Nason Creek, RM 3.4-4.6 Floodplain Enhancement

15% Basis of Design Report and Alternatives

SUBMITTED TO
Confederated Tribes of the Yakama Nation

June 11, 2019

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Confederated Tribes and
Bands of the Yakama Nation
P.O. Box 151, Fort Road
Toppenish, WA 98948

PREPARED BY
Inter-Fluve
501 Portway Ave.
Hood River, OR 97031

June 11, 2019

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1. Preface

The Nason Creek Floodplain Project is located along Nason Creek between RM 3.4 and RM 4.6 in Chelan County, WA, along Highway 207 on land owned by the United States Forest Service and Western Rivers Conservancy and Washington Department of Transportation (WSDOT) right of way

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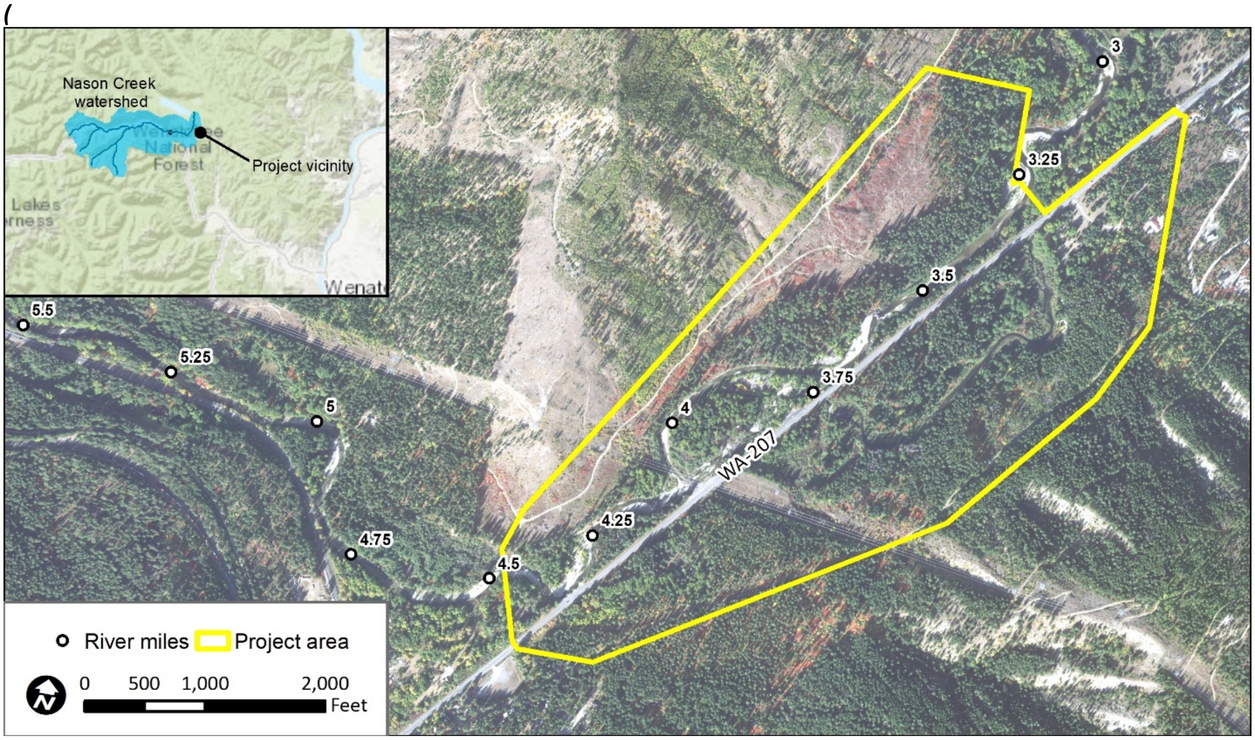


Figure 1). One privately owned parcel is located within the project area at the downstream side, on the East side of Highway 207. The valley bottom within the project area is bisected by Highway 207, which was constructed circa 1942. This significant reduction in the river migration corridor, and associated reduction in stream length, appears to have disrupted equilibrium, putting Nason Creek in a relatively imbalanced state. Nason Creek has repeatedly damaged the highway during flood events. An existing side channel, which was likely the historical main channel, is located east of Highway 207, and is connected to Nason Creek via two culverts approximately 12-feet in diameter under the highway near RM 3.3 and RM 3.75.

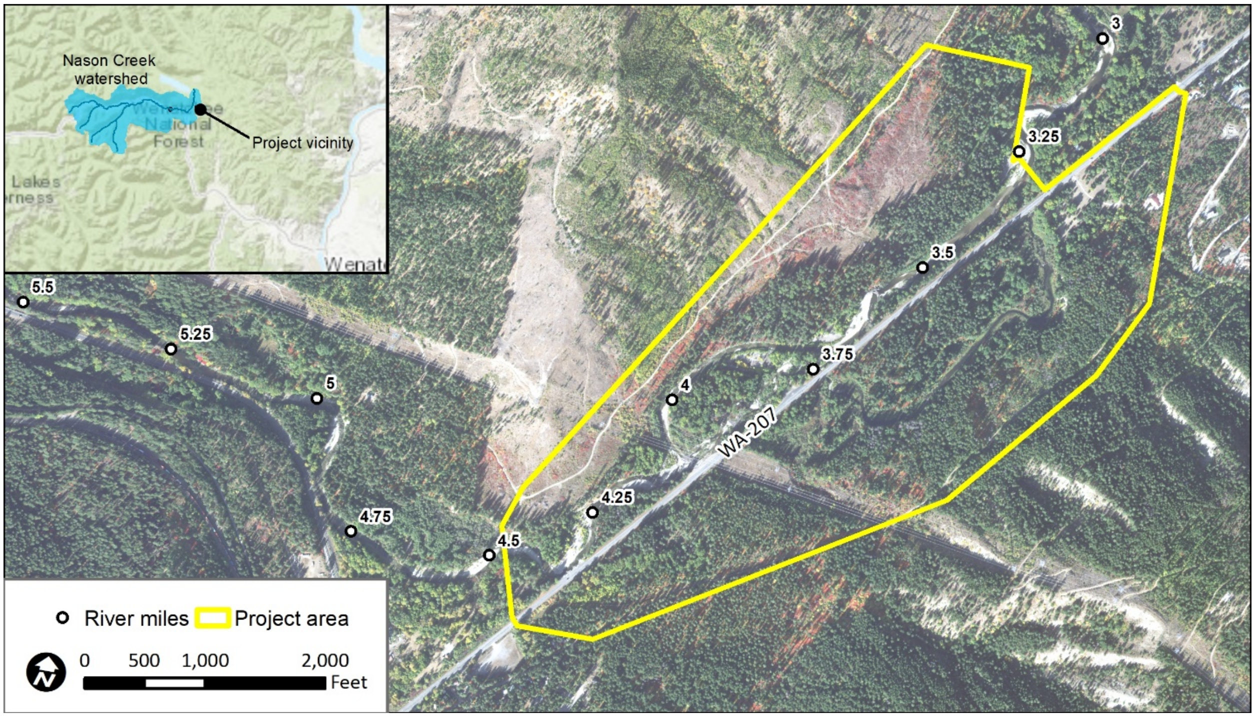


Figure 1. Nason Floodplain project area location.

The goal of the project is to identify alternatives that will enhance aquatic habitats while reducing conflicts between Nason Creek and Highway 207. Currently, Nason Creek is contacting Highway 207 road prism at three locations within the study area near RM 3.7, 4.15 and 4.35. A large and historically persistent log structure along the creek near RM 4.1 directs flow into the highway embankment (Figure 2). A mature meander bend near RM 4.4 (Figure 3b) has eroded the highway embankment. Both locations have required emergency placement of rock to stabilize the embankment. This project will seek to improve fish habitat while reducing conflicts with existing infrastructure.

Figure 2. Looking downstream at existing log structure, BPA powerlines, and Highway 207 near RM 4.1.

1.1 NAME AND TITLES OF SPONSOR, FIRMS AND INDIVIDUALS RESPONSIBLE FOR DESIGN

The project is sponsored by the Yakama Nation with Chris Butler as project manager. Inter-Fluve is the engineering design firm with Dan Miller (PE) the licensed engineer of record for this project and the main point of contact for Inter-Fluve.

1.2 LIST OF PROJECT ELEMENTS THAT HAVE BEEN DESIGNED BY A LICENSED PROFESSIONAL ENGINEER

Dan Miller (PE) is the licensed engineer of record for this conceptual alternatives analysis project. Project elements include the following, with BPA HIP III activity and risk category included:

Table 1. Activity categories and risk included in the Upper Kahler project.

Description of Proposed Enhancement	Work Element	HIP III Category	HIP III Risk Level
Habitat large wood structures, apex large wood structures, and tree-tipping within the existing side channel	Install habitat-forming natural material instream structures	2d	Medium
Bank habitat enhancements at existing riprap banks: **Option 1: Large wood bank treatments** **Option 2: Floodplain terrace with large wood fringe.**	Install habitat-forming natural material instream structures	2d	Medium
Create more frequently activated side channel habitat within existing historical channel scars on the floodplain	Improve secondary channel and wetland habitats	2a	Medium
Create a groundwater-fed side channel within existing historical channel scars on the floodplain	Improve secondary channel and wetland habitats	2a	Medium
Revegetation of all disturbed surfaces	Riparian vegetation planting	2e	Low
Culvert replacement (alternative A)	Bridge and culvert removal or replacement	1f	Medium
Culvert replacement	Remove existing 48" concrete culvert and replace with fish passage bottomless culvert for backwater alcove (no through flow).	1f	Low

1.3 IDENTIFICATION AND DESCRIPTION OF RISK TO INFRASTRUCTURE OR EXISTING RESOURCES

Infrastructure in the project vicinity includes Highway 207, two 12ft diameter corrugated metal pipe culverts under the road (RM 3.3 [Figure 3.A] and 3.75), miscellaneous concrete culverts ranging from 18" to 48" diameter under the road, a BPA powerline corridor which crosses Nason Creek at RM 4.1, miscellaneous overhead and buried utilities along Highway 207 and private residences downstream of the project area. Risk to Highway 207 is high and has historically been high under existing conditions, as evidenced by damage incurred regularly during high-flow events. Risk to BPA powerlines is low because the towers are located outside of the present-day active channel. Risk to private residences is low because they are located on a higher terrace and well setback from the active channel.

Figure 3. Infrastructure within the project area includes (A) CMP culvert with concrete headwalls (RM 3.75) which provide connectivity to the side channel on the east side of the highway, and (B) Highway 207 (RM 4.4) which has been reinforced with rock in several locations.

1.4 EXPLANATION AND BACKGROUND ON FISHERIES USE (BY LIFE STAGE – PERIOD) AND LIMITING FACTORS ADDRESSED BY THE PROJECT

Current fish known to utilize the project area iinclude ESA-listed spring Chinook (endangered), steelhead (threatened), Bull Trout (*Salvelinus confluentus*, threatened), species-of-concern Pacific Lamprey (*Lampetra tridentate*) and westslope cutthroat trout (*O. clarkii*), and non-listed summer Chinook, Coho Salmon (*O. kisutch*), mountain whitefish (*Prosopium williamsoni*), and non-native brook trout (*Salvelinus fontinalis*). Past redd counts show high Chinook Salmon and steelhead redd densities within the project area (Figure 4). The project reach is a low gradient reach with high quality spawning gravels located throughout.

