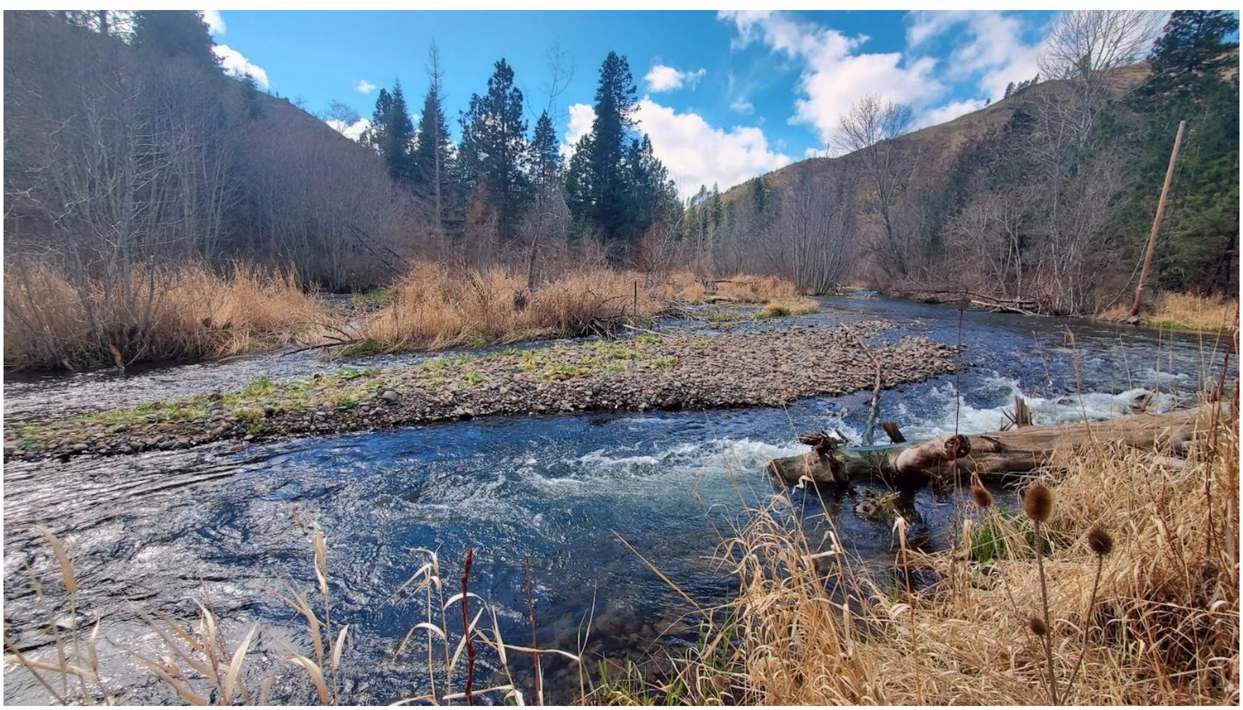
Tucannon River Big Four Floodplain Restoration Project

Tucannon River Basin, SE Washington

30% Design
Basis of Design Report



Project Area 9 Tucannon River 03-29-2024, A. Dysart

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1.0 PROJECT BACKGROUND

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) is leading the restoration of approximately 2 miles of the Tucannon River (River Miles 42.4 to 44.75) in the vicinity of Big Four Lake on the W.T. Wooten Wildlife Area, which is owned and operated by the Washington Department of Fish and Wildlife (WDFW). The project is co-managed by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Nez Perce Tribe (NPT), and Washington Department of Fish and Wildlife (WDFW). The project reach is identified as Project Areas (PA) 10.3 through 8 in the Conceptual Restoration Plan (Anchor QEA, 2011b). The Tucannon River is a tributary of the Snake River entering below Little Goose Dam. The project site is located approximately 26 miles east of Dayton, Washington.

CTUIR is pursuing restoration throughout the Tucannon River with a focus on addressing ecological concerns and restoration of First Foods as guided by the Umatilla River Vision (Jones, et al, 2008). Kris Fischer (CTUIR) is the project manager. Wolf Water Resources (W2r) has been contracted by CTUIR to design channel and floodplain improvements to this project area. This project aims to remove manmade features such as lakes and levees to improve natural floodplain connectivity by addressing stream power inequity and enhance habitat and floodplain complexity to support restoration efforts targeting bull trout, lamprey, mussels, and threatened Snake River steelhead and spring Chinook salmon in the Tucannon River Basin.

This Conceptual Basis of Design Report (BDR) summarizes existing conditions information and restoration design progress through the conceptual design phase. The project is seeking both Recreation and Conservation (RCO) Salmon Recovery Funding Board (SRFB) large capital grant funding for the 2024 grant cycle for construction, and Bonneville Power Administration (BPA) funding for design. The Project elements will be designed using HIP activity specific conservation measures, RCO Manual 18 Salmon Recovery guidance, as well as general conservation and construction measures.

PROJECT GOALS AND OBJECTIVES

1.0.1 GOAL

The goal of the project is to address the Primary Limiting Factors identified for the Tucannon River in the 2008 Fish Accords (Three Treaty Tribes-Action Agencies 2008), incorporating the primary touchstones described in the Umatilla River Vision (Jones, et al, 2008), and be consistent with the Snake River Salmon Recovery Plan for Southeast Washington (SRSRB 2006), Draft Columbia River Bull Trout Recovery Plan (USFWS 2010) and the Tucannon Sub basin Plan (CCD 2004).

The project will address the effects of the Big Four Lake put and take trout pond and its associated infrastructure, including the lake intake and return channels, pushup berms, and the incision that has resulted from the lake laterally confining the floodplain. The goal of the project is to improve and restore the system's ability to support First Foods using guidance provided by the Umatilla River Vision (Jones et al. 2008). The corresponding ecologic concerns affecting the River Vision touchstones that can be addressed specifically by this project include: high stream power and water temperatures; insufficient pools; shortage of LWD; loss of riparian vegetation; uncharacteristic vegetation; lack of trees in riparian zone for shade, cover, and large wood recruitment; stream-valley floor hydrologic connection; channel form, stability, sinuosity, pool/riffle ratios and aquatic fish habitat complexity; substrate embeddedness; wetland state; and beaver habitat. An overarching goal is to address these ecologic concerns in a manner that acknowledges their interconnectedness and positive feedbacks. The types of actions and ways these ecologic concerns can be addressed so they restore the five touchstones are laid out more specifically as project objectives in the next section.
CTUIR seeks to return the Tucannon River corridor to historic functioning capabilities to not only provide improved habitat for native fish species, but also to provide suitable habitat to promote the return of wildlife and native plants.

1.0.2 OBJECTIVES

Objectives specific to this design effort were developed as part of the Tucannon River Planning and Concept Design for PA 5-15 and address site specific constraints and opportunities. These will be used to guide development of the design. They include:

- Increase floodplain connectivity and frequency of inundation to a condition closer to historical and natural form. Re-engagement of the floodplain will result in flows that are less confined, decreased stream power, increased and more variable gravel deposition, raised groundwater tables, and decreased water temperatures. Improving the groundwater connection increases hyporheic flow and improves the prevalence of native riparian species.
- Increase channel complexity with channel morphology (channel form, sinuosity, complexity, geomorphic and hydrograph stability) closer to historical and functional form especially multi-thread channels, wood, pools, and a diversity of bed material sizes.
- Increase stream velocity diversity at both low and high flows.
- Increase quantity and quality of habitat diversity, especially large wood and pools.
- Reestablish geomorphically-appropriate sediment sorting and routing.
- Improve and reestablish in-stream thermal diversity throughout the year.
- Improve quality and diversity of in-stream and off-channel habitat for resident and anadromous fish in the Tucannon River by increasing locations suitable for adult spawning and increasing area available for juvenile rearing.
- Restore natural channel forming processes through the addition of large wood to increase channel complexity, and restoration of sediment routing processes through the removal of ponds, levees, and other floodplain impediments.
- Reestablish native floodplain plant communities and riparian function with site-appropriate native vegetation and off-channel habitat. Realistic, cost-effective planting plans will maximize plant survival and minimize labor and maintenance; the planting plan will reflect CTUIR First Food values.
- Work closely with the CTUIR and their project partners (restoration team) at each stage of design and obtain consensus on the design before proceeding to the next design stage.

