

Pole Creek Geomorphic Assessment to Address Fish Passage Barriers

Location: Pole Creek is located within the Wenatchee National Forest north of Lake Wenatchee. Pole Creek is a tributary stream to Big Meadow Creek and the Chiwawa River that supports threatened and endangered chinook salmon, steelhead trout, and bull trout. The site is on U.S.D.A Forest Service ownership in Section 4, Township 27 North, 17 East, W. M.

Existing Structures: The culvert for the USFS 6305-111 Road crossing of Pole Creek is undersized and poses a fish passage barrier. The site is located approximately 1,500 feet above its confluence with Big Meadow Creek. The road crossing has a relatively large fill and will require a new drainage structure.

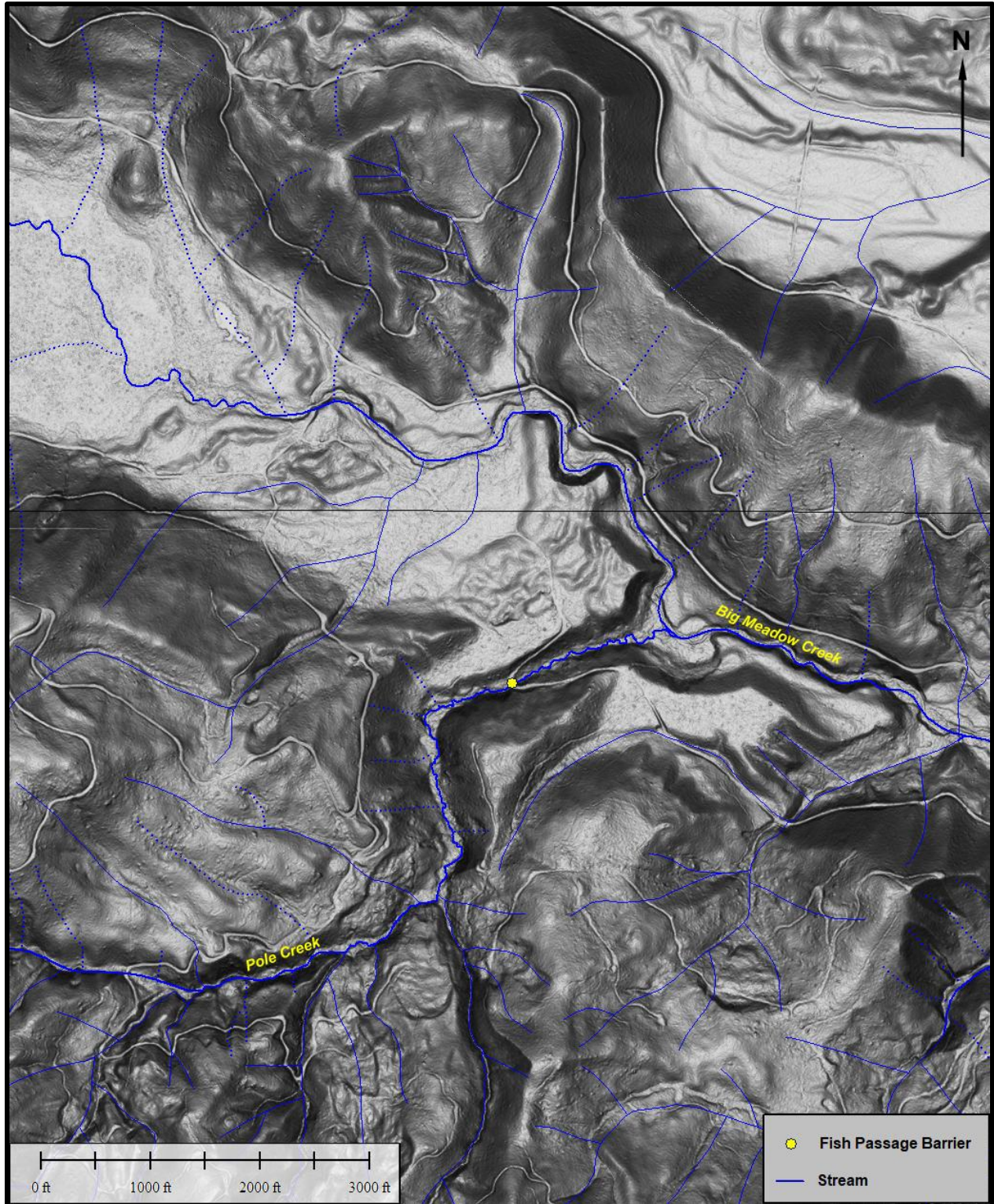
Access and Travel Management: The project area is accessed from U.S. Highway 2 to State Route 207 and then to Chiwawa Loop Road and Chelan County Road 22 at the east end of Lake Wenatchee before turning left onto Chiwawa River Road (USFS Road 62). After approximately 2 miles on Chiwawa River Road, turn left onto the USFS 6300 Road. Proceed for approximately 1.3 miles on the 6300 Road and turn left onto the USFS 6305 Road. About 0.3 miles up the 6305 Road, turn right onto the USFS 6305-111 Road. The Pole Creek crossing is located about 1.4 miles down the USFS 6305-111 Road.

