Cedar Valley Road Crossing Improvements: Brush Creek 175 Road & White Creek 191 Road 60% Design Report

prepared for

Yakama Nation Fisheries

prepared by

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Appendices

1.0 PROJECT BACKGROUND

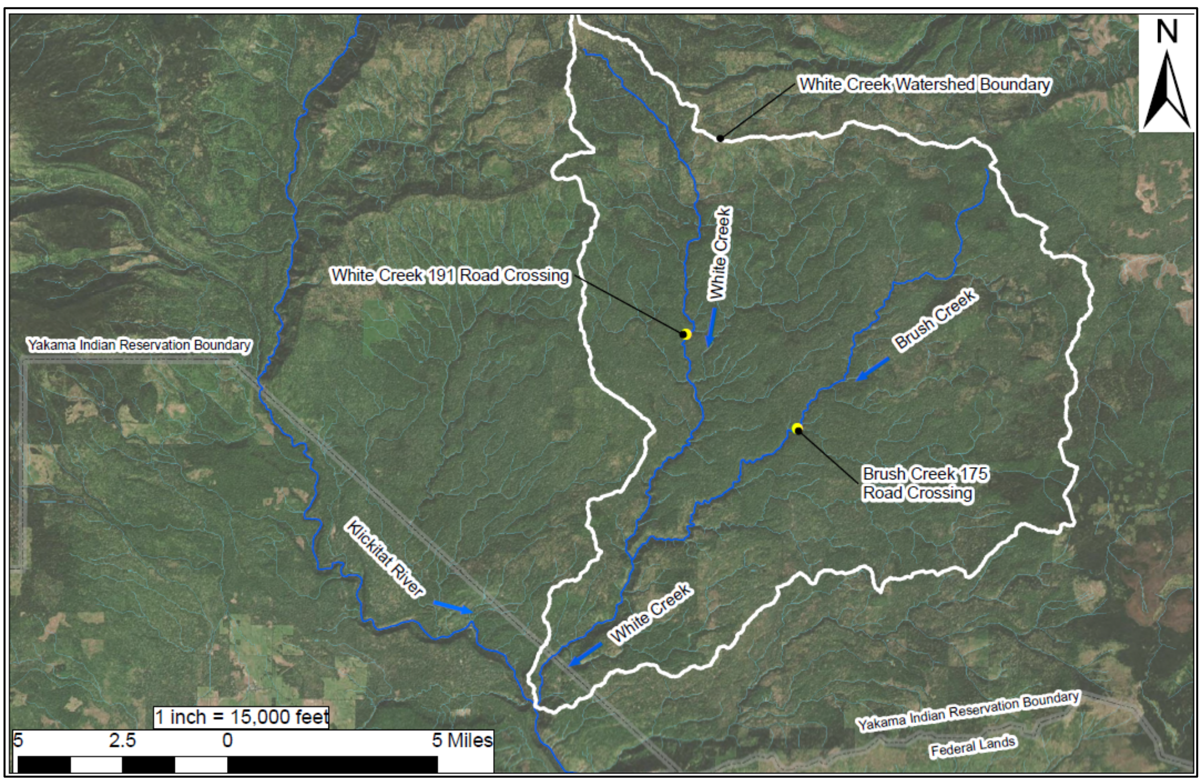
Scope of this Report

This report provides the 60% designs and the design rationale for the Cedar Valley Road Crossings Improvement Project, sponsored by the Klickitat Watershed Enhancement Project of the Yakama Nation Fisheries Program. The report follows the Basis of Design Report (BDR) template for documenting Bonneville Power Administration (BPA) Habitat Improvement Program (HIP) projects (BPA, 2019). This submittal covers the development of the 60% Design Drawings provided as **Appendix A** of this report.

Project Area

The project aims to improve fish passage at two road crossings in the White Creek watershed, a major tributary of the Klickitat River east of Mount Adams that provides critical spawning and rearing habitat for ESA-listed steelhead. The two road crossings – on the 191 Road over White Creek and on the 175 Road over Brush Creek – are located within the Closed Area of the Yakama Reservation (**Figure 1**). These two road crossings are the last major known impediments to fish passage in the White Creek watershed. The roads are used for Tribal member access to the Closed Area for hunting, fishing, gathering and timber harvest. The crossings are each located approximately 1 hour from either Glenwood, WA or White Swan, WA.

Figure 1 *– Location of Crossings Within the White Creek Watershed*



1.1 Name and Titles of Sponsor, Firm and Individuals Responsible for Design

- Project sponsor - Yakama Nation Fisheries
- Sponsor project manager – David Lindley, Southern Territories Habitat Coordinator
- Engineering Design Firm - Waterways Consulting, Inc.
- Project Manager and Lead Design Engineer – Jake Hofeld, P.E.
- Geomorphologist – Daniel Malmon, Ph.D, R.G.

1.2 List of Project Elements Designed by a Licensed Professional Engineer

The proposed design concepts for the project are depicted in the Design Drawings (**Appendix A**). **Table 1** Lists the proposed project elements.

Table 1 *– Primary proposed project elements in the Chiwawa Outlet Restoration Design concepts*

Element No.	Proposed Project Element	Description	Purpose(s)	HIP Category	HIP Risk Level
1	**White Creek Culvert Replacement**	Replace three culverts with bridge over White Creek	Improve steelhead passage	1f	Medium
2	**Brush Creek Culvert Replacement**	Replace three culverts with bridge over Brush Creek	Improve steelhead passage	1f	Medium

1.3 Explanation and Background of Fisheries Use (By Life Stage-Period) and Limiting Factors Addressed by the Project

1.3.1 Fisheries Use

White Creek, a tributary of the Klickitat River, and Brush Creek, the largest tributary of White Creek, provide important spawning and rearing habitat for ESA-listed Middle Columbia River steelhead. The White Creek watershed may be the most important spawning and rearing tributary watershed within the Klickitat subbasin. Recent studies by the Yakama Nations Fisheries Program have indicated that, on average, the White Creek drainage accounts for approximately 41% of the observed spawning in the Klickitat subbasin (D. Lindley, personal communication, 2020). The White Creek watershed is in the top tier of priority geographic areas identified in the Klickitat Lead Entity Region Salmon Recovery Strategy.

The Yakama Nation Fisheries Program has been researching O. mykiss life history strategies in the White Creek watershed since the early 2000s. Adult steelhead enter the Klickitat basin throughout the year, peaking in late summer and early fall (for wild steelhead). Spawning begins in January-February, peaks in April, and ends in late May. Fry emerge from redds about 6 to 10 weeks after spawning. Juveniles rear in White Creek for 1 to 3 years. During this time, significant seasonal movements of juvenile fish are necessary to access perennial habitat. Fish that exit White Creek as one-year-olds typically spend an additional year rearing in the mainstem Klickitat River before going to the ocean.

1.3.2 Limiting Factors Addressed by the Project

The limiting factor addressed by this project is fish access to limited critical rearing habitat. The low/no flow period in late summer/early fall presents a population bottleneck for juvenile *O. mykiss* due to stranding and desiccation. Currently, most reaches in the White Creek watershed dry up between July and October. Surface water in late summer is confined to disconnected reaches or individual pools, especially where there is spring flow.