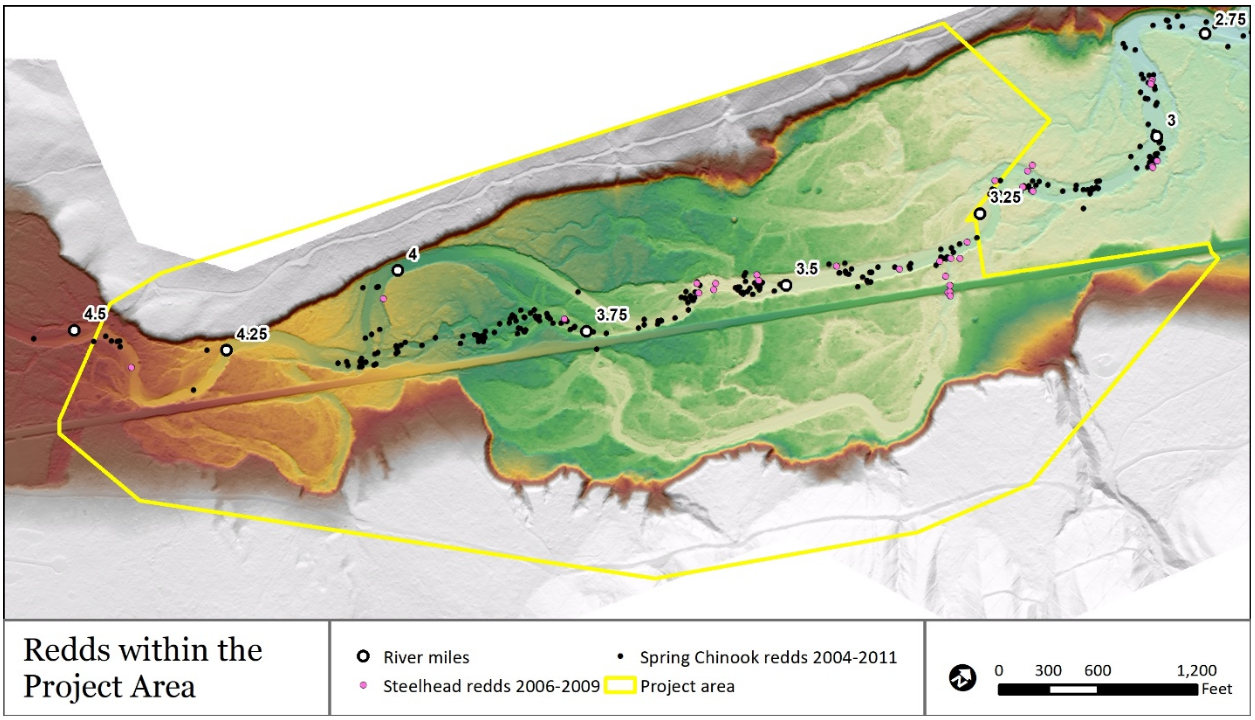


Figure 4. Steelhead and spring Chinook redds recorded in the project area for the specified years over LiDAR elevation data. Avulsion channel clearly visible in the LiDAR data. Redd data from Upper Columbia Salmon Recovery Board.

According to the Subbasin Plan (NWPCC 2004), habitat in the project area has high potential to improve populations of aquatic species, including ESA-listed salmonids within the lower Nason Creek. Summary of life-history timing for aquatic species are presented below (Figure 5). Detailed descriptions of habitat requirements by life stage for ESA-listed species are included in the following sections.

Figure 5. Life history timing of target species within the project area.

1.4.1 Steelhead

Adult steelhead enter the Wenatchee basin from August through April, holding in deep pools with overhead cover. Spawning begins in very late March, peaks in mid-April, and lasts through May. Egg survival is highly sensitive to intra-gravel flow and temperature (NWPCC 2004), and is particularly sensitive to siltation earlier in the incubation period (Healy 1991). Fry emerge from the redds 6-10 weeks after spawning (Peven 2003).

Age-0 juveniles spend their first year primarily in shallow riffle habitats, feeding on invertebrates and utilizing overhanging riparian vegetation and undercut banks for cover (Moyle et al. 2002, US Fish and Wildlife Service 1995). Age-0 steelhead use slower, shallower water than Chinook Salmon, preferring small boulder and large cobble substrate (Hillman et al. 1989). Older juveniles prefer faster moving water including deep pools and runs over cobble and boulder substrate (US Fish and Wildlife Service 1995). Juveniles outmigrate between ages one and three, though some hold over and display a resident life history form. Smolts begin migrating downstream from natal areas in March (NWPCC 2004).

1.4.2 Chinook Salmon

Adult spring Chinook enter the Wenatchee in May, holding in deeper pools with overhanging cover until water temperatures are suitable for spawning. Spawning typically begins in very late July, peaks in late August, and ends in late September (NWPCC 2004). Eggs are very sensitive to changes in oxygen levels and percolation, both of which are affected by sediment deposition and siltation in the redd (Healy 1991, Peven 2003). Fry emerge in June and July, which coincides with the rising hydrograph, forcing juveniles to seek out backwater or margin areas with lower velocities, dense cover, and abundant food (Quinn 2005). Fry are extremely vulnerable when they emerge, because their swimming ability is poor and flows are high. Near-shore areas with eddies, large woody debris, undercut tree roots, and other cover are very important for post-emergent fry (Hillman et al. 1989, Healy 1991). The proposed floodplain enhancement area is expected to provide low velocity rearing habitat for post-emergent spring Chinook salmon fry because there are high redd densities immediately upstream, and the feature is on the outside of a meander bend where the majority of water and fry are expected to be during high flows (Figure 4).

As they increase in size, juveniles begin to select for deeper and faster moving water, particularly areas with overhanging cover (Moyle et al 2002b). These areas provide more holding and feeding habitat area for the larger juveniles to occupy. Upper-Columbia spring Chinook express a stream-type life history, meaning they rear in freshwater for at least one year before outmigrating as yearlings. Smolts begin migrating in March from natal areas (NWPCC 2004).

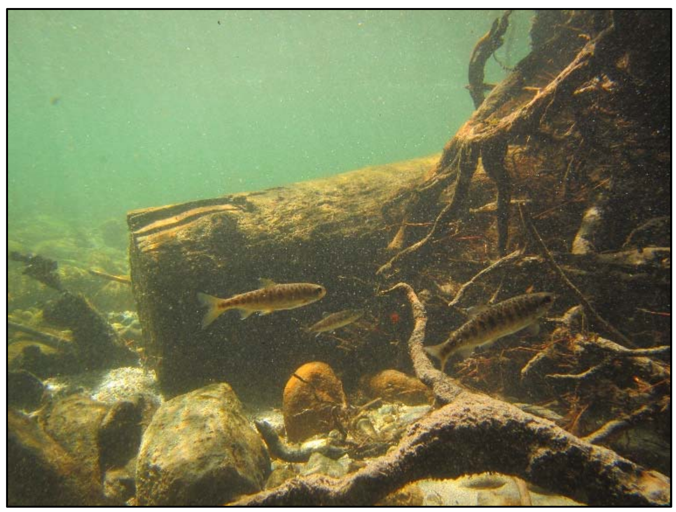


Figure 6. Chinook Salmon parr resting behind a constructed log structure in the Entiat River between feeding forays.

1.4.1 Bull trout

Nason Creek supports a population of resident and fluvial bull trout (NWPCC 2004). The project area is located in a reach of Nason Creek that is mapped as "possible bull trout spawning" in the Wenatchee Subbasin Plan (NWPCC 2004). Bull Trout spawn in the Wenatchee subbasin from August through October. Eggs incubate over the fall, winter, and spring, with fry emerging approximately 220 days after egg deposition. Juveniles select for margin habitat with overhanging cover, feeding primarily on aquatic insects until they grow larger and shift towards feeding on fish. Bull trout juveniles rear in headwater streams for at least two years before migrating downstream as adults or sub-adults to express fluvial life histories, or resident life histories in downstream reaches (McPhail and Baxter 1996). Downstream movement of bull trout in the nearby Chiwawa River has been documented as bimodal, with one pulse in the spring and a second in the fall (NWPCC 2004).

1.4.2 Limiting factors

Regional objectives for salmonid habitat protection and restoration in the Upper Columbia Region have been evaluated and summarized in the document *A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region* (2017) by the Upper Columbia Salmon Recovery Board (UCSRB) Regional Technical Team (RTT). This Biological Strategy is part of the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007) and recommends region-wide biological considerations and approaches for salmonid habitat restoration and protection actions. The RTT guides the development and evaluation of salmonid recovery projects within the Upper Columbia Region.

The Biological Strategy has identified several assessment units within the major watersheds of the Upper Wenatchee River. The Nason Floodplain project area falls within the Nason Creek Assessment Unit. Nason Creek is a Tier 1 watershed of highest priority for both protection and restoration.

All Chinook spawning that occurs in Nason Creek occurs in the lower 15 miles of the mainstem, which also contains the poorest quality habitat (UCRTT 2017). The RTT has prioritized a list of restoration actions to address key ecological concerns in the Nason Creek Assessment Unit, and are listed below in priority order (UCRTT 2017):

1. **Peripheral and transitional habitat**: Reconnect side channels and off-channel habitat.
2. **Channel structure and form**: Increase large wood complexes, remove or modify levees and roads where feasible, restore channel structure and form to reduce sediment transport capacity to counteract recent incision and confinement.
3. **Riparian condition:** Improve riparian conditions to improve long term LWD recruitment.
4. **Channel structure and form:** Restore instream habitat diversity by enhancing large wood recruitment, retention, and complexity.
5. **Food**
6. **Sediment conditions:** Decommission roads that are affecting sediment delivery to the stream.
7. **Species interaction (competition)**

1.5 LIST OF PRIMARY PROJECT FEATURES INCLUDING CONSTRUCTED OR NATURAL ELEMENTS

Primary project features consist of the following:

- **Bank habitat enhancements at existing riprap banks:** Nason Creek is currently contacting Highway 207 at 3 locations which has caused erosion of the road prism a number of times in the past. Bank habitat treatments are proposed at these three locations to provide fish habitat, channel complexity and greater separation of flow from the highway where exposed riprap is currently armoring the road prism. The existing riprap would remain under the new bank treatments to serve as a failsafe protection for the highway embankment. Bank habitat options are shown in the plan set (Appendix A). Bank habitat option 1 includes placing discrete log structures along the river margin to deflect flow away from the toe of embankment. Log structures would be stabilized using boulders. Bank habitat option 2 would include constructing a continuous meander bend structure along the entire river bank at each location (3 meander bend structures total). These structures would be partially buried, creating a floodplain terrace about 30 feet wide along the existing bank, with about 15 feet of LWM exposed to active flow. Slash would be placed beneath the rootwads. To maintain channel capacity, option 2 would include excavating the opposing gravel bar on river left. The excavated bar material would be used as log structure backfill. The fill would be revegetated with native riparian trees and shrubs.

