CHAPTER 3. SEDIMENT AND EROSION

Characterization

In the Gordon Creek Watershed, the main erosional processes are mass wasting and streambank erosion. Mass wasting processes include landslides, debris flows, slumps, and earthflows. These processes tend to occur on steep slopes and on weak soils. Shallow landslides occur most commonly in the uplands, and may initiate debris flows that enter the stream system. Super-saturated weak soils on steep slopes lose cohesion, triggering landslides and debris flows. Along lowland streams, the primary sources of sediment are generally streamside earthflows, streambank slumps, and surface erosion from exposed soil.

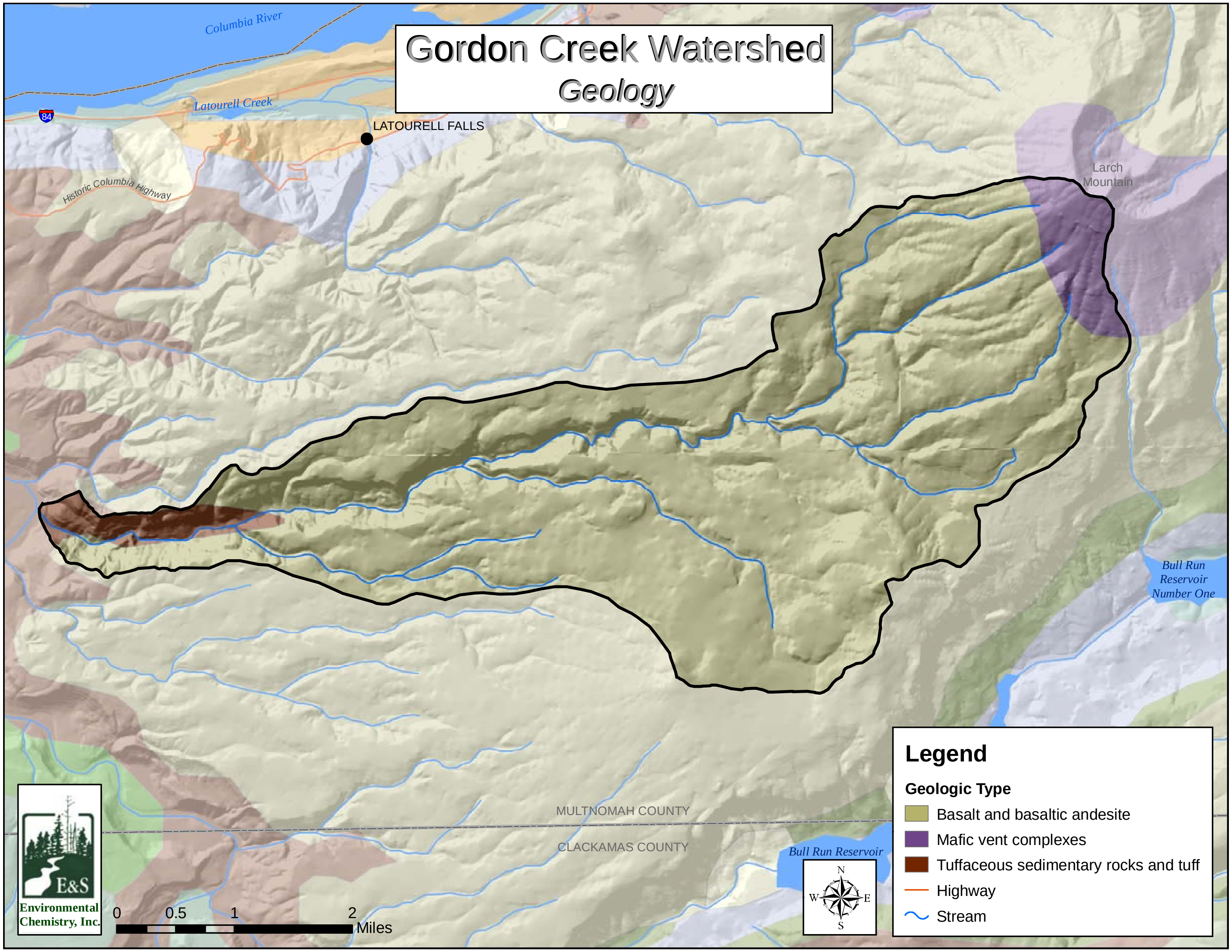
Erosional processes are determined primarily by geology, soils, topography, and climate. Disturbance that results in a weakening of the cohesiveness of soil due to a decline in root strength can also set the stage for erosional events. In particular, fire, windthrow, and disease outbreaks that alter or remove surface vegetation, resulting in root death and a reduction in transpiration, can increase the likelihood of mass wasting. Human activities on steep slopes, such as timber harvesting and road construction if improperly managed, may also influence the frequency and timing of mass wasting processes.

