Canyon Creek Watershed

LANDSLIDE HAZARD
ZONATION PROJECT

Snohomish County, Washington

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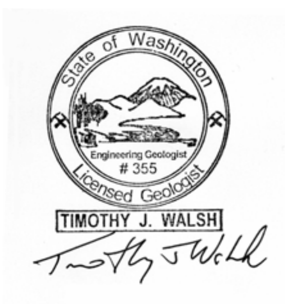

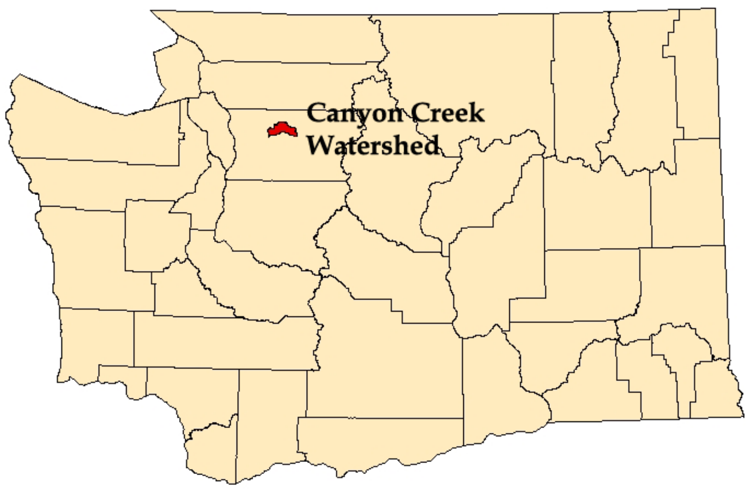

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1.1 Use of this report

The purpose of this mass wasting assessment is to identify non-federal, non-tribal areas within the Canyon Creek watershed administrative unit (WAU) that have moderate or high risk of landslides due to the effects of forest management (logging, roading, thinning, yarding, etc.). All lands within the WAU have been divided into designated mass wasting hazard landforms[1]. Maps of these landforms are designed for use by landowners in determining the areas likely to create landslide hazard and by the Department of Natural Resources regional staff to identify sites where future forest practice applications (Chapter 222-20 WAC) may require detailed investigation prior to forest practice classification (Chapter 222-16-050 WAC).

This is a reconnaissance survey, and its relatively broad resolution must be considered when using this document and its accompanying maps. Moreover, the survey was conducted within a constrained timeline that was budgeted to produce a statewide unstable slopes screening tool as quickly as possible. For this reason, it is likely that some landslides or unstable landforms have been overlooked, some benign features have been mistakenly mapped as landslides, and some landslides have been classified improperly. Thus, the landslide inventory presented in this report (Map A1 and Form A1) is intended to be a representative but not necessarily complete inventory.

This assessment was largely conducted remotely using the best map and image-based resources available, with support from limited field visits to verify mapping results. However, we note that landslide inventories that are conducted primarily using air photos have been demonstrated to omit up to 85% of the landslides that actually exist on the ground in heavily forested areas (Brardinoni and others, 2002). Furthermore, they tend to skew the location of the majority of landslide occurrences toward recently harvested areas because they are easier to spot in these areas than under canopy on air photos (Brardinoni and others, 2002).

Information was collected and compiled in a manner that was designed to respond to the Critical Questions that are outlined in Section II of the Landslide Hazard Zonation (LHZ) protocol, and to direct attention to areas where more detailed analysis is necessary. The objective of the data collection was to generate information sufficient to establish:

- A generalized characterization of mass wasting processes active in the basin;
- Areas of landscape that share similar physical characteristics related to mass-wasting behavior;
- The relative potential for mass wasting to occur among the various landform units.

1.2 Previous Investigations

The Stillaguamish watershed, of which the Canyon Creek WAU is a small part, has long been known to have non-point source pollution, such as high sediment yield caused from erosion and mass movement (SIRC, 2004). The Department of Ecology implemented the Stillaguamish Watershed Action Plan in 1990 (WDOE, 1990), bringing with it an extensive amount of research into the watershed, including studies pertaining to landslides. Two major landslide studies, which have been funded through the Stillaguamish Watershed Action Plan, have been found to intersect with the DNR LHZ project lands and are summarized below (SIRC, 2004).

The Department of Ecology, in conjunction with the Stillaguamish Tribe of Indians, conducted an orphaned road inventory for the Stillaguamish River Watershed in 1993, funded by the Stillaguamish Watershed Action Plan. This report focused on inventorying road systems of all classifications (active, inactive, abandoned and orphaned) to determine their susceptibility to mass wasting and erosion. Methods for road improvements, such as road drainage restoration and erosion control, are also mentioned within the report (Zander, 1993).

The most recent comprehensive landslide study in the Stillaguamish watershed, including Canyon Creek WAU, was conducted by Daniel Miller for the Stillaguamish Tribe of Indians in 2004. This study used 2001 aerial photos to create a landslide inventory to correlate landslides to quantified landscapes to determine slopes susceptible to mass wasting. One hundred and fifty-two landslides were categorized into landscapes. Of these landslides, 35 occurred within glacial landscapes and 117 in bedrock landscapes. No detailed landslide inventory map was included within the publication (Miller, 2004).

1.3 Summary of Methods

This assessment follows the Landslide Hazard Inventory Protocol dated July 13, 2005 (http://www.dnr.wa.gov/forestpractices/lhzproject/lhz_protocol_v2_final.pdf). Cadastral and archival topographic maps between 1884 to 1902 were used to determine pre-aerial photography logging activities, transportation routes, and areas affected by forest fires. The early General Land Office plat maps are the earliest map sources for the Canyon Creek WAU and are used as a basis for pre-settlement historical landscape. However, most of the logging activities, transportation routes, and areas affected by forest fires came from the 1899 1:250,000 USGS topographic map and the 1902 USGS Forest Service Map of Washington Showing Classification of Lands. These historical maps were scanned and entered into ArcGIS and georeferenced, in a methodology adapted from Collins and others (2003).

Four sets of aerial photographs acquired between 1965 through 2001 were viewed with a mirrored stereoscope with 3x magnification (Table 1). In addition, two sets of orthophotos from 1998 to 2003 were analyzed in ArcGIS. Unfortunately, some aerial photos were missing from DNR's collection in Olympia, resulting in incomplete flightlines. 1998 color ortho-photographs coverage and 2003 6-inch pixel color ortho-photos were used as a layer during GIS analysis and mapping.

Table 1. Photographic surveys used in this study.

Year	Scale	Image	Flight Number
1965	1:12:000	black and white	K-SN-65
1971	1:60:000	black and white	NW-H-71
1978	1:12,000	black and white	NW-78
1987	1:12:000	black and white	NW-87
1998	1:12,000	ortho-photographs	NWH-98
2001	1:12,000	Color	NW-C-01
2003	1:12,000	ortho-photographs	NWH-03

Slope failures observed on the stereo photos were classified and catalogued according to the mass wasting feature type. For the purposes of this analysis, landslides that failed below rooting depth are categorized as deep-seated landslides (per the Forest Practices Board Manual, 2004); all remaining slides are classified as shallow landslides. The mass wasting feature types include shallow-undifferentiated landslides, debris flows, debris slides and avalanches, rock topple and fall, snow avalanche, and deep-seated landslides (including earthflows).

The mapped landslides were ranked according to their relative level of certainty as questionable, probable, or definite. Features with some combination of distinct head scarps, lateral margins, scoured run-outs, oversteepened toes, obvious deposits with hummocky topography, or vegetation patterns that indicate landslide disturbance were considered to be definite landslides. Features that were more subdued or concealed by vegetation than those mentioned above made identification of them as landslides less than certain, and were thus considered to be probable landslides. Features that resemble degraded landslides but could have been formed by non-mass wasting processes were considered questionable landslides (following Wieczorek, 1984). Most landslides were mapped from air photos; however several were identified in the field that were not evident on the photos, either in areas of heavy canopy or landslides that postdate the most recent photo set.

Following stereo air photo analysis, all observed landslides were mapped directly into GIS. Transfer of mapped features to a digital database was accomplished by "heads-up" digitization of landslides into a GIS map with layers that included streams, roads, townships, geology, and a USGS 10-meter digital elevation model (DEM) with DEM-derived contours, slope gradients, and hillshades.

Because LIDAR was not yet available for this area, the maximum resolution of this map base is about 10 meters (33 feet). Slope gradients and elevations of small failures that were identified on high-resolution air photos are not accurately estimated by the 10 m DEM due to raster data smoothing. Typically, DEM-derived slope gradients are underestimated by at least 10% relative to field-measured gradients (Dragovich and others, 1993), and more so on smaller features that are smoothed over by the DEM's coarse resolution. However, despite these limitations, the 10 m DEM was used in place of field measurements for the sake of expeditiousness to estimate the gradients of landslides. It should be emphasized that all slope gradient estimates presented in this report are likely minimum approximations.

Slope gradients for shallow landslides were determined by calculating the maximum DEM-derived slope angle within each landslide initiation polygon. For deep-seated landslides, the average slope angle over the entire landslide polygon was calculated. We found that using the average slope gradient for deep-seated landslides provides the quickest and most reasonable representation of the pre-failure slope surface compared to other GIS slope measurement methods.

The air photo survey was also used to determine land use and to map rule-identified landforms (inner gorges, bedrock hollows, etc.). The 10m DEM and other GIS products were used to map low-hazard flat areas, low-gradient hillslopes, and ridgetops, according to the LHZ Protocol. The remaining land in the WAU was divided into analyst-described landforms. These landforms were identified from mass wasting and based on physical attributes of the landscape such as slope gradient, elevation, annual precipitation, lithology, and slope convergence. A combination of slope gradient and elevation data (derived from the 10m DEM), slope convergence data (derived from the DNR SLPSTAB model) (Shaw and Johnson, 1995), geologic data (from USGS 1:100,000 geologic maps), and precipitation and rain-on-snow data aided in the designation of these landforms. These landforms are intended to predict areas within the WAU that are at a particularly high hazard of mass wasting. Each landform was assigned a landslide frequency rate (LFR), a landslide area rate for delivery (LAR), and an overall hazard rating as called for by the LHZ Protocol.

2.0 Physical Setting Pertinent to Mass-Wasting Interpretations

2.1 Introduction

The Canyon Creek WAU covers 40,294 acres in the Cascade foothills, from the confluence of Canyon Creek and the South Fork of the Stillaguamish River in Snohomish County (Map A1) to the U.S. Forest Service Boundary near Olo Mountain. The study area, however, only covers 17,056 acres of the watershed, or all land exclusive of U.S. Forest Service ownership and the Jim Creek Naval Radio Station. Numerous landslides crossed the U.S. Forest Service boundary and were included in map A-1 to improve the robustness of the hazard assessment on LHZ project lands within the WAU.

The WAU ranges in elevation from 300 feet at the confluence of Canyon Creek and the South Fork of the Stillaguamish River to 3,451 feet on the summit of Olo Mountain.

Precipitation within the study area is moderate, averaging 50 inches near the confluence of Canyon Creek with the South Fork of the Stillaguamish River to over 70 inches near Mud Lake and Jim Creek in the northern section of the watershed. 75% of the precipitation within the watershed occurs between October and March. Stream flows peak in late fall-to-winter. Rain-on-snow events most likely occur between 1,500 feet to 2,700 feet. Rain-on-snow events have triggered widespread slope failures in many watersheds within the Cascade foothills (Toth, 1991; Sidle, 1985).

2.2 Topography

Canyon Creek drains the southern portions of the Canyon Creek WAU, from its headwater to its confluence with the South Fork of the Stillaguamish River. One major creek, Jim Creek, drains the northern section of the WAU.

Hillslope gradients range from flat (0%-10%) along Canyon Creek to steep to sheer cliffs in the canyon northwest of Olo Mountain.

2.3 Land use and Historical Considerations

<u>Introduction</u>

Canyon Creek WAU has experienced several historical events that contribute to stability within the watershed. Many of the deep-seated landslides, especially along the glacial terrace, were probably activated by a massive forest fire in the 1500's (see Landform 8). Many old yarding scars from the 1890 to 1930, caused by the dragging of old growth logs up hillsides, have been observed along Canyon Creek and can be misinterpreted as shallow landslides. The valley heading up to Mud Lake from Canyon Creek was the place of the Johnson Dean Mill. The creek along side of the road from Mud Lake to the old millpond appears to be an old flume.

<u>General History</u>

The towns of Granite Falls and Jordan (6 miles north of Granite Falls) have greatly influenced the activities that occurred within the Canyon Creek WAU. As settlers moved into the area, prospectors combed the land, searching for mineral wealth and western red cedar to cut into shingle bolts. In 1892, the Monte Cristo Railroad, funded by John D. Rockefeller was established through Granite Falls, on the way to Monte Cristo. This gave Granite Falls a huge economic boost, as fast, cheap access to Everett's lumber mills and smelters (Woodhouse and Wood, 1979). It also allows heavy equipment to be brought into Granite Falls, essential for expanding mining operations and establishing lumber mills. By 1902, numerous sawmills and shingle mills had begun operation around Granite Falls and many of these logs came from Canyon Creek WAU. The Johnson-Dean Lumber Company established a mill within Canyon Creek, building a millpond and flume as loggers and railroad tracks advanced up towards Mud Lake (aka Lake Serene) (Woodhouse and others, 2000). By the late 1930's, logging had cleared over half of the old growth timber. Logging was sporadic until the 1970's, when timber prices began to rise and logging was extensive. For more information, see Appendix D

Figure 1: Granite Falls on the South Fork of the Stillaguamish River.

Forest History

Forests within the Canyon Creek Watershed are predominantly western hemlock, Douglas fir, Sitka spruce, and western red cedar in the lower elevations and Pacific silver fir and sub-alpine fir in higher elevations. Deciduous trees can be found primarily in the lower elevations, most commonly red alder, vine maple and willow. Most of the watershed is currently managed as forestland and is now in second to third growth timber.

Forest fires occur in the Canyon Creek WAU at intervals of 200 to 300 years. The last major fire in the area occurred in1508, as estimated from dendrochronolgy, when a large fire stretched from Canyon Creek up to the Silverton WAU (SIRC, 2004). For more information, see Appendix E

Historical Weather Events

Historical records on storm events within Washington State were first recorded by European-American settlers in farming journals, dating back to the early 1850's. The major winter storms of 1860, 1861-1862, 1875, and 1880 most likely caused extensive flooding and mass movement, but no records exist for these storms within the Canyon Creek WAU. Storm systems of 1892, 1896, 1897, and 1902 caused damage to infrastructure within Canyon Creek, mostly to logging railroads and wagon roads.

The storm systems in November of 1990 and February of 1996 caused extensive flooding and slope failures within the WAU. Numerous debris flows and shallow landslides, mostly outside DNR regulated lands, were triggered by these storms.

Flow monitoring records listed on the USGS Water Resources website on the Stillaguamish River did not start until 1928 (USGS, 2005). Large peak flow events since the start of hydrologic monitoring occurred on February 26, 1932, February 9, 1951, Nov. 24, 1990, and Nov. 29, 1995. Canopy coverage and age deterred good aerial photo coverage for analysis of storm related slope failures. For more information on significant hydrologic events in this watershed, see Appendix F.

2.4 Geology

Introduction

The geology within Canyon Creek plays a vital role in determining areas of instability. Glacial outwash terraces composed of sand overlaying silt and clay have aided in initiating numerous deep-seated landslides. Metamorphic marine rocks and phyllitic rocks have been laterally spreading (known as sackungen), which has probably led to numerous deep-seated landslides along Olo Mountain.

Regional Geology

Regional bedrock that includes the Canyon Creek watershed belongs to the Western Mélange Belt, part of the Western and Eastern Mélange Belts (WEMB) terrain. The WEMB includes Mesozoic (late Jurassic to early Cretaceous) marine sedimentary rocks, along with lenses of Paleozoic limestone, Mesozoic intrusives, and other rock types in fault-bounded bodies that were tectonically juxtaposed (Tabor and others, 1993). The WEMB rocks underwent high pressure, low temperature metamorphism in the late

Cretaceous orogeny at about the time they were juxtaposed against the Northwest Cascade System terrain to the North.

Numerous faults trend northwest to southeast throughout the watershed.

