Upper Nason Creek Habitat Restoration

Conceptual Basis of Design Report

SUBMITTED TO
Confederated Tribes of the Yakama Nation

March 17, 2021

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Habitat Restoration Project

Conceptual Basis of Design Report

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Confederated Tribes and
Bands of the Yakama Nation
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March 17, 2021

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1. Preface

The Upper Nason Creek Habitat Restoration Project is located along Nason Creek between River Mile (RM) 13.7 and RM 16.3 in Chelan County, WA, along White Pine Road near Highway 2. The project reach is located on land owned by the United States Forest Service and one private landowner (Figure 1). Habitat conditions and geomorphic processes within the project area have been negatively impacted by historical logging within the watershed and the associated reduction of in-channel large wood structure and hydraulic roughness. The goal of the project is to improve instream and floodplain habitat conditions for adult and juvenile salmonids, while improving geomorphic conditions within the reach to restore natural habitat-forming processes.

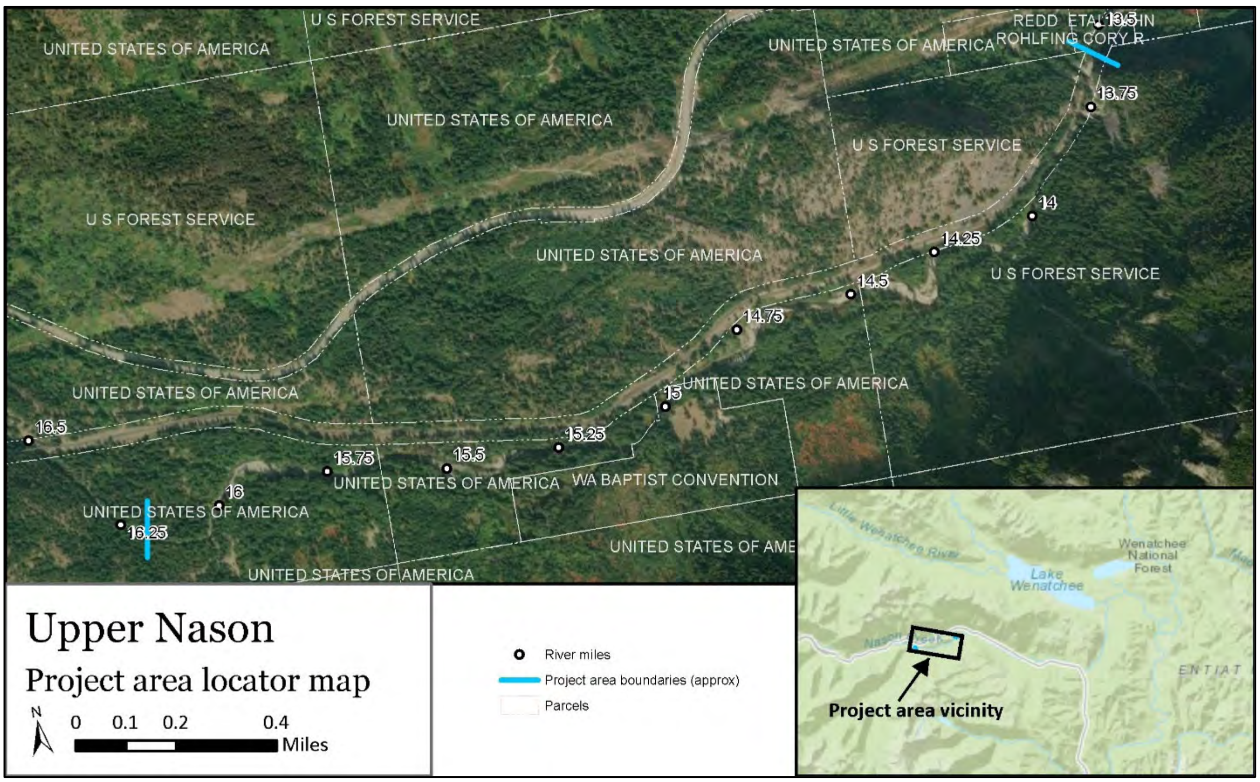


Figure 1. Upper Nason Creek project area locator map. Land ownership sourced from Chelan County GIS.

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 design project. Project elements include the following, with Bonneville Power Administration (BPA) Habitat Improvement Program (HIP) (2021) activity and risk category included (BPA, 2021):

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

Description of Proposed Enhancement	Work Element	HIP 2021 Category	HIP 2021 Risk Level
Large wood structure installation	Install habitat-forming natural material instream structures	2d	Medium
Side channel enhancement and beaver pond connector channel (pending field investigations)	Improve secondary channel and wetland habitats	2a	Medium
Revegetation of all disturbed surfaces	Riparian vegetation planting	2e	Low
Bed treatments and main channel re-route into historical alignment (pending field investigations)	Channel reconstruction	2f	Medium

1.3 IDENTIFICATION AND DESCRIPTION OF RISK TO INFRASTRUCTURE OR EXISTING RESOURCES

Infrastructure in the project vicinity includes the BNSF railroad embankment along river left and bridge, and Whitepine Creek road and bridge. Both bridges are located downstream of the project site near RM 13.75. There are several dispersed campsites, a 5.3’ span x 3.2’ rise metal culvert located on an unnamed tributary in the river right floodplain, and the Cascade Meadows Baptist Camp (Figure 2). There is a second vehicle bridge on USFS Road 6950500 crossing Upper White Pine Creek, approximately 300 feet above the confluence of White Pine Creek and Nason Creek. This bridge will not be affected by the project. Project features are not proposed for locations near any of these assets, and risk to infrastructure is considered to be low. Risk will continue to be evaluated as the designs progress through the design process. Large wood structure design will take potential risk to infrastructure into consideration.

A river recreational survey commissioned by the Yakama Nation Upper Columbia Habitat Restoration Program was completed by MIG in a 2013 report. In summary, 1) recreational use is low at the project site relative to other rivers in the area and the users that do use the reach are typically well-trained and experienced in complex channels; and 2) recreational users in Nason Creek are already accustomed to large wood in the channel, especially along the margins on the outside of bends.

Figure 2. Infrastructure within the project area vicinity includes (A) bridge on FS Road6950500over Whitepine Creek, (B) BNSF railroad grade and tracks which is an active rail line, and (C) a 5.3' span x 3.2' rise CMP culvert with substrate placed in invert located south of Nason Creek approximately 1,000 feet upstream long an unnamed tributary crossing of USFS Road located near the upstream end of the project reach.

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 include ESA-listed spring Chinook (endangered), steelhead (threatened), Bull Trout (*Salvelinus confluentus*, threatened), species-of-concern Pacific Lamprey (*Lampetra tridentate*), and non-listed westslope cutthroat trout (*O. clarkii*), summer Chinook, Coho Salmon (*O. kisutch*), mountain whitefish (*Prosopium williamsoni*), and non-native brook trout (*Salvelinus fontinalis*).

Past redd counts conducted from 2003 to 2017 show high Chinook Salmon redd densities within the project area, with low to moderate use by steelhead (Figure 3; UCSRB, 2017). Note that steelhead redd surveys are conducted during relatively high flow which is expected to under-represent the true number of steelhead redds to a greater degree than Chinook Salmon. The project reach upstream of RM 15 is higher gradient (~0.01 feet per foot) with larger substrate and lower spawning habitat quality, while areas downstream of RM 15 contain more suitable spawning gravels and a lower channel gradient (~0.006 feet per foot). Chinook redds were observed during on-site investigations (Figure 4).

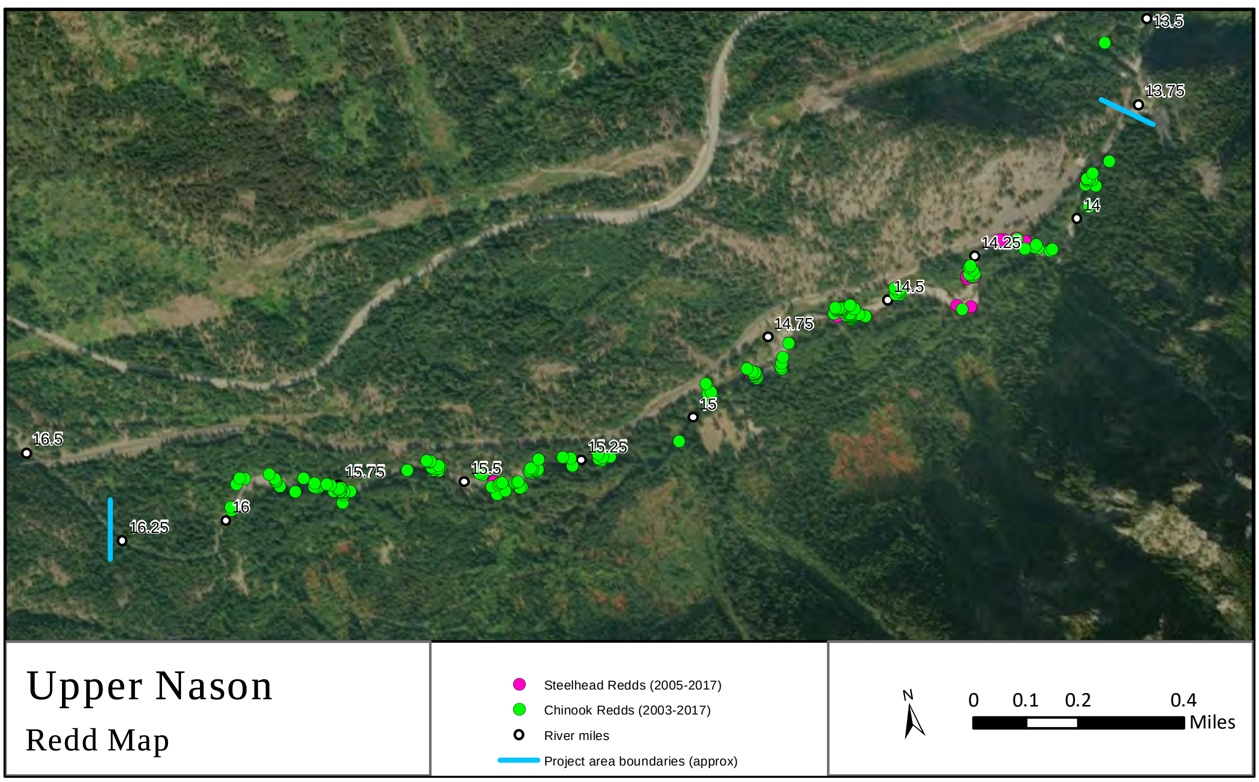


Figure 3. Steelhead and spring Chinook redds recorded in the project area (point data from UCSRB, 2018).

Figure 4. Spawning gravel are most prevalent downstream of RM 15, where channel gradient is lower. This image shows a Chinook redd observed near downstream end of the project area during the site reconnaissance walk.

Summary of life-history timing for aquatic species are presented below (Figure 5). Detailed descriptions of habitat requirements by life stage for anadromous and 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, 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 & Miller., 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 & Miller, 1989; Healy, 1991).

As they increase in size, juveniles begin to select for deeper and faster moving water, particularly areas with overhanging cover (Moyle, 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).

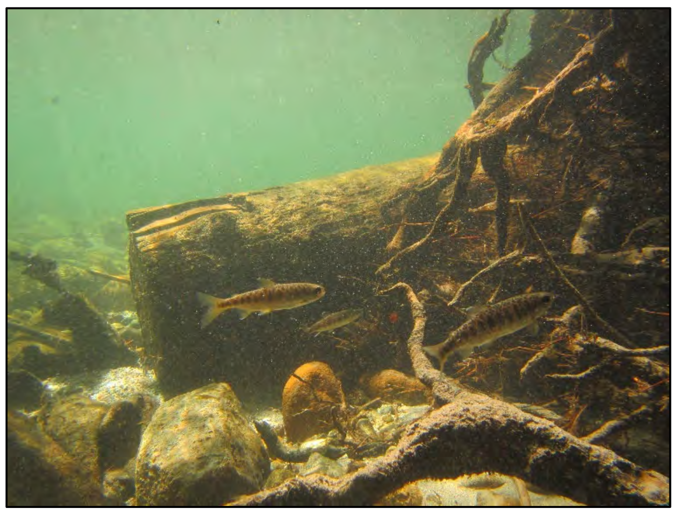


Figure 6. Chinook Salmon parr resting behind a constructed log jam in the Entiat River between feeding forays.

1.4.3 Bull trout

Nason Creek supports a population of resident and fluvial bull trout (NWPCC, 2004). Redd data from UCSRB shows only one recorded redd within the project area near RM 15.5. 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).

1.4.4 Coho salmon

Coho salmon were extirpated from the Upper Columbia River and tributaries, and current Coho populations in the basin are un-listed fish that are the result of re-introduction efforts by Yakama Nation Fisheries. Coho Salmon enter the Wenatchee River in September and October, with spawning occurring in October and November. Fry emerge from the gravel between March and May. Juveniles are present in freshwater year-round, and therefore rear during both summer low flow and winter high flow conditions. Juvenile Coho are poor swimmers relative to other salmonids, and respond to increased water velocities during high flow periods by moving to the nearest available low-velocity habitats, including beaver ponds and off-channel alcoves (McMahon & Hartman, 1989; Swales & Levings, 1989; Bustard & Narver, 1975; Bryant, 1984). Coho outmigrate from the system in the spring.

1.4.5 Pacific lamprey

Adult upstream migration of Pacific Lamprey in the Lower Willamette River occurs in August, with spawning occurring the following June and July. Spawning in other Columbia Basin tributaries generally occurs at temperatures between 10-15°C. Preferred spawning habitat is in low gradient runs and pool tail-outs with gravel substrate and ammocoete habitat nearby. Hatching date varies according to water temperature and is typically around 15 days after spawning. Ammocetes, the larval stage of the lamprey, spend 15 days in the redd after hatching before drifting downstream to suitable rearing habitats. Rearing habitat typically consists of low gradient areas with low water velocity, soft substrate, and organic material. Ammocetes can rear in freshwater for up to 7 years, during which time they filter feed on diatoms and suspended organic material. Juvenile downstream migration occurs from February through June, peaking in the spring. Ammocoetes metamorphose into macropthalmia (adult stage) during this outmigration, similar to smoltification in salmonids (CRITFC, 2011).

1.4.6 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* (UCRTT, 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 Upper Nason project area falls within the Nason Creek Assessment Unit. Nason Creek is a Tier 1 watershed of highest priority for both protection and restoration.

