Tucannon River Project Area 27/28 Floodplain Restoration Project

Tucannon River Basin, SE Washington

Basis of Design Report
Phase 3
80% Design

Project Area 27/28 Tucannon River 2-4-2021, A. Dysart

PREPARED FOR:

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1.0 PROJECT BACKGROUND

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) is leading the restoration of project areas 27/28 on the Tucannon River (River Miles 22.2-23.1). 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. The Tucannon River is a tributary of the Snake River entering below Little Goose Dam. The project site is located approximately 11.5 miles northeast of Dayton, Washington. CTUIR has entered into a Tucannon River Access, Implementation and Maintenance Agreement with the landowner, Ty Haberling that allows access to the private property on the Tucannon River. This agreement allows CTUIR to plan, implement and maintain habitat restoration efforts in support of threatened Snake River steelhead and spring Chinook salmon in the Tucannon River Basin. CTUIR seeks to improve natural floodplain connectivity and enhance fish habitat complexity for native species on this property. The current land use is a combination of rural residential and agricultural development. The project reach is approximately one mile long (22.2-23.1) and is identified as Project Area 27/28 (PA 27/28) in the Conceptual Restoration Plan, Reaches 6 to 10 Tucannon River Phase II (Anchor QEA, 2011b). The Project is planned in a series of phases based on funding and construction considerations. The first two Phases (Phase 0.0-0.5 and Phase 0.5-1) were completed in 2020 and 2021, respectively, and are described in the Basis of Design Reports dated June 2020 and July 2021. The previous phases BDRs includes Project-wide Project Background, Resource Inventory and Evaluation, and Technical Data.

This 80% Design report provides updates or additions to the previous BDRs as needed, including evaluation, technical data, design and modelling for the remaining portion of the project (Phase 3), but does not repeat the Phase 0.0-0.5 and Phase 0.5-1 reports in their entirety.

Phase 3 covers floodplain enhancements and channel treatments from approximately RM 22.525 downstream to RM 22.18.

PROJECT GOALS AND OBJECTIVES.

1.0.1 GOALS

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), Columbia River Bull Trout Recovery Plan (USFWS 2010) and the Tucannon Sub basin Plan (CCD 2004).

The project will address the effects of historic grazing, agricultural, and timber harvest and wood removal practices and associated ecologic concerns such that they improve and restore the system's ability to support the '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; 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 planning and previous phases for the reach 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 increased base flows and decreased water temperatures. Hyporheic flow and native riparian species will thrive.
- Increase channel complexity with channel morphology (channel form, sinuosity, complexity, geomorphic and hydrograph stability) closer to historical and functional form especially 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.
- Increase rearing habitat in the floodplain.
- Re-establish 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 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.

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

Project Sponsor – Confederated Tribes of the Umatilla Indian Reservation (CTUIR);
Design Engineer – Wolf Water Resources (W2r);
Land Owner/Manager – Ty Haberling/Rick Turner.

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:

- Expand and enhance the floodplain with side channel swales, and wetland depressions to support native emergent marsh and scrub-shrub vegetation.
- Place large wood structures and individual large logs throughout the project area to increase channel and habitat complexity, and increase floodplain connectivity;
- Place excavated materials in the mainstem channel to expand floodplain connectivity;

The outcomes expected from the preferred alternative include:

- 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;
- Increased water quality due to improved hydrologic conditions and increased channel and floodplain complexity; and
- Decreased stream power through the project reach in the mainstem.

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 and bridge will not be affected as a result of this project (Phase 3).
- The project is designed to result in no rise of 100-year floodplain upstream or downstream of the project.

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

Included in Phase 1 BDR dated June 2020 (Appendix A).

1.5 LIST OF PRIMARY PROJECT FEATURES INCLUDING CONSTRUCTED OR NATURAL ELEMENTS.

- Improve Floodplain Connectivity and Secondary Channels – excavate primary and secondary floodplain swales and lower the floodplain (reach downstream of King Grade Road).
- Channel Reconstruction – strategically place material in the incised portions of the channel to increase floodplain connectivity and spread flow to the excavated swales and secondary channels.
- Excavate wetland depressions and construct beaver dam analogue structures to promote native vegetation and beaver activity.
- Install Habitat-Forming Natural Structures – large wood and individual logs throughout the reach to increase channel complexity.
- 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.

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 implement the adaptive management plan at the site following the project actions as they continue to manage the property.

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

Phase 0.0 to 0.5 was completed in 2020, and Phase 0.5 to 1.0 was constructed in 2021. Phase 3, planned for construction in 2023, expands and enhances the floodplain adjacent to Phase 0.0 to 0.5 from RM 22.5 to RM 22.95, and is the focus of this 80% BDR.

Phase 3 will include work in the floodplain downstream of King Grade Road (RM 22.525-22.18):

- Excavation of primary and secondary floodplain swales to promote floodplain engagement throughout the project reach;
- Lowering the floodplain to increase frequency and depth of inundation;
- Selective placement on mainstem channel adjacent to the floodplain swale grading areas/excavation between approximate river miles 22.2 – 22.34.
- Placement of log jams/large wood in and associated with the new side channel swales;
- Placement of individual logs and small log structures across expanded floodplain; and,
- Invasive vegetation species treatment and revegetation.

The floodplain expansion grading will take place in the existing hay field with minimal impacts to riparian vegetation. This floodplain grading is outside of OHW and existing wetlands. The side channel fill area will be accessed through the floodplain grading areas, and for the mainstem channel fill equipment will be tracked through the side channel and in areas already impacted by the previous phases. Disturbance to existing native vegetation will be minimized. No in-stream or floodplain project activity is planned directly upstream or downstream of the King Grade Road and Bridge. 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 30th.

2.0 RESOURCE INVENTORY AND EVALUATION

The resources inventory and data evaluation for Phase 3 is included in Phase 0 to 0.5 BDR dated June 2020 (Appendix A), and the wetland assessment for Phase 3 is included as Appendix B.

LiDAR was flown in the fall of 2020 following the completion of Phase 0 to 0.5 and this DEM is the basis the Phase 3 design. Additional supplemental survey post construction of the Phase 0 to 0.5 was taken throughout the project reach by W2r in February 2021.

3.0 TECHNICAL DATA

3.0.1 ALTERNATIVE DEVELOPMENT AND PREFERRED ALTERNATIVE SELECTION AND INITIAL REVIEW

Alternatives were based on conditions and features identified in the Conceptual Restoration Plan (Anchor QEA 2011b) and from the goals and objectives identified by CTUIR. The primary alternatives for Phase 3 were developed to evaluate the level of floodplain enhancement based on target inundation areas for the floodplain swales and wetland expansion. The alternatives ranged from the most impact and greatest inundation area and were scaled down to the lowest impact and least amount of floodplain enhancement, see Alternative Figures, Appendix C.

The following general restoration alternatives were considered to address project goals and objectives:

- Alternative 1 -
  - Enhance the floodplain with low wetland areas and undulating islands to balance cut and fill within the floodplain. The target floodplain wetland finished grade elevation would inundate at the winter base flood to 2-year flood event.
  - Construct small and medium wood structures and single log placements throughout the floodplain and wetlands to increase split-flow and maximize floodplain complexity and habitat;
  - Install BDAs to accelerate floodplain and wetland recovery; and
  - Revegetate the islands with riparian, shrubs, and trees and the low-lying wetland swaths with emergent sedges, rushes, and scrub-shrubs.

- Alternative 2 –
  - Enhance the floodplain with a side channel swale and expanded wetland area. Target the side channel elevation to inundate at the at the winter base flood and spread water into the adjacent expanded wetland at the base flood to 2-year flood event.
  - Place excavated material in the low-lying floodplain areas downstream of the side channel to reduce flooding to the downstream property.
  - Construct small and medium wood structures and single log placements throughout the floodplain and wetlands to increase split-flow and maximize floodplain complexity and habitat;
  - Install BDAs to accelerate floodplain and wetland recovery; and
  - Revegetate the wetland area with emergent sedges, rushes, and scrub-shrubs, and the upland fill with shrubs.

- Alternative 3 –
  - Enhance the floodplain with a side channel swale with floodplain bench. Target the side channel elevation to inundate at the at the winter base flood.
  - Place excavated material in the low-lying floodplain areas downstream of the side channel to reduce flooding to the downstream property.
  - Construct small and medium wood structures and single log placements throughout the side channel to increase split-flow and maximize floodplain complexity and habitat; and
  - Revegetate the existing floodplain with riparian shrubs and trees.