Local Geology

Bedrock in the Canyon Creek WAU is mainly composed of the Western Mélange Belt, including the Trafton Unit (Tabor and others, 2002; Dragovich and others, 2002; Whetten and Jones, 1981). Sedimentary rocks were deposited during the late Jurassic to early Cretaceous (170 to 100 million years ago) periods, with small pockets of Devonian to Jurassic limestone and chert (Whetten and Jones, 1981; Carithers and Guard, 1945). The sedimentary rock formed from thick silt and mud deposited in a marine setting. This unit appears to have had subsequent submarine landslides, resulting in chaotic bedding called mélange (Tabor and others, 1993; Cowan, 1985). Most of the units in the Canyon Creek WAU have been metamorphosed so such features are locally difficult to discern. Peridotite (dark green to black plutonic rock) intruded around this time into the older marine sedimentary rocks. These rocks were then exposed to regional metamorphism (exposed to heat and pressure). The metamorphism changed the marine sediments into primarily argillite (metamorphosed siltstone), phyllite (metamorphosed mudstone), limestone, slate and chert (white to gray rock) (Yeats, 1964). Peridotite and dunite have metamorphosed into serpentinite (light green to dark green and black dense rock with waxy luster) and talc.

This unit was imbricated (thrust as slivers) into the North American plate by an accretionary wedge (Wells and Heller, 1988; Jett, 1986). The timing for this event is not well known, but is constrained to somewhere between early Cretaceous to the early Eocene (Tabor and others, 1993; Frizzell and others, 1987). This was primarily done by faults. Many of the faults responsible for this imbrication can still be seen trending northwesterly within the WAU, where they form saddles and linear drainages. Most or all of these faults are no longer active. Severe folding also occurred during emplacement and tightly folded and truncated anticlines and synclines can be found throughout the WAU.

A note should be added regarding the northwestern corner of Green Mountain. This area has experienced ‘mountain sagging’, sometimes referred to as sackungen, trending northeast. This area has many features that can be mistaken for other features, such as scarps of deep-seated landslides and sag ponds. Many of these scarps experience slow creep and trees may reflect this with bent trunks. Research on the effects of timber harvest activities on the activity of sackungen would be useful. (for further reading: Clague and Evans, 1994; Thorsen, 1989; Anderson and others, 1980; Dohrenwend and others, 1978; Tabor, 1971)

Numerous linear ponds along Dahlberg Mountain, including Dahlberg Ponds, Jordon Ponds, and Lost Lake do not appear to be from relict or recent deep-seated landslides and are probably a glacial feature known as pater noster lakes. Pater noster, Latin for “our Father” is a reference to the linear beads present on the string of the rosary beads. The feature is a series of bedrock depressions that were probably created by plucking and then scouring by the abrasive force of the glacial movements. Many of these ponds share similar features to pater noster lakes, which can easily be mistaken as sag ponds. Another possibility for these ponds is that they are fault related. Many faults in the region trend northwest.

Poorly-Consolidated Surficial Units

Figure 2: Jack Powell looking down on glacial outwash exposed on the scarp of an active deep-seated landslide.

Surficial units in the Canyon Creek WAU consist of continental glacial drift, alluvium and talus. About 14,000 years ago, the Puget Lobe of the Cordilleran ice sheet, which represents the most recent advance of continental ice sheet, flowed into surrounding valleys. The deposits of this glaciation are called the 'Vashon Drift' locally. Tongues of the Vashon glacier dammed valleys that were tributaries to the Puget Lowlands, creating large ice-dammed lakes. Continental glaciers advanced up the Stillaguamish River system covering the Canyon Creek WAU. Continental glaciers blocked the paleo-Stillaguamish river, impounding a large lake, leaving the valley filled with fluvial (river) and lacustrine (lake) deposits. As the continental glacier retreated, drainages formed in the channel of Mud Lake and formed thick outwash plains dotted with kettles (Tabor and others, 2002; Booth, 1990). Canyon Creek re-established its channel, cutting into the glacial outwash plain and lacustrine deposits. Some of the largest landslides within the WAU were triggered by the incision of Canyon Creek re-establishing its channel post-glaciation.

Stability Issues

Bedrock geology in this watershed has no clear pattern of instability. However, glacial material does have clear patterns relating to slope failures. The outwash plain surrounding Canyon Creek is composed of unconsolidated coarse sand underlain by fine-grained lacustrine clay and silt deposits. This combination allows water to easily infiltrate the sand, but flow along the clay and silt. As water daylights (usually as artesian springs), it creates an area that is highly unstable, leading to large landslide slumps. Further, undercutting by Canyon Creek has oversteepened these banks, leading to two-step landslides, which consist of a toe slope failure followed by a slump of highly saturated material from above. These landslides transport large amounts of sediment into Canyon Creek.

3.0 Summary of Landslide Inventory

Most of the landslides were recorded during this inventory from a review of 1965 to 2003 aerial photographs and recent field investigations (Form A-1). Landslides were rated as ‘questionable’ to ‘definite’, depending on their size and the amount of obscuring canopy. The aerial photos were used to determine land-use and delivery, as well as the landform features. All landslides were recorded into a GIS coverage to aid in identifying their delivery potential, slope shapes, gradient, and elevation. The information from these landslides, once inventoried and mapped, was used in the creation of the landform map (Form A-2).

Mass Wasting Feature Type	Number of Mass Wasting Features Mapped	Area (acres) of Mass Wasting Features
Shallow undifferentiated landslides	205	17
Debris flows	83	35
Debris slide/avalanche	27	8
Rock topple/fall	1	4
Deep-seated landslides	77	5,211

Table 2. Summary of the type and number of LHZ Protocol-specified mass-wasting features mapped in the Canyon Creek WAU.

This assessment found that 69% of the landslides identified were correlated to harvest related activities while 22% were correlated to road systems. Land use was determined for each landform feature (Appendix B). The remaining 9% are predominantly old deep-seated landslides that pre-date timber harvest. These landslides may have been triggered by earthquakes, forest fires, river or glacial erosion.

Figure 3: Deep-seated landslide on an active toe of a deep-seated landslide along Mud Lake.

For the purposes of this study, most landslides that failed below rooting depth are categorized as deep-seated, consistent with the Forest Practices Board Manual. Deep-seated landslides that moved rapidly and clearly deliver sediment are included in the analyses of sediment delivery.

In reviewing the Canyon Creek WAU, a representative sample of 393 landslides was recorded on DNR regulated lands. Of these landslides, 315 were shallow landslides, 77 were deep-seated landslides, and 1 was a rock topple. Three hundred and three landslides were interpreted to have delivered sediment and these were used in construction of the overall hazard ratings (Form A-4). Two hundred twenty-four of these landslides were not road related and were used to construct hazard ratings for harvest and other related forest practice uses. No deep-seated landslides were included in these calculations, but their locations and statistics are presented within this report. The deep-seated features should be evaluated during field visits because of the variability of their activity levels and potential to deliver. A quick review of Form A-1 should determine whether the deep-seated landslides were identified as 'definite', 'probable', or 'questionable' and their activity level. Deep-seated landslides can range in age from about 14,000 years (glacial related deep-seated landslides) to presently active.

Figure 4: Canyon Creek from the edge of the glacial terrace looking upstream (east). Note the deep-seated landslide scars in the foreground.

Toes and scarps should also be carefully evaluated even in dormant and extinct landslides in case of reactivation. Active deep-seated landslides are predominantly in glacial outwash material interbedded with fine-grained glacial deposits (see landform 8). Many of these landslides appear to become active when undercut by the migrating Canyon Creek. Further, harvest in the recharge areas directly above these landslides may increase groundwater and thus initiate or reactivate them. Recharge areas of glacial deep-seated landslides are rule-identified and need to be carefully evaluated and delineated. Kettles within these areas appear to direct water into the subsurface, adding to the glacial recharge. Kettles usually have a very circular appearance surrounded by steep walls and can be confused with sag ponds (landslide number 494 created one particularly large sag pond). The toes and scarps of deep-seated landslides are prone to shallow landsliding and so should also be carefully evaluated even in dormant and extinct landslides.

During the first harvest in this area, probably in the 1930's to 1940's, old growth trees were dragged up the slopes. This activity created large yarding gouges in the hillside, some of which look like old debris flows. However, numerous debris flows and shallow rapid landslides have also been active in this area. The easiest way to determine the difference between the landslides and yarding scars is where the initiation area is located. Shallow landslides, predominantly in this area, failed below old growth stumps or lower on the slope. Yarding scars can be seen as gouges that sometimes left grooves in the flat areas of a ridge.

Dormant to relict deep-seated landslides that occur in landform 9 are in meta-sedimentary units, (predominately argillite and phyllite) and have deflected glacial outwash deposit toes. This area has experienced sackungen (mountain sagging) with combination (complex) and rotational deep-seated landslides. The deep-seated landslides do not appear to be active as a unit; however, the toes of some of these landslides are active. Canyon Creek is actively undercutting these landslide toe slopes, which seems to increase the shallow landslide activity. These toes have spawned numerous shallow landslides, most depositing directly into Canyon Creek

Numerous shallow landslides have occurred in Landform 9, especially in the inner gorge system northeast of landslide 401. Many of these landslides occurred on slopes of 60 percent or greater and are sensitive to both harvest and road activities.

All of these deep-seated landslides on Olo Mountain (inside of the LHZ project area) appear to be dormant to relict. Most of these landslides have similar characteristics, in that they have streams that are close (some less than 100 feet) and parallel to one another. Many shallow landslides occurred in this area early in the photo years from the pre-1970 to 1980's, but have tapered off through the present. Many of these landslides were due to road related activity, especially where roads intersected with deep-seated landslides. Present forest practice rules may have played a key part in reducing the amount of road related landslides.

4.0 Landforms

The Canyon Creek WAU has been delineated into 12 landforms that characterize areas having similar features and identified through the Landslide Hazard Zonation Project Protocol. Landforms are based on a number of characteristics, such as geology, hydrology, geomorphology, topography, and landslide characteristics. The first landforms to be delineated were low slope areas with no evidence of mass wasting. These landforms have been split into flats (0% to 10%), low gradient hills (10% to 40%), and ridgetops (0% to 10%). Three named landforms (also known as rule-identified landforms), inner gorges, bedrock hollows and toes of deep-seated landslides were delineated by slope gradient and slope shape or convergence. The remainder of the area was then delineated by lithology, delivery potential, and also slope gradient and slope form. These areas include moderate gradient hills (40% to 70%), high gradient hills (70% and greater), bodies of active deep-seated landslides, scarps of active deep-seated landslides, glacial terraces, and active scarps. One of these landforms, Steep Valley Walls, has been similarly mapped in Spada Lake WAU and Sultan River WAU and has similar hazards and conditions (Sarikhan and Walsh, 2005; Sarikhan and Pringle, 2005). The following section presents the results of this investigation (4.2 landform description), which has been split into low- and high-hazard-potential landforms. High-hazard landforms will require careful review and field investigation.

4.1 Landform Descriptions
Low Hazard Descriptions (Landforms 1 through 3)

LANDFORM NUMBER: **1**
LANDFORM NAME: **Flats**
OVERALL HAZARD: **Low**
Description:

Landform 1 (Alluvial Plains) consists of level (0-10%) slopes of recent alluvium of the South Fork of the Stillaguamish River (Geologic Unit: Qa), glacial outwash (Geologic Unit: Qgo), glacial till (Geologic Unit: Qgt), and glacial lakebeds (Geologic Unit: Qgl). Small landslides were found on small terraces, but present no danger to harvest or road construction because the Landslide Rate Delivery is low. Confidence is high.

LANDFORM NUMBER: **2, 3**
LANDFORM NAME: **Ridge Tops, Ridge Noses and Low Gradient Hills**
OVERALL HAZARD: **Low to moderate**
Description:

Landform 2 (Ridge Tops and Ridge Noses) and 3 (Low Gradient Hills) comprise low hill slopes (10-40%) as well as ridge tops and noses of glacially carved hills. Some minor landslides have occurred along these hills but do not constitute a danger to harvest practices. Confidence is high.

Moderate to High Hazard Descriptions (Landforms 4 through 13)

4 – Moderate Gradient Hills

Description of Mass Wasting Unit: Landform 4 consists of moderate gradient hillslopes above the valley floors (over 40% gradient) to steep hillslopes (70% gradient).

Slopes: 40% to 70%
Slope Shape: Convergent to Planar
Material: Glacial outwash and till; meta-marine sediments
Elevation: 200 to 3,400 feet
Total Area: 2,316 acres

Mass Wasting Process: Shallow landslides, predominantly shallow rapid and debris flows have occurred uniformly on 40% slopes and greater. Landslides relating to harvest appear to have been caused by diminished root strength and increased run-off. Road failures were caused by sidecast and culvert failures. Landslides uniformly occurred on both convergent and planar slopes.

Forest Practice Sensitivity: Timber harvest is the primary trigger for shallow landslides failures. Post-harvest landslides seem to occur because of increased run-off from loss of canopy and loss of root strength. Slope failures peak 5 to 15 years after harvest and gradually decrease as re-planted trees age (15 to 30 years) and gain root strength. Road sidecast and culvert failures were more common in the past but are now occurring less frequently probably due to increased awareness of best management practices.

Mass Wasting Potential: Moderate for roads or harvest
Based on 41 shallow landslides within a total failed area of 8 acres, this landform has a moderate rate of failure. This landform has a Landslide Frequency Rate of 506 with roads and 383 without roads.

Delivery Potential/Criteria: Moderate. Failures that occur within this landform deliver to tributary streams and into the main channel of Canyon Creek. This landform has a Landslide Area Rate of Delivery of 97 with roads and 47 without roads.

Hazard Potential Rating: Moderate for roads and **Moderate** for harvest based on the LHZ Protocol.

Confidence: Moderate, based on the number of landslides located in this landform, excellent photo quality and coverage, personal communication with field foresters, and field observations. There was limited field verification of landslides within this landform.

5 – High Gradient Hills

Description of Mass Wasting Unit: Landform 5 consists of steep (>70%) hillslopes above the valley floors.

Slopes: Greater or Equal to 70%
Slope Shape: Predominantly planar and convergent
Material: Glacial outwash and till; meta-marine sediments
Elevation: 235 to 3,210 feet
Total Area: 1,050 acres

Mass Wasting Process: This landform is prone to debris flows, shallow rapid landslides, and debris avalanches. Shallow rapid landslides sometimes turn into debris flows that scour channels. This landform may contain old scarps of dormant or relict deep-seated landslides, many of which intersect with this landform.

Forest Practice Sensitivity: Timber harvest is the primary trigger for shallow landslides. Post-harvest landslides seem to occur because of increased run-off from loss of canopy and loss of root strength. Slope failures peak 5 to 15 years after harvest and gradually decrease as re-planted trees age (15 to 30 years) and gain root strength. Road sidecast and culvert failures were more common in the past but are now occurring less frequently probably due to increased awareness of best management practices.

Mass Wasting Potential: High for roads or harvest
Based on 43 shallow landslides within a total failed area of 9 acres, this landform has a high rate of failure with shallow landslides. This landform has a Landslide Frequency Rate of 1,170 with roads and 898 without roads.

Delivery Potential/Criteria: High. Failures that occur within this landform deliver to tributary streams and into the main channel of Canyon Creek. This landform has a Landslide Area Rate of Delivery of 250 with roads and 209 without roads.

Hazard Potential Rating: High for roads and **High** for harvest as described in the LHZ Protocol and standard Forest Practices Rules.

Confidence: Moderate, based on the number of landslides located in this landform, excellent photo quality and coverage, personal communication with field foresters, and field observations. There was limited field verification of landslides within this landform.

6 – Body of Deep Seated Landslide (Active)

Description of Mass Wasting Unit: Landform 6 consists of the bodies of active deep-seated landslides, primarily in glacial material. The largest of the landslides occur within landform 8 (on a glacial outwash plain), but smaller slides occur throughout the watershed.

Slopes: Greater or equal to 30%
Slope Shape: Predominantly planar and convergent
Material: Primarily glacial outwash and lakebed deposits.
Elevation: 570 to 925 feet
Total Area: 1,996 acres

Mass Wasting Process: The bodies of deep-seated landslides within Canyon Creek have few recorded shallow landslides. However, due to the unconsolidated nature of the predominant material in most of the active deep-seated landslides, shallow landslides are frequent, especially where angles become critical (see landform 8, 9). Shallow rapid landslides sometimes become debris flows, which can enter Canyon Creek or tributaries of Canyon Creek

Forest Practice Sensitivity: Harvest in the recharge areas directly above glacial deep-seated landslides may increase groundwater and thus initiate or reactivate them. Recharge areas of glacial deep-seated landslides are rule-identified and need to be carefully evaluated and delineated. Proper water management from roads on glacial deep-seated landslides is critical. This landform is sensitive to concentrated water and potentially to harvest in the recharge area. The addition of water due to the losses of canopy interception and evapotranspiration may adversely affect the stability of this landform. Decreased rooting strength, especially in unconsolidated material, has been observed to increase landslide activity on steep scarps and toes and in the inner gorges of the marginal streams.