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-buried large wood structure:** These structures are sited on outsides of bends and are designed to provide overhead cover and promote pool-scour over the long-term. These structures are ballasted with both piles and cobble/gravel/fines backfill. Deep-rooted plants will be incorporated into the structure to facilitate revegetation of the structure footprint and add a stabilizing influence to the structure.
- **Apex structure**: Apex large wood structures are intended to sort sediments, rack mobile wood, and promote split-flow conditions. These structures are sited adjacent to existing side channels or low swales in the floodplain, or in proximity to river banks that have mature trees at the edge. Structures sited next to swales and side channels are intended to push flow into those features so they are wetted more frequently, while structures sited next to banks are intended to encourage large wood recruitment into the river from the banks. Both uses of the structure reduce instream velocity and sort sediments. Apex structures are ballasted with piles and cobble backfill; slash is placed beneath exposed rootwads along the upstream face of the structure to add complexity. Deep-rooted plants will be incorporated into the structure to facilitate revegetation of the structure footprint and add a stabilizing influence to the structure.
- **Colluvial structure**: This structure type mimics a natural landslide (Figure 7) and is incorporated at the upstream end of the site. The structure is intended obstruct a large portion of the existing main channel and re-direct some percentage of streamflow into the side channel complex to the north. The structure is stabilized with cobble and earthen backfill, partially-buried key members, and piles. The desired porosity of the

structure to maintain some flow along the existing main stem will be determined in a future phase.

Figure 7. Avalanching on a recently burned hillslope in the upper Methow caused woody material to inundate the channel. The colluvial jams proposed for this project are intended to achieve a similar function, mimicking the mass wasting and avalanching present in the project reach. A key difference is that the structures will used to activate relic floodplain channels, splitting flow between the active relic channels.

- **Habitat/cover structure**: These structures are designed to provide a high level of overhead cover in existing pools or bank areas that lack overhead cover or margin habitat. Vertical logs and backfill will be utilized to provide stability. Whole trees and slash will be incorporated to provide interstitial habitat. For these structures to be successful, the channel bed in the bottom of the pool needs to be erodible such that scouring flows can maintain the pool structure. Else, the pool may fill in as the river moves away from the increase in roughness. The two sites proposed for this treatment will be field verified at a later date.
- **Large whole trees:** Large whole trees are proposed within the beaver dam complex to provide habitat and increase roughness. Placing a channel spanning log structure on the main stem is proposed to enhance moderate to high flows along a depression through the south floodplain. The structure will route more water into this complex, and whole trees placed in the existing ponds would provide additional habitat structure and roughness to slow flowing waters. Access into the beaver dam complex with heavy machinery may not be feasible due to soft ground and beaver ponds, and these trees would be installed by tipping existing standing trees or placed via helicopter.
- **Bar roughness:** Bar roughness structures are designed to increase roughness on existing gravel bars within the project reach to retain mobile fine sediments and support

vegetation growth and bar stability by creating low velocity zones. Willow baffles would be constructed by installing live willow cuttings in trenches accessing groundwater along the slack-water zone in the lee of these structures.

- **Channel spanning structure:** This structure is proposed downstream of the inlet to the beaver pond connector channel. Large trees that are currently growing along the top of bank would be tipped into Nason Creek and augmented with imported wood to create a partial channel obstruction and encourage flow into the adjacent floodplain. The structure is intended to be porous, allowing a portion of the flow to continue down the existing active channel (e.g., Figure 8).

Figure 8. The depicted in situ wood jam, located downstream on Nason Creek near Coles Corner provides a natural analog of a wood structure splitting flow between two active channels.

- **Main-channel re-route:** The main channel of Nason Creek upstream of the confluence with Whitepine Creek is plane-bed, lined with large cobble and boulder, and contains low levels of habitat and complexity. An existing channel network located in the north floodplain contains higher levels of complexity, a relatively large floodplain, and is located along a steep valley wall where bedrock presumably forces subsurface flows to the surface. Re-locating the channel into this new alignment is expected to increase complexity, activate additional habitats and potentially take advantage of subsurface flow inputs into the channel which could provide a thermal buffer during the summer and winter. This concept requires field investigation to understand opportunities and constraints.
- **Bed treatment**: This bed treatment is proposed along existing main stem of Nason Creek from the proposed colluvial jam at the upstream end of the project to

approximately 750 feet downstream of the confluence with White Pine Creek. The colluvial jam will divert the majority of the flow into the proposed main channel alignment, inundating the low surfaces and swale complex below. With reduced flows, the existing channel will be overwidened. The intent of this treatment is to narrow the existing channel to dimensions more aligned with the reduced flows. This bed treatment includes using a dig-and-pitch approach where gravel from the streambed will be excavated where the thalweg will be located, and placed along the inside bend of the river to partially occlude the channel and create a gravel bar. Small wood structures and whole trees will be used to add complexity to the altered alignment.

- **Side channel enhancement**: Side channel enhancement is proposed in a number of locations throughout the project reach in historical channel alignments visible in the LiDAR data. These side channels require field investigation to determine opportunities and constraints. Side channels will be activated more frequently through a combination of large wood placement in the main channel to push flows into the side channels and selective grading within the alignments. The level of grading needed to increase activation is expected to be minimal and will be refined in future design phases. Perennial through flow and avoidance of fish stranding will be addressed at the preliminary design phase.
- **Willow baffle**: Willow baffles consist of willows and slash placed in a trench, dug to groundwater level that is backfilled after stakes are installed. The result is a line of semi-rigid slash approximately perpendicular to flow that will provide hydraulic roughness while the willows grow and mature. Willow baffles are proposed on exposed gravel bars downstream of bar roughness wood structures to increase roughness and gravel bar stability. These features will aid in storage of fine sediments and provide velocity refuge during elevated flow levels, such as spring runoff. Establishing a riparian plant community on presently bare gravel bars will add cover, canopy, flow complexity and organic and forage inputs.

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, backfill, placement of large woody material and temporary access routes used to install the large wood structures and create the side channels and bed treatments. Channel fill will occur in association with areas selected for bed treatment. Log structures will be installed by excavation to subgrade, placement of large wood and alluvial backfill. 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. All disturbed areas will be covered with slash and 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 have been negatively impacted by logging within the watershed, which has reduced large wood recruitment to this reach and resulted is less large wood than historically would have existed. Large wood density in this reach is estimated to be around 10% of historical levels (Natural Systems Design, 2019), and has resulted in decrease habitat diversity, off-channel and floodplain habitat connectivity, and instream structure. The decreased large wood and associated roughness it provides also leads to increased shear stress in the channel, which results in coarsening of bed substrate and can lead to incision and floodplain disconnection. In the few locations where large wood is present within the active channel, it has led to gravel sorting, pool scour, and sediment storage (Figure 9).

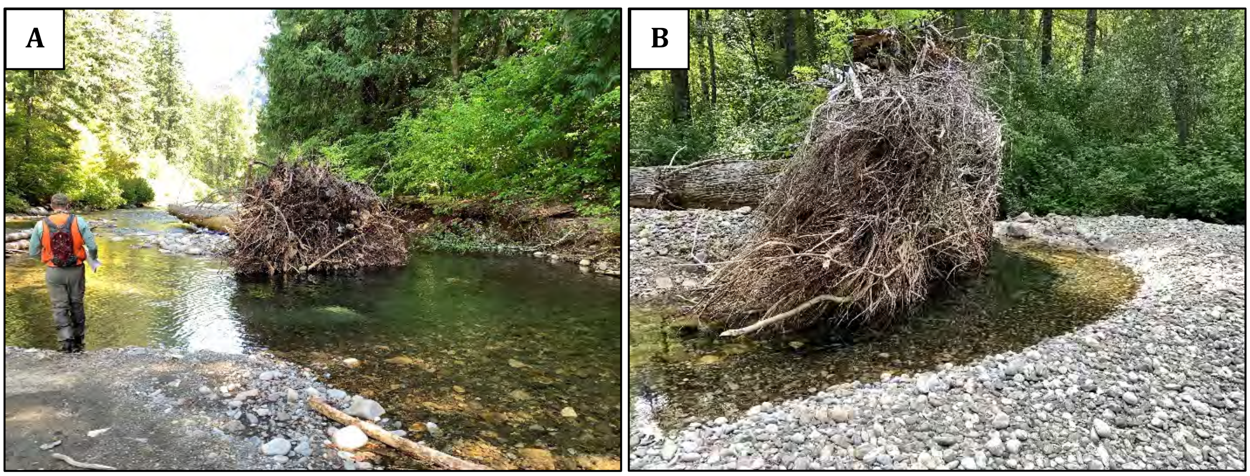


Figure 9. Large whole trees, where present, have a large impact on channel bedform in the reach. A) Whole tree within the active channel that had a scour pool at the upstream end and is wetted at low-flow. B) Side-view of a large tree on a gravel bar showing horseshoe-shaped scour pool at upstream end and gravel deposition at downstream end.

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

Nason Creek within the project reach is a single-thread pool-riffle channel with a slope that decreases in the downstream direction from ~1.1% to ~0.6%. The reduced volume of instream wood and lack of stable in-stream structures has promoted the single-thread channel planform (Natural Systems Design, 2019). Other features on the landscape that confine the channel have also led to this simplified channel type. Alluvial fans associated with Whitepine Creek and the Cascade Camp naturally confine the Nason Creek channel to the northern portion of the valley (Figure 10). Historical channel scars are prevalent in areas where the floodplain is wider. The BNSF railroad is located on the northern hillslope, and runs alongside the river outside of the active floodplain in several locations along the reach. The northern hillslope naturally confines the channel between RM 13.7 and 14.0 (Figure 10).

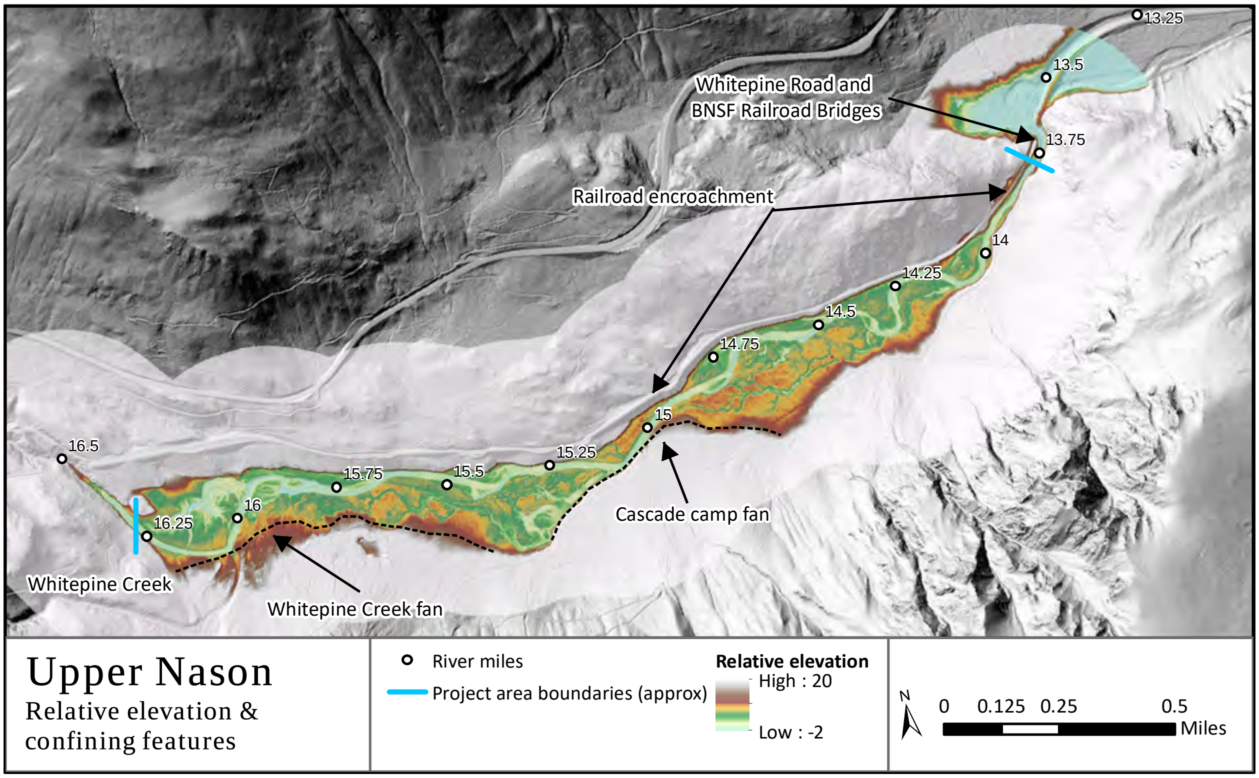


Figure 10. Relative elevation map of the project reach with features labeled that confine the channel (naturally or anthropogenically) in different locations.

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 western red cedar (*Thuja plicata*), black cottonwood (*Populus trichocarpa*), douglas fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), and Engelmann spruce (*Picea engelmanii*). 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 (Figure 11). Species include red osier dogwood (*Cornus sericea*), red alder (*Alnus rubra*), and willow (*Salix spp*) (Natural Systems Design, 2019). Wetlands have not yet been delineated.

Figure 11. Typical riparian conditions throughout the reach, showing willows and deciduous shrubs close to the active channel and conifer overstory occurring at slightly higher elevations.

2.5 DESCRIPTION OF LATERAL CONNECTIVITY TO FLOODPLAIN AND HISTORICAL FLOODPLAIN IMPACTS

Lateral connectivity in the project reach has primarily been controlled by mass wasting, wildfire, snow avalanches, and historical logging activities. Whitepine Creek Road and the railroad encroach on the floodplain, but have only a slight influence as the features are mostly situated along the floodplain margin. Alluvial fans from unnamed drainages entering from the southern side of the valley intermittently confine the channel and have pushed it to the north. Lacking in channel large trees and other roughness elements to slow the export of sediment from the reach, the channel has straightened (sinuosity ~1.1), incised and disconnected from remaining floodplain surfaces, upstream of the large fan on the Cascade Meadows Camp (near RM 15). Low floodplain surfaces adjacent to the channel show a complex network of relic channels and have a wandering planform (*sensu* Church, 2002). Preliminary hydraulic model results suggest that adjacent floodplain surfaces inundate around the 2- to 5-year return period peak flow. Despite the disconnectivity of the adjacent surfaces, a complex of beaver ponds has persisted upstream of the prominent fan. Discharge out of the ponds at the time of the field visit was low and visually estimated at about 1 cubic feet per second (cfs). Presumably, the majority of the water in the ponds is sourced from adjacent hillslopes to the south. Fish usage of the ponds is unknown, with passage into and out of the ponds likely limited to high flow periods.

Below the prominent fan near RM 15, the gradient is generally lower (~0.5%) and the channel becomes more sinuous (sinuosity ~1.4). Few pieces of large wood are in the active channel, which is dominated by large lateral and point bars. Similar to the upstream portion of the project area, the overbank areas show complex network of relic channels, in a wandering planform.

During longer periods of time without disturbances, Nason Creek historically had high floodplain connectivity, forced by wood accumulations, containing a myriad of off-channel wetlands, alcoves, and channels. Closer in time to disturbance events, mass wasting on adjacent hillslopes, avalanches would have periodically delivered large quantities of sediment and wood to the channel. This may have resulted in periods of time with relatively simple channel alignments as Nason Creek worked to process the sudden influx of bedload. Current conditions exhibit relatively low levels of floodplain connectivity than would have periodically existed historically, due to the lower density of large wood and associated roughness, which has led to channel incision and promoted a single-thread, simplified planform.