Many of the reaches in the White Creek and Brush Creek watersheds that contain surface water in late summer and fall are upstream of the two road crossings being addressed by this project (see **Figure 1**). These two road crossings are the last major known impediments to fish passage in the White Creek watershed. The primary target for fish passage is for adult migration, but the project will also provide passage for juveniles in the spring and early summer, as they seek suitable holding habitat for the low flow season.

1.4 List of Primary Project Features Including Constructed or Natural Elements

The proposed project would remove the existing culvert and fill at both crossings and replace these with bridges (**see Appendix A, sheet C3-C4 and C6-C7 for plan and section views of White Creek and Brush Creek, respectively**). The project would install rock slope protection along the bridge abutments (outside the general scour prism) and stream simulation material (SSM) in the channel to mimic natural conditions. The SSM thickness and gradation are based on the reference section pebble counts at each location. Field observations show the current bed is also armored with coarse cobble bed material and appears to be rarely if ever mobilized under the current flow regime.

1.5 Description of performance/sustainability criteria for project elements, assessment of risk of failure to perform, potential consequences, and compensating analysis to reduce uncertainty

This project consists of two bridge crossings over small, intermittent creeks with flow occurring only in certain time of the year when it receives ample water from springs, runoff or ground sources.

***Failure Mechanisms and Likelihood*.** The primary risks to the bridge and roads are from channel incision and toe scour along the base of the bridge abutments and road fill prism. Preliminary geotechnical field investigations indicate that bedrock is located at or near the surface of the channel bed. This suggests that there is a low likelihood of channel incision. The likelihood of toe scour of the bridge abutments and road fill is likely without supplemental scour protection measures.

Consequences of Failure. The crossings are in remote locations and failure would not be a danger of death or injury. The primary consequences of failure would be temporary loss of access on the two roads, the cost of replacing the bridges, and construction materials and impacts in the stream.

Compensating Analysis. A hydraulic analysis was performed at both crossings to determine parameters to support scour calculations for both stream simulation material mobility as well as sizing scour abutment measures. This is described in more detail in Section 3.6 and calculations are included in Appendix B.

1.6 Description of Disturbance Including Timing, Areal Extent, As Well As Potential Impacts Associated with Implementation of Each Project Element

Timing: We anticipated that both the upland and in-water work will occur between June 1st and September 15th during periods of low to no streamflow. In-channel work will occur during the approved work window for fish protection as provided by the Yakama Nation Fisheries Program and Yakama Nation Water Code. For the Klickitat River and its tributaries, the in-water work is July 1st through August 15th.

Aerial Extent: The area of disturbance for replacing the culverts with a bridge at the White Creek crossing is expected to be around 5,800 square feet (0.13 acres), and around 8,200 square feet (0.19 acres) at Brush Creek.

Impacts: Potential impacts associated with the implementation of the project elements at each creek crossing are expected to include temporary disturbance of the gravel road surface, road fill side slopes and the floodplain and channel bed in the vicinity of the crossings. There is also the potential for erosion related impacts during construction in the event of a storm event. These potential impacts will be minimized through application of Best Management Practices during construction as outlined in the most recent HIP guidance manual (BPA, 2021) as well as those presented in the Washington State Department of Ecology Stormwater Management Manual for Eastern Washington (WSDE, 2019). Permanent impacts include the removal of trees to construct the new bridges and the potential for erosion of unvegetated slopes.

1.7 Identification and Description of Risk to Infrastructure or Existing Resources

The HIP III Handbook (BPA, 2016) identified this section as required information for the General Project and Data Summary Requirement (GPDSR) for reporting, but it is not called for in the more recent version of the manual (BPA, 2021). For completeness this information is provided below.

The only known infrastructure in the vicinity of the Brush and White Creek crossings is the gravel roads and the existing culverts. Existing resources include trees and vegetation surrounding the road crossings and the existing channel upstream and downstream. The proposed projects will lower the risk to the existing infrastructure by providing greater flood flow and debris passage capacity. The risk to existing resources includes the loss of mature riparian trees and vegetation from construction activities and chances to the hydraulics potentially causing additional downstream erosion. Risks to the channel include potential for headcuts to form and sedimentation in the channel.

2.0 RESOURCE INVENTORY AND EVALUATION

A site-scale hydrologic/hydraulic analysis and geomorphic assessment were performed to help understand the current hydraulic and geomorphic functions of the site and to identify opportunities and constraints. The results of those analyses were used to inform the conceptual design.

2.1 Description of Past and Present Impacts on Channel, Riparian, and Floodplain Conditions

Yakama Nation Fisheries personnel have observed a range of indicators along White Creek and its tributaries that suggest land management activities have affected in-stream conditions to the detriment of aquatic habitat. The forested portion of the White Creek watershed has been utilized for commercial timber harvest since the 1950's. Timber harvest, road construction, road maintenance, and cattle grazing will continue into the foreseeable future.

Steelhead habitat in White Creek and Brush Creek are highly sensitive to climate change, which has already had important impacts on habitat. The low/no flow period in late summer/early fall presents a population bottleneck for juvenile *O. mykiss* due to stranding and desiccation. Currently, most of the channel reaches in the White Creek watershed (including the project reaches) generally dry up between July and October. Perennial flow is limited in late summer in many reaches of White Creek and Brush Creek, including at the two crossings. Anecdotal accounts from the 1960s suggest that at least some of these reaches were historically perennial.

2.2 Instream Flow Management and Constraints in the Project Reach

There are no continuous seasonal withdrawals of water from White Creek or Brush Creek upstream or near the project sites. Some minor developed water withdrawals are used for dust abatement (watering of roads) associated with timber hauling. There are no developed off-channel watering locations for cattle. Thus, except for where water is intercepted by roads and the routing is changed, water use in both creeks primarily follows natural runoff pathways and is primarily used for timber production, cattle forage production and watering, and fish and wildlife habitat. These uses will continue into the foreseeable future.

2.3 Description of Existing Geomorphic Conditions and Constraints on Physical Processes

The two crossings are on White Creek and Brush Creek on the Closed Area of the Yakama Nations lands in southcentral Washington. The geomorphology of the two creeks is dominated by the geology of the area, which controls variations in valley gradient and floodplain width, the sediment supply, the low flow water supply, and may also influence the size of floods. The White Creek and Brush Creek watersheds lie within the central segment of the Simcoe Mountains volcanic field, an extinct volcanic field of Pleistocene and Pliocene age (~4 million to 600,000 years old) (Hildreth and Fierstein, 2015). The underlying geology consists of basaltic lavas erupted from numerous volcanic centers and cinder cones and draped over the Yakima Foldbelt in south central Washington state. The two project sites on White

Creek and Brush Creek are separated by Poland Butte, a 1-million-year-old shield volcano capped with a 200-foot-high cone of scoria (vesicular basalt) (**Figure 2**)

The longitudinal profiles of the two project reaches are shown **Figure 3**. Both creeks have a stepped profile with notable profile convexities (from flat to steep gradient in the downstream direction). These convexities primarily reflect downstream changes in the volcanic stratigraphy underlying the two streams.

Averaged over several miles, the gradients of both reaches are between 1% and 2%; however, the gradient varies considerably. At Brush Creek, the local gradient appears to be much lower than the reach-scale gradient.

