Personally identifiable information has been removed from this report. Some pages have been removed for brevity of the example.

TECHNICAL MEMORANDUM

Re: Upper Burns & Angle Point Reaches of the Entiat River – Year 3 (2024) Monitoring Report

To: Yakama Nation Fisheries

From: Engineer of Record

Date: February 2025

1. Project Background

Yakama Nations Fisheries (YN) contracted Inter-Fluve to prepare design and construction documents, and to provide construction oversight at the Upper Burns & Angle Point reaches of the Entiat River. The project area consists of approximately 0.35 miles of the mainstem Entiat River between river miles (RM) 25.7 and 26.05, including floodplains on both sides of the river. Locations and details of project features are shown on the project plans with overview plan sheets attached herein. Final design and construction documents were completed by Inter-Fluve in January 2021. Construction was completed in July and August 2021 by K&K Construction, Inc. Vegetation was installed by BFI Natives in 2021 under a separate contract. The work included:

- Creation of a 950-foot-long "Upper Side Channel" through the river-right floodplain with two engineered riffles, associated large wood, and pool habitat.
- Creation of a 775-foot-long "Middle Side Channel" through the river-left floodplain with associated large wood, and pool habitat.
- Enhancement of a 600-foot-long "Lower Side Channel" situated on river-right within an existing high flow channel, associated large wood, and pool habitat.
- Excavation of approximately 5,650 cubic yards to create new side channels and pools.
- Placement of excavated spoils in sparsely vegetated areas on the river-right upper hillslope.
- Installation of three apex-style large wood structures at the inlets of each side channel. Structures are ballasted by partial burial and mechanical connections to vertical logs.
- Installation of four partially buried large wood habitat structures along the margins of the mainstem Entiat River.
- Placement of floodplain roughness structures using salvaged slash, treetops, whole trees, and vertical logs.
- Revegetation of channel margins, access routes, and staging areas.

This memorandum summarizes the Year 3 Post Implementation Monitoring site conditions and field observations made on August 15, 2024.

2. Snow Pack

To characterize hydrologic activity for the time period between construction and Year 3 monitoring, regional precipitation, snowpack and stream flows were evaluated. The Natural Resources Conservation Service (NRCS) maintain a number of SNOTEL stations in this region. The Pope Ridge SNOTEL site (Station PPRW1), located near the confluence of the Entiat River and Pope Creek, was queried for Water Year 2023 precipitation accumulation and snowpack water equivalent. While the station is not located within the Upper Burns watershed, it provides the best approximation of regional trends encompassing the project area. Precipitation was below the 1982 -2024 mean value from February to October of 2024 (Figure 1). Overall, 2024 received 6.45 inches less precipitation than an average year between 1982 - 2024. Snowpack in water year 2024 was also below the 1982-2024 mean for the majority of the year (Figure 2). Snowpack decreased to zero by April 30, 2024, whereas the 1982-2024 mean snow pack reaches zero in late May.