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 HIP 2021 SPECIFIC ACTIVITY CONSERVATION MEASURES FOR ALL INCLUDED PROJECT ELEMENTS

HIP 2021 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 September and October 2020 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. A rapid survey was performed to capture select cross sections at key hydraulic controls and geomorphic features (e.g., tops and bottoms of riffles, apex of bends, pools, relic channel inlet elevations, etc.) for use in design development. Survey was conducted by wading and collected data necessary for conceptual level analyses and designs. Collected data was used to develop design features and as a check against the 2015 and 2018 LiDAR datasets. 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

Geomorphic data primarily consisted of observations regarding: changes in grain sizes between adjacent hydrogeomorphic features and from the upstream end to the downstream end of the project reach; measured elevations of key surfaces and hydraulic controls; and, wood size and distribution. See section 3.4.

3.2.4 Hydrology data

Washington Department of Ecology (WDOE) records 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 solely for estimating flood peak flows. The WDOE gage does provide useful information on seasonal flow variation during the available period of record.

The USGS maintains a stream flow gage on nearby Icicle Creek (USGS Gage #12458000) which has a period of record from 1937 to present. The Icicle Creek watershed has many similarities to the Nason Creek watershed and is viable as a paired watershed to understand Nason Creek hydrology. The Icicle Creek data was used for paired watershed analyses for a number of studies including the U.S. Bureau of Reclamation Nason Creek Tributary Assessment (Reclamation, 2008).

No field flow measurements were collected for this conceptual analysis.

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. Within the project area, Whitepine Creek and Nason Creek contribute nearly equal amounts of flow based on StreamStats analyses. Figure 12 shows modeled median, high, and low exceedance flows for Nason Creek at RM 13.

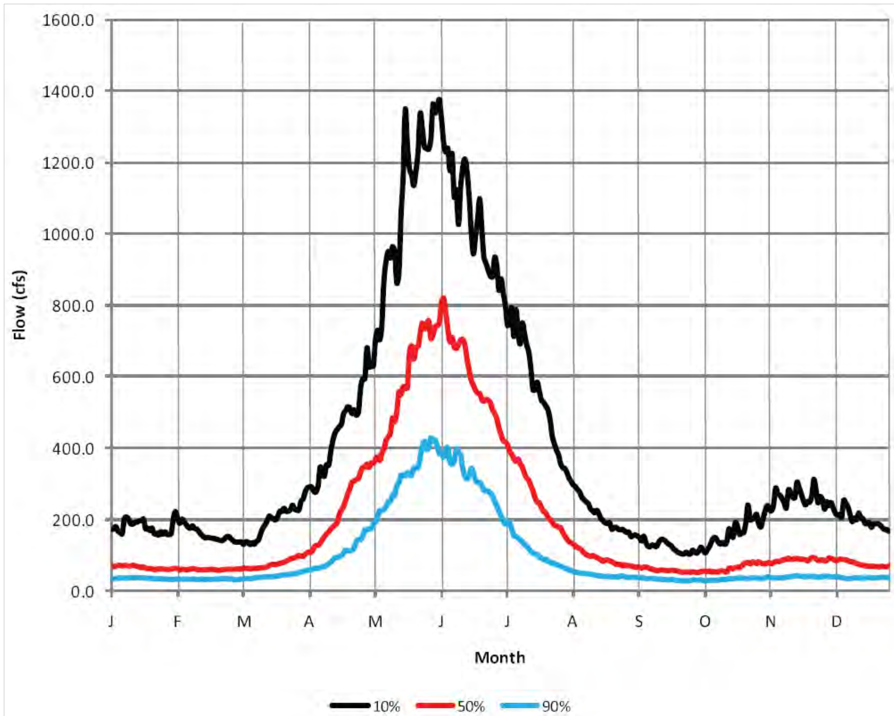


Figure 12. Modeled 10 percent, 50 percent, and 90 percent exceedance flows for RM 13 using data from 7 regional gages. Percentile flows represent the daily flow that is equaled or exceeded for the given percentage of time over the available period of record. Reprinted from Malmon (2010).

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 1959, November 1990, November 1995, and November 2006.

3.3.2 Peak Flow Hydrology

As noted above, data from the Washington Department of Ecology gage 45J070 near the mouth of Nason Creek has data since 2002. No long-term stream gage record is available on Nason to reliably estimate peak flows for the project reach. More detailed hydrologic analyses were completed by Inter-Fluve for the Upper White Pine Reach 2 project near RM 13.0 of Nason Creek using data from the DOE gage and the USGS Icicle Creek gage #12458000. The Icicle drainage has many similarities to Nason Creek and the gage has an extensive period of record. Predicted flows for the Upper White Pine Reach 2 project on Nason Creek near RM 13.5 project are used for this conceptual analysis as summarized in Table 2.

Table 2. Peak flow estimates for Nason Creek near BNSF Railroad bridge

Recurrence Interval (years)	Estimated flow at RM 13 (cfs)
2	**1,700**
10	**2,600**
25	**4,500**
50	**5,500**
100	**6,700**

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

Visual estimates of grain size distributions were made during a site visit in August/September, 2020 to aid in geomorphic process interpretations for the project area. This information was then used to develop a concept design. A detailed investigation of mobile sediments delivered to, sourced within, and evacuated from the project area will need to accompany future design phases.

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

3.5.1 Hydraulic Modeling

A two-dimensional (2D) hydraulic model was developed for the Nason Floodplain project reach in the U.S. Army Corps of Engineers HEC-RAS 5.0.7 software (USACE, 2019). HEC-RAS computes hydraulic properties related to the physical processes governing water flow through natural rivers and other channels. Model runs were developed for both existing and proposed conditions to assess the current and proposed channel dynamics, as well as assess the overall impacts of a wide range of flows on the existing landscape with and without the proposed design improvements.

The following sections describe the capabilities and limitations of HEC-RAS 5.0.7 and document the development and output processing of the project existing and proposed conditions models.

3.5.2 Model Capabilities and Limitations

HEC-RAS 5.0.7 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 channel constriction acting as a hydraulic control near RM 14.25. The upstream extent is about 1000 feet upstream of the confluence of Whitepine Creek with Nason Creek. The model coverage extends the full width of the valley bottom, encompassing the channel and floodplain.

3.5.4 Model Terrain

The existing conditions model terrain was developed from 2018 LiDAR data downloaded from the Washington Department of Natural Resources LiDAR portal. 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.

The proposed condition model terrains were copied from the existing conditions terrain and modified to incorporate the large wood structures 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 20-ft square computational mesh for the entire area of interest. Although the typical computation mesh size was greater than the terrain resolution, the modeling capabilities of HEC-RAS 5.0.7 integrates the sub-grid terrain into the computations and projects the results accordingly. The model domain and existing conditions mesh are shown in Figure 13.

3.5.6 Model Roughness

Roughness coefficients (Manning's n values) are used in 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 land surface conditions. Roughness coefficients were modified in the proposed conditions model 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 regions and values were defined as shown in Figure 13.

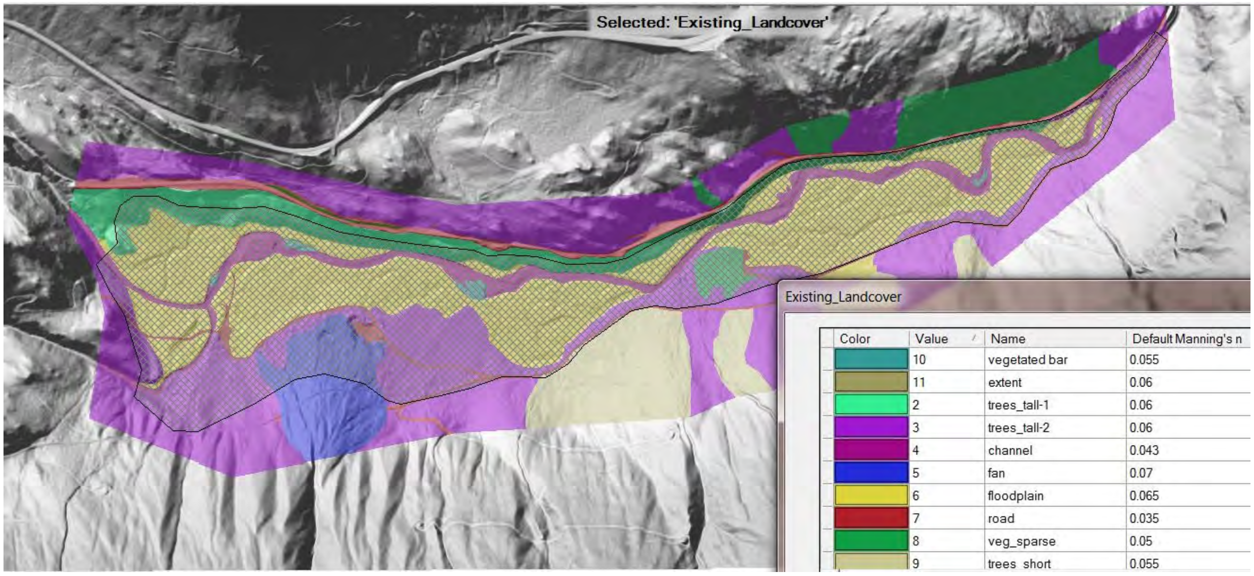


Figure 13. Existing conditions model mesh, Manning's n regions and values.

3.5.7 Model Discharges

The modeled discharges of interest included 2-, 10-, 25-, 50-, and 100-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: 33-, 48-, 332-, 637-, 800-, and 1400-cfs. StreamStats analyses of White Pine Creek and Nason Creek above the confluence with White Pine Creek were completed and indicated that nearly identical flows are generated by both streams to the confluence. Thus, the total flow was split evenly for inflow hydrographs to White Pine Creek and Nason Creek above the confluence. 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 similar to that shown in Figure 14. 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.

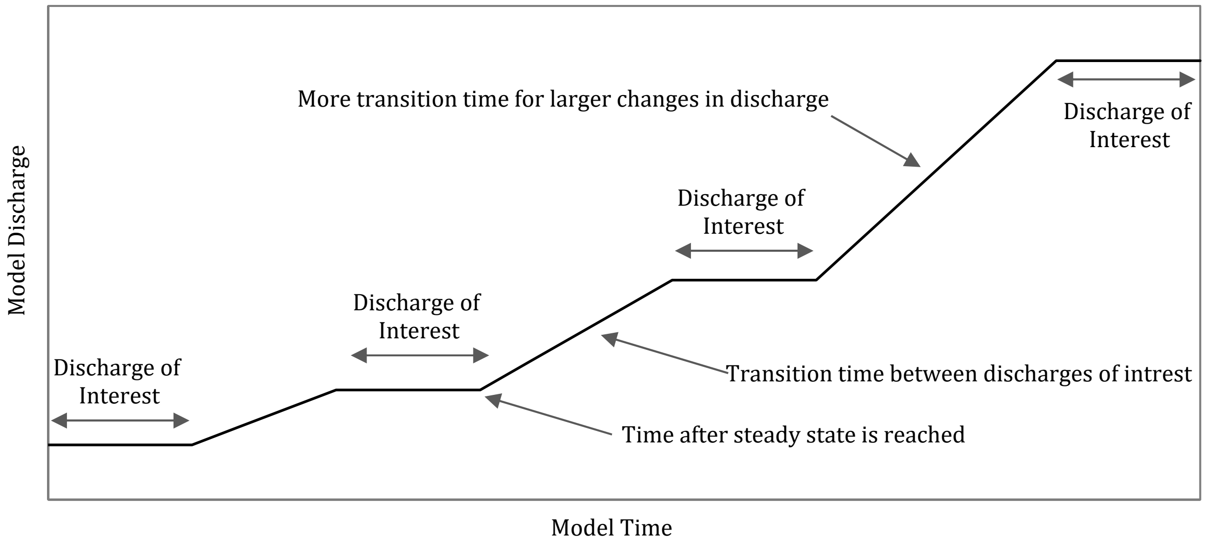


Figure 14. Stepped hydrograph example.

3.5.8 Model Boundary Conditions

HEC-RAS 5.0.7 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 conditions for Nason Creek and White Pine Creek above their confluence. The flow was initially distributed across the stream channel assuming normal flow depth at an assumed friction slope of 0.005 feet per foot. The downstream boundary condition assumed normal flow depth along the stream channel based on an assumed friction slope of 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 5.0.7 was used to generate results in the form of raster data sets at the discharges of interest. Model output graphics for computational mesh, Manning's n coverage, water depths for the entire modeled domain and velocities for the project area are included in Appendix B for existing conditions. Appendix C includes similar graphics for proposed conditions.

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, sediment mobility, bank resiliency and scour predictions.

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 & Fealko, 2014; Reclamation & ERDC, 2016), stream habitat restoration, 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 conceptual 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 HIP 2021 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.

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.

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

Arcement, G.J. and V.R. Schneider. 1989. Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains. USGS. Water-Supply Paper 2339.

Bonneville Power Administration (BPA). 2021. FY 2021 HIP Handbook. Guidance of Programmatic Requirements and Process. DRAFT.

Bryant, M.D. 1984. The role of beaver dams as coho salmon habitat in southeast Alaska streams, p. 183-192 In J.M. Walton, and D.B. Houston [ed.] Proceedings of the Olympic Wild Fish Conference, March 23-25, 1983, Port Angeles, WA.

Bustard, D.R. and D.W. Narver. 1975a. Aspects of the winter ecology of juvenile coho salmon (Oncorhynchus kisutch) and steelhead trout (Salmo gairdneri). J. Fish. Res. Board Can. 32: 667-680.

Church, M. 2002. Geomorphic thresholds in riverine landscapes. Freshwater Biology, 47: 541-557.

Columbia River Inter-Tribal Fish Commission (CRTIFC). 2011. *Tribal Pacific Lamprey Restoration Plan for the Columbia River Basin.*

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.

Inter-Fluve, Inc. 2017. Nason Creek Upper White Pine Subreach 2 (RM 13.3-13.8) Basis of Design Report – 100%.

Knutson, M. and J. Fealko. 2014. Pacific Northwest Region Resource & Technical Services Large Woody Material Risk Based Design Guidelines. U.S. Department of the Interior. Bureau of Reclamation. Pacific Northwest Region. Boise, ID.

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.

McMahon, T.E. and G.F. Hartman. 1989. Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon (Oncorhynchus kisutch). Can. J. Fish. Aquat. Sci. 46: 1551-1557.

McPhail, J. and J. Baxter. 1996. A review of bull trout (Salvelinus confluentus) life-history and habitat use in relation to compensation and improvement opportunities. Fisheries Management Report No. 104, 35 p.

MIG. 2013. Nason Creek Recreation And Large Wood Assessment for the Yakama Nation UCHRP.

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.

Natural Systems Design. 2019. Upper Nason Creek Reach Assessment – Habitat conditions and restoration opportunities from RM 13.7 to RM 16.2. Prepared for Yakama Nation Fisheries.

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.