Figure 2. *Portion of Geologic Map of the Simcoe Mountains Volcanic Field (Hildreth and Fierstein, 2015) showing locations of project sites relative to volcanic features in (with annotations added).*

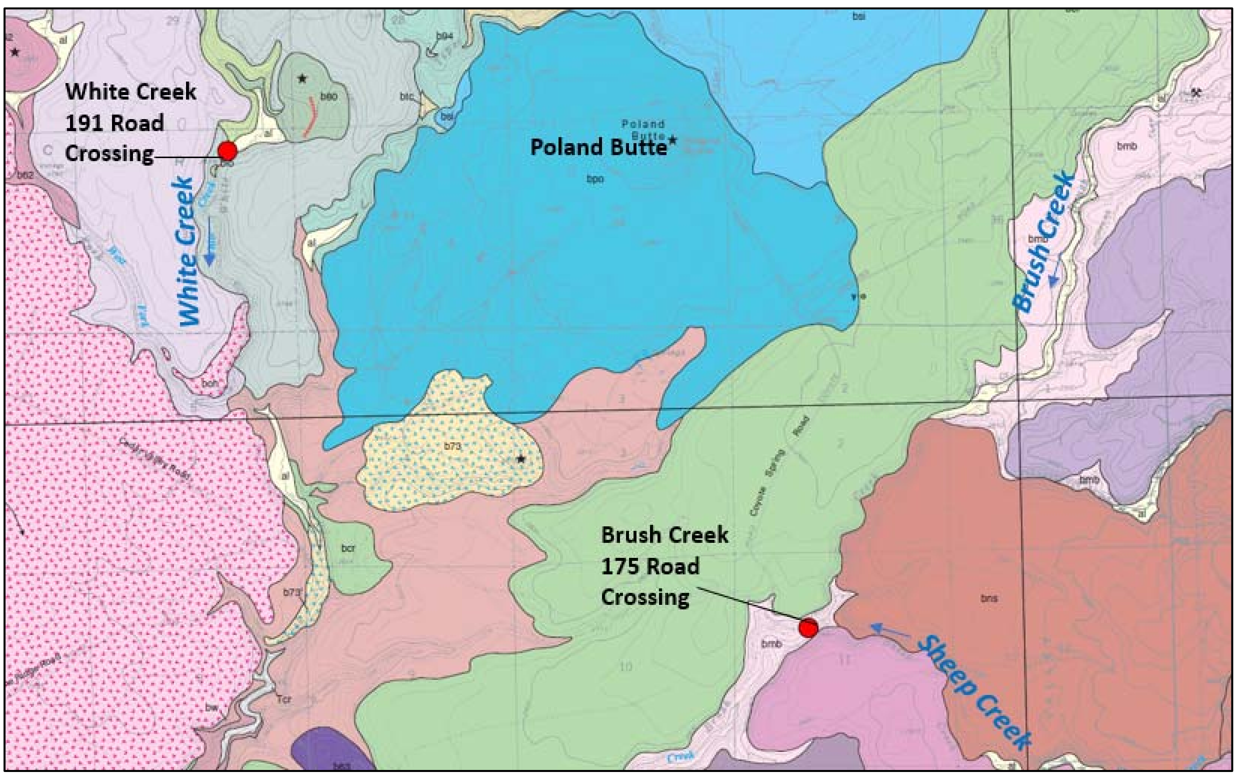
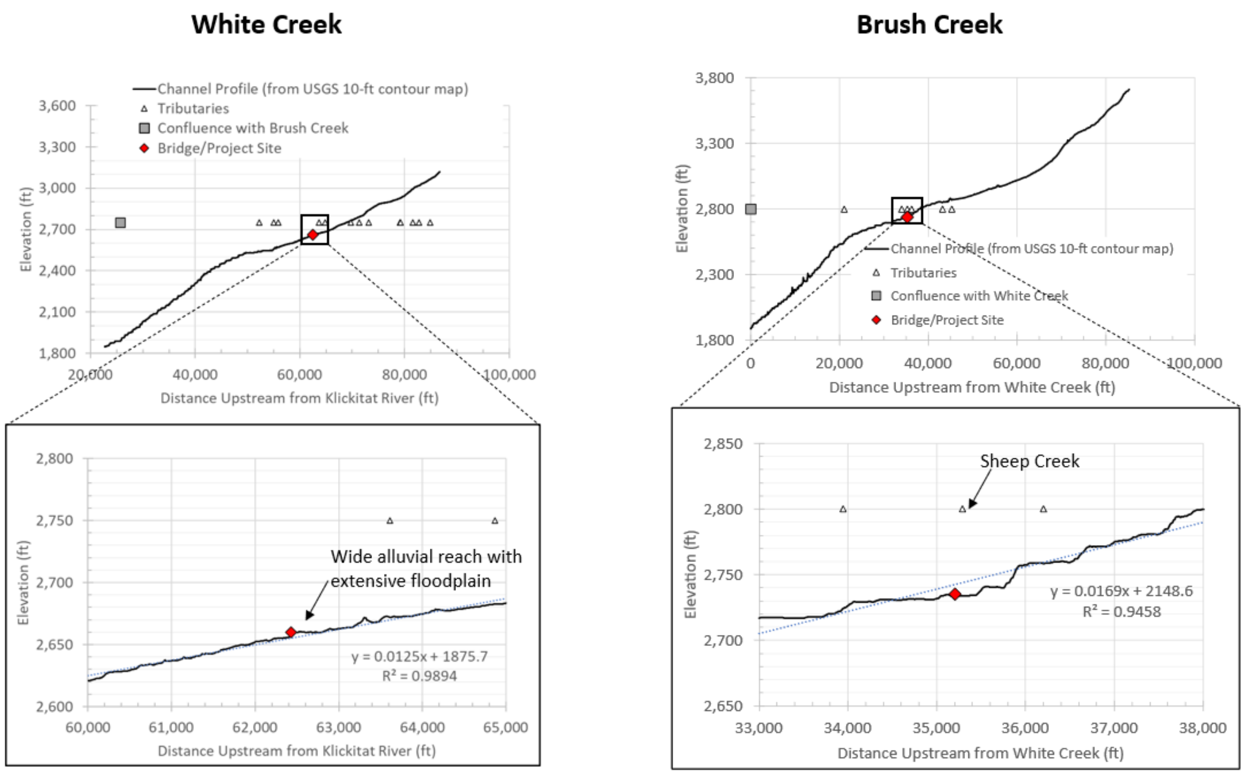