Erosion occurs both chronically during typical annual flood events, and episodically during infrequent large storm events that cause a pulse of sediment movement through the watershed. Extremely high flows are usually associated with rain-on-snow events, which occur when snowpack is melted by warm rain, rapidly releasing a large volume of water. Especially large storm events have occurred in the past half-century, in 1964, 1996 and 1999. The 1999 flood event was of greater magnitude in the neighboring Bull Run watershed than the 1996 flood (T. Parker, USFS, pers. comm.).

Current Conditions

Geology

In the Gordon Creek Watershed, the bedrock geology is predominantly basalt and basaltic andesite, which originated from lava flows during eruptions of Larch Mountain one to two million years ago. These rock types underlie 93.1 percent of the watershed area (Map 3-1, Table 3-1). Basaltic andesite is low in silica content and flows with low viscosity, allowing the molten material to spread broadly from the volcanic cone. Mafic vent complex rock types are found near the top of the watershed. Mafic vent complexes include a variety of volcanic materials associated with volcanic vents, including dikes, plugs, breccias, cinders, basalt, and basaltic andesite. Volcanic structures commonly associated with vent complexes include lava cones and flows. Mafic vent complex rock types account for 4.0 percent of



Map 3-1. Geologic types of the Gordon Creek Watershed. Source: Walker and MacLeod 1991

Table 3-1. Geologic types of the Gordon Creek Watershed.

Geologic Type	Acres	Percent
Basalt and basaltic andesite	10,390	93.1
Mafic vent complexes	444	4.0
Tuffaceous sedimentary rocks and tuff	325	2.9

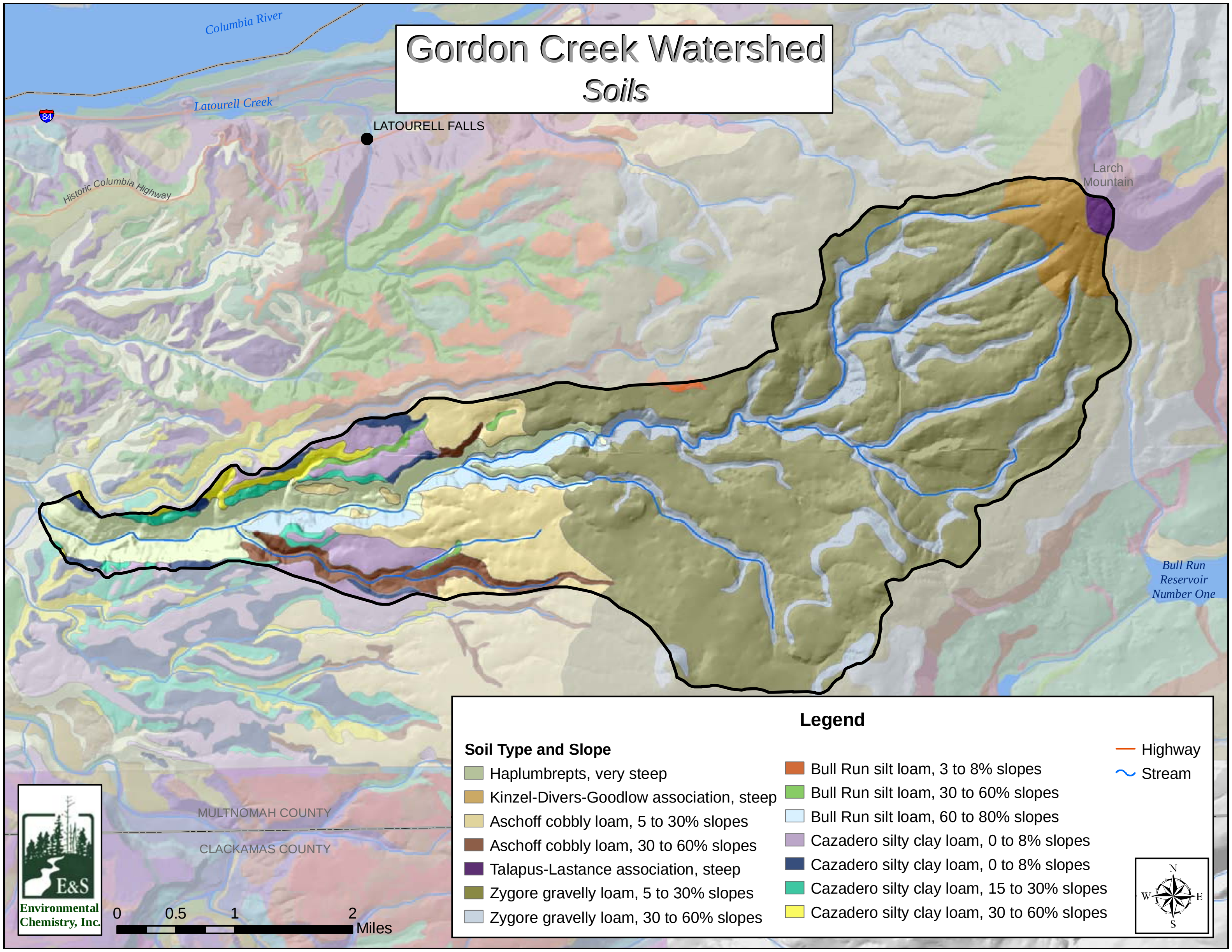
the watershed. Tuff and tuffaceous sedimentary rock types occur near the bottom of the watershed, extending from the mouth of Gordon Creek approximately a half-mile upstream of the confluence of Cat Creek. Tuff and tuffaceous sedimentary rock is formed from pyroclastic material, which includes rocks, gravel, ash, and gasses that are ejected by a volcano or vent.