Swales, S., and C.D. Levings. 1989. Role of off-channel ponds in the life cycle of coho salmon (Oncorhynchus kisutch) and other juvenile salmonids in the Coldwater River, British Columbia. Can. J. Fish. Aquat. Sci. 46: 232-242.

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.

Reclamation. 2008. Nason Creek Tributary Assessment. U.S. Department of the Interior. Bureau of Reclamation.

Reclamation and U.S. Army Engineer Research and Development Center (ERDC). 2016. National Large Wood Manual: Assessment, Planning, Design, and Maintenance of Large Wood in Fluvial Ecosystems: Restoring Process, Function, and Structure.

United States Fish and Wildlife Service. 1995. Working Paper on Restoration Needs: Habitat Restoration Actions to Double Natural Production of Anadromous Fish in the Central Valley of California. Vol 2. Stockton, CA: Prepared for the U.S. Fish and Wildlife Service under the direction of the Anadromous Fish Restoration Program Core Group.

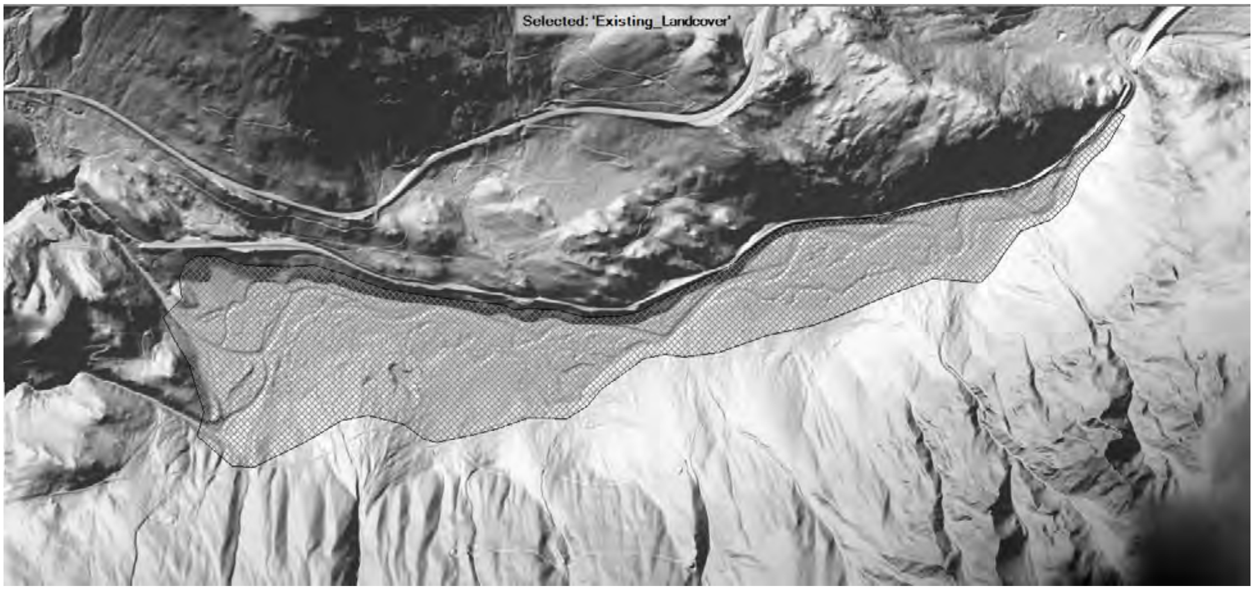
U.S. Geologic Survey. 2016. Stream Stats online.

Appendix A – Concept Drawings

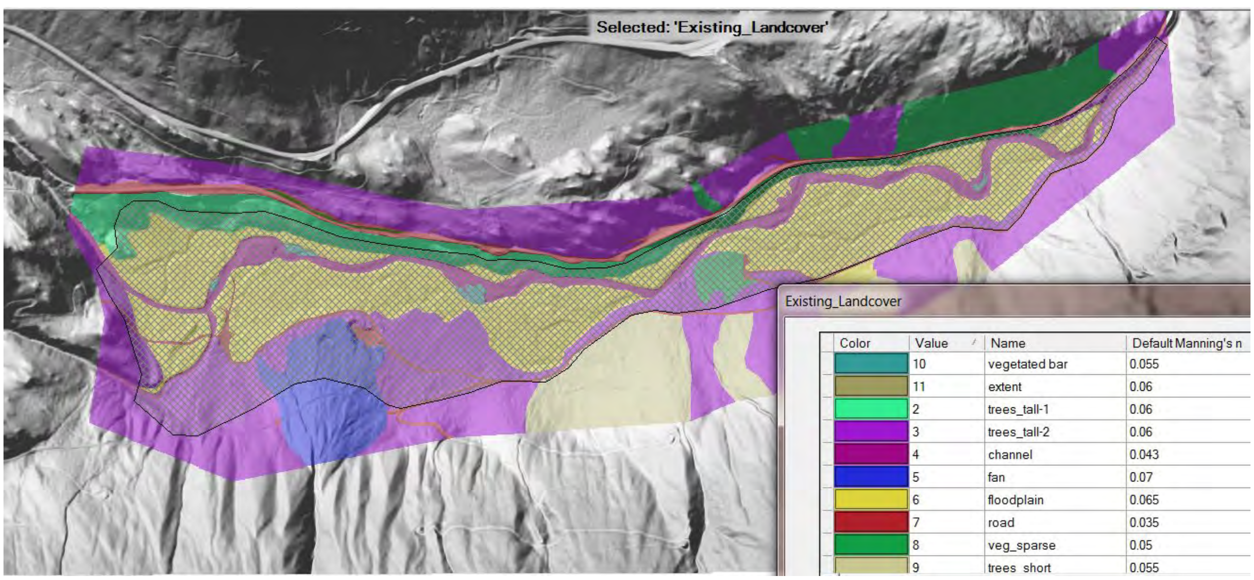
(See attached Plans)

Appendix B – Existing Conditions Hydraulic Model Results

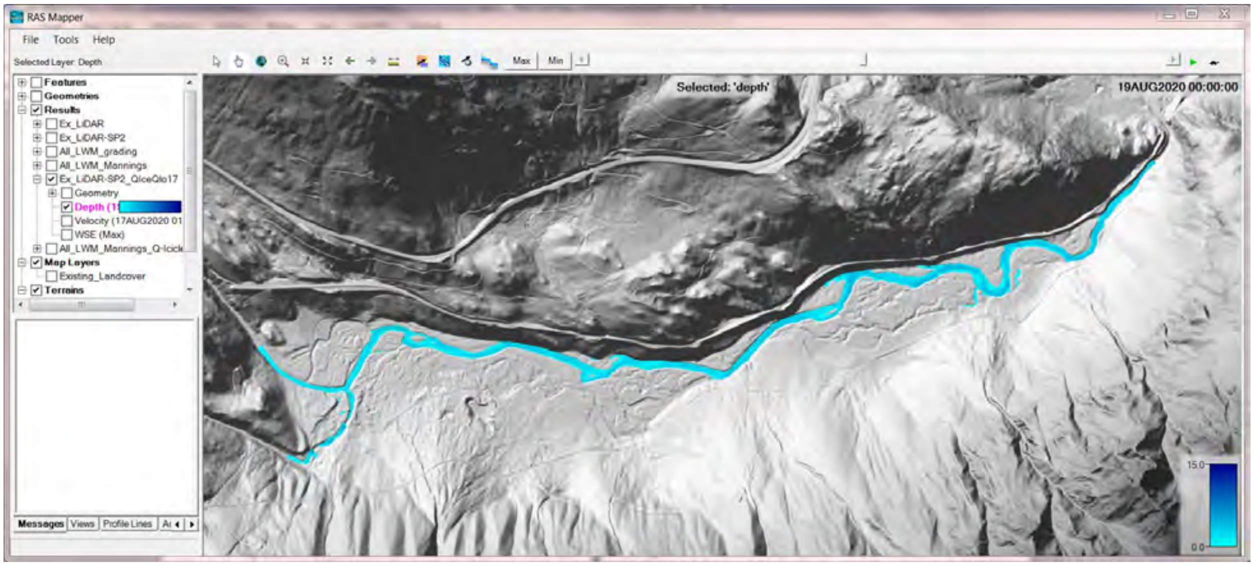
Existing condition model mesh



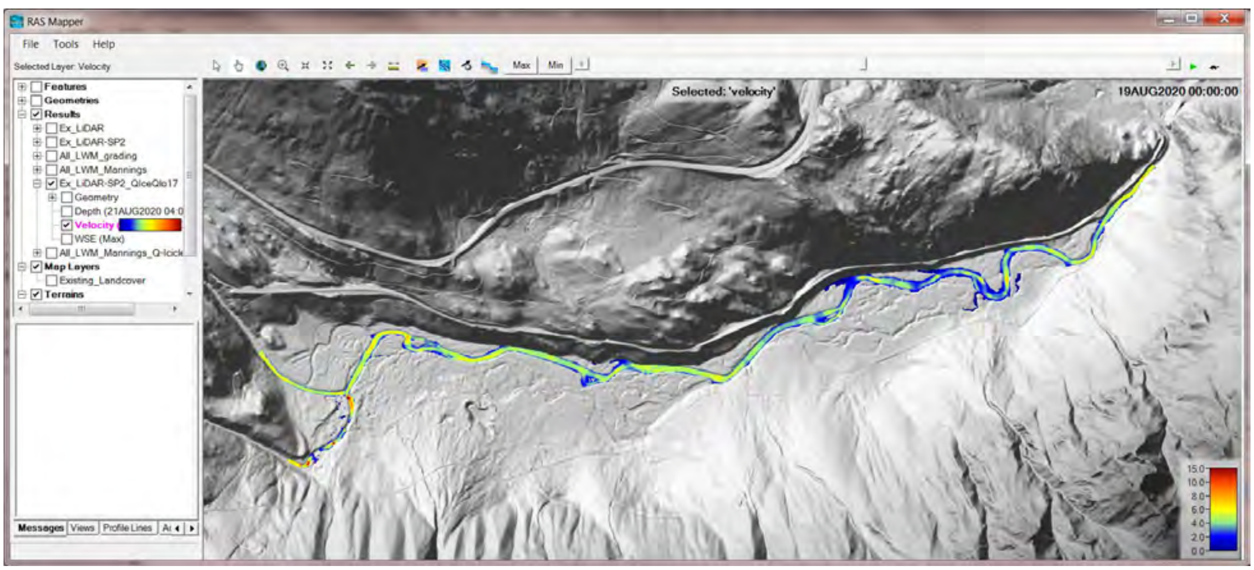
Existing condition Manning's n regions and values



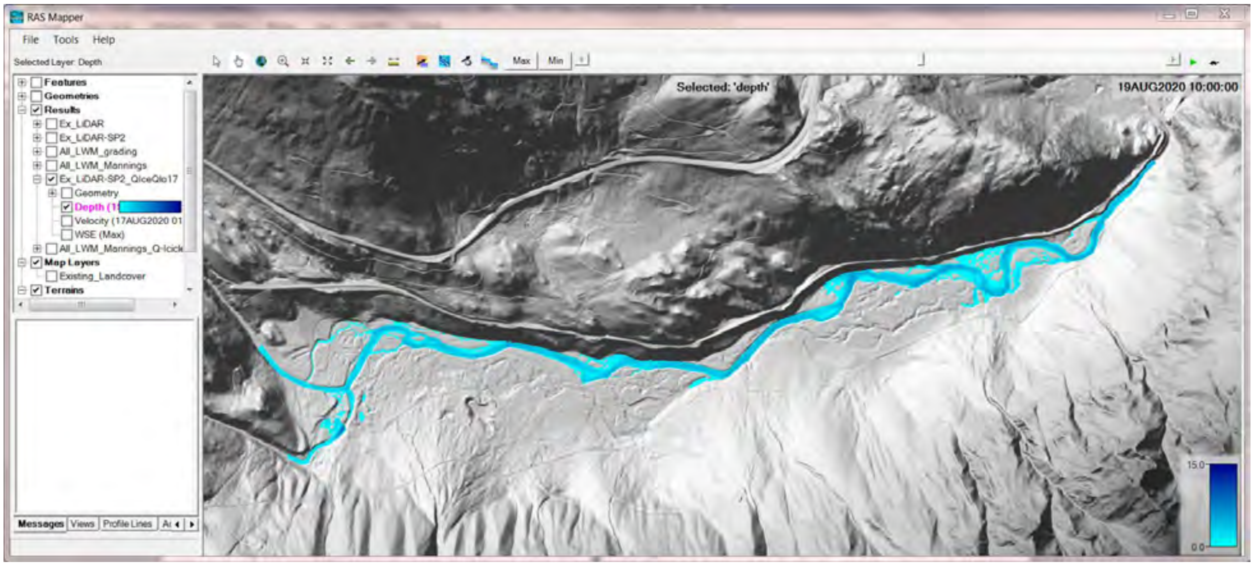
Existing condition: 1.5-year (1,400-cfs) flow depth



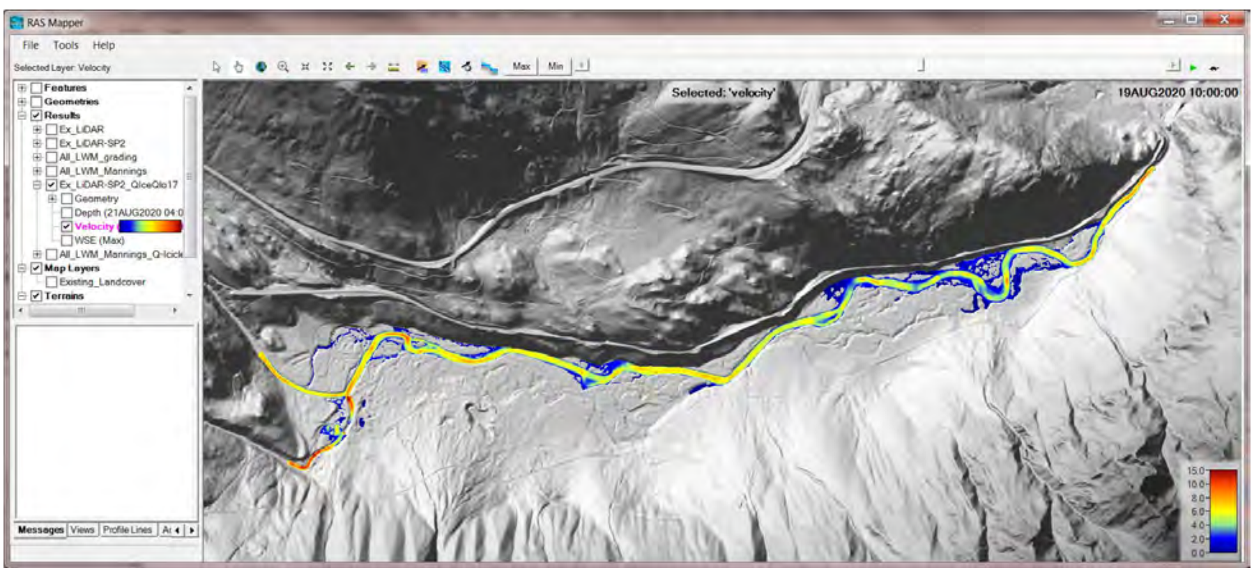
Existing condition: 1.5-year (1,400-cfs) flow velocity