1.0.3 DESCRIPTION OF FULL VALLEY RESTORATION TECHNIQUES

The driving goal of restoring the full valley is a type of approach that addresses channel-floodplain disconnection through lowering (grading) of artificially high (i.e. disconnected) floodplain areas and filling of incised channels. These actions effectively equalize floodplain and channel elevations to maximize floodplain engagement, minimize stream power per unit width, re-initiate sediment deposition, and raise groundwater tables to promote vegetation success. Specific elements of this approach include:

- Floodplain grading that targets removal of artificially high areas (such as berms and roads). Importantly, low areas such as those containing wetlands are avoided with floodplain excavations.
- Designs promote full floodplain connectivity to allow the stream to find its natural multi-threaded dynamic equilibrium. Maximum connectivity is achieved through partial filling of the channel with material excavated from high floodplain areas. Excavation of narrow side channels is de-emphasized.
- Placement of wood habitat structures, large logs, and other roughness elements further decrease unit stream power (stream power per unit width) across the floodplain.

The outcomes expected from the full valley restoration design approach include:

- Decreased stream power through the project reach in the mainstem;
- Improved connectivity of the floodplain and adjacent wetland complexes;
- Improved access and suitability of off-channel networks and shallow-water habitat for juvenile salmonids;
- Expanded edge habitat which will benefit multiple species by increasing primary production and prey availability within the food web;
- Increased ponding; and,
- Increased water quality due to improved hydrologic conditions and increased channel and floodplain complexity.

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

Project Sponsor – Confederated Tribes of the Umatilla Indian Reservation (CTUIR);
Project Partners – Nez Perce Tribe (NPT) and Washington Department of Fish and Wildlife (WDFW);
Land Owner/Manager – Washington Department of Fish and Wildlife (WDFW); and
Design Engineer – Wolf Water Resources (W2r).

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

The proposed project elements have been designed by a licensed engineer and are summarized below:

- Removal/regrading of the Big Four lake and infrastructure.
- Grading/excavation of existing push-up levees and berms to increase floodplain connectivity.
- Lowering and enhancement the floodplain and wetland depressions to support native emergent marsh and scrub-shrub vegetation.
- Placement of excavated materials in the incised mainstem channel to expand floodplain connectivity;
- Placement of large wood structures and individual large logs throughout the project area to increase channel and habitat complexity, and increase floodplain connectivity.
- Project flood risk assessment.

1.3 RISK TO INFRASTRUCTURE, POTENTIAL CONSEQUENCES AND COMPENSATING ANALYSIS TO REDUCE UNCERTAINTY.

- No damage to infrastructure is anticipated as a result of this project. Evaluation of all project elements will ensure the existing road will not be affected as a result of this project. The existing surface water diversion intake for Big Four lake was disconnected from the river due to incision caused by the 2020 flood and is no longer operational. Additionally, this incision has made accessing the lake for stocking and repairs difficult and hazardous.
- The project is designed to not result in increased flood risk to infrastructure adjacent to the project reach which includes roads, overhead power lines, campgrounds, and infrastructure associated with the operation of Curl, Watson, and Beaver Lakes.
- The project will consider the relocation of infrastructure including, but not limited to, overhead powerlines which run through the project area and are potentially at risk from flooding and erosion due to natural river processes.

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

Native fish assemblages in the Tucannon River Basin evolved in a system of cold, clean water with complex and dynamic lotic habitats, with dense riparian communities that were ecologically connected between the aquatic and terrestrial environment through floodplains. Past anthropogenic activities reduced the quality of fish habitat in the Tucannon River, causing the loss of natural processes that once connected the Tucannon to its floodplain. Fisheries information included here is a summary of information primarily derived from the Tucannon Subbasin Plan (TSP) (CCD 2004) and the Snake River Recovery Plan for SE Washington (SRSRP 2006).

The Tucannon River is used by multiple fish species of interest, including spring Chinook salmon (*Oncorhynchus tshawytcsha*), fall Chinook salmon (*O. tshawytscha*), (bull trout (*Salvelinus confluentus*) and summer steelhead (*Oncorhynchus mykiss*) listed as threatened under the ESA, which are all identified as aquatic focal species of concern in the Tucannon Subbasin Plan (TSP) (CCD 2004). These species collectively utilize the entire length of the river at some stage of their lifecycles and are present throughout the Tucannon River year-round. In particular, the project reach is important for steelhead and spring Chinook, specifically for steelhead rearing and spring Chinook spawning and rearing. Fall Chinook are known to use only the lower 18 miles of the Tucannon River.
Spring Chinook salmon in the Tucannon River are included in the Snake River spring/summer Chinook salmon ESU originally listed as threatened under the ESA in 1992 (57 FR 14653) and again in 2005 (70 FR 37159), with an update of the listing in 2014 (79 FR 208020) (National Oceanic and Atmospheric Administration [NOAA] Fisheries 2024). Spring Chinook salmon adults migrate into the Tucannon River from late April through mid-September and spawn in the project reach from mid-August to the end of September. Juveniles use the reach for rearing year-round following emergence in late March. Juveniles out-migrate from early October to early July.

Steelhead in the Tucannon River are part of the Snake River Basin steelhead evolutionarily significant unit (ESU), originally listed as threatened in 1997 (NMFS 2009) (62 FR 43937) and again in 2006 (71 FR 833), with an update of the listing in 2014 (79 FR 20802) (NOAA Fisheries 2024b). Summer steelhead adults migrate into the Tucannon River in September and spawn within the project reach in late February until mid-May. Juvenile rearing also occurs year-round throughout the project reach following emergence in July. Juveniles out-migrate from mid-October to Mid-July

The Tucannon River bull trout population is part of the Lower Snake River Critical Habitat Unit (USFWS 2010) and were listed as threatened in 1998. Bull trout life histories present in the Tucannon River include resident, fluvial, and adfluvial forms. Migratory bull trout move upstream from the Snake River into the upper Tucannon River in the spring and early summer. Critical habitat in the Tucannon Critical Habitat Subunit includes the mainstem Tucannon, Cummings Creek, Hixon Creek, the Little Tucannon River, Panjab Creek, Cold Creek, Sheep Creek, and Bear Creek (USFWS 2010). The Tucannon River is an important migratory corridor to spawning and rearing areas upstream in the watershed, including the project reach, headwaters and tributary streams.

Habitat conditions in the Tucannon River for aquatic focal species were assessed using an Ecosystem Diagnosis and Treatment (EDT) analysis (CCD 2004, Appendix B of TSP). This analysis identified the primary limiting factors (SRSRB 2006 and SRSRB 2011) to aquatic focal species in discrete reaches throughout the river. The ecological concerns identified in the reach include summer temperatures (warm), key habitat quantity (lack of complex rearing pools), habitat diversity (complexity and channel bed/form), channel instability, fine sediment and invasive species. More specifically, the reach apparently has incised from its pre-settlement condition as a result of site- and watershed-scale agricultural activities and grazing, floodplain manipulation, vegetation and wood removal, and road construction by European settlers. The incised condition (in concert with confining floodplain berms and spoil piles) and lack of large wood limits floodplain connectivity, increases in-stream shear stresses, has potentially lowered groundwater tables, and has resulted in decreased habitat diversity and complexity and elevated late-summer water temperatures. This project will address limiting factors listed above through process-based restoration that will re-establish the natural functions of floodplain processes to result in increased fine sediment storage on the floodplain and in wetlands, increased wood presence and associated hydraulic diversity both in-channel and across the floodplain, and improved floodplain hydrology. This will result in increased habitat quantity and complexity, decreased instability, decreased instream fine sediment, potentially lower late summer water temperatures, and re-establishment of a native plant community.