Area Description: Pole Creek is situated on the east side of the Cascade Range with a basin area of 1,506 acres. The stream initiates from moderate gradient terrain along Pole Ridge with elevations of up to about 4,000 feet above sea level. Pole Creek is tightly confined for most of its length to the confluence with Big Meadow Creek.

Geology

The Pole Creek basin is underlain by sedimentary rocks of the Chumstick Formation. The Eocene-age Chumstick Formation consists of sandstone, shale, and conglomerate. The sedimentary bedrock is covered by alpine glacial drift deposits in much of the basin area (Tabor et al. 1987). The Pleistocene glacial drift deposits range from till in the uplands and up-valley areas to gravelly outwash on broad valley floors.

Interpretation: The proposed passage barrier correction work will be operating in unconsolidated alluvial and glacial outwash deposits on the north side of Brush Creek that can have variable properties across the landscape. The south side of the stream is characterized by sedimentary bedrock outcrops with shallow colluvium on steep slopes of 70 to 120 percent gradient. Unconsolidated materials on steeper slope gradients can be subject to erosion hazards, rock fall, and slope stability issues, particularly if any road cuts are required.



Shaded relief derived from 2015 Chelan County LiDAR digital elevation models

Figure 1. Shaded relief map of the lower Pole Creek project area.

Soils

The Pole Creek basin is mapped largely as Choralmont cindery sandy loam with a till substratum on 30 to 60 percent gradient slopes (NRCS 2022). The well drained Choralmont cindery sandy loam has formed from volcanic ash and pumice over glacial till, and occasionally from local residuum. The rounded gravel from the glacial till ranges from 15 to 40 inches in depth and is situated above a strongly contrasting texture of cinders without any gravel. The depth to a restrictive layer or lithic bedrock is generally greater than 80 inches. Glacial outwash with rounded to subangular gravel and cobble in a matrix of sand and silt was also identified along the hillsides adjacent to the project reach. The Unified Soil Classification rating for the soil column is SM (silty sand) or SP (poorly graded, gravelly sand with few fines).

Interpretation: The Choralmont soil type has a high volcanic ash content and along with the glacial silt deposits can be subject to erosion, particularly following disturbance or compaction. Erosion control measures, such as slash placement, hay bales, or silt fences, will be needed to prevent sediment generated during ground-disturbing activities from reaching surface waters.

Vegetation

The riparian area along Pole Creek has a diverse set of conifer species including mature mountain hemlock (*Tsuga mertensiana*), western red cedar (*Thuja plicata*), grand fir (*Abies grandis*), Douglas-fir (*Pseudotsuga menziesii*), and Pacific silver fir (*Abies amabilis*). Other tree and shrub species include black cottonwood (*Populus trichocarpa*), mountain alder (*Alnus incana*), sitka alder (*Alnus sinuata*), Douglas maple (*Acer glabrum*), and red-osier dogwood (*Cornus stolonifera*). The riparian area along the upper Pole Creek crossing consists largely of mature trees (Figure 3).

Interpretation: The riparian vegetation communities immediately adjacent to the Pole Creek road crossing are relatively undisturbed, with mature trees lining much of the channel length. The deeply rooted trees and shrubs in the understory help to stabilize the stream banks and maintain cool water temperatures. The mature forest stand will also provide a long-term source of large woody debris to the stream channel.

Site History

The 1957 and 1963 aerial photographs of the Pole Creek basin do not show any signs of human disturbance. The 1974 aerial photographs show that the USFS 6305 and 6305-111 roads have been constructed to support timber harvest activities. Several recent patches of clear-cut timber harvest are present along the edges of the Pole Creek basin, but no logging has occurred along Pole Creek. By the time of the 1984 aerial photographs, several clear-cut patches and partial-cut stands are visible along Pole Creek. A 160-acre quarter-section of timber has been clear-cut along the middle portion of Pole Creek without any buffers on the stream. The downstream portion of Pole Creek, however, has a significant riparian buffer for most of its length to Big Meadow Creek. The 1992 aerial photographs show continued logging along Pole Creek, starting about 500 feet upstream of the 6305-111 Road crossing, with minimal, if any, buffers along the channel. A number of new clear-cut patches are also present within the upper Pole Creek basin. No significant changes can be seen in the aerial photographs from 1998 through 2021.