The design process selected a preferred alternative based on project stakeholder and BPA input, and a qualitative analysis of the anticipated floodplain response for each alternative. Portions of Alternative 2 were selected and refined to develop the Preferred Alternative. This alternative meets the project primary object to achieve maximum connectivity at the winter base flood using a combination of floodplain connectivity side channel swales, wetland depressions, and increased complexity (including fill of incised channel areas) in concert with wood placements of all sizes throughout the floodplain enhancement area and in the adjacent

main channel. This alternative effectively converts a frequently flooded field to wooded floodplain with more frequent inundation and active channels throughout.
The preferred alternative involves the following strategies and restoration actions:

- Preferred Alternative –
    - Enhance the floodplain with a primary side channel swale, secondary swales, and expanded wetland areas. Target the primary side channel elevation to inundate at the at the winter base flood and spread water into the adjacent expanded wetland at the base flood to 2-year flood event.
    - Place excavated material in the low-lying floodplain and upland areas downstream of the side channel to reduce flooding to the downstream property.
    - Construct small and medium wood structures and single log placements throughout the floodplain and wetlands to increase split-flow and maximize floodplain complexity and habitat;
    - Excavate depressional areas as beaver pond starts and install BDAs to accelerate floodplain and wetland recovery; and
    - Revegetate the wetland area with emergent sedges, rushes, and scrub-shrubs, and the upland fill with shrubs.
    - Place excavated material in the main channel to maximize channel and floodplain complexity and habitat.

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

The Tucannon River PA 27/28 Floodplain Restoration Project was designed using HIP activity specific conservation measures. Design, construction drawings and specifications developed for Phase 3 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 floodplain swales connected to the existing side channel to promote a multi-threaded channel and connected floodplain.
- **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.
- **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:**

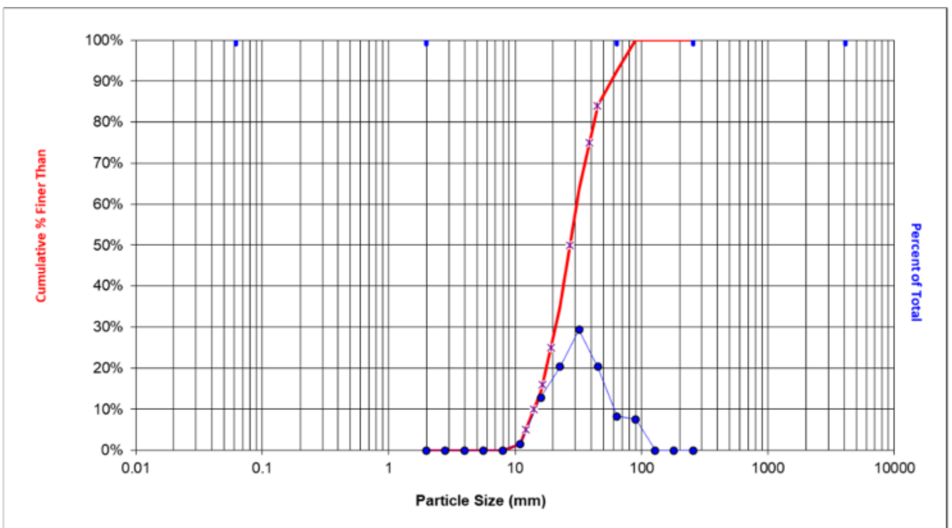
- Fill Incised Channel Areas - Selectively use excavated material to fill some incised channel areas to maximize floodplain engagement and reduce effects of past incision. Specific Conservation Measures ensure that these materials are appropriately sized and placed in incised segments that do not include spawning suitable areas.

- **Categories 3a and 3b - Invasive Vegetation Management and Revegetation:**

  - If herbicides are used for invasive vegetation control, only those listed in the HIP manual and appropriate for the targeted species will be used. Application will comply with label application rates and will be transported, mixed, and applied by a licensed applicator, who will prepare and follow the safety/spill response plan.

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

Phase 0 to 0.5 of the design was based on LiDAR collected by Geoterra in 2017 and visual field observations. Phase 3 is based on LiDAR collected in 2020 by Quantum Spatial, Inc, and supplemented with RTK survey performed by W2r in 2021. Floodplain soils were hand-sampled and pebble counts were taken on select river materials gathered in 2020. Two pebble counts were conducted, and distribution graphs were developed as shown in Figure 1. No detailed analyses were performed on these materials.



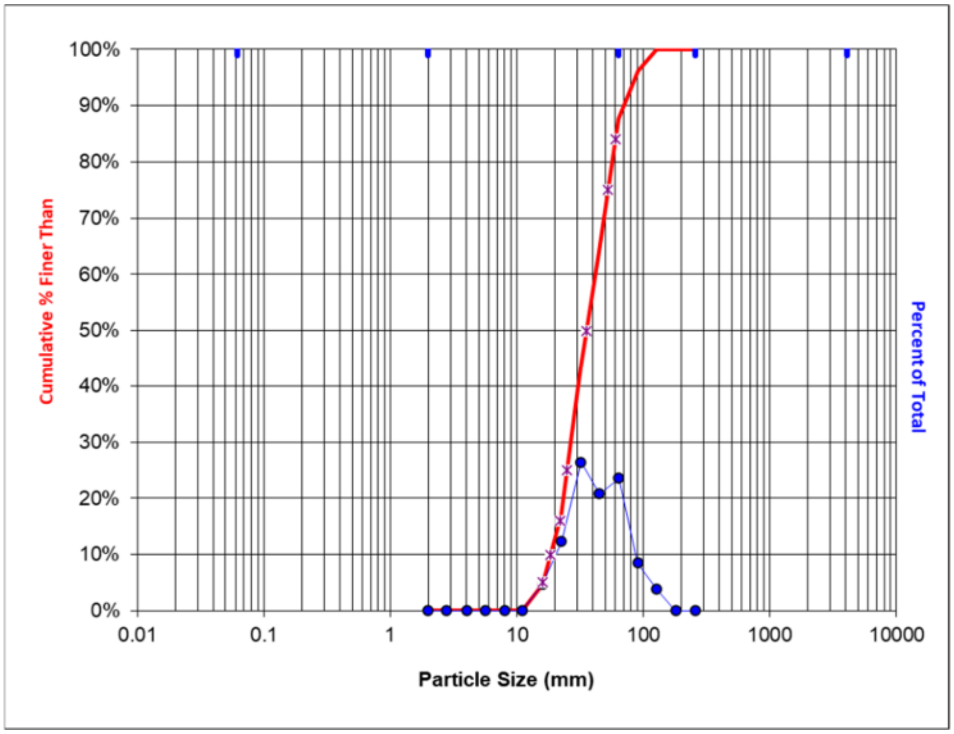


Figure 1 Grain size distribution curves based on two pebble counts

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.

The Tucannon River drains the northwestern Blue Mountains of Southeast Washington. The watershed contributing to the project reach is 170 square miles (mi^2), with a mean annual precipitation of 36 inches and a mean and maximum elevations of 3,920 and 6,370 feet. The Tucannon River has two active gages, one of which is located just upstream of the project reach at the Turner Road crossing (Table 1). Two sets of flow statistics were developed to inform design: (1) annual peak flow exceedance probabilities inform flood frequencies and (2) flow duration statistics characterize the frequency and duration of the broader flow distribution (including low flows).

Table 1 Table of stream gages on the Tucannon River.

Gage ID	Name	Agency	Dr. Area, mi^2	Record	Notes
35B150 (Ecology), 13344000 (USGS)	Tucannon River near Marengo	Ecology (active), USGS (past)	160	1913-1930 (USGS), 2003-2019	Turner Road Bridge
13344500	Tucannon River near Starbuck	USGS	431	1914-2019	

Peak flow statistics were developed by combining flow records of the two gages to develop an extended peak flow record upon which to develop annual exceedance probabilities. While well downstream of the site, the gage at Starbuck has a more extensive flow record that the gage upstream, which provides an opportunity to extend the flow record at the upstream gage site. To develop this extended record, we performed a linear regression analysis relating contemporaneous peak flows at the two gages which then allowed for estimation of flows in years where the gage at Starbuck was active and the gage at Marengo was inactive. The resulting equation relates flow at Marengo (Q_M) to flow at Starbuck (Q_S): $Q_M = 0.70 \times Q_S + 118.7$. With the resulting extended records, we then ran flood frequency statistics using recently updated USGS Bulletin 17C methods for the gage location at Marengo. Given the negligible drainage area difference between the two sites, we assumed peak flow frequencies developed at the gage reflected those at the site (Table 2).