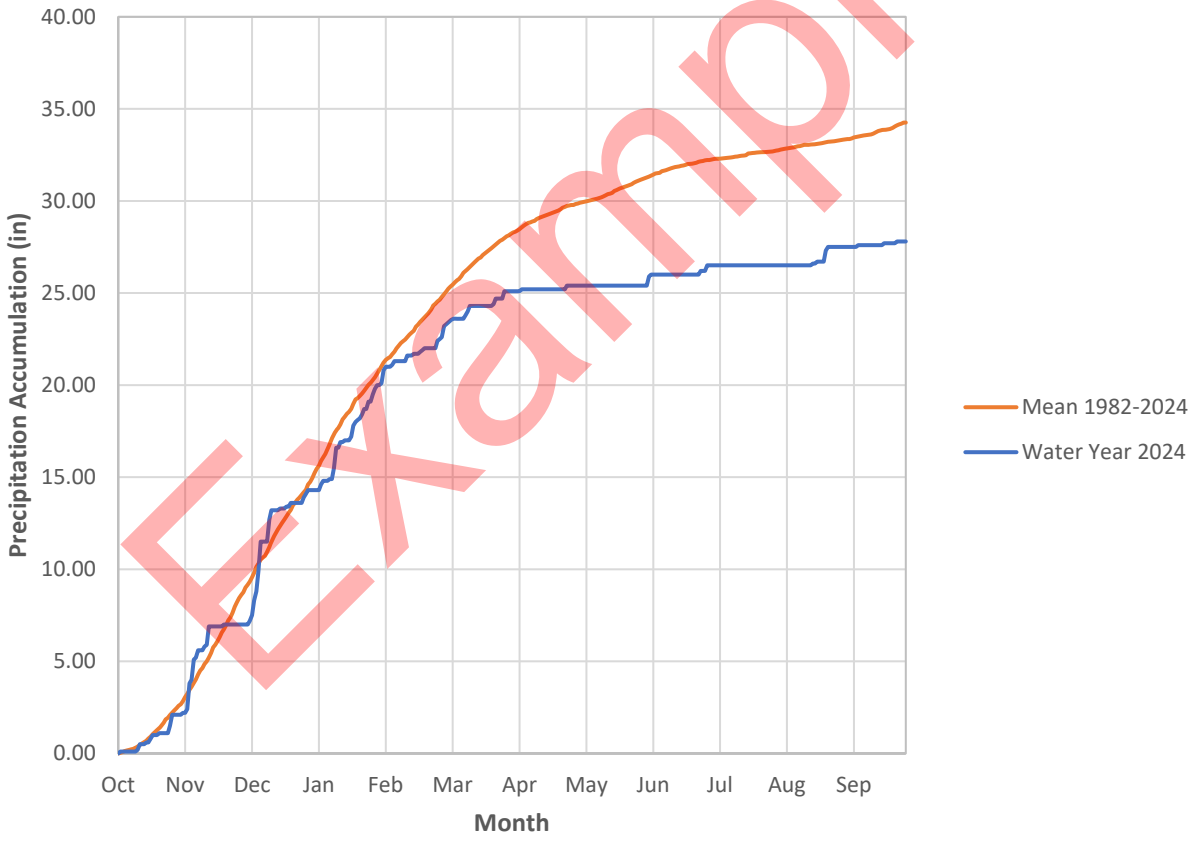


Figure 1. Precipitation accumulation of water year 2024 and the 1982 – 2024 mean (data from SNOTEL PPRW1 at Pope Ridge).

