Stemilt-Squilchuck Road Condition Survey

An assessment of road-stream interactions

February 2021

WASHINGTON CONSERVATION SCIENCE INSTITUTE

William L. Gaines, James S. Begley, Andrea L. Lyons in Collaboration with Erin McKay and Michael Kane, Chelan County Natural Resources

Introduction

We conducted a landscape evaluation for the Stemilt and Squilchuck subwatersheds in support of forest restoration and resource management planning for the Chelan County Natural Resources Department (CCNRD) and the Stemilt Partnership (Gaines et al. 2019). The Stemilt Partnership was established in 2007 and includes a broad coalition of agriculture, wildlife, recreation, development and conservation interests. The Partnership worked closely with Chelan County and The Trust for Public Land to develop a community vision and landscape strategy for the entire Stemilt-Squilchuck watershed (TPL 2007). One issue that was raised during the landscape evaluation process, and in related collaboration meetings, was a concern about how roads were interacting with streams and other waterbodies. To begin addressing this issue, a preliminary analysis was completed to assess the potential for sediment delivery from roads to streams. The results of this initial assessment were presented in the final landscape evaluation report along with the following recommendations:

- Update the roads and streams data layers.
- Use the results from preliminary sediment delivery potential assessment to focus field surveys on road segments with the greatest potential to deliver sediment to streams.
- Develop treatment recommendations to reduce sediment delivery from roads to streams and address documented resource damage that can be used to seek funding for project-level implementation.

Subsequent to the completion of the landscape evaluation, the CCNRD successfully obtained funding to further evaluate the impacts of roads on streams. The CCNRD contracted with WCSI to complete this work. This report documents the results of this work that included the following objectives, which also address the above listed recommendations:

- Complete road condition surveys for areas identified in the preliminary analysis as having potential to deliver sediment to streams.
- Document and rank road-related sediment delivery and resource damage areas.
- Update the road and stream layers based on field surveys.
- Re-run potential sediment delivery models and intersect with areas of high erosion hazard for use in future resource management planning.
- Develop treatment recommendations to reduce sediment delivery from roads to streams and address documented resource damage.

The Evaluation Area

The landscape evaluation area includes two 6th Code Subwatersheds (HUC 12) that lie to the south and west of the City of Wenatchee (Fig. 1). These two subwatersheds are a combined 38,960 acres in size and include 7% federal lands, 14% Washington Department of Natural Resources, 12% Washington Department of Wildlife, 8% Chelan County, and 60% private land. Additional details about the watershed can be

found in the Stemilt Partnership Vision Document and associated appendices (TPL 2007).