- **Habitat and apex large wood installation**: Construct large wood structures in the main channel and side channels of Nason Creek to provide complex salmonid holding and rearing habitat at a range of flow conditions. These structures also increase channel roughness which reduces the risk of a developing channel avulsion and aid in directing flow away from the road embankment. Scour pools may be constructed during installation. Typical wood designs will be included in future design phases.
- **Back water alcove**: Nason Creek flow backwaters through an existing 48inch concrete culvert through the highway embankment into a relic side channel near RM 4.2. Replace the existing 48inch concrete culvert with a larger bottomless culvert meeting WDFW fish passage criteria and grade existing channel to remove fish stranding conditions. Main stem flows backwatering into this area will provide off channel refuge habitats.
- **Tree tipping**: Existing spruce trees along the side channel (RM 3.3-3.75) on the east side of Highway 207 would be tipped over and moved into the channel to provide overhead cover and habitat complexity for juvenile salmonids. Hand crews equipped with rigging and power equipment (winches) will be used to tip the trees into the channel to avoid damage to the existing riparian forest by heavy machinery. A large log structure will be placed near the downstream end of the side channel to intercept floating wood and protect the downstream crossing structure.
- **Side channel enhancement**: Create three more-frequently inundated side channels on river left within or adjacent to existing high-flow scars. These features would serve to increase flood conveyance area and off-channel habitat, while reducing shear stress in the mainstem during high flow events. These side channels are sited within existing high-flow swales, and will function to provide off-channel habitat while diverting a fraction of flood flow from the mainstem, reducing mainstem shear stresses at each of the three locations where Nason Creek is contacting the Highway 207 road prism. These features are anticipated to have a relatively short life, during which time the existing gravel bars opposite the riprap bank treatments will adjust reforming channel conveyance area similar to existing conditions.
- **Groundwater channel enhancement**: Pending further analysis, create a groundwater-fed side channel within existing floodplain and relic channel scars. This concept would include an infiltration gallery that collects and transports groundwater from upslope, to the relic/disconnected side channel east of Highway 207 between RM 4.2 and 4.4. This would increase cool-water refuge in the summer and warm-water refuge in the winter, while also

providing low velocity refuge habitat during high flow events for juvenile salmonids. Feasibility of this alternative will be assessed in future design phases using water level loggers, test pits, and pump tests to establish groundwater elevations, subsurface conditions, and an estimate of the quantity of groundwater that could be collected using a gallery.

- **Alternative A, culvert replacement**: Replace existing culverts at RM 3.3 and 3.75 under Highway 207 with bridges designed to improve fish passage and water flow into and through the side channel. This alternative would improve mainstem habitat and geomorphic processes by reducing shear stress in the mainstem during high flow events. Flood deposits on either side of the existing culvert through the highway embankment near RM 3.75 would be removed using an excavator to improve conveyance and reduce the risk of fish stranding during low river stage.
- **Alternative B, side channel creation**: Create a more-frequently inundated side channel and wetlands complex through the river left floodplain from RM 3.2 to 3.6 at the downstream end of the project area. The side channel is sited within existing high-flow swales, and will function to provide off-channel habitat while reducing mainstem shear stresses.
- **Riparian revegetation**: Plant native species in all disturbed areas to promote riparian function and increase food production and habitat complexity for target species.

1.6 DESCRIPTION OF DISTURBANCE INCLUDING TIMING AND AREAL EXTENT AND POTENTIAL IMPACTS ASSOCIATED WITH IMPLEMENTATION OF EACH ELEMENT

Project disturbance at the site will be from excavation and temporary access routes used to install the large wood structures, create the side channelsand to install the infiltration gallery collection and conveyance pipe. Vegetation removed during excavation will be salvaged and used to supplement constructed large wood habitat structures. Disturbance during construction and to large trees will be minimized, and all disturbed areas will be re-vegetated.

2. Resource inventory and evaluation

2.1 DESCRIPTION OF PAST AND PRESENT IMPACTS ON CHANNEL, RIPARIAN AND FLOODPLAIN CONDITIONS

Riparian and floodplain conditions in the project site and vicinity have been impacted most heavily by the construction of Highway 207 circa 1942 along the Nason Creek floodplain. The circa 1900 plat map indicates that the mainstem of Nason Creek used to occupy the southeast side of the floodplain (Figure 7). The 1957 aerial shows Nason Creek in an alignment with planform basically similar to – though west of - what is seen today on the north side of the valley. As well the BPA power corridor is alsovisible. Logging in the vicinity, and associated road building, has had impacts on large wood recruitment and sediment delivery to Nason Creek. Construction of the highway has reduced total off channel habitat connectivity, concentrated more flow into the mainstem, and shortened overall channel length by cutting off a historical meander that is depicted in the circa 1900 plat map.

2.2 INSTREAM FLOW MANAGEMENT AND CONSTRAINTS IN THE PROJECT REACH

Not applicable to this project.

2.3 DESCRIPTION OF EXISTING GEOMORPHIC CONDITIONS AND CONSTRAINTS ON PHYSICAL PROCESSES

Figure 7, **Error! Reference source not found.** and **Error! Reference source not found.** show historical aerial imagery of the project area vicinity from 1957, 1963, 1974, 1991, 2006 and 2015. The 1942 Road Relocation plans include an indication of the Nason Creek alignment that appears similar to the 1957 photos. While in general the meandering plan form and bend locations are similar over the photographic history, the channel has migrated eastward closer to the highway. There appears to be a vegetated floodplain approximately 80- and 150-feet wide from the edge of Highway 207 to the right river bank at RM 4.4 and 4.1, respectively, in the 1942 plans and 1957 photos. It appears that Nason Creek encroached on to the road embankment during the time interval between the 1974 and 1991 photos. The side channel along the west side of highway between RM 3.7 to 4.1 is evident in all photos.

The Highway 207 embankment has isolated or limited flow to the floodplain to the east leading to fewer off channel and side channel habitats. No pre-development survey is available to determine whether and to what degree incision may have occurred, however it is believed that this unnatural confinement has led to some level of incision (UCRTT 2017).

Nason Creek delivers a dynamic supply of substrate and wood to the project reach. Areas of wood accumulation exhibit defined scour pools and sediment deposit tail spills creating diverse habitats. The numbers and locations of redds mapped (Figure 4) indicate that diversity of LWM and bed forms provide spawning habitats.

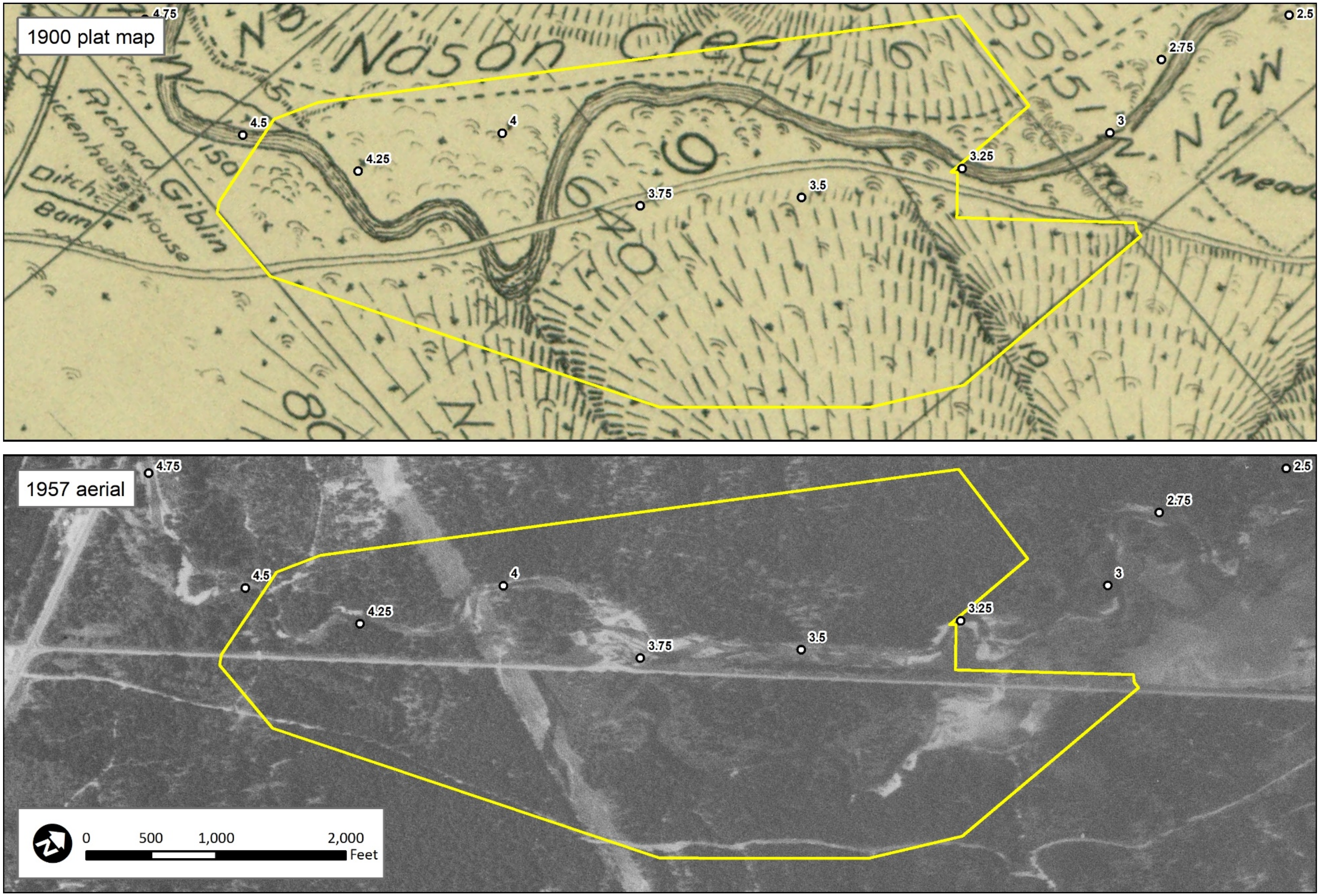


Figure 7. Historical plat map from 1900 and aerial image from 1957, project area boundary shown in yellow.