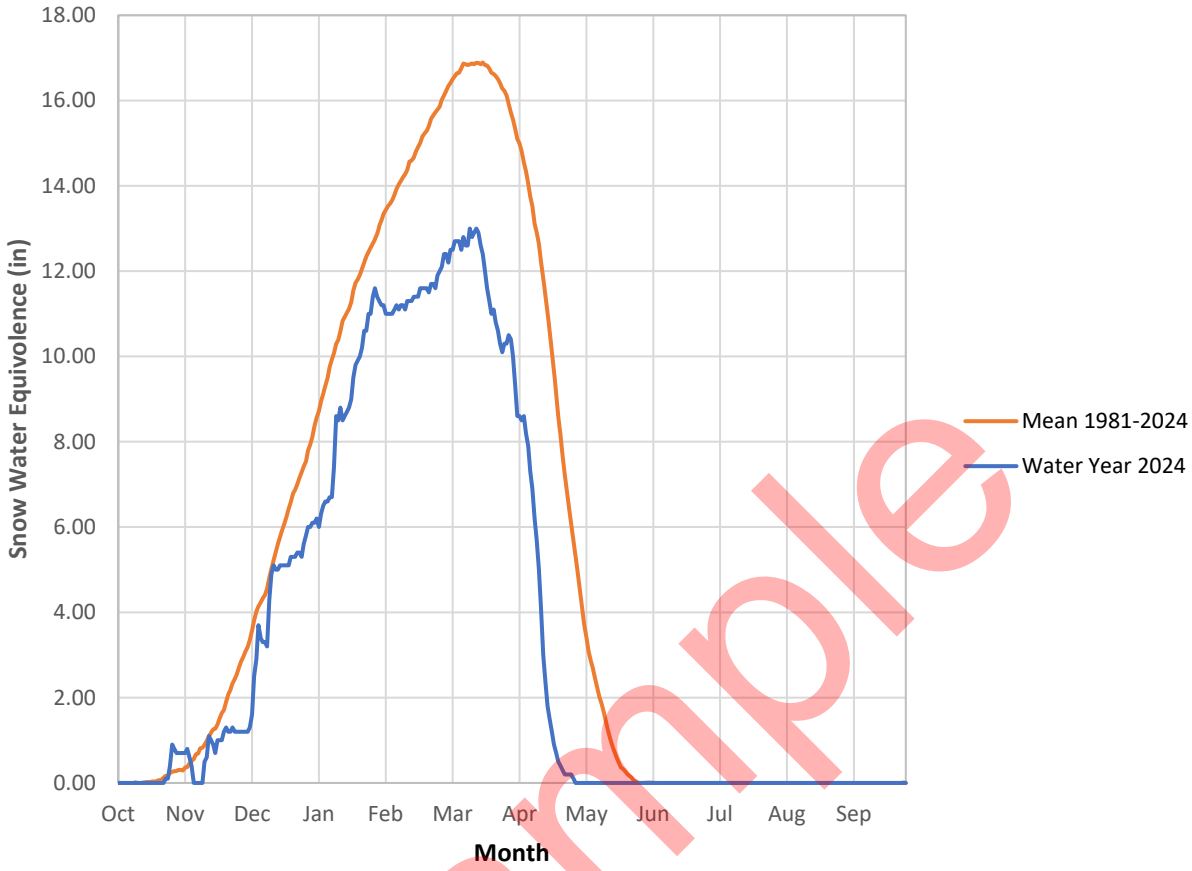


Figure 2. Snow water equivalent of 2024 water year and the 1982 – 2024 mean (data from SNOTEL PPRW1 at Pope Ridge).

3. River Flow History

Hydrology data from the US Geologic Survey (USGS) Entiat River gage near Ardenvoir (Gage 12452800), located approximately eight miles downstream from the Upper Burns project site, was used to estimate flow trends. The 2024 water year had flows above average for much of the winter and spring, and then below average after mid-May. Annual high flow events recorded at the gage since project implementation include 2,830 cfs on June 11, 2022, 3,570 cfs on May 5, 2023, and 1,690 cfs on May 17, 2024. For reference, the Entiat Tributary Assessment (USBR 2009) estimated a 2-year peak discharge of 2,706 cfs and 5 -year peak discharge of 3,656 cfs at the gage.

Site monitoring photos for both Monitoring Years 1 and 2 were taken when the Entiat River had a discharge below 60 cfs recorded at the gage, which is lower the minimum flow during most years. Year 3 photos were taken when the Entiat River gage recorded a discharge of over 90 cfs, and about 55 cfs when drone photos were collected.

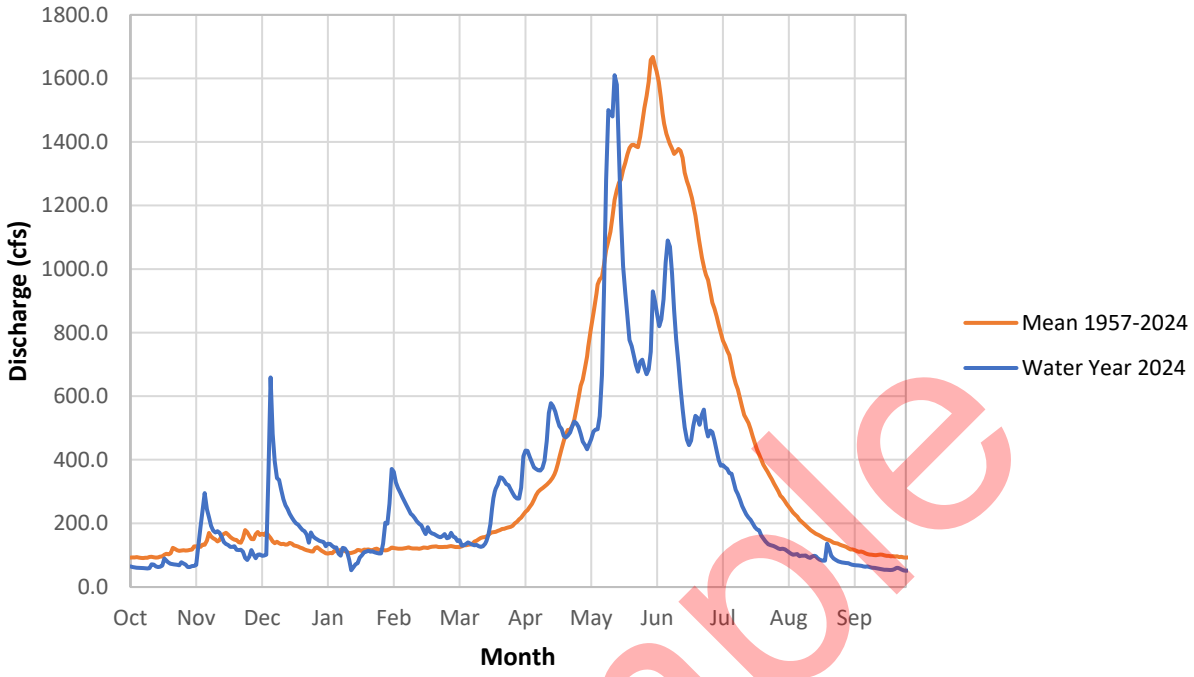


Figure 3. Mean daily discharge on the Entiat River near Ardenvior, WA (USGS gage 12452800) for water year 2024 and mean daily discharge for the period of record, 1957 - 2024.