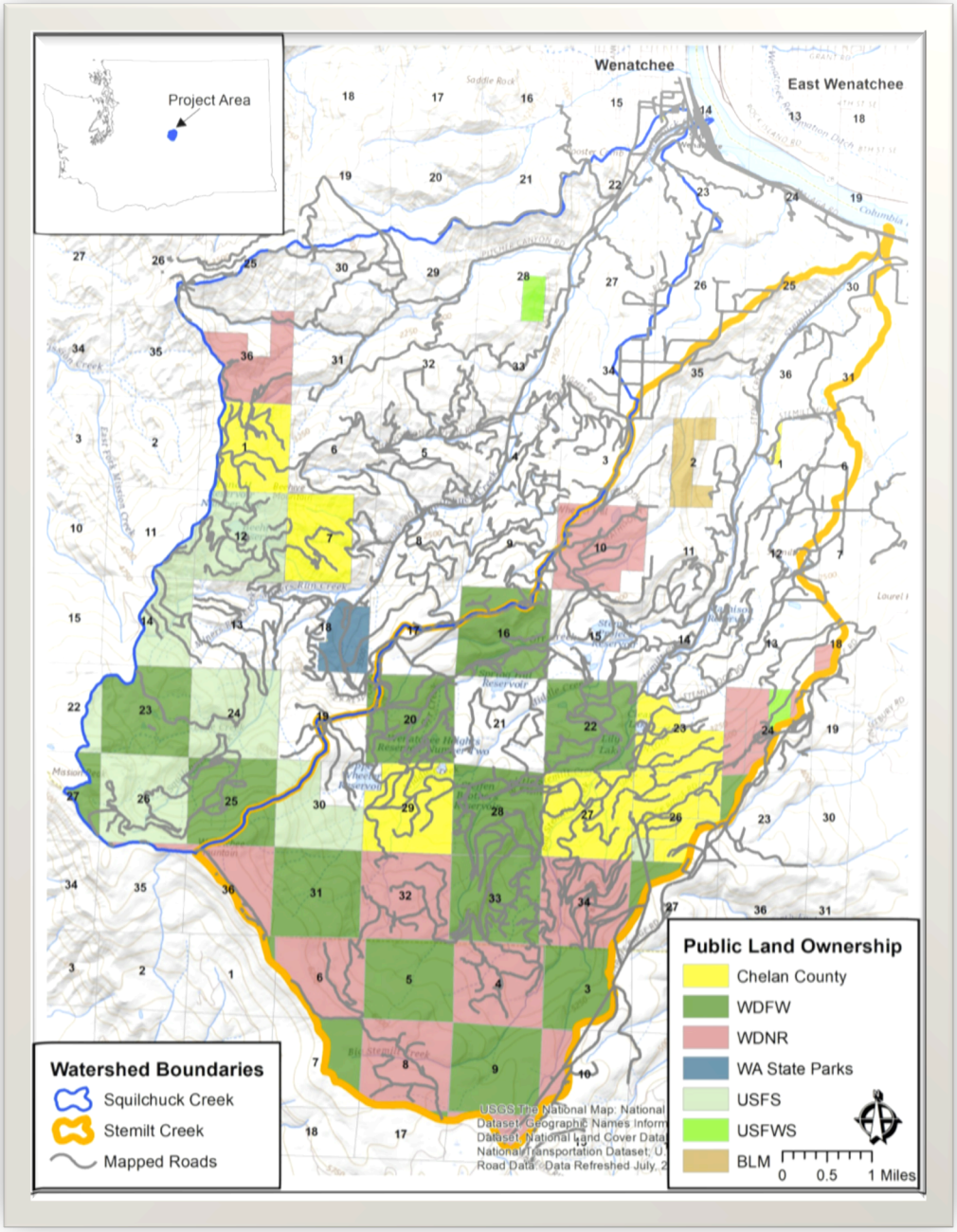

Figure 1. Map showing the landownership in the Stemilt and Squilchuck subwatersheds. Road conditions surveys were focused on state and federal lands within this area.

Methods

The approach used to assess the potential impacts of roads on streams included four primary components: (1) a field survey to identify sediment delivery points and assess their severity; (2) an assessment of the potential for sediment delivery from roads to streams using current models, and streams and roads layers; (3) an evaluation road segments in relation to their potential for slope failure using high resolution digital elevation data and current modeling approaches (Beechie et al. 2013), and (4) roads within or in close proximity to riparian areas. We have implemented similar approaches for other watersheds in eastern Washington such as Nason Creek (Gaines et al. 2017a) and North Fork Taneum Creek (Gaines et al. 2017b). The components of our assessment are described in detail below.

Field Surveys to Identify Road Erosion, Sediment Delivery, and Other Resource Damage

We accessed as many roads, including unauthorized user-built roads, as possible by vehicle or on foot to evaluate road-stream crossings, identify areas that were delivering sediment to streams, and to document other resource damage related to road use. The ArcGIS Collector App was used to collect data during the road surveys. A data collection template, with defined fields and attributes, was developed to collect standardized information for each Road Observation Point along the road being surveyed. A Road Observation Point is defined as a location that is or could potentially develop into an erosion and sediment delivery problem. Data recorded at each Road Observation Point included: Erosion Severity; Culvert Condition; Drainage Ditch Condition; Road Surface Condition; Road Surface Type; and Comments (Table 1). All Road Observation Point data were recorded in the field and stored in an ArcGIS file geo-database for the project. We created a spatial data-layer with Road Observation Point locations linked to meta-data with a description of the site along with photos in order to provide an archive of the survey results.

Sediment Delivery Potential

Erosion from road surfaces can increase streambed fine sediment, which affects aquatic habitat, macroinvertebrate populations, fish spawning habitats, and water quality (Luce and Black 1999, Wondzell 2001). In addition, fine sediment from roads can make streambeds and banks more susceptible to erosion during high flow events (Luce and Black 1999, Wondzell 2001). The GRAIP-Lite (Geomorphic Road Analysis and Inventory Package) tool (Nelson et al. 2019, NetMap 2020) was used to identify road segments that have the highest potential to deliver fine sediments to streams. Field data were used in combination with GRAIP-Lite to identify and prioritize road segments for maintenance, rehabilitation, and restoration.