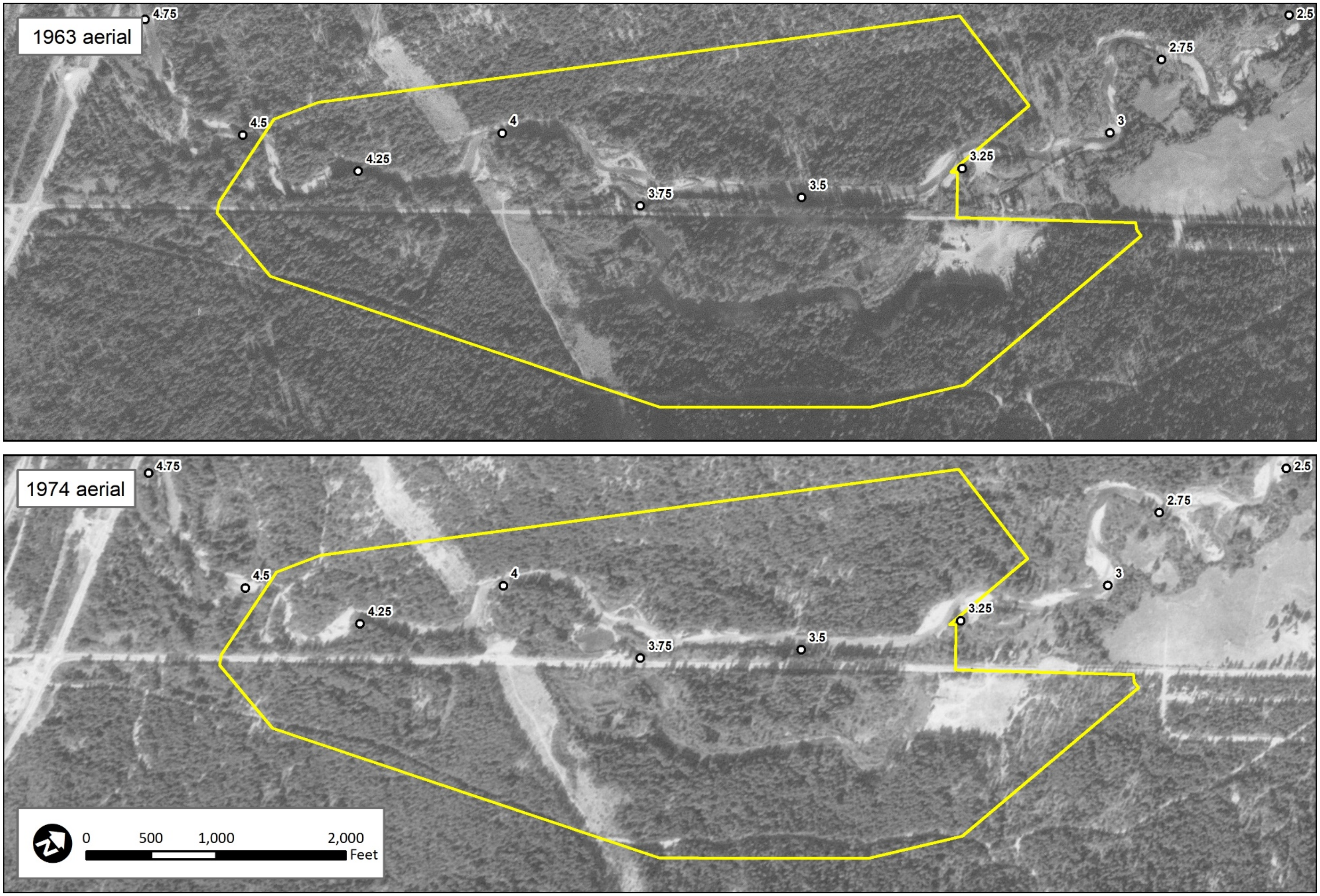


Figure 8. Aerial images from 1963 and 1974, project area boundary shown in yellow.

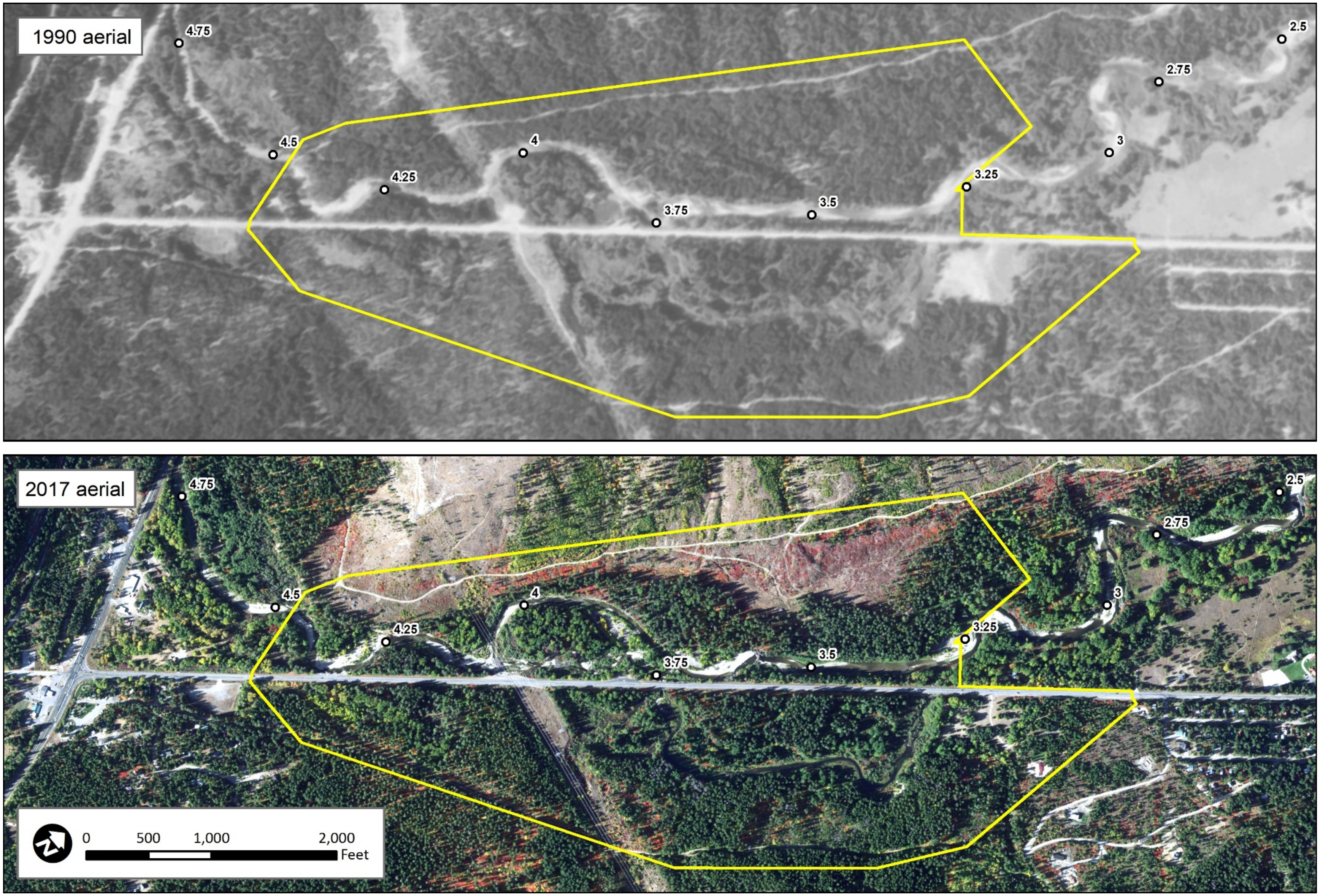


Figure 9. Aerial images from 1990 and 2017, project area boundary shown in yellow.

2.4 DESCRIPTION OF EXISTING RIPARIAN CONDITION AND HISTORICAL RIPARIAN IMPACTS

Riparian conditions in the project area are generally good. The forest is a mixed-age stand of Ponderosa Pine, Douglas fir, willow, dogwood and cottonwood. Typically, conifers occupy higher elevation terraces that have not been disturbed by river activity for a number of decades. Deciduous trees and woody shrubs occupy the riparian zones and areas disturbed by river migration in the recent past. Wetlands have not yet been delineated. Coniferous trees have been removed along the BPA power line corridor and recently logged at the western edge of the floodplain from approximately RM 3.2-3.7.

2.5 DESCRIPTION OF LATERAL CONNECTIVITY TO FLOODPLAIN AND HISTORICAL FLOODPLAIN IMPACTS

Nason Creek historically had high floodplain connectivity with a myriad of off-channel wetlands, alcoves, and channels. The highway embankment and culvert system have reduced floodplain connectivity and eliminated lateral channel migration to the east of the highway by limiting water movement onto floodplain surfaces to areas east of the highway. Approximately 40.7-acres of active side channel, wetlands and floodplain are located east of the highway RM 3.3-3.9. Approximately 10.9-acres of inactive side channel, wetlands and floodplain are located east of the highway RM 4.15-4.4. The reduced floodplain width constricted by the highway embankment has reduced the available migration corridor

2.6 TIDAL INFLUENCE IN PROJECT REACH AND INFLUENCE OF STRUCTURAL CONTROLS (DIKES OR GATES)

Not applicable to this project.

3. Technical data

3.1 INCORPORATION OF HIPIII SPECIFIC ACTIVITY CONSERVATION MEASURES FOR ALL INCLUDED PROJECT ELEMENTS

HIPIII conservation measures will be met through the project design during future design phases and requests for variances will be submitted for any conservation measures that cannot be met.

3.2 SUMMARY OF SITE INFORMATION AND MEASUREMENTS (SURVEY, BED MATERIAL, ETC) USED TO SUPPORT ASSESSMENT AND DESIGN

3.2.1 Elevation data

A ground survey was conducted in November, 2018 using total station and RTK GPS survey equipment. Survey control was established throughout the project site and correlated to RTK GPS base station static data corrected using the Online Positioning User Service (OPUS). Survey effort was focused in the main channel and side channel areas of the project site. Survey captured cross sections at hydraulic controls and geomorphic features (tops and bottoms of riffles, apex of bends, pools, etc.) for use in hydraulic model development. Survey was conducted by wading and collected data necessary for conceptual level analyses and designs, with the exception of two pools that were too deep to access. An existing conditions topographic surface was created for design and hydraulic modeling by supplementing survey data with existing LiDAR data from 2015. All data are referenced to the Washington State Plane North coordinate system, the NAVD88 vertical datum and US feet.

3.2.2 Fish use

Fish use data were collected from primary literature, the Wenatchee Subbasin Plan (NWPCC 2004), and the Upper Columbia biological strategy (UCRTT 2017).

3.2.3 Geomorphic data

A pebble count survey was conducted in the project area to evaluate substrate conditions and will be used during the design phase to estimate bed mobility, sediment transport capacity of Nason Creek and scour potential. See section 3.4.

3.2.4 Hydrology data

For this conceptual level analysis, return period peak flow flood discharges were estimated with StreamStats for Nason Creek. . Washington Department of Ecology (WDOE) does record flows along Nason Creek at gage 45J070 located near the mouth. The WDOE gage has a period of record from 2002 to the present and is reported to have some inconsistencies – thus was not used at this stage for flood peak flows. The WDOE gage does provide useful information on seasonal flow variation during the available period of record.

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

3.3.1 General Hydrology

Nason Creek drains high-elevation areas of the Chiwaukum Mountains and has a snowmelt-dominated hydrologic regime. Figure 10 shows modeled median, high, and low exceedance flows for Nason Creek at RM 12.

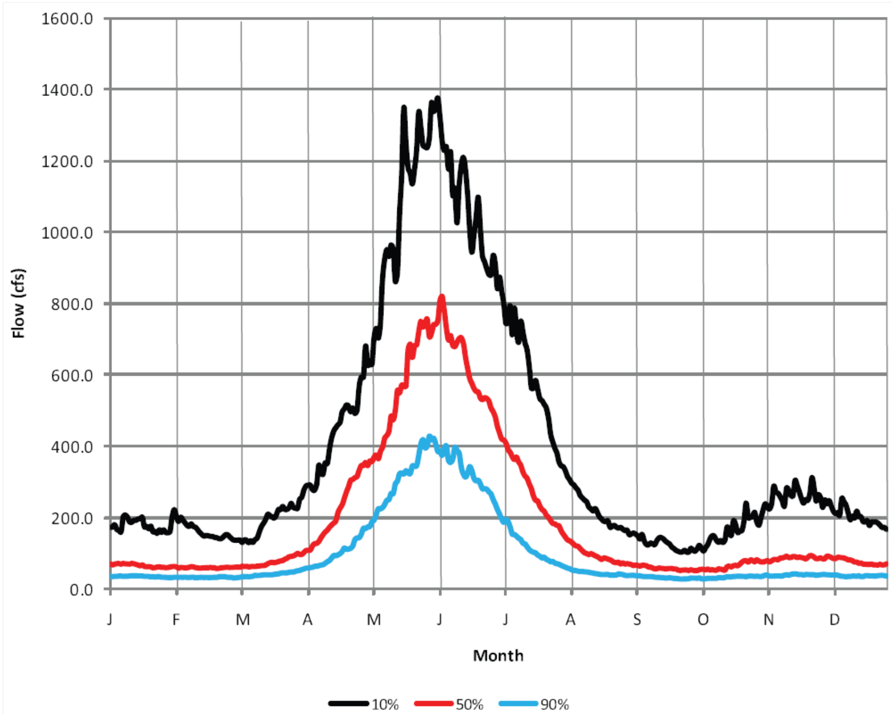


Figure 10. Modeled 10 percent, 50 percent, and 90 percent exceedance flows for RM 12 using data from 7 regional gages. Percentile flows represent the daily flow that is equaled or exceeded for the given percentage of time over the available period of record. Reprinted from Malmon (2010).

