	60	66
Dirty sand	66	87
Hardpan	87	90
Dirty sand	90	115
Pulled casing back from 115 to 61 feet.		
ABANDONED		
GROUTED FULL		
SEP 2		

Work started 5/7 1980 Completed 5/20 1980

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Roy Stanfill Drilling Co. (Person, firm, or corporation) (Type or print)

Address Rt. 10, 1745 Wm. Sutton Rd., Bremn., Wa., 98310

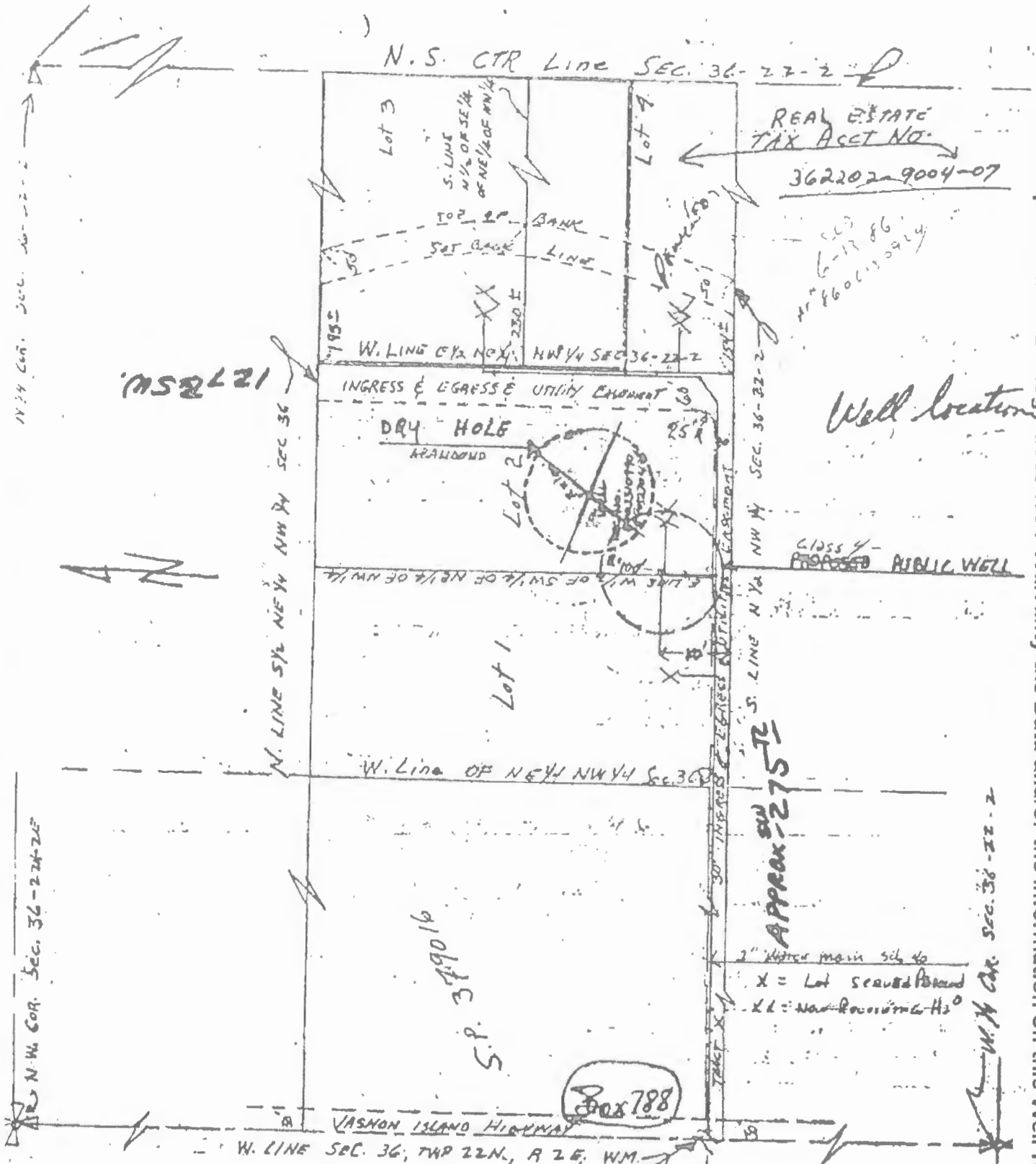
[Signed] Roy Stanfill (Well Driller)

License No. 0468 Date Aug. 26 1980

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1 20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.



The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

22/02-36C (9)

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No

Permit No

(1) OWNER: Name Ron Mitchell Address Rt. 2 Box A Burton, Wa. 9 013

(2) LOCATION OF WELL: County King E½ SW¼ NE¼ NW¼ Sec 36 T 22 N R 2E WM

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☒

(4) TYPE OF WORK: Owner's number of well (if more than one) 2

New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6" inches

Drilled 146 ft Depth of completed well 146 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam from 0 ft to 140 ft

Threaded ☐ " Diam. from ft to ft
Welded ☒ " Diam. from ft. to ft

Perforations: Yes ☐ No ☒

Type of perforator used
SIZE of perforations in by in
perforations from ft to ft
perforations from ft to ft
perforations from ft to ft.