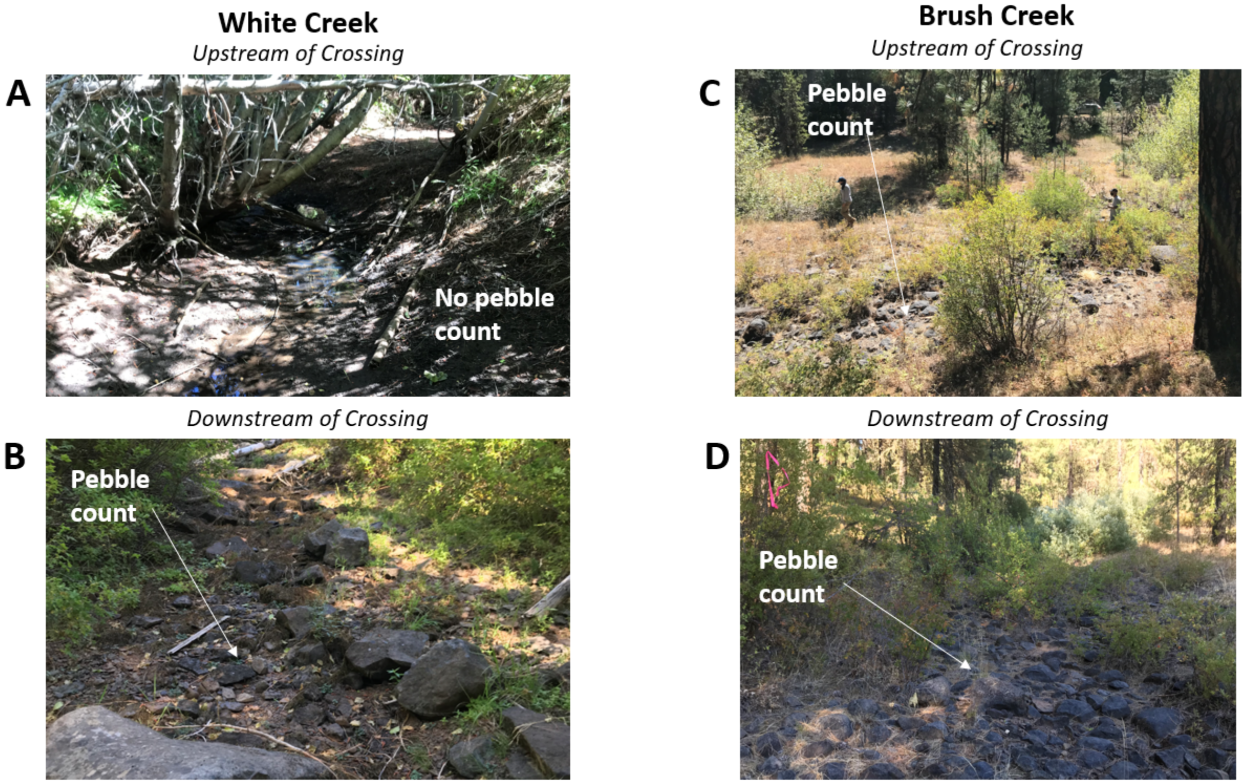
Figure 3. *Longitudinal profiles of White Creek and Brush Creek in the vicinity of the project areas based on USGS 10-foot contour maps. Lower graphs show close up of the areas near the two project reaches*



White Creek 191 Road Crossing. The geomorphology of White Creek transitions sharply at the 191 Road crossing. There is a wider alluvial reach upstream of the crossing, containing a fairly complex meandering channel with boulders eroding out of the banks, fallen trees, and discontinuous pools that contained relatively cool water in late August 2020 (10.8 degrees C, measured during field investigation) (**Figure 4A**). Downstream of the crossing, the valley is narrow with limited floodplain, and the channel has a straight, planar-bed form with boulder and cobble substrate. There were no pools or surface water downstream of the bridge in August 2020 (**Figure 4B**). This is a geologically-controlled transition: the geological map shows an alluvium-filled valley upstream of the crossing, downstream of which is a transition to a section in which the stream is confined between two different lava flows (see **Figure 2**).

The bankfull width of White Creek upstream of the crossing ranges from 8 to 12 feet, with bank heights between 2 and 6 feet. The bed material consists of mud and pebble-sized gravel. The floodplain contains ample evidence of beaver activity and a few active high flow pathways but is mostly incised and the floodplain is infrequently flooded. The reach upstream of the crossing appears to provide the geomorphic conditions for good steelhead habitat, so providing passage to this meadow should create an immediate benefit for fish.

Figure 4. *Photos of conditions upstream and downstream of both crossings*



Downstream of the crossing, White Creek has a very different geomorphic character, with a straight, steeper, single-thread channel and only a small floodplain on river-left. The bed material below the culvert is much coarser, consisting of angular cobble- and boulder-sized basalt clasts, relatively little heterogeneity, and no pools or water in late summer. Downstream of the crossing the channel appears to have been winnowed of fine material, leaving an armored bed that does not appear to mobilize often, if ever. The armoring of the bed and the apparent lack of evidence for large, bed-mobilizing floods suggests that there is little if any risk of forming headcuts that would propagate upstream through the reach and affect the crossing.

Brush Creek 175 Road Crossing. At the Brush Creek site, the channel form is mostly planar bed with an armored coarse cobble and boulder substrate (**Figure 4C-D)**. There is little evidence that recent high flows have mobilized the cobble-sized bed material; instead, the bed appears to be armored by winnowing of finer material over time. Upstream of the crossing, there is a poorly defined channel with low banks and a small depositional area behind the culverts. Locally the valley is fairly wide with gradual slope, approximately 100 to 200 feet wide. Sheep Creek, a tributary, enters Brush Creek about 150 feet above the crossing.

Although the average slope of Brush Creek over several miles is 2%, the local gradient is very low (**Figure 3**). This is a geologically controlled feature as the site is just downstream of the transition in Brush Creek from one volcanic flow to another (**Figure 2**). Therefore, this is a permanent depositional reach along

Brush Creek. While fish passage will be greatly improved by removing the culverts, the combination of low flows, coarse armored bed, and lack of pools in this reach may still make fish passage difficult.

Downstream of the crossing on Brush Creek, the channel narrows to a clearer single-thread channel with a bankfull width varying between 10 and 15 feet, and coarse cobble and boulder bed material. The channel is incised 4 to 5 feet below the adjacent floodplain and a subtle break in slope and vegetation suggests the bankfull height is about 1 foot, which is about the same as the amplitude of the cobble and boulders that dominate the bed material.

2.4 Description of Existing Riparian Condition and Historical Riparian Impacts

The riparian areas in the vicinity of the two road crossings generally consist of mature forest containing of willow, black cottonwood, ponderosa pine, with ground cover including spirea and snowberry. The most extensive riparian floodplain areas around the two project sites is the wider floodplain section upstream of the White Creek crossing. This floodplain is formed as a result of wider area between basaltic flows and contains a reasonably intact riparian floodplain with mature trees, ground cover, downed trees, and evidence of beaver activity. The riparian area below the White Creek crossing, and both upstream and downstream of the Brush Creek crossing, are limited in extent and contain sparse pine and ground cover. The channel appears to be incised relative to the floodplain upstream and downstream of both crossings, with bank heights appearing to be higher than bankfull height.

Throughout both watersheds, impacts from grazing - in the form of altered riparian vegetation, bank erosion, and channel incision – are evident in the wider floodplain reaches.

2.5 Description of Lateral Connectivity to Floodplain and Historic Floodplain Impacts

Because of the geology, White Creek and Brush Creek alternate between narrow canyon reaches lacking floodplains and wider alluvial reaches. The alluvial reaches have floodplains, but the channel is mostly incised through these reaches with a relative lack of floodplain connectivity. Yakama Nation observes that alluvial reaches throughout the watershed are also incised. The wider valley meadow reaches are most seriously incised and eroded where fine texture soils (clay) are present, and cattle use is concentrated. At the two project sites, floodplain connectivity is limited.