4. Photo Documentation and Field Notes

Year 3 monitoring conditions were photo documented on August 15, 2024, followed by drone photos being collected on September 19, 2024. A series of annotated photos of channels and wood structures are shown in Appendix A. Photo point locations are indicated on the attached monitoring plan graphics.

5. Site Monitoring

In general, the entire project is performing well to very well. A breakdown by project area is provided below.

5.1 LOWER SIDE CHANNEL

The project components are stable but, starting in 2022, the Lower Side Channel has accumulated a significant volume of medium to large size wood that has collected on the inlet jam. Some of this material has floated past the inlet and has accumulated within the side channel approximately 250 to 350 feet downstream. A portion of the wood that has collected mid-reach is likely from loose slash material that was placed within constructed floodplain roughness jams, but the majority of the wood was transported during high flow events over the past 3 years. The wood accumulation at the face of inlet jam had little change in size or shape during 2024.

At the moment, this added wood appears to be providing a mostly positive impact on habitat quality since the mucky bed material has eroded and formed deep pools in the mid-reach segment of the Lower Side Channel and the wood is providing great cover habitat. Furthermore, the wood accumulation on the inlet jam is not blocking flow or fish passage, but it does partially shield the channel during higher flows which could limit the future delivery of excess sediment and wood into the channel. Evidence of this shielding effect may already exist since less volume of wood material accumulated within the channel in 2023 compared to 2022, even though 2023 had higher peak flows. This same trend of less wood accumulation within the channel held true in 2024.

The situation should continue to be monitored because the wood accumulation may result in future bed aggradation if it continues to grow larger and the banks do not erode in response. Currently, limited bank erosion has occurred, and one minor sediment plug has formed approximately 130 feet downstream of the inlet. The plug was likely formed due to a local accumulation of wood on a channel spanning salvaged tree that was placed during construction, but this tree floated to a new position in 2023 and the small woody material has dispersed further downstream. The sediment plug was observed in the same area in 2024, but it hadn't appreciably grown. The plug may partially dissipate during a future high flow event if additional sediment delivery is partially cutoff by the racked wood at the inlet jam.

The outlet of the Lower Side Channel connects to a split flow channel along the right margin of the Entiat River. Similar to pre-project conditions, this split flow channel disconnects from the mainstem during low flow periods. This was generally anticipated due to observed sediment deposition patterns and modeled shear stresses. The deep pools and hyporheic connectivity in the Lower Side Channel appear to provide suitable habitat for any rearing salmonids that wish to remain in the side channel through the summer. If necessary, juveniles can exit the side channel through the inlet.

Finally, it should be noted that even with the deep pools and slow-moving water, limited beaver activity was observed.

Recommendations: It may be worth considering hand removal of some small woody debris spanning the channel, but it is still not yet clear if this is creating any negative impacts.

5.2 MIDDLE SIDE CHANNEL

The project components are stable and the channel has experienced limited change since construction in 2021. There are channel segments with slight adjustments to the margins, but all of the erosion and deposition appear to be within natural expected ranges. During low flow conditions, it was observed that some of the constructed pools have partially filled in with sediment, but there

are several pools that have persisted near large wood structures. Minor bank erosion will likely continue to slow as vegetation becomes more established.

The constructed large wood structures remain in-place, although a couple channel spanning logs have slightly shifted position. No logs appear to be at risk of floating out of the side channel, and there are no large debris accumulations. A large cottonwood snag has fallen adjacent to the channel, but it is not impacting conveyance.

The entire channel appeared to be passable for fish, even during very low flows. The riffle near the upper end of the channel is in good condition and maintaining surface flow.

Recommendations: No intervention is needed currently.