1.5 LIST OF PRIMARY PROJECT FEATURES INCLUDING CONSTRUCTED OR NATURAL ELEMENTS

- Improved Floodplain Connectivity– excavation to lower or remove high ground and berms to promote lateral connectivity.
- Channel Reconstruction – strategically place material in the incised portions of the channel to increase floodplain connectivity and spread flow to the lowered floodplain.
- Install Habitat-Forming Natural Structures – large wood and individual logs throughout the reach to increase channel complexity.
- Construct beaver dam analogue structures to promote native vegetation and beaver activity.
- Riparian Planting and invasive vegetation control (throughout reach).

1.6 DESCRIPTION OF PERFORMANCE / SUSTAINABILITY CRITERIA FOR PROJECT ELEMENTS AND ASSESSMENT OF RISK OF FAILURE TO PERFORM, RISK TO INFRASTRUCTURE, POTENTIAL CONSEQUENCES AND COMPENSATING ANALYSIS TO REDUCE UNCERTAINTY

The design and construction of the project incorporate the following to reduce or eliminate potential risk and consequences:

- The design will incorporate both stability and roughness elements (structures) to reduce the risk of headcutting from downstream into the project.
- Wetlands will be preserved with very little alteration. No fill will be added to wetlands. Wetlands will be improved by adding wood only.
- Stream power will be distributed and floodplain connectivity increased by scraping down a high ground terrace and levee, excavating two swales, and placing that material in degraded portions of the mainstem channel.
- The project monitoring and adaptive management plan will be developed in collaboration with CTUIR. CTUIR will coordinate with WDFW to implement the adaptive management plan at the site following the project actions as WDFW continues to manage the property.

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

The Big Four Floodplain Reconnection project will include:

- Excavation and placement of channel fill from existing push-up levees and berms in the floodplain;
- Placement of log jams/large wood in and associated with channels;
- Placement of individual logs and small log structures on floodplain; and
- Invasive vegetation species treatment and revegetation.

Equipment will be tracked to individual installation sites with only minimal scraping and grading as needed. Access routes will be selected to minimize disturbance to existing native vegetation. Construction of project elements below Ordinary High Water (OHW) will be carried out during the summer in-water work window for the Tucannon River, July 15th through August 15th. The timing of excavation at the site will coincide with low site hydrology.

2.0 RESOURCE INVENTORY AND EVALUATION

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

A historical summary of the Tucannon River watershed is provided in the Tucannon River Geomorphic Assessment and Habitat Restoration Study (Anchor QEA, 2011a). The watershed has experienced a history of livestock grazing, agriculture, timber harvest, wildfires, road building, and sparse settlement. These watershed-scale land-uses and impacts have likely combined to degrade habitat throughout Tucannon River by increasing fine sediment loading, degrading riparian areas, limiting natural geomorphic processes especially large wood recruitment and floodplain connectivity.

Specific impacts to the project area including lakes, push-up levees or side-cast berms, road and bridge building, clearing and gravel removal, and the School Fire in 2005 have all directly impacted the channel and floodplain processes. These impacts include decreased floodplain connectivity, increased stream power, and channel incision. Channel wood-clearing and removal of large trees from the floodplain and adjacent areas have decreased the volume of large wood material available for recruitment as well as decreased shading leading to increased water temperatures. Artificial floodplain lakes in the project reach reduce channel migration and contribute to hydrologic modification of the river by diverting water. Restoration activities in this reach over the recent past have focused on restoring large wood, promoting pool formation, and increasing floodplain connectivity.

Historical channel straightening has been identified as having significant impact on the Tucannon River. Based on comparison of a series of aerial photographs (1937, 1954, 1964, and 1978), Hecht (1982) estimated that the Tucannon River channel through the project area shortened in length between 1937 and 1978. The study noted that the Tucannon River appeared to be trending toward a braided channel form rather than a “stable meandering pattern” over this same time period. Another observation in the study was that the most visible significant change in the photos was the reduction in floodplain vegetation and canopy cover as well as total length of “wooded banks”. The author acknowledged that the Tucannon is a relatively steep alluvial channel with a geomorphic propensity to develop braided channels rather than a single-thread meandering channel and that the noted channel straightening in this upper segment of the river was largely a result of channel response to major floods.

The floodplain and riparian area vegetation has most recently been altered by the School Fire, which occurred in 2005. The fire severely burned the riparian area in the downstream half of the project area and all of the subbasins draining directly to the reach. This fire significantly degraded riparian cover and the reach still has not fully recovered. Additionally, in areas where the floodplain has been disconnected there are problems with invasive vegetation and uncharacteristic vegetation establishment including cheat grass and reed canary grass. Generally, cottonwood trees, red alder, and a few scattered groves of aspen make up the canopy vegetation, with increasing density of ponderosa pine and Douglas fir in the upstream portion of the project reach.

2.2 DESCRIPTION OF EXISTING GEOMORPHIC CONDITIONS AND CONSTRAINTS ON PHYSICAL PROCESSES

As described in the Tucannon River Geomorphic Assessment and Habitat Restoration Study (Anchor QEA 2011a) the Tucannon watershed consists primarily of Miocene-aged Columbia River Basalt flows of the Grande Ronde, Wanapum, and Frenchman Springs members with recent Quaternary river alluvium along the valley floor. Basalt is exposed at the surface upstream of Tumalum Creek (RM 35.5) and along the valley walls between RM 35.5 and RM 18. The valley fill in much of the basin is Quaternary flood outburst and alluvial deposits consisting of stratified sand, gravel, and cobble, with recent Quaternary river alluvium along the valley floor (Anchor QEA 2011a, Anchor QEA 2021). Alluvial fans line the valley floor at the mouths of tributaries throughout the study area. Ancient alluvial fan and hillslope deposits are present in many locations that constrict the overall valley and floodplain width.

The Big Four Project Area is a moderately confined to unconfined reach with an average channel gradient of 1.3%. The highest confinement is present from RM 42.4 to 43.4 and from RM 44.2 to 44.3 and is influenced by the road, infrastructure associated with Beaver, Watson, and Big Four Lakes, and narrow portions of the valley created by alluvial fans and bedrock outcrops (e.g. RM 42.8). Between these sections the river is unconfined, however, much of the floodplain within the unconfined sections is largely disconnected due to channel incision, which worsened during the 2020 flood in many areas. The river through the project reach is primarily a single thread, meandering channel with local braided sections. In unconfined areas the river is typically a series of long anabranch channels often separated by forested floodplain that is several feet above the channel elevation. The moderate grade and relative lack of confinement suggest that the reach has potential to function as a depositional “response” reach as denoted by Montgomery and Buffington (1997). Tree and large wood removal from the channel and floodplain combined with the effects of the recent large flood in February of 2020 have had significant impacts resulting in simplified channel bed geometry and a general reduction or lack of large pools.

Channel incision appears to have been occurring since the influx of European settlement in the past two centuries due to deforestation of the valley floor, draining of riparian wetlands, and channel diversion and simplification. The construction of a series of lakes within the floodplain between RM 36 and RM 46 in the 1950s arrested the channel in its incised state and in many cases exacerbated channel incision. The encroachment of infrastructure has further prevented the channel from widening or developing a multi-thread channel and limited the recovery potential. Reduced overbank flooding and fine sediment deposition resulting from incision has impacted in-stream sediment transport and contributed to the channel and floodplain simplification. This reach exhibits some gravel bar and overbank fine sediment deposition with apparent sediment supply greater than described for other reaches.

2.3 DESCRIPTION OF EXISTING RIPARIAN CONDITION AND HISTORICAL RIPARIAN IMPACTS

The existing riparian condition is primarily ponderosa pine with cottonwood and some Doulas fir. In wetland areas native species persist, however reed canary grass is both present and dominant in many areas. Also see Section 2.1 for description of historical impacts.

2.3.1 ORDINARY HIGH WATER AND WETLANDS

A planning–level assessment of wetland areas was performed in September 2023. This evaluation included a desktop assessment which was refined through field verification of the presence or absence of wetlands. National Agriculture Imagery Program (NAIP) imagery and a relative elevation model were used to identify the OHWM boundary and where wetland hydrology was likely present. During the field investigation, vegetation communities and geomorphic position were observed and documented.

