VI. Sediment Sources

Introduction

This section of the watershed assessment focuses on instream sediment loads and the sources of those sediments. Precipitation falling on the landscape, together with the action of biological agents, breaks down rocks through weathering, forming soil composed of minerals and sediments of various sizes (Dunne and Leopold, 1978). Some of the precipitation becomes overland flow, which carries weathered sediments to stream channels across various natural and artificial landscapes (Dunne and Leopold, 1978). The sediment load carried by streams is a natural attribute of the stream system, necessary for the maintenance of relative stability among streambed and stream banks, erosion and deposition (Allan, 1995; Dunne and Leopold, 1978). Most of the sediment load is derived from the streambed and stream banks but erosion from hillslopes is the ultimate source of sediments (Allan, 1995; Dunne, 1978; WPN, 1999). Hillslope erosion can be in the form of surface erosion of fine sediments or more drastically as slope failures leading to debris flows.

Human developments and occupance within a watershed almost always results in increased erosion of hillslopes. Rural road surfaces, urban surfaces, and agricultural lands are sources of fine sediments within a developed watershed. Increases in fine sediments have the greatest impact on aquatic insects and fish. Excessive turbidities impede adult salmon and trout on their migration to spawning areas and fine sediments decrease the suitability of streambeds for spawning (Bjornn and Reiser, 1991). During incubation of the embryos and alevins of salmon and trout, high turbidity levels caused by fine sediments (organic and inorganic) will reduce the percentage of young fish that survive and emerge from the redd (Bjornn and Reiser, 1991).

Slope failures also contribute a substantial amount of sediments to stream channels. Slope failures occur naturally in forests of the Pacific Northwest; however forest roads, rural roads and clearcuts increase the frequency and volume of hillslope failures (Amaranthus et al, 1987; Rice and Lewis, 1991; Sullivan, 1985). Land development, including forest practices, can also cause an alteration of the hydrology of a watershed. Forest and rural roads, paved surfaces, and rooftops channel rainfall directly to streams, increasing peak flows and decreasing the amount of precipitation that enters the water table, resulting in lower summer flows (see Section IV: Hydrology and Water Use Assessment). Increased peak flows can cause greater in-channel scouring of streambeds and stream banks, leading to high sediment loads.

Fish and other aquatic organisms in a region are adapted to the range of sediments that may enter the stream, and are placed at risk when land management practices result in elevated sediment loads. Salmon and trout lay their eggs in shallow depressions formed in the gravel beds of riffles. Stream flows prevent the eggs from washing out of these shallow nests because water flows into the gravel at the head of the riffle pushing the eggs downward (Dunne and Leopold, 1978). The eggs remain in the gravel for 3-5 months after which time they hatch and remain in the gravel for an additional 2-3 weeks while feeding on a large yolk sack (Meehan and Bjornn, 1991). Increased erosion can lead to sedimentation of gravels, suffocating the salmonid eggs and clogging the gills of the developing salmonids.

Separating human induced erosion from natural erosion can be difficult. Natural erosion and sediment loads can be quite variable depending on the geology, topography and climate of the watershed. Additionally, the amount of erosion in the watershed and the debris load carried in a stream channel varies with the seasons. Erosion is greatest during the winter when high rainfall leads to peak streamflows, increased erosion from urban areas, rural roads, agricultural lands, and hillslopes, and an increased occurrence of slope failures. The following pages of the sediment sources assessment will examine slope stability, road instability, rural road runoff, urban runoff, erosion from crop lands, and erosion from pasture lands.

Methodology

Slope Instability

For this part of the assessment, the Western Oregon Debris Flow Hazard Maps created by the Oregon Department of Forestry (ODF) were used to evaluate slope stability. These maps contain locations subject to naturally occurring debris flows as well as the initiation sites and locations along the paths of potential debris flows. Confined stream channels and locations below steep slopes were used to identify paths of potential debris flows, and geologic maps of sedimentary materials were used to identify potentially unstable soils. A debris flow is a mass movement of soil that contains a high proportion of water and resembles a viscous fluid (Dunne and Leopold, 1978). Debris flows sweep soil, rocks, and large pieces of vegetation, including whole trees, down steep confined channels, depositing their load in low gradient stream segments. These maps may also indicate the initiation points of other types of hillslope failures, including debris avalanches, debris slides, and earthflows.

The following description is given for the methodology used to create the debris flow hazard maps (ODF, 1999):

> "Mapping is based on slope steepness at an area (from 2-3.5 acres to a small watershed) scale. All lands containing no DEM [digital elevation model] slopes of greater than 40% (for a minimum distance of 200 feet) were given a low rating.

Areas of greater than 3.5 acres with average DEM slopes of greater than 40% (actual slope will be somewhat steeper) were given at least a moderate rating.

For the Tyee and similar geologic formations, all areas greater than 2 acres with average DEM slopes of greater than 65 percent were given a high rating. Because of slope dissection that is especially common in portions of the Tyee formation, the 30-meter DEMs appear to miss many localized steep slope areas. Therefore, watersheds with at least 1/4 of their slopes over 70 percent (1/3 their slopes over 60 percent in the Tyee formation) were rated high hazard for the entire basin, down to a point where the major stream is not in a confined valley.

For other geologic units, all areas greater than 2 acres with average DEM slopes of greater than 70 percent were given a high rating, as were watersheds containing over about 1/2 of their slopes over 70% steepness.

Extreme hazard was only assigned to watersheds and landforms next to these watersheds which were known to have experienced multiple, very rapid debris flows over the last 35 years.