5.3 UPPER SIDE CHANNEL

The Upper Side Channel project components are stable, and this channel has also exhibited limited change since construction in 2021. Adjustments to the channel margin have been well-within the natural rate of erosion. Some of the constructed pools have partially filled in with finer sediment, with much of this sediment likely derived from construction disturbances. The finer sediment may continue to flush out of the side channel during future high flow events.

The constructed large wood structures remain in-place, and the two constructed riffles near the outlet of the channel are in good condition and maintaining surface flow. A small amount of medium-sized wood debris had previously collected near the inlet large wood structure, but it didn't shift or grow in size in 2024 and there are no accumulations of wood within the side channel.

The entire channel appears to be passable for fish, even during the very low flows that were observed during the 2022 and 2023 monitoring visits. However, the inlet has a small amount of coarse substrate deposition which has slightly reduced the amount of flow that enters the channel. The deep pool at the inlet is still providing a passable connection to the side channel, but future sediment deposition should be monitored and evaluated.

Finally, it should be noted that there are no signs that surface flow is being lost through the reach. Unlike the other two channels, the Upper Side Channel was constructed slightly above the recorded groundwater table during the summer months. This decision was made to reduce excavation and maximize floodplain connectivity. There does not appear to be any significant issues with performance thus far. It is possible, if not likely, that the influx of river flow has raised the local groundwater table in the floodplain, although I am not aware of any supporting groundwater data to prove this hypothesis.

Recommendations: Consider hand improvements near the inlet to remove a small volume of sediment and woody debris. Otherwise, continue to monitor the Middle Side Channel for future changes in channel trajectory.

6. References

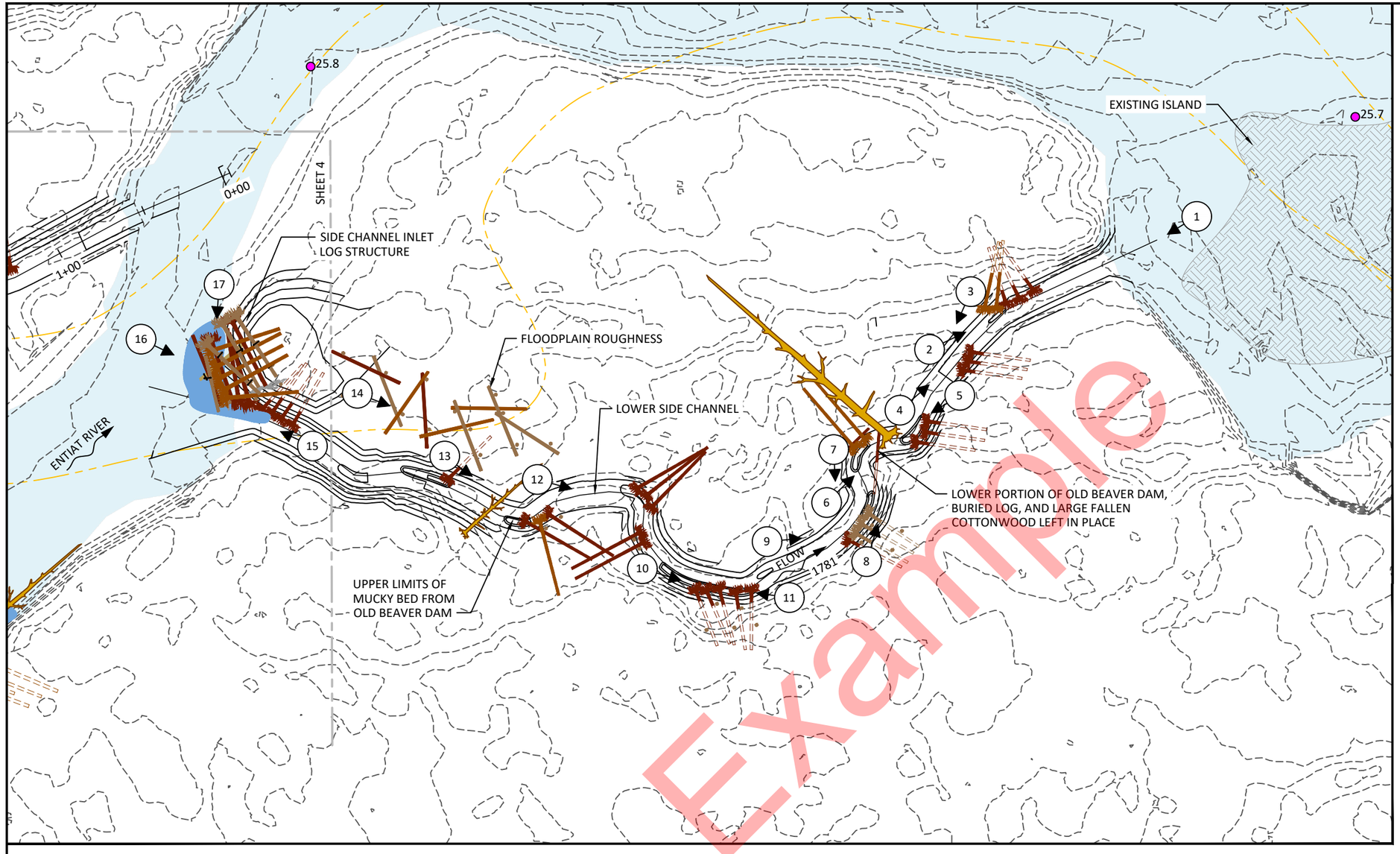
Inter-Fluve, 2021. Entiat Upper Burns & Angle Points Areas Habitat Enhancement Project Monitoring Plan. Submitted to Yakama Nation Fisheries December 2021.