Within the project reach, there is one artificial lake previously managed by WDFW for recreation. The Big Four lake is shallow and no longer functions as a put and take pond, but has an adjacent wetland complex with hydrology originating from water seeping through the lake berm and margins. The wetlands occur on both the upstream and downstream margins of the lakes. During high-flow events, these wetlands are hydrologically connected to the water table of the adjacent river. Additionally, numerous instances of groundwater contributing to hillslope seeps at the slope toe and floodplain edge were observed.

A wetland assessment memorandum draft that includes the project reach was submitted to CTUIR on January 24, 2024. Description of observed wetlands and determination methodology are described in further detail in this memo. This assessment of wetland areas is not comprehensive. Varying sources of wetland hydrology limit predictability of wetland hydrogeomorphic classification. Additional project specific fieldwork will be required once projects impacts are better defined. We used the resulting shapefiles of delineated ordinary high water (OHW) and wetland features for preliminary design.

2.4 EFFECTS OF FEBRUARY 2020 FLOOD EVENT.

In early February 2020 a large flood event occurred throughout southeast Washington and northeast Oregon. The Tucannon River experienced an approximately 25-year flow during this event. Visual observations of the physical impacts to the project site include:

- Big Four lake overtopping and berm and bank erosion.
- Reworked gravel bars sporadically throughout the length of the project area
- Overbank/floodplain gravel and fine sediment deposits sporadically throughout the low floodplain surface
- New woody material deposition and re-positioned woody material within the low floodplain area throughout the project area

Post-flood observations indicate that some gravels and woody materials were reworked and deposited, and there likely were some additional gravel and wood materials transported into the reach, with the initial result of trending toward the restoration goals developed for this project. However, additional removal or modification of existing infrastructure (berms and lake) as well as floodplain and channel grading to address channel incision is required to fully achieve those goals.

3.0 TECHNICAL DATA

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

The Tucannon River Big Four Floodplain Restoration Project was designed using HIP activity specific conservation measures. Design and construction drawings and specifications (developed during the next design phase) will follow and include all HIP Conservation Measures Specific to these activities as well as the general conservation and construction measures. Primary project actions are described in the context of the HIP Activity Specific Conservation Measures as follows:

- **Category 2a - Improve Secondary Channel and Floodplain Interactions:**
    - Reconnect the floodplain and create new self-sustaining side channel and wetland habitats.
    - Excavate and lower artificial barriers to floodplain connection including levees, push-up berms, and high ground adjacent to incised channel sections. Target reconnection of floodplain swales and existing side channels to promote a multi-threaded channel and connected floodplain.
- **Category 2b – Set-back or Removal of Existing Berms, Dikes, and Levees:**
    - Remove artificially high features on the floodplain including the Big Four Lake and associated berms and infrastructure, and any other berms and dikes levees identified within the project reach which are no longer necessary for flood protection.
- **Category 2d – Install Habitat Forming Instream and Floodplain Wood Placements:**
    - Medium-to-large wood placements (primarily apex log jam type structures). Medium-to-Large wood structures will be designed to mimic the natural accumulation of wood with no or minimal artificial anchoring. Only natural, non-treated wood materials will be used. Stability analyses will be performed as required.
    - Small wood and single log placements throughout the floodplain and wetlands to increase split-flow and maximize floodplain complexity and habitat. Only natural and non-treated wood

materials will be used. Anchoring will consist of passive methods only, such as partial burying or no anchoring at all.

  - Beaver dam analogues will be installed in floodplain swales and side channels to encourage ponding and temporarily raise the water table in support of native riparian vegetation and rearing juvenile salmonids.

- **Category 2e - Riparian Planting:**
  - Native species will be used and the riparian planting plan will be prepared by personnel with native riparian vegetation design experience.
- **Category 2f - Channel Reconstruction:**
  - Fill Incised Channel Areas - Selectively use excavated material to fill some incised channel areas to maximize floodplain engagement and reduce effects of past incision. Specific Conservation Measures ensure that these materials are appropriately sized and placed in incised segments that do not include spawning suitable areas.

3.2 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

The Tucannon River drains the northwestern Blue Mountains of southeast Washington. The watershed contributing to the project reach is 93 square miles (mi^2), with a mean annual precipitation of 43 inches and a mean and maximum elevations of 4,580 and 6,370 feet (StreamStats). The Tucannon River has two active gages, both of which are located downstream of the project reach. As part of the geomorphic study performed by Anchor QEA a hydrologic analysis (Anchor QEA, 2011a) was performed for each reach identified in the report. This analysis was performed using a Partial Duration Series methodology in which the largest 54 independent flood events were selected (one for each year in the period of record), regardless of the year they occurred. A benefit of this method over the standard Bulletin 17C method is that it accounts for drought years during which no appreciable flood event occurred, typically providing higher estimates for more frequent events, and only slightly lower estimates for the highest flood events. To determine peak discharges at ungauged sites, such as the Big Four Project Site (Reach 9 in the Anchor Report), a basin scaling method developed by Thomas et. al. (1994) and referenced in the USGS fact sheet *Methods for Estimating Flood Magnitude in Washington* (2001) was used. These results were further refined using stream gage correlations between the two active gages on the Tucannon River and a gage on the nearby Pataha Creek. The details of these gages and the resulting peak discharge estimates for the project reach are summarized below in Table 1 and Table 2. For comparison, a USGS StreamStats analysis was run at the downstream end of the project reach. This analysis significantly underpredicted peak discharges for events above the 10-year recurrence interval and produced a higher estimate for the 2-year event.

Table 1. Table of stream gages on the Tucannon River.

Gage ID	Name	Agency	River Mile	Dr. Area, mi^2	Period of Record Used in Study	Notes
35B150 (Ecology), 13344000 (USGS)	Tucannon River near Marengo	Ecology (active), USGS (past)	27.2	160	1913-1930 (USGS), 2003-2009	Turner Road Bridge
13344500	Tucannon River near Starbuck	USGS	8.8	431	1914-2009	
35F050	Pataha Creek	Ecology	N/A	184	2003-2009	Pataha Creek near mouth

Table 2. Peak flood statistics for the project reach.

Annual Exceedance Probability	Recurrence Interval, yr	Low Discharge Estimate (Anchor, 2011)	High Discharge Estimate (Anchor, 2011)	USGS StreamStats
99%	1	174	272	-
50%	2	425	665	784
20%	5	948	1,481	1,060
10%	10	1,457	2,276	1,270
4%	25	2,322	3,627	1,550
2%	50	3,151	4,923	1,800
1%	100	4,160	6,498	2,040

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

Based on the presence of active gravel bars, the reach appears to have a relative abundance of gravel. Anchor's (2011a) sediment budget and transport assessment provides context for the observed sediment dynamics. Their transport assessment made use of shear stress outputs from hydraulic modeling, and subsequent calculations of sediment transport capacity at a range of flows (the results of which are shown in Figure 1). Sediment transport capacity was specifically reported in terms of critical grain diameter, which is the grain size that experiences incipient motion during given flow conditions. The longitudinal trends in modeled critical diameters indicate that the project reach lies in a broader ~2-mile reach (RM 42-44) of declining sediment transport capacity, which suggests the reach acts as a depositional reach.

Anchor (2011a) also measured the flux of suspended sediment at the gage location at Marengo (downstream of the site), which indicates annual suspended yields are roughly 8500 tons/year. Using a conservative assumption that bedload represents 25% of suspended load (this proportion can vary widely but is commonly assumed to be 10%, Turowski et al. (2010), the estimated gravel load may be as high as 2125 tons/year. Using standard assumptions of gravel density, this translates to about 1400 cubic yards/year. Based on a recent data compilation by Legg (2020), this annual volumetric supply is relatively high for the intermountain west.

In summary, Anchor's sediment transport and supply estimates indicate that the reach is transitional to depositional in nature and has relatively high gravel supplies provided from upstream. These results are consistent with observations of active gravel bars throughout the reach and suggest that there is a naturally high pace of dynamism and habitat formation in the project reach.