Mass Wasting Potential: <u>Moderate for road construction and timber harvest.</u> Because harvest and road management are associated with active deep-seated landslides, they are at a higher risk for failure and potential for reactivation of slide activity. This landform, by calculation, has a Landslide Frequency Rating of low, however is considered moderate due to the potential hazard as described in the LHZ protocol.

Delivery Potential/Criteria: High. Shallow landslides failing from the scarp of deep-seated landslides have delivered to Canyon Creek or adjoining tributaries. Failures on the bodies of these deep-seated landslides, especially where angles are high, have a high chance of delivering as well.

Hazard Potential Rating: <u>Moderate for roads and harvest</u> as described in the LHZ Protocol.

Confidence: <u>High</u>, based on the number of landslides located in this landform, excellent photo quality and coverage, personal communication with field foresters, and field observations. Careful field review will be necessary to delineate all the areas containing increased risk of failures within these features, because field investigation has located a number of features masked by canopy.

7 – Toes and Scarps of Deep Seated Landslides

Description of Mass Wasting Unit: Landform 7 consists of active toes and scarps of deep-seated landslides. The most active toes are located southeast of Olo Mountain, where Canyon Creek is undercutting toes of dormant deep-seated landslides, activating the toes. The other active toe is located west of Mud Lake. Small active scarps are located on landslides in the glacial outwash plain southwest of Olo Mountain.

Slopes: Greater than or equal to 65%
Slope Shape: Convergent and Planar
Material: Predominantly fine grained glacial lakebeds
Elevation: 600 to 1,500 feet
Total Area: 886 acres

Mass Wasting Process: Because of the oversteepening caused by the active toe, this landform is prone to shallow rapid landslides, soil slips, debris flows, and debris avalanches. Smaller deep-seated landslides have also been activated on the toes, most likely because of weakened material and steepened slopes.

Forest Practice Sensitivity: Harvest has had significant impacts in landslide failures. Landslides post-harvest seem to fail because of increased run-off and progress as root strength diminishes. Slope failures peak between clearcutting (0 to 5 years) and young standing timber (5 to 15 years) and sharply decrease as root strength redevelops. Future harvest on scarps and toes of deep-seated landslides would likely cause further slope failures due to loss of root strength and increased water run-off, similar to the way they failed after the last harvest. Road construction on these landforms could increase run-off and exacerbate the unstable nature of the toes and scarps of these deep-seated landslides.

Mass Wasting Potential: <u>High for road construction and timber harvest.</u> Deep-seated landslide tToes over 65% are rule-identified in the LHZ Protocol and are high hazard. Scarps also pose a danger of failure, but are not rule-identified. 36 shallow landslides were recorded on scarps, with smaller deep-seated landslides activated on the toes. Because these features are associated with active deep-seated landslides, they are at a high risk for failure and/or potential for increased slide activity. The landform has a <u>Landslide Frequency Rating</u> of 1,161 with or without roads.

Delivery Potential/Criteria: <u>High.</u> Shallow landslides have been observed to fail directly into Canyon Creek or in tributaries reaching Canyon Creek. The unit has a calculated <u>Landslide Area Rate of Delivery</u> of 64 with or without roads.

Hazard Potential Rating: <u>High for roads and harvest</u> as described in the LHZ Protocol and Standard Forest Practices Rules.

Confidence: <u>Moderate</u>, based on the number of landslides located in this landform, excellent photo quality and coverage, personal communication with field foresters, and field observation. There was limited field verification of landslides within this landform.

8 – Glacial Terraces

Description of Mass Wasting Unit: This landform is underlain by two distinct geological units, loose to medium dense, coarse sand and gravel alluvium and medium dense to dense sandy recessional outwash glacial deposit (Taber and others, 2002). At an elevation of about 800 feet, it has been observed that a thick layer of glaciolacustrine silt and clay layer exists. Springs are common near this contact zone (fp2806171). Sag ponds are present near the terrace faces and most of the cliffs have been formed by deep-seated landslide failures.

Slopes: Greater than or equal to 70%
Slope Shape: Convergent and Planar
Material: fine grained glaciolacustrine clay and silt overlain by sand and gravel
Elevation: 500 to 1,400
Total Area: 270 acres

Mass Wasting Process: Because of the glacial sediment emplacement and steep terraces created by Canyon Creek, this landform is prone to deep-seated and shallow landslides, shallow rapid landslides, soils slips, and debris flows. Shallow landslides sometimes turn into debris flows, flowing directly into Canyon Creek.

Forest Practice Sensitivity: This landform is sensitive to water concentration and loss of rooting strength. Dozens of shallow landslides, apart from the active deep-seated landslides, have occurred after the last harvest. Shallow rapid landslides would likely recur due to loss of root strength similar to the way they failed after the last harvest.

Mass Wasting Potential: <u>Very High for road construction and for timber harvest</u> based on 26 shallow landslides and numerous deep-seated landslides, both active and dormant, with a total amount of landslide area of 2.9 acres. The landform has a <u>Landslide Frequency Rating</u> of 3,500 with roads and 2,756 without roads.

Delivery Potential/Criteria: <u>Very High</u>. Landslides produced within this landform have caused water quality issues by delivering high amounts of sediment into Canyon Creek. After the last harvest, deep-seated landslides failed, causing tens of thousands of cubic yards of sediment to be delivered into Canyon Creek. Shallow landslides appear to have formed after the last harvest and more recently on portions of the scarps. Some of the shallow landslides became debris flows and flowed into Canyon Creek, its tributaries, or side channels. Delivery criteria are based on historical occurrences of landslides observed on aerial photographs and confirmed during field investigations. The unit has a calculated <u>Landslide Area Rate of Delivery</u> of 470 with roads and 303 without roads.

Hazard Potential Rating: <u>Very High</u> for roads and for harvest as described in the LHZ Protocol and Standard Forest Practices Rules.

Confidence: <u>High</u>, based on the number of landslides located in this landform, excellent photo quality and coverage, personal communication with field foresters, and field observations.

9 – Steep Valley Walls

Description of Mass Wasting Unit: This landform was formed by Canyon Creek creating very steep valley walls between Olo Mountain and Green Mountain. Slopes above 70% gradient are prone to repeated failures. This canyon has experienced numerous deep-seated landslides, on which many toes are still active.

Slopes: Greater than or equal to 70%
Slope Shape: Convergent and Planar
Material: Glacial outwash and till; meta-marine sediments
Elevation: 750 to 3,200 feet
Total Area: 413 acres

Mass Wasting Process: Shallow rapid landslides, debris flows, and debris avalanches are common within this landform. Many of the shallow rapid landslides and debris avalanches have formed into debris flows, often scouring the channel down to Canyon Creek, creating large sediment plumes. Rock topples can occur within this landform and have delivered rock at least halfway down the valley walls (800 to 1,000 feet of elevation). Dormant to relict deep-seated landslides encompass the whole valley. These appear to be moving very slowly as creep. Many of the deep-seated landslides have active toes.

Forest Practice Sensitivity: Road construction and harvest have both had significant impacts on slope stability. Road issues such as culvert and sidecast failures, have produced large debris flows, most of which delivered directly to Canyon Creek. In-unit failures suggest that timber harvest and loss of root strength is the primary trigger for shallow landslides failures. Landslides post-harvest seem to occur because of increased run-off and progress as root strength diminishes. As interpreted from the air photos, slope failures peak 5 to 15 years after the last harvest in the 1970's and gradually decrease as the trees become older (15 to 30 years) and regain root strength. Future harvest in these areas may cause slope failures again due to loss of root strength and increased water run-off similar to the way they failed after the last harvest.

Mass Wasting Potential: <u>Very High naturally, regardless of forest practices activities.</u> Based on 46 shallow landslides having a total failure area of 11.2 acres, this landform is extremely unstable. Landslides from this landform could become debris flows that would deliver sediment to Canyon Creek and its tributaries. This landform has a <u>Landslide Frequency Rate</u> of 3,178 with roads or 1,381 without roads.

Delivery Potential/Criteria: <u>Very High.</u> Slope failures that occur within this landform usually deliver to streams that flow directly into Canyon Creek. Due to the steep slopes and numerous streams, landslides have a high tendency to deliver. This landform has a <u>Landslide Area Rate of Delivery</u> of 773 with roads or 235 without roads.

Hazard Potential Rating: <u>Very High</u> for Roads and for harvest as described in the LHZ Protocol and standard Forest Practices Rules.

Confidence: <u>Moderate</u>, based on the number of landslides located in this landform, excellent photo quality and coverage, personal communication with DNR field foresters, and field observations. There was limited field verification of landslides within this landform.

10 and 11 - Inner Gorges and Bedrock Hollows

Description of Mass Wasting Units: These mass wasting units consist of inner gorges and bedrock hollows. The bedrock hollows of Canyon Creek WAU are steep (>70%) spoon shaped depressions or swales 75 to 200 feet across. Bedrock hollow evacuations can trigger debris flows that scour channels forming inner gorges. The inner gorges are steep walled (>70%) gullies formed by a combination of stream action and mass wasting.

Slopes: Greater than or equal to 70%
Slope Shape: Convergent
Material: Inner gorges and bedrock hollows occur in all rock types in this watershed
Elevation: 220 to 3,080 feet
Total Area: 1,214 acres (landform 10) and 7 acres (landform 11)

Mass Wasting Process: These landforms are prone to repeated shallow landslides (shallow rapid landslides and debris flows). Shallow landslides within the bedrock hollows and inner gorges can initiate debris flows. These landforms can be located on deep-seated landslides, which can increase instability of these landforms.

Forest Practice Sensitivity: These landforms are naturally unstable, and more so when water is concentrated on them. Water can greatly impact landslides on this landform and should be directed off them. Extreme storm events and prolonged rain events have initiated numerous shallow landslides and debris flows, regardless of forest practice activity.

Mass Wasting Potential: Very High regardless of forest practice activity based on 92 (landform 10) and 5 (landform 11) landslides totaling 25 acres of failed material. The inner gorges (landform 10) have a Landslide Frequency Rating of 2,165 with roads or 1,695 without roads. Bedrock hollows (landform 11) have a Landslide Frequency Rating of 19,564 with roads or 3,913 without roads.

Delivery Potential/Criteria: Very High. Delivery criteria are based on historical occurrence observed on aerial photographs and proximity of the unstable feature to streams and confirmed during field investigation. Inner gorges and most bedrock hollows are part of the drainage network and inner gorges are adjacent to or contain streams. Inner gorges have a Landslide Area Rate of Delivery of 505 with roads or 334 without roads. Bedrock hollows have a Landslide Area Rate of Delivery of 13,378 with roads or 798 without roads.

Hazard Potential Rating: Very High for roads and harvest based on LHZ Protocol and Standard Forest Practices Rules.

Confidence: Moderate, based on the number of landslides located in this landform, excellent photo quality and coverage, personal communication with field foresters, and field observation. There was limited field verification of landslides within this landform.

5.0 Hazard Ratings

Pursuant to the LHZ Protocol, hazard ratings for mass-wasting landforms were determined by the following: 1) rule-identified status (WAC 222-16-050), 2) the Landslide Frequency Rate (LFR) and Landslide Area Rate for Delivery (LAR), 3) the professional judgment of the analyst, or 4) an interpretation of deep-seated landslide hazard. The Landslide Area Rate for Delivery is the area of delivering landslides normalized for the period of study and the area of each landform. These values are then multiplied by one million for easier interpretation. Limited application suggests that Landslide Area Rates for Delivery less than 76 are low hazard, rates of 76 to 150 are moderate hazard, rates of 151 to 799 are high hazard, and rates greater than 799 are very high hazard (Lingley, 2004). Note that higher Landslide Area Rates for Delivery can be achieved by reducing the area of the Landform. While this may appear to be 'data gerrymandering', it helps limit the area of high-hazard landforms to those areas that are actually demonstrated to have high hazard. The Landslide Frequency Rate is calculated similarly, however the number of delivering landslides is used instead of the area of delivering landslides. As of the writing of this report, the qualitative rating system below is used (Table 3). Form A-4 (Appendix D) summarizes all landform hazard ratings.

Qualitative Ratings	Landslide Frequency Rate	Landslide Area Rate for Delivery
Low	< 100	<76
Moderate	100 to 199	76 to 150
High	200 to 999	151 to 799
Very High	>999	>799

Table 3: Qualitative rating system for the LFR and LAR.

6.0 Note on Confidence in Work Products

The confidence in this mass wasting assessment is <u>Moderate</u>. This rating is based on the Landslide Hazard Zonation Project design to provide a watershed overview of slope stability in a timely manner with minimal field verification. Therefore, fieldwork and the number of aerial photograph sets examined are held to reasonable minimums. Omissions will be present due to the limited field verification of individual features, particularly in forested areas with heavy canopy.

It is critical for the reader to understand that while these decisions are sufficient to characterize aspects of the slope failure as functions of forest management, <u>this assessment would be entirely insufficient and misleading if it is used as a stand alone document for protecting private and public resources or for land use planning.</u> Keep in mind that this is only a reconnaissance study, and <u>undoubtedly, some landslides have been omitted and some benign features may be incorrectly mapped as landslides herein</u>.

In addition, there are several sources of systematic error that reduce the confidence in the work products of this analysis, those being omission, misinterpretation, and limits to accuracy and precision. Omission occurs when mass wasting features are not identified on aerial photographs or in the field due to canopy cover, gaps in the aerial photo record, quality of aerial photos, or interpreter errors. Misinterpretation occurs when a mass-wasting feature is identified but incorrectly classified or data are transposed, and where unrecognized software/file instability occurs. Accuracy involves the degree to which the physical parameters of a mass-wasting feature are correctly measured, and precision describes how variability within an assessment can be controlled when making multiple measurements over varying time and spatial scales.

This mass wasting assessment was primarily conducted with aerial photographs, and as a result, there is a high likelihood that errors of omission occurred, primarily in areas covered by mature forest canopies, steep north facing slopes always in shadow at any given time, and those areas covered with extensive glacial deposits (Brardinoni and others, 2002). The scarcity of mass wasting features identified under mature canopy and steep north slope aspect shadow conditions is not necessarily an indication of the relative stability of slopes with mature vegetation regimes or steep north face aspects.

Because many deep-seated landslide features are quite large, remain heavily vegetated during movement, and may not have obvious scars visible through the vegetation canopy, misinterpretation is more likely. A recent detailed study in Cowlitz County, Washington, suggests that up to 25 percent of inferred deep-seated landslides identified from aerial photograph analysis are misinterpreted (Wegmann, 2003). Confidence in work products related to classification of deep-seated landslide processes in this watershed is high due to visibility and completeness of photo coverage.

Another important source of potential error in this assessment is in the accuracy and precision of measurements of mass wasting features. Because less than 50% of landslides were actually visited in the field, it is not possible to report the degree to which location and measurement error in the GIS environment compares to on-the-ground field measurements. Similarly, measurements of slope angle from digital elevation models typically misrepresent the true hill slope angle. Given these sources of error, the confidence in the precise location and accuracy of measurements of individual landslides is considered moderate.