The most floodplain connectivity near the two sites is upstream of the 191 Road Crossing in White Creek. Upstream of the crossing is an alluvial reach with a relatively wide, forested floodplain. Banks heights range from 2 to 6 feet high, but there is some moderately active floodplain units about 2 to 3 feet high. Downstream of the 191 Road crossing, and on Brush Creek, the floodplain is narrower due to confinement by steep valley walls, and there is no evidence of frequent overbank flows. The lack of floodplain connectivity in these reaches may not necessarily be due to an incised condition of the creek, but because of the apparent lack of frequent high flood peaks.

2.6 Tidal Influence in the Project Reach and Influence of Structural Controls (Dikes or Gates)

Not applicable to this project.

3.0 TECHICAL DATA

3.1 Incorporation of HIP IV Activity-Specific Conservation Measures for All Included Project Elements

The General and Species-Specific Conservation Measures as defined the HIP Handbook (BPA, 2021) will be incorporated throughout the design and implementation of the project.

3.2 Summary of Site Information and Measurements (Survey, Bed Material, Etc.) Used to Support Assessment and Design

3.2.1 Topographic Data

The assessment and design made use of a combination of topographic data sets. At the time of the assessment, LiDAR data was provided by Yakama Nation for the White Creek crossing. This data was collected by WSI for the Klickitat River and tributaries for Yakama Nation Fisheries between April and June, 2013, with a grid size of 3 feet. No LiDAR data was available for the Brush Creek site, so the assessment used USGS digital topographic maps.

Waterways and Yakama Nations Fisheries staff collected key information for the designs using a total station collected on August 25 and 26, 2000. This data was sufficient to create a topographic surface for the crossings and the areas upstream and downstream of both crossings for the purpose of developing the design plans (Appendix A).

3.2.2 Geomorphic Data

Geomorphic data collected by Waterways on August 25 and 26, 2000 included qualitative observations of the geomorphology (described above), bankfull width and depth estimates upstream and downstream of both crossings, and pebble counts upstream and downstream of both crossings. The bed material data are provided in section 3.4 below.

3.3 Summary of hydrologic analyses conducted, including data sources and period of record including a list of design discharge (Q) and return interval (RI) for each design element.

Neither White Creek nor Brush Creek have any known historic flow records to use as the basis for a hydrologic analysis, so peak discharge recurrence intervals were determined using several methods. These discharge results were then used as inputs to the hydraulic models (discussed in detail below) to compare hydraulic results with hydraulic indicators (bankfull width and floodplain elevations) observed during field reconnaissance.

StreamStats, a USGS based web application, was the first method used to estimate the peak flow recurrence intervals. This platform relies on established regional regression equations along with GIS delineated basin characteristics to estimate these peak flows. **Table 2** shows the StreamStats estimated peak discharges.

Table 2 – Peak flow rates (cfs) by recurrence interval with lower (Pll) and upper (Plu) prediction intervals as estimated by StreamStats

Recurrence Interval (yr)	White Creek			Brush Creek		
	Value	Pll	Plu	Value	Pll	Plu
2	343	134	881	731	280	1880
5	609	244	1520	1300	519	3260
10	827	332	2060	1770	709	4420
25	1130	441	2890	2420	943	6210
50	1380	525	3620	2960	1130	7790
100	1650	613	4440	3540	1310	9540
200	1920	696	5290	4120	1490	11400
500	2330	809	6710	5030	1740	14500

Because of the high level of variability within the prediction intervals for StreamStats flows (e.g. 613 to 4440 cfs for the 100-year RI), a second hydrologic analysis tool is used to further refine peak flow values for the design RI's. For this project was to develop peak flow rates for the 2 year and 100 year recurrence interval using U.S. Army Corps of Engineers HEC-HMS software (version 4.6). These represent the two main flow rates used in the sizing of bridge openings. This model relies on the use of drainage area, land cover, soil type, and precipitation to develop peak flow rates and is generally considered more accurate than regression-based models like StreamStats. Basin characteristics taken from StreamStats including drainage area and slope, land cover is characterized using Google Earth aerial imagery for the basins, and precipitation is based on Washington Department of Transportation 24-hour Isopluvial Maps. No USGS soil survey data is available for this area that would allow for the estimation of hydrologic soil type that determines the water infiltration capacity; however, it is likely that peak flow events in these creeks are driven by rain on snow events where soil infiltration is limited. Therefore, the HEC-HMS model assumes Hydrologic Soils group type D with little infiltration capacity as the soil type on each basin to model this scenario. **Table 3** shows the results of this analysis.

***Table 3** – Peak flow rates (cfs) by recurrence interval as estimated using HEC-HMS*

Recurrence Interval (yr)	White Creek	Brush Creek
2	171	308
100	1032	1920

Note that all of these values fit within the lower end of both upper and lower prediction intervals used by StreamStats which further suggest the values listed in **Table 2** are overestimations. Because the modeled flow rates can have a pronounced effect on the sizing of bridge openings to provide freeboard above the 100-year flood and because the HEC-HMS model accounts for basin specific land cover and precipitation, these flow rates for both the 2- and 100-year RI were used for hydraulic modeling.

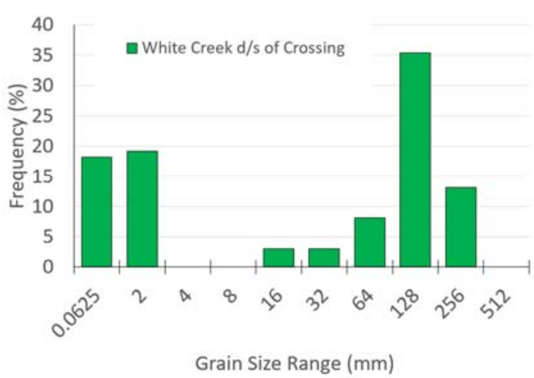
3.4 Summary of sediment supply and transport analyses conducted, including data sources including sediment size gradation used in streambed design

Field measurements of particle size were collected using standard pebble counts using random sampling within the channel bed. The pebble counts were done upstream and downstream of the crossing at Brush Creek, and downstream of the White Creek road crossing. As discussed above, upstream of the road crossing is an alluvial reach with patches of fine and coarse sediment, so a pebble count is less indicative of the grain size at that location. The three pebble count locations are identified in **Figure 4** (above).

The pebble count data are presented in **Figures 5 and 6**. The median grain size in White Creek below the crossing is 50 mm. The median grain size is not a good indicator of the typical size of sediment in the channel bed, however, because the bed material distribution is bimodal: the most common grain size is cobbles (between 64 and 256 mm), but the bed also has a significant component of mud and sand. The grain size upstream of the crossing in White Creek is also bimodal with significant fractions of sand and pebble size gravel; however, this pattern is evident over a larger spatial scale as the bed consists of sorted sand and gravel patches.

In Brush Creek, the pattern is not bimodal but is dominated by coarser, cobble and boulder bed material. Based on the two pebble counts, grain size is slightly coarser upstream of the crossing than downstream of it (**Figure 6**). This may be due to the fact that the upstream pebble count was made above the confluence with Sheep Creek, which contributes slightly finer bed load compared with the mainstem of Brush Creek. The median grain sizes of the pebble counts upstream and downstream of the road crossing are 132 and 100 mm, respectively.