Table 2 Peak flood statistics for the project reach.

Annual Exceedance Probability	Recurrence Interval, yr	Q, cfs
95%	1.05	215
90%	1.11	270
80%	1.25	380
67%	1.5	540
50%	2	792
20%	5	930
10%	10	2440
4%	25	3560
2%	50	5000
1%	100	5500

Flow duration statistics (developed by USGS) recorded at the gage upstream were also considered to be adequate for the site. The flow duration curve and specific statistics are shown on Figure 2.

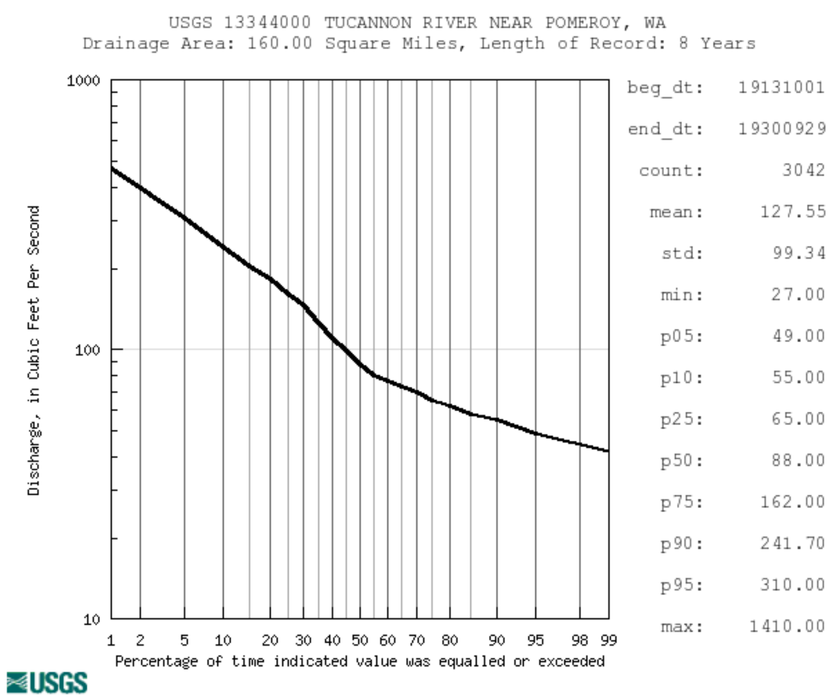


Figure 2 Flow duration curve developed from flows recorded at the historic USGS gage (13344000) located immediately upstream of the site.

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

3.4.1 EXISTING SEDIMENT SUPPLY AND TRANSPORT

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 3). 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 22-24) 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 (just upstream 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. This flux per year suggests a volume deficit created by 1 feet of incision over the entire reach could be replaced with about 5 years of gravel supply. 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.

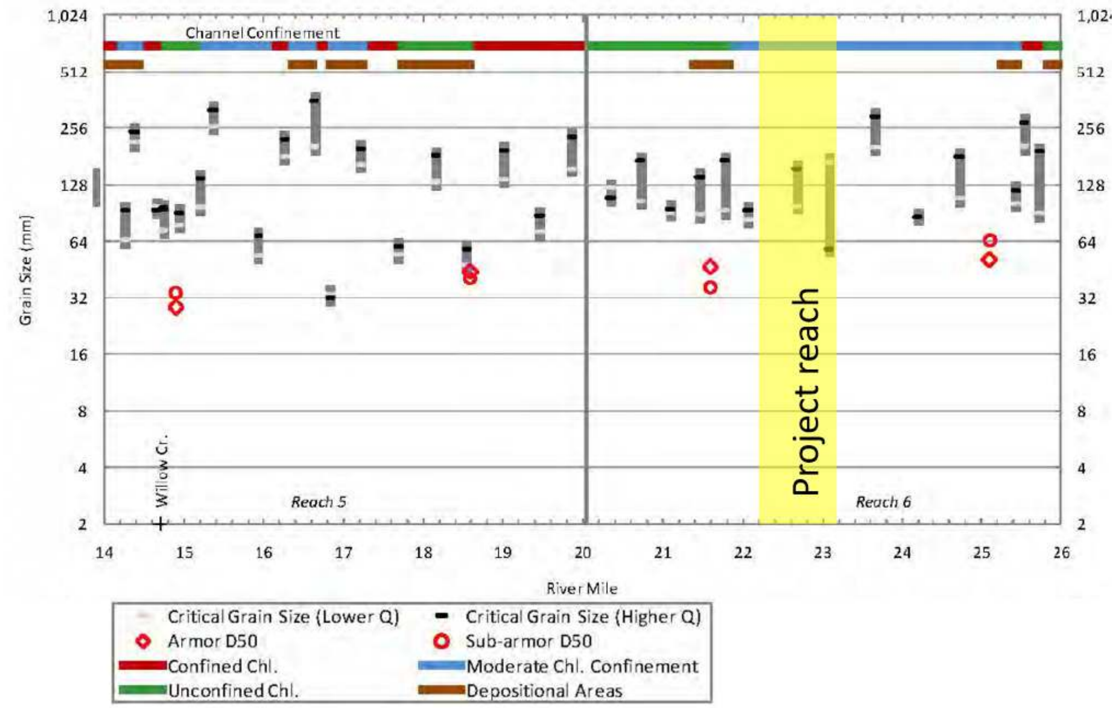


Figure 3 Anchor (2011a) longitudinal plots of modeled sediment transport capacity and measured grain sizes shown.

As described in Section 2.7 of the June 2020 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:

- A few areas of bank erosion, predominantly in the area of the irrigation diversion upstream from the bridge and along the south bank at the downstream end of the project area near RM 22.3
- 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
- Silt deposition and return flow sheet and gully erosion in the adjacent agricultural fields

Post-flood observations indicate that while some gravels and woody materials were reworked and deposited, and there likely were some additional gravel and wood materials transported into the reach, the result is that the project area is trending closer to the restoration goals originally developed for this project.

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

3.5.1 MODEL DEVELOPMENT

A 2D HEC-RAS (version 6.3.1) model was developed to evaluate the existing conditions and proposed design and to conduct a floodplain analysis. This modeling software uses a 2D mesh laid over a high-resolution terrain dataset to provide quality representation of the ground surface while remaining computationally robust and efficient. The primary objective of the hydraulic analysis was to evaluate existing flow patterns, hydraulic parameters, and inundation extents to characterize current riverine conditions within the project reach. Establishing baseline hydraulic conditions enables quantitative comparison with the proposed condition modeling, representing restoration actions to be completed in future project phases. This comparison is critical to ensure that the design elements meet project goals without increasing risk to adjacent and downstream structures and properties.

CTUIR commissioned a bathymetric LIDAR survey in the fall of 2020 following the first phase of construction and the King Grade Road raise. This survey provided a high-resolution topographic and bathymetric surface for the existing and proposed model terrains. The LIDAR surface was merged with augmented ground surfaces, built in AutoCAD Civil 3D, to improve the resolution of existing irrigation ditches, incorporate as-built surfaces of the construction completed in the summer of 2021, and include proposed grading to assess alternatives for Phase 3 and the preferred 80% design.

Hydraulic modeling requires an assessment of the drag forces that the ground cover and structures exert against the flow to calculate energy losses. In HEC-RAS the magnitude of these forces is represented by the Manning's n values, which are spatially varied and assigned by landcover type in accordance with standard hydraulic reference manuals (Chow, 1959). Typically, Manning's n values decrease as the depth of flow increases; however, this model makes the simplifying assumption that the values are constant through all flow events. This assumption likely overestimates the Manning's n values during extreme flood events, providing a conservative estimate of flood extents. The assigned values are shown in Table 3.

Table 3. Modeled Manning's n Values

Landcover Type	Manning's n Value
Active Channel	0.04
Floodplain – forested, downed trees with undergrowth	0.12-0.16
Floodplain – forested, downed trees, cleared undergrowth	0.08
Floodplain – tall grasses	0.075
Floodplain – cultivated, no crop	0.035
Floodplain – light development	0.045
Channel w/ dense WHS	0.1
Channel w/ WHS	0.06

The following flows from the hydrologic analysis were selected for modeling.