Table 1. A description of the information collected at each Road Observation Point that was identified in the field during the Stemilt-Squilchuck road condition survey.

Erosion Point Information	Description
Erosion Severity	A subjective ranking: High, Moderate, and Low. High erosion severity would be features such as a failed culvert or heavily eroded road surfaces delivering sediment directly to or in close proximity to streams. Moderate erosion severity would be features such as partially blocked culverts and notably less severe erosional issues. Low erosion severity are typically features, such as a culvert on a decommissioned road, that observers felt collecting information would be useful but does not necessarily have any immediate erosional or sediment delivery issues.
Culvert Condition	Attributes include: None, Good, Partially Filled, Filled, Partially Crushed, Crushed, and Failed.
Ditch Condition	Attributes include: None, Good, Partially Filled, Filled, and Gullied.
Surface Condition	Attributes include: Good, Eroded/Rilled, Water Bar, Rutted, Rocky, Ripped, Decommissioned, Recontoured, and Tilled.
Surface Type	Attributes include: Native, Crushed Rock, and Paved.
Fish Barrier	Attributes include: Yes/No. Does the feature potentially block fish passage?
Comments	Recorded to provide additional descriptions and information that was not captured in the standard attributes which could be used to further determine the estimated Erosion Severity rank of the Erosion Points.
Photos	Taken at most locations to accompany associated field data collected at the Erosion Points. The Erosion Points data and the attached photos are stored in the project geodatabase and can be accessed and used to facilitate resource managers in identifying roads and locations for aquatic restoration, erosion control, and more intensive field surveys throughout the Project Area.

Erosion Hazard Potential

We assessed road segments that were located in landscape positions that make them prone to the risk of slope failure, referred to as erosion hazard. We used the General Erosion Potential-Delivered (GEPdel) model in NetMap (2020) to identify landscape conditions (gullies, steep drainages, etc.) that are prone to landslides and slope failures. We then intersected these areas with the roads datalayer to identify road segments that are at risk of failure. These areas can be used to conduct field

assessments that evaluate potential slope failure that might be influenced by vegetation treatments, road restoration, or road construction.

Roads in Riparian
We identified road segments within or close to riparian habitats by buffering the stream layer by 50 meters on each side of a mapped stream. This provided an approximation of areas with potential riparian habitats. This data layer was then intersected with the road data layer to identify road segments in riparian habitats.

Results

We surveyed a total of 85.2 miles of roads in the Squilchuck and Stemilt subwatersheds to assess road condition and identify areas with potential for sediment to be delivered to streams (Table 2). In addition, we located and documented resource damage areas associated with road use.

Table 2. Miles of road surveyed by ownership within each subwatershed.

Land Ownership	Squilchuck Creek	Stemilt Creek	Grand Total
Chelan County	0.1	10.0	**10.1**
US Forest Service	2.8	0.0	**2.8**
Washington State Department of Fish and Wildlife	0.2	11.4	**11.6**
Washington State Department of Natural Resources	0.1	19.5	**19.7**
Washington State Parks	1.8	0.0	**1.8**
Private	21.7	17.4	**39.1**
Grand Total	**26.8**	**58.4**	**85.2**

Road Observation Points – Erosion, Sediment Delivery, and Other Resource Damage
Road condition surveys identified 219 road observation points, of which 24 problems/issues were rated as high severity, 76 as moderate severity, and 119 and low severity (Table 3, Fig. 2). In addition, we identified 127 area of resource damage that was associated with road use (Table 3, Fig. 2).

We were not able to access the primary road within the Mission Ridge Ski area due to the road being closed to all access due to safety issues with large equipment being used to install a new ski lift. Unfortunately, this situation persisted during the entire length of our field season. We plan to complete this survey as soon as conditions allow in the spring of 2021.