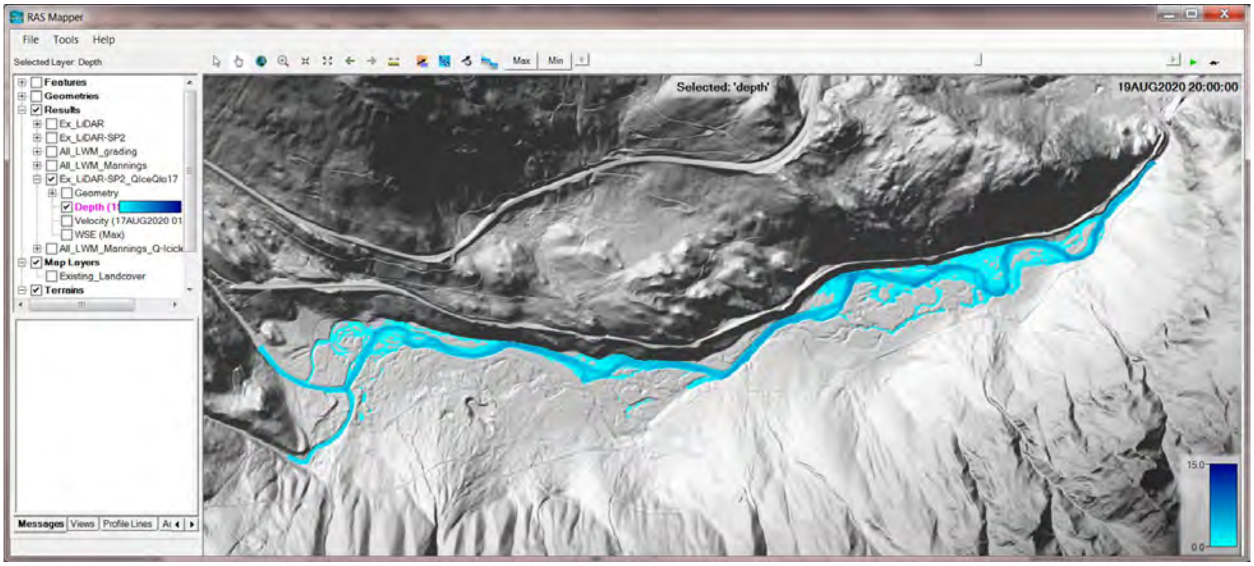
Existing condition: 2-year (1,700-cfs) flow depth



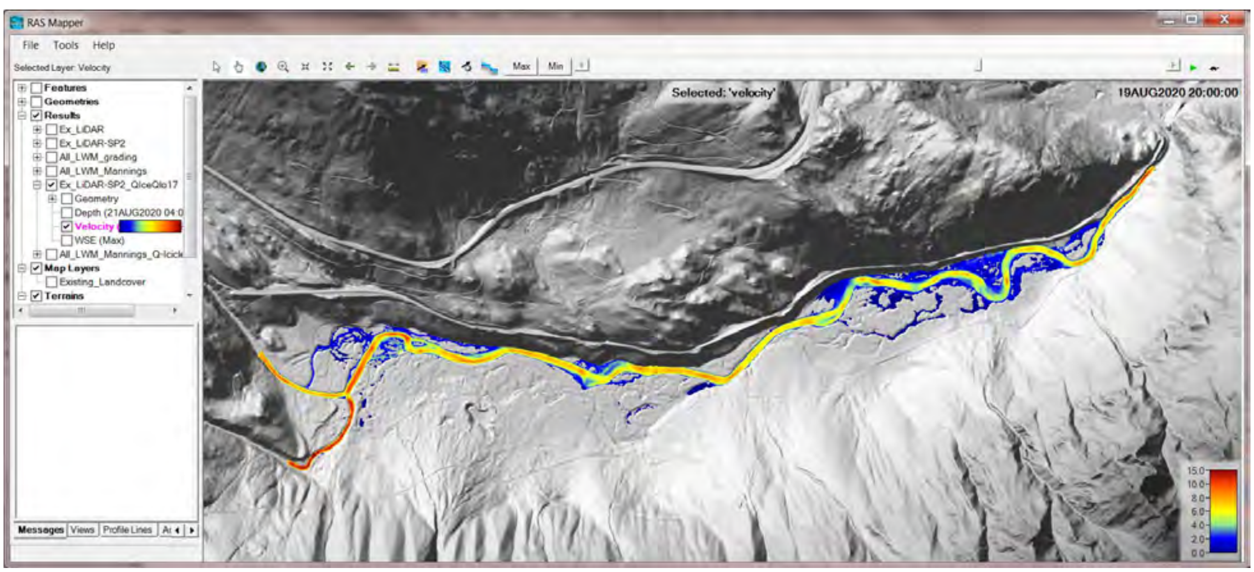
Existing condition: 2-year (1,700-cfs) flow velocity



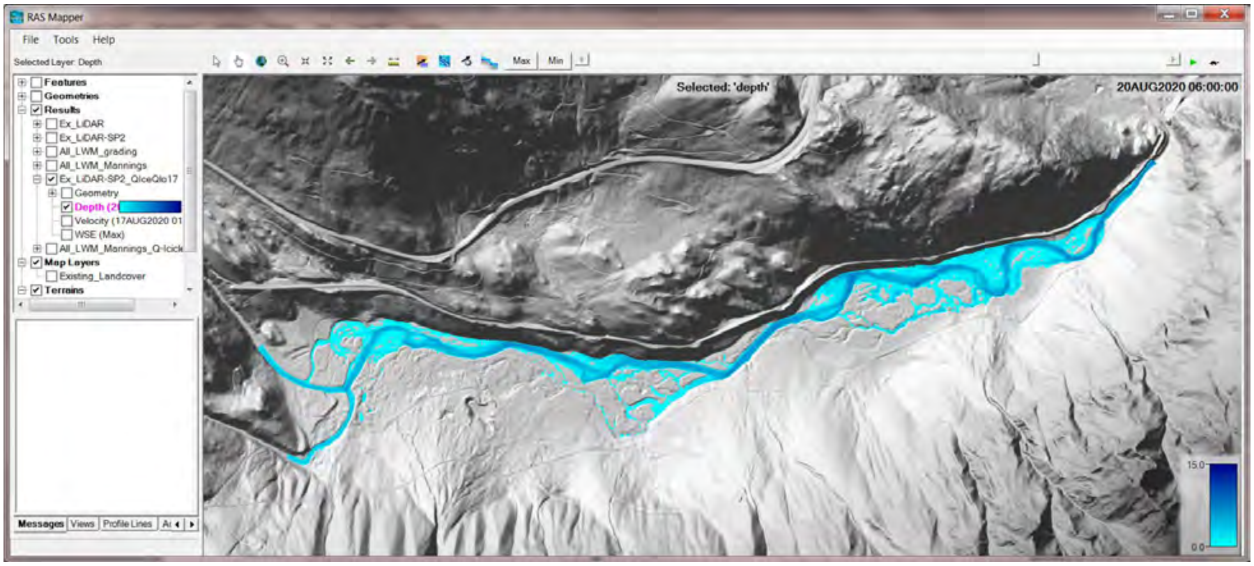
Existing condition: 5-year (2,600-cfs) flow depth



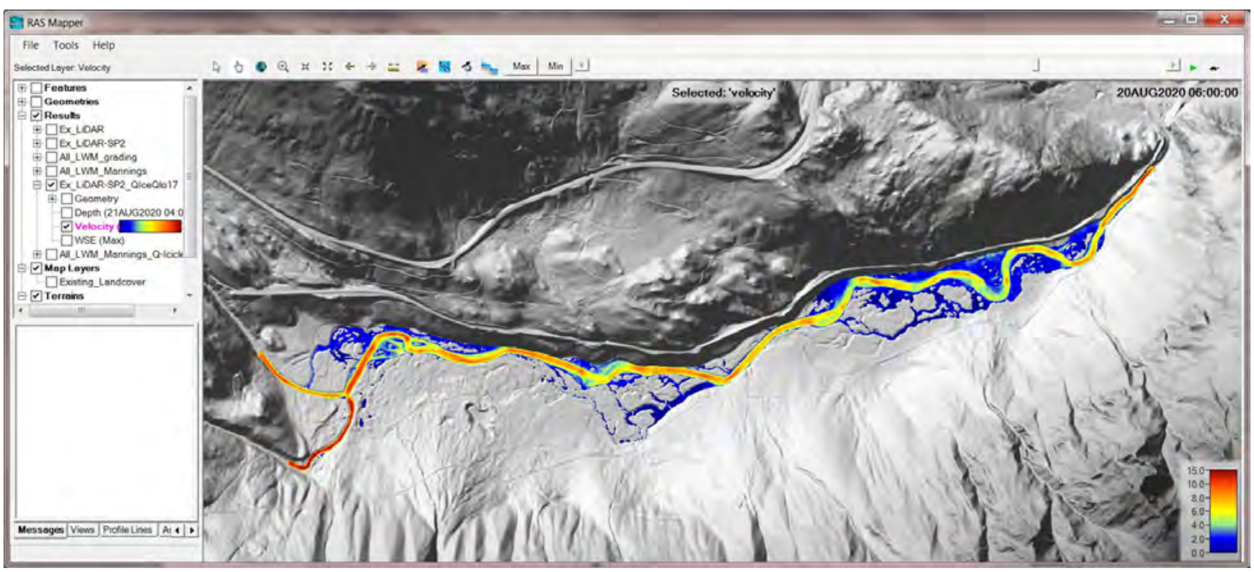
Existing condition: 5-year (2,600-cfs) flow velocity



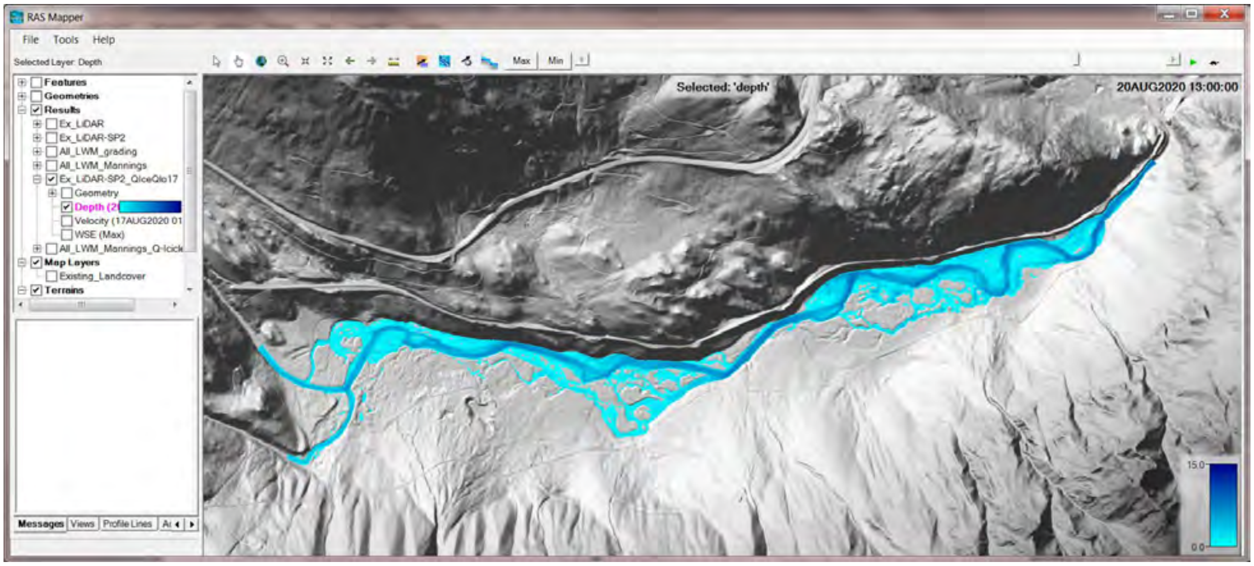
Existing condition: 10-year (3,400-cfs) flow depth



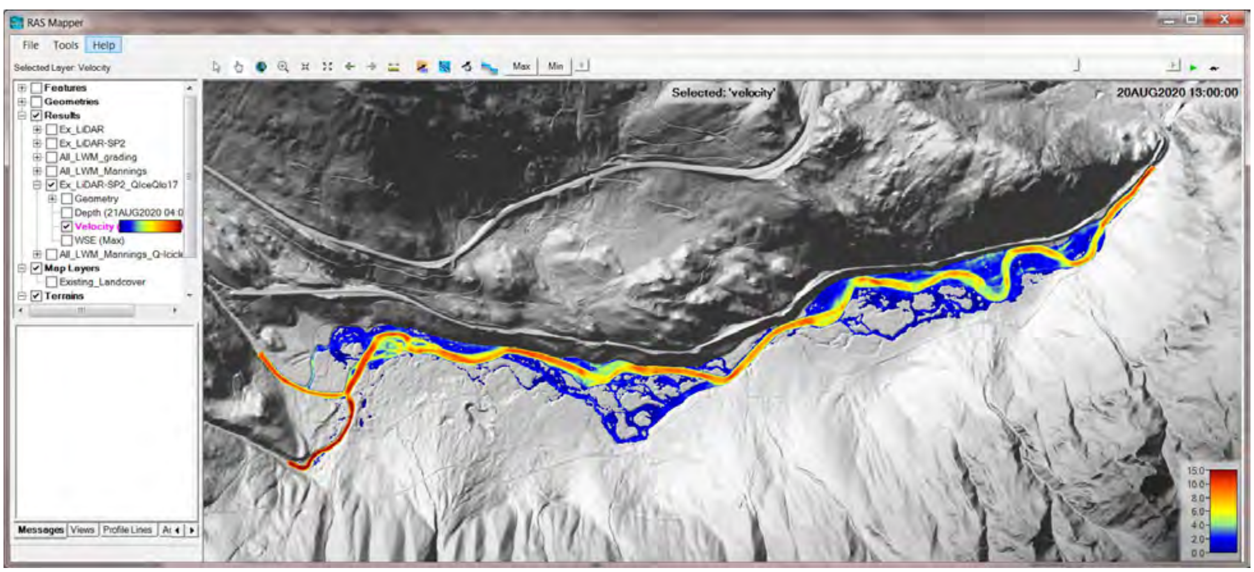
Existing condition: 10-year (3,400-cfs) flow velocity