Although peak flows typically occur due to snowmelt in the late spring or early summer, some of the largest floods have occurred from rain-on-snow events in late fall. Large past flood events occurred in May 1948, November 1990, November 1995, and November 2006. As noted in Chelan County's Feasbility Study (2012), the November 1995 event washed out portions of Highway 207. As of 2011, three repairs in 10years at this location lead to nomination for the WSDOT Chronic Environmental Deficient program.

3.3.2 Peak Flow Hydrology

Washington Department of Ecology operates gage 45J070 near the mouth of Nason Creek since 2002, but no long-term stream gage record is available on Nason to reliably estimate peak flows for the project reach. For this reason, at this conceptual stage we used USGS Stream Stats to estimate flood magnitudes near the mouth of Nason Creek. No major tributaries enter Nason Creek between the project and confluence. More detailed hydrologic analyses will be completed in the design phase to investigate if other gages (e.g the Icicle Creek gage USGS Gage #12458000) can be incorporated to refine the hydrology estimates. The estimated flood magnitudes are presented in

Table 2.

Table 2. Peak flow estimates for Nason Creek near the mouth

Recurrence Interval (years)	Estimated flow at RM 13 (cfs)
2	**3,180**
10	**4,140**
25	**4,600**
50	**5,030**
100	**5,630**
500	**6,190**

3.4 SUMMARY OF SEDIMENT SUPPLY AND TRANSPORT ANALYSES CONDUCTED, INCLUDING DATA SOURCES INCLUDING SEDIMENT SIZE GRADATION USED IN STREAMBED DESIGN

There are some bed rock expressions in the stream bed, banks and valley wall along the west edge of the Nason Creek flood plain. Occasional boulders that are not mobile during normal flood flows have been delivered to the valley bottom during much larger glacial outwash flows and delivered to the contemporary channel by being eroded out of the adjacent outwash terraces or exhumed as Nason eroded down through the post glacial outwash. Placed riprap occurs along the Highway 207 embankment, some of which has moved into and downstream along the streambed a short distance. With this understanding, substrate measured by the pebble count is a good approximation of frequently mobile bedload transported through the project reach and found in alluvial formed bed, bar and bank deposits.

Wolman pebble counts were completed in Nason Creek near RM 4.45 to help estimate sediment particle sizes moving into and through the project reach. Pebble counts were performed at two locations along the river right bar surfaces at the crest (Figure 11.A) of a riffle and along the edge of the same riffle (Figure 11.B) to capture the range of substrates observed.

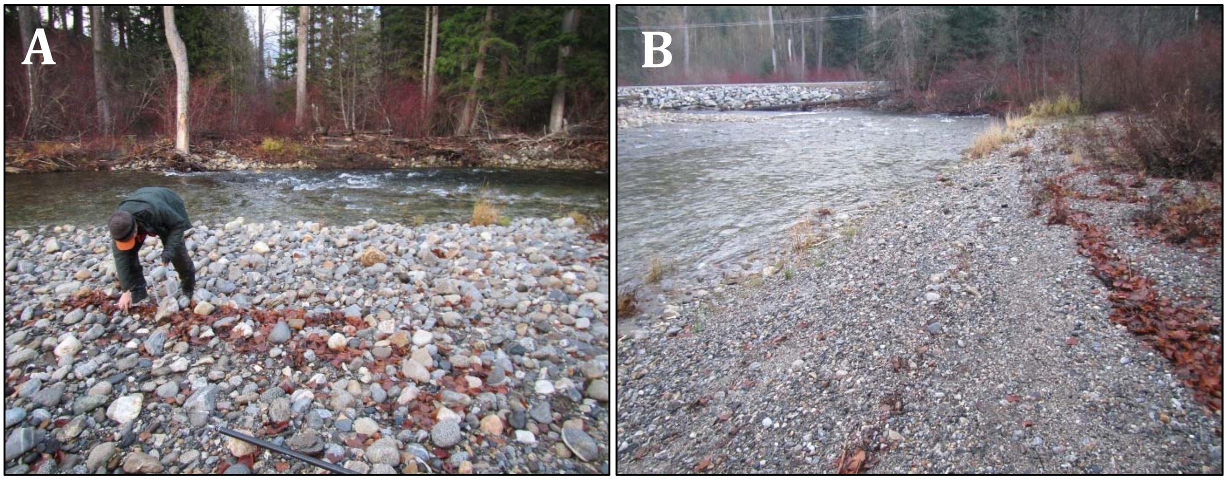


Figure 11. Location of pebble counts performed on Nason Creek. A) GC01 was performed on a gravel bar adjacent to a riffle, on river right of Nason Creek. B) GC02 was performed on a bar adjacent to a riffle on river left.

Results of the pebble count provide a grain size distribution. GC01 contained coarser material compared to GC02, with a d50 best described as very course gravel (Figure 12). Some sand and finer gravels were found within the interstices of larger material. GC02 contained finer material with a d50 best described as medium gravel.

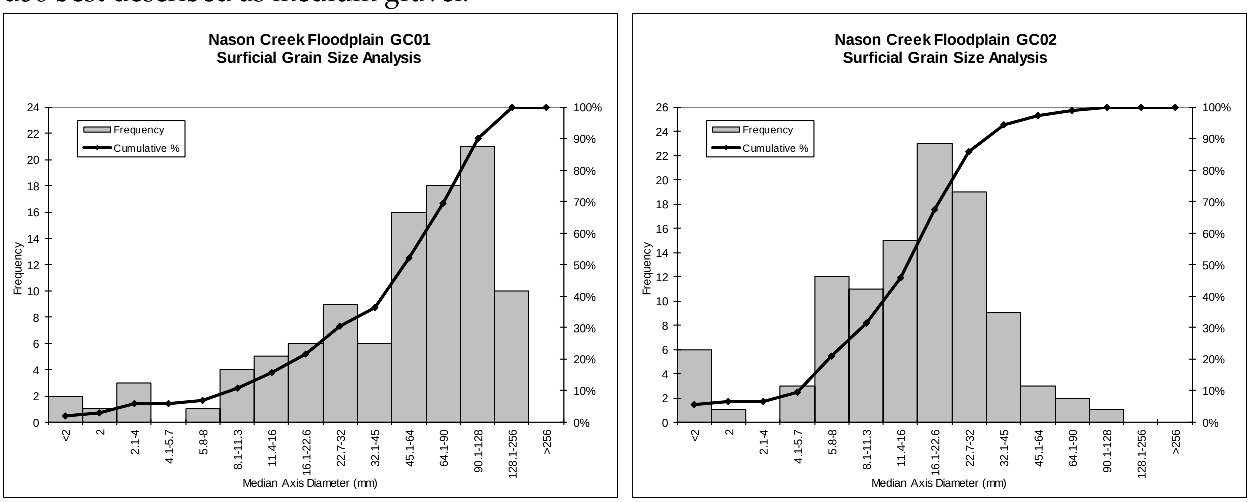


Figure 12. Grain size distribution at GC01 and GC02 based on Wolman pebble counts.

3.5 SUMMARY OF HYDRAULIC MODELING OR ANALYSES CONDUCTED AND OUTCOMES – IMPLICATIONS RELATIVE TO PROPOSED DESIGN

3.5.1 Hydraulic Modeling

Although flow pathways, wetted widths, and flow velocity can be observed on the landscape and recorded by collecting survey data or imagery, the information is only relevant to the conditions during that particular time and flow rate. Parameters such as velocity and depth can be difficult to measure in the field, particularly during flooding. Hydraulic modeling is useful for predicting the effects of various flow conditions, including extreme low flow and various floods, upon the existing landscape. It is also an industry-standard tool for predicting effects of possible enhancement actions. Thus, hydraulic modeling is important for evaluating the site locations and configurations of projects that influence - and are influenced by - the hydraulic properties of channels and floodplains. Two-dimensional (2D) hydraulic models were developed for the project site to represent existing conditions and the proposed alternatives conditions in order to better understand flood effects and help predict impacts of the alternatives on site hydraulics. The 2D hydraulic models for the site were developed in the U.S. Army Corps of Engineers HEC-RAS 5.0.5 software (USACE 2018). The following sections describe the capabilities and limitations of HEC-RAS 5.0.5 and document the development and output processing of the project existing and proposed conditions models.

3.5.2 Model Capabilities and Limitations

HEC-RAS 5.0.5 was used in its two-dimensional (2D) unsteady flow simulation mode with the capacity to model the complex flow patterns, on-site water storage, and temporally variable boundary conditions. The 2D hydraulic model calculates depth averaged water velocities (including magnitude and direction), water surface elevation, and mesh cell face conveyance throughout the simulation. Other hydraulic parameters such as: depth, shear stress, and stream power can be calculated by the model following completion of the simulation. The model does not simulate vertical variations in velocities or complex three-dimensional (3D) flow eddies.

3.5.3 Model Extent

The downstream extent of the model is at a riffle crest hydraulic control near RM 3.2. The upstream extent is about 2000 feet upstream of the project site. Width of the model is valley wide, encompassing channel and floodplain including east of the existing Highway 207.

3.5.4 Model Terrain

The existing conditions model terrain was developed using both ground/bathymetric survey data collected by Inter-Fluve in November 2018, along with aerial LiDAR acquired in June and July of 2015 (Quantum Spatial 2016). The LiDAR provided a 1 meter (3.28 feet) horizontal resolution bare earth digital elevation model (DEM) raster for the entire site, including floodplain areas and valley hillslopes. LiDAR was primarily used on the floodplain and hillslopes with select use to help define certain gravel bars where survey data were sparse. Ground/bathymetric survey data were used for river and side-channel bathymetry, active channel areas that may have changed since the LiDAR flight, and other areas of interest, including regions where potential project elements may occur. The ground and bathymetric survey data (points and break lines) were used to create a triangulated irregular network (TIN) surface for the surveyed areas. The ground survey surface was then resampled to a 1-foot resolution DEM raster and pasted into the LiDAR DEM to create the existing conditions model terrain. The ground survey surface superseded the LiDAR surface within the irregular extent of the ground survey. No transitional buffer between the ground survey and the LiDAR DEMs was used, occasionally resulting in minor surface discontinuities. The proposed condition model terrains were copied from the existing conditions terrain and modified to incorporate the design grading TIN surfaces. Large wood structures were represented in the model as regions of extremely rough Manning's n coefficient values The model terrains are projected on the Washington State Plane North Zone, North American Datum 1983 (NAD83), coordinate system with US feet distance units. The terrain elevations are in US feet relative to the North American Vertical Datum of 1988 (NAVD88).

3.5.5 Model Geometry

The 2D model geometry used a 40-ft square computational mesh for the entire area of interest. The Highway 207 road embankment was modeled as a lateral structure with road treated as a weir for correct physical modeling of flow patterns. Although the typical computation mesh size was greater than the terrain resolution the modeling capabilities of HEC-RAS 5.0.5 integrates the sub-grid terrain into the computations and projects the results accordingly.