United States Bureau of Reclamation (USBR). 2009. Appendix B—Hydrology Data and Geographic Information Systems, Entiat Tributary Assessment, Chelan County, Washington. Technical Service Center, Flood Hydrology and Meteorology Group (86-68250), Denver, CO.

USDA NRCS SNOTEL, 2024. Pope Ridge, Site PPRW1. https://www.nwrfc.noaa.gov/snow/snowplot.cgi?PPRW1

United States Geological Survey (USGS), 2024. Entiat River near Ardenvoir, Gage 12452800. https://waterdata.usgs.gov/monitoring-location/12452800

Appendix A: Monitoring Photo Reference Maps



PLAN LEGEND

- PROPOSED CHANNEL ALIGNMENT
- EXISTING 1 FT CONTOUR
- PROPOSED 1 FT CONTOUR
- PROPERTY BOUNDARIES
- EXISTING ISLAND
- 1 VIEWPOINT LOCATIONS

0 60 120

SCALE IN FEET

NO.	DATE	REVISION DESCRIPTION

CP	MR	DM
DRAWN	DESIGNED	CHECKED
-	12/31/2021	16-02-19
APPROVED	DATE	PROJECT

Upper Burns & Angle Point Habitat Enhancement Project
Confederated Tribes and Bands of The Yakama Nation
Chelan County, WA

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LOWER SIDE CHANNEL
MONITORING PHOTOS

SHEET
1 OF 3

Appendix B: Monitoring Photos

Photo Point 1: Lower Side Channel (LSC) outlet, looking upstream

2021:

2023:

2024:

No significant changes since project implementation. Outlet is well connected to right bank split flow channel of river; however, the split flow channel is still disconnected from the mainstem during low flow.

Photo Point 2: LSC outlet, looking downstream

2021:

2023:

2024:

Limited changes in channel geometry since construction in 2021. LWS is intact.

Photo Point 15: LSC inlet looking upstream

2021:

2023:

2024:

Significant large woody debris accumulation at face of inlet structure formed in 2023. The obstruction is still not limiting fish passage as there is a deep pool under the wood and the corner of the LWS, which is intact. See next photo point for additional comments.

Photo Point 16: LSC Inlet Jam, looking downstream

2021:

2023:

2024:

Significant large woody debris accumulation at face of inlet LWS. The wood may actually help keep the side channel open since it will likely limit the amount of sediment and smaller woody debris that can enter the lower side channel. A year after its formation, the jam appears to still have the same size and shape, and no action is recommended. This area should continue to be monitored though.

Drone Image: Lower Side Channel (LSC) 1, Outlet

2021:

2023: Photo taken on Oct 19, 2023

2024: Photo taken on Sept 19, 2024

Right split flow of river has returned to its pre-project condition and is disconnected from the mainstem during low flows. It appears someone has constructed a rock dam across the channel (circled), but it likely has limited impact. The channel remains wetted year around with deep pools, so it likely is suitable habitat until flows return.

Drone Image: LSC 2

2021:

2023: Photo taken on Oct 19, 2023

2024: Photo taken on Sept 19, 2024

Deep pools have formed in the mucky bed material that existed in the middle segment of the upper side channel. Moderate-sized wood debris jams have formed, including a couple jams that span the channel. However, the deep pools seem to at least partially offset the risk of bed accumulation.