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SLIDE_ID	LSI_PROCES	CERTAINTY	ID_DATE	LS_SIZE	ID2_DATE	ID2_SIZE	INIT_ELEV	PHOTO_NUM	LANDFORM	LANDFORM_2	SLP_SHP	GRADIENT	DELIVERY	LANDUSE	GEOL_UNIT	WAU_LANDFO	ACTIVITY_L
101	4	D	1965	0	0	0	2079	DEM	8	0	3	22	Y	9		0	DI
102	2	D	1965	0	0	0	1038	K-SN-65 31-37	0	0	3	65	Y	2		0	
103	2	D	1965	0	0	0	891	K-SN-65 31-37	0	0	5	77	Y	2		0	
104	1	D	1965	0	0	0	2465	K-SN-65 31-39	0	0	1	76	Y	5		0	
105	1	D	1965	0	0	0	1410	K-SN-65 27-104	0	0	3	72	Y	2		0	
106	3	D	1965	0	0	0	318	K-SN-65 26D-18	0	0	3	61	Y	3		0	
107	4	P	1965	0	0	0	2321	DEM	8	0	3	72	P	9		0	R
108	2	D	1965	0	0	0	3173	K-SN-65 31-39	0	0	1	30	Y	5		0	
109	2	D	1965	0	0	0	2878	K-SN-65 31-39	0	0	1	61	Y	5		0	
110	1	D	1987	0	0	0	986	NW87 13 65-121	0	0	3	68	P	2		0	
111	1	D	1965	0	0	0	1438	K-SN-65 27-104	0	0	3	63	Y	2		0	
112	1	D	1987	0	0	0	867	NW87 13 65-119	4	0	4	84	Y	3		0	
113	4	P	1978	0	0	0	1093	NW-78 78C-119	8	0	2	52	Y	2		0	DD
114	1	D	1965	0	0	0	900	K-SN-65 30-37	0	0	3	52	Y	5		0	
115	1	D	1978	0	0	0	1215	NW-78 78C-119	0	0	1	77	Y	1		0	
116	1	D	1987	0	0	0	843	NW87 13 65-119	4	0	4	83	Y	3		0	
117	4	P	1965	0	0	0	1218	DEM	8	0	2	59	P	9		0	R
118	1	D	1987	0	0	0	683	NW87 13 60-50	1	0	2	55	Y	2		0	
119	4	D	1987	0	0	0	1548	NW87 13 65-121	8	0	3	72	Y	2		0	AR
120	2	D	1965	0	0	0	1400	K-SN-65 27-104	0	0	2	66	Y	2		0	
121	2	P	1965	0	0	0	2152	K-SN-65 31-39	0	0	3	47	Y	2		0	
122	2	D	1965	0	0	0	2251	K-SN-65 31-37	0	0	3	82	Y	2		0	
123	4	P	1965	0	0	0	2155	DEM	8	0	3	51	Y	9		0	DI
124	4	D	1965	0	0	0	1444	K-SN-65 27-102	8	0	3	69	Y	2		0	DD
125	3	D	1987	0	0	0	973	NW87 13 65-121	0	0	3	63	Y	3		0	
126	4	D	2005	0	0	0	970	Field	8	0	3	53	P	5		0	AR
127	2	P	1965	0	0	0	852	K-SN-65 28-39	0	0	3	104	Y	5		0	
128	4	D	1965	0	0	0	2911	DEM	8	0	3	40	P	9		0	DI
129	4	P	1965	0	0	0	2207	DEM	8	0	3	48	Y	9		0	DD
130	1	D	1965	0	0	0	1302	K-SN-65 27-102	0	0	4	91	Y	2		0	
131	4	P	1965	0	0	0	1112	K-SN-65 28-41	8	0	1	92	Y	3		0	DD
132	1	D	1987	0	0	0	1023	NW87 13 65-121	0	0	2	66	Y	2		0	
133	1	D	1978	0	0	0	1334	NW-78 78C-121	1	0	2	77	Y	1		0	
134	3	D	1987	0	0	0	2007	NW87 13 65-122	1	0	4	70	Y	2		0	
135	4	P	1965	0	0	0	2094	DEM	8	0	4	72	P	9		0	DI
136	1	D	1978	0	0	0	1766	NW-78 78C-119	0	0	3	70	Y	5		0	
137	1	D	1978	0	0	0	1420	NW-78 78C-119	0	0	2	86	Y	1		0	
138	3	D	1987	0	0	0	1773	NW87 13 65-121	0	0	3	93	Y	5		0	
139	4	D	1965	0	0	0	419	K-SN-65 26D-18	8	0	2	35	Y	3		0	DD
140	1	D	1978	0	0	0	2203	NW-78 78C-121	0	0	1	93	Y	1		0	
141	1	D	1965	0	0	0	1449	K-SN-65 27-104	0	0	3	70	Y	2		0	
142	1	D	1978	0	0	0	840	NW-78 78C-119	0	0	3	94	Y	1		0	
143	4	D	2005	0	0	0	975	Field	8	0	2	60	P	2		0	AR
144	4	D	1965	0	0	0	2802	DEM	8	0	3	67	Y	9		0	DD
145	1	D	1978	0	0	0	1333	NW-78 78C-119	0	0	4	85	Y	1		0	
146	2	P	1978	0	0	0	2787	NW-78 77F-4	0	0	1	22	Y	5		0	
147	2	P	1965	0	0	0	1093	K-SN-65 29-36	0	0	1	58	Y	2		0	
148	1	D	1987	0	0	0	1045	NW87 13 65-121	0	0	2	60	Y	2		0	
149	1	D	1987	0	0	0	1000	NW87 13 65-121	0	0	3	96	P	2		0	
150	1	D	1965	0	0	0	1414	K-SN-65 27-104	1	0	3	91	Y	2		0	
151	2	D	1965	0	0	0	1513	K-SN-65 27-104	0	0	3	50	Y	2		0	

152	1	D	1965	0	0	0	1368	K-SN-65 27-104	0	0	2	62	Y	2		0	
153	1	D	1987	0	0	0	639	NW87 13 61-74	0	0	3	46	I	1		0	
154	2	D	1965	0	0	0	2927	K-SN-65 31-39	0	0	1	50	Y	5		0	
155	1	D	1965	0	0	0	1178	K-SN-65 30-37	0	0	3	72	Y	5		0	
156	4	P	1965	0	0	0	945	K-SN-65 31-37	8	0	1	55	Y	2		0	DD
157	1	D	1978	0	0	0	1395	NW-78 78C-119	0	0	1	70	Y	1		0	
158	1	D	1978	0	0	0	1196	NW-78 78C-119	0	0	4	67	P	1		0	
159	1	D	1987	0	0	0	1092	NW87 13 65-121	0	0	2	61	Y	2		0	
160	1	D	1965	0	0	0	1106	K-SN-65 27-102	0	0	3	52	Y	3		0	
161	1	D	1978	0	0	0	1139	NW-78 78C-119	0	0	2	92	P	1		0	
162	1	P	1965	0	0	0	1939	K-SN-65 31-41	0	0	3	46	Y	2		0	
163	1	D	1978	0	0	0	1039	NW-78 78C-119	0	0	2	62	Y	1		0	
164	1	D	2005	0	0	0	662	Field	0	0	3	71	P	5		0	
165	4	P	1965	0	0	0	1335	DEM	8	0	3	54	Y	9		0	DI
166	1	D	1965	0	0	0	2201	K-SN-65 31-39	0	0	3	50	Y	2		0	
167	2	D	1965	0	0	0	837	K-SN-65 31-37	4	0	3	86	Y	2		0	
168	2	D	1965	0	0	0	956	K-SN-65 31-37	4	0	1	101	Y	2		0	
169	3	D	1996	0	0	0	1796	Field	0	0	3	51	Y	5		0	
170	2	D	1965	0	0	0	2222	K-SN-65 31-37	0	0	2	72	Y	2		0	
171	1	D	1965	0	0	0	1811	K-SN-65 31-41	0	0	1	51	Y	5		0	
172	1	P	1965	0	0	0	2026	K-SN-65 31-41	0	0	4	44	Y	2		0	
173	1	D	1978	0	0	0	1309	NW-78 78C-119	0	0	1	75	Y	1		0	
174	4	P	1965	0	0	0	1367	DEM	8	0	3	77	Y	9		0	DI
175	1	D	1965	0	0	0	910	K-SN-65 27-102	0	0	2	62	Y	3		0	
176	1	D	1965	0	0	0	1772	K-SN-65 31-41	0	0	4	64	Y	1		0	
177	4	D	1965	0	0	0	988	K-SN-65 30-37	8	0	2	66	Y	3		0	AR
178	1	D	1987	0	0	0	1462	NW87 13 60-54	1	0	3	52	Y	3		0	
179	1	D	1987	0	0	0	970	NW87 13 65-121	0	0	3	69	P	2		0	
180	1	D	1965	0	0	0	950	K-SN-65 30-37	0	0	3	84	Y	2		0	
181	4	P	1965	0	0	0	1007	K-SN-65 28-39	8	0	4	62	Y	5		0	DI
182	1	D	1965	0	0	0	1801	K-SN-65 31-41	0	0	3	47	Y	5		0	
183	1	D	1987	0	0	0	1009	NW87 29 62-5	0	0	3	72	P	1		0	
184	3	D	1978	0	0	0	1759	NW-78 78C-121	0	0	1	78	Y	5		0	
185	3	D	1965	0	0	0	301	K-SN-65 26D-18	0	0	3	55	Y	3		0	
186	1	D	1978	0	0	0	1444	NW-78 78C-119	0	0	3	108	P	5		0	
187	1	D	1965	0	0	0	1399	K-SN-65 27-104	0	0	3	57	Y	2		0	
188	2	P	1965	0	0	0	1124	K-SN-65 28-39	0	0	1	48	Y	5		0	
189	4	D	1965	0	0	0	1371	K-SN-65 31-37	8	0	3	53	Y	2		0	DD
190	2	D	1965	0	0	0	1207	K-SN-65 29-36	0	0	2	37	Y	2		0	
191	2	D	1978	0	0	0	1765	NW-78 78C-119	0	0	3	75	Y	5		0	
193	1	D	1965	0	0	0	1407	K-SN-65 27-104	0	0	2	58	Y	2		0	
194	4	P	1978	0	0	0	1086	DEM	8	0	3	65	Y	3		0	DI
195	1	D	1978	0	0	0	1250	NW-78 76C-121	0	0	3	62	P	1		0	
196	2	D	1965	0	0	0	1341	K-SN-65 27-104	0	0	2	61	Y	2		0	
197	4	P	1978	0	0	0	1026	DEM	8	0	2	43	Y	3		0	DD
198	4	D	1965	0	0	0	1012	K-SN-65 30-37	8	0	2	35	Y	3		0	DD
199	4	P	1965	0	0	0	2841	DEM	8	0	3	74	Y	9		0	DI
200	2	D	1978	0	0	0	2441	NW-78 78C-121	0	0	3	78	Y	1		0	
201	1	D	1987	0	0	0	3020	NW87 13 65-122	0	0	2	30	Y	1		0	
202	2	D	1978	0	0	0	1055	NW-78 78C-121	1	0	1	60	Y	5		0	
203	4	D	1965	0	0	0	1356	DEM	8	0	3	45	P	9		0	DD
204	1	D	1978	0	0	0	1745	NW-78 78C-121	1	0	3	92	Y	5		0	

205	1	D	1978	0	0	0	1043	NW-78 78C-119	0	0	3	88	P	1		0	
206	4	P	1978	0	0	0	1003	DEM	8	0	1	40	Y	3		0	DD
207	1	D	1978	0	0	0	1067	NW-78 78C-119	9	0	2	97	Y	1		0	
208	3	D	1996	0	0	0	1728	Field	0	0	3	58	Y	5		0	
209	1	D	1978	0	0	0	1130	NW-78 78C-119	0	0	3	66	Y	1		0	
210	2	P	1965	0	0	0	1607	K-SN-65 30-37	0	0	3	60	Y	5		0	
211	2	D	1978	0	0	0	1700	NW-78 78C-121	0	0	1	69	Y	5		0	
212	1	D	1965	0	0	0	857	K-SN-65 31-37	4	0	4	83	Y	2		0	
213	2	D	1965	0	0	0	2871	K-SN-65 31-39	0	0	1	66	Y	5		0	
214	2	P	1965	0	0	0	2185	K-SN-65 29-38	0	0	1	54	Y	2		0	
215	3	D	1987	0	0	0	1160	NW87 13 65-121	1	0	2	61	Y	2		0	
216	1	D	1978	0	0	0	842	NW-78 78C-119	0	0	3	87	P	1		0	
217	1	D	1978	0	0	0	1420	NW-78 78C-119	1	0	2	82	Y	1		0	
218	1	D	1987	0	0	0	1502	NW87 13 60-54	0	0	3	52	Y	3		0	
219	4	P	2001	0	0	0	1549	NW-C-01 65-60-149	8	0	3	52	Y	2		0	DD
220	2	D	1965	0	0	0	1419	K-SN-65 27-104	0	0	3	67	Y	2		0	
221	1	D	1978	0	0	0	871	NW-78 77E-73	4	0	1	83	Y	3		0	
222	4	P	1978	0	0	0	1000	DEM	8	0	1	56	Y	3		0	DD
223	1	D	1987	0	0	0	1083	NW87 13 65-121	0	0	2	68	Y	2		0	
224	1	D	2005	0	0	0	657	Field	0	0	3	59	P	3		0	
225	3	D	1987	0	0	0	2465	NW87 13 65-122	1	0	2	86	Y	2		0	
226	4	P	1965	0	0	0	1024	K-SN-65 31-37	8	0	3	36	Y	2		0	DI
227	4	P	1965	0	0	0	1424	K-SN-65 27-104	8	0	3	47	Y	2		0	AR
228	3	D	1996	0	0	0	1764	Field	0	0	3	72	Y	5		0	
229	4	D	1965	0	0	0	1052	K-SN-65 30-37	8	0	3	43	Y	3		0	AR
230	1	D	1987	0	0	0	2155	NW87 13 65-122	1	0	3	66	Y	2		0	
231	3	D	1996	0	0	0	1770	Field	0	0	3	61	Y	5		0	
232	1	D	1965	0	0	0	2300	K-SN-65 31-41	0	0	2	70	Y	2		0	
233	2	D	1965	0	0	0	2487	K-SN-65 31-39	0	0	3	64	Y	5		0	
234	4	D	1965	0	0	0	1801	K-SN-65 31-41	8	0	2	54	Y	1		0	DD
235	1	D	1965	0	0	0	864	K-SN-65 30-37	0	0	2	50	Y	5		0	
236	4	P	1978	0	0	0	1092	DEM	8	0	2	54	Y	3		0	R
237	1	D	1978	0	0	0	1925	NW-78 78D-4	1	0	2	61	Y	1		0	
238	1	D	1987	0	0	0	624	NW87 13 61-74	0	0	3	64	I	1		0	
239	1	D	1965	0	0	0	919	K-SN-65 30-37	0	0	2	79	Y	5		0	
240	1	D	1978	0	0	0	1337	NW-78 76C-121	0	0	3	80	P	1		0	
241	1	D	1978	0	0	0	1155	NW-78 78C-119	0	0	2	73	Y	1		0	
242	1	D	1978	0	0	0	1405	NW-78 78C-119	0	0	2	95	Y	1		0	
243	4	P	1965	0	0	0	3400	DEM	8	0	3	23	Y	9		0	R
244	4	D	1965	0	0	0	955	K-SN-65 30-37	8	0	3	44	Y	3		0	AR
245	1	D	1978	0	0	0	1584	NW-78 76C-123	0	0	3	63	P	1		0	
246	4	P	1965	0	0	0	3464	DEM	8	0	3	46	Y	9		0	R
247	4	D	2005	0	0	0	665	Field	8	0	2	50	P	5		0	AR
248	3	D	1987	0	0	0	1079	NW87 29 62-5	0	0	2	82	Y	1		0	
249	1	D	1978	0	0	0	1120	NW-78 78C-119	0	0	2	67	P	1		0	
250	4	P	1965	0	0	0	2210	DEM	8	0	3	50	Y	9		0	DI
251	4	P	1978	0	0	0	1034	DEM	8	0	2	62	Y	3		0	DI
252	1	D	1965	0	0	0	999	K-SN-65 30-37	0	0	5	44	Y	5		0	
253	3	D	1987	0	0	0	1145	NW87 13 65-121	0	0	3	68	Y	2		0	
254	4	D	1965	0	0	0	380	K-SN-65 26D-18	8	0	3	81	Y	3		0	AR
255	3	D	1987	0	0	0	1683	NW87 13 65-121	1	0	2	75	Y	2		0	
256	2	D	1987	0	0	0	2836	NW87 13 65-124	0	0	1	45	Y	1		0	