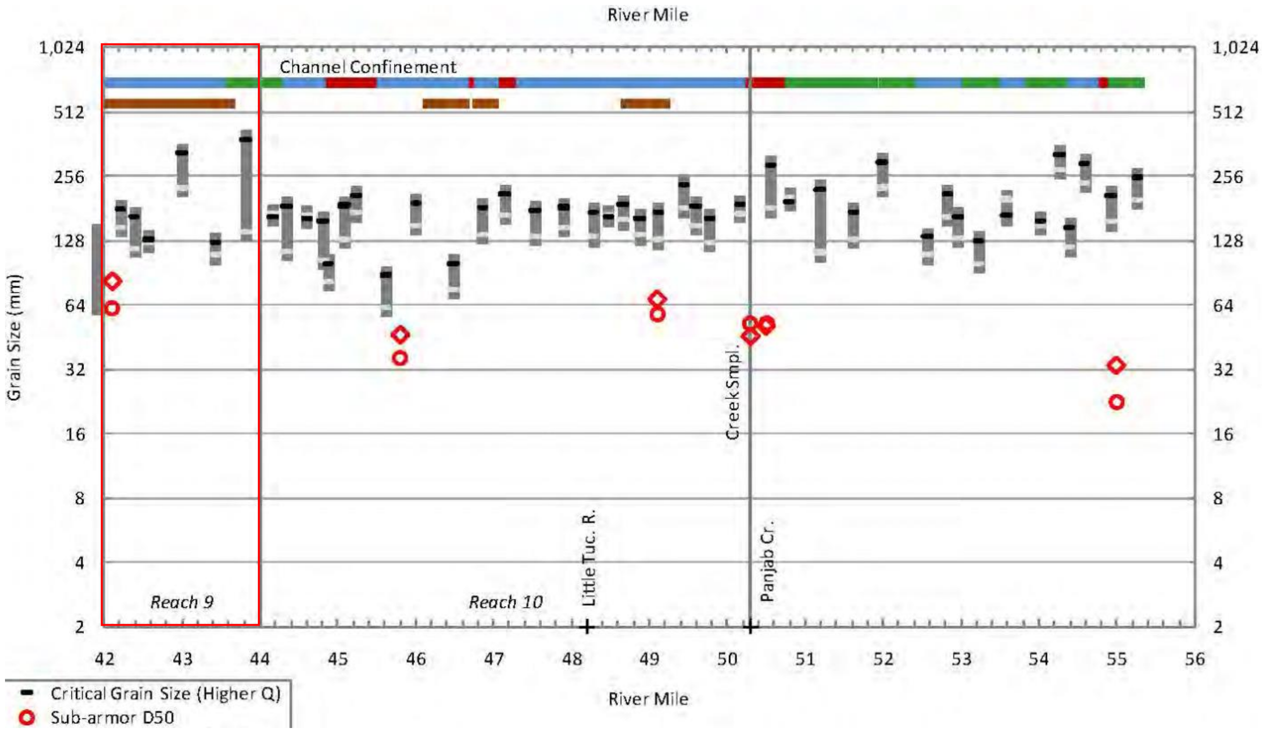

Figure 1 Anchor (2011a) longitudinal plots of modeled sediment transport capacity and measured grain sizes shown.

As described in Section 2.4 in this report, the Tucannon River experienced an approximately 25-year flow event in February, 2020. Visual observations of the physical impacts to the project site include:

- Big Four lake overtopping and berm and bank erosion.
- Reworked gravel bars sporadically throughout the length of the project area
- Overbank/floodplain gravel and fine sediment deposits sporadically throughout the low floodplain surface
- New woody material deposition and re-positioned woody material within the low floodplain area throughout the project area

3.4 DESCRIPTION OF HOW PRECEDING TECHNICAL ANALYSIS HAS BEEN INCORPORATED INTO AND INTEGRATED WITH THE DESIGN DOCUMENTATION.

Sections in Chapter 3 include technical analyses associated with the project reach.

At the preliminary design phase, LiDAR which was flown in 2020, provides the topographic data used to estimate grading and channel planform. Future work will include topographic and bathymetric survey in critical areas to confirm LiDAR accuracy and improve estimates for grading volumes and target elevations.

Hydrologic analysis performed during a previous study by Anchor QEA, and checked through the USGS StreamStats tool provided the design team with expected flow regimes for the Tucannon River in the project reach. Expected annual and bank full discharge flows as well as flood events aid design of channel and floodplain as well as large wood stability analysis.

Hydraulic modeling (to be performed at a later design phase) will inform channel and floodplain design with velocities, shear and water surface elevations, critical to optimize flow spreading and floodplain connectivity while minimizing flood impacts to surrounding infrastructure. Additionally, hydraulic model output will inform placement and design of wood habitat structures and associated stability analysis.

4.0 PROJECT ALTERNATIVES, CONCEPTUAL DESIGN, AND PRELIMINARY DESIGN

4.1 RESTORATION ALTERNATIVES AND SELECTION

Project alternatives were based on conditions and features identified in the Tucannon River Planning and Concept Design for PA 5-15 Assessment (Anchor QEA, 2011b) and from the goals and objectives identified by CTUIR and the Snake River Salmon Recovery Plan for the Tucannon River. These are described in detail in sections 1 and 2 of this report. Initial review of alternative design elements, and the selection of the preferred alternative occurred primarily through verbal and email communication. Refer to Appendix 1 for figures of the alternatives.

The alternatives considered the following general restoration design elements to achieve project goals and objectives:

- **Removal of the Big Four Lake**, associated berms, and infrastructure. The existing lake is in disrepair, currently inaccessible for fish stocking or recreation, and significantly constricts the Tucannon River floodplain. This action would remove the berms and infrastructure maintaining the lake, fill the lake, and restore the floodplain to its original width. Removal of this encroachment is key to the restoration of natural geomorphic processes within the project reach. With a broader connection, energy can be dissipated across the floodplain, reducing velocities and shear stresses (erosive forces) in the main channel and allowing the channel to migrate laterally to develop complex anastomosing channel systems and a diverse planform.
- **Floodplain Grading** to lower broad areas of high ground features on the floodplain. The intent of this action would be to partially address the channel's incised condition by lowering portions of the floodplain to an elevation closer to the channel to encourage more frequent floodplain connection. The exact locations of these grading areas would be selected based on their potential to reconnect broader existing wetland, side channels, and other low-lying areas which would have the potential to be converted to wetland through restored hydrologic connection. This action reduces the threshold for floodplain connection and encourages the formation and connection of multiple flow paths which distributes energy and sediment more broadly across the riverscape, encouraging beneficial geomorphic processes to take over to develop and maintain a diverse and dynamic channel-floodplain-wetland complex.
- **Side channel reconnection** would grade select areas to open inlets to reconnect side channel and low-lying off-channel wetlands. This would increase the frequency of connection to these features and distribute higher flows to reduce stream power per unit width in the mainstem, improving the retention of gravels and large wood and reducing the risk of redd scour which has been identified as a limiting factor in the Tucannon watershed. The connection of these features provides a diversity of hydraulic conditions which is beneficial for many species throughout the full range of the annual hydrograph. This has been demonstrated in reference reaches nearby where observational data and modeling show higher scores for habitat suitability indices.
- **Channel Fill** to broadly raise the channel profile throughout the project reach. This would be intended to reverse historic incision and improve connectivity to the floodplain and side channel features, restoring a braided, anastomosing channel morphology with low banks and a high level of connectivity to floodplain and emergent wetland habitats, this action would be considered high impact and high benefit. This treatment is intended to be a long-term solution to the historic incision and straightening of the main channel which has occurred. By filling the channel geomorphic processes would be jump started, allowing for a much more rapid recovery time than through the placement of wood alone or through gravel augmentation. This action immediately maximizes floodplain connection and all the habitat and geomorphic benefits that come with it. Material used for channel fill would consist of native alluvium sourced from the removal of Big Four Lake, Floodplain Grading areas, and the removal of other berms and levees within the project reach.