A 200-foot buffer is added around the high and moderate hazard classifications, to account for debris flow runout and map inaccuracies. In addition, stream channels identified as confined received a 200-foot total width buffer centered on the mid-line of that confined stream. The hazard rating applied to these streams is the dominant hazard rating in the upper watershed. In addition, identified fan-shaped landforms were mapped with the same hazard as the hillslope area above the fan, regardless of fan length. For stream channels that leave long lengths of steep slopes (high bluffs, and the sides of significant mountains) the actual USGS maps (digital versions) are used to identify debris flow runout, again looking at confined channels base on the contour maps."

Road Instability

A GIS layer for roads was derived from United States Geological Service (USGS) digital line graphs (DLG's) and USGS digital orthophoto quads (aerial photographs). DLG's were overlaid on aerial photographs within a GIS and all roads and trails, including skid trails, are included in the layer regardless of size.

Road hazard maps and data were requested from ODF and private timber management companies but no information was acquired from either source. The ODF has information regarding road construction, reconstruction, and improvement of roads on private and state forestlands. Slope failures due to road construction would be included in road reconstruction notifications required under the ODF Forest Practice Administrative Rules section 629-605-140. The location of road washouts is pertinent to an evaluation of sediment sources within the watershed. Requests for information were made with the ODF field offices at Astoria, Columbia City, and Forest Grove, but no cooperation was received.

In lieu of not being able to attain road instability information for private and state forest roads, potentially unstable road segments have been identified through the use of the debris flow hazard maps. Overlay analysis of the road and debris flow hazard GIS layers was performed to create a map of at-risk road segments. Regardless of the position of the road relative to the stream channels, all road segments falling within debris flow hazard areas are rated based on the debris flow hazard rating system established by ODF.

Sediments from rural roads

Sediments from rural roads were evaluated based on slope, proximity to streams, surface type, and level of use. Roads analyzed in this portion of the assessment include forest roads, roads in agricultural areas and roads used to access rural residential areas. Roads within urban land uses were excluded from this portion of the assessment. Within GIS a buffer of 200 feet was created around all streams and then used to clip road segments that are within 200 feet of streams. Digital elevation models with a resolution of 10-meters were used to identify stream segments on slopes greater than 50% (CLAMS, 2000). Road surfaces and level of use were determined through field visits, maps, and information gathered from the Columbia County Roads Department, ODF, Oregon Department of Transportation (ODOT), and USGS. Surface types were identified as either paved or unpaved. Aerial photographs and digital raster graphics (digital representation of USGS 7.5 minute topographic maps) were also used to evaluate surface type and level of use. High use roads are connected to urban centers, rural residences, highways, or industrial areas. Low use roads are typically spur roads, skid trails, and private roads that have limited access.

The analysis of rural road runoff produced a screening level evaluation of sediment potential for each road segment within 200 feet of a stream (see the box to the right). Surface type, level of use, and slope were used to rank the sediment potential of road segments. Roads ranked as having a high potential for contributing sediments to streams are found on hills that have a slope greater than 50%. Rain falling on steep hillslopes and cut banks along roads can transport sediments

Sediment Potential	**Surface Type**	**Use Level**	**Slope**
High	Paved	High or Low	>50%
	Unpaved	High	>50%
Moderate	Paved	High or Low	<50%
	Unpaved	Low	>50%
	Unpaved	High	<50%
Low	Unpaved	Low	<50%

downslope into roadside ditches, increasing the sediment load delivered to streams.

Sediments from urban areas

Runoff from urban areas is a minor source of sediments within the subbasin. Urban areas account for 1% of the subbasin and are found in four watersheds out of a total of thirty-two. Therefore, the analysis of urban runoff has been simplified into a summary of the storm water systems, treatment facilities, street cleaning practices, and the percent of urban land area per watershed (Table 6.4).

Sediments from cropland

The evaluation of sediment potential from croplands was based on the erosion potential of soils, slope steepness, and position in the watershed. USDA soil surveys were used to identify the soil erosion factor K, and 10-meter digital elevation models (DEMs) were used to calculate slope steepness for all croplands. The soil erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water (surface erosion). Susceptibility to erosion is based on percentage of silt, very fine sand, sand, and organic matter and on soil structure and permeability. High K-values indicate that the soil is very susceptible to erosion by water. Soil erosion factors have been classified into three ranges: low (< 0.20), moderate (0.20-0.40), and high (>0.40). However, there are no soils within agricultural areas of the subbasin that have a high erosion potential (K-values >0.40).

Slope steepness is a calculation of the difference in elevation between two points divided by the distance between the points. Percent is used as the unit of slope steepness in this assessment. A minimum mapping unit of 10 meters square is used to evaluate slope steepness; the mapping of slope steepness is limited by the resolution of the DEMs. A 10-meter resolution is adequate for a screening level assessment, however actual slopes may be steeper than calculated using these DEMs. Slope steepness is classified into four ranges: <10%, 10-19%, 20-39%, >39%. Croplands within the subbasin are on slopes that are <10%, so there is no need for the upper slope classes in this analysis.

Overlay analysis of soil erosion factors and slope steepness was used to delineate areas of moderate and low erosion potential. All of the croplands are slopes that are less than 10%, so the soil erosion factor was used to rate the erosion potential of croplands. Croplands are rated as having either a moderate or low potential for surface erosion based on soil erosion factors alone. Position of croplands within the watersheds of the subbasin was also noted to evaluate the significance of croplands as a source of sediments. The evaluation of croplands within this section was used to produce a screening level assessment of the significance of these lands as a source of sediments. Further analysis of actual crop types and farming practices may be necessary if areas of high sediment potential are identified. This screening level assessment of sediment potential from croplands is intended to save time and money by first evaluating the significance of these land uses as a source of sediments.