Table 4. Modeled Flows

Flow Description	Annual Exceedance (%)	Flow (cfs)
Winter Base Flow	55-65	100
Q2	50%	792
Q10	10%	2440
Q100	1%	5500

The restoration treatments are intended to provide benefits through the full range of flows expected during the design life of the project. Modeling typical winter base flow identifies benefits of the proposed restoration actions during typical winter flow conditions and ensures that the Project does not risk creating a fish passage barrier during migratory periods. The Q2-Q10 events provide an assessment of the upper and lower ends of the range of peak flow events expected to occur with some regularity, and those which are most significant to overall bed load transport and channel formation. Analysis of impacts at the Q100 ensures the Project does not increase risk to adjacent or downstream properties and structures, through the failure of wood structures and/or increased water surface elevations (WSE).

3.5.2 MODEL RESULTS

The analysis of the model results focused on the changes between the existing and proposed conditions water surface elevations (WSE), wetted area, mainstem velocity, and bed shear stresses, as well as depth and velocity on the floodplain where there are proposed wood placements. Together these metrics paint a picture of how the morphology of the channel is expected to respond to the proposed restoration treatments and identify potential risk factors.

The analysis focuses on two regions downstream of the Kings Grade Rd. Bridge between RM 22.2 and 22.34. A swath of the adjacent agricultural field will be lowered to expand wetland and floodplain habitat, the excavated material along with large wood will selectively be used to partially fill the main channel. Large wood structures will be constructed within the channel, and individual logs placed on the floodplain.

The model results indicate that the proposed restoration actions will have the intended effects, meeting the stated Project objectives listed in section 1. See Appendix E for model results figures.

Floodplain Connectivity:

A primary project objective is to increase the wetted area under target flow conditions. The greatest increase in wetted area is seen between the winter base flow and 2-year recurrence interval flood condition. There is no increase in flood extents under the Q100 event, suggesting the project will not increase the risk of flooding. The changes in wetted area are summarized below in Table 5.

Table 5. Modeled Wetted Area

Flow Event	Change in Wetted Area (Acres)	Change in Wetted Area (%)*
Winter Base Flow	+2.2	+53%
Q2	+7.1	+59%
Q10	-0.02	0.0%
Q100	-2.15	-4%

*The area sampled begins at the downstream property boundary and extends upstream to approximately STA 132+00 as shown on the Plans.

As a result of the proposed fill placement, above the 10-year event there begins to be a reduction in wetted area. A large portion of this is a result of spill-over from the ditch (seen in Figure 5) which is eliminated by the placement of the proposed fill. This result is highly subjective to the model terrain, in which the ditch is not well defined. The reduction shown in the model outputs is likely exaggerated by the terrain ditch-spill over which is not actually happening on the ground. Additionally, it should be considered that these reductions are in areas with low habitat value and are not likely to adversely affect floodplain hydrology (capture and storage).

Figure 4 shows the existing vs proposed inundation extents during a Q2 event, with a cross section showing existing and proposed water surface elevations.

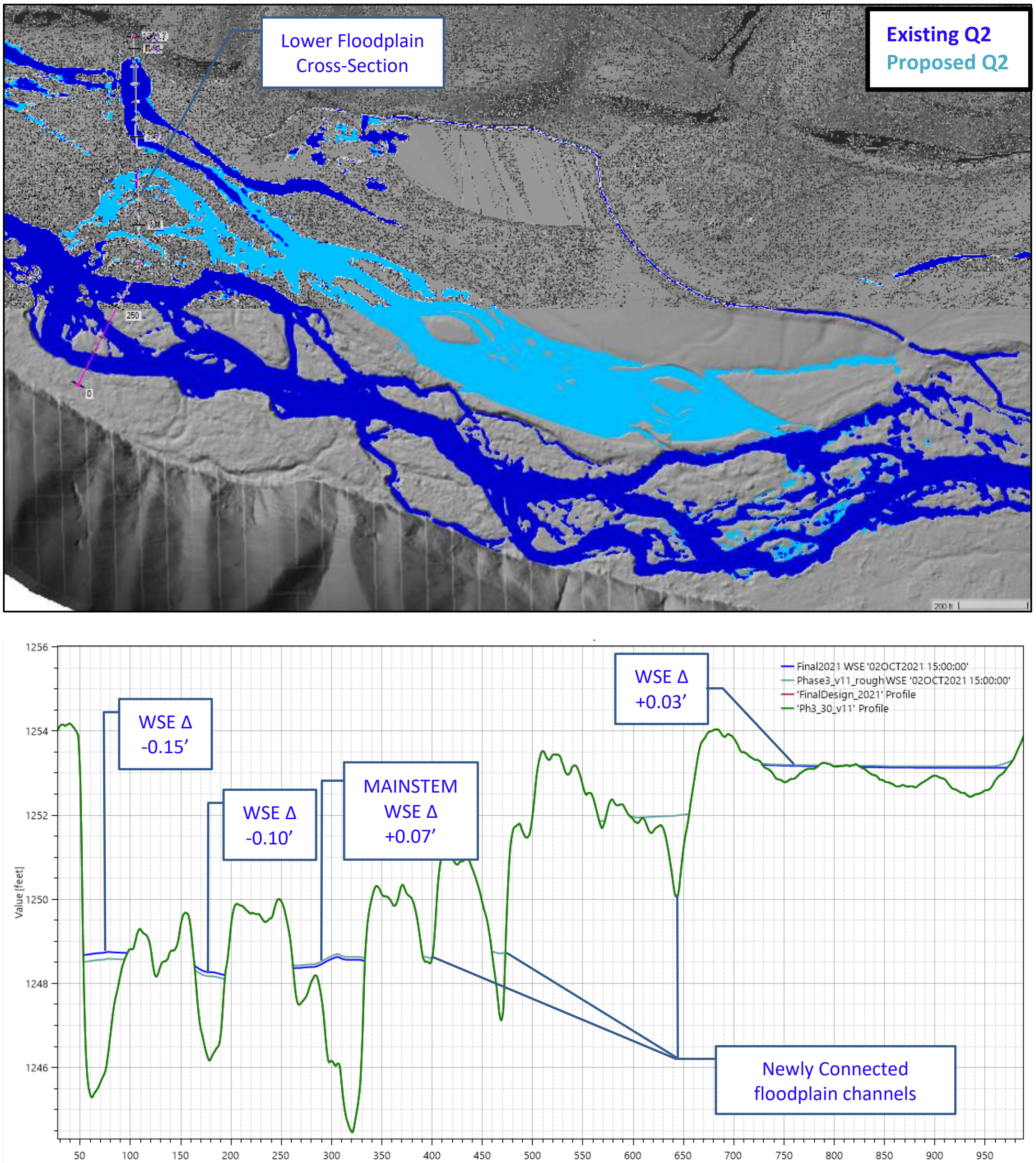


Figure 4. Modeled Q2 Extents and Floodplain Cross-Section.

The proposed floodplain expansion is estimated to divert 4-13% of the flow from the mainstem into the expanded floodplain area between the 2- and 10-year recurrence interval flood events. The reduction in flow in the mainstem corresponds with a slight reduction in stream power, the energy available for sediment transport, in the mainstem reach that parallels the floodplain expansion, dispersing it more broadly across the site.

While expanding wetted area at annual flows and more frequent flood events, the Project does reduce floodplain inundation in the fields downstream of the proposed expansion. This is a result of upstream floodplain conveyance being partially captured by the expanded floodplain and returning a portion of the flow to the main channel upstream of where these flows return under existing conditions. Under the proposed design, flows in the mainstem reach downstream of the project are increased 11-19% between the 10 and 100-year recurrence interval flood events. The existing vs proposed flow patterns are shown below in Figure 5 and Figure 6 respectively.