Soils

Soils in the Gordon Creek Watershed are primarily Zygore gravelly loam soils on slopes between 5 and 30 percent (Table 3-2, Map 3-2). Soils extending along the riparian zone of upper Gordon Creek and its tributaries are also Zygore gravelly loams of a similar texture, though the hillslope gradients are steeper (30 to 60 percent). These soil types account for more than two thirds (67.8 percent) of the watershed. In the western half of the watershed, the soil composition becomes more varied, with higher proportions of silt and clay (Map 3.2). Soils downstream of Cat Creek and on the northern bank of Gordon Creek are shallow, weak and prone to slumping, especially on steep slopes. Descriptions of each soil type are summarized below from the Soil Survey of Multnomah County (NRCS 1983).

Table 3-2. Soils of the Gordon Creek Watershed.

Soil and Slope Description	Acres	Percent
Zygore gravelly loam, 30 to 60% slopes	7,571	67.8
Aschoff cobbly loam, 30 to 60% slopes	1,210	10.8
Haplumbrepts, very steep	830	7.4
Cazadero silty clay loam, 30 to 60% slopes	761	6.8
Kinzel-Divers-Goodlow association, steep	383	3.4
Bull Run silt loam, 60 to 80% slopes	359	3.2
Talapus-Lastance association, steep	44	< 1.0
Riverwash	2	< 1.0



Map 3-2. Soils of the Gordon Creek Watershed. Source: NRCS 1983

Zygore gravelly loam

This soil is most often found on broad ridgetops in mountainous areas. It is derived from basalt and andesite, colluvium, and till mixed with volcanic ash. The main uses for this soil are timber production, wildlife habitat, and water supply. Native tree species include western hemlock, Douglas-fir, grand fir, red alder, and western redcedar. When these soils are on steep slopes, erosion potential is high and conventional logging practices are not advised.

Aschoff cobbly loam

These soils can be found in mountainous areas in the Sandy River basin. The soil is derived from basalt and andesite colluvium with some volcanic ash. Typical uses for this soil are timber production and wildlife habitat. Native vegetation is typically red alder, western redcedar, western hazel, bigleaf maple, and dogwood. The high content of coarse fragments is often limiting to timber production. Due to steep slopes, erosion potential is very high and conventional logging practices are not possible.