- **Gravel Augmentation** would be a lower impact placement of fill in the channel compared to the full channel fill and would be intended to increase connectivity in some locations, partially filling the channel, constructing riffles, and building out bars using material generated from side channel reconnection grading and the removal of the Big Four Lake berms. This action would be paired with the installation of large wood structures to maximize the benefits of each action.
- **Construct large-scale channel spanning jams** (typically between 15-25 logs per jam) to create high energy dissipation in the main channel flows to force flow out of the main channel, increase floodplain connectivity, and trigger aggradation and dynamism in the main channel. Historically the Tucannon River was estimated to have much more frequent large wood jams, at least 2-3 per mile, than it does today. These jams are a key component driving the channel's natural geomorphic processes and provide critical habitat for spawning adults and rearing juvenile salmonids.
- **Construct medium-to-large instream wood structures** (primarily apex and channel spanning log jam type structures) with the intent of maximizing floodplain engagement, activation of side channels, triggering aggregation and flow distribution, and increasing instream and floodplain habitat complexity.
- **Small wood and single log placements** throughout the floodplain and wetlands to increase floodplain complexity and habitat, and to provide a source of instream large wood as the channel forms new flow paths or avulses.
- **Broadcast large wood placement** throughout the channel, side channel, floodplain, and wetland areas. This strategy of wood placement would prescribe the placement of approximately 70 large key members per acre to be distributed throughout the project site in all graded areas, reconnected floodplain, and side channels. This action would be used in areas where flows are generally distributed shallow and where the stream power has been greatly reduced so that wood stability can be achieved without the need for engineered jams. This method is intended to allow for some dynamic movement of large wood as the channel migrates laterally across the floodplain to ensure that there are always pieces interacting with the channel as it gradually develops or is changes with large flood events.
- **Installation of Beaver Dam Analogues (BDAs)** or similar simple structures to encourage ponding of water in off-channel areas to accelerate floodplain and wetland recovery. These structures typically have a short lifespan; and may require some annual maintenance if the effects are to be maintained. Ideally the goal in these areas is to create conditions that are attractive to beaver and encourage colonization so that they construct and maintain their own structures; however, this is extremely difficult to predict.
- **Invasive vegetation management and revegetation** would coincide with all grading activities. The existing vegetation on the site is largely native; however, with any large ground disturbance it's critical that native species be reestablished as quickly as possible to prevent the introduction and proliferation of any invasive species in the freshly disturbed areas.

ALTERNATIVE 1: DO NOTHING

One option is to take a no action approach in this reach. This would leave the defunct Big Four Lake intact, and maintain the channel in its existing configuration, with no structures added. During the most recent large flood event in February 2020, it was observed at the reach below the diversion structure for Beaver and Watson Lakes and adjacent to Big Four Lake incised further, threatening the water supply for these lakes. The confinement upstream at Big Four Lake and downstream at Beaver and Watson Lakes, the lack of large wood input, and the low bedload, leave few opportunities for the channel to recover function without intervention.

ALTERNATIVE 2: ENGINEERED LARGE WOOD STRUCTURES AND BIG FOUR LAKE REMOVAL

Alternative two is to treat the project reach with numerous engineered large wood structures and to remove Big Four Lake, using the berm material to fill the lake. The engineered large wood structures would be strategically placed to promote floodplain and side channel connectivity, encourage channel dynamism, capture sediment to aggrade the channel, improve sediment sorting, and increase the overall diversity of instream habitat. The structures installed would primarily be a mix of apex jams and various sizes of full channel spanning jams. This alternative removes the constriction at Big Four Lake and relies on large wood to trigger the positive feedback loops necessary for the system to begin reversing the historic pattern of incision. This alternative is likely a short to medium-term treatment and carries a high risk of the channel avulsing around structures, leaving abandoned or blown out structures. Relying on just wood placements may have local habitat benefits, but is not sufficient to shift the overall trajectory of the reach. Similar large-wood placements in lower reaches have only minimally improved side-channel and floodplain connectivity

An important consideration of this alternative is the limited access to the channel in many locations due to the terrain and vegetation. It is likely that a large portion of the wood would require placement by helicopter, which makes it more difficult to meet stability requirements. This alternative would have a low impact to existing resources (i.e. wetlands, vegetation, etc.), but is unlikely to generate the same level of long-term uplift that more intensive treatments may produce. Due to the large number of structures, the methods of construction that may be required, and the fact that these structures will be installed in an incised channel exposed to high hydraulic forces, this alternative carries a higher risk that structures may fail and could affect the infrastructure downstream at Beaver and Watson Lakes.

In summary, this alternative would take the following actions (described above):

1. Removal of the Big Four Lake;
2. Construct large channel-spanning jams;
3. Construct medium to large instream wood structures;
4. Small wood and single log placements;

ALTERNATIVE 3: SIDE CHANNEL RECONNECTION, GRAVEL AUGMENTATION, AND LARGE WOOD PLACEMENT

The third alternative would build on alternative two with the addition of minor grading and levee removal to improve floodplain and side channel connection, and the use of spoils material as channel fill in the form of gravel augmentation. The gravel augmentation would partially fill the channel in select locations to raise the base water level and improve connection to off-channel habitat and alternate flow paths. The large wood and increased connection to side channels and floodplain is intended to reduce the stream power per unit width in the mainstem to reduce average shear stress and encourage a net deposition of material throughout the reach. It is important to consider that the typical bed load estimated to be moving through this reach is less than 1,400 cubic yards of material, only a fraction of which could be expected to be deposited. This suggests that while this approach may temporarily improve instream habitat and connectivity it is unlikely to succeed in reversing channel incision in a meaningful timeframe. Considering the risk of side channels being disconnected due to deposition at the inlets or channel migration and avulsion, this alternative offers minor benefits over Alternative 2 and carries similar risks to downstream infrastructure and lakes.

To summarize this alternative includes the following actions (described above):

1. Removal of the Big Four Lake;
2. Construct large channel-spanning jams;
3. Construct medium to large instream wood structures;
4. Small wood and single log placements;
5. Side channel reconnection; and,
6. Gravel augmentation.

ALTERNATIVE 4: VALLEY RESET

This alternative is intended to actively treat and reverse historic incision and the factors which have contributed to it within the project reach by partially or fully filling a combined 1.6 miles of the mainstem Tucannon River channel, removing artificial features, including the Big Four Lake, which constrain the channel, and grading the floodplain to improve connectivity. The primary goal of this alternative is to establish the conditions for the channel to maintain a dynamic, and evolving multithreaded channel morphology, as it would have been historically. The channel fill material would be sourced from the removal of artificial high ground, including the Big Four Lake berms, and from floodplain grading areas which would lower broad swaths of high ground to improve connection throughout the project reach. The floodplain grading areas would be focused on reconnecting relic side channels and low-lying areas that have disconnected as a result of channel incision, to restore the hydrology necessary to support productive emergent wetland habitat. This alternative proposes the placement of approximately 77,300 cubic yards of material which, based on the assumptions of annual bedload volume described in the sections above, represents approximately 55 years of total natural bedload estimated to be moving through the reach. This highlights that, if the reversal of incision is a primary objective, the timeline required for this level of recovery exceeds the lifespan of other more passive treatment alternatives including large wood placement and side channel reconnection.

1. Removal of the Big Four Lake;
2. Construct large channel-spanning jams;
3. Construct medium to large instream wood structures;
4. Small wood and single log placements;
5. Floodplain Grading;
6. Side Channel Reconnection;
7. Channel Fill; and,
8. Gravel augmentation.

4.2 PREFERRED ALTERNATIVE SELECTION

The design team selected a preferred alternative based on a qualitative alternative selection tied to simplified project objectives and general rationale about the expectations for the different suites of restoration treatments. This selection focused on the potential risk related to flooding and downstream infrastructure and the biophysical benefits of the restoration alternatives as categorized by CTUIR's River Vision Touchstones.

Aside from project goals and objectives outlined in Sections 1.0 and 1.5, the Big Four preferred alternative was selected with consideration for the following design objectives:

- Ensure minimal adverse impacts or increased flood risk, nuisance or regulatory, to the lakes downstream of the project area.
- Achieve maximum connectivity using a combination of full valley restoration techniques (including berm/levee removal, floodplain lowering, and filling incised channel areas) in concert with wood placements of all sizes both in-stream and adjacent to the main channel, and in existing side channels and flowpaths and wetlands.
- Improve and enhance floodplain interaction at and above the winter base flow level (~120 cfs).
- Construct or maintain pools and habitat features that provide refuge for fish immediately post construction activities.