Sediments from pastureland

The evaluation of pasturelands as a sediment source is similar to the analysis of croplands with two exceptions, slope steepness is classified into only two ranges: <40% and >=40% (for a description of slope steepness refer to the cropland runoff methodology). The reason for using only two slope classes is because soil erosion on pasturelands is more subtle than croplands. Pasturelands are not tilled and generally are vegetated with grass year-round, providing a substantial barrier to surface erosion. The soil erosion factor k is classified into three ranges: low (< 0.20), moderate (0.20-0.40), and high (>0.40).

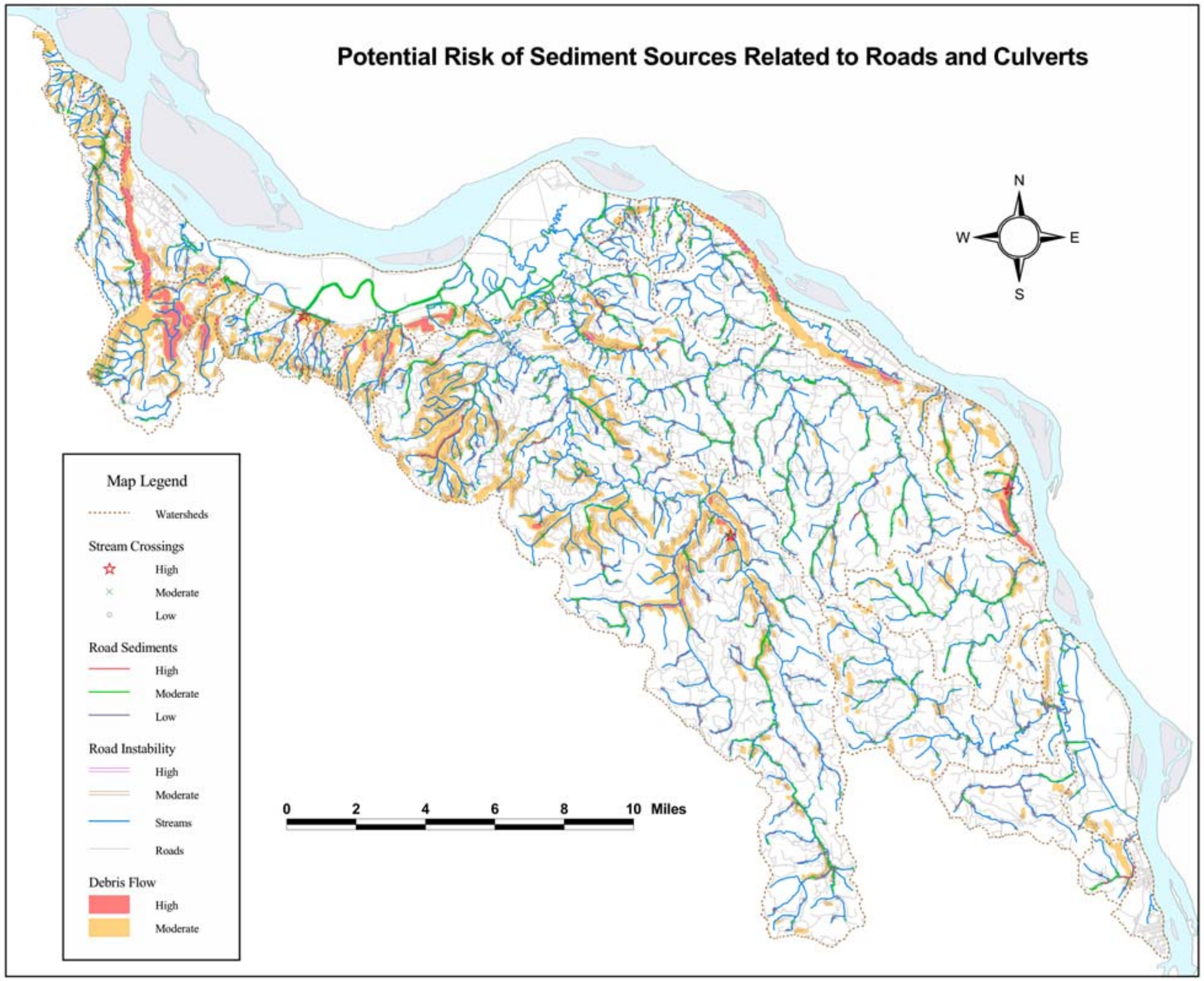
Overlay analysis of soil erosion factors and slope steepness was used to delineate areas of high, moderate, and low erosion potential. The evaluation of pasturelands within this section was used to produce a screening level assessment of the significance of these lands as a source of sediments. Further analysis of actual management practices and conditions of pasturelands may be necessary if areas of high sediment potential are identified. This screening level assessment of sediment potential from pasturelands is intended to save time and money by first evaluating the significance of these land uses as a source of sediments.

Results

Slope Instability

Slope instability has been estimated by using the debris flow hazard maps created by ODF. Debris flow hazard ratings include extreme, high, and moderate potential for slope failures leading to debris flows. While there are no extreme hazard areas within the subbasin, there are many high and moderate hazard areas. A map of the debris flow hazard areas is presented as Figure 6.1 and a summary is given in Figure 6.2. Figure 6.2 displays the percent of each watershed covered by debris flow hazard areas.

The largest concentration of debris flow hazard areas is found in the northwestern portion of the subbasin. In six out of eight watersheds that drain into the Westport Slough, more than 30% of the area in each watershed is at risk of slope failures and debris flows. Of these six watersheds, Tandy Creek and West Creek watersheds have the



Data source: USGS digital line graph files; ODF debris flow hazard maps.

Figure 6.1: Debris flow hazard areas, road instability, roads near streams, and high risk culverts based on slope stability.