Haplumbrepts

These soils can usually be found on broken landscapes along the Sandy and Columbia rivers. Slopes are very steep, ranging from 50 to 90 percent. This soil type is often used for timber production, wildlife habitat, and recreation. Native trees include Douglas-fir, western hemlock, western redcedar, bigleaf maple, red alder, and black cottonwood. The steep slopes of this soil type result in high erosion potential, preventing the use of conventional logging practices.

Cazadero silty clay loam

This soil type can typically be found on convex side slopes of broad, rolling ridgetops. It is formed from old alluvium, loess (silt deposits), and volcanic ash. This soil is suitable for farming, timber production, urban development, and wildlife habitat. Tree species commonly found on Cazadero silty clay loam soils include Douglas-fir, red alder, bigleaf maple, and western redcedar. When these soils are on steep slopes, erosion potential is high and conventional logging practices are not practical.

Kinzel-Divers-Goodlow association

These soils formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash. This soil is mainly used for timber production, wildlife habitat, and water supply. Predominant tree species include Douglas-fir, western hemlock, noble fir, and western redcedar. Timber production is limited in these high-elevation soils because of cold temperatures, acid soil conditions, and high content of coarse fragments. Logging is restricted on these soils during periods of heavy snow pack and when the soil is wet.

Bull Run silt loam

Formed in silty materials mixed with volcanic ash, this well-drained soil is typically found on rolling ridgetops. The soil is not well suited for farming, though it can be used for hay and pasture. Natural vegetation includes Douglas-fir, red alder, bigleaf maple, western redcedar, and western hemlock. Douglas-fir grows well in this soil. When these soils are on steep slopes, erosion potential is high and conventional logging practices are not recommended.

Talapus-Lastance association

These soils are present on side slopes and canyons of the Cascade Mountains. They originate from andesite and basalt colluvium mixed with volcanic ash. The Talapus-Lastance association is best suited for timber production, wildlife habitat, and water supply. Commonly-found native tree species include western hemlock, Douglas-fir, and noble fir. Due to steep slopes, erosion potential is very high and conventional logging practices are not possible.