Screens: Yes ☒ No ☐

Manufacturer's Name Johnson
Type Stainless Steel Model No
Diam 5 Slot size .016 from 140 ft to 146 ft
Diam Slot size from ft to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ft to ft

Surface seal: Yes ☒ No ☐ To what depth? 18 ft
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name Sears
Type Sub mersible H.P. 3/4

(8) WATER LEVELS: Land-surface elevation above mean sea level ft
Static level 133 ft below top of well Date 11/8/83
Artesian pressure lbs per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? Morris Drilling
Yield 5 gal./min. with ft drawdown after 2 hrs.
6 5½ 4 "
"

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
0	138½	30 Sec	136½	60 Sec	135
0.5 c	13[illegible]	[illegible] Min	13[illegible]		

Date of test 11/ 8 1983
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water 48° Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Sandy Topsoil	0	3
Brown Gravelly Till	3	50
Brown Sand	50	76
Sand And Gravel	76	102
Brown Gravelly Till	102	122
Brown Sand	122	135
Brown Sand And Water	135	146

DEPARTMENT OF ECOLOGY NORTHWEST REGION

Work started 10/20 1983 Completed 11/8 1983

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Morris Drilling Co. (Person, firm, or corporation) (Type or print)

Address 7215 132 Ave. S.E. Renton, Wa. 98056

[Signed] Thomas J. Morris (Well Driller)

License No 0327 Date 11/14 1983

(USE ADDITIONAL SHEETS IF NECESSARY)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

(10)

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No

Permit No

(1) OWNER: Name Ron Mitchell Address Rt 3 Box 224A Burton, Wa. 98013

(2) LOCATION OF WELL: County King E1/2 - SW1/4 - NW1/4 NW1/4 Sec 36 T 22 N, R 2E W M

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
New well ☒ Method Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6" inches
Drilled 112 ft Depth of completed well 112 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam from 0 ft. to 106 ft
Threaded ☐ " Diam. from ft to ft.
Welded ☒ " Diam from ft to ft

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in by in.
perforations from ft. to ft
perforations from ft to ft.
perforations from ft to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Johnson
Type Stainless Model No
Diam 5" Slot size .010 from 103 ft to 112 ft
Diam Slot size from ft to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft to ft

Surface seal: Yes ☒ No ☐ To what depth? 18 ft
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft
Static level 98 ft below top of well Date 10-1983
Artesian pressure lbs per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes by whom?
Yield gal./min with ft drawdown after hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 5 gal./min with 3 ft drawdown after 2 hrs.
Artesian flow g.p.m. Date 10-19-83
Temperature of water 48 Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation

MATERIAL	FROM	TO
Sandy topsoil	0	3
Brown rocky till	3	10
Brown sandy clay	10	30
some water	29	30
Brown Gravelly Till	30	42
Red compact sand some gravel	42	60
Brown sandy clay	60	107
Sandy clay + water	107	109

NOV 15 1983

Work started 10-12 1983 Completed 10-19 1983

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Morris Drilling Co. (Person, firm, or corporation) (Type or print)

Address 7215 - 122 - Ave S.E. Renton Wa 98056

[Signed] Thomas J. Morris (Well Driller)

License No. 0327 Date 10-30 1983

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

22-2-36F

Start Card No. 098553 (11)

ENTERED

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

UNIQUE WELL I.D. #

Water Right Permit No.

(1) OWNER: Name Ruth Williams Address 15118 Vermontville Rd Vashon

(2) LOCATION OF WELL: County King SE 1/4 NW 1/4 Sec 36 T 22 N, R 2E W.M.

(2a) STREET ADDRESS OF WELL (or nearest address)

(3) PROPOSED USE: [X] Domestic [ ] Irrigation [ ] DeWater Industrial [ ] Test Well [ ] Municipal [ ] Other [ ]

(4) TYPE OF WORK: Owner's number of well (if more than one)
Abandoned [ ] New well [X] Deepened [ ] Reconditioned [ ]
Method: Dug [ ] Cable [ ] Rotary [X] Bored [ ] Driven [ ] Jetted [ ]

(5) DIMENSIONS: Diameter of well 6 inches
Drilled 420 feet Depth of completed well 420 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6" Diam from 0 ft. to 410 ft
Welded [ ] Liner installed [ ] Threaded [ ] " Diam from ft. to ft
" Diam from ft. to ft

Perforations: Yes [ ] No [X]
Type of perforator used
SIZE of perforations in. by in
perforations from ft to ft
perforations from ft to ft
perforations from ft to ft

Screens: Yes [X] No [ ]
Manufacturer's Name JOHNSON
Type Stainless Model No
Diam. 6 Slot size 012 from 410 ft. to 415 ft
Diam 6 Slot size 020 from 415 ft to 420 ft

Gravel packed: Yes [ ] No [ ] Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes [X] No [ ] To what depth? 20 ft
Material used in seal BENTONITE
Did any strata contain unusable water? Yes [ ] No [X]
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level
Static level 265 ft. below top of well Date 2/5/98
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes [ ] No [ ] If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 15 gal./min. with 10 ft. drawdown after 1 hrs.
Artesian gal./min. with stem set at ft. for hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes [ ] No [X]

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
BROWN H.P.	0	40
BROWN SAND	40	180
BROWN SAND & GRAVEL	180	183
GRAY CLAY	183	200
BROWN SANDY H.P.	200	340
GREENISH SAND (W.B.)	340	380
" SAND & SMALL	380	412
GRAVEL (WATER BEARING)		
MED. TO LARGE	412	420
GRAVEL (WATER BEARING		

Work Started 1/31/98, 19 Completed 2/5, 98

RECEIVED
APR 7 1998
NWRO - WR
DEPT OF ECOLOGY

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME STATEWIDE DRILLING CO. (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 1333 Bronx Way S. Renton WA 98055 772-577
(Signed) [signature] (WELL DRILLER) License No. 0220
Contractor's Registration No. STATEDI*126 Date 2/5, 1998

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6600. The TDD number is (206) 407-6006.

ECY 050-1-20 (9/93)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.