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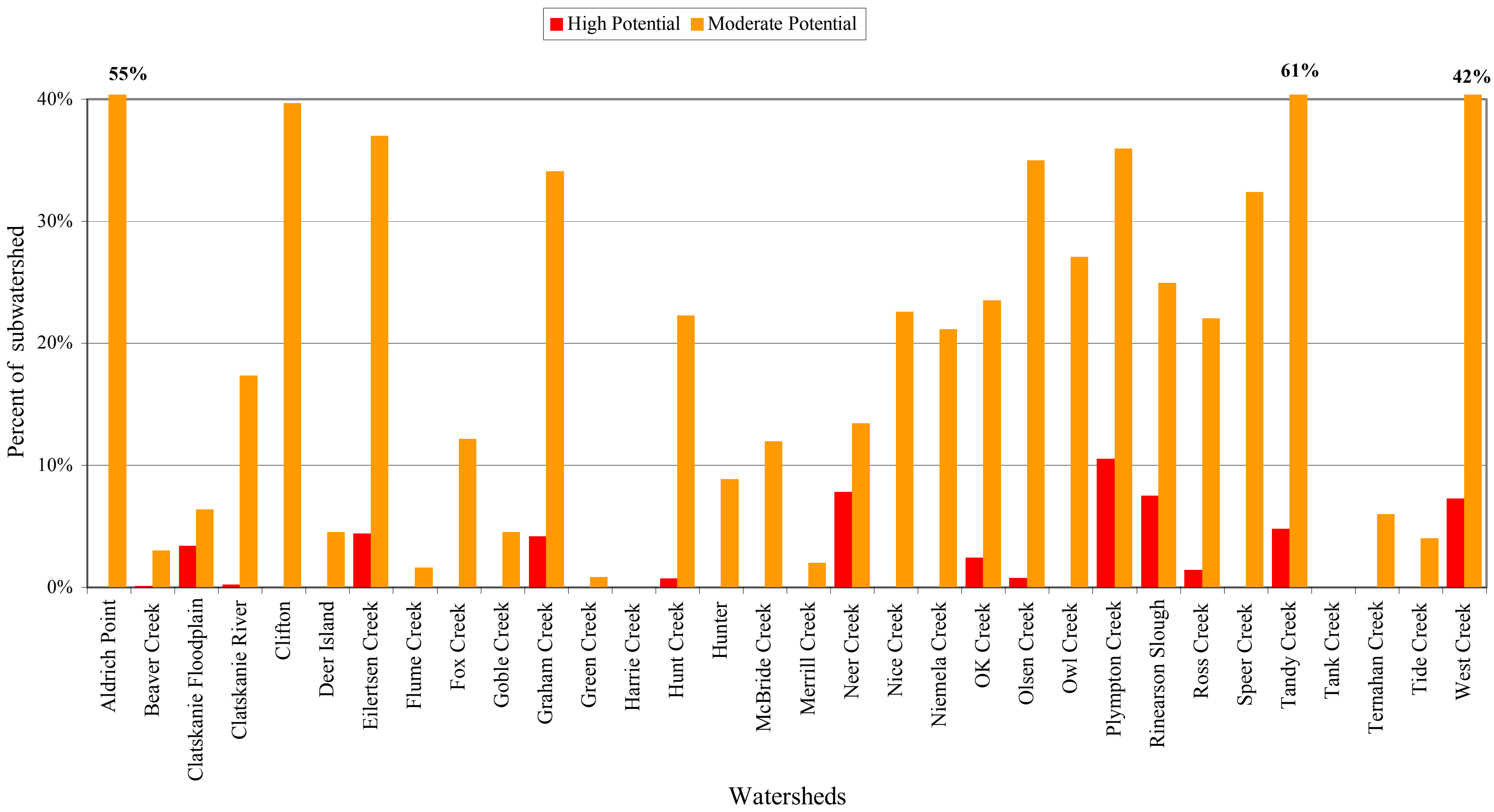


Figure 6.2: Summary of the ODF debris flow hazard mapping.

highest concentration of hazard areas. More than half of the total area within these watersheds is considered to have a moderate to high potential for slope failures that may result in debris flows (For locations and names of watersheds see Section IV, the Hydrology and Water Use Assessment). Within the watershed of Tandy Creek, 5% of the watershed has a high potential for slope failures and 61% a moderate potential. Eleven percent of the Plympton Creek watershed has a high potential for slope failures and debris flows, which is the highest concentration per watershed.

Within the Clatskanie River Watershed, about 18% of the area has a moderate potential for slope failures and debris flows. A high concentration of hazard areas can be found in Conyers Creek and within the middle section of the Clatskanie River, near Carcus Creek and the North Fork of the Clatskanie River. There are very few areas of high potential for slope failures and debris flows within the Clatskanie River Watershed.

Road Instability

There are a total of 1492 miles of roads within the Lower Columbia-Clatskanie Subbasin. The subbasin has an average of five linear miles of road per square mile of area. Roads segments found within debris flow hazard areas are mapped in Figure 6.1 and summarized by watershed in Figure 6.3 and Table 6.1. Within Figure 6.3 the miles of road segments have been divided by total watershed area (square miles), to make it easier to compare watersheds.