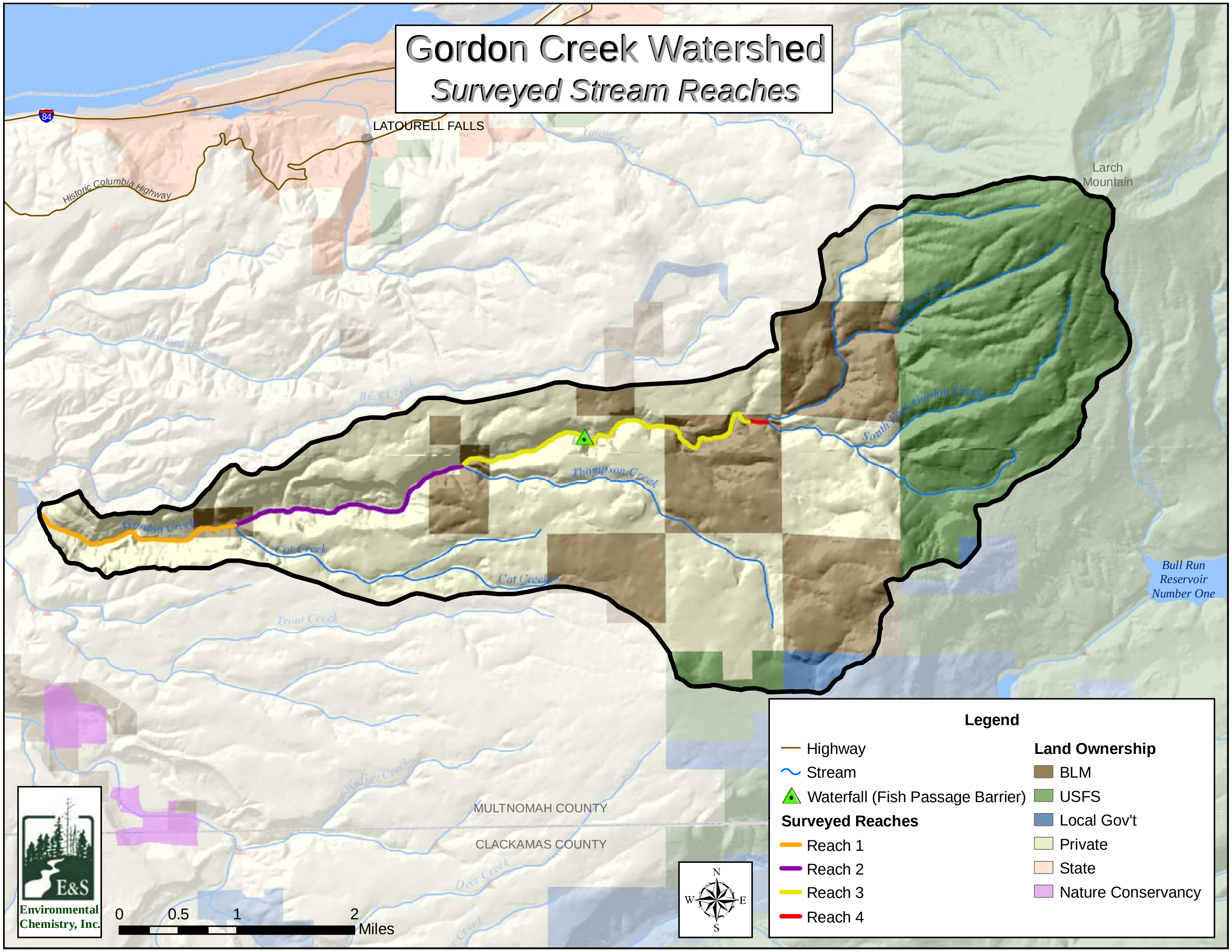
Riverwash

These are sandy and gravelly areas that appear derived from basalt and andesite. Permeability is very rapid. Vegetation types include grasses, shrubs, and willows. These soils are used for recreation, as a gravel source, and by wildlife.

Mass Wasting Processes

We are unaware of any recent or comprehensive aerial photo or on-the-ground inventories of mass wasting or landslides in the Gordon Creek Watershed. The only source of information regarding landslide locations that we found was the ODFW stream habitat surveys conducted in 1993. This database did not record the actual locations of landslides, but rather the number of landslides encountered along each ODFW-defined stream reach (Map 3-3). Stream reaches varied in length from less than 0.05 mile to 1.0 mile, and were selected based on characteristics of stream geomorphology. Surveys were conducted on the mainstem of Gordon Creek from the mouth upstream to the confluence of the South Fork of Gordon Creek. Two landslides were recorded on Gordon Creek, one in reach one and another in reach four (Table 3-3). However, only landslides that reached the surveyed streams were recorded, and this survey was not designed as a study of mass wasting, so these data do not provide a comprehensive view of landslides in the watershed. It is possible that there were more landslides on upper slopes and along tributary streams. In addition, this survey was conducted before the storm event of February, 1996, which caused a large number of landslides and debris flows throughout the Pacific Northwest, and most likely was associated with mass wasting in the Gordon Creek Watershed.

An analysis of slope gradient in the Gordon Creek Watershed revealed a pattern of steep slopes adjacent to stream channels, and broad, moderate



Map 3-3. **Surveyed stream reaches.**

Table 3-3. Landslides and streambank erosion along Gordon Creek, based on information from ODFW stream habitat surveys conducted in 1993. Source: ODFW 1993

Stream	Reach	Stream Miles	Stream Gradient (Percent)	Landslides (#/Reach)	Streambank Erosion (Percent of Reach)
Gordon Creek	1	0.50	3.1	1	0
	2	0.70	4.4	0	1.2
	3	1.00	3.9	0	0
	4	0.05	2.1	1	7.5

gradient uplands (Map 3-4). Slope gradients for nearly two thirds (63%) of the watershed are less than 20 percent (Table 3-4). Thirty percent of the watershed had slopes ranging between 20 and 50 percent, and only seven percent of the watershed had slopes steeper than 50 percent gradient. Most of the steep slopes are associated with the canyon walls adjacent to the main channel of Gordon Creek and its larger tributaries. The low (less than 20 percent) and moderate (20 to 50 percent) slope gradient categories correspond to regions of predominantly basaltic rock types and gravelly loam soils that are relatively erosion-resistant (Maps 3-1, 3-2, and 3-4).