257	4	D	1965	0	0	0	3302	DEM	8	0	2	62	Y	9		0	DI
258	4	P	1965	0	0	0	1043	K-SN-65 31-37	8	0	3	72	Y	2		0	DD
259	1	D	1965	0	0	0	1715	K-SN-65 31-41	0	0	2	77	Y	1		0	
260	2	D	1965	0	0	0	907	K-SN-65 28-39	0	0	2	128	Y	3		0	
261	1	P	1987	0	0	0	1443	NW87 13 65-119	0	0	3	62	I	1		0	
262	2	D	1965	0	0	0	1180	K-SN-65 31-37	0	0	3	95	Y	5		0	
263	1	P	1965	0	0	0	681	K-SN-65 28-39	0	0	3	49	P	5		0	
264	1	D	1965	0	0	0	402	K-SN-65 26D-18	0	0	2	74	Y	3		0	
265	4	D	1965	0	0	0	1952	DEM	8	0	2	64	P	9		0	DD
266	1	D	1965	0	0	0	1481	K-SN-65 30-37	0	0	3	80	Y	3		0	
267	2	D	1965	0	0	0	1413	K-SN-65 27-104	0	0	2	44	Y	2		0	
268	1	D	1978	0	0	0	1545	NW-78 76C-123	0	0	3	62	P	1		0	
269	3	D	1987	0	0	0	2176	NW87 13 65-122	0	0	1	61	Y	2		0	
270	2	D	1987	0	0	0	977	NW87 29 62-3	0	0	3	22	Y	5		0	
271	2	D	1965	0	0	0	1160	K-SN-65 27-102	0	0	1	82	Y	2		0	
272	1	D	1978	0	0	0	788	NW-78 78C-119	0	0	4	68	Y	1		0	
273	2	D	1978	0	0	0	2633	NW-78 78C-121	0	0	3	48	Y	5		0	
274	1	D	1978	0	0	0	1344	NW-78 78C-119	0	0	1	87	Y	1		0	
275	1	D	1978	0	0	0	2778	NW-78 78C-121	0	0	3	89	Y	5		0	
276	2	D	1987	0	0	0	969	NW87 29 62-5	0	0	3	70	Y	5		0	
277	4	P	1965	0	0	0	1168	K-SN-65 29-36	8	0	3	8	Y	2		0	DI
278	1	D	1978	0	0	0	789	NW-78 78C-119	0	0	3	84	Y	1		0	
279	1	D	1978	0	0	0	856	NW-78 78C-119	0	0	3	81	P	1		0	
280	4	P	1978	0	0	0	1047	DEM	8	0	1	42	Y	1		0	DI
281	1	D	1978	0	0	0	1658	NW-78 76C-123	0	0	3	64	Y	1		0	
282	4	P	1965	0	0	0	2191	DEM	8	0	2	51	P	9		0	DI
283	1	D	1978	0	0	0	1930	NW-78 78C-121	0	0	3	37	Y	5		0	
284	1	D	1965	0	0	0	1362	K-SN-65 27-104	0	0	2	60	Y	2		0	
285	1	D	1965	0	0	0	808	K-SN-65 27-102	0	0	2	89	Y	3		0	
286	1	D	1965	0	0	0	934	K-SN-65 31-37	4	0	2	91	Y	2		0	
287	4	D	1965	0	0	0	1139	DEM	8	0	3	52	I	9		0	DI
288	1	D	1965	0	0	0	1469	K-SN-65 30-37	0	0	3	75	Y	3		0	
289	2	D	1987	0	0	0	2356	NW87 13 65-122	0	0	3	37	Y	5		0	
290	2	D	1965	0	0	0	1038	K-SN-65 29-36	0	0	1	45	Y	2		0	
291	2	D	1987	0	0	0	2836	NW87 13 65-121	0	0	2	59	Y	2		0	
292	1	D	1965	0	0	0	1454	K-SN-65 27-104	0	0	3	44	Y	2		0	
293	1	D	1987	0	0	0	1085	NW87 13 61-76	0	0	3	55	Y	3		0	
294	1	D	1978	0	0	0	1635	NW-78 78C-121	0	0	2	82	Y	5		0	
295	1	D	1965	0	0	0	1298	K-SN-65 27-102	0	0	2	65	Y	2		0	
296	3	D	1965	0	0	0	1313	K-SN-65 30-37	0	0	3	72	Y	5		0	
297	1	P	1965	0	0	0	2009	K-SN-65 31-41	0	0	3	46	Y	2		0	
298	4	P	1965	0	0	0	1641	DEM	8	0	3	38	I	9		0	DD
299	1	D	1978	0	0	0	1045	NW-78 78C-119	1	0	1	60	Y	1		0	
300	1	P	1965	0	0	0	1471	K-SN-65 30-37	0	0	3	66	Y	2		0	
301	1	D	1978	0	0	0	2670	NW-78 77F-4	0	0	2	45	P	1		0	
302	1	D	1978	0	0	0	925	NW-78 78C-119	0	0	3	90	Y	1		0	
303	1	D	1965	0	0	0	2168	K-SN-65 31-39	0	0	2	45	Y	2		0	
304	1	D	1978	0	0	0	930	NW-78 77E-73	4	0	3	73	Y	3		0	
305	2	D	1978	0	0	0	1405	NW-78 78C-119	1	0	2	82	Y	1		0	
306	1	D	1965	0	0	0	933	K-SN-65 31-37	4	0	3	82	Y	2		0	
307	1	D	1978	0	0	0	1216	NW-78 78C-119	0	0	3	80	Y	1		0	
308	1	D	1987	0	0	0	3020	NW87 13 65-122	0	0	1	30	Y	1		0	

309	2	D	1978	0	0	0	2016	NW-78 78C-121	0	0	2	96	Y	1		0	
310	1	P	1987	0	0	0	1481	NW87 13 65-119	0	0	1	45	I	1		0	
311	4	D	2005	0	0	0	970	Field	8	0	3	52	P	5		0	AR
312	1	D	1965	0	0	0	1237	K-SN-65 27-102	0	0	1	86	Y	2		0	
313	1	D	1965	0	0	0	1271	K-SN-65 27-104	0	0	3	68	Y	2		0	
314	3	D	1987	0	0	0	826	NW87 13 65-121	0	0	3	84	Y	2		0	
315	2	D	1965	0	0	0	2345	K-SN-65 31-37	0	0	3	78	Y	2		0	
316	4	D	1978	0	0	0	2277	NW-78 76C-125	8	0	2	20	Y	2		0	DD
317	1	D	1987	0	0	0	1034	NW87 29 62-5	0	0	3	69	Y	5		0	
318	4	P	1978	0	0	0	1082	DEM	8	0	1	42	Y	5		0	DI
319	1	D	1965	0	0	0	2364	K-SN-65 31-39	0	0	2	62	Y	2		0	
320	1	D	1987	0	0	0	1171	NW87 13 65-121	0	0	3	65	Y	2		0	
321	1	D	1987	0	0	0	926	NW87 13 60-50	1	0	2	56	Y	2		0	
322	1	D	1965	0	0	0	1137	K-SN-65 27-102	0	0	3	54	P	3		0	
323	4	D	1965	0	0	0	1096	K-SN-65 28-39	8	0	2	81	Y	2		0	DD
324	2	P	1965	0	0	0	1668	K-SN-65 30-37	0	0	3	62	Y	5		0	
325	4	P	1978	0	0	0	1006	DEM	8	0	3	45	Y	3		0	DI
326	2	D	1965	0	0	0	1265	K-SN-65 27-104	0	0	1	60	Y	2		0	
327	1	D	1987	0	0	0	1000	NW87 13 65-121	0	0	3	60	P	2		0	
328	4	Q	1978	0	0	0	1021	DEM	8	0	3	65	Y	3		0	DI
329	1	P	1987	0	0	0	1494	NW87 13 65-119	0	0	2	40	I	1		0	
330	1	D	1987	0	0	0	753	NW87 13 65-119	4	0	4	82	Y	3		0	
331	1	D	1978	0	0	0	1241	NW-78 78C-119	0	0	3	70	P	1		0	
332	4	D	1965	0	0	0	2832	DEM	8	0	3	51	P	3		0	DI
333	1	D	1965	0	0	0	1437	K-SN-65 27-104	0	0	3	62	Y	2		0	
334	4	D	1965	0	0	0	2785	DEM	8	0	3	81	Y	9		0	DD
335	1	D	1987	0	0	0	1072	NW87 13 65-121	0	0	2	60	Y	2		0	
336	1	D	1978	0	0	0	1410	NW-78 78C-121	0	0	3	76	P	5		0	
337	4	P	1965	0	0	0	1162	DEM	8	0	3	50	P	9		0	DI
338	1	D	1978	0	0	0	2763	NW-78 77F-4	0	0	3	46	P	1		0	
339	1	D	1978	0	0	0	1937	NW-78 78C-121	0	0	3	39	Y	5		0	
340	1	D	1965	0	0	0	971	K-SN-65 31-37	4	0	1	91	Y	2		0	
341	4	P	1965	0	0	0	1897	DEM	8	0	2	72	Y	9		0	DI
342	1	D	1965	0	0	0	944	K-SN-65 31-37	4	0	2	89	Y	2		0	
343	1	D	1978	0	0	0	2500	NW-78 77F-4	0	0	3	43	P	1		0	
344	2	D	1965	0	0	0	2336	K-SN-65 31-37	0	0	3	71	Y	2		0	
345	1	D	1965	0	0	0	2104	K-SN-65 30-41	0	0	2	30	Y	2		0	
346	2	P	1965	0	0	0	1553	K-SN-65 29-38	0	0	3	30	Y	2		0	
347	4	P	1965	0	0	0	2804	DEM	8	0	3	53	P	9		0	R
348	1	D	1987	0	0	0	775	NW87 13 65-119	4	0	4	81	P	3		0	
349	2	D	1965	0	0	0	2337	K-SN-65 31-39	0	0	3	60	Y	5		0	
350	3	D	1987	0	0	0	1094	NW87 13 65-121	0	0	1	70	Y	2		0	
351	1	D	1978	0	0	0	1308	NW-78 78C-121	0	0	2	132	Y	1		0	
352	1	D	1987	0	0	0	1739	NW87 13 65-121	0	0	2	77	Y	5		0	
353	1	D	1965	0	0	0	1420	K-SN-65 27-104	0	0	3	58	Y	2		0	
354	4	P	1978	0	0	0	998	DEM	8	0	4	43	Y	3		0	DD
355	1	D	1978	0	0	0	1568	NW-78 76C-123	0	0	3	55	Y	1		0	
356	1	D	1965	0	0	0	1135	K-SN-65 30-37	0	0	3	74	Y	3		0	
357	2	D	1978	0	0	0	1638	NW-78 78C-121	0	0	1	75	Y	5		0	
358	3	D	1987	0	1994	0	1401	NW87 13 65-121	1	0	2	90	Y	2		0	
359	1	D	1965	0	0	0	2256	K-SN-65 31-39	0	0	2	60	Y	2		0	
360	1	D	1978	0	0	0	1601	NW-78 76C-123	0	0	2	60	Y	1		0	

361	1	D	2005	0	0	0	648	Field	0	0	3	73	P	5		0	
362	1	D	1987	0	0	0	786	NW87 13 60-50	0	0	2	82	Y	2		0	
363	2	D	1965	0	0	0	1336	K-SN-65 27-104	0	0	2	66	Y	2		0	
364	3	D	1996	0	0	0	1693	Field	0	0	3	50	Y	5		0	
365	4	D	1965	0	0	0	1382	K-SN-65 31-37	8	0	1	53	Y	2		0	DD
366	1	D	1965	0	0	0	1208	K-SN-65 27-102	0	0	1	59	Y	2		0	
367	1	D	1965	0	0	0	1236	K-SN-65 27-102	0	0	2	82	Y	3		0	
368	3	D	1978	0	0	0	1573	NW-78 78C-121	0	0	2	73	Y	1		0	
369	4	P	1965	0	0	0	1096	K-SN-65 28-41	8	0	3	77	Y	3		0	DD
370	1	D	1978	0	0	0	1223	NW-78 78C-119	0	0	1	82	Y	1		0	
371	1	D	1987	0	0	0	708	NW87 13 60-50	0	0	2	57	Y	2		0	
372	2	D	1987	0	0	0	1780	NW87 13 65-121	0	0	3	95	Y	5		0	
373	1	D	1978	0	0	0	1258	NW-78 76C-121	0	0	3	70	P	1		0	
374	1	D	1978	0	0	0	1278	NW-78 76C-121	0	0	3	46	P	1		0	
375	1	D	1978	0	0	0	1048	NW-78 78C-119	0	0	2	70	P	1		0	
376	1	D	1965	0	0	0	958	K-SN-65 30-37	0	0	3	76	Y	5		0	
377	1	D	1978	0	0	0	1272	NW-78 76C-121	0	0	3	70	P	1		0	
378	1	D	1965	0	0	0	980	K-SN-65 29-36	0	0	3	74	Y	2		0	
379	4	D	1965	0	0	0	2561	DEM	8	0	3	43	P	9		0	DI
380	3	D	1996	0	0	0	1682	Field	0	0	3	77	Y	5		0	
381	2	D	1965	0	2000	0	2125	K-SN-65 31-39	0	0	3	48	Y	5		0	
382	4	P	1965	0	0	0	1329	DEM	8	0	3	79	Y	5		0	DI
383	2	D	1978	0	0	0	1400	NW-78 78C-119	0	0	3	78	Y	1		0	
384	3	D	1987	0	0	0	852	NW87 13 65-119	0	0	3	97	Y	2		0	
385	2	P	1965	0	0	0	1059	K-SN-65 28-39	0	0	1	44	Y	5		0	
386	3	D	1987	0	0	0	956	NW87 13 65-121	0	0	3	65	Y	2		0	
387	2	D	1978	0	0	0	1766	NW-78 78C-121	1	0	3	94	Y	5		0	
388	2	P	1965	0	0	0	1022	K-SN-65 29-36	0	0	2	67	Y	2		0	
389	2	D	1965	0	0	0	2084	K-SN-65 31-41	0	0	3	61	Y	3		0	
390	3	D	1965	0	0	0	330	K-SN-65 26D-18	0	0	1	87	Y	3		0	
391	2	D	1987	0	0	0	933	NW87 29 62-3	0	0	1	72	Y	5		0	
392	2	D	1978	0	0	0	1645	NW-78 78C-121	1	0	3	105	Y	5		0	
393	4	P	1965	0	0	0	1413	K-SN-65 27-104	8	0	3	61	Y	2		0	DI
394	2	D	1978	0	0	0	3061	NW-78 77F-4	0	0	1	58	Y	1		0	
395	2	P	1965	0	0	0	1642	K-SN-65 30-37	0	0	3	70	Y	5		0	
396	1	D	1965	0	0	0	385	K-SN-65 26D-18	0	0	2	67	Y	3		0	
397	1	D	1978	0	0	0	1059	NW-78 78C-119	0	0	3	89	P	1		0	
398	1	D	1965	0	0	0	1000	K-SN-65 28-41	0	0	3	96	Y	3		0	
399	1	D	1978	0	0	0	850	NW-78 78C-119	0	0	3	79	Y	1		0	
400	1	D	1987	0	0	0	990	NW87 13 65-121	0	0	3	62	P	2		0	
401	4	D	1965	0	0	0	2845	DEM	8	0	3	76	Y	9		0	DD
402	1	D	1965	0	0	0	990	K-SN-65 31-37	4	0	2	82	Y	2		0	
403	2	P	1978	0	0	0	2140	NW-78 76C-125	0	0	1	20	Y	2		0	
404	1	D	1965	0	0	0	1266	K-SN-65 27-102	0	0	2	86	Y	2		0	
405	4	P	1965	0	0	0	3244	DEM	8	0	2	58	P	9		0	DI
406	4	D	1965	0	0	0	754	DEM	8	0	2	52	P	9		0	DD
407	1	D	1978	0	0	0	1267	NW-78 76C-121	0	0	4	52	P	1		0	
408	2	D	1965	0	0	0	1258	K-SN-65 27-104	0	0	3	63	Y	2		0	
409	1	D	1987	0	0	0	1424	NW87 13 60-54	0	0	3	58	Y	3		0	
410	1	D	1965	0	0	0	1419	K-SN-65 27-104	0	0	3	62	Y	2		0	
411	1	D	1987	0	0	0	986	NW87 13 65-121	0	0	3	86	P	2		0	
412	2	D	1965	0	0	0	1085	K-SN-65 31-37	0	0	3	90	Y	5		0	