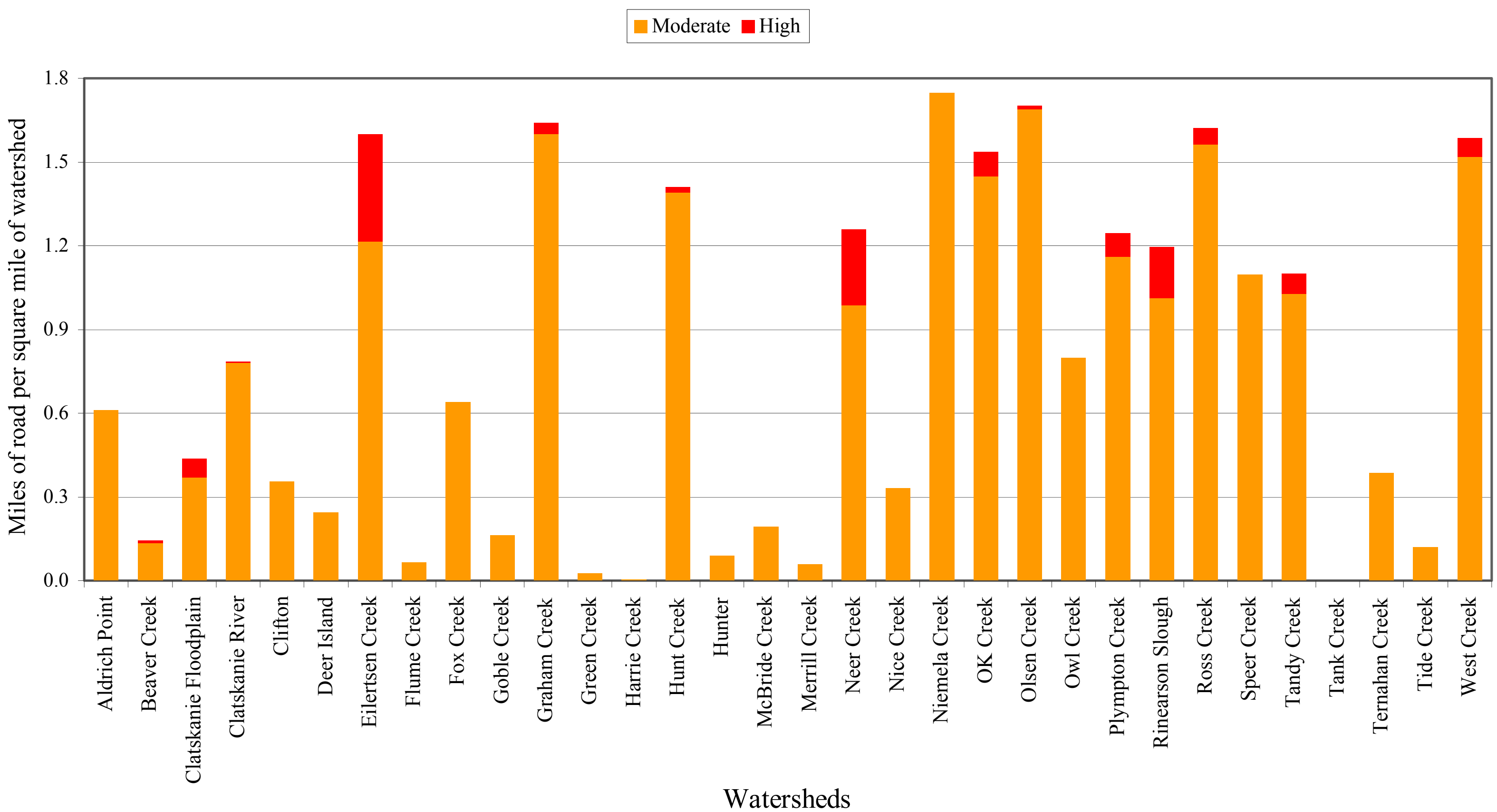
Road instability is greatest in the northwestern part of the subbasin. Ten out of thirteen watersheds with a density of at-risk roads equal to or greater than 1.1 mi/mi^2 are found west of the Clatskanie River. Hunt Creek has an abundance of at-risk road segments near the mainstem of the creek from about the middle of the watershed downstream. Six out of the seven watersheds above a density of 1.5 mi/mi^2 of at-risk roads drain into the Westport Slough. Eilertsen Creek has the highest density of roads within high debris flow hazard areas.

The Clatskanie River watershed has a density of at-risk roads that ranks 15th highest amongst the 32 watersheds of the subbasin (Table 6.1). Roughly 90% of the at-risk roads are captured within the lower two-thirds of the Clatskanie River watershed, downstream of the Little Clatskanie River (Figure 6.1). The highest concentration of at-risk road segments is concentrated in the Conyers Creek subwatershed. The mainstem and tributaries from the Little Clatskanie River downstream to Carcus Creek is lined with debris flow hazards and at-risk road segments. Keystone Creek, Miller Creek, and Page Creek subwatersheds also have a high concentration of at-risk roads.

Table 6.1: Density of at-risk roads (mi/mi^2) and rank of watersheds based on density.

Watershed	Density	Rank
Niemela Creek	1.75	1
Olsen Creek	1.70	2
Graham Creek	1.64	3
Ross Creek	1.62	4
Eilertsen Creek	1.60	5
West Creek	1.59	6
OK Creek	1.54	7
Hunt Creek	1.41	8
Neer Creek	1.26	9
Plympton Creek	1.24	10
Rinearson Slough	1.20	11
Tandy Creek	1.10	12
Speer Creek	1.10	13
Owl Creek	0.80	14
Clatskanie River	0.79	15
Fox Creek	0.64	16
Aldrich Point	0.61	17
Clatskanie Floodplain	0.44	18
Ternahan Creek	0.39	19
Clifton	0.36	20
Nice Creek	0.33	21
Deer Island	0.24	22
McBride Creek	0.19	23
Goble Creek	0.16	24
Beaver Creek	0.14	25
Tide Creek	0.12	26
Hunter	0.09	27
Flume Creek	0.07	28
Merrill Creek	0.06	29
Green Creek	0.03	30
Harrie Creek	0.01	31
Tank Creek	0.00	32

Figure 6.3: Roads within debris flow hazard areas (at risk road segments).