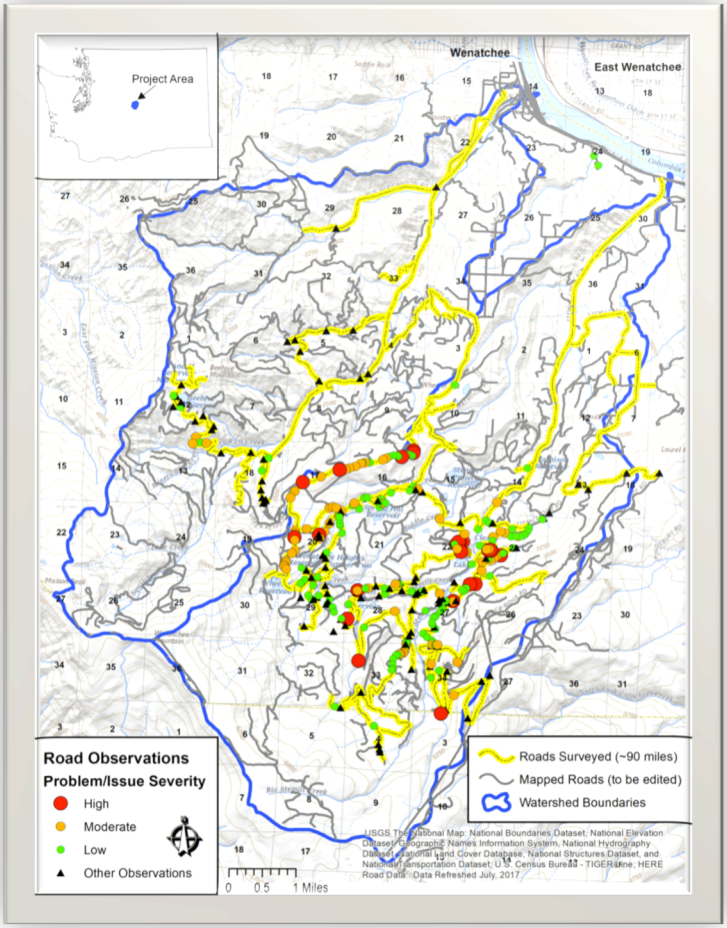

Figure 2. Map showing the roads surveyed, observations of road erosion and sediment delivery issues, and areas recommended for road layer edits.

Table 3. Road Observation Points by severity category and other resource damage observations for each landownership in the Stemilt-Squilchuck road condition in the survey area.

Land Owner	Problem/Issue Severity			Other Obs	Grand Total
	Low	Moderate	High		
Chelan County	40	16	7	30	**93**
US Forest Service	2	1	0	8	**11**
Washington State Department of Fish and Wildlife	36	21	11	13	**81**
Washington State Department of Natural Resources	22	23	4	31	**80**
Washington State Parks	2	0	0	9	**11**
Private	17	15	2	36	**70**
Grand Total	**119**	**76**	**24**	**127**	**346**

Of the 24 Road Observation Points that were rated as high severity there were 3 failed culverts, 2 stream crossings with no culvert or bridge causing considerable sediment delivery, 6 dispersed or recreation sites with extensive rutting and soil compaction, and 13 road segments with extensive rutting and erosion (Table 4).

Table 4. A summary of the types of road-related issues that resulted in a high severity road observation point and the data point reference number so the site can be geo-referenced.

High Severity Point Category	**Number of Sites**	**High Severity Point Reference Number**
Failed Culvert	3	15, 21, 340
Road-Stream Crossing	2	226, 314
Dispersed/Recreation Site	6	88, 89, 92, 93, 94, 98
Road Ruts/Erosion	13	7, 12, 13, 43, 44, 52, 66, 70, 75, 149, 162, 164, 165

Sediment Delivery Potential

The GRAIP-Lite analysis showed that there are 41 miles of roads in the evaluation area with a high potential to deliver sediment to streams, 78 miles with a moderate potential, and 203 miles with a low potential (Table 5, Fig. 3). These results are similar to those from other subwatersheds showing that typically 10-15% of the road network has the greatest potential to deliver sediment to streams.