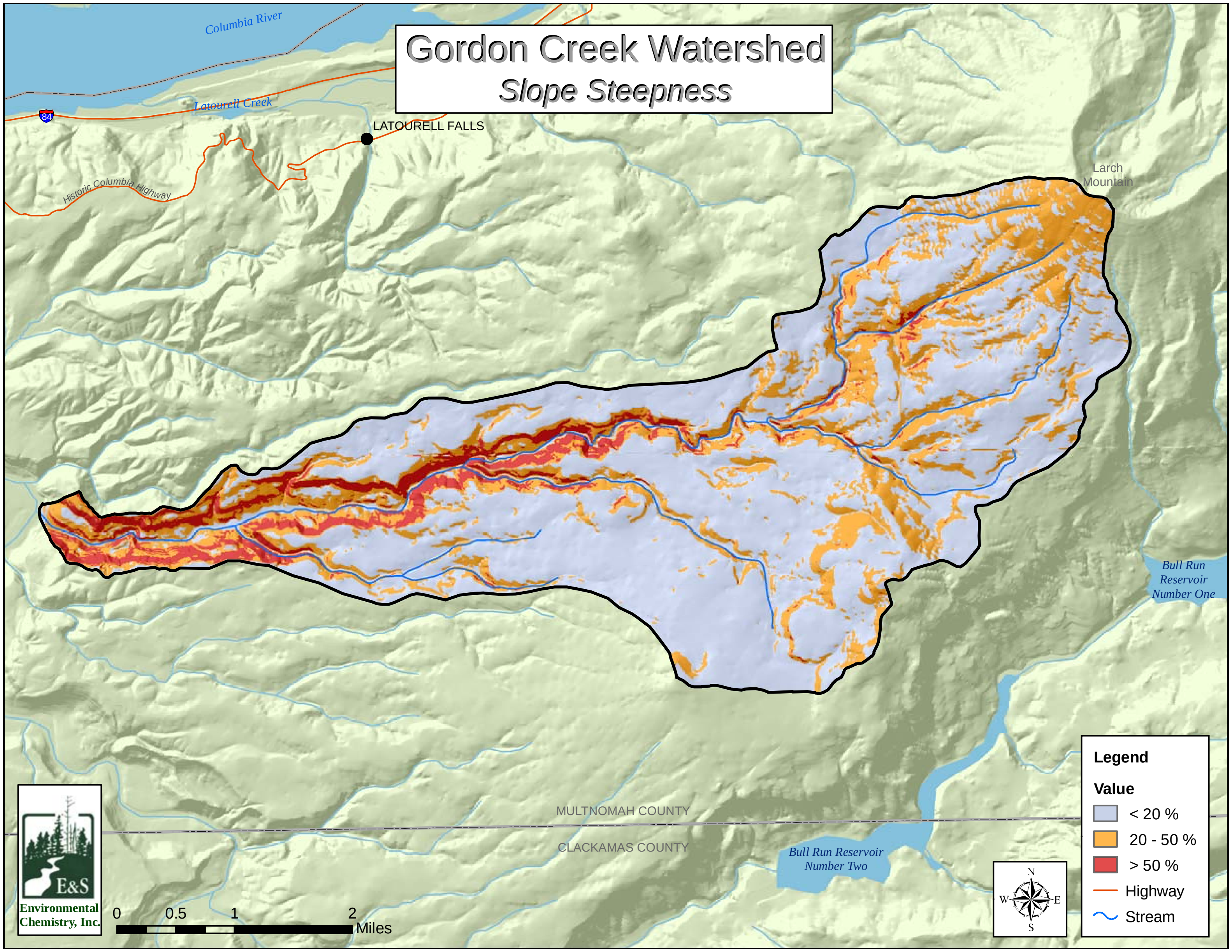
In 1997, a detailed watershed analysis was conducted for the Bull Run Watershed, which is adjacent to the Gordon Creek Watershed to the southeast (USFS 1997). The geologic types of the Gordon Creek Watershed that were also present in the neighboring Bull Run Watershed were found to be geologically stable and characterized by a low landslide frequency (USFS 1997). Surface erosion from undisturbed forest lands was also found to be low. Considering the relatively stable bedrock geology and moderate slope gradients throughout the majority of the Gordon Creek Watershed, we expect landslide frequency to be low when compared to other mountainous regions of the Pacific Northwest.