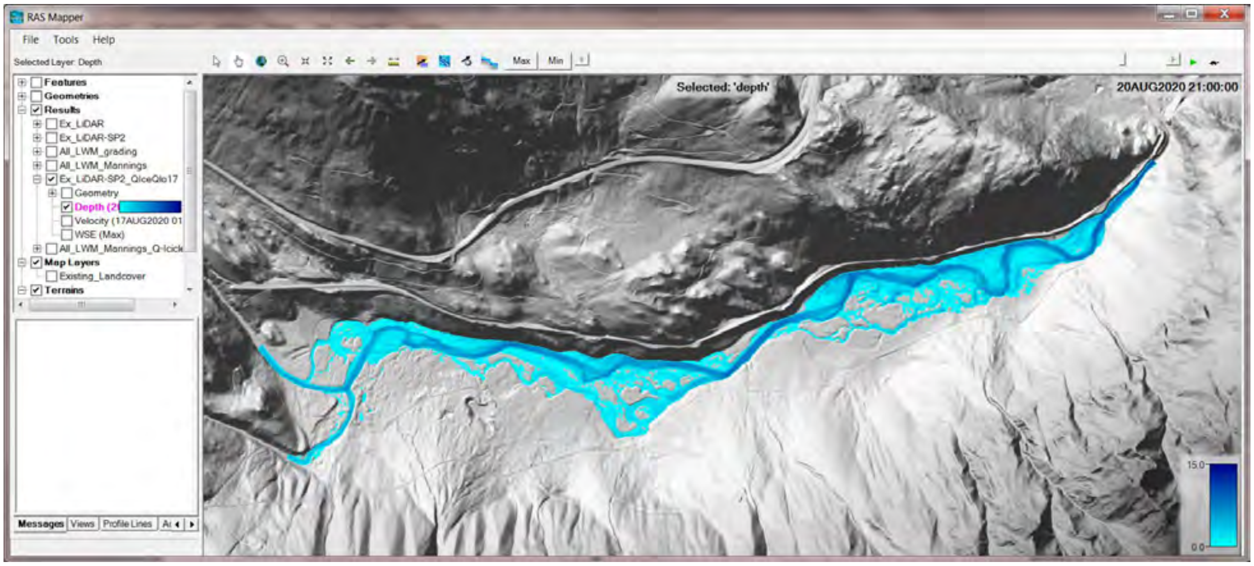
Existing condition: 25-year (4,500-cfs) flow depth



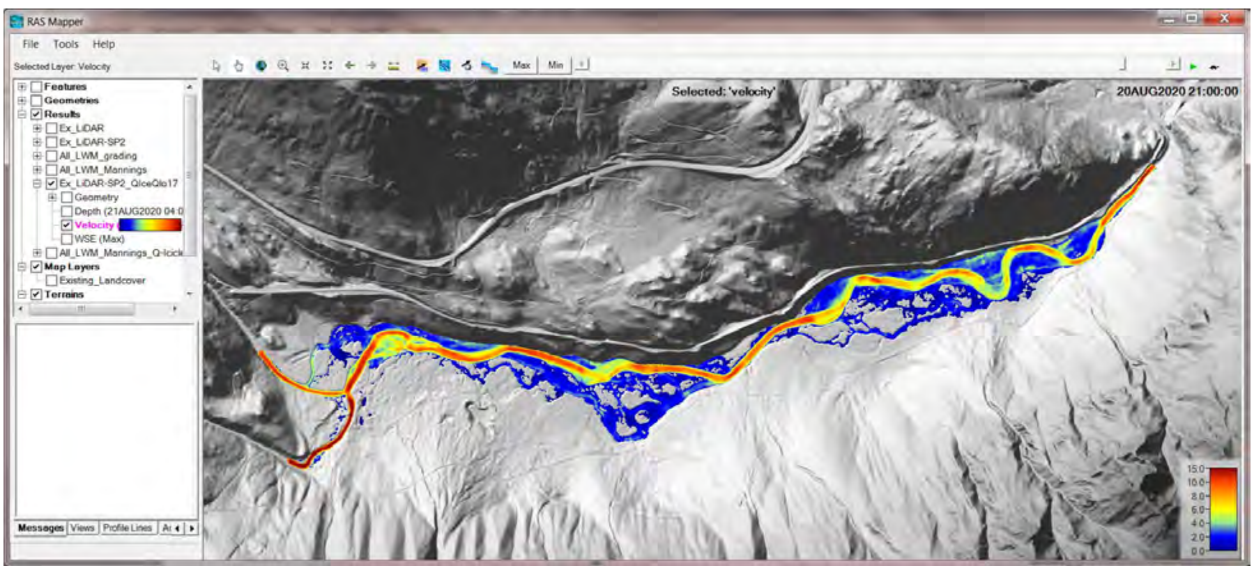
Existing condition: 25-year (4,500-cfs) flow velocity



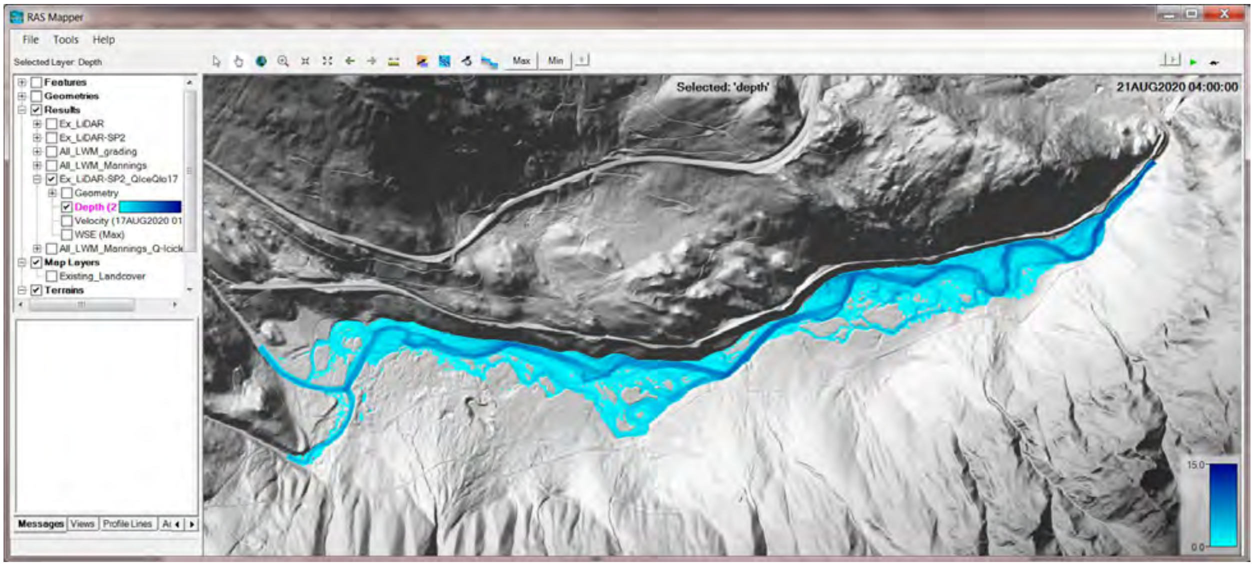
Existing condition: 50-year (5,500-cfs) flow depth



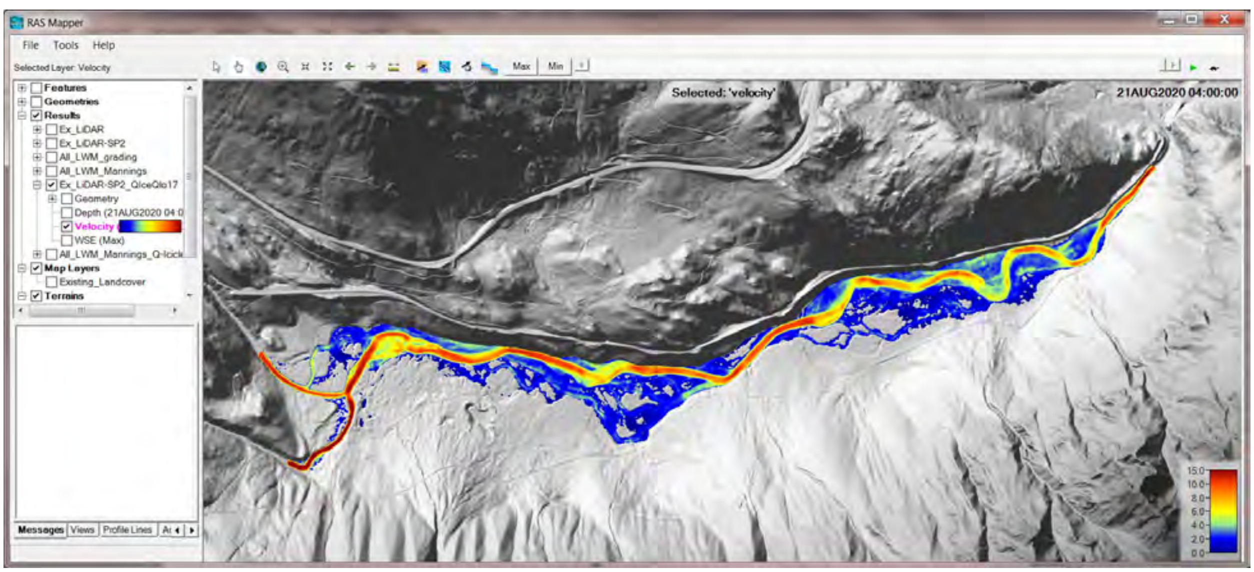
Existing condition: 50-year (5,500-cfs) flow velocity



Existing condition: 100-year (6,700-cfs) flow depth

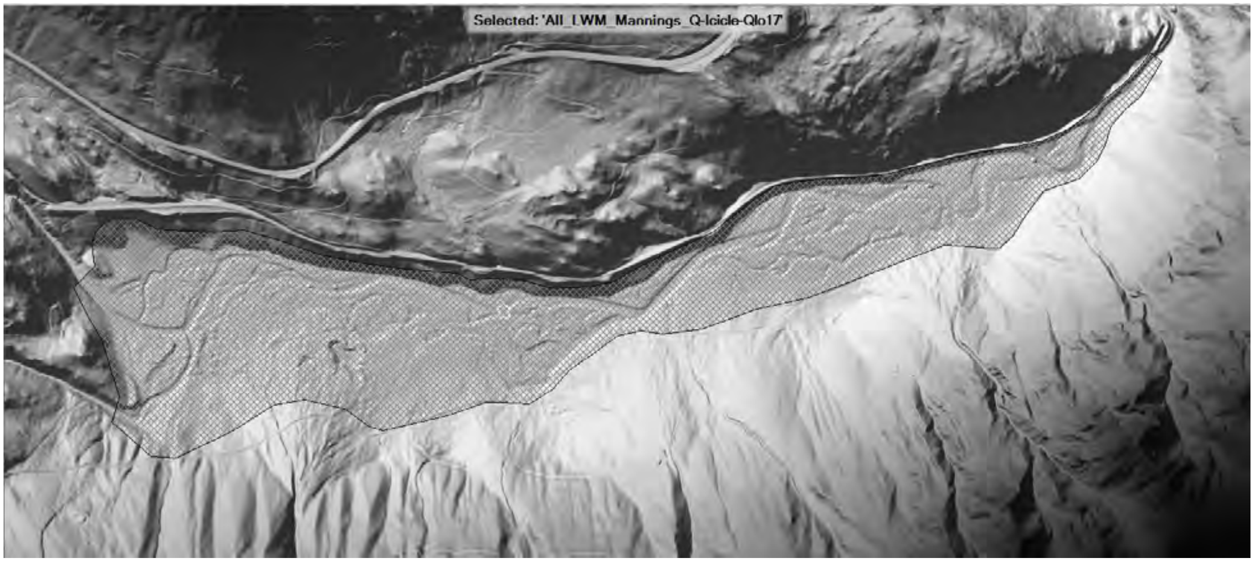


Existing condition: 100-year (6,700-cfs) flow velocity

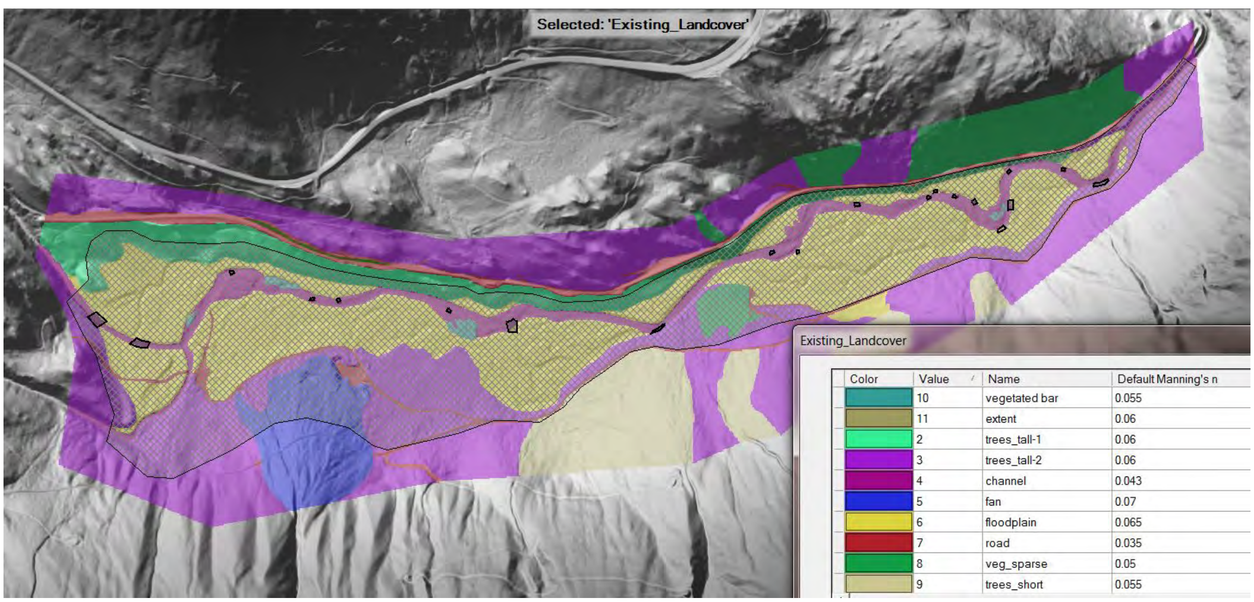


Appendix C – Proposed Conditions Hydraulic Model Results

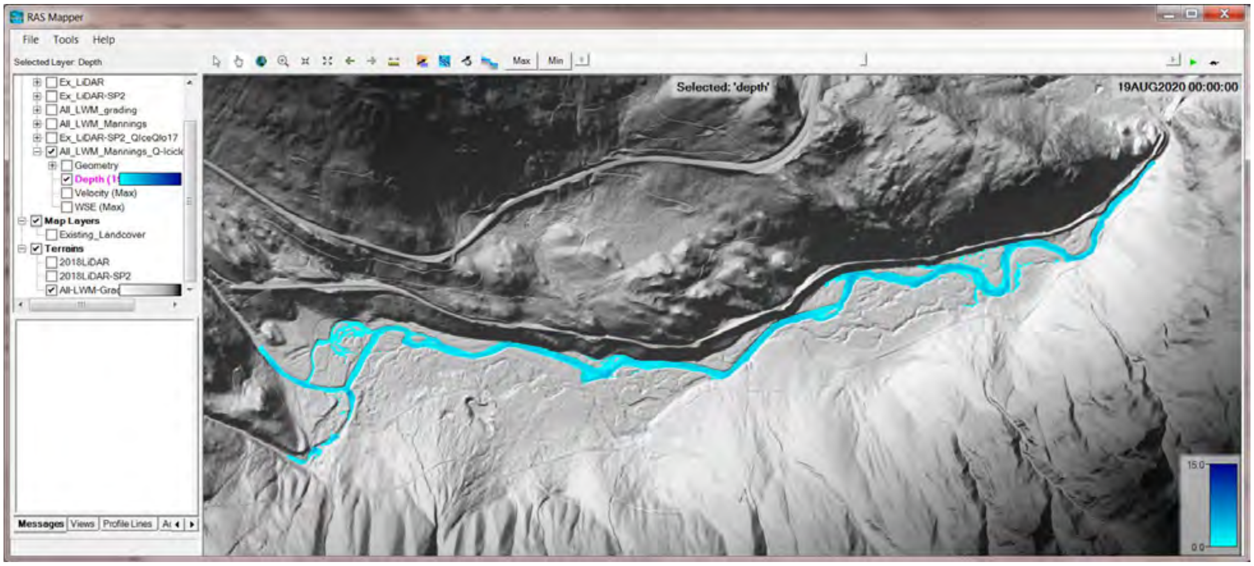
Proposed condition model mesh.