Sediments from rural roads

Roads are common in the Lower Columbia-Clatskanie Subbasin. There are a total of 1492 miles of roads within the subbasin, of which 1159 miles are unpaved. Most of the roads are considered to be rural because urban areas comprise only 1% of the subbasin. Figure 6.4 and Table 6.2 summarize the sediment potential of rural roads within 200 feet of streams. The results are presented as density of road segments, which is equal to the total miles of roads per watershed divided by the area, in square miles, of the watershed.

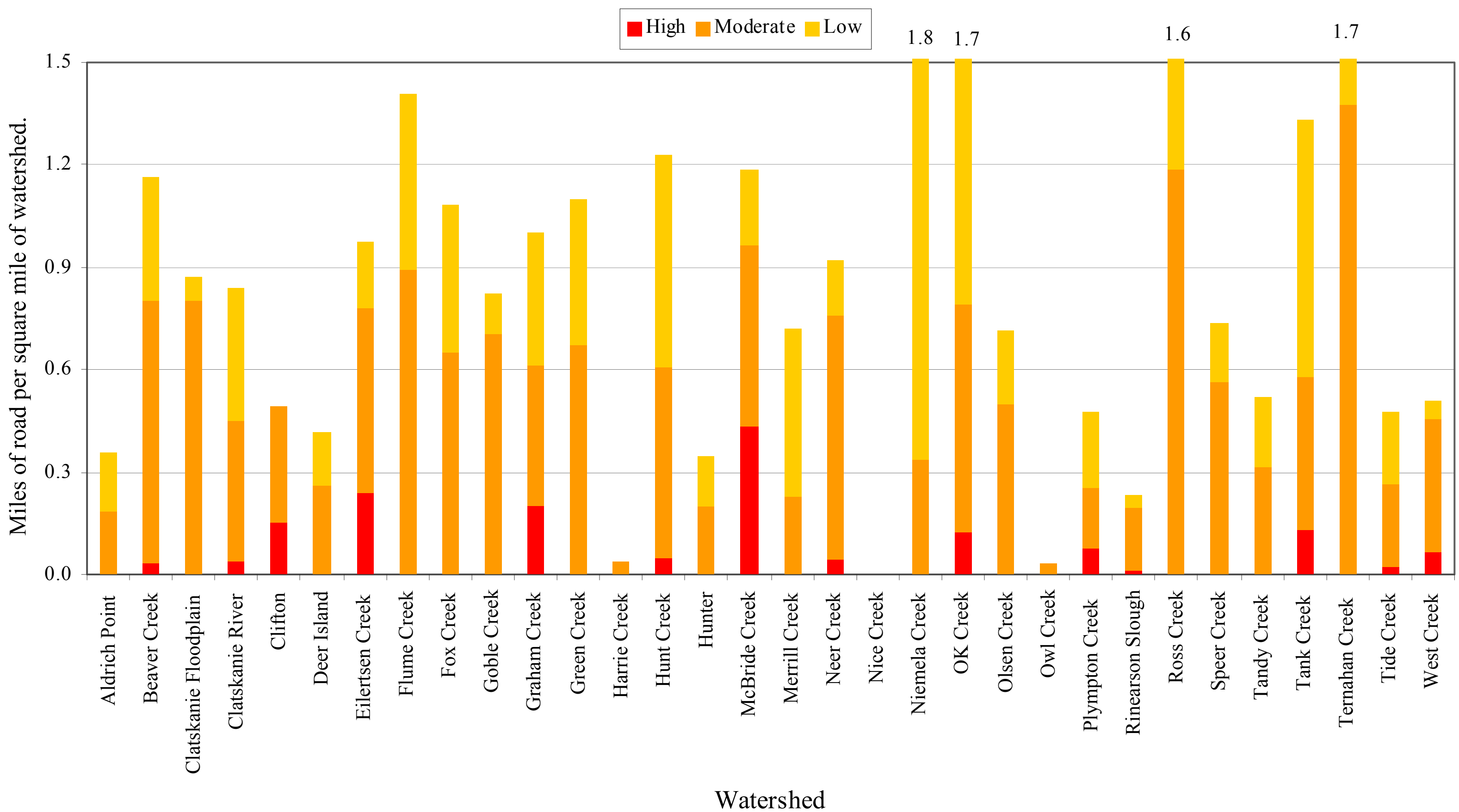
Table 6.2 summarizes the density of road segments that are within 200 feet of stream channels within each watershed. These road segments include paved and unpaved roads within areas that are not urban. Table 6.2 lists the watersheds according to rank, with the watershed that has the highest density of road segments ranked #1. The rank of the watersheds is unique to this analysis; rank in this table is separate from rank in Table 6.1.

Seven of the top eight watersheds in Table 6.2 are small watersheds, less than 3 square miles, with limited salmonid habitat. Hunt Creek is ranked number seven in this table and number eight in Table 6.1. Road sediments and road instability are both key issues in Hunt Creek. Beaver Creek is ranked nine and covers a substantial area of land that is about 49 square miles. Even though Beaver Creek has an impassable falls in the lower section of the mainstem, upstream habitat and sediment transport conditions are important because they affect the lower mainstem. Green Creek and Fox Creek watersheds are ranked fairly high on the list of watersheds. These two watersheds have potential habitat for coho salmon and steelhead production. Although the Clatskanie River watershed is ranked number sixteen, it has a fair number of roads next to streams. The data in Table 6.2 are skewed by high scores from a few, small watersheds with relatively little habitat for salmonids. If we disregard the top six watersheds, then the Clatskanie River watershed, as can be seen on Figure 6.4, falls into the middle of the range of road densities.