Table 3-4. Slope steepness from 10 m DEM data in three gradient categories for the Gordon Creek Watershed.

Slope Percent	Acres	Percent of Watershed
< 20	7,025	63%
20 - 50	3,341	30%
> 50	793	7%

Streambank Erosion

The ODFW reach and habitat surveys provide limited information on streambank erosion (Table 3-3). Based on the 1993 surveys, streambank erosion along Gordon Creek was uncommon. Active erosion was present on



Map 3-4. Slope Steepness.

1.2 percent of the streambanks of reach two and 7.5 percent of reach four. No streambank erosion was detected in reaches one and three.

No additional information regarding streambank erosion was available. However, based on the steep slopes and weak soils along the banks of Gordon Creek in the western half of the watershed, we believe that there may be some active zones of slumping and some earthflows. Further investigation is necessary to determine the status of streambank erosion along Gordon Creek.

Roads and Sediment

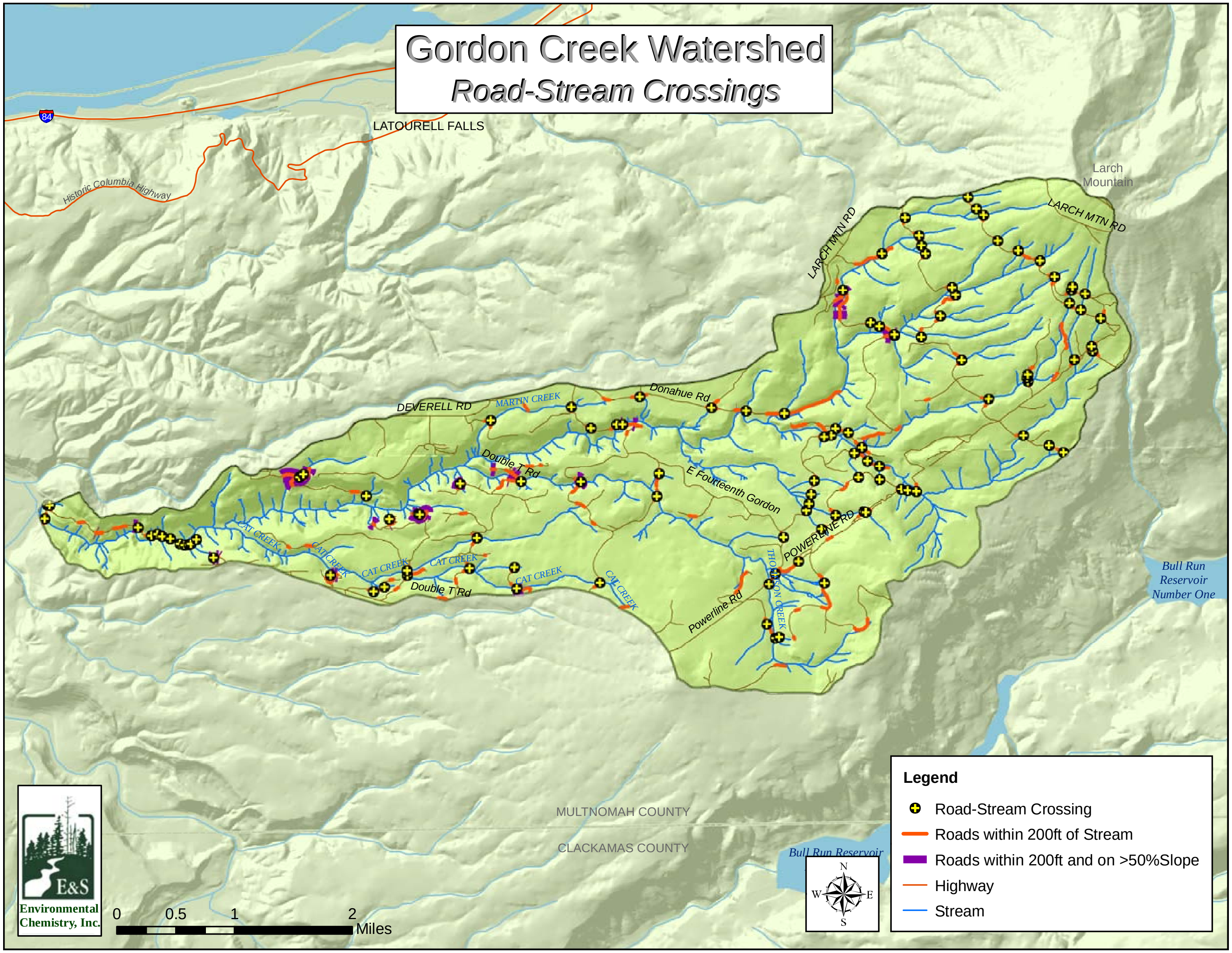
Roads are the most significant source of increased sediment from forest management activities in the western United States. Road construction, especially on steep slopes, can lead to slope failure and result in increased landslide activity (WPN 1999, Sessions et al. 1987). In addition, water draining from roads may deposit sediment in streams. However, the amount of sediment potentially contained in road runoff is difficult to quantify, because road conditions and the frequency and timing of use can change rapidly.