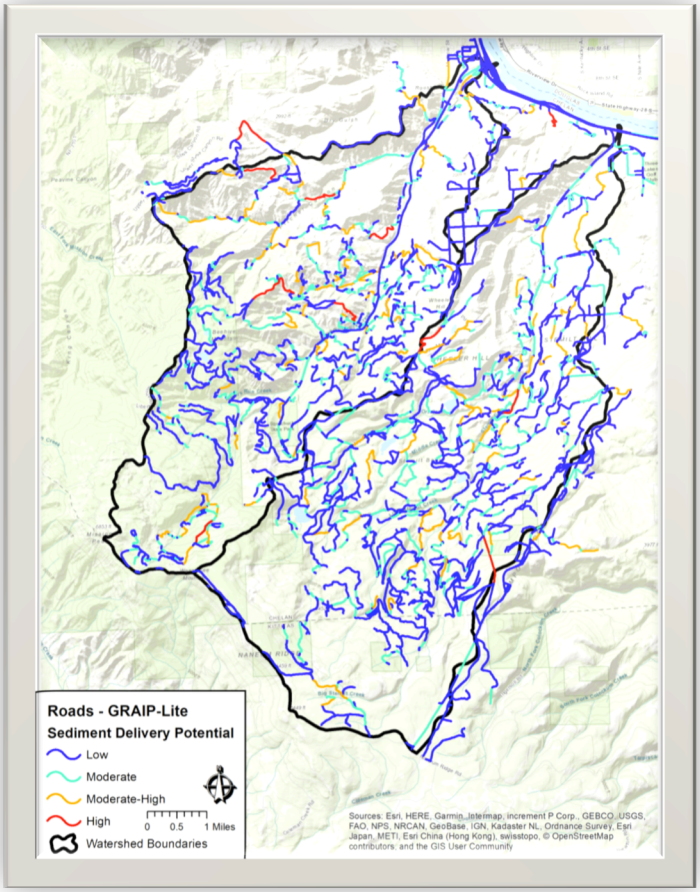

Figure 3. Map showing the results of the GRAIP-Lite model results with road segment as high, low, moderate-high, and high potential to deliver sediment to a stream.

Table 5. A summary of the GRAIP-Lite results showing the miles of road in each subwatershed with High, Moderate, and Low sediment delivery potential

Subwatershed	**Miles of Road (percent)**		
	Low	**Moderate**	**High**
Stemilt	116 (65%)	44 (25%)	19 (10%)
Squilchuck	87 (61%)	34 (24%)	22 (15%)
TOTALS	203 (63%)	78 (24%)	41 (13%)

Erosion Hazard Potential-General

Using the General Erosion Potential model framework we classified the erosion potential for the entire area within each subwatershed. The Squilchuck subwatershed showed that 50% of the area is low, 47% moderate, and 3% as high erosion hazard potential (Table 6, Fig. 5). In the Stemilt subwatershed, 74% was rated as low, 25% as moderate, and 1% as high erosion potential (Table 7, Fig. 4).

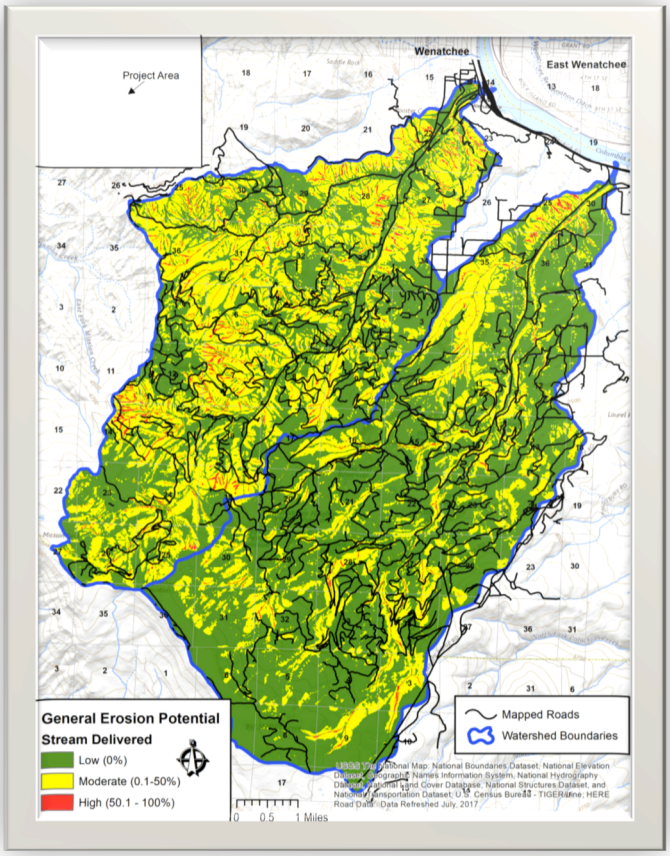

Figure 4. Map showing the results of the General Erosion Potential model (stream delivered) for the Stemilt and Squilchuck subwatersheds.

Table 6. Acres of low, moderate and high erosion hazard potential in the Squilchuck subwatershed.