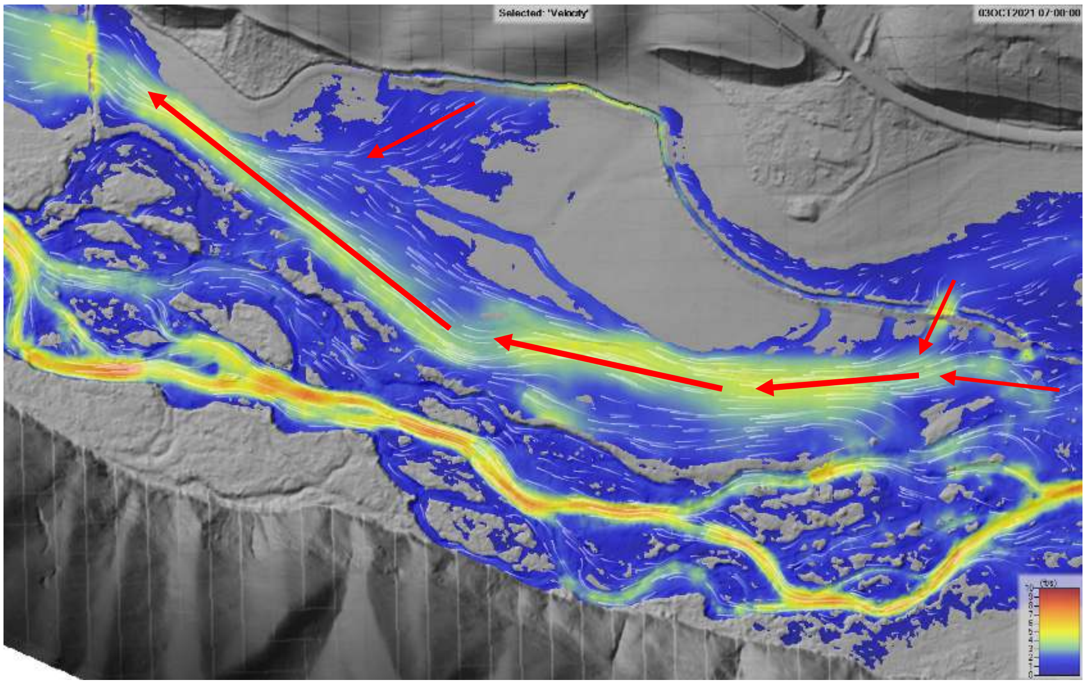


Figure 5. Existing condition velocity map with flow patterns (10-year flow event).

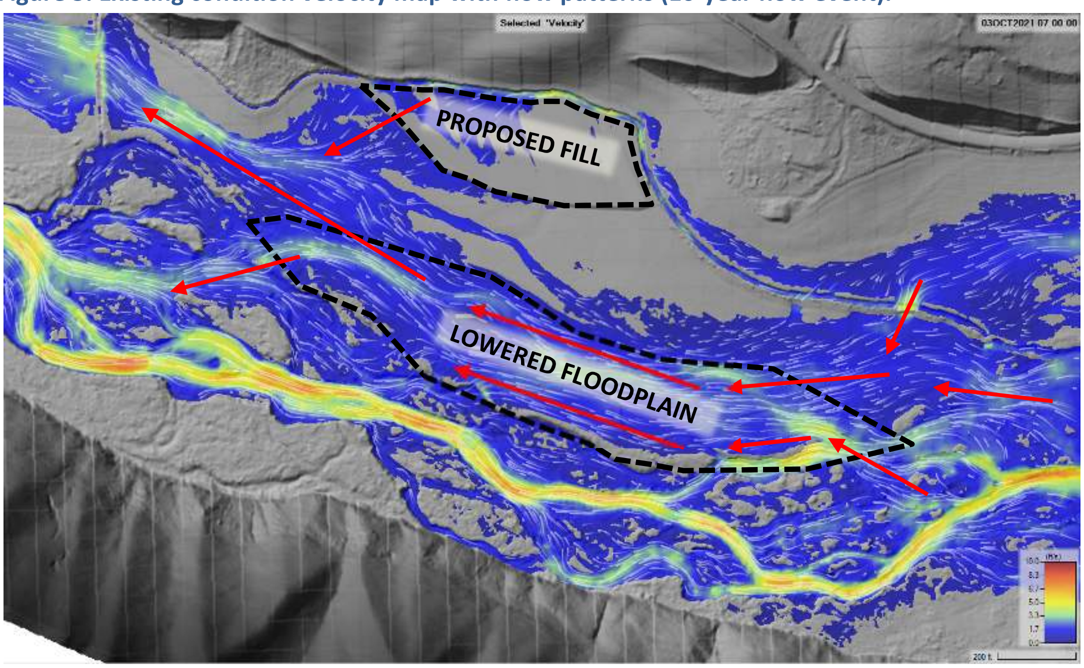


Figure 6. Proposed condition velocity map with flow patterns (10-year flow event)

As seen in Figure 5, under existing conditions flows during high-water events enter the project site from upstream and concentrates in a broad swale, creating relatively high velocities (~5 ft/s) over what is currently a fallow hay field. Flows remain concentrated through the property and continue through the fields downstream on the downstream property before returning to the channel. Figure 6 highlights that a major result of the project is a reduction of velocities as flows are distributed more broadly across the expanded floodplain. The proposed floodplain expansion achieves this by lowering the existing high ground that currently confines flows entering the field from upstream. Lowering this high ground allowing flows to spread out more uniformly across the floodplain as well as increasing interaction between the mainstem and floodplain.

The project improves hydraulic conditions across the project area and the mainstem that parallels it; however, the model suggest that it may capture approximately 50% of the existing floodplain conveyance through the fields, returning it to the main channel anywhere from 1,375 to 2,285 feet upstream of where it currently returns. Notably, the channel reach into which the proposed actions would reintroduce flows is very confined by the valley wall on the left bank and an artificial berm on the right bank. As shown in Figure 7, the proposed floodplain grading reduces flows to the downstream of property at the 5-year event and greater. The change in flow balance is summarized in Table 6. These results show that the conversion of field to active floodplain increases habitat benefits within the project area substantially. The reduction in flooding of downstream fields may pose more of a risk to salmonids as flows returning to the river may be disconnected and too shallow. This project considers a balance of risk to farming and floodplain habitat.

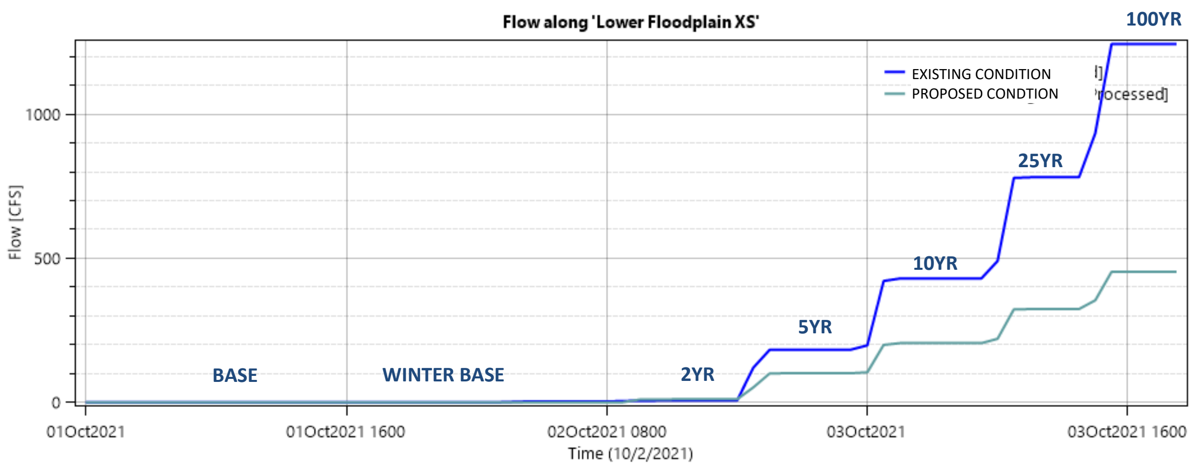


Figure 7. Floodplain discharge relative to proposed floodplain discharge at a range of flows at the Lower Floodplain Cross-Section.

Table 6. Modeled Mainstem Conveyance Impacts (Downstream of Project)

Model Scenario	Mainstem Flow (cfs)	Floodplain Conveyance (cfs)	Mainstem Change %
Winter Base - Existing	100	0	0%
Winter Base - Proposed	**100**	**0**	
Q2 -Existing	785	7	- 0.5%
Q2 - Proposed	**781**	**11**	
Q10 -Existing	2007	430	+ 11.3%
Q10 - Proposed	**2234**	**206**	
Q25 - Existing	2780	781	+ 16.4%
Q25 - Proposed	**3237**	**324**	
Q100 – Existing	4250	1244	+ 18.50%
Q100 - Proposed	**5039**	**453**	

Velocity

The model suggests that during typical winter flow conditions and major flood events up to the 10-year recurrence interval, the Project will reduce the average velocity by between 2-5%, the Project is expected to have a lesser effect on maximum velocities with the model showing a 2% reduction shown at the winter base flow, and an increase of 1% during the 10-year flood event. Velocities across the proposed floodplain expansion and swales will increase, improving hydraulic diversity across the site.

Table 7. Modeled Mainstem Velocity Impacts (Parallel to Floodplain Expansion)

Flow Event	Change in Mean Velocity (%)*	Change in Max Velocity (%)*
Winter Base Flow	-5%	-2%
Q2	-3	0%
Q10	-2%	+1%

*Area sampled is the existing mainstem adjacent the Phase 3 work area, beginning upstream of the proposed channel fill, and extending downstream to the Project boundary.