- Balance cut and fill to avoid the need for material on- or off-haul. This emphasis relates to the assumed material deficit in the reach created by historic channel incision. The restoration actions ideally would avoid contributing to this deficit.
- Minimize disturbance to existing vegetation and floodplain wetlands.

A conceptual design discussion and review with CTUIR, NPT, SRSRP, WDFW, and W2r's consultant team was held on March 25th, 2024, and a site visit was conducted on March 29th, 2024 with the project partners to help select a preferred alternative. The following matrix was developed to summarize the benefits and project objectives that are achieved by each alternative. The alternative the best meets the project goals and objectives and maximizes floodplain processes is alternative 4 which was selected as the preferred alternative.

Table 3. Alternative Selection Matrix

Alternative	Flood Risk and Risk to Infrastructure	Hydrologic Benefit	Geomorphic Complexity	Floodplain Connectivity (at or above winter base flow)	Short term Impact Wetland & Riparian Vegetation	Expansion of Wetland & Riparian Vegetation	Capital Cost
1							
2							
3							
4							

	No benefit or high risk/impact
	Low to medium benefit or moderate risk/impact
	High benefit or low risk/impact

4.3 CONCEPTUAL DESIGN

The preferred alternative was progressed to a concept level using a targeted floodplain approach. The targeted floodplain elevation is based on LiDAR collected in November 2020 by Quantum Spatial, Inc and visual field observations. The LiDAR surface was used to develop a modified version of the Geomorphic Grade Line [GGL] presented by Powers, Helstab and Niezgoda (2018). This modified approach uses average floodplain elevations calculated from regularly spaced cross-sections (50-foot intervals) to create a longitudinal profile representing the average floodplain elevation. Some cross-sections were omitted from the analysis if they were deemed unrepresentative of natural, such as those cross-sections that traced along a berm or through a pond. To smooth the GGL a 500-ft long-stream window was used to average the average floodplain elevations for each cross-section. A GGL surface is created by interpolating points between the smoothed floodplain elevations. Finally, the GGL relative elevation map [REM] was created by subtracting the GGL surface from the LiDAR surface. Alternative 4 shows the GGL REM planform and target floodplain width, which represents the typical native floodplain grade and lateral migration zone. This elevation was used as the target elevation for proposed grading (cut/fill) in the design and will be refined to blend into the adjacent landscape.

Specific restoration elements of design discussed below include (1) floodplain and channel grading, (2) large woody material (LWM) elements, and (3) other habitat structures.

1. Floodplain and Channel Grading - The proposed terrain surface includes the following elements:
    - *Lake and Berm removal* to promote natural floodplain inundation. Grading areas avoid existing wetland areas, and mostly avoid existing mature vegetation. The target elevations of berm removal are determined to coincide with natural floodplain elevations while producing expected material needed for fill areas.
    - *Partial Filling of incised portions of the existing channel* to similar relative elevations as the proposed floodplain to fully reengage the floodplain. The channel and floodplain grading are intended to be geomorphically and hydraulically dynamic and change over time. The channel fill elevation was targeted to engage the floodplain at moderate winter flows and promote hyporheic exchange. Increasing flow through the hyporheic zone can recharge the ground water table and increase cold water up welling into the scour holes and pools providing cold water refugia for fish.

Cut and fill maps highlight the proposed grading and are included in Appendix 2 – Conceptual Design Planset

2. Large Woody Material - Logjams are designed to mimic racking and accumulation of large wood in natural rivers. The project design includes the following large wood jam types with specific habitat functions in mind:
    - Floodplain Roughness Logs – Floodplain logs will be distributed throughout Floodplain Grading, Channel Fill, and areas targeted for reconnection at a rate of approximately 60 logs per acre. This represents most of the large wood that is proposed for placement on the site. These logs will be placed in a messy and randomized manner with many overlapping and partially embedded in the floodplain and channel fill to provide immediate roughness creating local scour and deposition, while distributing and splitting flows. These logs are meant to reduce stream power while vegetation recolonizes the treatment areas.
    - Margin Deflector Jam - Improves local stream bed heterogeneity and habitat diversity by simulating natural jams accumulated against fallen logs from the bank. The current design includes 6 margin structures.
    - Large Apex Jam – Supports mid-channel bar and island growth to accumulate salmon spawning gravels and increase local floodplain inundation. The current design includes 1 large apex structure.

- Small Apex Jam – Supports smaller mid-channel bar and island growth to accumulate salmon spawning gravels and increase local floodplain inundation. The current design includes 18 small apex structures.
- Channel Spanning Structures – Adds channel complexity by accumulating sediment behind the large members and creating localized scour holes. They also act as a “catcher’s mitt” in downstream project areas to catch wood and slow down flow to promote floodplain engagement. These structures are porous and are not buried grade control structures, flow can go through and around them, providing flow paths for fish passage. The current design includes 20 channel spanning structures.
- Strainer Jam – Supports hydraulic diversity across the floodplain by slowing water at the entrance to reactivated side channels and the channel fill. These structures are porous and are not buried grade control structures, flow can go through and around them, providing flow paths for fish passage. The current design includes 14 strainer jams.

The large wood structures will not include anchoring or pinning with cables, chains, nuts, or other methods. Channel wood will involve importing large logs.

Log jam buoyancy and scour calculations will be performed at a later design phase, however, log jam designs incorporate general principles of logjam stability. Relatively shallow flow depths on the floodplain and the forested riparian area in this reach are favorable for relative logjam stability without significant ballast. Margin structures and floodplain logs are intended to be somewhat mobile and are expected to move periodically during high water events. The apex structures and channel spanning jams exposed to greater depths and velocities will be designed with higher levels of stability to create hardpoints within the reach and aid in the retention of gravels and large wood moving downstream. These larger jams will be designed with rock ballast and native stream bed material to counteract buoyant forces.

INCORPORATION OF HIP IV SPECIFIC CONSERVATION MEASURES FOR ALL INCLUDED PROJECT ELEMENTS

The Tucannon River Big Four Project designs will be developed based on HIP activity specific conservation measures. Design, construction drawings and specifications will follow and include all HIP Conservation Measures Specific to these activities as well as the general conservation and construction measures. Primary project actions are described in the context of the HIP Activity Specific Conservation Measures as follows:

- **Category 2a - Improve Secondary Channel and Floodplain Interactions:**
    - Grade the floodplain to improve connectivity to existing secondary channels and to create new self-sustaining side channel and wetland habitats.
- **Category 2b – Set-back or Removal of Existing Berms, Dikes, and Levees:**
    - Remove artificially high features on the floodplain including the Big Four Lake and associated berms and infrastructure, and any other berms and dikes levees identified within the project reach which are no longer necessary for flood protection.
- **Category 2d – Install Habitat Forming Instream and Floodplain Wood Placements:**
    - Medium-to-large wood structures (Large and small channel spanning, apex, and margin types) will be designed to mimic the natural accumulation of wood with no or minimal artificial anchoring. Only natural, non-treated wood materials will be used. Stability analyses will be performed as required.
    - Small wood and single log placements, including broadcast wood placement, throughout the floodplain and wetlands to increase split-flow and maximize floodplain complexity and habitat.

Only natural and non-treated wood materials will be used. Anchoring will consist of passive methods only, such as partial burying or no anchoring at all.

- **Category 2e - Riparian Planting:**
  - Graded and disturbed areas will be planted with native riparian and wetland vegetation species. The riparian planting plan will be prepared by personnel with native riparian vegetation design experience.
- **Category 2f – Channel Reconstruction:**
  - Fill Incised Channel Areas - Selectively use excavated material to fill incised channel reaches to maximize floodplain engagement and reverse effects of past incision. Specific Conservation Measures ensure that these materials are appropriately sized and placed in incised segments avoiding areas with well-documented spawning activity.