Land Owner – Squilchuck Subwatershed	**Erosion Hazard Potential**			**Grand Total**
	Low	**Moderate**	**High**	
Chelan County	337.2	563.4	56.9	**957.5**
US Bureau of Land Management	0.0	0.0	0.0	**0.0**
US Fish and Wildlife Service	16.3	43.3	9.3	**68.9**
US Forest Service	1,285.6	1,082.7	84.0	**2,452.3**
Washington State Department of Fish and Wildlife	897.7	449.8	21.6	**1,369.1**
Washington State Department of Natural Resources	162.0	328.0	22.0	**511.9**
Washington State Parks	166.4	107.5	1.7	**275.6**
Private	6,040.1	5,702.1	372.1	**12,114.3**
Grand Total	**8,905.2**	**8,276.7**	**567.6**	**17,749.6**

Table 7. Acres of low, moderate and high erosion hazard potential in the Stemilt subwatershed.

Land Ownership-Stemilt Subwatershed	Erosion Hazard Potential			Grand Total
	Low	Moderate	High	
Chelan County	1,719.3	440.0	13.5	**2,172.9**
US Bureau of Land Management	65.6	156.1	5.2	**226.9**
US Fish and Wildlife Service	37.6	29.4	0.4	**67.4**
US Forest Service	260.8	156.5	6.4	**423.7**
Washington State Department of Fish and Wildlife	3,427.0	1,124.8	36.7	**4,588.5**
Washington State Department of Natural Resources	4,561.6	1,035.3	39.1	**5,636.0**
Washington State Parks	0.0	0.0	0.0	**0.0**
Private	5,675.9	2,288.2	113.3	**8,077.4**
Grand Total	**15,747.8**	**5,230.3**	**214.6**	**21,192.6**

Erosion Hazard Potential-Roads

We intersected the existing roads data with the erosion hazard potential and identified 3.2 miles of road in high hazard potential areas, 86.1 miles of road in moderate, and 231.9 miles in low hazard potential areas (Tables 8 and 9, Fig. 5).

Table 8. Miles of road in low, moderate and high erosion hazard potential areas in the Squilchuck subwatershed.

Land Ownership-Squilchuck Subwatershed	Erosion Hazard Potential			Grand Total
	Low	Moderate	High	
Chelan County	4.1	3.9	0.2	**8.2**
US Bureau of Land Management	0.0	0.0	0.0	**0.0**
US Fish and Wildlife Service	0.0	0.0	0.0	**0.0**
US Forest Service	11.3	6.9	0.5	**18.7**
Washington State Department of Fish and Wildlife	5.0	2.0	0.1	**7.0**
Washington State Department of Natural Resources	1.4	1.3	0.0	**2.7**
Washington State Parks	2.2	0.7	0.0	**2.9**
Private	65.6	35.5	1.4	**102.4**
Grand Total	**89.5**	**50.3**	**2.2**	**142.0**

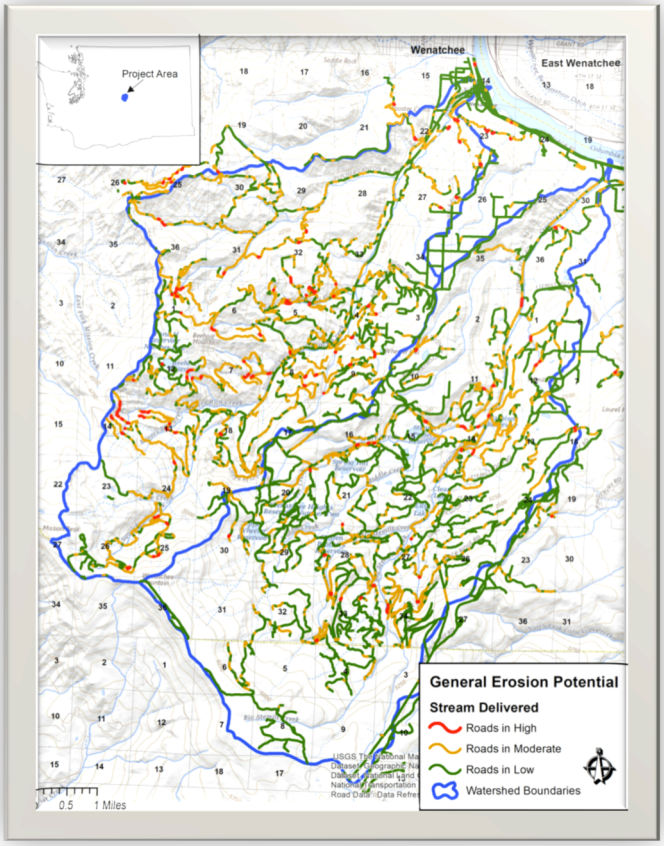

Figure 5. Map showing the results of the General Erosion Potential Model intersected with roads to show road segment with low, moderate and high erosion potential.