3.5.6 Model Roughness

Roughness coefficients (Manning's n values) are used by the 2D model to calculate flow energy losses, or frictional resistance, caused by channel bed materials, and the type and density of floodplain vegetation. Existing conditions roughness coefficients were applied across the model extent to represent the various types and densities of vegetation or surface conditions. Roughness coefficients were modified in the proposed conditions models to represent immediate post construction conditions. In general, roughness regions were delineated based on field observations, aerial photos, and proposed designs. Roughness values for each region were selected using professional judgment and guided by published guidelines (Arcement & Schneider 1989) for channel types and vegetation conditions. At this conceptual stage manning's n values were defined for:

- Channel as 0.040-0.045 depending on complexity and amount of LWM.
- Forested bars and floodplain as 0.080
- LWM structures as 0.1.

3.5.7 Model Discharges

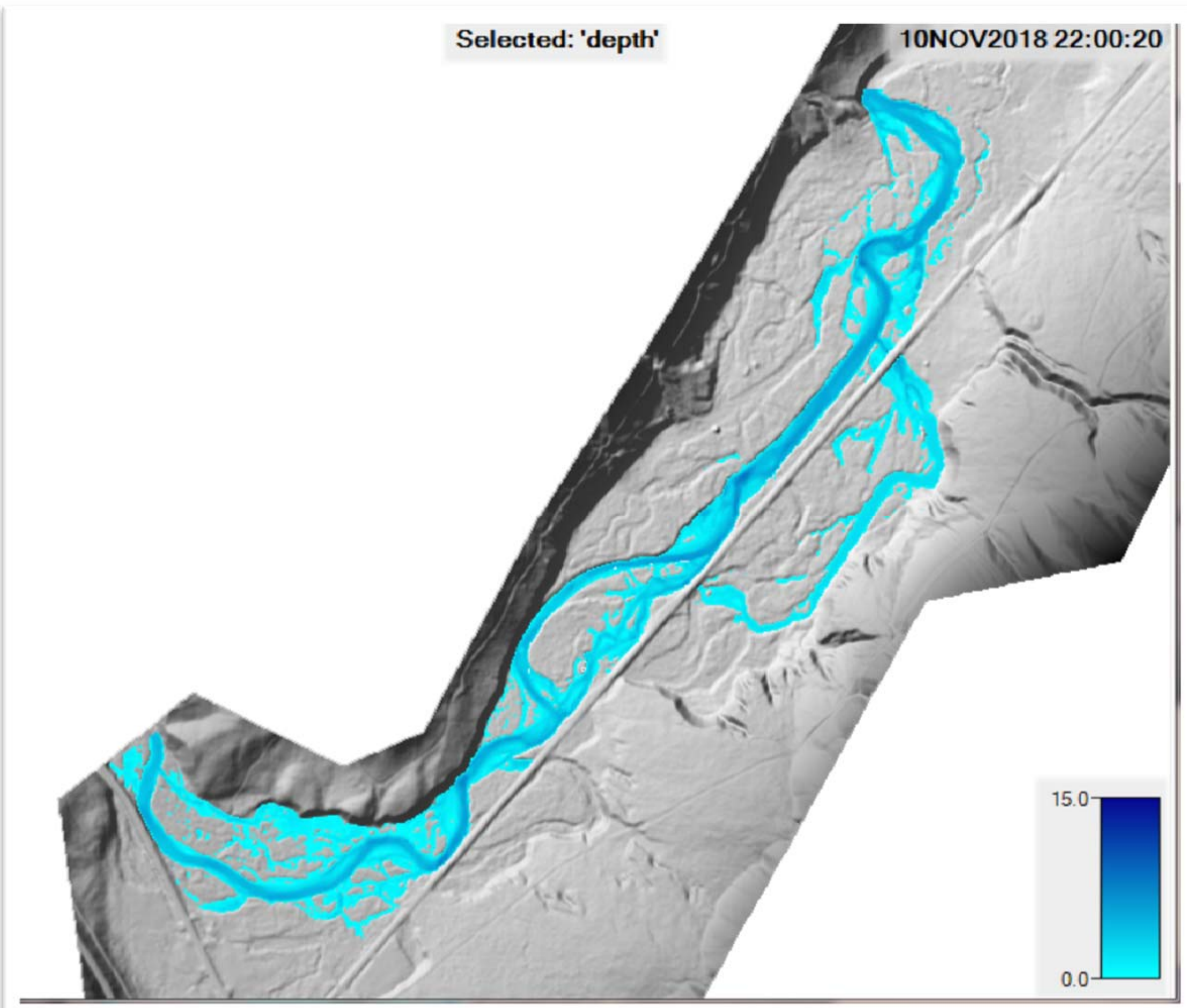
The modeled discharges of interest included 2-, 10-, 25-, 50-, 100-, and 500-year recurrence interval peak flows listed in Table 2. Additional low flows of interest included summary low flow through extrapolated annual peak discharges and included: 20-, 50-, 100-, 200-, 300-, 750-, 1500-, 2000- and 2,800-cfs. These discharges were incorporated into a synthetic hydrograph with periods of steady flow (at the discharges of interest) to create a stair-step like pattern. The periods of steady flow allow the model to come to a quasi-steady state condition, improving the interpretation of hydraulics at discharges of interest.

3.5.8 Model Boundary Conditions

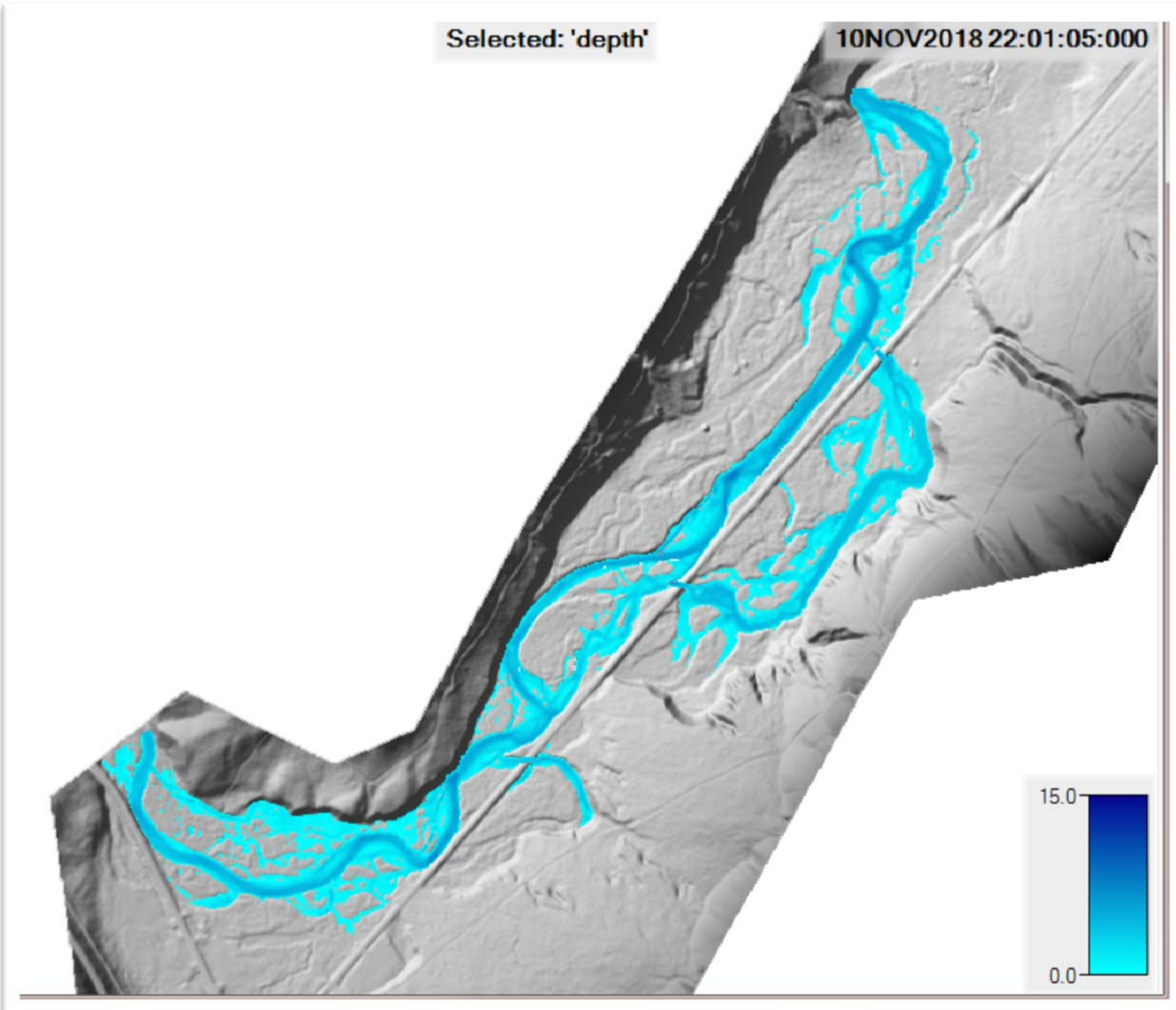
HEC-RAS 5.0.5 2D models require boundary conditions at the upstream and downstream ends of the model to control the flow into and out of the model extent. The synthetic hydrograph described above was applied as the upstream boundary condition. The flow was initially distributed along the boundary assuming normal flow depth at a friction slope estimated from the average channel slope upstream of the model (0.005 feet per foot). The downstream boundary condition assumed normal flow depth at a friction slope estimated from the average channel slope downstream of the model (0.005 feet per foot).

3.5.9 Model Output

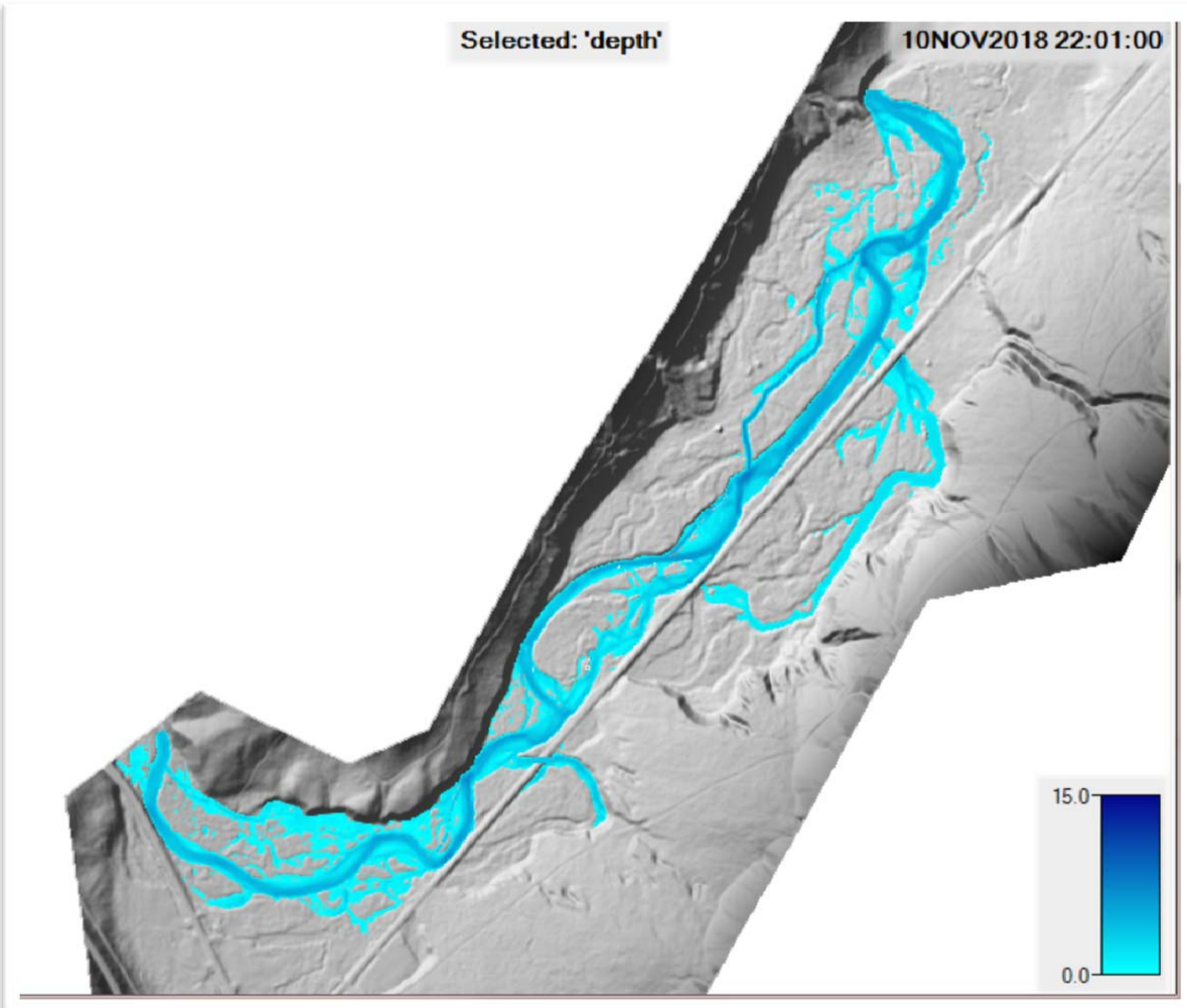
To examine the inundation patterns, velocities, and other hydraulic parameters within the model extent for existing and proposed conditions, the RAS Mapper utility of HEC-RAS 5.0.5 was used to generate results in the form of raster data sets at the discharges of interest. Modeled water depths under existing and Alternatives A and B conditions are displayed for the 1.5-year estimated flow of 2,800-cfs and the 100-year flood event in the following figures.