413	2	D	1978	0	0	0	1330	NW-78 78C-119	0	0	2	102	Y	1		0	
414	1	P	1965	0	0	0	897	K-SN-65 28-39	0	0	2	75	Y	5		0	
415	1	D	1965	0	0	0	931	K-SN-65 31-37	4	0	3	77	Y	2		0	
416	1	D	1965	0	0	0	1227	K-SN-65 27-102	0	0	2	80	Y	3		0	
417	1	D	1978	0	0	0	2729	NW-78 78C-121	0	0	3	80	Y	5		0	
418	2	P	1965	0	0	0	2168	K-SN-65 31-39	0	0	3	56	Y	2		0	
419	4	P	1965	0	0	0	2268	DEM	8	0	3	41	P	9		0	R
420	1	D	1965	0	0	0	1363	K-SN-65 27-104	0	0	2	67	Y	2		0	
421	2	D	1978	0	0	0	2796	NW-78 77F-4	0	0	1	48	Y	1		0	
422	1	D	1965	0	0	0	994	K-SN-65 28-41	0	0	3	95	Y	3		0	
423	1	D	1965	0	0	0	2113	K-SN-65 30-41	0	0	2	20	Y	2		0	
424	4	P	1965	0	0	0	2176	DEM	8	0	2	44	P	9		0	DI
425	1	D	1987	0	0	0	980	NW87 13 65-121	0	0	3	65	P	2		0	
426	1	D	1987	0	0	0	1035	NW87 29 62-5	0	0	3	70	Y	1		0	
427	1	D	1978	0	0	0	1080	NW-78 78C-119	0	0	2	69	Y	1		0	
428	2	D	1978	0	0	0	1488	NW-78 78C-119	0	0	3	83	Y	1		0	
429	1	D	1965	0	0	0	1707	K-SN-65 30-39	0	0	1	46	Y	5		0	
430	4	D	1965	0	0	0	856	DEM	8	0	3	35	I	9		0	DI
431	4	P	1965	0	0	0	3035	DEM	8	0	3	54	P	9		0	DI
432	1	D	1978	0	0	0	1070	NW-78 78C-119	9	0	2	97	P	1		0	
433	1	D	1978	0	0	0	1391	NW-78 78C-119	0	0	1	77	Y	1		0	
434	2	D	1965	0	0	0	1450	K-SN-65 27-104	0	0	3	68	Y	2		0	
435	2	D	1965	0	0	0	1450	K-SN-65 27-104	0	0	3	70	Y	2		0	
436	1	D	1978	0	0	0	2851	NW-78 77F-4	0	0	2	42	Y	5		0	
437	1	D	1978	0	0	0	2668	NW-78 78C-121	0	0	3	91	Y	5		0	
438	1	D	1978	0	0	0	1565	NW-78 78C-121	0	0	2	75	Y	1		0	
439	1	D	1987	0	0	0	605	NW87 13 61-74	1	0	2	51	Y	2		0	
440	2	D	1965	0	0	0	1425	K-SN-65 27-104	0	0	3	50	Y	2		0	
441	1	D	1987	0	0	0	904	NW87 29 62-5	0	0	3	49	Y	1		0	
442	1	D	1978	0	0	0	1130	NW-78 78C-119	0	0	3	90	P	1		0	
443	1	P	1965	0	0	0	1933	K-SN-65 31-41	0	0	2	45	Y	2		0	
444	2	D	1978	0	0	0	1361	NW-78 78C-121	1	0	1	57	Y	5		0	
445	2	D	1978	0	0	0	999	NW-78 78C-119	0	0	1	68	Y	1		0	
446	3	D	1987	0	0	0	1574	NW87 13 65-121	1	0	2	52	Y	5		0	
447	1	D	1978	0	0	0	1564	NW-78 76C-123	0	0	3	64	P	1		0	
448	1	D	1987	0	0	0	1100	NW87 13 65-121	0	0	3	62	Y	2		0	
449	2	D	1978	0	0	0	1780	NW-78 78C-121	1	0	3	82	Y	5		0	
450	1	D	1978	0	0	0	1566	NW-78 78C-121	0	0	2	112	Y	5		0	
451	1	D	1987	0	0	0	945	NW87 29 62-3	0	0	2	68	Y	5		0	
452	1	D	1978	0	0	0	2724	NW-78 78C-121	0	0	3	112	Y	5		0	
453	1	D	1978	0	0	0	1409	NW-78 78C-119	0	0	2	79	P	1		0	
454	4	P	1965	0	0	0	3115	DEM	8	0	2	40	P	9		0	DD
455	4	D	1965	0	0	0	476	K-SN-65 26D-18	8	0	2	62	Y	3		0	DD
456	1	D	1978	0	0	0	1328	NW-78 78C-119	0	0	2	75	P	1		0	
457	1	D	1987	0	0	0	1011	NW87 13 65-121	0	0	2	72	Y	2		0	
458	2	D	1965	0	0	0	810	K-SN-65 30-37	0	0	3	16	Y	5		0	
459	2	D	1978	0	0	0	2660	NW-78 78C-121	0	0	1	105	Y	5		0	
460	1	D	1965	0	0	0	1807	K-SN-65 31-41	0	0	4	60	Y	1		0	
461	4	D	1965	0	0	0	1675	DEM	8	0	4	65	Y	9		0	DI
462	2	D	1987	0	0	0	1762	NW87 13 65-121	0	0	3	88	Y	5		0	
463	1	D	1965	0	0	0	1103	K-SN-65 27-102	0	0	3	43	Y	3		0	
464	2	D	1978	0	0	0	1566	NW-78 78C-121	1	0	1	93	Y	5		0	

465	2	D	1978	0	0	0	2199	NW-78 78C-121	1	0	1	95	Y	1		0	
466	2	D	1987	0	0	0	1465	NW 87 13 65-122	1	0	1	54	Y	5		0	
467	2	D	1987	0	0	0	2810	NW87 13 65-122	1	0	2	52	Y	5		0	
468	2	D	1987	0	0	0	2831	NW 87 13 65-122	0	0	2	81	Y	5		0	
469	2	D	1987	0	0	0	2317	NW87 13 65-122	1	0	3	61	Y	5		0	
470	8	P	1967	0	0	0	2740	NW 87 13 65-122	6	0	3	141	P	2		0	
471	1	D	2006	0	0	0	1032	Field	0	0	3	45	P	5		0	
472	1	D	2006	0	0	0	1022	Field	2	1	3	68	Y	1		0	
473	1	D	2006	0	0	0	986	Field	2	1	3	69	P	1		0	
474	1	D	2006	0	0	0	957	Field	0	0	3	80	P	3		0	
475	1	D	2006	0	0	0	869	Field	8	0	3	81	N	3		0	
476	1	P	2004	0	0	0	804	Ortho	0	0	4	114	N	2		0	
477	1	D	2006	0	0	0	1033	Field	8	0	2	89	N	3		0	
478	1	D	2006	0	0	0	955	Field	8	0	2	125	N	3		0	
479	1	D	2006	0	0	0	947	Field	8	0	2	124	N	3		0	
480	1	D	2006	0	0	0	944	Field	8	0	2	112	N	3		0	
481	1	D	2006	0	0	0	930	Field	8	0	2	107	N	3		0	
482	1	D	2006	0	0	0	949	Field	8	0	2	95	N	3		0	
483	1	D	2006	0	0	0	924	Field	0	0	3	75	P	3		0	
484	2	D	2005	0	0	0	895	Field	0	0	3	74	P	3		0	
485	1	D	2006	0	0	0	784	Field	8	0	3	64	N	3		0	
486	1	D	2006	0	0	0	856	Field	8	0	1	74	P	3		0	
487	1	D	2006	0	0	0	854	Field	8	0	1	68	P	3		0	
488	1	D	2006	0	0	0	1031	Field	8	0	2	81	N	3		0	
489	1	D	2006	0	0	0	870	Field	8	0	2	89	N	3		0	
490	1	D	2006	0	0	0	879	Field	8	0	2	80	P	3		0	
491	2	D	2005	0	0	0	927	Field	0	0	3	88	P	3		0	
492	1	D	2006	0	0	0	932	Field	8	0	3	95	P	3		0	
493	1	D	2006	0	0	0	938	Field	8	0	2	112	N	3		0	
494	4	D	0	0	0	0	1124	Field	8	0	2	52	Y	9		0	DD

COMMENTS	FIELD_CHEC	SOU	TY	PC	LSI_UNIQID	WATERSHED	SOURCE_TYP	SOURCE_NAM	SOURCE_DAT	CONTACT_NU	ACRES	SHAPE_AREA
		0	C	0	9	Canyon Creek	0				65.2	2840991.91
		0		0	8	Canyon Creek	0				0.2	8316.50
		0		0	7	Canyon Creek	0				0.1	2856.00
		0		0	10	Canyon Creek	0				0.1	4862.00
		0		0	10	Canyon Creek	0				0.0	1092.50
		0		0	10	Canyon Creek	0				0.0	1474.00
		0	C	0	5	Canyon Creek	0				335.0	14591096.22
	12/13/2005	0		0	10	Canyon Creek	0				1.4	59161.50
	12/13/2005	0		0	11	Canyon Creek	0				0.7	29349.50
On Toe of DSLS		0		0	7	Canyon Creek	0				0.0	460.88
		0		0	10	Canyon Creek	0				0.0	2079.00
		0		0	8	Canyon Creek	0				0.0	2084.60
		0	C	0	8	Canyon Creek	0				5.8	253036.00
	12/13/2005	0		0	8	Canyon Creek	0				0.5	22755.50
		0		0	10	Canyon Creek	0				0.0	819.00
		0		0	8	Canyon Creek	0				0.1	6147.05
		0	C	0	12	Canyon Creek	0				64.9	2827076.92
		0		0	10	Canyon Creek	0				0.0	401.48
		0	C	0	9	Canyon Creek	0				3.1	135188.43
		0		0	12	Canyon Creek	0				0.0	1538.00
		0		0	5	Canyon Creek	0				0.0	2081.50
		0		0	10	Canyon Creek	0				0.7	32664.50
		0	C	0	5	Canyon Creek	0				230.7	10051170.90
	12/8/2005	0	R	0	12	Canyon Creek	0				68.4	2978912.00
		0		0	7	Canyon Creek	0				0.1	3634.91
	12/13/2005	0	C	0	8	Canyon Creek	0				0.4	17503.00
		0		0	12	Canyon Creek	0				0.2	9340.50
		0	C	0	5	Canyon Creek	0				179.5	7817612.45
		0	C	0	9	Canyon Creek	0				86.5	3768669.36
		0		0	12	Canyon Creek	0				0.3	11894.50
		0	C	0	7	Canyon Creek	0				4.4	193562.00
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	1185.84
		0		0	10	Canyon Creek	0				0.0	1023.00
		0		0	10	Canyon Creek	0				0.1	2482.65
		0	R	0	5	Canyon Creek	0				186.5	8124187.64
		0		0	10	Canyon Creek	0				0.2	7240.00
		0		0	9	Canyon Creek	0				0.0	370.00
		0		0	9	Canyon Creek	0				0.3	13736.61
		0	R	0	5	Canyon Creek	0				2.9	125747.00
		0		0	10	Canyon Creek	0				0.0	714.50
		0		0	12	Canyon Creek	0				0.0	444.50
On Toe of DSLS		0		0	7	Canyon Creek	0				0.1	3937.00
	12/13/2005	0	C	0	8	Canyon Creek	0				0.5	22343.50
		0	R	0	9	Canyon Creek	0				134.7	5868795.40
		0		0	9	Canyon Creek	0				0.0	441.00
		0		0	5	Canyon Creek	0				0.5	20304.50
		0		0	10	Canyon Creek	0				0.5	21028.00
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	419.82
On Toe of DSLS		0		0	7	Canyon Creek	0				0.0	405.94
		0		0	10	Canyon Creek	0				0.1	2209.50
		0		0	10	Canyon Creek	0				0.0	1215.50

		0		0	12	Canyon Creek	0				0.0	167.50
		0		0	5	Canyon Creek	0				0.0	120.00
	12/13/2005	0		0	11	Canyon Creek	0				0.9	38909.00
		0		0	10	Canyon Creek	0				0.2	6934.50
		0		0	8	Canyon Creek	0				4.5	197991.00
		0		0	10	Canyon Creek	0				0.0	472.50
		0		0	9	Canyon Creek	0				0.0	1498.50
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	462.38
		0		0	5	Canyon Creek	0				0.1	2807.00
		0		0	10	Canyon Creek	0				0.0	903.00
		0		0	5	Canyon Creek	0				0.1	2657.00
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	1694.00
	12/13/2005	0		0	8	Canyon Creek	0				0.2	8174.00
		0	C	0	10	Canyon Creek	0				2.9	127602.46
		0		0	5	Canyon Creek	0				0.0	689.00
		0		0	8	Canyon Creek	0				0.1	5573.00
		0		0	8	Canyon Creek	0				0.1	6429.50
		0		0	12	Canyon Creek	0				0.9	40615.78
		0		0	12	Canyon Creek	0				0.7	31310.00
		0		0	5	Canyon Creek	0				0.1	6151.50
		0		0	5	Canyon Creek	0				0.1	3662.50
		0		0	10	Canyon Creek	0				0.0	222.00
		0	R	0	10	Canyon Creek	0				2.4	106403.02
		0		0	10	Canyon Creek	0				0.0	278.50
		0		0	12	Canyon Creek	0				0.2	9842.50
	12/13/2005	0	C	0	8	Canyon Creek	0				12.7	603792.54
		0		0	5	Canyon Creek	0				0.0	1817.73
On Toe of DSLS		0		0	7	Canyon Creek	0				0.0	383.35
		0		0	10	Canyon Creek	0				0.1	3212.50
		0	C	0	12	Canyon Creek	0				3.7	159935.00
		0		0	10	Canyon Creek	0				0.2	9060.50
		0		0	10	Canyon Creek	0				0.0	1119.29
Culvert blow-out		0		0	10	Canyon Creek	0				0.1	3775.50
		0		0	10	Canyon Creek	0				0.0	1654.50
		0		0	9	Canyon Creek	0				0.0	1588.50
		0		0	5	Canyon Creek	0				0.0	1730.00
		0		0	10	Canyon Creek	0				1.3	55323.50
		0	C	0	9	Canyon Creek	0				15.2	662201.50
		0		0	12	Canyon Creek	0				0.6	27828.50
	12/13/2005	0		0	9	Canyon Creek	0				0.2	9625.50
		0		0	12	Canyon Creek	0				0.0	173.00
		0	C	0	8	Canyon Creek	0				13.3	580839.50
		0		0	10	Canyon Creek	0				0.0	507.00
		0		0	12	Canyon Creek	0				0.0	1387.00
		0	C	0	8	Canyon Creek	0				9.9	431945.50
	12/13/2005	0	C	0	8	Canyon Creek	0				15.5	708474.25
		0	C	0	9	Canyon Creek	0				108.6	4728683.43
		0		0	9	Canyon Creek	0				0.2	8439.00
		0		0	3	Canyon Creek	0				0.0	1341.91
		0		0	11	Canyon Creek	0				1.4	60636.00
		0	C	0	12	Canyon Creek	0				31.5	1370338.72
		0		0	9	Canyon Creek	0				0.1	3319.50

		0		0	9	Canyon Creek	0				0.0	111.00
		0	C	0	8	Canyon Creek	0				18.8	818445.00
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	1124.00
		0		0	12	Canyon Creek	0				0.2	8152.49
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	130.00
		0		0	12	Canyon Creek	0				0.1	6354.00
		0		0	10	Canyon Creek	0				0.3	13513.00
		0		0	8	Canyon Creek	0				0.2	9741.50
	12/13/2005	0		0	10	Canyon Creek	0				1.0	41744.50
		0		0	10	Canyon Creek	0				2.8	122862.50
		0		0	10	Canyon Creek	0				0.1	6271.85
		0		0	7	Canyon Creek	0				0.0	216.00
		0		0	9	Canyon Creek	0				0.0	264.00
		0		0	5	Canyon Creek	0				0.1	3180.83
		0	R	0	10	Canyon Creek	0				3.9	168333.00
		0		0	12	Canyon Creek	0				0.0	969.50
		0		0	8	Canyon Creek	0				0.2	6907.00
		0	C	0	8	Canyon Creek	0				13.7	597475.50
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	293.44
	12/13/2005	0		0	8	Canyon Creek	0				0.2	8051.00
		0		0	10	Canyon Creek	0				0.8	35665.61
		0	C	0	8	Canyon Creek	0				10.5	489635.59
		0	E	0	10	Canyon Creek	0				0.2	9954.00
		0		0	12	Canyon Creek	0				0.9	37813.53
	12/13/2005	0	C	0	8	Canyon Creek	0				9.3	405908.90
		0		0	10	Canyon Creek	0				0.1	2425.63
		0		0	12	Canyon Creek	0				0.7	31301.96
		0		0	12	Canyon Creek	0				0.1	4904.50
	12/13/2005	0		0	10	Canyon Creek	0				0.7	28928.50
		0	R	0	12	Canyon Creek	0				2.2	96677.00
	12/13/2005	0		0	8	Canyon Creek	0				0.4	18486.00
		0	C	0	8	Canyon Creek	0				15.2	660027.69
		0		0	10	Canyon Creek	0				3.1	136235.00
		0		0	5	Canyon Creek	0				0.0	95.40
		0		0	10	Canyon Creek	0				0.1	3772.00
		0		0	10	Canyon Creek	0				0.0	1719.50
		0		0	10	Canyon Creek	0				0.0	333.00
		0		0	9	Canyon Creek	0				0.0	420.50
		0	C	0	9	Canyon Creek	0				526.2	22921172.06
	12/13/2005	0	C	0	8	Canyon Creek	0				3.8	197246.73
		0		0	12	Canyon Creek	0				0.0	78.50
		0	C	0	9	Canyon Creek	0				382.8	16676030.68
	12/13/2005	0	C	0	8	Canyon Creek	0				2.2	94165.00
		0		0	10	Canyon Creek	0				0.2	9039.06
		0		0	9	Canyon Creek	0				0.0	72.00
		0	C	0	9	Canyon Creek	0				79.8	3477839.42
		0	C	0	8	Canyon Creek	0				4.2	184009.50
		0		0	5	Canyon Creek	0				0.2	8686.00
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	1824.00
		0	T	0	10	Canyon Creek	0				0.4	18625.50
		0		0	10	Canyon Creek	0				0.0	1780.16
		0		0	5	Canyon Creek	0				0.5	20152.61