Bed Shear Stress

Within the mainstem channel, the model indicates the project will not have a measurable impact on the mean or maximum bed shear stress. The mobile particle size class under existing conditions is aligned with field observations of the bedload material and while the project will not reduce the size class transported, it will allow the river to access new sources of sediment on the expanded floodplain, expand on the already diverse hydraulic conditions, and provide more room for greater lateral connection. A summary of the modeled shear stresses in the mainstem of the project area is summarized in Table 8. The mobile particle classes have been included for reference based on critical shear values identified by Berenbrock and Tranmer (USGS, 2008).

Table 8. Modeled Bed Shear in Mainstem Channel Adjacent to the Floodplain Expansion

Model Scenario	Mean Shear* (lb/ft^2)	Mean Particle Class Transported**	Max Shear* (lb/ft^2)	Max Particle Class Transported**
Winter Base - Existing	0.32	Coarse Gravel	3.66	Coarse Cobble
Winter Base - Proposed	**0.29**	**Coarse Gravel**	**3.62**	**Coarse Cobble**
Q2 -Existing	1.00	Very Coarse Gravel	5.41	Small Boulders
Q2 - Proposed	**0.95**	**Very Coarse Gravel**	**5.24**	**Small Boulders**
Q10 -Existing	1.45	Fine Cobble	7.31	Boulders
Q10 - Proposed	**1.41**	**Fine Cobble**	**7.24**	**Boulders**

*Shear values were extracted within the footprint of the channel fill area.
**Based on critical shear stresses identified by Berenbrock and Tranmer (USGS, 2008).

The greatest area for concern related to potentially increased shear stress is the confined portion of the channel immediately downstream of the Project, where the Project is expected to increase mainstem conveyance during high flow events. Shear stress values for a 10-year event were sampled along the thalweg profile through the confined reach experiencing increased flows. These values are summarized in Table 9.

Table 9. Shear stress measured along downstream thalweg profile.

Shear Stress Statistic	Existing - 10-year (lb/sf)	Proposed - 10-year (lb/sf)	% Change
Average	1.26	1.27	+0.9%
Max	4.54	4.73	+5.7%

The ~6% increase in peak shear stress indicates that in some localized areas the project does increase scour during high flow events through this downstream reach. While this is a notable risk at bank margins, field observations have identified artificial bank armoring present through this confined section. This armoring could be adequate to preclude any increase in scour risk, further assessment is needed through this reach. Additionally, the peak shear stress through this reach are significantly lower than the peak shear stress modeled in the upstream channel adjacent to the project reach (see Table 8). This suggests that, even accounting for the slight impact, the shear stresses are well within the natural range for this system.

3.5.3 FLOOD RISK ASSESSMENT

The modeling of the floodplain expansion and proposed channel fill considers two primary flood-related risks that must be evaluated in the design of the proposed enhancement actions. These risks include triggering a rise in the 100-year flood elevation beyond the Project boundary and interrupting the continuity of existing floodplain conveyance and processes. These risks are described in more detail below.

100 Year Flood Elevation

The Project actions have been designed to minimize risk to the King Grade Road and Bridge as well as the downstream neighboring property. The two design elements that introduce the greatest risks with respect to flooding are the lowering of the floodplain, and the coinciding channel fill. The flood elevation at the King Grade Bridge was found to be most sensitive to the floodplain grading. The result of lowering the floodplain here is that a portion of the floodplain flow currently conveyed on the fields is captured and returned to the main river corridor upstream of the existing return location. This, combined with the proposed roughening of what is currently a hay field, causes a very slight rise in the 100-year flood water surface elevation measured just downstream of the bridge. The proposed design was modeled both with and without channel fill. The maximum rise was determined to be 0.04 feet, with 0.03 feet of rise attributable to the floodplain expansion, and only 0.01 feet of rise attributable to the proposed channel fill. The stated rise occurs only in the mainstem channel at the Kings Grade Bridge, with no rise observed along the rest of the road embankment where flood elevations are currently perched relative to the main channel. The rise does not result in a change in flood extents as shown in Figure 8, nor were any increases in velocity shown.

The project is located in a Zone A Flood Hazard Zone with no defined floodway or designated base flood elevation (BFE). Per Federal Regulation44 CFR 60.3 the proposed Project meets the requirement that "until a regulatory floodway is designated, that no new construction or substantial improvements, or other development (including fill) shall be permitted within Zones A1-30 and AE on the community's FIRM, **unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community.**"

Based on this modeling, the risk to the Kings Grade Road and Bridge from the proposed Project actions is be considered to be negligible, and meets FEMA requirements for Zone A.

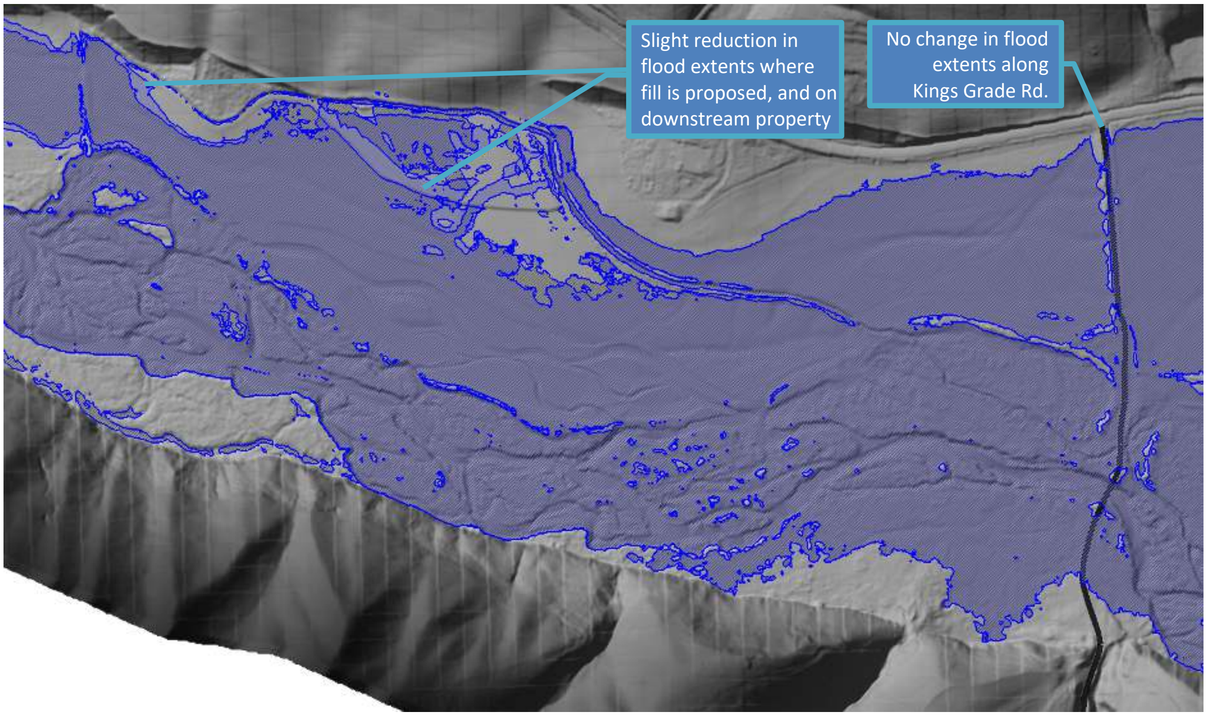


Figure 8. Existing (light blue) versus proposed (dark blue) 100-year flood extents.

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

The project team assessed reach-scale user and property risk using Bureau of Reclamation's Risk Assessment methods (2014, discussed in greater detail in Appendix F), which provide recommendations on safety factors and design floods for logjam stability. This analysis found that both user and property risks are low for the reach. Low risks have associated recommendations of 10-year design flood and minimum safety factors of 1.25-1.5 for sliding, buoyancy, and rotation. Log jam buoyancy and scour calculations are included in Appendix G.

Wood Habitat Structures

The log structures will not require anchoring that requires cables, chains or other mechanical methods that are not allowed under the HIP. The apex structures 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 native boulder ballast and stream bed material to counteract buoyant forces. 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.

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

Sections in Chapter 3 include technical analyses associated with the project reach. Data collection of in situ site information included: topographical survey, hydrology analysis, hydraulic modeling and stability analysis. The collection of survey data combined with LiDAR provides the base map information for the existing terrain utilized for the proposed design and hydraulic modeling.