Table 6.2: Density (miles of road/mi^2 of watershed) of road segments within 200 feet of stream channels.

Watershed	Density	Rank
Niemela Creek	1.75	1
OK Creek	1.74	2
Ternahan Creek	1.74	3
Ross Creek	1.64	4
Flume Creek	1.41	5
Tank Creek	1.33	6
Hunt Creek	1.23	7
McBride Creek	1.18	8
Beaver Creek	1.16	9
Green Creek	1.10	10
Fox Creek	1.08	11
Graham Creek	1.00	12
Eilertsen Creek	0.97	13
Neer Creek	0.92	14
Clatskanie Floodplain	0.87	15
Clatskanie River	0.84	16
Goble Creek	0.82	17
Speer Creek	0.74	18
Merrill Creek	0.72	19
Olsen Creek	0.71	20
Tandy Creek	0.52	21
West Creek	0.51	22
Clifton	0.49	23
Plympton Creek	0.48	24
Tide Creek	0.47	25
Deer Island	0.42	26
Aldrich Point	0.36	27
Hunter	0.35	28
Rinearson Slough	0.24	29
Harrie Creek	0.04	30
Owl Creek	0.03	31
Nice Creek	0.00	32

Figure 6.4: Sediment potential from rural roads.



Sediments from urban areas

Urban areas comprise 1% of the subbasin and are found in the following watersheds: Clatskanie River, Fox Creek, Nice Creek, and Harrie Creek. Sediment potential from urban areas is summarized in Table 6.3. The cities of Rainier and St. Helens have storm water systems, infrequent street cleaning, and mostly are residential. Sediment production from residential areas is typically low (WPN, 1999). St. Helens has detention ponds for treatment of storm water. The city of Clatskanie does not have a storm water system but new developments are required to install storm water systems. Sediment production within Clatskanie is presumably low because of the predominance of residential land use. All of the urban areas are found in the lower section of the watersheds and comprise from 1 to 6% of the watershed area.

Table 6.3: Summary of sediment potential of urban land uses.

Watershed	City	Stormwater System	Street cleaning	Sediment removal	Sediment production	Production Type	Acres Drained	Watershed Acres	Percent of Watershed
Clatskanie River	Clatskanie	No	Infrequent	Unknown	Low	Residential	620	60724	1%
Fox Creek	Rainier	Yes	Infrequent	None	Low	Residential	22	2041	1%
Nice Creek	Rainier	Yes	Infrequent	None	Low	Residential	43	803	5%
Harrie Creek	St Helens	Yes	Infrequent	Det Pond	Low	Residential	64	985	6%

Sediments from croplands

Table 6.4: Summary of sediment potential of croplands expressed as a percent of watershed.

Watershed	Low K-value	Moderate K-value	Grand Total
	Slope < 10%	Slope < 10%	
Clatskanie Floodplain	2%	43%	45%
Clatskanie River	0%	0%	0%
Deer Island	2%	9%	11%
Niemela Creek	0%	10%	10%
Rinearson Slough	1%	22%	23%
Tank Creek	0%	0%	0%
Tide Creek	0%	0%	0%
West Creek	0%	1%	1%

Table 6.4 summarizes the sediment potential from croplands based on the percent of the total watershed area managed for crops. There are no soils within croplands of the subbasin that have a high K-value. Also, slope steepness is less than 10% within all if the croplands of the subbasin. The Clatskanie Floodplain watershed is a historic floodplain of the Columbia River that has been drained and diked for agricultural and residential use. Most of the agricultural lands in the Clatskanie Floodplain watershed are on alluvial deposits with slopes less than 10% and soils that have a moderate K-value. Deer Island is another example of a historic floodplain of the Columbia River. Sediment potential from croplands on Deer Island are very similar to the Clatskanie Floodplain, with most of the croplands rating as low slope and soils with a moderate k-value. The subbasin as a whole is characterized by low sediment potential from croplands because nearly all the croplands are found on soils with a moderate k-value and slopes less than 10%. Sediment from croplands is not a significant concern because of this fact and also because these croplands for the most part are not connected to free flowing streams. Croplands in the subbasin are located in diking districts where the stream channels, which are actually sloughs, have been nearly cutoff from the rest of the subbasin by levees, tide gates, and pump houses.

Sediments from pasture lands

Table 6.5 summarizes the sediment potential from pasturelands throughout the subbasin. Similar to the analysis of croplands, there is a very low potential of sediments from pasturelands. There are no pasturelands found on a slope of 40% or more, based on 10-meter DEMs, within the subbasin. Soils with a high k-value are also uncommon in pasturelands. A total of six watersheds have a small amount of land area managed for pasture that also have soils with a high k-value. The majority of the pasturelands within the subbasin are found on soils with a moderate k-value but also with slopes less than 40%. Throughout the subbasin, sediment potential from pasturelands is generally rated as moderately low.

Table 6.5: Summary of sediment potential from pasturelands expressed as a percent of watershed.