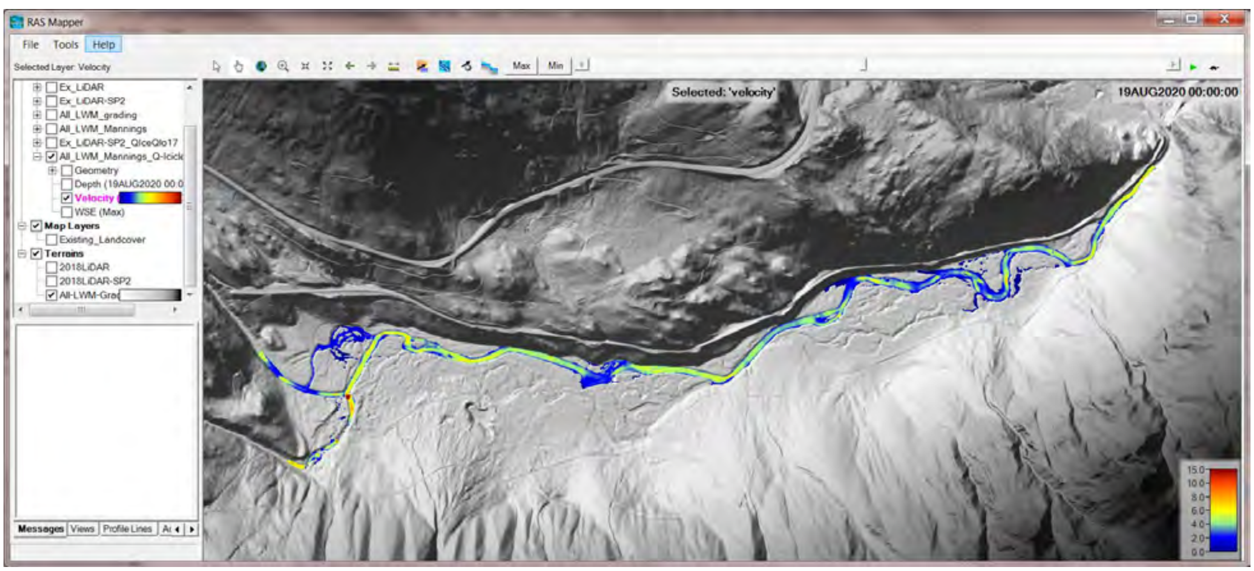
Proposed condition Manning's n regions and values. Small polygons are LWM override regions with n = 0.25.



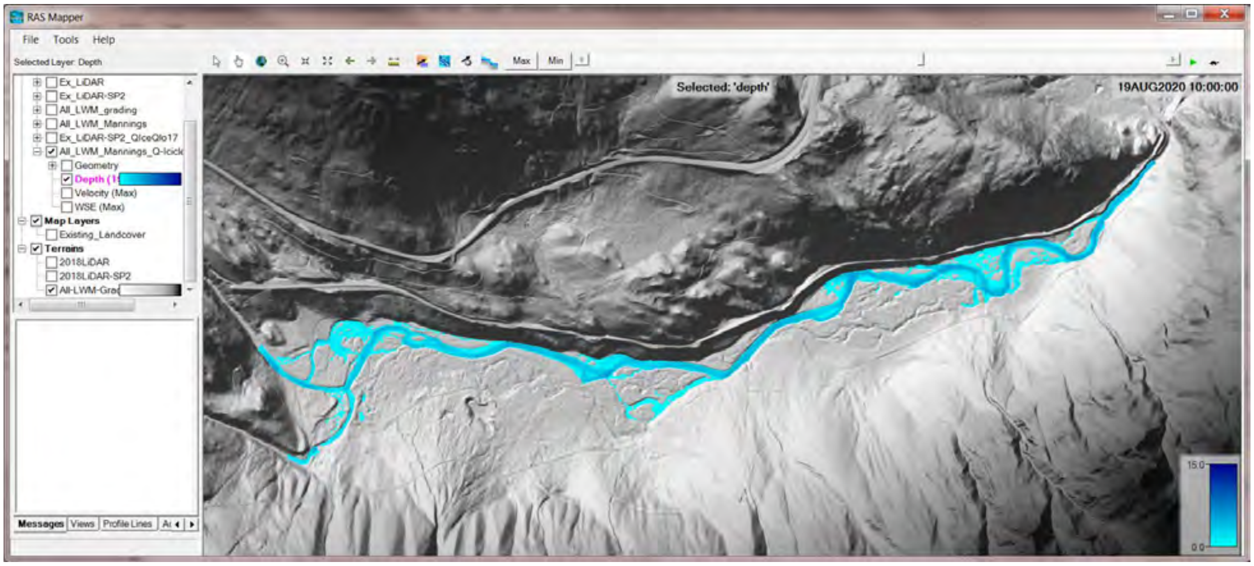
Proposed condition: 1.5-year (1,400-cfs) flow depth



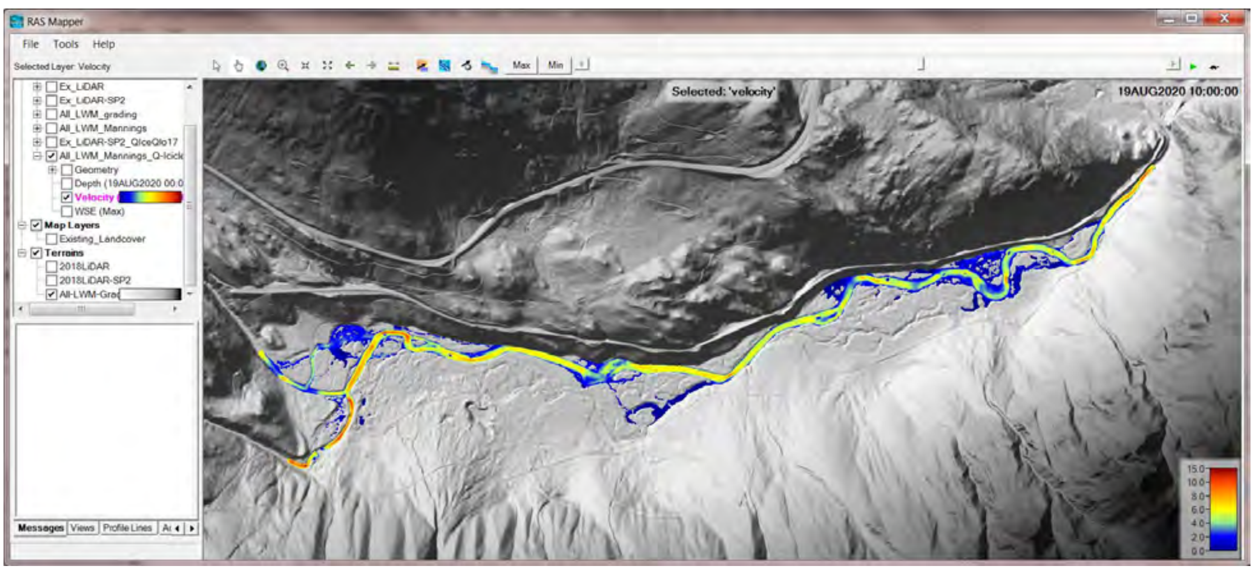
Proposed condition: 1.5-year (1,400-cfs) flow velocity



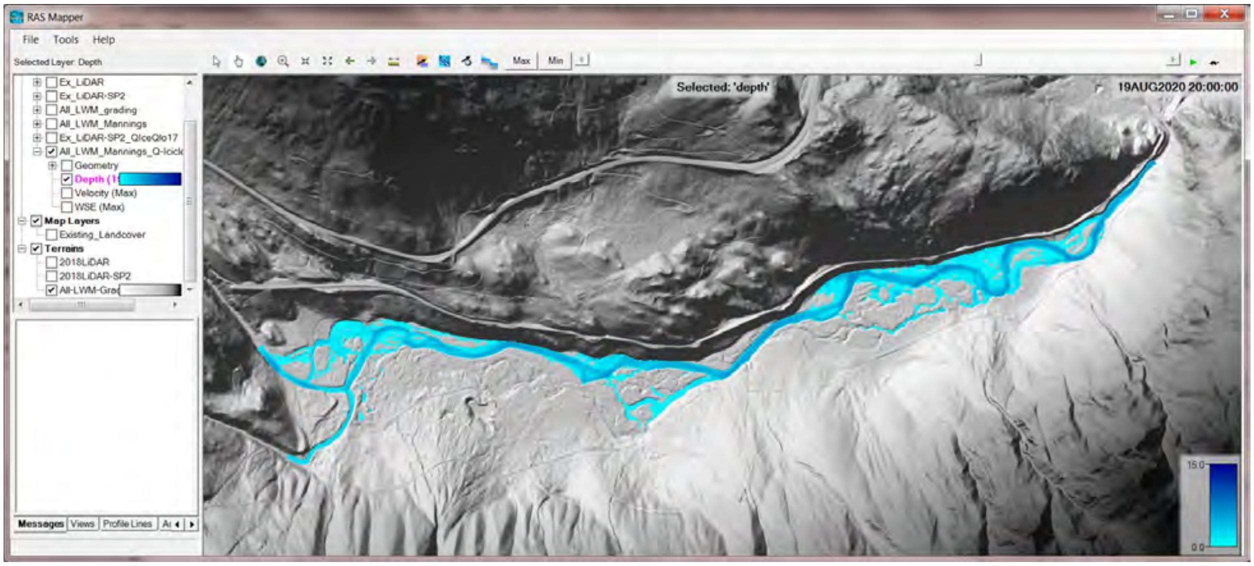
Proposed condition: 2-year (1,700-cfs) flow depth



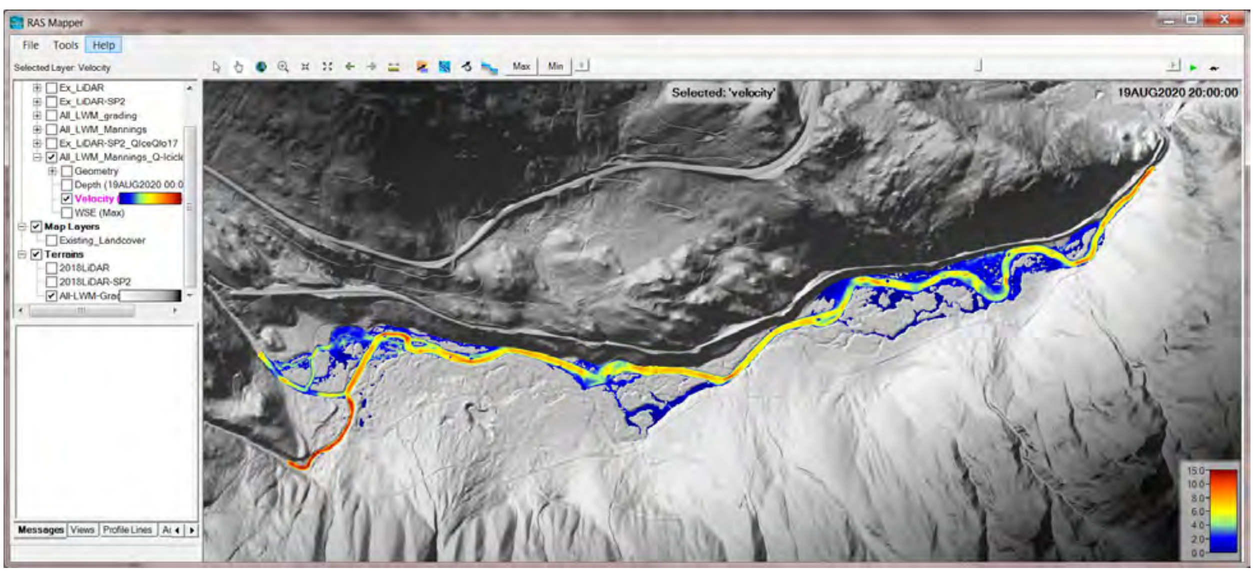
Proposed condition: 2-year (1,700-cfs) flow velocity