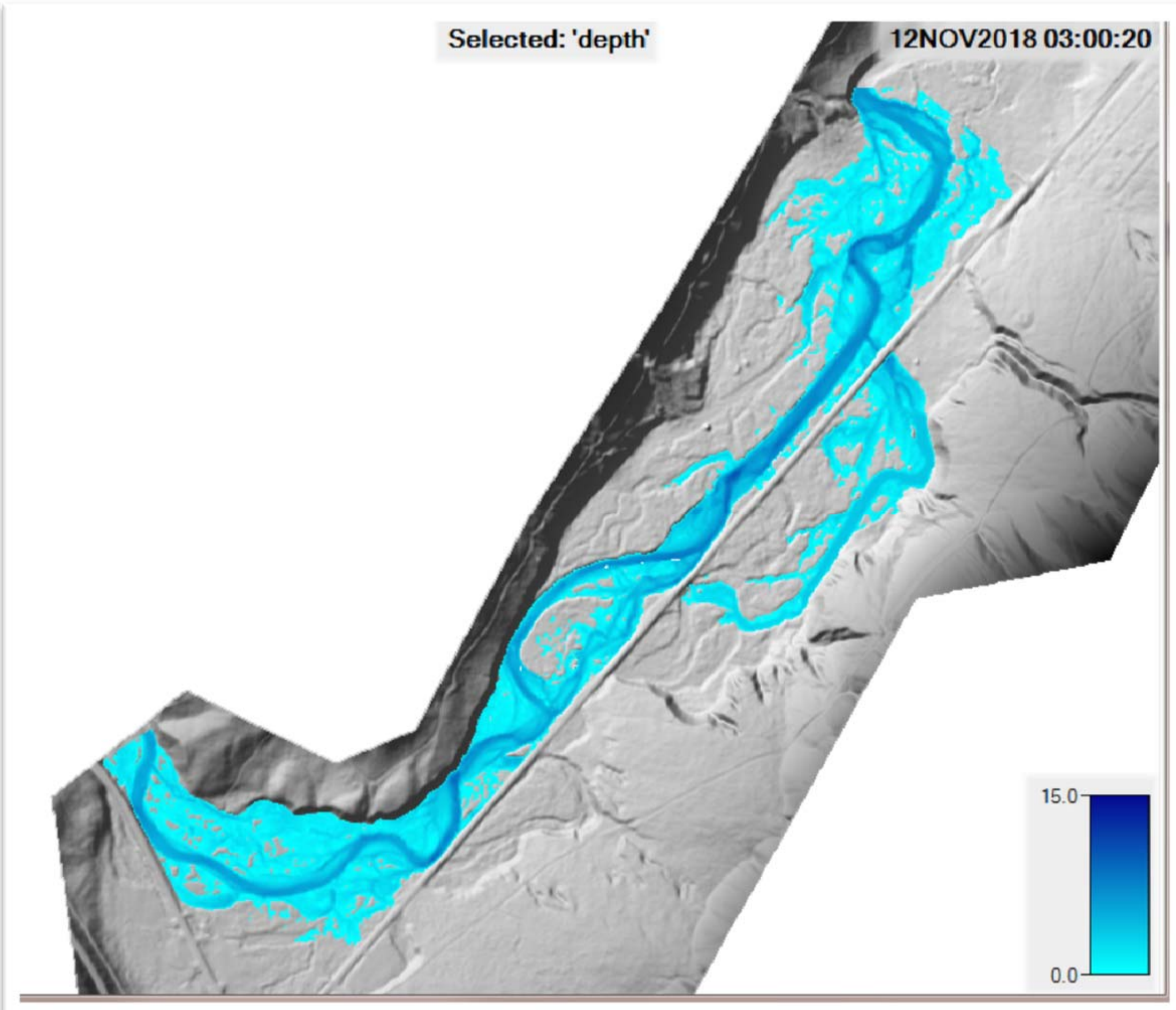
Existing conditions depth at 1.5-year event.



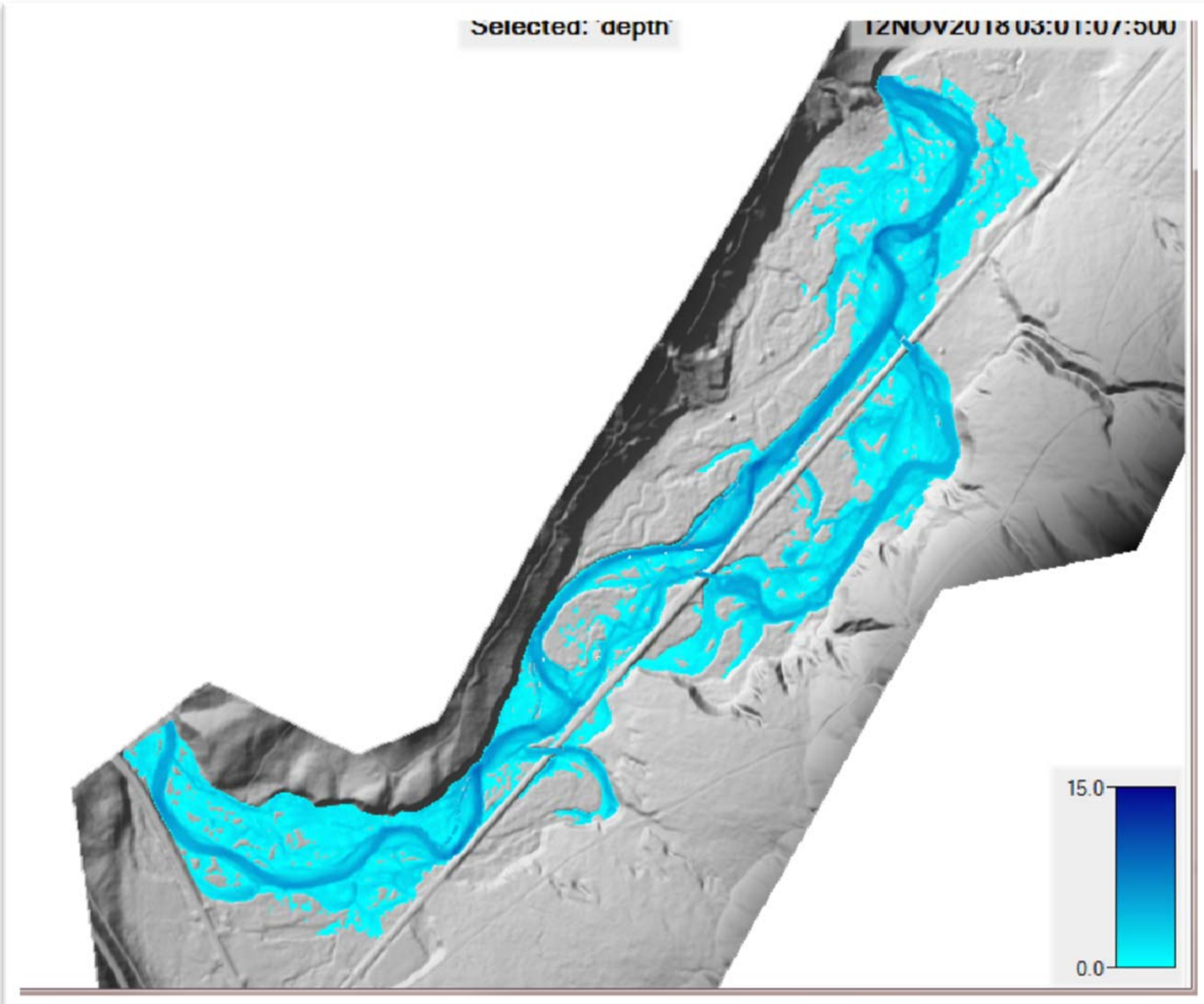
Alternative A conditions depth at 1.5-year event.