		0	C	0	5	Canyon Creek	0				231.4	10079832.40
		0		0	8	Canyon Creek	0				12.8	558176.00
		0		0	12	Canyon Creek	0				0.1	4467.00
		0		0	12	Canyon Creek	0				0.3	15137.00
		0		0	5	Canyon Creek	0				0.0	401.10
		0		0	9	Canyon Creek	0				0.2	7602.50
		0		0	5	Canyon Creek	0				0.1	2329.00
		0		0	10	Canyon Creek	0				0.0	1902.50
		0	R	0	12	Canyon Creek	0				217.4	9471654.63
		0		0	10	Canyon Creek	0				0.0	1297.50
		0		0	10	Canyon Creek	0				0.0	704.00
		0		0	12	Canyon Creek	0				0.0	54.00
		0		0	9	Canyon Creek	0				0.7	31381.04
		0		0	3	Canyon Creek	0				0.1	4020.31
		0		0	10	Canyon Creek	0				0.5	20266.50
		0		0	7	Canyon Creek	0				0.1	2928.50
		0		0	9	Canyon Creek	0				0.4	16076.50
		0		0	10	Canyon Creek	0				0.0	705.50
		0		0	9	Canyon Creek	0				0.0	1638.50
		0		0	10	Canyon Creek	0				0.3	13096.46
		0	C	0	5	Canyon Creek	0				34.4	1497618.00
		0		0	7	Canyon Creek	0				0.1	4092.50
		0		0	7	Canyon Creek	0				0.0	651.00
		0	C	0	8	Canyon Creek	0				12.0	524191.50
		0		0	12	Canyon Creek	0				0.0	2032.00
		0	C	0	12	Canyon Creek	0				47.3	2060405.99
		0		0	9	Canyon Creek	0				0.0	1873.00
		0		0	12	Canyon Creek	0				0.0	298.50
		0		0	10	Canyon Creek	0				0.0	247.00
		0		0	8	Canyon Creek	0				0.1	2333.00
		0	C	0	5	Canyon Creek	0				88.7	3864422.16
		0		0	10	Canyon Creek	0				0.1	2300.50
		0		0	9	Canyon Creek	0				0.7	31718.86
		0		0	10	Canyon Creek	0				0.2	8420.00
		0		0	11	Canyon Creek	0				0.2	8881.92
		0		0	5	Canyon Creek	0				0.0	2033.50
		0		0	12	Canyon Creek	0				0.0	755.35
		0		0	10	Canyon Creek	0				0.0	897.00
		0		0	12	Canyon Creek	0				0.2	10066.50
		0		0	10	Canyon Creek	0				0.1	6290.00
		0		0	5	Canyon Creek	0				0.1	4604.00
		0	E	0	5	Canyon Creek	0				11.4	496988.11
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	644.00
		0		0	10	Canyon Creek	0				0.1	3983.50
		0		0	5	Canyon Creek	0				0.0	153.00
On Toe of DSLS		0		0	7	Canyon Creek	0				0.1	4131.50
		0		0	5	Canyon Creek	0				0.0	492.00
		0		0	8	Canyon Creek	0				0.2	9482.00
		0		0	9	Canyon Creek	0				0.3	12506.50
		0		0	8	Canyon Creek	0				0.1	5711.50
		0		0	10	Canyon Creek	0				0.0	171.00
		0		0	3	Canyon Creek	0				0.0	1711.80

		0		0	9	Canyon Creek	0				0.1	5219.50
		0		0	5	Canyon Creek	0				0.0	829.17
	12/13/2005	0	C	0	8	Canyon Creek	0				0.2	9741.00
		0		0	12	Canyon Creek	0				0.1	5805.00
		0		0	10	Canyon Creek	0				0.0	1647.50
		0		0	7	Canyon Creek	0				0.4	15616.41
	12/13/2005	0		0	9	Canyon Creek	0				1.1	46406.50
		0	E	0	3	Canyon Creek	0				175.3	7638117.50
		0		0	8	Canyon Creek	0				0.1	3458.28
		0	C	0	8	Canyon Creek	0				19.3	838782.50
		0		0	10	Canyon Creek	0				0.0	1495.00
		0		0	7	Canyon Creek	0				0.2	8577.35
		0		0	10	Canyon Creek	0				0.0	853.78
		0		0	5	Canyon Creek	0				0.0	539.50
		0	C	0	7	Canyon Creek	0				4.7	205451.50
		0		0	12	Canyon Creek	0				0.1	3099.50
		0	C	0	8	Canyon Creek	0				24.0	1045124.00
		0		0	12	Canyon Creek	0				0.0	1535.50
On Toe of DSLS		0		0	7	Canyon Creek	0				0.0	529.51
		0	C	0	8	Canyon Creek	0				6.6	288401.50
		0		0	5	Canyon Creek	0				0.0	875.71
		0		0	8	Canyon Creek	0				0.1	6081.17
		0		0	9	Canyon Creek	0				0.0	252.00
		0	C	0	12	Canyon Creek	0				147.8	6438280.22
		0		0	5	Canyon Creek	0				0.0	1428.00
		0	R	0	9	Canyon Creek	0				67.8	2955342.33
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	454.41
		0		0	9	Canyon Creek	0				0.3	12126.00
		0	C	0	8	Canyon Creek	0				74.6	3249016.36
		0		0	5	Canyon Creek	0				0.0	180.00
		0		0	9	Canyon Creek	0				0.1	3877.50
		0		0	8	Canyon Creek	0				0.1	2505.00
		0	C	0	9	Canyon Creek	0				49.2	2143532.16
		0		0	8	Canyon Creek	0				0.0	1040.00
		0		0	5	Canyon Creek	0				0.0	150.00
		0		0	12	Canyon Creek	0				0.8	37009.00
		0		0	3	Canyon Creek	0				0.1	3294.50
		0		0	5	Canyon Creek	0				0.9	41017.50
		0	C	0	12	Canyon Creek	0				115.1	5013804.01
		0		0	8	Canyon Creek	0				0.1	4840.96
	12/13/2005	0		0	5	Canyon Creek	0				0.3	11439.50
		0		0	7	Canyon Creek	0				0.2	10547.70
		0		0	10	Canyon Creek	0				0.0	509.00
		0		0	9	Canyon Creek	0				0.1	5361.40
		0		0	5	Canyon Creek	0				0.0	1341.00
		0	C	0	8	Canyon Creek	0				15.0	654697.00
		0		0	5	Canyon Creek	0				0.0	582.00
		0		0	10	Canyon Creek	0				0.5	23778.00
		0		0	10	Canyon Creek	0				0.1	5159.50
		0		0	10	Canyon Creek	0				0.6	24531.85
		0		0	10	Canyon Creek	0				0.1	2476.50
		0		0	12	Canyon Creek	0				0.1	4272.00

	12/13/2005	0		0	8	Canyon Creek	0				0.1	4918.00
		0		0	10	Canyon Creek	0				0.0	548.27
		0		0	12	Canyon Creek	0				0.0	2138.50
		0		0	12	Canyon Creek	0				0.2	8823.18
		0	C	0	9	Canyon Creek	0				21.6	940133.50
		0		0	10	Canyon Creek	0				0.0	2095.00
		0		0	10	Canyon Creek	0				0.0	554.50
		0		0	10	Canyon Creek	0				0.4	16653.50
		0	C	0	7	Canyon Creek	0				7.0	305079.00
		0		0	10	Canyon Creek	0				0.0	177.00
		0		0	10	Canyon Creek	0				0.0	701.72
		0		0	9	Canyon Creek	0				0.2	10334.34
		0		0	10	Canyon Creek	0				0.0	130.50
		0		0	5	Canyon Creek	0				0.0	230.00
		0		0	9	Canyon Creek	0				0.0	717.00
		0		0	10	Canyon Creek	0				0.1	5892.50
		0		0	10	Canyon Creek	0				0.0	232.00
		0		0	12	Canyon Creek	0				0.2	9683.00
		0	C	0	5	Canyon Creek	0				65.6	2855360.38
		0		0	12	Canyon Creek	0				0.3	12698.92
		0		0	5	Canyon Creek	0				0.4	17888.00
		0	C	0	10	Canyon Creek	0				2.1	93025.02
		0		0	10	Canyon Creek	0				0.1	3271.50
		0		0	8	Canyon Creek	0				0.3	11716.13
		0		0	5	Canyon Creek	0				0.9	39305.00
On Toe of DSLS		0		0	7	Canyon Creek	0				0.1	5743.63
		0		0	9	Canyon Creek	0				0.1	2249.50
		0		0	12	Canyon Creek	0				0.6	26811.00
		0		0	12	Canyon Creek	0				0.4	16811.35
		0		0	10	Canyon Creek	0				0.1	4306.00
		0		0	8	Canyon Creek	0				0.2	8902.91
		0		0	9	Canyon Creek	0				0.0	1390.00
		0	R	0	10	Canyon Creek	0				0.1	5413.00
		0		0	10	Canyon Creek	0				1.5	65604.00
		0		0	12	Canyon Creek	0				0.1	4358.50
		0		0	10	Canyon Creek	0				0.2	10360.00
		0		0	9	Canyon Creek	0				0.0	432.00
		0		0	7	Canyon Creek	0				0.1	3405.00
On Toe of DSLS		0		0	7	Canyon Creek	0				0.1	3720.00
On Toe of DSLS		0		0	7	Canyon Creek	0				0.0	390.94
		0	R	0	9	Canyon Creek	0				109.7	4779289.49
		0		0	8	Canyon Creek	0				0.0	1866.00
		0		0	3	Canyon Creek	0				0.6	25095.00
		0		0	10	Canyon Creek	0				0.1	4517.00
		0	C	0	5	Canyon Creek	0				205.3	8942574.98
		0	C	0	8	Canyon Creek	0				23.4	1021173.57
		0		0	10	Canyon Creek	0				0.0	209.50
		0		0	12	Canyon Creek	0				0.0	1519.50
		0		0	10	Canyon Creek	0				0.1	2330.82
		0		0	10	Canyon Creek	0				0.0	1580.50
On Toe of DSLS		0		0	7	Canyon Creek	0				0.0	306.94
		0		0	9	Canyon Creek	0				0.2	7327.50

		0		0	10	Canyon Creek	0				0.1	6127.50
		0		0	10	Canyon Creek	0				0.6	26899.50
		0		0	8	Canyon Creek	0				0.2	6980.50
		0		0	10	Canyon Creek	0				0.0	340.00
		0		0	9	Canyon Creek	0				0.1	3751.50
		0		0	5	Canyon Creek	0				0.0	2011.00
		0	E	0	3	Canyon Creek	0				253.7	11049574.86
		0		0	10	Canyon Creek	0				0.1	3580.50
		0		0	5	Canyon Creek	0				1.4	61758.00
		0		0	7	Canyon Creek	0				0.1	3642.50
		0		0	3	Canyon Creek	0				0.2	7050.00
		0	C	0	5	Canyon Creek	0				41.6	1811131.25
On Toe of DSLS		0		0	7	Canyon Creek	0				0.0	370.41
		0		0	10	Canyon Creek	0				0.0	2011.32
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	1010.00
		0		0	9	Canyon Creek	0				0.1	3309.00
		0		0	5	Canyon Creek	0				1.1	49680.00
		0	E	0	5	Canyon Creek	0				40.8	1779181.77
		0	C	0	5	Canyon Creek	0				131.7	5736094.04
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	425.50
		0		0	10	Canyon Creek	0				0.0	306.00
		0		0	12	Canyon Creek	0				0.0	1005.50
		0		0	12	Canyon Creek	0				0.0	946.50
		0		0	5	Canyon Creek	0				0.1	4132.50
		0		0	9	Canyon Creek	0				0.0	1940.00
		0		0	9	Canyon Creek	0				0.0	1780.00
		0		0	5	Canyon Creek	0				0.0	2045.80
		0		0	12	Canyon Creek	0				0.1	2985.50
		0		0	10	Canyon Creek	0				0.0	1210.57
		0		0	9	Canyon Creek	0				0.0	126.00
		0		0	5	Canyon Creek	0				0.1	5315.50
		0		0	9	Canyon Creek	0				0.4	16600.50
		0		0	10	Canyon Creek	0				0.0	1917.50
		0		0	9	Canyon Creek	0				0.5	22596.31
		0		0	12	Canyon Creek	0				0.0	80.50
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	384.29
		0		0	9	Canyon Creek	0				0.1	2914.50
		0		0	10	Canyon Creek	0				0.0	355.50
		0		0	8	Canyon Creek	0				0.0	1864.02
		0		0	9	Canyon Creek	0				0.1	2370.50
		0		0	9	Canyon Creek	0				0.1	3316.50
		0	C	0	5	Canyon Creek	0				109.1	4751843.39
		0	R	0	10	Canyon Creek	0				2.8	122072.50
		0		0	10	Canyon Creek	0				0.0	454.50
Toe DSLS?		0		0	7	Canyon Creek	0				0.0	441.10
		0		0	5	Canyon Creek	0				0.4	16665.50
		0		0	10	Canyon Creek	0				0.3	12598.50
		0		0	12	Canyon Creek	0				0.1	3436.50
		0	R	0	9	Canyon Creek	0				32.9	1434353.75
		0		0	9	Canyon Creek	0				0.3	14087.85
		0		0	5	Canyon Creek	0				0.0	1688.50
		0		0	10	Canyon Creek	0				0.2	10098.50

		0		0	9	Canyon Creek	0				0.7	31237.00
		0		0	9	Canyon Creek	0				2.4	102585.49
		0		0	11	Canyon Creek	0				0.3	11160.04
		0		0	9	Canyon Creek	0				0.6	26751.76
		0		0	9	Canyon Creek	0				0.4	15963.80
		0		0	9	Canyon Creek	0				3.8	166081.96
		0		0	3	Canyon Creek	0				0.0	1045.54
		0		0	10	Canyon Creek	0				0.0	965.63
		0		0	10	Canyon Creek	0				0.0	1062.18
		0		0	8	Canyon Creek	0				0.0	632.51
Headscarp failures		0		0	8	Canyon Creek	0				0.0	621.11
		0		0	8	Canyon Creek	0				0.0	1107.68
Headscarp failures		0		0	8	Canyon Creek	0				0.0	155.36
Headscarp failures		0		0	8	Canyon Creek	0				0.0	34.29
Headscarp failures		0		0	8	Canyon Creek	0				0.0	84.70
Headscarp failures		0		0	8	Canyon Creek	0				0.0	59.32
Headscarp failures		0		0	8	Canyon Creek	0				0.0	520.64
Headscarp failures		0		0	8	Canyon Creek	0				0.0	196.42
		0		0	8	Canyon Creek	0				0.0	1490.39
FP App 2806171 considers these yarding scars, however, they never reach the top of the hillside		0		0	8	Canyon Creek	0				0.0	563.93
Headscarp failures		0		0	8	Canyon Creek	0				0.1	2697.56
Headscarp failures		0		0	8	Canyon Creek	0				0.0	946.83
Headscarp failures		0		0	8	Canyon Creek	0				0.0	1127.52
Headscarp failures		0		0	8	Canyon Creek	0				0.0	766.46
Headscarp failures		0		0	8	Canyon Creek	0				0.1	2633.27
Headscarp failures		0		0	8	Canyon Creek	0				0.1	4492.52
FP App 2806171 considers these yarding scars, however, they never reach the top of the hillside		0		0	8	Canyon Creek	0				0.1	6208.70
Headscarp failures		0		0	8	Canyon Creek	0				0.1	3377.54
Headscarp failures		0		0	8	Canyon Creek	0				0.1	3243.15
		0	R	0	8	Canyon Creek	0				53.9	2346305.61