Figure 5. *Pebble Count Data from White Creek and Brush Creek*



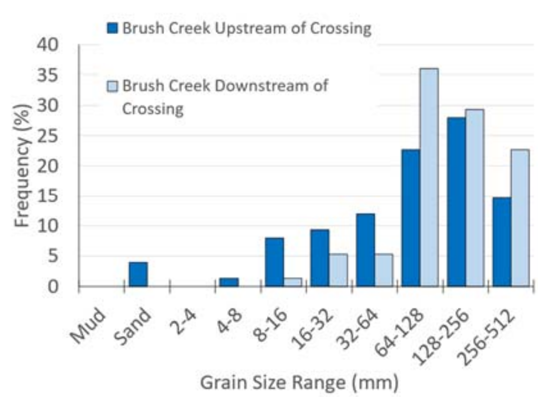
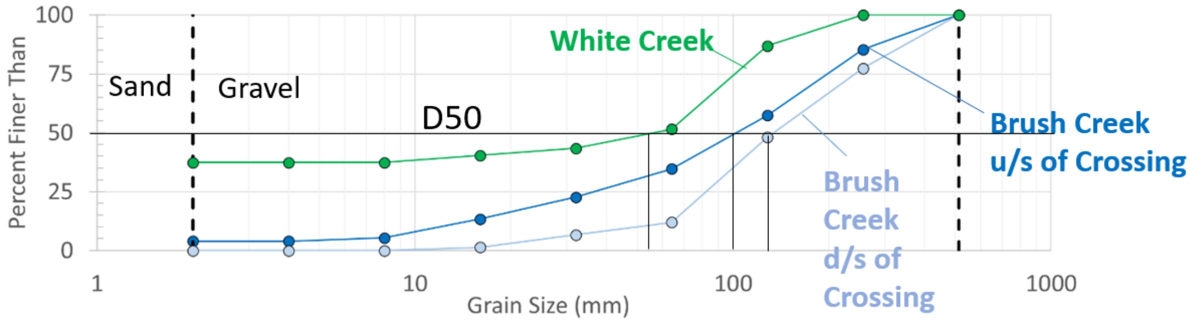


Figure 6. Comparison of Cumulative Grain Size at the White Creek and Brush Creek



3.5 Summary of hydraulic modeling or analyses conducted and outcomes – implications relative to proposed design

3.5.1 Model Purpose

One-demensional (1D) hydraulic models were developed using the U.S. Army Corps of Engineers software HEC-RAS (version 5.0.7) at both crossing locations. The primary purpose of these hydraulic models are as follows:

- Determine the bridge height necessary to provide a minimum 1 foot of freeboard above the 100-year return interval.
- Determine material size for resisting scour and channel erosion around the bridge.

3.5.2 Model Set Up

The 1D model geometry is based on cross sections of the topographic surface surveyed by Waterways at each location modified to include a new bridge and channel matching the bankfull dimensions detailed in this report. Manning's roughness values for the channel mountain streams with no vegetation in the channel and bed comprised of gravels, cobbles and few boulders as described in Table 3-1 of the HEC-RAS Reference Manual. The flood plains on both creeks are characterized as medium to dense brush, in winter. Both models run under steady flow conditions with HEC-HMS flow rates and a downstream boundary condition set to the long stream profile slope established from the topographic survey.

3.5.3 Model Results and Interpretations.

Figures 7 and 8 shows the hydraulic model results for the proposed bridge crossing at the cross section on the upstream side of the bridge at White Creek and Brush Creek, respectively.

Figure 7. *Hydraulic Model Cross section at upstream end of proposed White Creek bridge.*

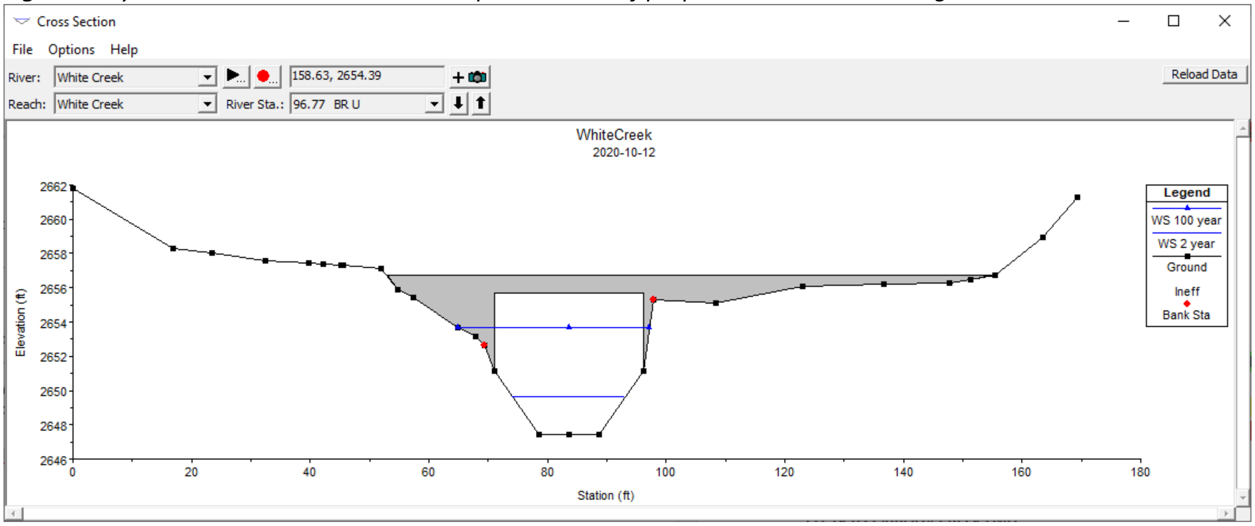
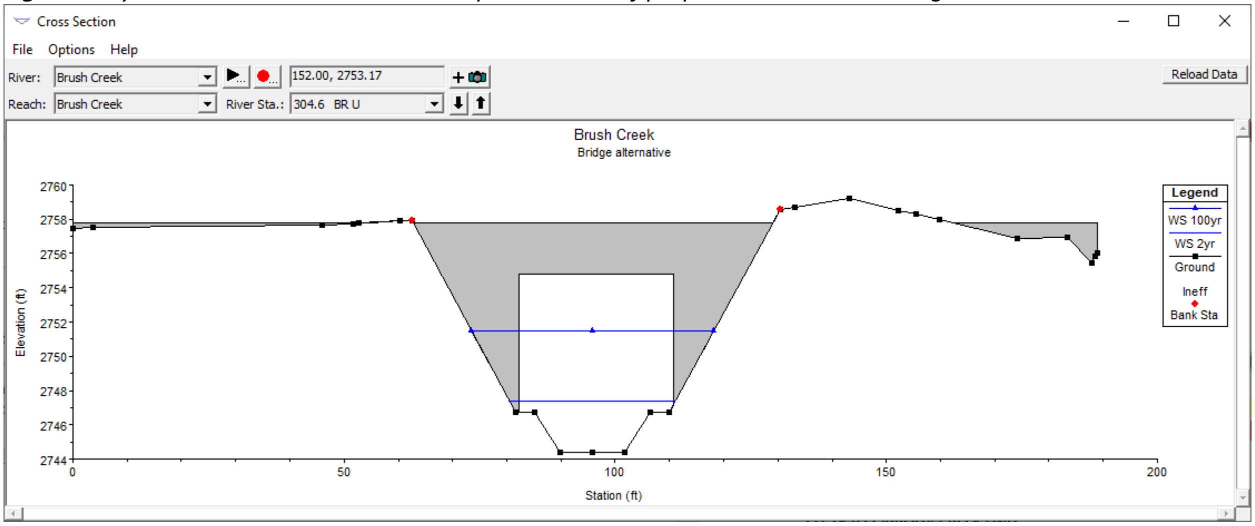