Hydrologic analysis provides the design team with expected flow regimes for Tucannon River. Expected annual and bank full discharge flows as well as flood events aid design of channel and floodplain design as well as large wood stability analysis.

Hydraulic modeling informs 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 properties. Additionally, hydraulic model output informed placement and design of wood habitat structures and associated stability analysis.

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 WIDTHS UPSTREAM AND DOWNSTREAM OF THE STRUCTURE SHALL BE USED TO DETERMINE THE POTENTIAL FOR CHANNEL DEGRADATION.

Phase 3 does not include any actions that address profile discontinuities.

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.

Phase 3 does not include any actions that address profile discontinuities.

4.0 CONSTRUCTION – CONTRACT DOCUMENTATION

4.1 INCORPORATION OF HIPIII GENERAL AND CONSTRUCTION CONSERVATION MEASURES

HIP Construction Conservation Measures are included in the design drawings in Appendix D.

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.

The construction plan set, including plan, profile, sections, and detail sheets for the design elements is in Appendix D. Project design specifications are included in Appendix H.

4.2.1 80% DESIGN

Aside from project goals and objectives outlined in Sections 1.0 and 1.5, the Phase 3 design has the following design objectives:

- Improve and enhance floodplain interaction at the winter base event.
- Construct or maintain pools and habitat features that provide refuge for fish immediately post construction activities.
- Ensure no adverse impacts or increased flood risk, nuisance or regulatory, to the private property downstream of the project area.

- 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.

Specific restoration elements of design discussed below include; floodplain and channel grading, large woody material (LWM) elements, and other habitat elements such as native revegetation.

Floodplain and Channel Grading - The proposed terrain surface includes the following elements:

- *Floodplain lowering* to promote natural floodplain inundation. Grading areas avoid existing wetland areas, and mostly avoid existing mature vegetation. The target elevations of the existing field was determined to coincide with natural floodplain elevations.
- *Floodplain Swale expansion* to provide multiple flow paths during moderate winter flows. Swale inlet elevations were targeted to match the adjacent side channel elevations to promote multi-threaded channels.
- *Partial filling of mainstem channel* in the Phase 0-0.5 reach and adjacent to the floodplain enhancement grading to fully re-engage the floodplain. The channel and floodplain finished grade intended to be geomorphically and hydraulically dynamic and change over time. The channel fill elevation is designed to engage the floodplain swales and existing side channel during typical winter flows, but is slightly lower than the adjacent floodplain to avoid overly distributing low summer flows and maintain depths in the main channel. In addition, raising the channel bed elevation and reducing incision will promote hyporheic exchange. Increasing flow through the hyporheic zone can recharge the groundwater table, and increase cold water upwelling into scour and pools, enhancing cold water refugia for fish.

Cut and fill quantities are listed below in Table 10 and grading areas are included in Appendix D – Engineering Planset.

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:

- 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 31 margin structures.
- Large Apex Jam – Placed mid-channel these structures promote bar formation and island growth to accumulate salmon spawning gravels and increase local floodplain inundation. When placed at constructed side channel inlets they promote scour to maintain the inlet and help to split flows, maintaining connection of the new side channels. The current design includes 2 large apex structures.
- Small Apex Jam – Placed mid-channel these structures support smaller mid-channel bar formation and island growth to accumulate salmon spawning gravels and increase local floodplain inundation. When placed at constructed side channel inlets they promote scour to maintain the inlet and help to split flows, maintaining connection of the new side channels. The current design includes 2 small apex structures.
- Floodplain Roughness Logs – Provides roughness to reduce energy across the floodplain and distribute flows, force multiple flow paths to develop, retain fine sediment, and support riparian growth on floodplains. The current design includes 71 floodplain log structures.
- Channel Spanning Logs – Provide channel spanning obstructions to rack and capture debris, provide in-channel roughness to dissipate energy, create hydraulic drops during high-flows to promote scour pool formation. The current design includes 10 channel spanning log structures.

4.3 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). 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 engineers and contractors estimates of the swell and loose factors.

Table 10. Materials Summary Table.

Grading Location	Cut Volume (cubic yards)	Fill Volume (cubic yards)
Floodplain cut	13,970	---
Side channel fill	---	635
Main channel fill	---	620
Upland fill	---	12,715
Total	**13,970**	**13,970**

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

Table 11. Log Summary Table.

Log Type	Length/ DBH	Quantity	Unit
LARGE W/ ROOTWAD	MIN 40' / 18-24"	117	EA
MEDIUM W/ ROOTWAD	MIN 40' / 12-18"	109	EA
SMALL W/ ROOTWAD	MIN 30' / 8-12"	30	EA
PIER LOG	MIN 20' / MIN 10"	139	EA
RACKING	MIN 15' / MIN 6"	168	EA
WILLOW	MIN 5' / 1-2"	1500	EA
SLASH		416	CY
BOULDER	MIN DIAM 3'	0	EA

The estimate of probable cost shown in Table 12 and Appendix I 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 2023 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 10% of all other fixed costs;
- Erosion & Water Pollution Control – Assumed to be 3% of all other fixed costs;
- Logs for the Wood Habitat Structures (WHS) are precured, hauled and installed as part of the construction contract.
- High ground, and swale grading/excavation – excavation costs assume common excavator, bulldozer, scraper and high capacity dump truck equipment;
- Onsite Disposal – the cost estimate assumes that natural material excavated from the levee, high ground and swales will be used to fill areas in channels;
- Contingencies – 20% construction contingency is included in the total bid estimate to account for future design changes and unforeseen conditions.

Table 12 Estimate of Probable Construction Cost

	Costs			
Item	**Qty**	**Unit**	**Unit Cost**	**Total**
MOBILIZATION	1	LS	$ 69,000	$ 69,000
TEMPORARY STREAM DIVERSION & PLAN	1	LS	$ 15,000	$ 15,000
EROSION & WATER POLLUTION CONTROL	1	LS	$ 20,000	$ 20,000
CLEARING AND GRUBBING	16	AC	$ 4,000	$ 64,000
EARTHWORK EXCAVATION	14,000	CY	$ 11	$ 154,000
NATIVE WETLAND SEEDING & PLANTING	7.0	AC	$ 6,000	$ 42,000
NATIVE UPLAND SEEDING & PLANTING	9.0	AC	$ 4,000	$ 36,000
WHS TYPE 1 - LARGE APEX JAM	2	EA	$ 16,300	$ 32,600
WHS TYPE 2 - SMALL APEX JAM	2	EA	$ 5,800	$ 11,600
WHS TYPE 3 - MARGIN JAM	31	EA	$ 6,200	$ 192,200
WHS TYPE 4 - FLOODPLAIN LOG, SINGLE	24	EA	$ 1,400	$ 33,600
WHS TYPE 5 - FLOODPLAIN LOG, DOUBLE	19	EA	$ 2,800	$ 53,200
WHS TYPE 6 - UNPINNED FLOODPLAIN LOG	28	EA	$ 700	$ 19,600
WHS TYPE 7 - CHANNEL SPANNING	10	EA	$ 3,900	$ 39,000
WILLOW TRENCH BDA	3	EA	$ 1,700	$ 5,100
SECTION TOTAL				**$ 787,000**
Design Contingency			20%	$ 157,400
TOTAL CONSTRUCTION COST				**$ 945,000**

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

The previous design plan set includes HIP General Aquatic Conservation measures to follow during and post construction, which includes temporary erosion and sediment control (TESC) measures as well as best management practices (BMP's). 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. Temporary 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 also provides an area for washout prior to construction equipment leaving the site.

1. SITE ACCESS STAGING AND SEQUENCING PLAN.

Access and staging locations are shown in the design drawings provided in Appendix D. Vehicular access points are strategically located throughout the project area. Access routes follow existing roads and avoid sensitive areas such as wetlands to the highest extents possible. Key entrance points are shown based on land type and access from existing roadways. All equipment staging areas are currently to be 150 feet from delineated wetland and Ordinary High Water (OHW) limits, meeting HIP pollution prevention requirements for re-fueling.

Excavated material from the floodplain and swales will be placed in the upland fill area and stockpiled adjacent to the mainstem channel fill areas on a gravel bar to minimize the impact and number of times equipment will access the channel or need temporary crossings. All in channel grading will take place after fish salvage and stream diversion.

Detailed construction sequencing that minimizes potential impacts to wildlife, water quality and habitat is included in the design drawings provided in Appendix D.