Proposed condition: 5-year (2,600-cfs) flow depth



Proposed condition: 5-year (2,600-cfs) flow velocity



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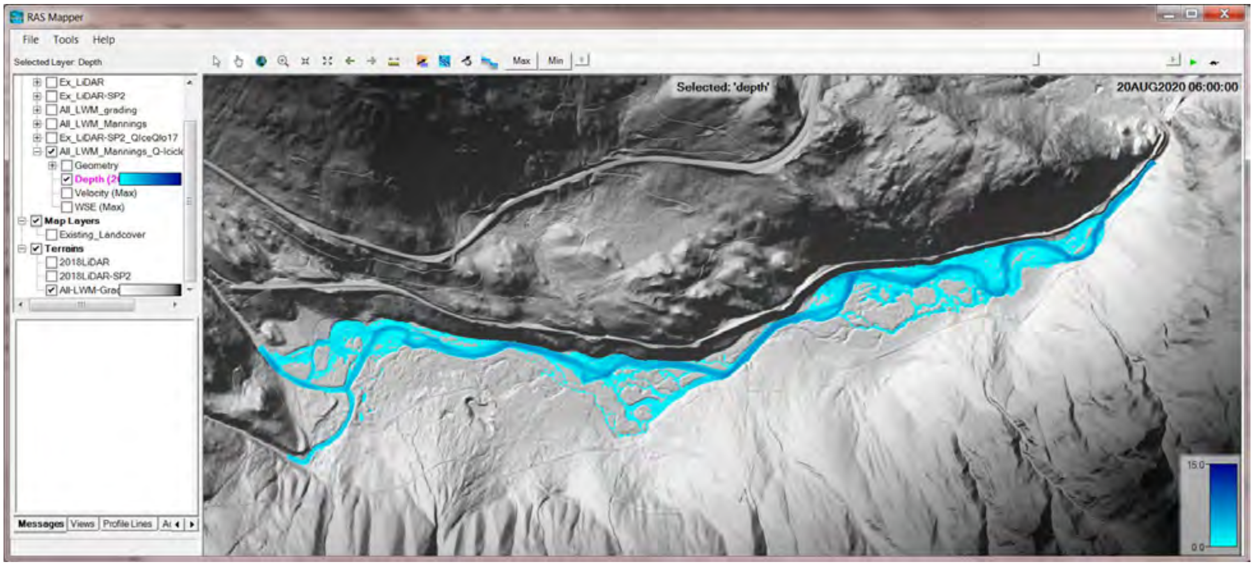
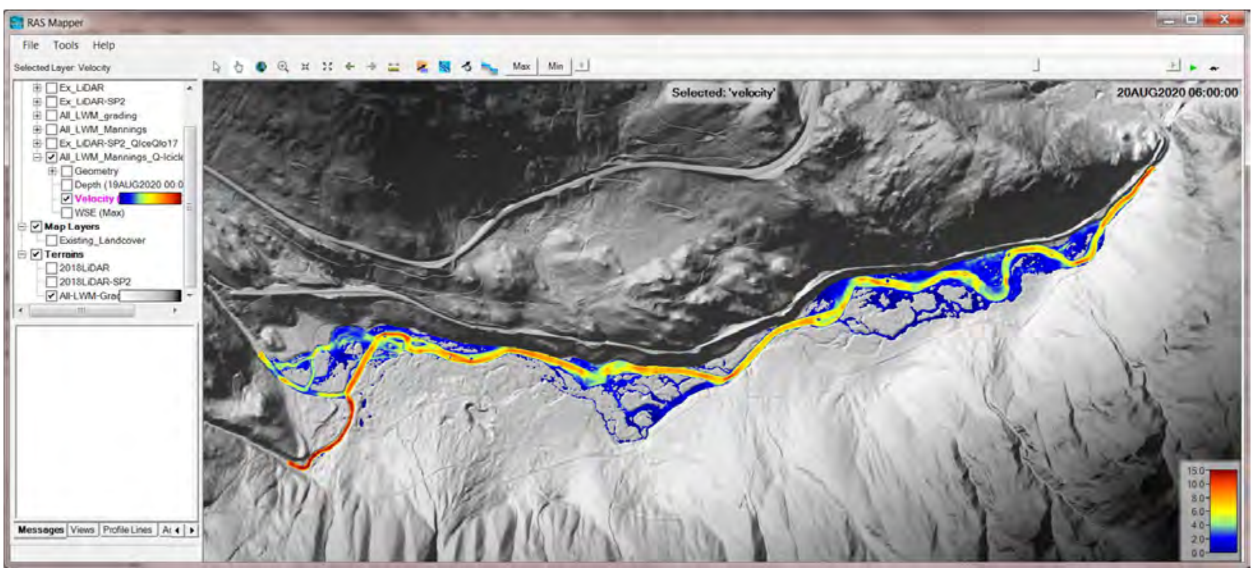
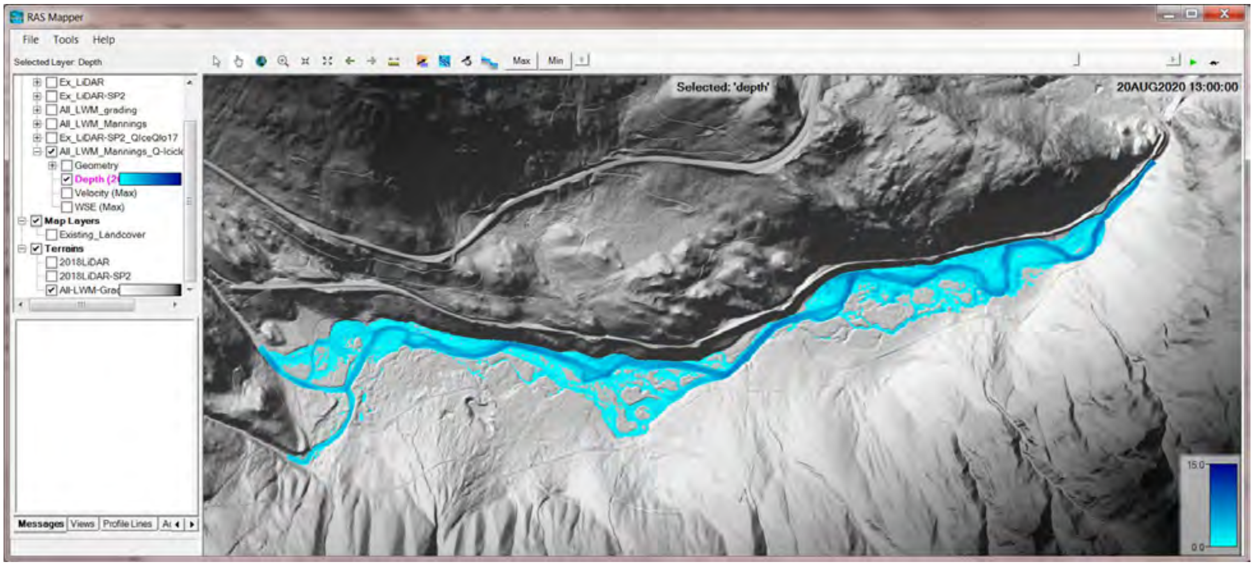


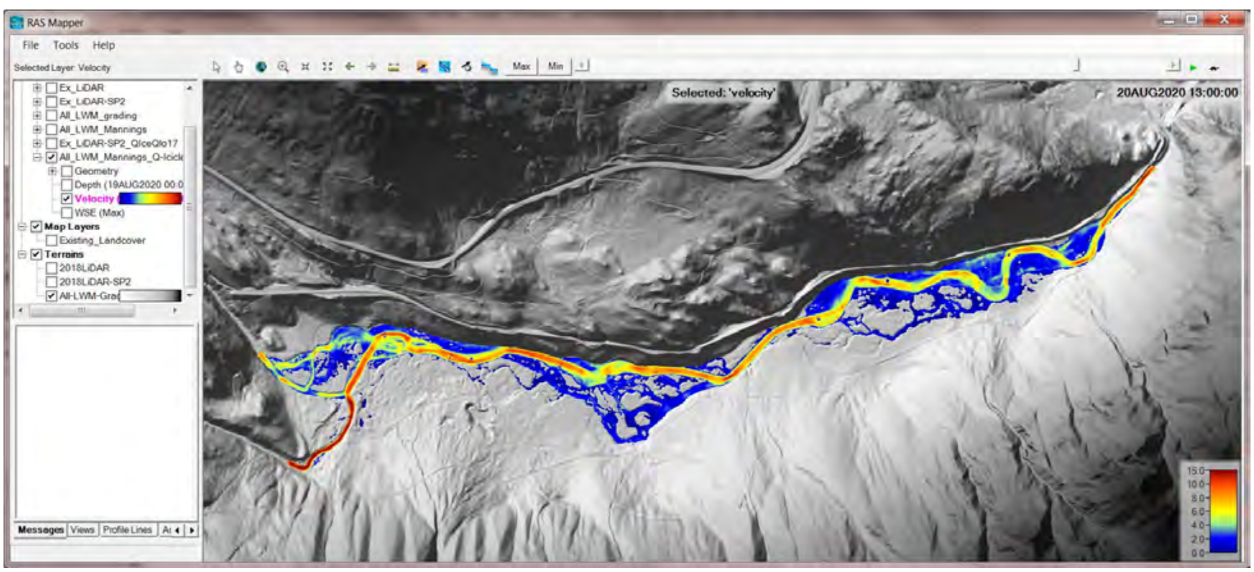
Proposed condition: 10-year (3,400-cfs) flow velocity



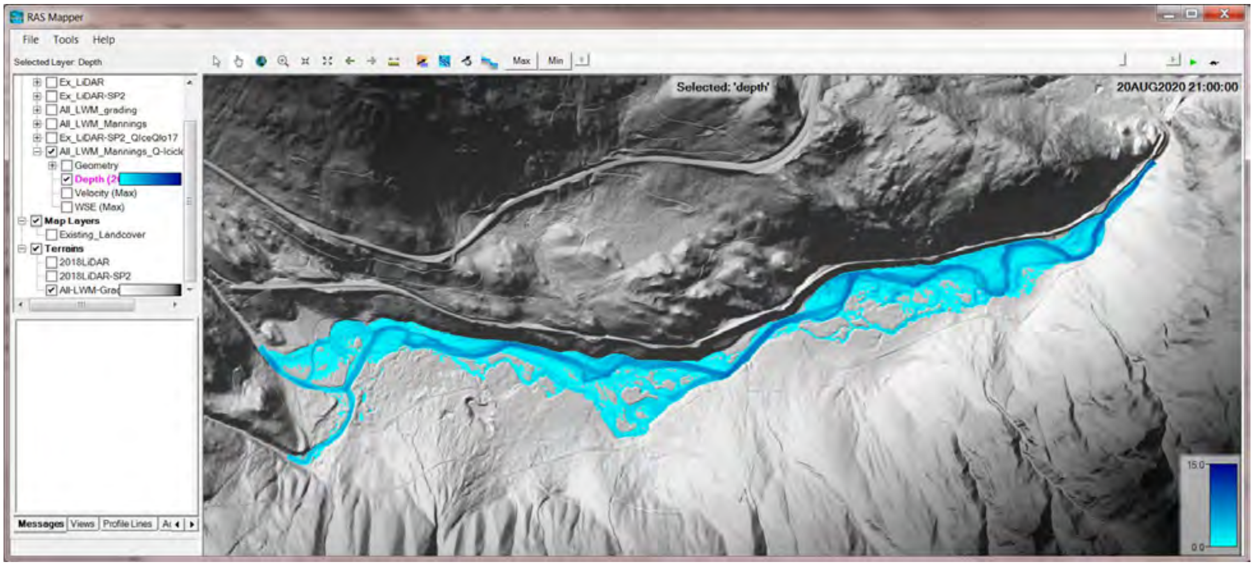
Proposed condition: 25-year (4,500-cfs) flow depth



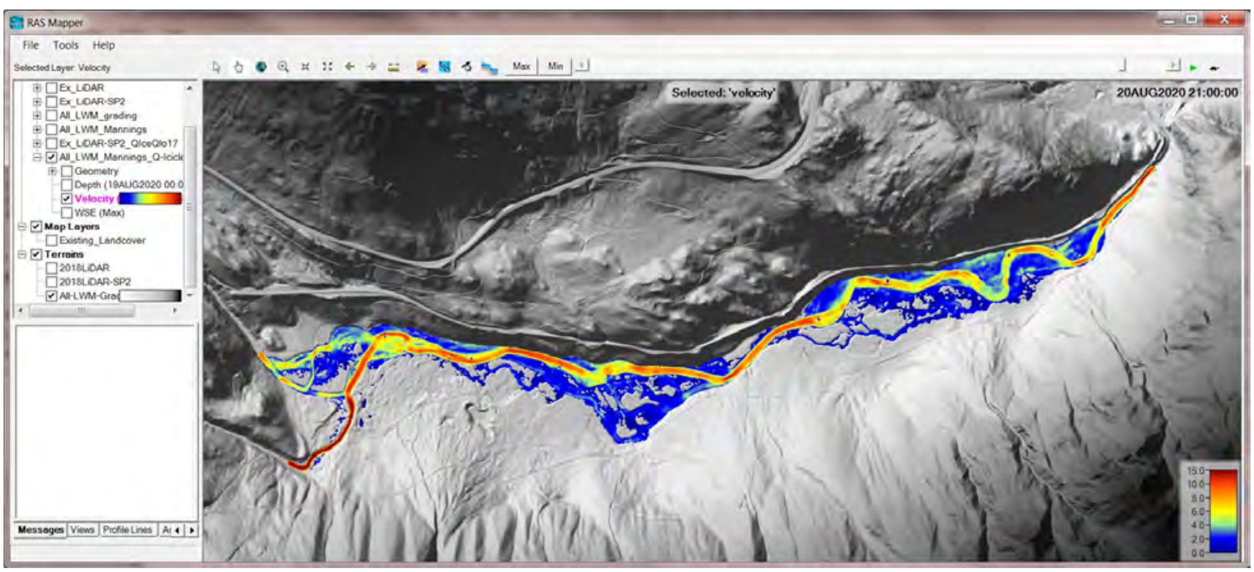
Proposed condition: 25-year (4,500-cfs) flow velocity



Proposed condition: 50-year (5,500-cfs) flow depth



Proposed condition: 50-year (5,500-cfs) flow velocity



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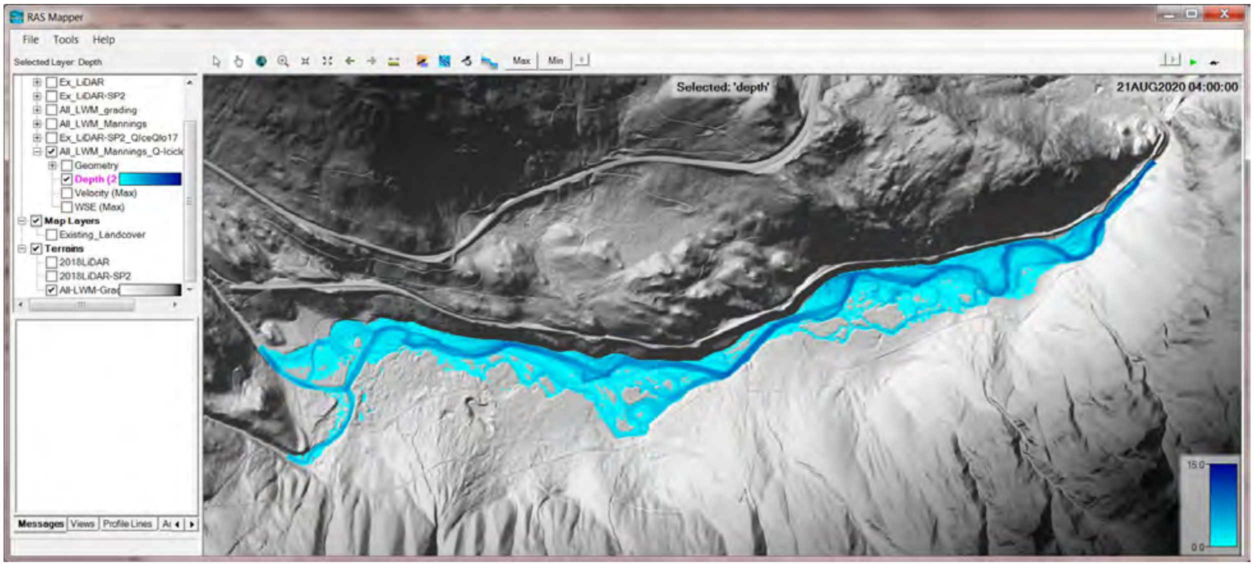

Proposed condition: 100-year (6,700-cfs) flow velocity