Table 9. Miles of road in low, moderate and high erosion hazard potential areas in the Stemilt subwatershed.

Land Ownership-Stemilt Subwatershed	Erosion Hazard Potential			Grand Total
	Low	Moderate	High	
Chelan County	19.8	3.7	0.0	**23.6**
US Bureau of Land Management	0.1	0.0	0.0	**0.1**
US Fish and Wildlife Service	0.3	0.3	0.0	**0.7**
US Forest Service	0.5	0.0	0.0	**0.6**
Washington State Department of Fish and Wildlife	19.0	5.2	0.2	**24.4**
Washington State Department of Natural Resources	48.3	8.7	0.2	**57.2**
Washington State Parks	0.0	0.0	0.0	**0.0**
Private	54.3	17.8	0.5	**72.6**
Grand Total	**142.4**	**35.8**	**1.0**	**179.2**

Roads in Riparian Habitat

There are 99.8 miles of road within the assessment area that occur within 150 feet of a mapped stream (Table 10, Fig. 6). Many of these roads overlap with those in which field surveys identified high severity delivery points.

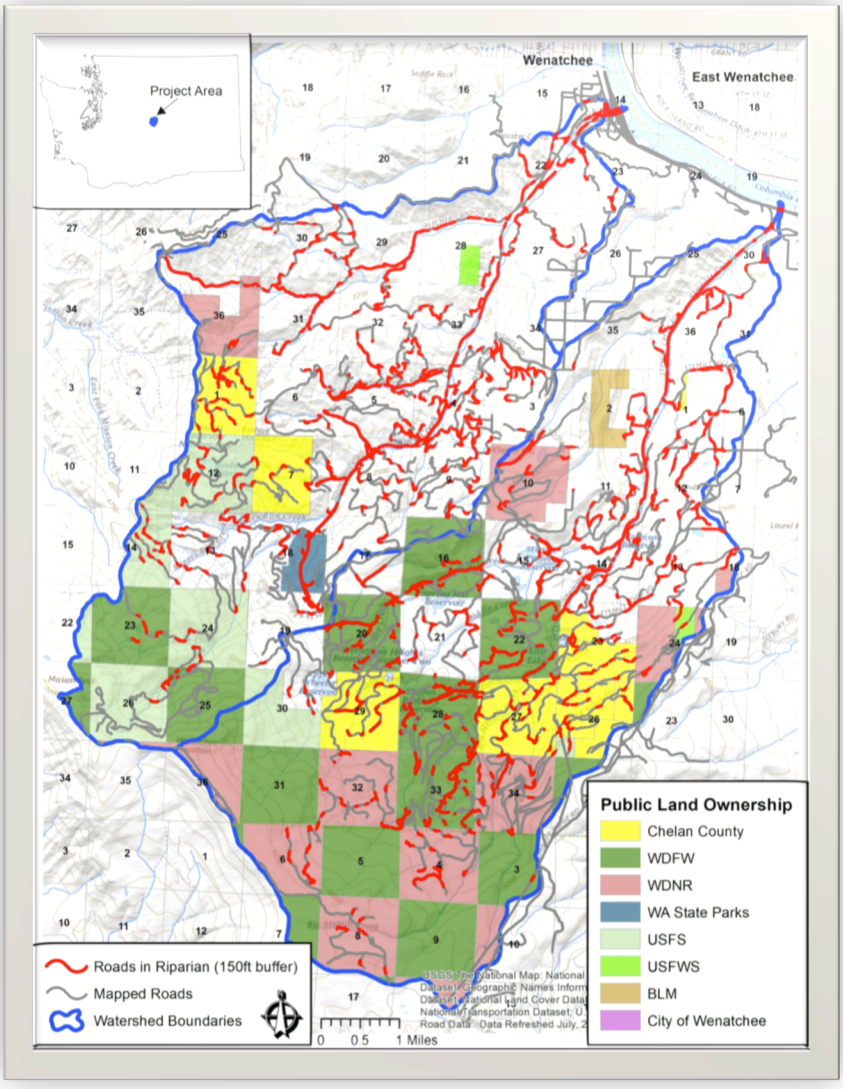

Figure 6. Map highlighting road segments that are within 150 feet of a mapped stream.