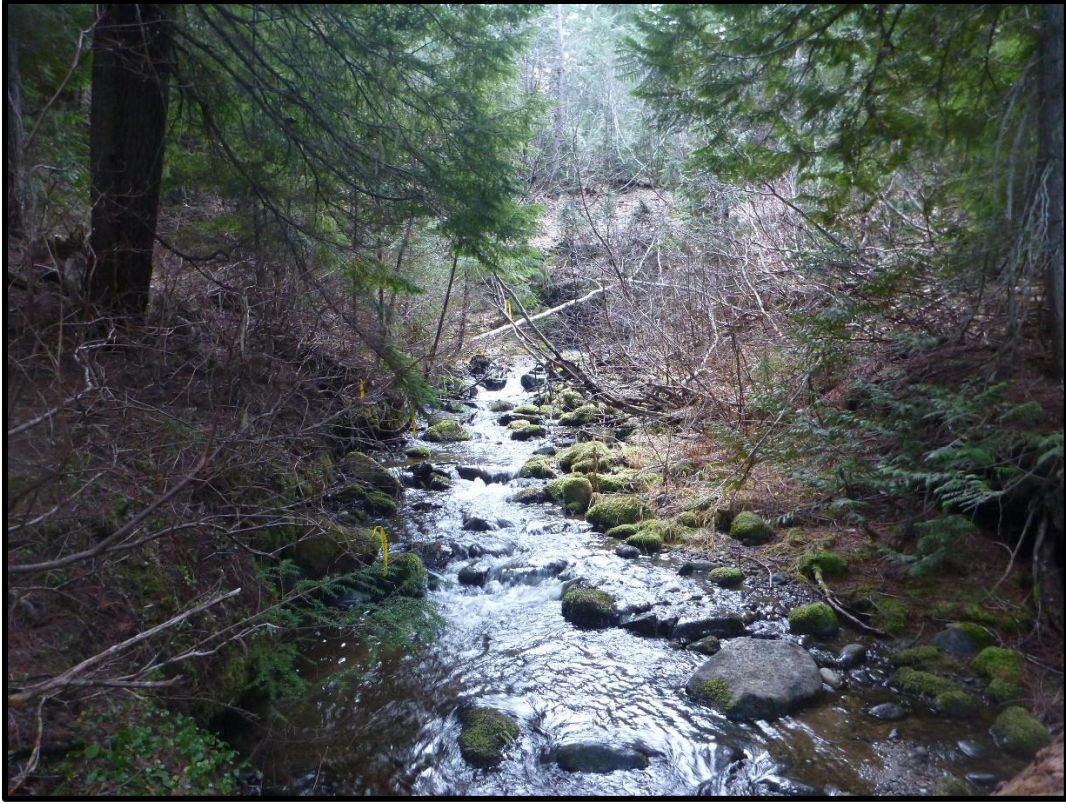


Figure 2. Typical conditions along lower Pole Creek below the USFS 6305-111 Road crossing.



Figure 3. Typical conditions along Pole Creek above the USFS 6305-111 Road crossing.

Interpretation: No significant alterations have occurred in the project area since the initial road construction. No evidence of beaver activity was seen around the road crossing site and does not appear to be a significant design issue.

Slope Stability Issues

A review of historical aerial photographs from 1957 to 2021 did not show any signs of landslides or debris flows in the Pole Creek basin. Most of the Pole Creek basin area has slopes of less than 60 percent gradient, but the steep, largely planar slopes along the south side of Pole Creek above the inlet of the USFS 6305-111 Road culvert can reach 70 to 120 percent gradient. These steep slopes above Pole Creek show signs of significant soil creep, dry ravel, isolated rockfall, and small historical slumps of colluvium into the channel.

Interpretation: The steep slopes on the south side of Pole Creek above the inlet of the USFS 6305-111 Road culvert have a high risk of erosion following disturbance, but the risk of significant landslides or debris flows appears to be low.

Channel Type and Stability

The stream channel above the USFS 6305-111 Road crossing generally ranges from 4 to 7 percent gradient, except for a short reach immediately above the crossing with a 3 percent channel gradient (Figure 4). The reach below the road crossing averages 4.5 percent gradient and then drops to 3 percent gradient as it reaches the Big Meadow Creek confluence. This entire stream reach is confined by glacial outwash terraces and Chumstick Formation sedimentary bedrock.