In order to identify locations where roads may potentially contribute sediment to streams in the Gordon Creek Watershed, we used the GIS to identify all locations where mapped roads cross streams. We found a total of 111 locations where roads cross streams, a density of one stream crossing for every 9.9 acres of the Gordon Creek Watershed (Map 3-5). Protecting these areas with erosion control measures is important to reducing excess sediment loading to Gordon Creek.

In addition to identifying road-stream crossings, we also selected all road segments near streams, defined as being within 200 feet of a stream. Of those, we identified road segments on slopes greater than 50 percent gradient. Of the 64.7 miles of road in the Gordon Creek Watershed, 16.0 miles travel within 200 feet of a stream. There are only 1.3 miles of road that are within 200 feet of a stream and on a slope greater than 50 percent. Although the road length in this category is small, it is advisable to investigate these road segments to evaluate the erosion risk.

Reference Conditions

Although specific information regarding distribution of stand age classes and species composition prior to Euro-American settlement is unavailable for the Gordon Creek Watershed, it is likely to have been similar to other areas of western Oregon. For the Sandy River basin as a whole, late-seral forest was estimated to vary historically from 47 to 59 percent of the basin, while early-seral forest ranged from 8 to 28 percent (USFS 1993). The natural disturbance regime of fires, windthrow, and disease created a patchy mosaic of forest types, age classes, and structural diversity prior to Euro-American



Map 3-5. Stream crossings and roads near streams.

settlement. Erosion and sediment movement occurred episodically subsequent to large disturbance events and large floods. It is likely that during the past century intensive clearcut logging and associated practices, including railroad and road construction, and possibly splash damming, contributed excessive sediment to the stream system. However, the predominance of well-established mid-seral forests in the watershed today, together with improved road management practices, suggests that erosional conditions are likely to be within the natural range of variability. Nevertheless, the road network represents an auxiliary source of sediment that potentially could contribute excessive sediment to the stream system. Proper maintenance of the road system, especially ditches and culverts, is essential to minimize sedimentation of streams.

Discussion

Erosion and the movement of sediment through a watershed are natural processes that provide essential components of stream habitat for fish and other aquatic organisms. However, if the amount of sediment traveling through the stream system becomes excessive, stream habitat quality may become compromised. The more that sediment levels deviate (either up or down) from the natural pattern in a watershed, the more likely it is that aquatic habitat conditions will be significantly altered.

Although landslides occur under natural conditions, human activities have been shown to increase the rate of erosion throughout western Oregon (WPN 1999, Naiman and Bilby 1998, Robison et al. 1999). In particular, road-cuts may undercut slopes and concentrate runoff along roads, and road-fills on steep slopes may give way, initiating landslides. Road ditches intercept and redirect the flow of water, sometimes exacerbating erosion and accelerating the rate of runoff. Poor road surfaces that are used primarily in dry weather may have a smaller impact on sediment than roads used heavily during wet seasons.

The geology, soils, and slope gradient throughout most of the Gordon Creek Watershed suggest a low frequency of mass wasting. However, inventories of landslide occurrence and streambank erosion are lacking. The weak tuff and tuffaceous rock types present in the lower elevations of the watershed may pose a risk for landslide activity in those areas, especially on steep slopes.