	High K-value		Moderate K-value		Low K-value		
Watershed	Slope < 40%	Slope > 40%	Slope < 40%	Slope > 40%	Slope < 40%	Slope > 40%	Grand Total
Beaver Creek	1%	0%	7%	0%	1%	0%	9%
Clatskanie Floodplain	0%	0%	9%	0%	2%	0%	11%
Clatskanie River	0%	0%	1%	0%	0%	0%	2%
Deer Island	1%	0%	38%	0%	17%	0%	56%
Flume Creek	0%	0%	11%	0%	0%	0%	11%
Fox Creek	0%	0%	1%	0%	0%	0%	1%
Goble Creek	1%	0%	12%	0%	1%	0%	13%
Graham Creek	0%	0%	2%	0%	0%	0%	3%
Green Creek	1%	0%	15%	0%	1%	0%	17%
Harrie Creek	0%	0%	2%	0%	0%	0%	2%
Hunter	3%	0%	6%	0%	0%	0%	9%
McBride Creek	0%	0%	2%	0%	1%	0%	3%
Merrill Creek	0%	0%	4%	0%	0%	0%	4%
Neer Creek	0%	0%	5%	0%	2%	0%	7%
Niemela Creek	0%	0%	12%	0%	0%	0%	12%
Owl Creek	0%	0%	3%	0%	0%	0%	3%
Rinearson Slough	0%	0%	10%	0%	8%	0%	18%
Speer Creek	0%	0%	3%	0%	0%	0%	3%
Tandy Creek	0%	0%	8%	0%	2%	0%	10%
Tank Creek	0%	0%	0%	0%	0%	0%	0%
Ternahan Creek	0%	0%	11%	0%	0%	0%	11%
Tide Creek	1%	0%	10%	0%	1%	0%	12%

Conclusions

Slope failures and debris flows are most likely to occur in the western and northwestern portions of the subbasin. Hillslopes, geologic conditions, and channel morphology are used as indicators of risk of slope failure and debris flow. However, human developments, such as roads, can exacerbate conditions, leading to an increased risk of slope failures under a variety of geologic and topographic conditions. In addition, within the areas identified as high or moderate risk of slope failure and debris flow, human developments can magnify the risk of slope failures and debris flows. For this reason, roads, culverts and harvest activities within the high and moderate risk areas should be further investigated through field surveys.

Additional investigations of slope failures and debris flows that occurred during the floods of 1996 and 1997 will improve upon the slope instability and road instability analysis. Aerial photographs taken after these flood events along with information from ODF can be used to identify sediment sources that are contributing to background sediment loads, and areas of high risk for future slope failures.

Forest and rural roads are common in the Lower Columbia-Clatskanie Subbasin. There are a total of 1492 miles of roads, including urban roads, of which 1159 miles are unpaved. Urban areas comprise 1% of the subbasin; therefore urban roads make up a small portion of the total miles of roads. Some of the smallest watersheds in the subbasin have high densities of at-risk roads and roads next to streams. These small watersheds skew the results of Tables 6.1 and 6.2, and give the false impression that conditions within other watersheds are insignificant. If the few high scoring small watersheds (less than 2.5 square miles) are ignored, the data from Tables 6.1 and 6.2 indicate that the Clatskanie River watershed has a moderately high density of at-risk road segments and roads next to streams, when compared to other watersheds of the subbasin. Additionally, members of the Lower Columbia River Watershed Council believe that the road density of the Clatskanie River Watershed is underestimated by the GIS data (Lower Columbia River Watershed Council Meeting, May 22, 2001). Actual road density may be substantially higher. The lower two-thirds of the Clatskanie River watershed contains most of the debris flow and slope failure hazard areas. Based on the analysis presented here, salmonid habitats within the lower two-thirds of the watershed have the highest risk of sedimentation from slope failures, debris flows, and at-risk roads.

Elsewhere in the subbasin, road instability is a concern in the northwestern watersheds but the density of roads next to streams is high in various watersheds throughout the subbasin. Road instability due to natural conditions is greatest in watersheds that drain into the Westport Slough. Six out of the seven highest ranked watersheds for density of at-risk roads empty into the Westport Slough. Sediment potential from forest and rural roads is not as definitive for streams connected to the Westport Slough. Only OK Creek and Ross Creek watersheds are ranked amongst the top eleven watersheds for density of roads within 200 feet of streams. In eastern part of the subbasin, Beaver Creek, Green Creek and Fox Creek are ranked within the top eleven for density of roads next to streams. Even though Beaver Creek has an impassable falls within the lower mainstem, upstream habitat conditions and sediment sources influence the mainstem within the range of anadromous salmonids.

Sediments from urban areas are a minor concern within the subbasin. Urban areas are found in four watersheds of the subbasin and range from 1% to 6% in watershed area. Location is important when evaluating the sediment potential of urban land uses. Within the Clatskanie River watershed, the town of Clatskanie is situated within the tidal zone of influence about two miles from the confluence with the Columbia River. This section of the Clatskanie River is a floodplain habitat that would naturally have a high percentage of fine sediments.

Sediments from croplands are also a minor concern within the subbasin. Croplands within the subbasin are located on historic floodplains of the Columbia River that have, for the most part, little if any surface water connections to the rest of the subbasin. These floodplains once contained key habitats utilized by migrating and rearing salmonids but now play a minimal role in the production of salmonids due to land developments.

Pasturelands are scattered throughout the subbasin, with the greatest concentration in the floodplains of the Columbia River and in the watersheds of the eastern part of the subbasin. The analysis of pasturelands as a source of sediments indicates that nearly all pasturelands are on a slope of less than 40% and soils with moderate k-values. Based on these findings, sediments from pasturelands are not a significant issue within the subbasin. However, if water quality samples or habitat surveys indicate high sediment loads in streams, then a further analysis of site-specific management conditions on pasturelands may be warranted.

Data Gaps

Despite repeated requests for road hazard inventories of state lands and road instability information on private lands, the ODF refused to cooperate with the Lower Columbia River Watershed Council (LCRWC) and Portland State University (PSU) in their efforts to evaluate the significance of road and slope instability within the Lower Columbia-Clatskanie Subbasin. Letters and emails were sent and phone calls were made to the Astoria field office of ODF requesting all road inventory data during the summer 1999. Additionally, phone calls were placed to the Columbia City and Forest Grove offices of ODF in June of 2000 requesting all road inventories of state lands and information about road failures on private timber lands. PSU and LCRWC received no cooperation from ODF.

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