Appendix B - Form A-3: Mass Wasting Summary Table

			Total			
Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	60	11	2	1	0	74
2 = young stands (timber 5-15 yrs)	52	14	11	13	0	90
3 = submature timber (15-50 years)	41	2	4	50	0	97
4 = mature timber (>50 years)	0	0	0	0	0	0
5 = road	34	30	4	2	0	70
6 = partial cut	0	0	0	0	0	0
7 = yarding	0	0	0	0	0	0
8 = alpine	0	0	0	0	0	0
9 = other-e.g., housing, agriculture	0	0	0	0	0	331

Landform 4

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	10	2				12
2 = young stands (timber 5-15 yrs)	11	3		1		15
3 = submature timber (15-50 years)	5			14		19
4 = mature timber (>50 years)						0
5 = road	5	5				10
6 = partial cut						0
7 = yarding						0
8 = alpine						0
9 = other- e.g., housing, agriculture						0

Landform 5

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	8			1		9
2 = young stands (timber 5-15 yrs)	9	13		1		23
3 = submature timber (15-50 years)	1	2		6		9
4 = mature timber (>50 years)						0
5 = road		4	6	1		11
6 = partial cut						0
7 = yarding						0
8 = alpine						0
9 = other- e.g., housing, agriculture						0

Landform 7

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total

1 = clearcut (timber 0-5 yrs)	13					13
2 = young stands (timber 5-15 yrs)	15		4	1		20
3 = submature timber (15-50 years)	2		1	2		5
4 = mature timber (>50 years)						0
5 = road		1				1
6 = partial cut						0
7 = yarding						0
8 = alpine						0
9 = other- e.g., housing, agriculture						0

Landform 8

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)				1		1
2 = young stands	8	3	1	5		17
3 = submature timber (15-50 years)	24	2		18		44
4 = mature timber (>50 years)						0
5 = road	6	1		2		9
6 = partial cut						0
7 = yarding						0
8 = alpine						0
9 = other- e.g., housing, agriculture						0

Landform 9

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total	
1 = clearcut (timber 0-5 yrs)	13	5				18	
2 = young stands (timber 5-15 yrs)		1	1	3		5	
3 = submature timber (15-50 years)				11		11	
4 = mature timber (>50 years)						0	
5 = road	10	14	2			26	
6 = partial cut						0	
7 = yarding						0	
8 = alpine						0	
9 = other- e.g., housing, agriculture						0	
9 = other- e.g., housing, agriculture							0

Landform 10

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total	
1 = clearcut (timber 0-5 yrs)	24	4	2			30	
2 = young stands (timber 5-15 yrs)	17	7	5	3		32	
3 = submature timber (15-50 years)	10		3	5		18	
4 = mature timber (>50 years)						0	
5 = road	9	9	2			20	
6 = partial cut						0	
7 = yarding						0	
8 = alpine						0	
9 = other- e.g., housing, agriculture						0	
9 = other- e.g., housing, agriculture							0

Landform 11

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)						0
2 = young stands (timber 5-15 yrs)	1					1
3 = submature timber (15-50 years)						0
4 = mature timber (>50 years)						0
5 = road	4					4
6 = partial cut						0
7 = yarding						0
8 = alpine						0
9 = other- e.g., housing, agriculture						0

Appendix C - Form A-4: Landslide Area Hazard Rates

Landforms	Landform 1	Landform 2	Landform 3	Landform 4	Landform 5	Landform 6	Landform 7	Landform 8	Landform 9	Landform 1	Landform 1	Total WAU
Years	35	35	35	35	35	35	35	35	35	35	35	35
Landform Area	3343.90	53.90	5505.80	2315.80	1050.30	1996.10	885.90	269.50	413.60	1214.00	7.30	17056.10
Number of 'Delivering' Landslides	0	0	7	41	43	0	36	33	46	92	5	303
Area of 'Delivering' Landslides (acres)	0.00	0.00	1.00	7.88	9.18	0.00	2.00	4.44	11.20	21.44	3.42	60.55
Landslide Frequency Rate (Number of slides/Landform Area/Years) x 10^6	0.00	0.00	36.33	505.84	1169.73	0.00	1161.05	3498.54	3177.67	2165.22	19564.11	507.57
Landslide Area Rate for Delivery (Delivering Landslide Area/Landform Area/Years) x 10^6	0.00	0.00	5.19	97.22	249.75	0.00	64.44	470.18	773.42	504.65	13378.33	101.43
Overall Rating	**LOW**	**LOW**	**LOW**	**MODERATE**	**HIGH**	**LOW**	**HIGH**	**VERY HIGH**	**VERY HIGH**	**HIGH**	**VERY HIGH**	**MODERATE**

Without Roads

Landforms	Landform 1	Landform 2	Landform 3	Landform 4	Landform 5	Landform 6	Landform 7	Landform 8	Landform 9	Landform 1	Landform 1	Total WAU
Years	35	35	35	35	35	35	35	35	35	35	35	35
Landform Area	3343.90	53.90	5505.80	2315.80	1050.30	1996.10	885.90	269.50	413.60	1214.00	7.30	17056.10
Number of 'Delivering' Landslides	0	0	5	31	33	0	36	26	20	72	1	224.00
Area of 'Delivering' Landslides (acres)	0.00	0.00	0.88	3.83	7.67	0.00	2.00	2.86	3.40	14.20	0.20	35.05
Landslide Frequency Rate (Number of slides/Landform Area/Years) x 10^6	0.00	0.00	25.95	382.47	897.70	0.00	1161.05	2756.43	1381.60	1694.52	3912.82	375.23
Landslide Area Rate for Delivery (Delivering Landslide Area/Landform Area/Years) x 10^6	0.00	0.00	4.59	47.25	208.62	0.00	64.44	303.31	235.18	334.14	797.82	58.71
Overall Rating	**LOW**	**LOW**	**LOW**	**MODERATE**	**HIGH**	**LOW**	**HIGH**	**VERY HIGH**	**VERY HIGH**	**HIGH**	**VERY HIGH**	**MODERATE**

Appendix D

The towns of Granite Falls and Jordan (6 miles north of Granite Falls) have greatly influenced the activities that occurred within the Canyon Creek WAU. Granite Falls was occupied by its first European-American settler in 1883 when Joseph S. Enas settled in the land. Slowly, more settlers moved into the area, the name of the new town became a question of light argument. Formally, the area was known as the 'Big Burn', which applied to the surrounding area as well. The main contenders for the name, Portage, named because the Indians carried their canoes across land from one fork of the river to the next and Granite Falls, named after the falls located just north of town (Robe-Summitt, 2002). In 1890 the first post office, with John L. Sneathan as postmaster was established, with the agreed upon name of Granite Falls (Woodhouse and others, 2000). In 1891, the town site was officially platted with 18 blocks. As settlers moved into the area, prospectors combed the land, searching for mineral wealth rumored in the Cascade Mountains. The first minerals claims were established in December of 1888, located between Pilchuck Creek and the Stillaguamish River. This became known as the Pilchuck Iron Lode and organized as the Pilchuck Iron Mining Company, drawing a capitalization of $500,000. By 1891, smaller prospects were established and a mining district was formed around the town. In 1892, a major ore deposit was uncovered by H.H. and James Humes, who established 15-patented claims on two rich mineral veins, the Phoenix and the Red Bird, 900 feet apart. Two shafts and numerous exploratory adits cut 778 feet into the earth, extracting ore deep below the Stillaguamish River. The plant was capable of producing 250 tons of ore per day (shipped to the Everett Smelter) and over it's lifetime produced about $500,000 of high-grade ore (Northwest Underground Explorations, 1997; Hodges, 1897).

Figure 2: Logging Locomotive in Canyon Creek.

The town of Jordan was established in April of 1900, named after Mrs. Charles Lundberg-Jordan. This town supported small farms, but its primary livelihood was from seams of coal and zinc ore found nearby. The Washington Zinc mine was established within the town of Jordan. Smaller prospects were established across the hillside to Kings Lake (Personal Communication with Daryl Jacobson, NWUE, 2006; Northwest Underground Explorations, 1997). The Jordan Coal mine was short lived owing to a small vein deposit (8 inches) and high in sulfur (Personal Communication with Tim Walsh, DNR, 2006). As with many boom and bust towns, this town stepped down its post office in February of 1908 after the mineral veins had played out.

In 1892, the Monte Cristo Railroad, funded by John D. Rockefeller was established through Granite Falls, on the way to Monte Cristo (for more information, see the Silverton WAU, Sarikhan and Walsh, 2006). This gave Granite Falls a huge economic boost, as fast, cheap access to Everett's lumber mills and smelters

(Woodhouse and Wood, 1979). It also allows heavy equipment to be brought into Granite Falls, essential for expanding mining operations and establishing lumber mills.

Before the establishment of the railroads and mills, western red cedar shingles in Snohomish County were an economic base. These were split by hand by small groups of men and used as a medium of exchange (especially because money was scarce) with merchants. As infrastructure became established (transportation and mills), companies paid men and the old pioneer ways faded.

By 1899, J.A. Theurer established the Canyon Lumber Company at the town of Robe (located just upstream of Granite Falls on the Stillaguamish River). By 1900, a sawmill with a capacity of 40,000 board feet and a shingle mill of 75,000 shingles per day was established. In 1902, the Robe and Menzel Mill was established to exploit the expanded logging operations, with a daily output of 30,000 to 40,000 feet of lumber, including a planing mill and lath factory. Many of these logs came from Canyon Creek, which was slowly logging up valleys. The Johnson-Dean Lumber Company established a mill within Canyon Creek, building a millpond and flume as loggers and railroad tracks advanced up towards Mud Lake (aka Lake Serene) (Woodhouse and others, 2000).

Although abundant timber was harvested, mills struggled to make a profit. Because of the sharp turns and bends of the Monte Cristo and Everett Railway, carrying full-length logs on flatcars was not possible. The railroad owners demanded that timber must be cut to fix in boxcars. The mills did so, but as larger timber from surrounding valleys (especially the North Stillaguamish River) became abundantly available in Everett, the profits from transporting smaller timber kept shrinking. Most major operations ended in the 1930's.

Figure 3: Monte Cristo Railroad as it traverses through Canyon Creek WAU, from the USGS 1899 topography map.

As trucks replaced trains for hauling timber, Canyon Creek experienced a brief expansion of logging. By the late 1930's, logging had cleared over half of the old growth timber. Logging was sporadic until the 1970's, when timber prices began to rise and logging was extensive. Logging continues in the watershed at present, but much of the land is in second to third generation harvest.

Appendix E

Forest History

Forests within the Canyon Creek Watershed are predominantly western hemlock, Douglas fir, Sitka spruce, and western red cedar in the lower elevations and Pacific silver fir and sub-alpine fir in higher elevations. Deciduous trees can be found primarily in the lower elevations, most commonly red alder, vine maple and willow.

Forest fires occur in the Canyon Creek WAU at intervals of 200 to 300 years. The last major fire in the area occurred in1508, as estimated from dendrochronolgy, when a large fire stretched from Canyon Creek up to the Silverton WAU (SIRC, 2004). Forest fires were observed early on as a potential problem in flooding and snowmelt. In Forest reserves: U.S. Geological Survey Annual Report, an excellent explanation on the effects of fires on snow melt and flooding was observed. 'The Stilaguamish [Stillaguamish] heads in somewhat higher mountains and has a recently burnt forest (burned in 1894) of about 15 square miles. To attribute the whole flood on the Stilaguamish [Stillaguamish] to the burning of these 15 square miles of its forest would be erroneous, but, whether mere coincidence or cause and effect, the floods since the fire have been greater than those known before. It seems reasonable that fires should have such effects, for at moderate temperatures in higher altitudes it was found that on the wooded areas more of the snow was melted as it fell than in the openings. The covering of the trees seemed to keep the earth under them warmer. The water from this melted snow had filtered away gradually. The accumulated snow in the opening awaited a warm rain, or "chinook," which would melt it rapidly, and then the waters from both the rain and the snow would run off at the same time. At lower temperatures snow ceases to melt as it falls in the woods, and in spring the shading woods greatly retard the melting of snow. In the unburnt woods, too, the moss and litter is usually a foot deep and forms a great absorbent, acting as a sponge or reservoir and regulating the flow of the water. Fires destroy this sponge, as well as the trees, and the water from rain falling or snow melting on the bare surface has nothing to retard it.' (Gannet, 1900)

Appendix F

Historical Weather Events

Historical records on storm events within Washington State were first recorded by European-American settlers in farming journals, dating back to the early 1850's. The major winter storms of 1860, 1861-1862, 1875, and 1880 most likely caused extensive flooding and mass movement, but no records exist for these storms within the Canyon Creek WAU.

The first major recorded storm in the Canyon Creek WAU rolled through the area in 1892, destroying some of the right-of-way being constructed on the Everett and Monte Cristo Railroad. An excerpt from The Everett and Monte Cristo Railway book has an excellent description of this storm:

"The lofty peaks around Silverton were already covered with fresh snow in November 1892, and the snowpack was growing each night. But, on November 16, Mother Nature's mood changed. The temperature rose rapidly, the wind began to blow out of the southwest, and for several days a fierce rainstorm raged. Both the Great Northern and Everett and Monte Cristo lines in the Snohomish Valley were under water in places. The Snohomish River ran 20 feet above the low-water mark – the highest it had been since 1872. The entire lower half of Snohomish City was flooded. The Great Northern Bridge at Snohomish was threatened, and every wagon bridge on the Everett and Monte Cristo tote road between Granite Falls and Silverton was washed away. In the canyon, water ran through tunnel #6, filling it with logs and debris. Cribbing and ballasting were washed away almost the entire length of the roadbed. One man drowned – a fellow named George Meader.

The *Engineer News* of October 5, 1893, said that in 1892 'great boulders were carried down and tossed about the canyon, striking against one another and the sides of the canyon grinding, grating, and clashing with a noise almost deafening.'" (Woodhouse and others, 2000)

In 1896, there were two storm events, one in November, and the other in December. An except from The Everett and Monte Cristo Railway book has a description of the storm. "By November, snow was 6 to 10 feet deep and rains in the lowlands began to swell the rivers.

Downstream residents began preparing for floods, and ranchers started moving livestock to higher ground. But few, if any, residents expected the two days of warm Chinook winds that quickly melted the vast snowfields, turning the rivers and creeks into foaming torrents. On November 14, the Snohomish River was at the highest level ever recorded. In only a few hours, the river burst over its banks and turned the rich Snohomish Valley into an enormous lake. The lake rose so fast that much livestock was lost. Homes were flooded, and some were carried down the valley. Rail service and all nonfloating transportation came to a complete standstill. The next day, the river was 18 feet above normal.

Old-timers said it was much worse than the big flood of 1860, which had held the record. On November 16, temperatures began to drop, giving needed relief to the flood-ravaged lowlands and bringing snow to the mountains."(Woodhouse and others, 2000)

In Forest Reserves: U.S. Geological Survey Annual Report the November of 1897 storm was stated as a storm "greater than any known in the tradition of the Indians – flooding farms, drowning cattle, washing out roads and railroads and endangering lives. The losses approximated $10,000,000." (Gannet, 1900)

The description continues: "Heavy, warm rains began the night of the [November] 16th and continued until noon of the 18th. At 10.00 a. m. on the 17th the Pilchuck was nearly full bank, and on the 18th, at noon, was considered unusually high. But before this the Stilaguamish [South Fork of the Stillaguamish] had rendered the Everett and Monte Cristo Railway impassable, with water 30 feet above its usual height in the canyon [Robe Canyon], running in fierce torrents through the tunnels and over the tracks. Punctuating the roar of the water, the boom of large bowlders [boulders] being rolled down the bed of the river could be heard and felt, while the angry, leaping torrent demonstrated its power to the eye by tearing out stone-filled cribbing, bending steel rails, and tossing heavy logs, even whole trees, in its muddy course. But the destruction caused was not very great." (Gannet, 1900)

Another severe storm system triggered a large flood event during the winter of 1902, once again destroying tracks along the Everett and Monte Cristo railway, mostly from landsliding. The largest flooding was recorded on February 26, 1932, most likely a rain-on-snow event. A severe storm system swept through during the winter of 1943-1944 and caused severe flooding (Carithers and Guard, 1945). Another severe storm system swept through on February 9, 1951 and was most likely a rain-on-snow event. The storm systems in November of 1990 and February of 1996 caused extensive flooding and slope failures within the WAU. Numerous debris flows and shallow landslides, mostly outside DNR regulated lands, were triggered by these storms.

Flow monitoring records listed on the USGS Water Resources website on the Stillaguamish River did not start until 1928 (USGS, 2005). Large peak flow events since the start of hydrologic monitoring occurred on February 26, 1932, February 9, 1951, Nov. 24, 1990, and Nov. 29, 1995. Canopy coverage and age deterred good aerial photo coverage for analysis of storm related slope failures.