4.4 LIST OF ALL PROPOSED PROJECT MATERIALS AND QUANTITIES.

Material quantities for excavation are estimated in units of bank cubic yards (calculated in place prior to removal). This quantity does not include increases in volume due to "swell" and "loose" factors that are important to contractors when estimating haul and other costs. It is often preferred by contractors for excavation quantities to be specified on a bank cubic yard basis to eliminate discrepancies between the engineer and contractor estimates of the swell and loose factors.

Table 4. Materials Summary Table.

Grading Location	Cut Volume (cubic yards)	Fill Volume (cubic yards)
Floodplain cut	77,300	---
Mainstem channel fill	---	72,900
Lake fill	---	3,400
Total	**77,300**	**77,300**

The total number of logs and the log length/DBH are summarized in Table 5 below:

Table 5. Log Summary Table.

Log Type	Length / DBH	Quantity	Unit
Full Tree	Min 60' / 18-24"	32	EA
Large w/ rootwad	Min 40' / 18-24"	92	EA
Medium w/ rootwad	Min 35' / 12-18"	214	EA
Floodplain log	Min 25' / 8-18"	3000	EA
Pier log	Min 20' / Min 10"	282	EA
Racking	Min 15' / Min 6"	287	EA
Slash		810	CY
BDA		1100	LF

The estimate of probable cost shown in Table 6 provides an approximation of quantities and total project costs. This table does not include estimated project costs for permitting, design, monitoring, and/or ongoing maintenance. Estimated costs are presented in 2024 dollars and would need to be adjusted to account for price escalation for implementation in future years.

Note that the actual cost of construction may be impacted by the availability of construction equipment and crews and fluctuation of supply prices at the time the work is bid. W2r makes no warranty, expressed or implied, as to the accuracy of such opinions as compared to bids or actual costs.

Primary assumptions of the cost estimate include:

- Unit costs – include contractor markup, profit, and overhead;
- Mobilization/demobilization – Assumed to be 12% of all other fixed costs;
- Berm and levee excavation – excavation costs assume common excavator, bulldozer, scraper and high-capacity dump truck equipment;
- Onsite Disposal – the cost estimate assumes that natural material excavated for the berm and levee removals will be used to fill areas in channels;

Table 6 Estimate of Probable Construction Cost

ITEM NO.	ITEM	Costs			
		Qty	Unit	Unit Cost	Total
1	MOBILIZATION	1	LS	$ 540,000	$ 540,000
2	CONSTRUCTION SURVEY	1	LS	$ 35,000	$ 35,000
3	EROSION AND SEDIMENT CONTROL	1	LS	$ 120,000	$ 120,000
4	TEMPORARY ACCESS ROADS AND STAGING	1	LS	$ 100,000	$ 100,000
5	TEMPORARY ACCESS BRIDGE	2	LS	$ 80,000	$ 160,000
6	DEMO BIG FOUR LAKE INFRASTRUCTURE	1	LS	$ 20,000	$ 20,000
7	FISH SALVAGE	1	LS	$ 30,000	$ 30,000
8	TEMPORARY WATER MANAGEMENT	1	LS	$ 150,000	$ 150,000
9	CLEARING AND GRUBBING	10	AC	$ 7,000	$ 70,000
10	FLOODPLAIN EXCAVATION	77,300	CY	$ 12	$ 927,600
11	FLOODPLAIN LOGS (INCL. WHS 4, 5, & 6)	60	AC	$ 23,000	$ 1,380,000
12	WHS TYPE 1 - LARGE APEX JAM	1	EA	$ 8,000	$ 8,000
13	WHS TYPE 2 - SMALL APEX JAM	18	EA	$ 5,000	$ 90,000
14	WHS TYPE 3 - MARGIN JAM	6	EA	$ 4,000	$ 24,000
15	WHS TYPE 7 - CHANNEL SPANNING JAM W/ SALVAGED TREES	16	EA	$ 15,000	$ 240,000
16	WHS TYPE 8 - CHANNEL SPANNING WOOD STRUCTURE	4	EA	$ 7,000	$ 28,000
17	WHS TYPE 9 - STRAINER JAM	14	EA	$ 16,000	$ 224,000
18	BDA	1,100	LF	$ 85	$ 93,500
19	SEEDING AND PLANTING	50	AC	$ 15,000	$ 750,000
				TOTAL CONSTRUCTION COST (ROUNDED)	**$ 5,000,000**

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

The design plan set includes HIP General Aquatic Conservation measures to follow during and after construction. These measures include temporary erosion and sediment control (TESC) measures, pollution prevention control measures, and best management practices (BMP's) for work area isolation and dewatering, fish salvage, and aquatic and sensitive habitat preservation. Use of erosion control measures such as fiber rolls and silt fencing will aid in addressing the stockpiling of spoil material and associated storm water runoff from leaving the site. Establishment of improved temporary access routes will assist with controlling runoff and roadway rutting, while erosion control around stockpiles and staging areas assists with runoff and run-on associated with precipitation events.

1. SITE ACCESS STAGING AND SEQUENCING PLAN.

Proposed staging and access routes are shown in the design plans included in Appendix 2. Access will require the use of a temporary bridge to cross the Tucannon River in multiple locations. The proposed access and staging areas have been selected to minimize the disturbance of established vegetation. Stabilized construction entrances will help to prevent erosion associated with heavy equipment entering the site and provide areas for washout prior to construction equipment leaving the site.

A sequencing plan will be developed for future deliverables.

2. WORK AREA ISOLATION AND DEWATERING PLAN.

A work area isolation and dewatering plan will be developed for future project deliverables. This plan will detail the layout and sequencing of work area isolations for channel fill activities including temporary bypass channels, diversion, and isolation structures as well as turbidity control measures. Bypass channels will be designed to provide volitional fish passage, which will be maintained throughout construction.

3. EROSION AND POLLUTION CONTROL PLAN.

The design drawings in Appendix 2 include HIP General Aquatic Conservation Measures applicable to erosion control, stockpiling, dust abatement, spills and invasive species control measures. Subsequent design submittals will include the location of specific BMP measures to be incorporated during construction.

Specific measures proposed for the project will likely include use of erosion control measures such as fiber rolls and silt fencing to address the stockpiling of spoil material and associated storm water runoff from leaving the site. Use of improved access routes will assist with runoff and roadway rutting, while erosion control around stockpiles and staging areas assists with runoff and run-on associated with precipitation events. The stabilized construction entrance helps to prevent erosion associated with heavy equipment entering the site and provides an area for washout prior to construction equipment leaving the site.

4. SITE RECLAMATION AND RESTORATION PLAN.

Site restoration and reclamation plans will be developed at a later design phase. These plans will involve the decommissioning of all access and staging areas, and restoration of these areas to, at minimum, the original condition. This will involve decompaction, slashing, seeding, planting, and the removal and off haul of all non-native materials. These plans will include the following work items.

- Access routes through the floodplain and to structure installation locations will be decommissioned (ripping and roughening, followed by planting/seeding).
- Live staking/planting/seeding in all disturbed areas including, but not limited to, floodplain and channel work, and staging areas and access routes.

5. LIST PROPOSED EQUIPMENT AND FUELS MANAGEMENT PLAN.

The design drawings in Appendix 2 include HIP General Aquatic Conservation Measures applicable to construction equipment and spill prevention, control and counter measures. Section 5 – Equipment of these notes includes conservation measures addressing the use, staging, maintenance and refueling of equipment. Section 9 – Spill, Prevention, Control and Counter Measures of these notes include procedures and precautions for storing, handling any hazardous materials onsite.

4.5 CALENDAR SCHEDULE FOR CONSTRUCTION/IMPLEMENTATION PROCEDURES.

Construction is anticipated to begin July of 2026 with the project elements below ordinary high water (OHW) carried out during the in-water work window July 15th through August 15th. Project elements in areas above OHW may be completed during June/July through September/October.

Revegetation of areas disturbed will begin in the fall, following completion of constructed project elements. Seeding will be applied on access routes, staging areas and other disturbed areas immediately after construction, followed by planting later in the fall.

5.0 References

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APPENDICES

1 ALTERNATIVE DESIGN FIGURES

2 CONCEPTUAL DESIGN PLANSET