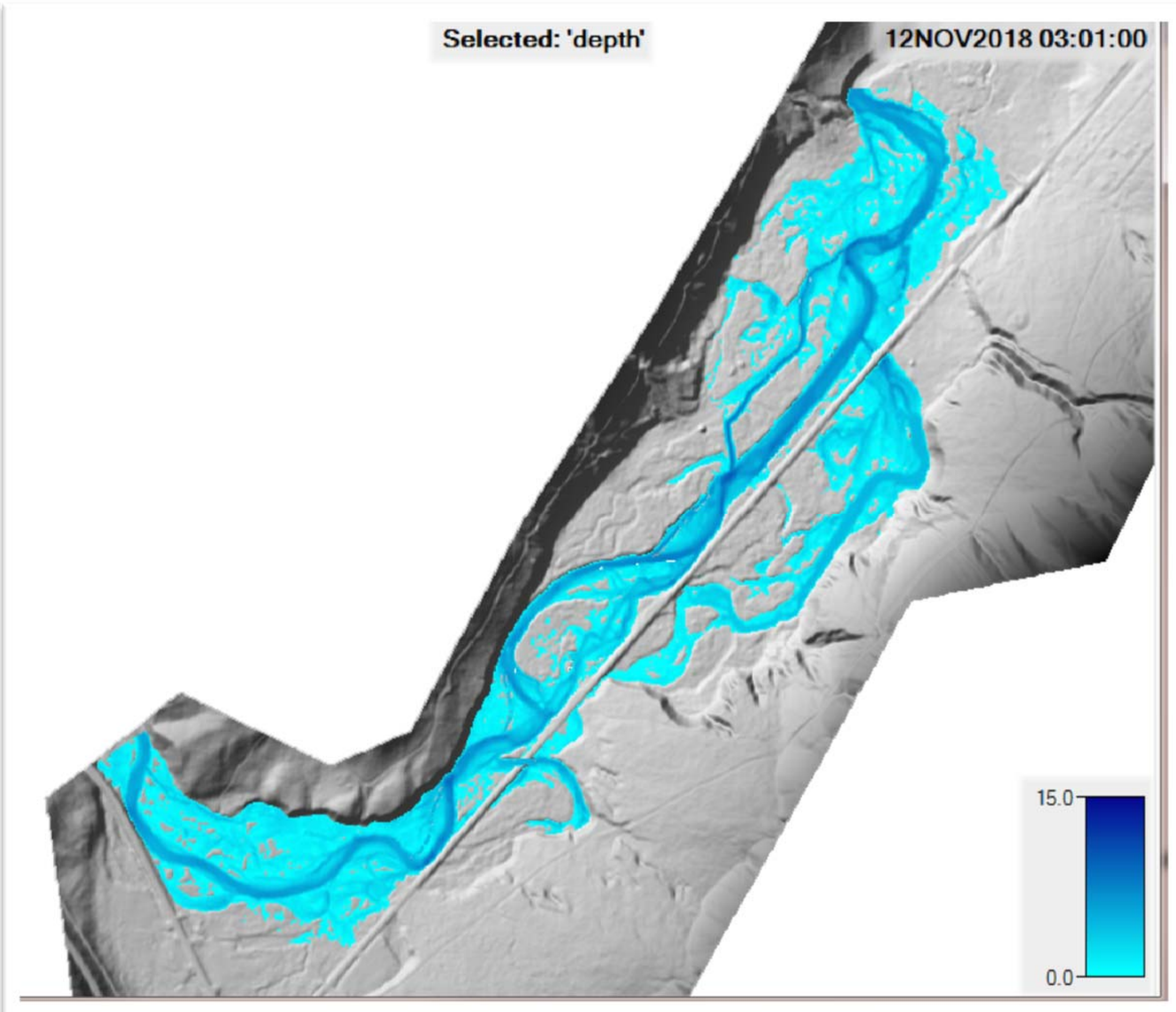
Alternative B conditions depth at 1.5-year event.



Existing conditions depth at 100-year event.



Alternative A conditions depth at 100-year event.



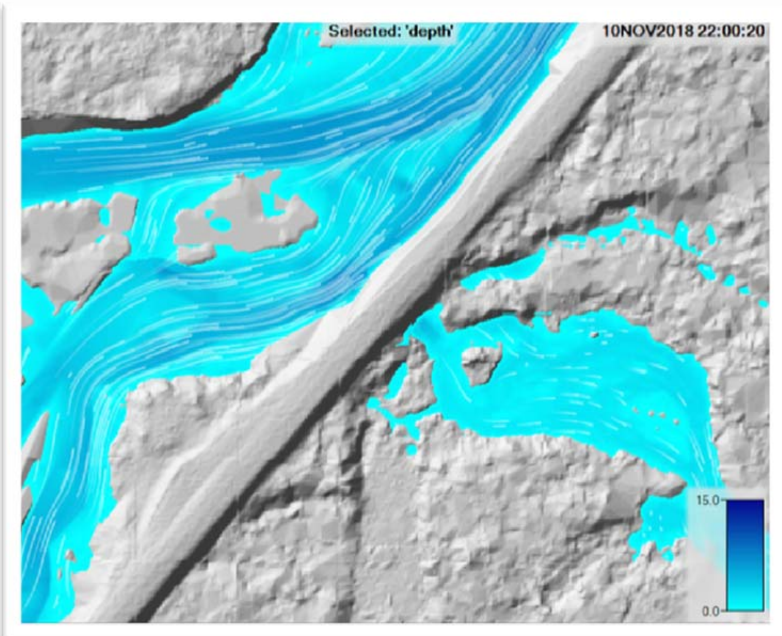
Alternative B conditions depth at 100-year event.

3.5.10 Model Findings

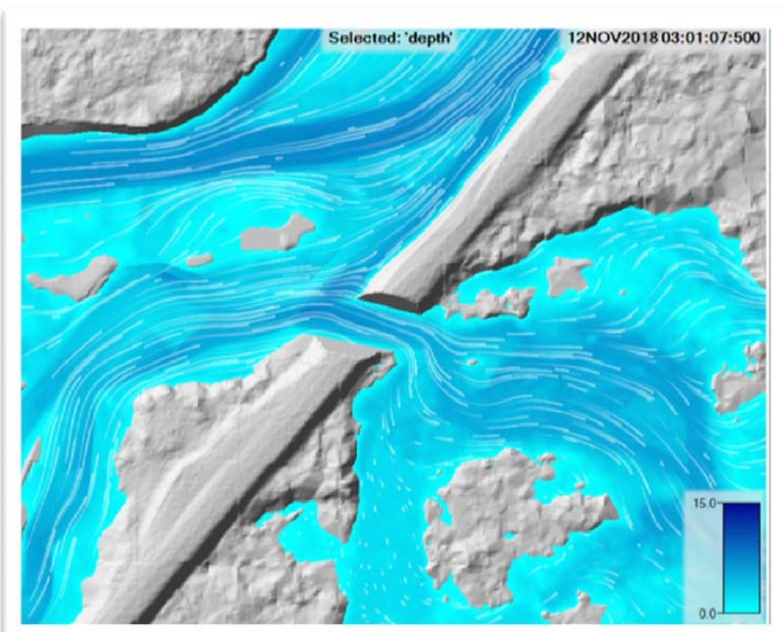
Model findings are preliminary, and the model will be updated and more analysis performed in future design phases. Model results at design phases will be used for design of LWM structures, road crossing structures and sediment mobility, bank resiliency and scour predictions.

Of note, the Alternative A bridges are shown in the model to be more effective at flow connection the flood plain east of Highway 207.

Flow path tracing for the 1.5-year event at the upstream proposed bridge:



Flow path tracing for the 1.5-year event at the upstream proposed bridge:



3.6 STABILITY ANALYSES AND COMPUTATIONS FOR PROJECT ELEMENTS, AND COMPREHENSIVE PROJECT PLAN

Detailed stability analysis and computations for project elements will be provided in subsequent design phases. Stability analysis and computations for project elements will follow professional practice guidelines for large wood design (Knutson et. al. 2014 and USBR/ERDC 2016), stream habitat restoration (Cramer 2012), and institutional knowledge combined with professional judgment for the design of specific project elements.

3.7 DESCRIPTION OF HOW PRECEDING TECHNICAL ANALYSIS HAS BEEN INCORPORATED INTO AND INTEGRATED WITH THE CONSTRUCTION – CONTRACT DOCUMENTATION

The preceding analysis is the basis for the alternatives described in the 15% design drawings. The drawings will be edited in future design phases to provide an engineering stamped construction drawing set with sufficient detail to allow contractors to bid and build the project.

3.8 FOR PROJECTS THAT ADDRESS PROFILE DISCONTINUITIES (GRADE STABILIZATION, SMALL DAM AND STRUCTURE REMOVALS): A LONGITUDINAL PROFILE OF THE STREAM CHANNEL THALWEG FOR 20 CHANNEL WIDTH UPSTREAM AND DOWNSTREAM OF THE STRUCTURE SHALL BE USED TO DETERMINE THE POTENTIAL FOR CHANNEL DEGRADATION

Not applicable to this project.

3.9 FOR PROJECTS THAT ADDRESS PROFILE DISCONTINUITIES (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) TO CHARACTERIZE THE CHANNEL MORPHOLOGY AND QUANTIFY THE STORED SEDIMENT

Not applicable to this project.

4. Construction – contract documentation

4.1 INCORPORATION OF HIPIII GENERAL AND CONSTRUCTION CONSERVATION MEASURES

General and construction conservation measures will be included in the stamped construction drawing set submittal at a later date.

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 BIDDING AND IMPLEMENTATION

To be included in future design phases after a preferred alternative is selected and brought to a more detailed design phase.

4.3 LIST OF ALL PROPOSED PROJECT MATERIALS AND QUANTITIES

To be included in future design phases.

4.4 DESCRIPTION OF BEST MANAGEMENT PRACTICES THAT WILL BE IMPLEMENTED AND IMPLEMENTATION RESOURCE PLANS INCLUDING:

To be included in future design phases after a preferred alternative is selected and brought to a more detailed design phase.

4.5 CALENDAR SCHEDULE FOR CONSTRUCTION/IMPLEMENTATION PROCEDURES

A construction timeframe has not been determined at this time.

4.6 SITE OR PROJECT SPECIFIC MONITORING TO SUPPORT POLLUTION PREVENTION AND/OR ABATEMENT

To be included in future design phases after a preferred alternative is selected and brought to a more detailed design phase. Standard erosion and pollution control measure will be shown and detailed in the stamped construction drawing set.

5. Monitoring and adaptive management plan

The monitoring and adaptive management plan will be determined at the discretion of Yakama Nation Fisheries in subsequent design phases.

6. References

Chelan County Natural Resources Department. May 8, 2012. Nason Creek River Mile 3.3-4.6 Feasibility Study.

Healey, M. C. 1991. Life history of chinook salmon (Oncorhynchus tshawytscha). Pages 313-393 IN: C. Groot and L. Margolis, Editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, Canada.

Hillman, T. W. and M. D. Miller. 1989. Seasonal habitat use and behavioral interaction of juvenile chinook salmon and steelhead. I: Daytime habitat selection. Pages 42-82 IN: Don Chapman Consultants, Inc. Summer and winter ecology of juvenile chinook salmon and steelhead trout in the Wenatchee River, Washington. Final report to Chelan County PUD. Wenatchee, Washington.

Malmon, D. 2010. Nason Creek Hydrology: Characterization of flow rates in the Lower White Pine Reach based on USGS and DOE stream gages. Technical Memo prepared by CH2M Hill for ICF International.

Moyle P. 2002. Salmon and Trout, Salmonidae – Rainbow Trout, (*Oncorhynchus mykiss*) *in* Inland Fishes of California. Los Angeles, California: University of California Press, 271-282.

Moyle P. 2002b. Salmon and Trout, Salmonidae - Chinook Salmon, (Oncorhynchus tshawytscha) in Inland Fishes of California. Los Angeles, California: University of California Press, 251-263.

Northwest Power and Conservation Council (NWPCC). 2004. Wenatchee Subbasin Plan. May 28, 2004. Pages 1-394.

Peven, C.M. 2003. Population structure, status and life histories of upper Columbia steelhead, spring and late-run chinook, sockeye, coho salmon, bull trout, westslope cutthroat trout, non-migratory rainbow trout, pacific lamprey, and sturgeon. Wenatchee, Washington.

Quinn T. 2005. The Behavior and Ecology of Pacific Salmon and Trout. American Fisheries Society in Association with University of Washington Press. Seattle, WA.

Upper Columbia Regional Technical Team (UCRTT). 2017. A Biological strategy to protect and restore salmonid habitat in Upper Columbia Region (revised). A Report to the Upper Columbia Salmon Recovery Board from the Upper Columbia Regional Technical Team.

Upper Columbia Salmon Recovery Board (UCSRB). 2007. Upper Columbia salmon and Steelhead recovery plan: Upper Columbia Salmon Recovery Board, Wenatchee, Washington, 300 pp. Web site: http://www.ucsrb.com/plan.asp.

U.S. Army Corps of Engineers. 2018. Hydrologic Engineering Center River Analysis System HEC-RAS, version 5.0.5.

U.S. Geologic Survey. 2016. Stream Stats online.