2. WORK AREA ISOLATION AND DEWATERING PLAN.

Removal of water details for temporary bypass of the river or individual wood structure installations are shown in the design drawings in Appendix D. Details include a step-by-step process and configurations for dewatering and rewatering the river before, during and after bypass. Additional details include bulk bag coffer dam installations and area isolation for large wood structure installations. More information regarding the detailed location for coffer dam locations and dewatering activities are incorporated into the sequencing plan on Sheet C1.2 in Appendix D.

3. EROSION AND POLLUTION CONTROL PLAN.

The design drawings in Appendix D 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 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. Temporary 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 also provides an area for washout prior to construction equipment leaving the site.

4. SITE RECLAMATION AND RESTORATION PLAN.

Native seeding of all disturbed areas including access routes and staging areas will be completed immediately following construction. The bulk of the project area revegetation including tree and shrub planting will occur after the following phase(s) of the project. Site seeding plan is included on sheet L1.1 of the design drawings in Appendix D.

5. LIST PROPOSED EQUIPMENT AND FUELS MANAGEMENT PLAN.

Sheet G2.1 & G2.2 of the design drawings in Appendix D 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 scheduled to begin July 2023 with the project elements below ordinary high water (OHW) carried out during the in-water work window July 15 – August 30. Project elements in areas above OHW may be completed during August through September. Also see sequencing details on Sheets C1.2 and ESC1.1 in Appendix D – Engineering Planset.

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

Site and project specific monitoring details are included in Appendix D, Engineering Planset, Sheet ESC 1.1 and ESC 1.2.

5.0 MONITORING AND ADAPTIVE MANAGEMENT PLAN

5.1 INTRODUCTION

The Tucannon Programmatic is currently working to formalize a basin wide monitoring strategy to support adaptive management decisions for habitat restoration projects within the basin. The approach is being developed by restoration and monitoring practitioners working in the basin and is focusing on using habitat metrics that are currently being measured as part of ongoing restoration and monitoring effort in the basin. Project Area 27/28.1 monitoring and adaptive management plan is being developed to fit within the guidelines being developed for the entire basin.

The project area is being addressed as part of this restoration effort.

5.4 PROJECT REVIEW TEAM TRIGGERS

Project Type	Objective	Trigger/Event/Risk	Management Response
LWD Addition	Maintain LWD density of >2key pieces/bankfull width	Visible and effective LWD Key pieces frequency is below minimum objective of deteriorates prior to the development of adequate recruitment potential is met.	Wood loading or additional structures to raise LWD density to target level.
LWD Addition	Increase quality pool (>1 m deep) density to 1 /7 bankfull width	Quality pools > 1 m deep do not develop	Add more wood/ structures, make structures larger, increase hydraulic purchase, and consider gravel supply and augmentation.
LWD Addition	Do no harm	Structure or treatment is causing harm or has potential to cause harm to infrastructure or environment	Remove or alter structure or parts of the treatment
Floodplain Reconnection	Inundate floodplain during designed bankfull flows	Structures not promoting overbank flow as expected	Build up structures taller/wider
Floodplain Reconnection	Inundate floodplain during bankfull flows	Bed elevation too low, channel too incised	Add structures upstream to encourage sediment recruitment/channel widening, consider gravel augmentation
Floodplain Reconnection	Do no harm	Treatment resulted in flooding or threatening infrastructure	Add setback levee, add structure to divert flood flows, remove problematic structure
Riparian	Hard stem and herbaceous plant cover and densities		
Riparian	Invasive species		

5.5 MONITORING FREQUENCY, TIMING, AND DURATION

BASELINE SURVEY

LiDAR was collected in November 2020 by Quantum Spatial, Inc. Additional survey was conducted in February 2021. Since this project is a multiple year phased survey, summer surveys will be conducted prior to the initiation of each work season.

AS-BUILT SURVEY

As-built survey for Phase 3 will be conducted post construction.

MONITORING SITE LAYOUT

The monitoring site layout for the rapid habitat surveys include the entire project implementation area, including the floodplain flow paths. LiDAR coverage for the project area covers the entire valley bottom.

POST-BANKFULL EVENT SURVEY

The current survey frequency at project site has to either conduct a survey 2 freshets following the as built survey or following the first bank full event and every 5yr flow following the as-built survey through the duration of the Programmatic.

FUTURE SURVEY (RELATED TO FLOW EVENT)

Currently project sponsors visit project sites frequently to visually assess function and safety both during and following freshets and flood flows. The sponsor plans to conduct surveys rapid habitat surveys following significant flow events to make observations in habitat function using the results to track changes in the limiting factors to ensure project restoration goals and objectives are being met.

5.6 MONITORING TECHNIQUE PROTOCOLS

In the Tucannon basin we are using a rapid habitat survey (RHS) protocol combined with strategic LiDAR data to conduct implementation/effectiveness monitoring and longer term change detection monitoring. The rapid habitat monitoring protocol is derived from the CHAMP protocol paired way down to capture changes in LWD structure frequency for jams formed by LWD pieces >6 m long and 0.3 m in dia, develop pool frequency with and estimate for pool area and maximum depth. The protocol also delineated perennial and ephemeral side channels using the CHAMP protocol for small side channels, collecting bankfull width, flow and length.

The use of periodic LiDAR survey for the entire basin are being used to monitoring change detection at the basin scale, though the development of a wide of model layers to develop estimate from automated data set for floodplain connectivity, channel complexity and riparian habitat. Floodplain connectivity is being modeled as existing and disconnected at the 2 and 5 year flood intervals. Channel complexity is being derived from an automated data layer for the winter low flow (130cfs) and the winter mean flow (300 cfs). Riparian extent and canopy height is being derived from LiDAR data points in 2010 and 2020 and will be extracted from future surveys. The approach to assessing floodplain connectivity is being formalized in the Tucannon Conceptual Restoration Plan and is taking into account connectivity gained from removal of coifing features and recusing incision and entrenchment.

PHOTO DOCUMENTATION AND VISUAL INSPECTION

Photo documentation is being done through both ground-based georeferenced photo points of habitat units and as-built LWD structures and aerial photographic imagery and video captured by fixed wing aircraft and low elevation drone video.

LONGITUDINAL PROFILE

Longitudinal profile and changes in the profile are extracted from analysis and modeling products produced from LiDAR survey data.

HABITAT SURVEY

Rapid habitat surveys include:

- A channel delineation for perennial and ephemeral flow paths at base flow (<120 cfs) over the entire project reach
- A count of LWD structures, and a count of LWD key pieces (>6 m long & 0.3 m dia) within bankfull width
- Pool frequency, an estimate of pool surface area and maximum depth.
- Development of georeferenced photo points of pre-project habitat features, post project condition and post high flow habitat changes.

LiDAR Survey data products include:

- Channel complexity analysis in the form of 1-year, mean winter and low winter flow islands
- Floodplain connectivity in the form of connected and disconnected 2 & 5-year floodplain
- Channel migration analysis channel trace comparisons
- Geomorphic change analysis topographic difference
- Relative elevation change
- Bare Earth and first return modeled layers to illustrate ground layer and vegetation growth and area.

CHANNEL AND FLOODPLAIN CROSS-SECTIONS

We will use LiDAR analysis to make observations in channel and floodplain changes over time beginning with pre-project survey collected in 2017, compared to post Phase 0 to 0.5 project LiDAR collected in 2020, and future LiDAR to be collected post Phase 3. Currently the project reach is being used as part of the ad hoc AEM floodplain monitoring project being conducted by Cramer Fish Sciences.

5.7 DATA STORAGE AND ANALYSIS

Data analysis will be conducted as part of the annual Programmatic reporting for project conducted in the Tucannon basin, in the 2023 annual report with future implementation phases in future reports on an annual basis.

Data is stored in its original form at the Snake River Salmon Recovery Board Office. It is also stored in the CTUIR online data base through a Tucannon River portal and at Tucannon.org.

5.8 MONITORING QUALITY ASSURANCE PLAN

Data collection is automated using a GIS supported filed collection guide template to minimized missed data fields or miss assigned data fields. In the office prior to exporting data to storage field personnel export data sets to spreadsheet to assess data point which are out of range or erroneous. One final check of data occurs by plotting spatial date to observe mapping irregularities.

6.0 References

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APPENDICES

A PHASE 0 TO 0.5 AND 0.5 T0 1 BDRS

B WETLANDS DETERMINATION (PHASE 3)

C ALTERNATIVE FIGURES

D 80% DESIGN ENGINEERING PLANSET

E MODELING RESULTS FIGURES

F BOR RISK ASSESSMENT

G WOOD STABILITY CALCULATIONS

H DESIGN SPECIFICATIONS

I COST ESTIMATE