Figure 8. *Hydraulic Model Cross section at upstream end of proposed Brush Creek bridge.*



Results of the hydraulic analysis for both crossings indicates that the opening width of 1.5 times the bankfull width (with an extra 10 feet of width to account for abutment scour protection), is also sufficient to convey the 100 year RI flow with the required 1 foot of freeboard between the bottom of the bridge deck and water surface without changing the grade of the approach roads.

3.6 Stability Analyses and Computations for Project Elements, and a Comprehensive Project Plan

Project elements which will require stability calculations include the proposed stream simulation material and sizing scour protection for the abutments.

General scour elevations for the streambed at each location were determined using the guidelines from the 2020 (HIP4) Conservation Measures Version 1.0. Results of this calculation at each location showed negative scour depths. This suggests that the critical velocities needed to mobilize the streambed material are greater than the mean velocities in the channel during a bank full flow event and that the streambed will be stable up through this event. This determination is supported by the field observations of streambed mobility discussed in Section 1.4.

The depth of rock slope protection over the abutments at each location are based Federal Highway Administration guidelines for evaluating scour at bridges for the 100 year event. These calculations show that between 1 and 2 feet of scour is anticipated during this event at each of the bridges based on “live-bed” and “clear-water” assumptions, so 2-foot deep rock protection is included along the stream side of the abutments at each bridge outside the general scour prism.

3.7 Description of How Preceding Technical Analysis has Been Incorporated into and Integrated with the Construction

The geomorphic analysis of the two project sites is used to determine the bankfull channel geometry and bridge clear span opening at both locations. The pebble count data is used to determine the gradation of the proposed streambed simulation material along with hydraulic modeling results to ensure stability. The hydraulic model is used to determine scour depths for abutment protection and confirm that the proposed bridges will have a minimum of 1 foot of freeboard above the 100 year return event at each location.

3.8 For projects that address profile discontinuities (e.g., grade stabilization, small dam and structure removals), a longitudinal profile of the stream channel thalweg for 20 channel widths upstream and downstream of the structure shall be used to determine the potential for channel degradation.

Not applicable.

3.9 For projects that address profile discontinuities (e.g., grade stabilization, small dam and structure removals), a minimum of three cross-sections (one downstream of the structure, one through the reservoir area upstream of the structure, and one upstream of the reservoir area outside of the influence of the structure) shall be used to characterize the channel morphology and quantify the stored sediment.

Not applicable.

4.0 CONSTRUCTION – CONTRACT DOCUMENTATION

4.1 Incorporation of HIP General and Construction Conservation Measures

To be included on stamped 100% design drawings and specifications.

4.2 Design – Construction Plan Set Including but Not Limited to: Plan, Profile, Section, and Detail Sheets That Identify All Project Elements and Construction Activities of Sufficient Detail to Govern Competent Execution of Project Billing and Implementation

60% level design drawings are provided as **Appendix A**. These include plan, profile, sections, and typical details. These designs are not yet of sufficient detail to govern project billing or implementation as specific project elements have yet to be selected and refined. The final stamped plans and specifications will be of sufficient detail for project contracting, billing, and implementation.

4.3 List of All Proposed Project Materials and Quantities

In addition to a prefabricated bridge deck at each crossing, **Table 4** is a list of proposed project materials and quantities based on the conceptual design plans included as **Appendix A**. To be included in future Preliminary design drawings.

***Table 4** – Material quantities for the proposed project based on level of design.*

Item	White Creek	Brush Creek
Total Cut – Excavation (CY)	243	594
Total Fill (CY)	29	41
Stream Substrate Material (CY)	40	55
Concrete Abutments (CY)	108	190
Rock Slope Protection (CY)	43	54

4.4 Description of Best Management Practices That Will Be Implemented and Implementation Resource Plans

The proposed project in in the conceptual design phase. Best management practices to be implemented will be selected in future phases of design such that temporary impacts associated with construction are minimized and mitigated. Subsequent design submittals will include the following plans and associated BMPs:

- Site access and staging plan;
- In-channel work area isolation and dewatering plan with specific provisions for anticipated aquatic species (if necessary during construction);
- Temporary Erosion and Sediment Control Plan (TESC);
- Spill pollution prevention plan;
- Concrete washout locations;
- Site restoration plan; and
- List of proposed equipment and equipment fuel/lubricant management plan.

4.5 Calendar Schedule for Construction/Implementation Procedures

A construction timeframe has not been determined at this time.

The proposed project is in the design phase; as such, a specific timeline for implementation has not yet been determined. The project proponent, Yakima Nations Fisheries, will develop an implementation schedule following securing of funding and obtaining permits for implementation.

4.6 Site or Project Specific Monitoring to Support Pollution Prevention and/or Abatement

The design drawings include requirements for monitoring protocols to support pollution prevention. These protocols and BMPs will include:

- Turbidity monitoring for in-channel activities when water is flowing,
- Establishment of fueling/lubricating facilities a minimum of 150’ from ordinary highwater,
- Fuel/lubricant spill containment and absorbent measures,
- Weather forecast monitoring to anticipate precipitation events and temporarily stabilize soils,
- Concrete washout control,
- Construction dust control, and
- Other practices as needed for construction pollution prevention.

5.0 MONITORING AND ADAPTIVE MANAGEMENT PLAN

It has not yet been determined whether an Adaptive Management Plan is required for this project. This will be decided at a future time by Yakama Nation Fisheries.

6.0 REFERENCES

Bonneville Power Administration. 2019. HIP Handbook: Guidance of Programmatic Requirements and Process. Version 5.2. Accessed via the World Wide Web at: https://www.bpa.gov/efw/Analysis/NEPADocuments/esa/2019(HIP4)HandbookVer5.2(FINAL).pdf

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Appendix A: 60% Design Drawings

Appendix B: Scour Calculations

General Scour Elevations

Project:	Cedar Valley Road Crossing at White Creek
Project #:	20-026
Date:	3/2/2021
Calculated by:	MM
Checked by:	JDH