Table 10. The miles of road by ownership that are within 150 feet of a mapped stream.

Land Ownership	Miles within 150 feet of a Stream
Private	64.5
Washington Department of Fish and Wildlife	15.1
Chelan County	8.2
Department of Natural Resources	7.3
US Forest Service	3.4
State Park	0.9
US Fish and Wildlife Service	0.3
Bureau of Land Management	0.1
Grand Total	**99.8**

Application of Results to Inform Road Management

Prioritization of road rehabilitation and maintenance actions:

- The photo-documentation and erosion point severity information could be used to prioritize road rehabilitation and maintenance actions. For example, there area 24 erosion points rated as high that would involve culvert replacements, road drainage rehabilitation, and road maintenance actions.
    - Failed culverts (3) – sites 15, 21, 340
        - Replace culverts and assure site is sufficient to accommodate increased flows resulting from climate change projections
    - Stream Crossings (2) – sites 226, 314
        - Restore drainage and install culvert or bridge
    - Dispersed Camp/Recreation Sites (6) – sites 88, 89, 92, 93, 94, 98
        - These sites could be restored and closed or constrained by barriers to prevent continued expansion of resource damage.
    - Road Damage and Drainage Issues (Rutting) Potentially Leading to Sediment Delivery (13) – sites 7, 12, 13, 43, 44, 52, 66, 70, 75 149, 162, 164, 165
- The results from the Graip-Lite and riparian-roads assessments, in combination with further field evaluations could be used to identify road rehabilitation and maintenance actions in places where there is high potential for sediment to be delivered to a stream in the future. Thus preventative actions could be employed.

Roads Used for Management and Recreation

- The erosion hazard potential can be used to identify areas would be the most sensitive to future erosion or slope failures. This, along with field assessments, could inform any future road development, vegetation treatment prescriptions, or recreation site development.

- The erosion potential by road segment could be used to identify roads that are prone to slope failures and erosion that may be used for management activities or recreation. In some cases road relocation or closure maybe a remedy while in other situations heavy road maintenance could be applied.

Other Road Related Resource Damage

- The survey resulted in the identification of user-built roads that are causing resource damage. These could be rehabilitated and closed.
- A number of dispersed camping sites that have considerable erosion issues were identified that could be closed or rehabilitated. Placement of barriers around the perimeter of the sites to retain would help to reduce the spread of highly compacted areas and limit erosion.
- A considerable amount of road damage was related to use during wet seasons. Road damage could be reduced by limiting travel on these roads to dry periods, increasing maintenance, and/or the application of a more durable road surface.

Literature Cited

Beechie, T., G. Pess, S. Morely, L. Butler [and others]. 2013. Watershed assessments and identification of restoration needs. Pages 50-113 in Roni, P., and T. Beechie. Eds. Stream and Watershed Restoration: a guide to restoring riverine processes and habitats. Wiley-Blackwell, Hoboken, NJ.

Gaines, W.L., J.S. Begley, A.L. Lyons, and J. Hadersberger. 2017a. Nason Creek Watershed Roads Assessment: final report. Washington Conservation Science Institute, Leavenworth, WA.

Gaines, W.L., J.S. Begley, and A.L. Lyons. 2017b. Manastash-Taneum Resilient Landscapes: Supplemental aquatic and riparian landscape evaluation for the North Fork Taneum Creek. Washington Conservation Science Institute, Leavenworth, WA.

Gaines, W.L., J.S. Begley, D. Churchill, and R.J. Harrod. 2019. Stemilt-Squilchuck landscape evaluation: final report. Washington Conservation Science Institute, Leavenworth, WA.

Luce, C.H., and T.A. Black. 1999. Sediment production from forest roads in western Oregon. Water Resources Research. 35: 2561-2570.

Nelson, N., C. Luce, and T. Black. 2019. GRAIP_Lite: a system for road impact assessment. USDA Forest Service, Rocky Mountain Research Station, Boise Aquatic Sciences Lab, Boise, ID.

Wondzell, S.M. 2001. The influence of forest health and protection treatments on erosion and stream sedimentation in forested watersheds of eastern Oregon and Washington. Northwest Science 75(Special Issue): 128-140.