The lower reach of Pole Creek on both sides of the 6305-111 Road crossing would be classified as an A3 stream type according to the Rosgen stream classification system (Rosgen 1994). The channel substrate is generally dominated by a mix of cobble and gravel, with occasional boulders and relatively minor amounts of sand. The lower reach of Pole Creek is confined by a glacial outwash terrace on the north bank and by bedrock on the valley wall to the south. The single-threaded channel has low to moderate sinuosity and is largely entrenched. The average bankfull width in the reach above the road crossing is 12.3 feet. The stream has limited to no floodplain adjacent to the channel and does not experience any significant channel migration. The lowest reach of Pole Creek from about 1,000 feet below the road crossing down to its confluence with Big Meadow Creek would be classified as a B3/B4 channel as the valley bottom widens, sinuosity increases, and entrenchment decreases.

The lower reach of Pole Creek would be classified as a step-pool channel by Montgomery and Buffington (1993). Step-pool channels consist of repeating sequences of steps and plunge pools formed by woody debris, bedrock, or boulders, typically with gradients ranging from 3 to 7.5 percent. These steeper gradient, confined channels have a relatively high transport capacity that efficiently moves sediment and debris on an annual basis. The lower gradient reaches could also be classified as plane-bed channel types. Plane-bed channels have gradients ranging from 1 to 3 percent and are characterized by glides, riffles, and rapids. They generally lack discrete bars or pools and have a low width-to-depth ratio. Pole Creek has low to moderate amounts of large woody debris that can capture sediment and contribute to pool formation. The banks are occasionally undercut and largely stabilized by riparian vegetation. The narrow valley bottom is comprised mainly of alluvial deposits, with moderate to steep valley walls composed largely of glacial outwash sediments on the left bank and sedimentary bedrock on the right bank.

Interpretation: The lower reach of Pole Creek at the USFS 6305-111 Road crossing is an A3 Rosgen stream type that has a step-pool and plane-bed channel form. Low to moderate amounts of large wood are present in the channel that help to store sediment and create pools. No significant changes are expected in channel location or sediment supply at the road crossing. Minor grade control measures may be needed due to the large pool at the culvert outlet and the lower gradient channel caused by sediment storage above the culvert inlet. Otherwise, the channel gradient on either side of the crossing is similar and has a low potential for significant head-cutting following culvert replacement.



Figure 4. Longitudinal profile of lower Pole Creek above its confluence with Big Meadow Creek.

Large Woody Debris Hazard

Pole Creek has a relatively small amount of woody debris, but the wood that is present is typically large and unlikely to be transported during higher flows. Little debris transport is expected from this moderate-gradient stream.

Interpretation: The road crossing site has a low potential for plugging as a result of mobile wood transport, but the stream is capable of moving smaller logs during high flows.

Risk of Sediment Retention

Step-pool channel types are considered reaches of sediment transport, rather than deposition (Montgomery and Buffington 1993). Plane-bed channel types are considered transitional reaches between sediment transport and sediment deposition, depending on the bed material and roughness elements. The relatively coarse nature of the streambed substrate around the road crossing suggests that the channel has a low sediment supply relative to its transport capacity. Wood appears to be the primary cause of sediment retention in the channel.

Interpretation: Pole Creek has a low risk of significant sediment deposition and retention at the USFS 6305-111 Road crossing.

Streambank Sensitivity

The riparian area along Pole Creek is generally well vegetated with large trees and shrubs. Deep-rooted trees and densely-rooted shrubs help to maintain stable banks. Undercut banks are present in portions of this reach, indicating the effectiveness of the plant root systems.

Interpretation: The stream banks can adjust to minor changes in sediment transport and erosion without being destabilized.

Site Proximity to Important or Sensitive Resources

Fish use and distribution within Pole Creek is uncertain at this time, but is likely used by the same resident fish species as Big Meadow Creek. Big Meadow Creek is known to support resident westslope cutthroat trout (*Oncorhynchus clarkia lewisi*), rainbow trout (*Oncorhynchus mykiss*), and eastern brook trout (*Salvelinus fontinalis*) (Washington Department of Fish and Wildlife 2022).

Interpretation: Pole Creek may be used by three different resident fish species. The site design should minimize disturbance and maintain current channel conditions.

Overall Risk Assessment

Based on the limited slope stability concerns for the steep slopes above the road crossing, the relatively stable channel form, and mature riparian forest, the overall risk of geomorphic changes to the site is considered low.

Project Objectives:

- Provide free passage for aquatic species, sediment, and woody debris using a stream simulation design for the crossing structure.
- Minimize disturbance and sediment release during construction activities.

References

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- Tabor, R. W., V. A. Frizzell, Jr., J. T. Whetten, R. B. Waitt, D. A. Swanson, G. R. Byerly, D. B. Booth, M. J. Hetherington, and R. E. Zartman. 1987. Geologic map of the Chelan 30-minute by 60-minute quadrangle, Washington. U.S. Geological Survey Miscellaneous Investigations Series Map I-1661, scale 1:100,000. 56 pp.
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