Instructions: Enter variables in RED cells only

2YR

Critical Velocity

Inputs should be defined from pebble count

Equation #1

$$V_c = 11.17 y^{1/6} D_{50}^{1/3}$$

V_c = Critical velocity above which bed material of size D and smaller will be transported (ft)
y = Bankfull depth within the proposed culvert or bridge (ft)
D_{50} = Particle for which 50% is finer (ft)

y = 2.29 ft
D_{50} = 0.190289 ft

V_c = 7.376156 ft

Scour Depth

Velocity should be taken from 2-yr model results

Equation #2

$$d_s = y\left(\frac{V_m}{V_c} - 1\right)$$

d_s = Scour depth below streambed at thalweg (ft)
y = Bankfull depth within the proposed culvert or bridge (ft)
V_c = Critical velocity above which bed material of size D and smaller will be transported (ft)
V_m = Mean velocity within the proposed culvert or bridge (ft)

y = 2.29 ft
V_c = 7.376156 ft
V_m = 5.28 ft

d_s = -0.65077 ft

Contraction Scour Type: **Live-bed**

Note:
General Scour equations taken from 20200(HIP4) Conservation Measures Ver 1.0

Abutment Scour Calculations - NCHRP 24-20 Approach

Location: White Creek
Calculations by: MM
Date: 3/2/2021
Checked by: JDH
Waterways Project Number: 20-026

Parameter	Value	Notes
Bridge RAS Station	96.77	
Upstream RAS Station	101.65	
Design Storm	Q100	
Discharge, Q, cfs	1032	
Scour condition	Live-bed	
Bed median particle size, D_{50}, inches	2.283464567	
Bed median particle size, D_{50}, feet	0.19028871	
Units conversion factor, K_u	11.17	For HEC-18 Equation 8.6
Upstream depth, y_1, (ft)	6.54	
Upstream effective flow width, w_e, ft	35	Flow width less ineffective flow areas
Upstream velocity, v_1, ft/sec	7.2	
Upstream flow area, A_1, sq ft	143.32	
Contracted flow area, A_c, sq ft	143.96	
Contracted flow depth before scour, y_0, ft	6.54	Flow depth at bridge, before scour
Width of bridge opening, w_b, ft	25	
Projected length of abutment, river left, L_L, ft	29	
Projected length of abutment, river right, L_R, ft	34.2	
Contracted velocity, V_c, ft/sec	7.2	Q/A_c
Contracted unit Discharge, q_{2c}, ft^2/sec	46.88	$q=Vc*y_0$
Upstream Unit Discharge, q_1, ft^2/sec	47.1	y_1*v_1
Ratio of unit discharges	1	q_{2c}/q_1
Flow depth including live-bed contraction scour, y_c, ft	7	$y_c=y_1(q_{2c}/q_1)^{6/7}$, **HEC-18 Eq'n 8.5**
Clear water flow depth, $y_{c\text{-}cw}$, ft	5	$y_c=(q_{2f}/K_uD_{50}^{1/3})^{6/7}$, **HEC-18 Eq', 8.6**
Live-bed amplification factor	1.2	α_A from figure 8.10 in HEC-18
Clear-water amplification factor	1.5	αB from figure 8.12 in HEC-18
Max flow depth, y_{max}, ft	8.40	α_A*y_c, **HEC-18 Eq'n 8.3**
Max clear-water flow depth, ymax, ft	7.50	α_B*y_c, **HEC-18 Eq'n 8.3**
Estimated live-bed abutment scour depth, y_s, ft	**2.0**	$y_s=y_{max}-y_0$, **HEC-18 Eq'n 8.4**
Estimated clear-water abutment scour depth, $y_{s\text{-}cw}$, ft	**1.0**	$y_s=y_{max}-y_0$, **HEC-18 Eq'n 8.4**

Reference:

Federal Highway Administration. Evaluating Scour at Bridges, Fifth Edition, HEC-18, April 2012.

General Scour Elevations

Project:	Cedar Valley Road Crossing at Brush Creek
Project #:	20-026
Date:	3/2/2021
Calculated by:	MM
Checked by:	JDH

Instructions: Enter variables in RED cells only

2YR

Critical Velocity

Inputs should be defined from pebble count

Equation #1

$$V_c = 11.17y^{1/6}D_{50}^{1/3}$$

V_c = Critical velocity above which bed material of size D and smaller will be transported (ft)
y = Bankfull depth within the proposed culvert or bridge (ft)
D_{50} = Particle for which 50% is finer (ft)

y =	3.01	ft
D_{50} =	0.400262	ft
V_c =	9.891509	ft

Scour Depth

Velocity should be taken from 2-yr model results

Equation #2

$$d_s = y\left(\frac{V_m}{V_c} - 1\right)$$

d_s = Scour depth below streambed at thalweg (ft)
y = Bankfull depth within the proposed culvert or bridge (ft)
V_c = Critical velocity above which bed material of size D and smaller will be transported (ft)
V_m = Mean velocity within the proposed culvert or bridge (ft)

y =	3.01	ft
V_c =	9.891509	ft
V_m =	7.06	ft
d_s =	-0.86163	ft

Abutment Scour Calculations - NCHRP 24-20 Approach

Location: Brush
Calculations by: MM
Date: 3/2/2021
Checked by: JDH
Waterways Project Number: 20-026

Parameter	Value	Notes
Bridge RAS Station	304.6	
Upstream RAS Station	317.33	
Design Storm	Q100	
Discharge, Q, cfs	1920	
Scour condition	Clearwater	
Bed median particle size, D_{50}, inches	4.803149606	
Bed median particle size, D_{50}, feet	0.40026247	
Units conversion factor, K_u	11.17	For HEC-18 Equation 8.6
Upstream depth, y_1, (ft)	7.88	
Upstream effective flow width, w_e, ft	39.66	Flow width less ineffective flow areas
Upstream velocity, v_1, ft/sec	8.86	
Upstream flow area, A_1, sq ft	216.76	
Contracted flow area, A_c, sq ft	218.88	
Contracted flow depth before scour, y_0, ft	7.88	Flow depth at bridge, before scour
Width of bridge opening, w_b, ft	28.4	
Projected length of abutment, river left, L_L, ft	29	
Projected length of abutment, river right, L_R, ft	34.2	
Contracted velocity, V_c, ft/sec	8.8	Q/A_c
Contracted unit Discharge, q_{2c}, ft^2/sec	69.12	$q=Vc*y_0$
Upstream Unit Discharge, q_1, ft^2/sec	69.8	y_1*v_1
Ratio of unit discharges	1	q_{2c}/q_1
Flow depth including live-bed contraction scour, y_c, ft	8	$y_c=y_1(q_{2c}/q_1)^{6/7}$, **HEC-18 Eq'n 8.5**
Clear water flow depth, $y_{c\text{-}cw}$, ft	6	$y_c=(q_{2f}/K_uD_{50}{}^{1/3})^{6/7}$, **HEC-18 Eq', 8.6**
Live-bed amplification factor	1.2	α_A from figure 8.10 in HEC-18
Clear-water amplification factor	1.5	αB from figure 8.12 in HEC-18
Max flow depth, y_{max}, ft	9.60	α_A*y_c, **HEC-18 Eq'n 8.3**
Max clear-water flow depth, ymax, ft	9.00	α_B*y_c, **HEC-18 Eq'n 8.3**
Estimated live-bed abutment scour depth, y_s, ft	**1.7**	$y_s=y_{max}-y_0$, **HEC-18 Eq'n 8.4**
Estimated clear-water abutment scour depth, $y_{s\text{-}cw}$, ft	**1.0**	$y_s=y_{max}-y_0$, **HEC-18 Eq'n 8.4**

Reference:
Federal Highway Administration. Evaluating Scour at Bridges, Fifth Edition, HEC-18, April 2012.